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Wireless Sensor Network Strain Gage/Bridge Completion Node

NI WSN-3214

- Ideal for wireless structural health monitoring applications
- Create a reliable network, with support for hundreds of nodes, to monitor your assets or environment
- Programmable with the LabVIEW Wireless Sensor Network (WSN) Module: Customize node behavior to extend battery life, save data locally, and perform local analysis and digital I/O control
- NI-WSN software provides easy network configuration, drag-and-drop LabVIEW programming, and support for logging, alarming, and web-based data visualization
- Low-power operation with up to 3-year battery life
- 2.4 GHz, IEEE 802.15.4 radio that provides up to 300 m outdoor range
- 4 analog input channels configurable for quarter-/half-/full-bridge completion, strain gage, or ratiometric measurements
- Hardware-timed waveform acquisition, with sample rates up to 1 kS/s per channel
- 2 bidirectional digital channels configurable for input, sinking output, or sourcing output
- Industrial ratings: -40 to 70 °C operating temperature and 50 g shock, 5 g vibration

Overview

The NI wireless sensor network (WSN) platform delivers low-power measurement nodes that offer industrial certifications, reliable networking, and optional weatherproof outdoor enclosures for long-term, remote monitoring applications. The measurement nodes have direct sensor connectivity and a 2.4 GHz radio to wirelessly transmit data to a WSN gateway. Each measurement node offers four analog input channels and two to four digital I/O channels that you can configure for input, sinking output, or sourcing output. With graphical LabVIEW software, you can easily configure your network, collect measurement data, trigger alarms through SMS or email, and even view monitoring data within a web browser. With the NI LabVIEW Wireless Sensor Network (WSN) Module, you can customize the behavior of programmable NI WSN measurement nodes. Use this module to optimize node behavior for your application: customize sample and transmission rates, perform onboard analysis or data reduction, respond to digital value changes, perform local control of digital I/O lines, and even store data to flash memory.

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Application and Technology

Hardware-Timed Waveform Acquisition

The NI WSN-3214 measurement node adds support for hardware-timed waveform acquisition to the NI wireless sensor network (WSN) platform. It features four analog input channels that you can configure on a per channel basis for quarter-/half-/full-bridge completion, strain gage, and ratiometric measurements. The node provides 2.5 V excitation and supports 350 Ω and 1 kΩ strain gages. With the flexible analog front end, you can define sample rate, waveform size, and waveform interval (see Figure 1) and use the high-speed and high-resolution analog input modes to configure the node to meet your unique application needs. The configuration of these parameters dictates the performance and power consumption of your node. Refer to the Power section to see how varying sample rate and waveform size affect the battery life of your device.

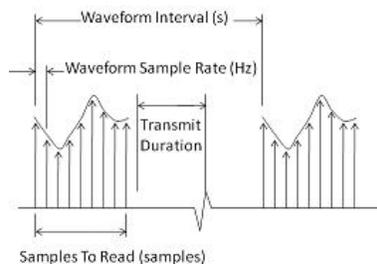


Figure 1. The user dictates waveform interval, waveform sample rate, and number of samples to configure the acquisition on the WSN-3214.

Programmable WSN Measurement Nodes and the LabVIEW WSN Module

With the LabVIEW WSN Module, you can use graphical programming to customize node firmware and optimize node operation for your applications.

You can use LabVIEW WSN applications to extend battery life, perform onboard analysis or data reduction, and even programmatically control digital I/O lines in response to analog data or network status changes. The programmable nodes also deliver access to the node's onboard flash memory, where you can store measurement data or other node parameters.

An example LabVIEW WSN application might be used to acquire a 1024-point strain waveform at 1 kHz and then perform onboard analysis of the waveform, such as an FFT or RMS measurement. Then it could transmit the FFT or RMS value instead of the entire waveform, thereby reducing the time and power consumption required to transmit the entire waveform. This same application could be used to turn on a relay or actuator if analog data rose above a specified threshold, such as turning on an LED if the acquired strain measurement was above a critical level. And since these applications are written in the LabVIEW graphical development environment, customizing node firmware is easy and doesn't require any low-level assembly or machine code knowledge. With the LabVIEW WSN Module, the custom applications are wirelessly downloaded to the node's onboard processor, where they can dictate sample and transmission rates, onboard data analysis, and the node's response to network status changes or digital value changes.

Power

You can power the WSN-3214 measurement node with four 1.5 V AA alkaline or lithium battery cells. The node also features an external power port so you can provide line power, or you can use other forms of power such as solar or vibration energy harvesting. The WSN-3214 supports battery backup, meaning you can connect both external and battery power; the node defaults to external

power and automatically switches to battery power if the external power drops below a voltage threshold. The external power input should be used to power NI WSN nodes operating in router mode, which is a feature that you can enable in software to set up a self-healing mesh network of nodes. Router nodes increase density, distance, and redundancy in your wireless network.

