Wireless Sensor Network Programmable Analog Input Measurement Nodes

NI WSN-3202, NI WSN-3212 *NEW!*

- Programmable with the LabVIEW Wireless Sensor Network (WSN) Module Pioneer
  - Extend battery life
  - Increase sample rates
  - Embed local decision making
- NI-WSN software provides easy network configuration and drag-and-drop LabVIEW programming
- Up to 3-year battery life
- 2.4 GHz, IEEE 802.15.4 radio
- Outdoor range up to 300 m with line of sight
- Four analog input channels
- Four bidirectional digital channels (input, sinking output, or sourcing output)
- Industrial ratings:
  - -40 to 70 °C operating temperature
  - 50 g shock, 5 g vibration

Model	Signal Type	Analog Input Channels	Resolution (bits)	Minimum Sample Interval (seconds)[1]	Input Range(s)	DIO Channels	DIO Voltage Range (V)	Max DIO Sourcing (aggregate)	Additional Features
NI WSN-3202	Voltage	4	16	1	±10, ±5, ±2, ±0.5 V	4 (sinking or sourcing)	5 to 30	1 A	12 V, 20 mA sensor power output
NI WSN-3212	Thermocouple	4	24	2	±73 mV	4 (sinking or sourcing)	5 to 30	500 mA	Support for J, K, R, S, T, N, B, E thermocouple types

[1]Node sample intervals can be improved by customizing how the node samples and transmits data. Refer to the section on Node Programming for more information.

Table 1. WSN Node Specifications

Overview

National Instruments wireless sensor networks (WSNs) deliver low-power measurement nodes that offer industrial certifications, reliable networking, and optional weatherproof outdoor enclosures for long-term, remote deployments. The measurement nodes have direct sensor connectivity and a 2.4 GHz radio to wirelessly transmit data to the WSN Ethernet gateway. Each measurement node offers four analog input channels and four digital I/O channels that you can configure for input, sinking output, or sourcing output. You can customize the behavior of programmable NI WSN measurement nodes with the NI LabVIEW Wireless Sensor Network (WSN) Module Pioneer. Use this module to perform custom analysis, embed decision making on NI WSN measurement nodes, and extend battery life by optimizing node behavior.

Power

You can power the NI WSN measurement nodes with four 1.5 V AA alkaline battery cells, with operation up to three years on battery power at one sample per minute, or with a 9 to 30 V supply of external power.

You can configure the four 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 500 mA on the NI WSN-3212 and 1 A on the NI WSN-3202. The WSN-3202 also offers a 12 V, 20 mA sensor power output line that drives external sensors.

Wireless Networking

The measurement nodes and the NI WSN-9791 Ethernet gateway 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 and provides an outdoor range of up to 300 m with line of sight. The gateway maintains a list of nodes (by serial number) that have been authorized for network access. When a node powers up, it scans for available networks, locates either a gateway or mesh router node, and attempts to join. If the gateway has the node in its list, the node joins the network, downloads the latest configuration from the gateway, and begins its normal operation of acquiring measurement data and controlling digital I/O.

NATIONAL INSTRUMENTS™

Mesh Networking

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 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. Router nodes must remain on to send and receive data across the network, and should be powered with an external source such as a 9 to 30 V supply, solar panel, or larger battery.

Software Overview

With NI-WSN software, you can easily configure your sensor network in the NI Measurement & Automation Explorer (MAX) configuration utility (see Figure 1) and quickly extract measurement data from your wireless sensor network with the LabVIEW graphical development environment.

Network Configuration

MAX provides an intuitive user interface to add and remove measurement nodes and configure wireless settings. Upon connection, the WSN-9791 Ethernet gateway is autodetected under Remote Systems in MAX, and you can assign WSN nodes to the gateway by entering the node serial number. Upon power-up or reset, the nodes automatically connect to the assigned gateway. If a node is unable to connect, it executes a retry sequence with increasingly higher wait periods beginning with one minute between connect attempts and ending with 55 minutes between connect attempts. This preserves battery power if a gateway is offline.

