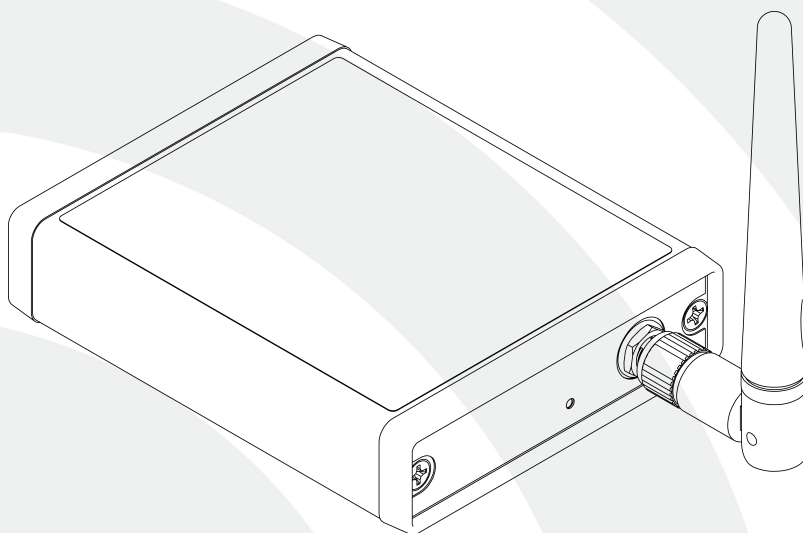


WSDA[®]-Base-104[®]
Wireless USB Base Station





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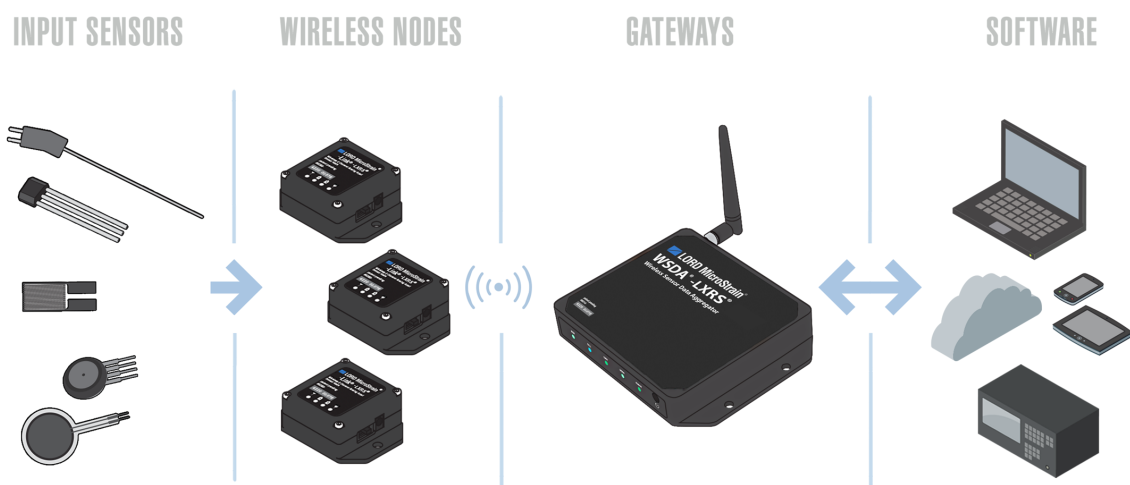
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1. Wireless Sensor Network Overview

The LORD MicroStrain® Wireless Sensor Network is a high-speed, scalable, sensor data acquisition and sensor networking system. Each system consists of wireless sensor interface nodes, a data collection gateway, and full-featured user software platforms based on the LORD MicroStrain® Lossless Extended Range Synchronized (LXRS®) data communications protocol. Bidirectional wireless communication between the node and gateway enables sensor data collection and configuration from up to two kilometers away. Gateways can be connected locally to a host computer or remotely via local and mobile networks. Some gateways also feature analog outputs for porting sensor data directly to standalone data acquisition equipment.



The selection of available nodes allows interface with many types of sensors, including accelerometers, strain gauges, pressure transducers, load cells, torque and vibration sensors, magnetometers, 4 to 20mA sensors, thermocouples, RTD sensors, soil moisture and humidity sensors, inclinometers, and orientation and displacement sensors. Some nodes come with integrated sensing devices such as accelerometers. System sampling capabilities are IEEE 802.15.4-compliant and include lossless synchronized sampling, continuous and burst sampling, and data logging. A single gateway can coordinate many nodes of any type, and multiple gateways can be managed from one computer with the Node Commander® and SensorCloud™ software platforms. Integration to customer systems can be accomplished using OEM versions of the sensor nodes and leveraging the LORD MicroStrain® data communications protocol.

Common wireless applications of LORD MicroStrain® Sensing Systems are strain sensor measurement, accelerometer platforms, vibration monitoring, energy monitoring, environmental monitoring, and temperature monitoring.

2. Gateway Overview

The WSDA[®]-Base-104[®] Wireless USB Base Station is a data acquisition gateway designed to configure, co-ordinate, and collect sensor data from LORD MicroStrain[®] wireless sensor nodes. The gateway supports all data acquisition sessions between wireless nodes and host computers including: continuous sampling, burst sampling, and datalogging. The gateway also facilitates precision sampling synchronization between sensor nodes by transmitting a continuous, system-wide timing reference known as the beacon.

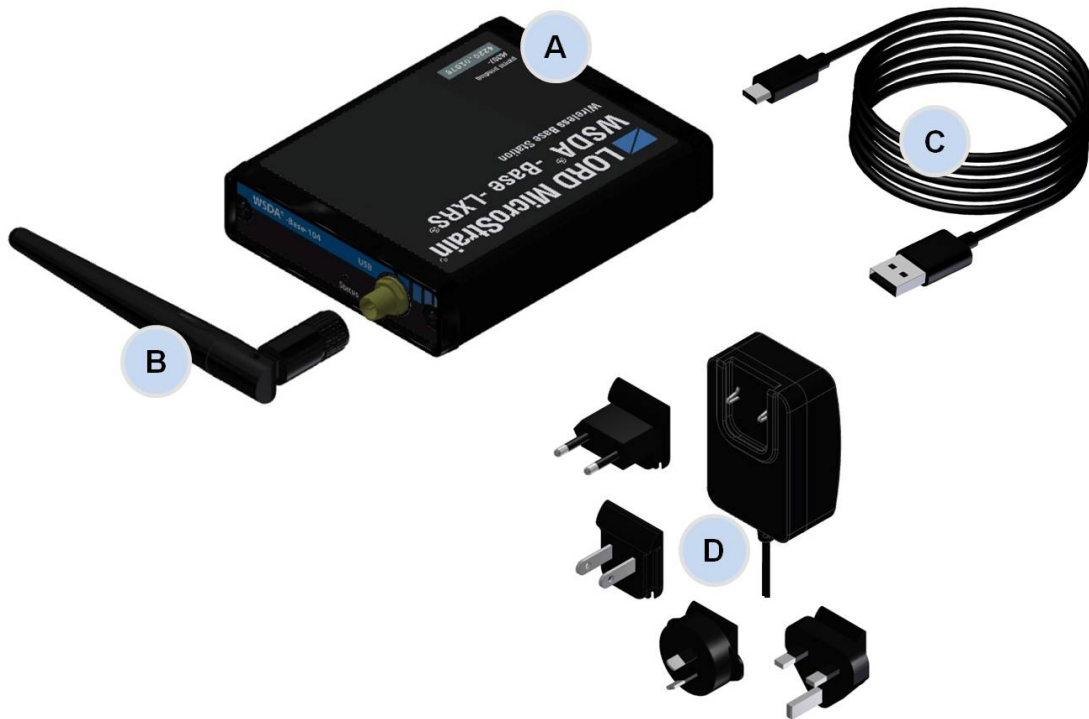
The WSDA[®]-Base-104[®] utilizes a USB interface to transfer data from the wireless nodes to a host computer for viewing, analysis, and storage.