Each node offers bidirectional digital I/O channels for input, sinking output, or sourcing output. You must use an external power supply to provide sourcing output through the digital I/O channels, with a maximum total current output (aggregate on all channels) of 1 A.

To understand the battery-operated lifetime of the WSN-3214, refer to the following graphs. With the flexible analog front end of the node, you can specify sample rate, waveform size, and waveform interval. Using LabVIEW WSN, you can customize the node to also modify transmit interval (Without customization, the transmit interval matches the sample interval and all acquired samples are transmitted over the radio).

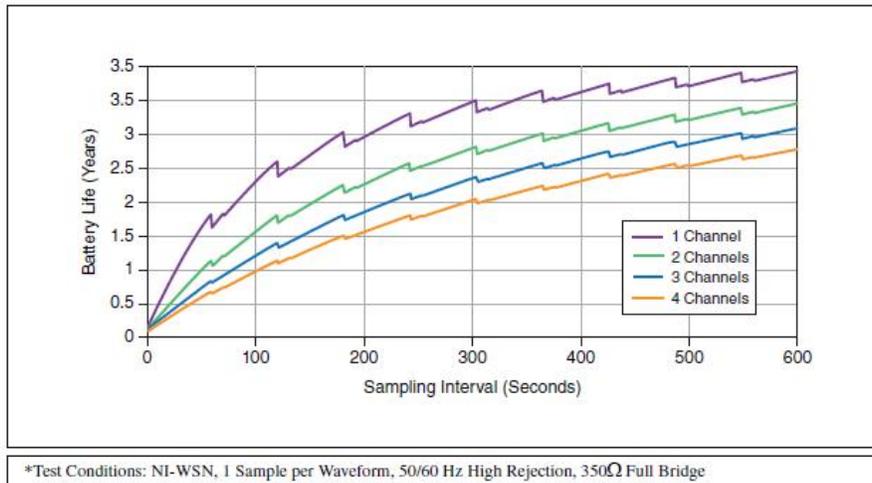


Figure 2. Expected Battery Lifetime Versus Waveform Sample/Transmit Interval

Note: Sample and transmit intervals are equal when using NI-WSN. You can use programmable nodes and LabVIEW WSN to customize transmit intervals and increase battery life.

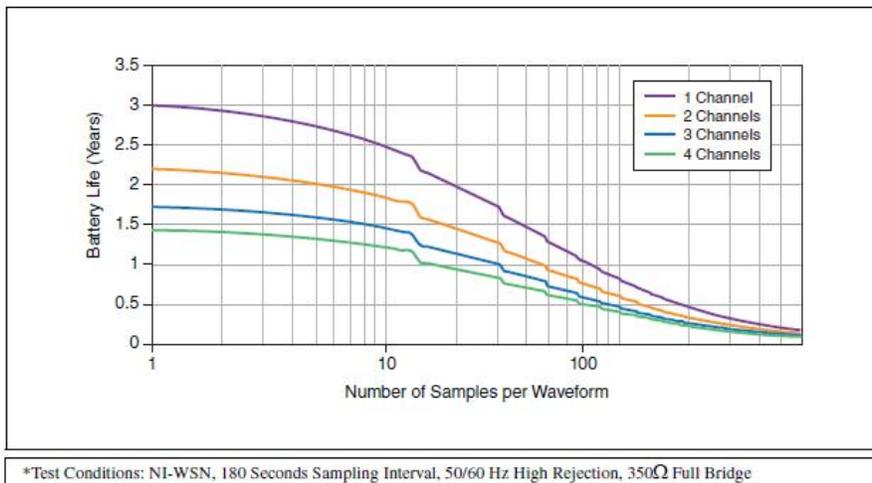


Figure 3. Expected Battery Lifetime Versus Number of Samples per Waveform

To learn more about using LabVIEW WSN to increase battery life, visit the *NI WSN-3214 User Guide and Specifications* manual, which is linked from the model page on ni.com.

Wireless and Mesh Networking

The measurement nodes and gateways communicate wirelessly using 2.4 GHz radios and the reliable NI-WSN protocol based on IEEE 802.15.4. The network accommodates up to 36 nodes per gateway, with access to 14 nonoverlapping wireless channels, so you can reliably configure 14 36-node networks (2,016 analog channels) in the same vicinity without sharing any wireless bandwidth. Each radio delivers an outdoor range of up to 300 m with line of sight and up to 100 m indoors, performing reliably even in high EMI environments.