MAX also provides an overview of the nodes connected to your network including their last communication time, battery status, and link quality. In addition, MAX offers an interface to set the wireless communication channel, configure the gateway IP address, and wirelessly update firmware on the measurement nodes.

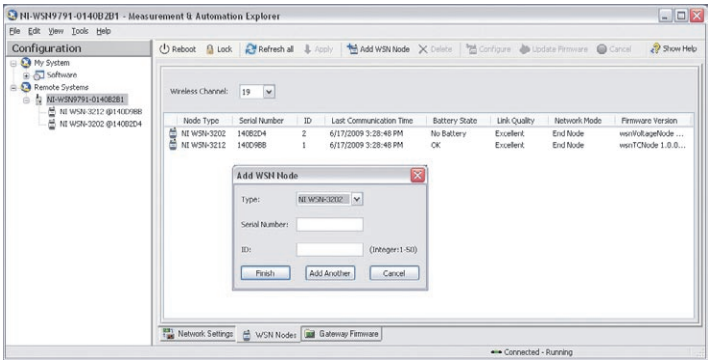

Figure 1. Network Configuration in MAX

Programming

You can integrate your NI WSN measurement data directly into the LabVIEW graphical development environment. After adding the WSN Ethernet gateway to a LabVIEW project, the nodes configured with the gateway in MAX are automatically added underneath the gateway in the project, giving you instant access to their I/O and properties (see Figure 2).

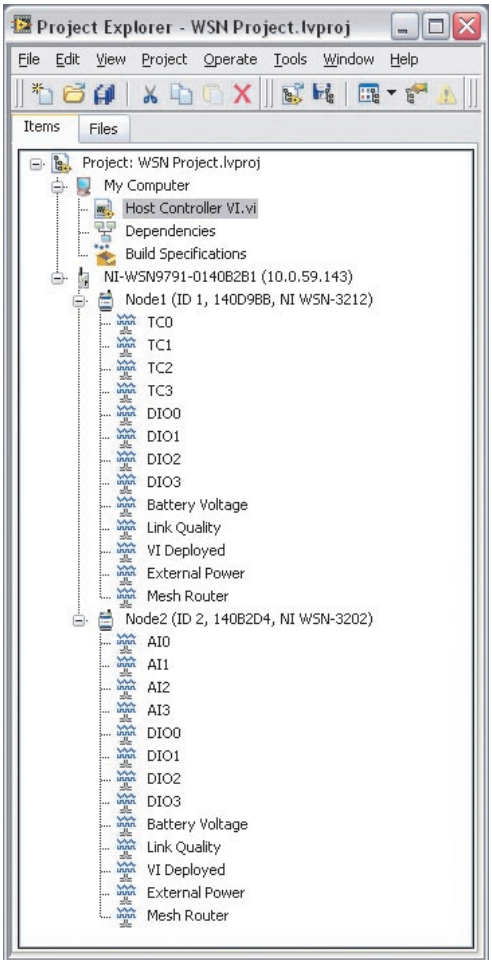

Figure 2. NI WSN System in the LabVIEW Project

Simply drag and drop I/O variables from a LabVIEW project to a LabVIEW block diagram for data extraction, analysis, and presentation (see Figure 3).

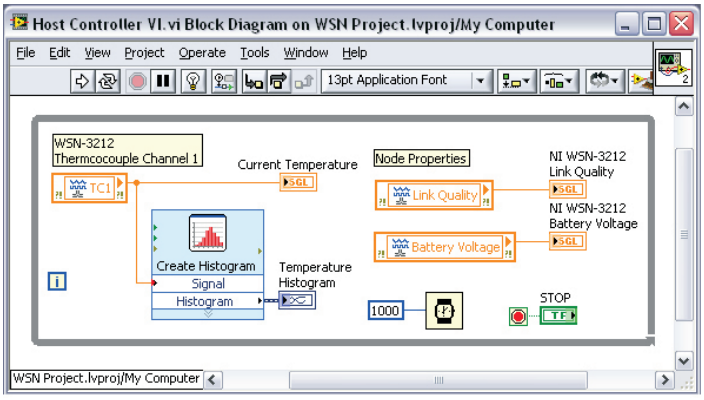

Figure 3. Extracting NI WSN Measurement Data Using LabVIEW

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. The LabVIEW Project interface also offers access to node property configuration utilities. You can modify node sample intervals, define the analog and digital channel parameters, and provide aliases.