Figure 1 - WSDA[®]-Base-104[®] USB Base Station

2.1 Gateway Components

The WSDA[®]-Base-104[®] can be purchased individually or as part of a starter kit. The starter kit includes everything required to operate the WSDA[®]-Base-104[®] including an external antenna, a power supply for charging sensor nodes, and a USB cable for interfacing with the host computer or network. For a complete list of available configurations, accessories, additional system products, and ordering information [see Parts and Configurations on page 45](#).



Item	Description	Quantity
A	WSDA [®] -Base-104 [®] USB Base Station	1
B	Standard whip antenna (FCC compliant)	1
C	USB cable	1
D	Node power supply and plug adapter kit	1
--	Node Commander [®] Software Suite, User Manual, and Quick Start Guide	1

Table 1 - Starter Kit Components

2.2 Gateway Interface

The WSDA[®]-Base-104[®] interface includes a USB port and a connector for attaching the gateway antenna.

There are device status indicators on the front of the WSDA[®]-Base-104[®]. The following table describes indicator behavior.

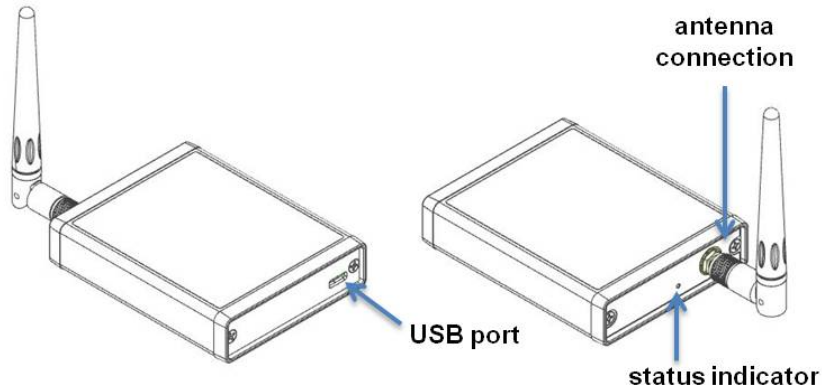


Figure 2 - Ports and Indicators

Indicator	Behavior	Node Status
Device Status Indicator	OFF	Gateway is off
	ON green	Gateway is powered & idle
	Flashing blue	Sync sampling beacon enabled or incoming data from other sampling modes
	Flashing red	WARNING: another gateway beacon is detected on the same frequency

Table 2 - Basic Indicator Behaviors

3. System Operation Overview

The gateway is the interface between LORD MicroStrain[®] sensor nodes and the data acquisition computer. The gateway co-ordinates the configuration and sampling of the nodes and can handle many nodes simultaneously. Communication between the nodes and gateway is wireless and uses the LORD MicroStrain[®] LXRS[®] data communications protocol. LXRS[®] nodes, and many legacy nodes, will communicate with any LXRS[®] gateway.

LORD MicroStrain[®] has two software programs available for the Wireless Sensor Network: the Node Commander[®] Software Suite and SensorCloud[™]. Users can also write their own programs by utilizing the LORD MicroStrain[®] Wireless Sensor Networks Data Communications Protocol.

The **Node Commander[®] Software Suite** is included with all data gateways and is also available on the LORD MicroStrain[®] website for download. It includes the following programs:

- **Node Commander[®]** is used for configuring nodes and acquiring, viewing, and saving data.
- **Live Connect[™]** is a TCP/IP-to-serial conversion tool that translates the communications between Node Commander[®] and an Ethernet gateway. This program is only used with the WSDA[®] -1500 - LXRS[®] or other Ethernet gateways.
- **WSDA[®] Data Downloader** is used to download acquired data from the flash memory card embedded in an applicable gateway to a host computer. This program is only used with the WSDA[®] -1500 - LXRS[®] or other Ethernet gateways.

SensorCloud[™] is an optional data collection, visualization, analysis, and remote management tool. It is based on cloud computing technology and is accessed directly from a web connection. Automatic, real time data collection is available through Ethernet gateways, such as the WSDA[®] -1500 - LXRS[®] and any already collected data can be easily uploaded for visualization and analysis. Because it is web-based, SensorCloud[™] requires no installation. For more information [see Data Processing on page 22](#).

This operational overview describes system hardware and software setup, including gateway and node communication, and an overview of the Node Commander[®] software menus required to configure a sensor connected to the node and begin data acquisition. A brief overview of porting data to SensorCloud[™] is also included. This section is intended as a quick start guide and is not a complete demonstration of all system and software capabilities.

3.1 Software Installation

To install Node Commander[®] Software Suite on the host computer, run the installer executable file and follow the on-screen prompts for a complete installation. The software is provided with all gateways and is available on the LORD MicroStrain[®] website ([see References on page 52](#)).

NOTE

The Node Commander[®] software includes hardware drivers required for use with USB gateways. Once installed, the software will automatically detect and configure any USB gateways that are plugged into the host computer.

3.2 System Connections

To acquire sensor data the following components are needed: user-supplied external sensors (as applicable), a LORD MicroStrain[®] wireless sensor node, a LORD MicroStrain[®] data gateway and a local or networked host computer with access to the data acquisition software (such as Node Commander[®] and SensorCloud[™]).

The sensor, node, gateway, and software selection is application-dependent, but the basic interfaces are the same. For a connections overview using the WSDA[®]-Base-104[®] refer to [Figure 3 - System Connections](#).