Gateways, routers, and end nodes work together to form a mesh network. Measurement nodes can operate as routers or end nodes, providing the flexibility to extend the range or density of your sensor network. When nodes are configured as routers, they can repeat messages from end nodes and extend network range while acquiring measurement data.

When a node powers up, it scans for available networks, locates either a gateway or router node, and attempts to join. When the node joins the network, it downloads the latest configuration from the gateway and begins its normal operation of acquiring measurement data, controlling digital I/O, and transmitting data back to the gateway for processing, alarming, and visualization.

Software Overview

With NI-WSN software, you can easily configure your sensor network and quickly extract measurement data from your wireless sensor network with the LabVIEW graphical development environment.

NI WSN measurement nodes configured with a gateway are automatically added to your LabVIEW project, giving you instant access to their I/O and properties. Simply drag-and-drop I/O variables from a LabVIEW project to a LabVIEW block diagram for data extraction, analysis, and presentation. Using the drag-and-drop LabVIEW variables, you can monitor the analog and digital channels as well as other node attributes such as link quality, battery voltage, and whether a node is configured as a router or end node. These properties help you intelligently maintain your network and choose the best locations for your measurement nodes. The LabVIEW project interface also offers access to node property configuration utilities. This is where you can modify waveform acquisition rates and intervals, define the analog and digital channel parameters, and provide aliases.

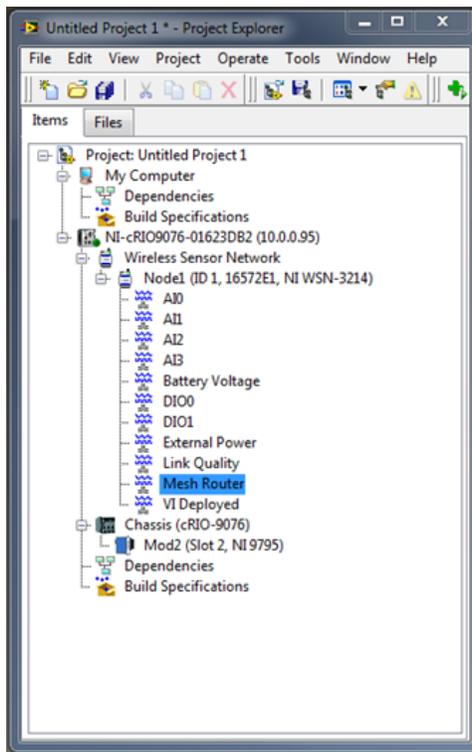


Figure 4. LabVIEW Project With WSN-3214

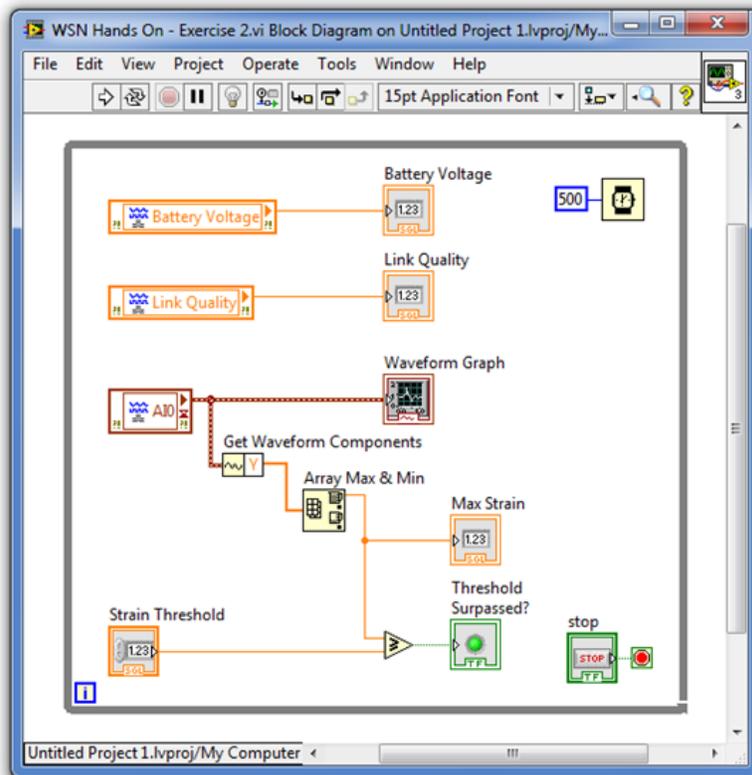


Figure 5. Extracting Waveform Measurement Data Using LabVIEW

Node Programming (LabVIEW WSN)

You can customize the behavior of programmable NI WSN measurement nodes with the LabVIEW WSN Module. Use this module to perform custom analysis, extend battery life, and embed local decision making on NI WSN measurement nodes.