Node Programming

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

With LabVIEW WSN Pioneer, 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 Pioneer, 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.

This also helps you achieve higher sample rates by customizing how the node acquires and transmits data. Exact sample rates depend on how many channels you are sampling, the analysis performed on each sample, and how many samples are transmitted back to the host. Without transmitting samples, the programmable WSN-3202 node can achieve a 35 Hz sample rate on one channel, while the programmable WSN-3212 can achieve a 4 Hz sample rate on one channel. Refer to the *LabVIEW WSN Benchmarking* white paper on NI Developer Zone for more information on increasing sample rates.

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 Pioneer to scale and convert raw sensor data into meaningful engineering units before transmitting.

With LabVIEW WSN Pioneer, you can also embed decision making 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

With NI WSNs and access to the full breadth of NI platforms through LabVIEW, you have the flexibility to create simple, stand-alone wireless monitoring networks or completely integrated wired and wireless measurement solutions. In a simple architecture, as seen in Figure 4, the WSN measurement nodes acquire data and communicate wirelessly to the central gateway, which provides a wired Ethernet connection to a Windows or LabVIEW Real-Time host controller where you can log, analyze, process, and present your data.

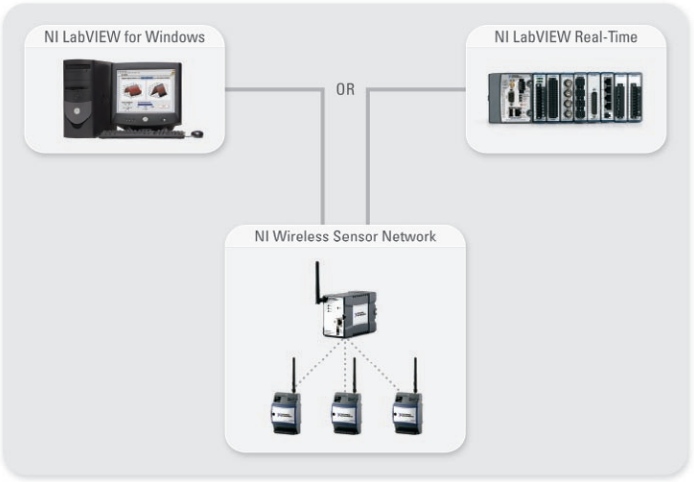

Figure 4. NI WSN systems provide flexible connectivity to Windows or LabVIEW Real-Time host controllers.

Furthermore, you can combine NI WSNs with other NI platforms to customize and enhance your measurement capabilities. You can complement your NI WSN with programmable automation controllers (PACs), vision systems, or even human machine interfaces (HMIs) to create a fully integrated solution that meets your unique application needs (see Figure 5).

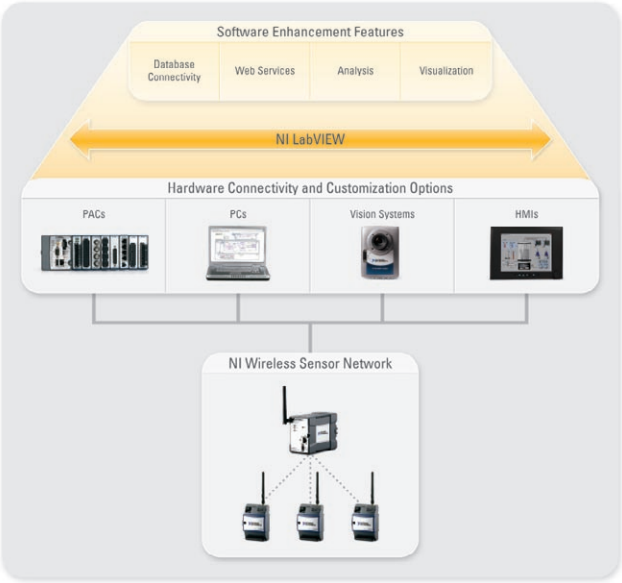

Figure 5. Customize and enhance your NI WSN system.