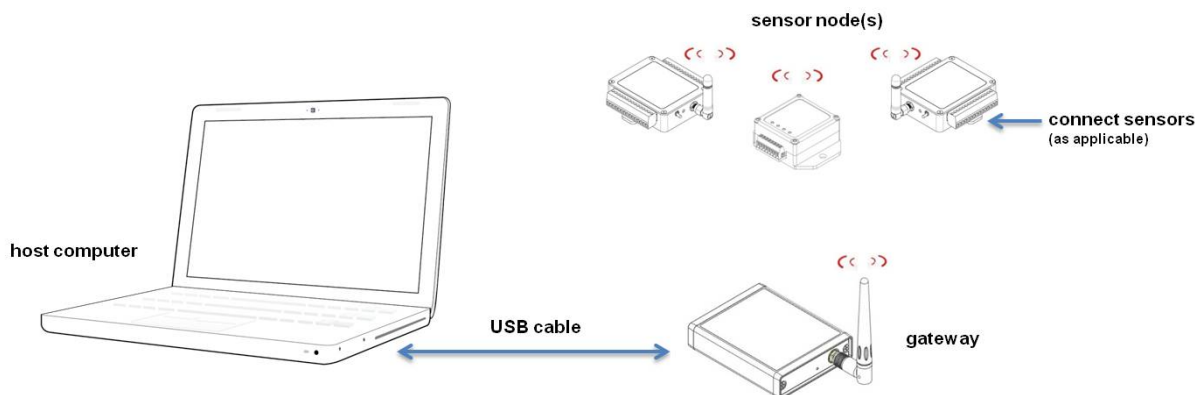


Figure 3 - System Connections

3.3 Gateway USB Communication

For USB gateways, drivers need to be installed on the host computer. These drivers are included with the Node Commander[®] software. Once the software is installed, the USB gateway will be detected automatically whenever the gateway is plugged in.

1. Open the Node Commander[®] software.



2. Make all hardware connections ([see System Connections on page 11](#)). Power is applied to the gateway through the USB connection. Verify the gateway status indicator is illuminated.
3. Open Node Commander[®].
4. When connected, the gateway should appear in the Controller window automatically with a communication port assignment ([Figure 4 - USB Gateway Communication](#)). If it is not automatically discovered, verify the port is active.

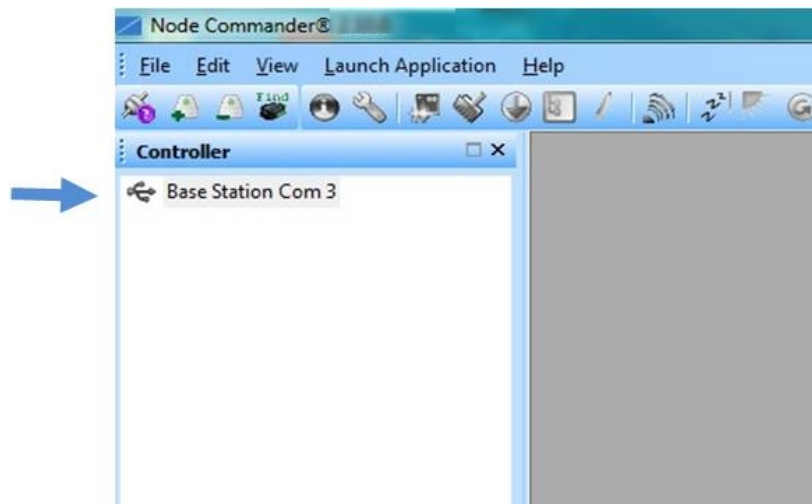


Figure 4 - USB Gateway Communication

3.4 Connect to Nodes

Several methods can be used to establish communication with the nodes in Node Commander®. This quick start section covers the two simplest methods for establishing node communication: adding a node by address and by using the node discovery feature.

3.4.1 Adding a Node by Address

Adding a node by address requires the node to be on the same communication frequency as the gateway. The node address and frequency are indicated in the documentation included with the node when it is purchased. The gateway's initial frequency setting is indicated in the documentation that is included when it is purchased. The frequency setting can also be checked once gateway communication is established with the host computer ([see Transmit Frequency on page 28](#)).

1. To add a node by address, right-click on the gateway name in the Controller window, and select Add Single Node ([Figure 5 - Adding a Node by Address](#)).
2. Enter the node address, and select OK. If the node is not found, a message will appear and provide the option to scan for the node on other frequencies. Once communication has been established, additional node information can be viewed by selecting the “+” symbol next to the node name.

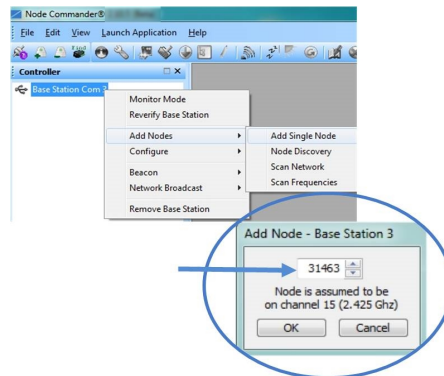


Figure 5 - Adding a Node by Address

3.4.2 Using Node Discovery

The node discovery feature allows connection between the gateway and node to occur even if they are on different frequencies. To connect to all available nodes using node

discovery, the nodes must initially be powered off.

NOTE

Automatic node discovery may not work in some boot-up modes. If the node is not in normal boot up mode, the assigned one can be bypassed to enable node discovery. For more information [see Troubleshooting on page 36](#).

1. Right-click on the gateway name and select Add Node > Node Discovery.

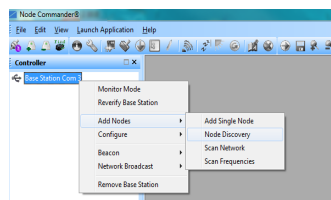


Figure 6 - Adding a Node in Node Commander®

2. Turn the node on with the node power switch. During power-up, the node will transmit a message with its operating frequency within a few seconds.
3. When the device status indicator on the node ends the rapid flash sequence and begins pulsing at one-second intervals, it has completed the normal boot-up sequence and is running in idle mode. At this point the node should be listed in the Controller window, and scanning can be stopped by selecting the Stop button in the Node Discovery window. Additional node information can be viewed by selecting the “+” symbol next to the node name. If the information list appears, communication has been established ([Figure 7 - Node Discovery](#)).

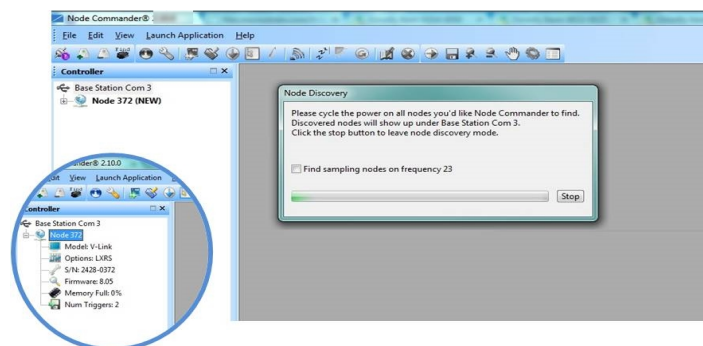


Figure 7 - Node Discovery

3.5 Channel Configuration

The sensor settings are stored in the node memory of the node channel it is connected to. Only the channels and configuration options that are available on the type of node being used will appear in the configuration menus.