With the LabVIEW WSN Module, you can significantly increase the battery life of your NI WSN measurement nodes while increasing performance and flexibility. By default, a node transmits every acquired value back to the gateway at the specified sample interval; however, in many applications, it is sufficient to simply monitor a given input for a threshold crossing or average values over a period of time. In these applications, powering the radio to transmit every acquired sample uses excessive power and reduces battery life. With LabVIEW WSN, you can add intelligence to the node to transmit data only when required. Additionally, you can monitor battery voltage and network status as well as modify the sample interval of the node to optimize behavior for specific operating conditions.

Using a subset of LabVIEW analysis functions and floating-point math operations, you can preprocess data acquired by NI WSN measurement nodes. A variety of analog and digital sensors can interface directly with these nodes, and you can use LabVIEW WSN to scale and convert raw sensor data into meaningful engineering units before transmitting.

With LabVIEW WSN, you can also embed intelligence on NI WSN measurement nodes, so decisions can be made autonomously without transmitting the stimulus and response to and from a host computer or embedded controller. You can use the digital output lines on an NI WSN measurement node to actuate relays and perform simple on/off control. For example, a programmed node can turn on a fan when a temperature threshold is exceeded, which reduces response time and increases reliability by removing the need for host interaction.

NI WSN Applications and Architectures

NI wireless sensor networks are ideally suited for long-term remote monitoring applications such as environmental monitoring, water quality monitoring, structural health monitoring, energy quality and consumption monitoring, transportation, and machine condition monitoring. NI WSN measurement nodes can withstand outdoor and industrial environments and reliably monitor assets or surroundings to provide enhanced visibility into the overall health of your systems or processes.

The NI WSN platform can function as a simple, stand-alone wireless monitoring system, or be combined with other hardware components to achieve a complete wired and wireless measurement and control system. Through LabVIEW, you can combine NI WSN devices with other NI platforms to customize and enhance your measurement capabilities. You can complement your NI WSN with embedded CompactRIO systems, vision systems, or even human machine interfaces (HMIs) to create a fully integrated solution that meets the unique needs of your application.

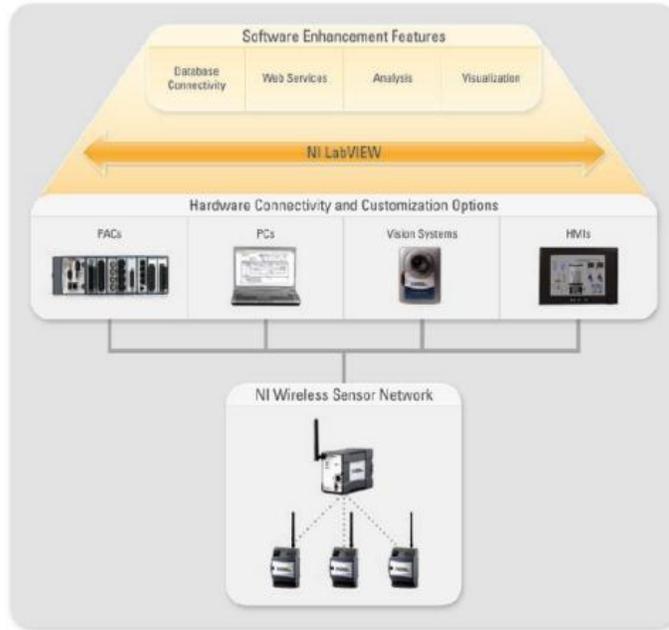


Figure 6. Customize and enhance your NI WSN system.

Accessories

NI WSN accessories include options for gateway and measurement node mounting as well as weatherproof enclosures for outdoor use of the measurement nodes and gateways. Mounting accessories include options to panel mount and DIN-rail mount WSN measurement nodes and gateways. The NI WSN-3281 magnetic panel mount kit provides easy setup and takedown on virtually any metal surface. For high shock and vibration applications, NI recommends a panel mounting configuration rather than DIN-rail.

The NI WSN-3291 is an outdoor, weatherproof enclosure for NI WSN measurement nodes. The enclosure features two I/O glands for routing power or sensor cables and is shipped with four I/O gland inserts and two I/O gland plugs so you can customize the glands for your application. The WSN-3291 offers an IP65 (Ingress Protection) rating to protect NI WSN measurement nodes for long-term, outdoor deployment.

Please view the WSN Accessories data sheet for a complete list of WSN mounting accessories, outdoor enclosures, backshell kits, and power supplies.

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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.

Classroom training in cities worldwide - the most comprehensive hands-on training taught by engineers.

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.

Visit ni.com/training for more information.

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

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