LabVIEW integration with NI WSNs delivers a common development environment for your applications as well as rapid programming, easy network configuration, and remote data access with LabVIEW Web services. You can also use other NI software such as DIAdem to conduct advanced data processing and analysis or the LabVIEW Datalogging and Supervisory Control Module for integrated event detection and alarming.

Mechanical Information

The measurement node housing measures 5 by 3.3 by 1.5 in. (H by W by D), with the external antenna extending 4.25 in., resulting in a total height of 9.25 in. You can unscrew the faceplate of the measurement node to reveal the battery compartment, which holds four AA alkaline batteries and a reset button for manual reboots. Consult the user guide for detailed mechanical information.

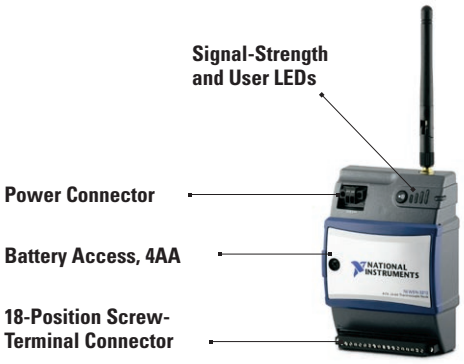

Figure 6. Measurement Node External Features

The nodes also offer screw terminals for direct sensor connectivity and signal-strength LEDs for network monitoring.

Accessories

NI WSN accessories feature options for gateway and measurement node mounting as well as a weatherproof enclosure for outdoor use of the measurement nodes. Available 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.

Accessory	Description
NI WSN-3280	NI WSN node panel mount bracket with spring-loaded screw-locking mechanism and integrated strain relief
NI WSN-3281	NI WSN node magnetic panel mount bracket with spring-loaded screw-locking mechanism and integrated strain relief
NI WSN-3282	NI WSN DIN-rail mount kit for nodes or gateway (includes four screws)
NI WSN-3283	NI WSN panel mount plate for nodes or gateway (recommended for gateway) with additional four keyholes for mounting to wall in multiple orientations (includes four screws)

Table 2. Mounting Kits

The NI WSN-3291 is an outdoor, weatherproof enclosure for NI WSN measurement nodes (see Figure 7). 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 IP64 (Ingress Protection) rating to protect NI WSN measurement nodes for long-term, outdoor deployment.

Figure 7. Outdoor Enclosure with NI WSN Measurement Node (not included)

Accessory	Description
NI WSN-3291	IP64 outdoor enclosure for WSN measurement nodes
NI WSN-3292	Set of replacement I/O glands: two glands, four inserts, two plugs
NI WSN-3293	Additional I/O gland inserts (set of 5)

Table 3. Outdoor Enclosure and Accessories

You can choose from several power accessories that provide external power to the WSN Ethernet gateway or WSN measurement nodes.

Accessory	Description
Desktop Power Supply	This power supply provides 12 VDC power up to 1.25 A /15 W, and is rated for 0 to 70 °C. The supply terminates with a 2-position MINI-COMBICON connector that plugs directly into the WSN gateway or measurement nodes.
PS-5 Power Supply	This DIN-rail-mountable, 24 VDC power supply delivers up to 5 A of current and is rated for operation from -25 to 60 °C. Recommended for industrial installations.

Table 4. External Power Supplies

The connectivity accessories for NI WSN products include additional screw-terminal kits for the measurement nodes and a power connector backshell kit that contains a strain relief attachment for the two-position power connector on the Ethernet gateway and measurement nodes.