1. To enter the configuration menu, right-click on the node name, and select Configure > Configure Node. The Channels tab displays channel options available for the node.
 - a. **Channel Enabled:** indicates the channel number. The check box is used to enable the channel and select it for sampling. The icon next to the check box describes the channel type intrinsic to the node being used. In the following example (*Figure 8 - Node Channels Menu*): a1) analog differential channel icon, a2) analog single ended channel icon, and a3) temperature channel icon.
 - b. **Current channel configuration:** The Data Output, Units, Input Range, and Label fields describe how the channel is currently configured.
 - c. **Configure:** Select the channel's Configure button to change the channel parameters, such as measurement units, gain and offset settings, and calibration values. The channel must be enabled first by selecting its adjacent check box.

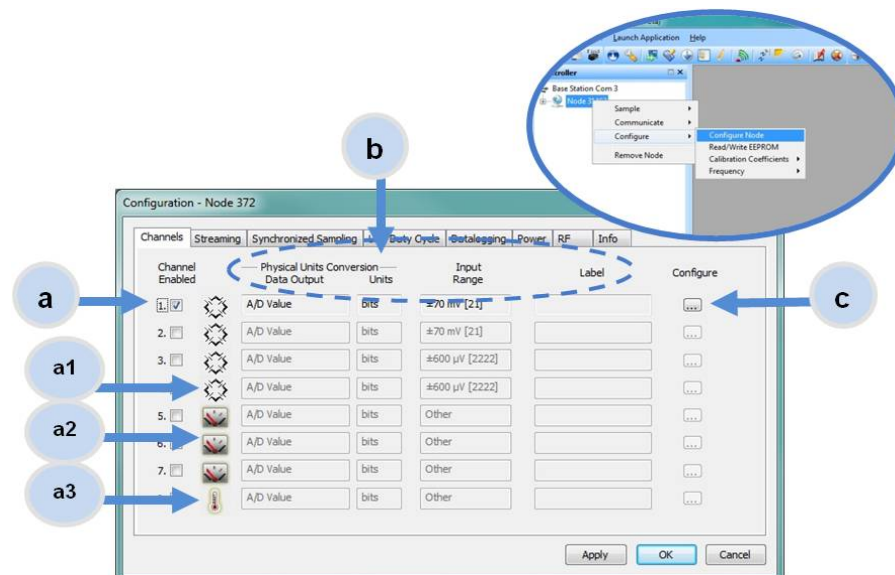


Figure 8 - Node Channels Menu

3.6 Sampling Settings

Depending on the type of node, up to four sampling modes are available: Synchronized Sampling, Low Duty Cycle, Streaming, and Datalogging. Some modes have user-configurable settings for sample rate, sample duration, and datalogging. Other settings are automatic, depending on number of active channels and other variables. For more information on sampling modes refer to the Node Commander[®] user manual ([see References on page 52](#)).

NOTE

Streaming mode (which enables continuous sampling and transmitting) uses a large amount of system bandwidth and can significantly reduce node battery life. Streaming is recommended primarily for diagnostics and is not supported in SensorCloud[™].

In general, when determining which sample mode and rate is most suitable for the application, consider the following:

- Increasing the sample rate reduces the available over-the-air transmission bandwidth and therefore also reduces the number of nodes that can be reporting simultaneously.
- Increasing the sample rate increases the power requirement of the node and therefore reduces battery life.
- When measuring vibration or other analog signals, it is important to use a sample rate at least twice the value of the target measurement frequency. This is the minimum sample rate required to produce an accurate digital representation of the measured signal. The higher the sample rate the more accurate the digital representation.

Sampling settings are accessed through the Configure Node menu. There is a tab for each sampling mode available for the particular node ([Figure 9 - Sample Settings Menu](#)).

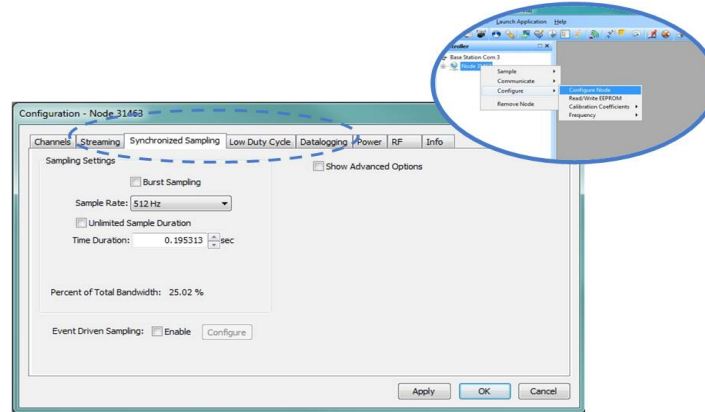


Figure 9 - Sample Settings Menu

3.7 Data Acquisition

NOTE

Once sampling has started it will continue as configured without the need to leave Node Commander[®] open. However, if the node is powered off and is not configured to sample on boot-up, data acquisition will end and must be restarted in Node Commander[®]. To resume viewing data after the sampling window has been closed, use Monitor Mode (found in the gateway menu).

NOTE

Touching sensors or charging the node battery while acquiring data may induce noise on sensitive sensor signals and is not recommended.

When data acquisition is started, each of the sampling modes has different menu options and views. Some open a settings menu before data acquisition begins and may include a data list view and/or a graph view. The following is an example of Synchronized Sampling ([Figure 10 - Starting a Sampling Session](#)). For information on other sampling menus refer to the node user manual or the LORD MicroStrain[®] website ([see References on page 52](#)).

To start a sampling session, nodes can be selected individually or as a group. When selected as a group, they will all be set to the same sampling mode. Right-click on the nodes and select Sample. The menus are different, depending on which method is selected.

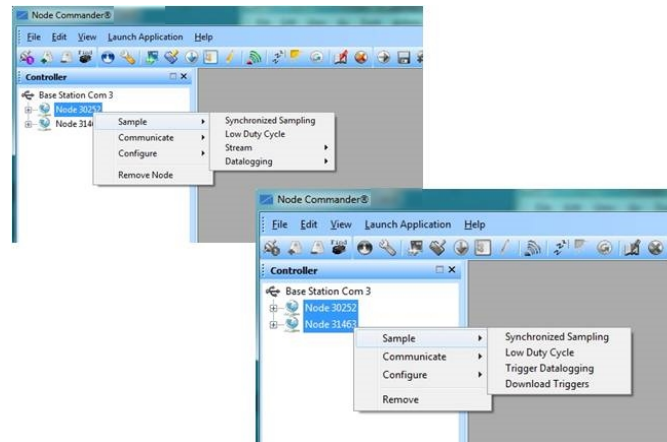


Figure 10 - Starting a Sampling Session

When a synchronized sampling session is started, the sampling menu appears and includes settings to enable optional sampling features, configure nodes, and specify where the data is saved. The built-in bandwidth calculator displays the total bandwidth used by the nodes selected for synchronized sampling ([Figure 11 - Synchronized Sampling Menu](#)).