Accessory	Description
NI WSN-3284	Extra 18-position screw-terminal connectors for WSN-3202 – 2 top entry, 2 side entry – with labels
NI WSN-3285	Extra 18-position screw-terminal connectors for WSN-3212 – 2 top entry, 2 side entry – with labels
Power Connectors	Extra 2-position MINI-COMBICON power connectors – quantity 4
Power Connector Backshell	Strain relief attachment for the 2-position power connector on the measurement nodes and gateway; clips to the connector and includes a zip tie to hold the power cable in place

Table 5. Connectivity Accessories

Ordering Information

NI WSN Starter Kit (Americas) 781080-01
NI WSN Starter Kit (Europe/Asia) 781080-11

Ethernet Gateway

NI WSN-9791 (Americas) 780996-01
NI WSN-9791 (Europe/Asia) 780996-11

Programmable Measurement Nodes

NI WSN-3202 (Americas) 780997-02
NI WSN-3202 (Europe/Asia) 780997-12
NI WSN-3212 (Americas) 780998-02
NI WSN-3212 (Europe/Asia) 780998-12

Nonprogrammable Measurement Nodes

NI WSN-3202 (Americas) 780997-01
NI WSN-3202 (Europe/Asia) 780997-11
NI WSN-3212 (Americas) 780998-01
NI WSN-3212 (Europe/Asia) 780998-11

Power Accessories

Desktop supply 780703-01
U.S. power cord 763000-01
PS-5 industrial supply 778805-90

Mounting Accessories

NI WSN-3280 780999-01
NI WSN-3281 781073-01
NI WSN-3282 781074-01
NI WSN-3283 781075-01

Connectivity Accessories

NI WSN-3284 781076-01
NI WSN-3285 781077-01
Power connectors 780702-01
Power connector backshell kit 196375-01

Outdoor Enclosure and Accessories

NI WSN-3291 780994-01
NI WSN-3292 195712-01
NI WSN-3293 195738-01

BUY NOW

For complete product specifications, pricing, and accessory information, call 800 813 3693 (U.S.) or go to **ni.com/wsn**.

NI WSN-3202 Specifications

These specifications are typical for the range -40 to 70 °C unless otherwise noted. Some specifications (such as sample interval and power consumption) can be optimized by customizing node behavior with the LabVIEW Wireless Sensor Network (WSN) Module Pioneer. See the *LabVIEW WSN Benchmarking* document, found on NI Developer Zone, for more information.

» For complete WSN-3202 analog input node specifications, see the *NI WSN-3202 User Guide and Specifications* manual at **ni.com/manuals**.

Analog Input Characteristics

Number of channels ..... 4 single-ended channels
ADC resolution ..... 16 bits
DNL ..... No missing codes guaranteed
INL ..... Refer to the Absolute Accuracy Formulas
Minimum sample interval[1] ..... 1 second
Input coupling ..... DC
Nominal input ranges ..... ±10 V, ±5 V, ±2 V, ±0.5 V
Minimum over range 4%
Input impedance (at DC)
  Powered on ..... >1 GΩ
  Powered off/overload ..... 10 kΩ
Input bias current ..... 3 nA
Crosstalk (at 1 kHz)
  Adjacent channels ..... >100 dB
  Nonadjacent channels ..... >100 dB
Analog bandwidth ..... 7 kHz
Overvoltage protection ..... ±30 V (one channel only)

[1]Minimum sample interval for WSN-3202 can be improved by customizing node behavior with the LabVIEW Wireless Sensor Network (WSN) Module Pioneer. See the *LabVIEW WSN Benchmarking* document, found on NI Developer Zone, for more information.

AI Absolute Accuracy Tables and Formulas

The values in the following tables are based on calibrated scaling coefficients, which are stored in the onboard EEPROM.