- a. **Save Location:** indicates where the data file will be saved on the host computer. Use the Browse button to select a preferred location.
- b. **Node configuration:** includes the node serial number, sampling settings, bandwidth calculation, and current status. Highlight any node or group of nodes, and the Remove, Configure, and Refresh buttons become active. The Configure button opens the node configuration menus to adjust settings as needed and recalculates the node bandwidth. Multiple nodes can be configured together by using the Shift or Ctrl key to select them.

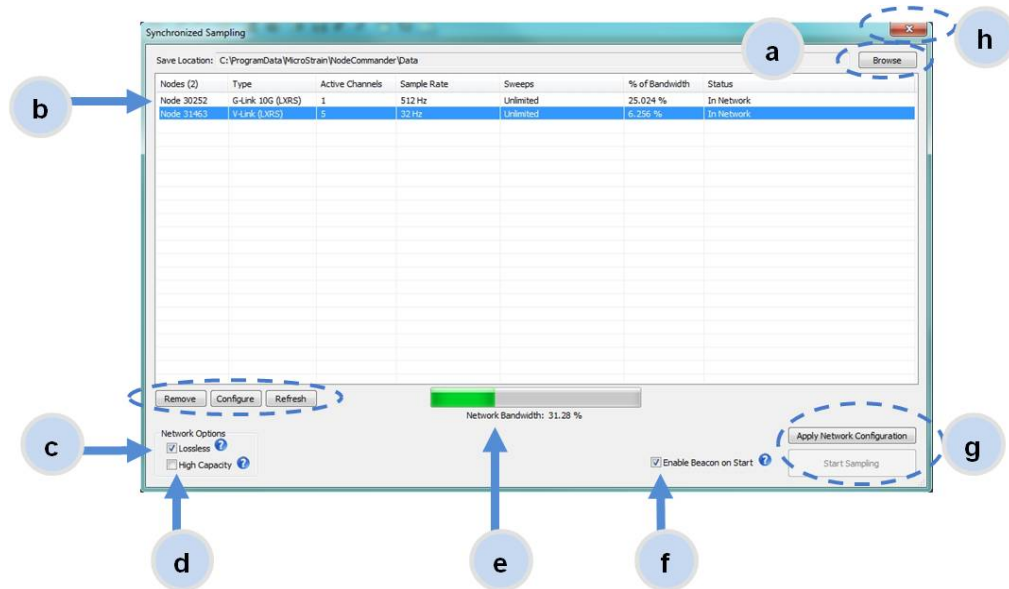


Figure 11 - Synchronized Sampling Menu

- c. **Lossless:** enables the lossless data protocol. The protocol enables buffering and retransmission of data in order to provide 100% data collection success. Using this feature may increase data display latency.
- d. **High Capacity:** reduces the transmit rates in order to optimize bandwidth and power savings among nodes with slower sample rates.
- e. **Network Bandwidth:** is the total bandwidth used by all the nodes.
- f. **Enable Beacon on Start:** When synchronized sampling is started the nodes wait for the first beacon transmission to initiate sampling. When this option is selected, the gateway beacon is enabled and will begin transmitting at a fixed interval when sampling is started. Disabling the beacon on start (unchecking the box) will set the nodes to wait for the beacon, but it does not actually start the beacon when sampling is started. This can be used if there is a need for sampling to be initiated later, or if the beacon is being received from another source than the gateway. Enabling the beacon in this way is the same as enabling the beacon in the gateway menu [see Using the Beacon on page 31](#).
- g. **Apply settings and start sampling:** Before acquisition can begin, use the Apply Network Settings to save the session settings to the node. When completed, select Start Sampling to begin.

- h. **Close sampling window** with the red "X" to exit sampling or, once the sampling has been started, to view the data window behind it.

Synchronized sampling features two data views: a grid view and a graph view. Once sampling is started, the data grid view is the default view.

NOTE

Depending on the synchronized sampling settings, it may take many seconds before the first sample to appear in Node Commander®.

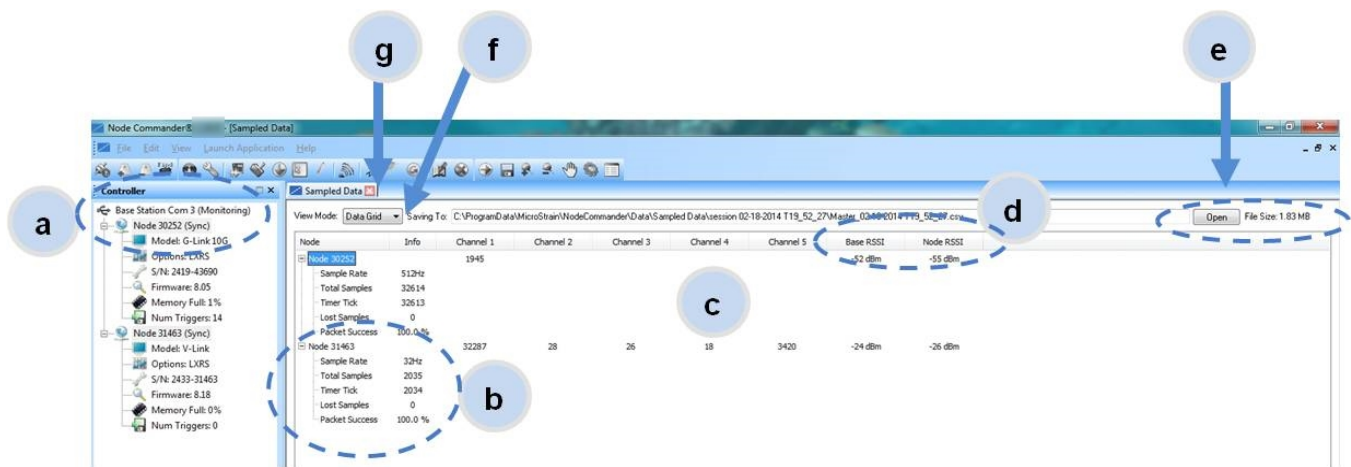


Figure 12 - Synchronized Sampling Data View

- Device status:** Node sampling mode and gateway status are displayed in parentheses next to the device name.
- Node information:** includes node serial number and sampling statistics. Right-click on the node name for more menu options such as Stop Nodes.
- Data:** is a display of the sampled data with each channel in a column.
- Radio strength:** indicates how good the communication is between the gateway and node. [See Range Test on page 35.](#)
- Data file:** the location and size of the data file, as data is added. View the data in .CSV format with the Open File button.
- View menu:** Select between Data Grid and Graph views.

- g. **End sampling:** The red "X" is used to exit the sampling window and/or end sampling.

Use the view menu to select the Graph view of the data. Click on the node to view the graph for that node. Click again to hide it.

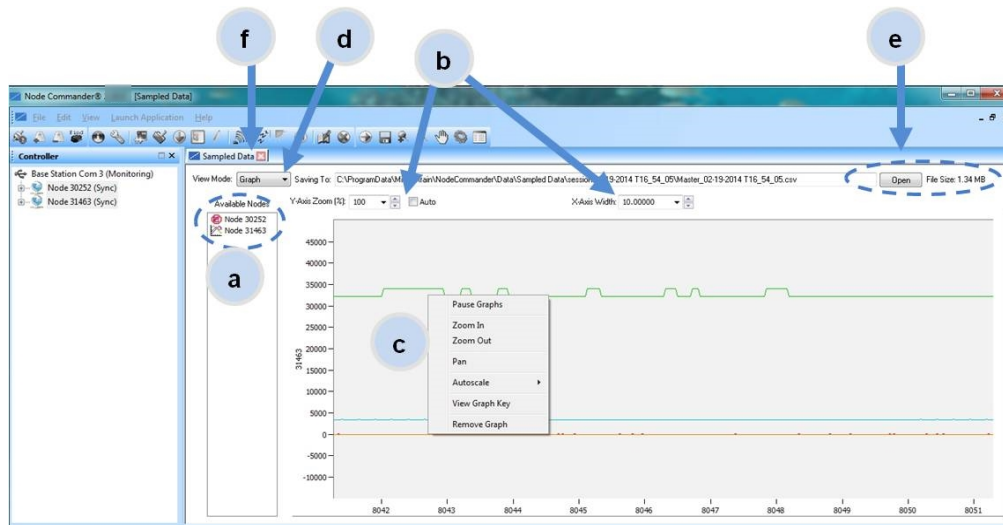


Figure 13 - Synchronized Sampling Graph View

- a. **Available Nodes:** Click on the node to display the graph for that node. Click again to hide it. Right-click on the node name for more menu options such as Stop Nodes and Save Stream.
- b. **Axis range:** Select the X-axis width and Y-axis zoom percentage, or use the Auto check box for automatic scaling.
- c. **Graph:** The node graph shows the sampled data. Each active channel is displayed in a different color. The X-axis is time in seconds and the Y-axis is the A/D value (bits). Right click on the graph for additional menu options such as View Graph Key, Pan, Zoom, Pause, and Remove Graph.
- d. **View menu:** Select between Data Grid and Graph views.
- e. **Data file:** The location and size of the data file as data is added. View the data in .CSV format with the Open File button.
- f. **End sampling:** The red "X" is used to exit the sampling window and/or end sampling.

3.8 Data Processing

Data acquired through Node Commander® is automatically saved on the host computer. Data can also be uploaded to the LORD MicroStrain® SensorCloud™ web platform for display, monitoring, data storage, and analysis ([Figure 14 - Data Visualization and Analysis](#)).

SensorCloud™ is based on cloud computing technology and is designed for long term collection and preservation of data. Features include time series and visualization graphing, automated alerts, and data interpretation tools such as data filtering, statistical analysis, and advanced algorithm development with the integrated MathEngine® interface. Basic SensorCloud™ services are available to all users free of charge. For more information refer to the LORD MicroStrain® website ([see References on page 52](#)).



Figure 14 - Data Visualization and Analysis

3.8.1 Sensor Data Files

Data acquired in Node Commander® is stored in .CSV format and can be opened with Microsoft Excel, Quattro Pro, Open Office, or other CSV editors/spreadsheet programs. Data in this format is very easily uploaded to SensorCloud™ as well using the SensorCloud™ CSV Uploader. The data files can be found on the host computer in the default directory or the location specified at the beginning of sampling (as applicable).

The default directory is: **C:\ProgramData\Microstrain\NodeCommander\SampledData**

Different sampling modes will output different file types, and they will be categorized in separate folders by sampling mode and then further categorized by date, session, and/or node serial number.

Synchronized sampling and low duty cycle files are found in the Sampled Data folder.

Datalogging files need to be downloaded from the node before they are available for viewing and can be accessed through datalogging menus as well as the File menu. They are stored by default in the Downloaded Triggers folder.

Streaming data is stored in the Streaming folder.

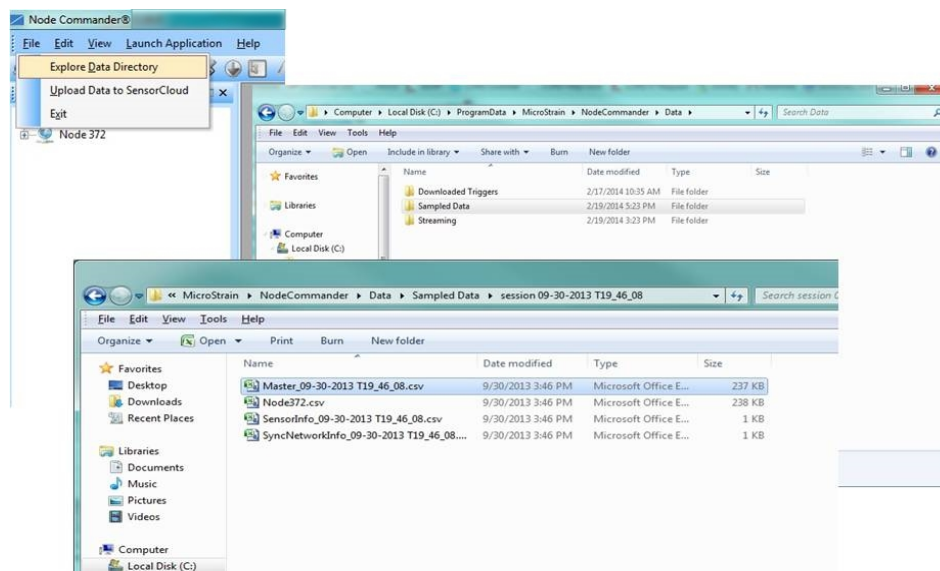


Figure 15 - Exploring Data

NOTE

The Microsoft Excel the Time data column in the data file may have to be changed to "m/d/yyyy h:mm:ss:000" format to make it more readable.