Nominal Range (V)	Absolute Accuracy at Full Scale (mV)[1]	Random Noise $\Sigma(\mu V_{rms})$	Sensitivity[2] (µV)
±10	27.61	342	137
±5	16.61	172	68.5
±2	7.72	69	27.5
±0.5	1.95	18	7

[1]Absolute accuracy values at full scale on the analog input channels assume the device is operating within 45 °C of the last calibration and are valid for averaging 100 samples immediately following calibration. Refer to the Absolute Accuracy Formulas for more information.
[2]Sensitivity is the smallest voltage change that can be detected. It is a function of noise.

Table 6. Accuracy Summary

Nominal Range (V)	Residual Gain Error (ppm of Reading)	Gain Tempco (ppm/°C)	Residual Offset Error (ppm of Range)	Offset Tempco (ppm of Range/°C)	INL Error (ppm of Range)
±10	102	31	164	22	100
±5	137	41	240	22	100
±2	182	48	420	22	100
±0.5	160	50	300	24	100

Table 7. Accuracy Details

Absolute Accuracy Formulas

$AbsoluteAccuracy = Reading \cdot GainError + Range \cdot OffsetError + NoiseUncertainty$

$GainError = ResidualGainError + GainTempco \cdot TempChangeFromLastCal$

$OffsetError = ResidualOffsetError + OffsetTempco \cdot TempChangeFromLastCal + INL\_Error$

$NoiseUncertainty = (3 \cdot RandomNoise)/\sqrt{NumberofReadings}$ for a coverage factor of 3 σ and averaging 100 points

Absolute accuracy at full scale on the analog input channels is determined using the following assumptions:

$TempChangeFromLastCal = 45\ °C$

$NumberOfReadings = 100$

$CoverageFactor = 3\ \sigma$

For example, on the 10 V range, the absolute accuracy at full scale is as follows:

$GainError = 10\ V \cdot (102\ ppm + 31\ ppm \cdot 45) = 14.97\ mV$

$OffsetError = 10\ V \cdot (164\ ppm + 22\ ppm \cdot 45 + 100\ ppm) = 12.54\ mV$

$NoiseUncertainty = 3 \cdot 342\ \mu V/100^{0.5} = 0.103\ mV$

$AbsoluteAccuracy = 27.61\ mV$

Digital I/O

Static Characteristics

Number of channels ..... 4 bidirectional, individually settable
Modes (configurable per channel) ..... Drive High Only, Drive Low Only, Drive High and Low, and Tristate
Voltage range
  Input ..... 0 to 30 V
  Output (sourcing) ..... 5 to 30 V
Output current (sourcing or sinking) ..... 1 A max on any one channel, 1 A total for all four channels
Power-on output state ..... High impedance, tristate
DIO power supply voltage range ..... 5 to 30 V
Digital input logic levels
  Input high range ..... 1.65 to 30 V
  Input low range ..... 0 to 0.45 V
Input current
  0 V input ..... -160 µA
  5 V input ..... 125 µA
  30 V input ..... 220 µA

DIO output voltage drop
- Sourcing ..... 0.5 V at 0.1 A; 1.1 V at 1 A
- Sinking ..... 0.06 V at 0.1 A; 0.52 V at 1 A

DIO overcurrent fuse
- Maximum voltage ..... 30 V
- Hold current ..... 1.1 A at 25 °C
- Trip time ..... 2.5 s at 5 A at 25 °C

Dynamic Characteristics

Output delay time
- Sinking, 10 kΩ pull up ..... 15 µs
- Sourcing, 10 kΩ pull down ..... 3.5 ms

Power Requirements

Caution: Use the WSN-3202 with a 24 VDC, UL-listed, limited power source (LPS) supply. The power supply bears the UL-listed mark, LPS. It must also meet any safety and compliance requirements for the country of use. Do not use rechargeable batteries.

The following power requirements specifications are typical at 25 °C.