4. Gateway Communication and Settings

Node Commander® is used to configure sensors nodes, set sampling parameters, and begin data acquisition. This section describes how to verify communication with the gateway in Node Commander® and adjust wireless communication settings. For detailed settings information, refer to the Node Commander® User Manual (*see References on page 52*).

When a gateway is communicating with the host computer in Node Commander® it will appear on a list in the Controller window with a name that includes the communications port for which it is configured and an icon symbolizing the type of communication interface.

Node Commander® remembers gateways and nodes that have been communicated with previously. They will appear on the list when the software is started, however the name and icon will be grayed out if the device is not currently communicating. To remove a gateway that is no longer used, select Remove Base Station from the gateway menu.

Right clicking on the gateway name will produce a list of menu options available for the gateway . *Figure 16 - Gateway Communication* shows a USB gateway that is communicating on ComPort 3, with the corresponding menu and a serial gateway that is not connected.

USB gateways connect automatically when plugged into the host computer.

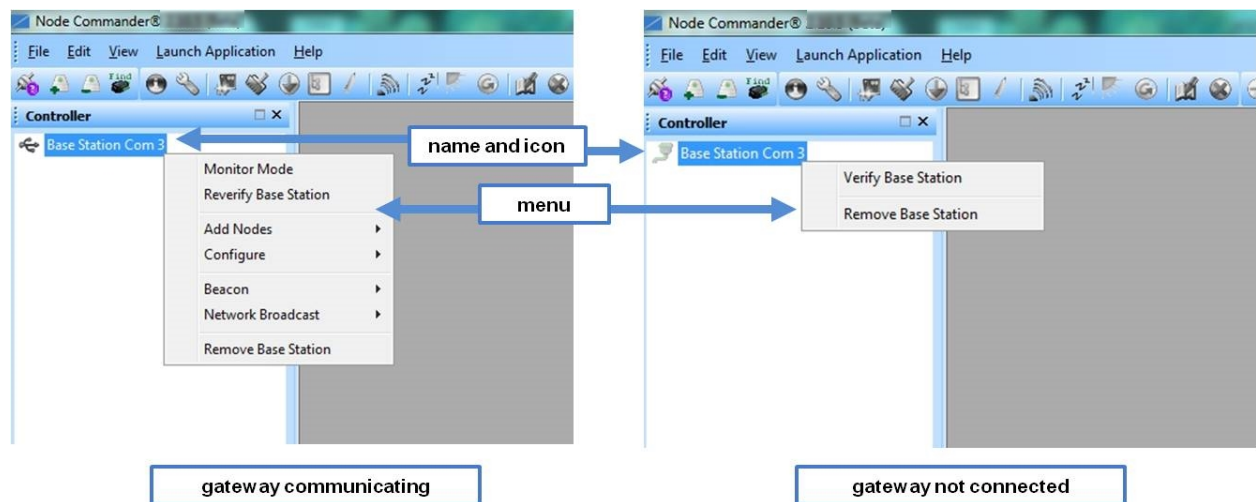


Figure 16 - Gateway Communication

4.1 Verify Gateway Communication

The Verify and Reverify Base Station commands can be used to check the communication status of the gateway to the host computer. The Verify command is available in the gateway menu if no communication has been previously established. The Reverify command is in the gateway menu if communication has already be established, and it is used to check the current status. Right-click on the gateway name, and select the command.

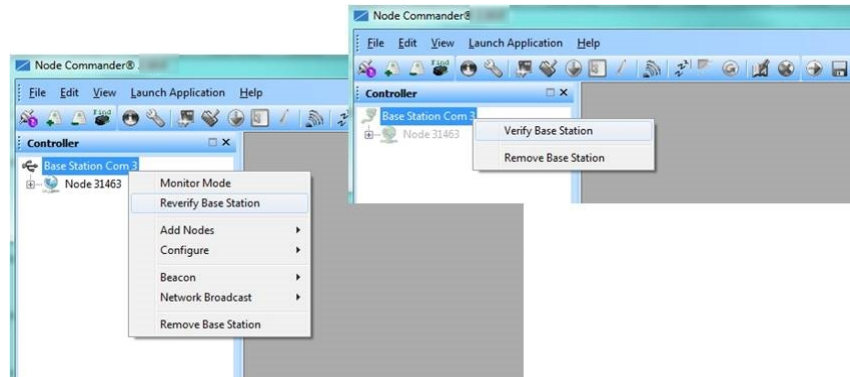


Figure 17 - Verify Gateway Communication

4.2 Communication Timeout

Node Commander® will attempt to establish communication with the gateway for the amount of time set as the communication timeout; the default setting is 20 milliseconds. If communication cannot be established, try adjusting this value for a longer timeout. Right-click on the gateway name, and select Configure > Configure Timeout. Adjust the value, and then select the Test Value button to test the communication to the gateway ([Figure 18 - Communication Timeout](#)). This feature can also be used if communication to the node is intermittent.

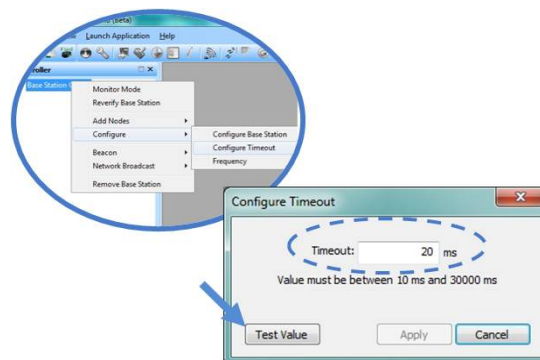


Figure 18 - Communication Timeout

4.3 Removing a Gateway

To remove a gateway that is no longer used, right-click on the gateway name in the Controller window, and select Remove Base Station from the gateway menu .

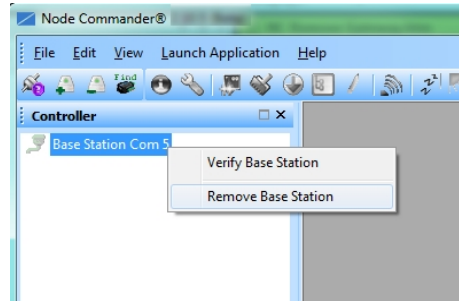


Figure 19 - Removing Gateways

4.4 Gateway Information

Gateway information (such as the model type, serial number, radio type, operating frequency, current communications port, and firmware revision) is found in the gateway Information window. Right-click on the gateway name and select Configure > Configure Base Station.

There is also a Label field to give the gateway a unique name, which is useful when there are multiple gateways in the system. Gateway transmit power can also be selected in this window. For additional information [see Transmit Power on page 27](#).