Battery Power

Internal battery
- Type ..... 4 AA, alkaline only
- Voltage range ..... 3.6 to 7.5 V
- Power consumption[1, 3]
  - 60-second sample interval ..... 0.5 mW at 6 V
  - 1-second sample interval ..... 13.3 mW at 6 V

Battery life[1]
- 60-second sample interval ..... Up to 3 years
- 1-second sample interval ..... Up to 1 month

External Power

External power ..... 9 to 30 V

Power input mating connector ..... 2-position MINI-COMBICON, Phoenix Contact part number: 1714977

Power consumption[3]
- End node mode
  - 60-second sample interval ..... 16 mW at 24 V
  - 1-second sample interval ..... 33 mW at 24 V
- Router mode[2] ..... 300 mW at 24 V

[1]Device executing NI-WSN firmware. End node mode. Sensor power not used.

[2]Router connected directly to gateway. Routing messages for one end node at a one minute sample interval.

[3]Power consumption for WSN-3202 can be improved by customizing node behavior with the LabVIEW Wireless Sensor Network (WSN) Module Pioneer. See the *LabVIEW WSN Benchmarking* document, found on NI Developer Zone, for more information.

NI WSN-3212 Specifications

These specifications are typical for the range -40 to 70 °C unless otherwise noted. Some specifications (such as sample interval and power consumption) can be optimized by customizing node behavior with the LabVIEW Wireless Sensor Network (WSN) Module Pioneer. See the *LabVIEW WSN Benchmarking* document, found on NI Developer Zone, for more information.

» For complete WSN-3212 thermocouple input node specifications, see the *NI WSN-3212 User Guide and Specifications* manual at **ni.com/manuals**.

Analog Input Characteristics

Number of channels	Thermocouple input channels
ADC resolution	24 bits
Type of ADC	delta-sigma
Voltage measurement range	±73 mV
Common-mode range	
Channel-to-common	±700 mV
Common-mode rejection ratio (0 to 60 Hz)	
Channel-to-common	95 dB
Temperature measurement ranges	
Thermocouple types J, K, R, S, T, N, and B	Works over temperature ranges defined by NIST
Thermocouple type E	-270 to 950 °C
Minimum sample interval[1]	2 seconds
Input bandwidth (-3 dB)	1 Hz
Noise rejection	65 dB min at 50/60 Hz
Overvoltage protection	±30 V between any input and common
Differential input impedance	20 MΩ
Input current	50 nA
Input noise	0.5 μV_{rms}
Gain error	0.02% max at 25 °C, 0.03% typ at -40 to 70 °C, 0.1% max at -40 to 70 °C
Offset error (with autozero)	11 µV typ, 12.5 µV max

[1]Minimum sample interval for WSN-3212 can be improved by customizing node behavior with the LabVIEW Wireless Sensor Network (WSN) Module Pioneer. See the *LabVIEW WSN Benchmarking* document, found on NI Developer Zone, for more information.

Digital I/O

Static Characteristics

Number of channels	4 bidirectional, individually settable
Modes (configurable per channel)	Drive High Only, Drive Low Only, Drive High and Low, and Tristate
Voltage range	
Input	0 to 30 V
Output (sourcing)	5 to 30 V
Output current (sourcing or sinking)	500 mA max on any one channel, 500 mA total for all four channels
Power-on output state	High impedance, tristate
DIO power supply voltage range	5 to 30 V
Digital input logic levels	
Input high range	1.65 to 30 V
Input low range	0 to 0.45 V
Input current	
0 V input	-160 µA
5 V input	125 µA
30 V input	220 µA
DIO output voltage drop	
Sourcing	0.5 V at 0.1 A; 0.763 V at 0.5 A
Sinking	0.057 V at 0.1 A; 0.286 V at 0.5 A
DIO overcurrent fuse	
Maximum voltage	30 V
Hold current	1.1 A at 25 °C
Trip time	2.5 s at 5 A at 25 °C

Dynamic Characteristics

Output delay time	
Sinking, 10 kΩ pull up	15 µs
Sourcing, 10 kΩ pull down	3.5 ms

Power Requirements

Caution: Use the WSN-3212 with a 24 VDC, UL-listed, limited power source (LPS) supply. The power supply bears the UL-listed mark, LPS. It must also meet any safety and compliance requirements for the country of use. Do not use rechargeable batteries.

The following power requirements specifications are typical at 25 °C.

Battery Power

Internal battery	
Type	4 AA, alkaline only
Voltage range	3.6 to 7.5 V
Power consumption[1, 3]	
60-second sample interval	0.4 mW at 6 V
2-second sample interval	7.4 mW at 6 V
Battery life[1]	
60-second sample interval	Up to 3 years
2-second sample interval	Up to 2 months

External Power

Voltage range	9 to 30 V
Power input mating connector	2-position MINI-COMBICON, Phoenix Contact part number: 1714977

Power consumption[3]

End node mode

60-second sample interval..... 15 mW at 24 V

2-second sample interval..... 25 mW at 24 V

Router mode[1]..... 300 mW at 24 V

[1]Device executing NI-WSN firmware. End node mode. Sensor power not used.

[2]Router connected directly to gateway. Routing messages for one end node at a one-minute sample interval.

[3]Power consumption for WSN-3212 can be improved by customizing node behavior with the LabVIEW Wireless Sensor Network (WSN) Module Pioneer. See the *LabVIEW WSN Benchmarking* document, found on NI Developer Zone, for more information.

NI WSN-3202 and NI WSN-3212 Specifications

Node Resources for LabVIEW WSN

User flash size ..... 248 kB
Number of flash erase cycles
per sector 100,000

Wireless Characteristics

Radio mode ..... IEEE 802.15.4
RF data rate ..... 250 kbits/s
Indoor range ..... Up to 90 m
Outdoor range ..... Up to 300 m
Frequency band[1] ..... ISM 2.4 GHz (2400 to 2483.5 MHz)
Channels[2] ..... 11 to 24
TX power

Version	Maximum Radio Output
Americas	+17 dBm max (50 mW)
Europe/Asia	+10 dBm max

Modulation type ..... DSSS (O-QPSK)
Receiver sensitivity ..... -102 dBm
Antenna
Connector ..... Female RP-SMA connector
VSWR MAX.2.0
Impedance ..... 50 Ω
Directivity ..... Omni
Nominal gain ..... 1.5 dBi

[1]Due to regulations, the frequency bands depend on the country of operation.
[2]Due to regulations, the valid channels depend on country of operation.

Physical Characteristics

Screw-terminal wiring ..... 14 to 24 AWG wire
Torque for screw terminals ..... 0.2 to 0.25 N•m
Dimensions ..... See the *NI WSN-32xx User Guide* manuals for device dimensions.
Weight ..... Approx. 242 g (8.5 oz)
Weight with antenna ..... Approx. 256 g (9 oz)

Environmental

For outdoor use, mount the system in a suitably rated enclosure.

Operating temperature ..... -40 to 70 °C (IEC-60068-2-1 and IEC-60068-2-2)
Storage temperature ..... -40 to 85 °C (IEC-60068-2-1 and IEC-60068-2-2)
Operating humidity ..... 10 to 90% RH, noncondensing (IEC-60068-2-56)
Storage humidity ..... 5 to 95% RH, noncondensing (IEC-60068-2-56)
Maximum altitude ..... 2,000 m
Pollution degree ..... 2 (IEC 60664)

Shock and Vibration

Operating vibration, random ..... 5 g_{rms}, 10 to 500 Hz (IEC 60068-2-64)
Operating shock ..... 30 g, 11 ms half sine, 50 g, 3 ms half sine, 18 shocks at 6 orientations (IEC 60068-2-27)
Operating vibration, sinusoidal ..... 5 g, 10 to 500 Hz (IEC 60068-2-6)

NI Services and Support

NI has the services and support to meet your needs around the globe and through the application life cycle – from planning and development through deployment and ongoing maintenance. We offer services and service levels to meet customer requirements in research, design, validation, and manufacturing.
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Training and Certification

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Professional Services

Our NI Professional Services team is composed of NI applications and systems engineers and a worldwide National Instruments Alliance Partner program of more than 600 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit **ni.com/alliance**.

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