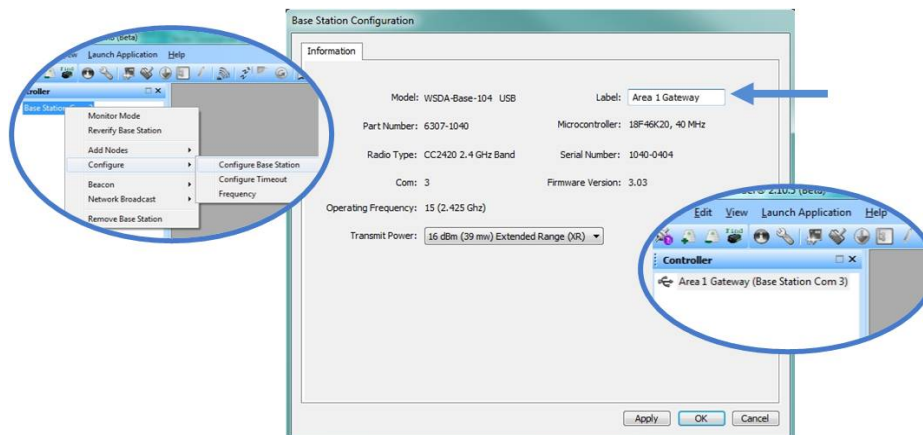


Figure 20 - Gateway Information and Name

4.5 Transmit Power

The transmit power level may require adjustment if power consumption is a concern or in regions where there are transmit power restrictions. Lowering the power output reduces power consumption, but it also reduces the wireless communication range between the gateways and nodes.

NOTE

Actual range is highly dependent of how the nodes and gateways are installed and the conditions in the surrounding environment ([see Range Test on page 35](#)).

Setting	Power Output	Maximum Range
Extended	16 dBm (39mW)	2 km
Standard	10dBm (10mW)	1 km
Low	0dBm (1mW)	70 m

Table 3 - Transmit Power Settings

The transmit power setting for the gateway is found in the gateway Configure Base Station menu.

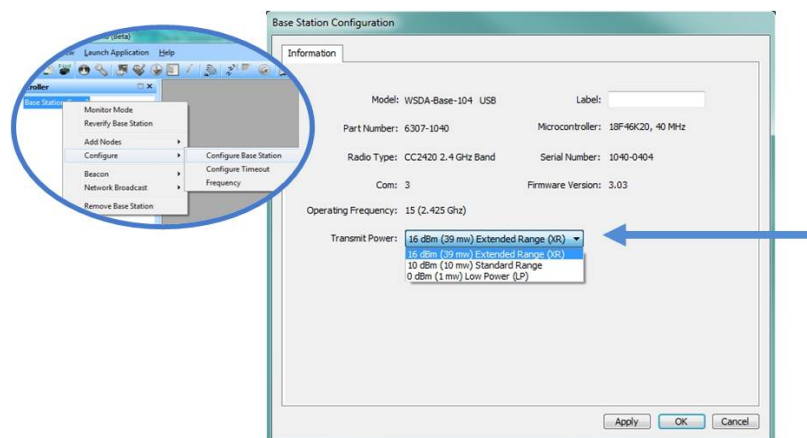


Figure 21 - Transmit Power Setting

4.6 Transmit Frequency

The transmit frequency of the wireless sensor network refers to the communication link between the gateway and the node. There are 14 available frequency channels between 2.405 and 2.470 GHz.

NOTE

- The gateway can automatically manage nodes operating on different frequencies by using the Node Discovery feature in Node Commander[®]. In this routine, the gateway listens for node broadcasts on the frequency channel to which it is set. If the node is in normal boot-up mode, it will provide the broadcast when it is initially powered-on, and it will broadcast on all channels. As long as the node is powered-on after activating the Node Discovery feature, the gateway will link to it and remember the channel setting for future node queries.
- Manually matching the node and gateway frequency channels is required in some applications. For example, when sending broadcast messages from the gateway to multiple nodes (including the synchronized sampling beacon) all nodes must be on the same channel as the gateway in order to receive the broadcast. Assigning channels is also a good idea when multiple gateways are attached to one host computer or when other wireless equipment is nearby and frequency or transmission interference may occur.

The frequency setting for the gateway can be changed from the Configure menu. .

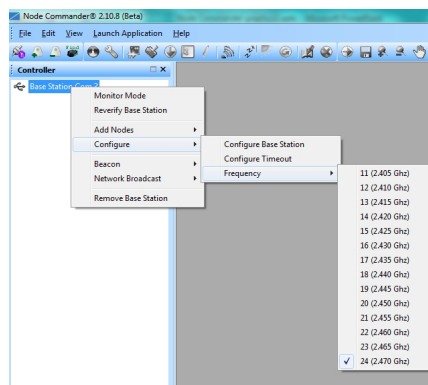


Figure 22 - Gateway Frequency

4.7 Monitor Mode

Monitor mode is used to observe any low duty cycle and synchronized sampling activity that is occurring on nodes connected to a particular gateway. When monitor mode is selected, the sampling window opens and displays the data. This is useful if the node was configured to start sampling on boot up or if the data acquisition screen was closed without stopping the node. It is a way to enter the data and graph view windows after data acquisition has already begun. The gateway will only monitor nodes that are on the same frequency (channel) that it is on.

To monitor a node, right click on the gateway name and select Monitor Mode.

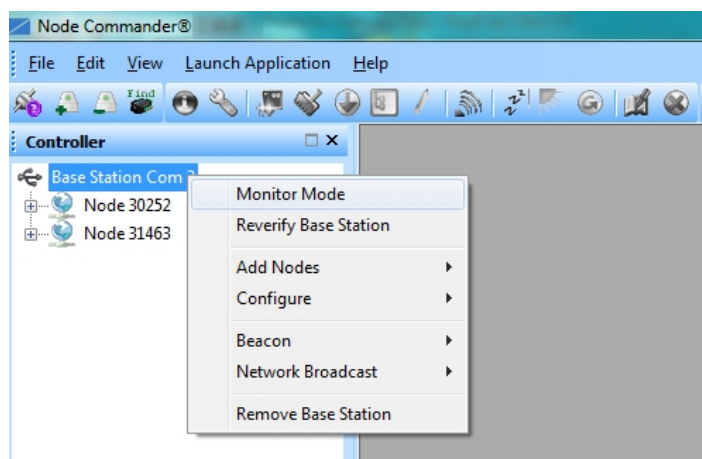


Figure 23 - Monitor Mode

4.8 Network Broadcast

The network broadcast feature is used to send the same command at the same time to multiple nodes connected to the same gateway. Nodes must be on the same transmission frequency (channel) as the gateway to receive broadcast commands. Network broadcast functions include communications, sampling, and configuration commands.

Network broadcast commands are found in the gateway menu. Right click on the gateway name, and select Network Broadcast. Then select the desired category and command.

Sample

- Synchronized Sampling Start
- Low Duty Cycle Start
- Armed Datalogging
- Trigger Datalogging Session
- Erase

Communicate

- Ping
- Stop Node
- Wake Node
- Sleep
- Cycle Power

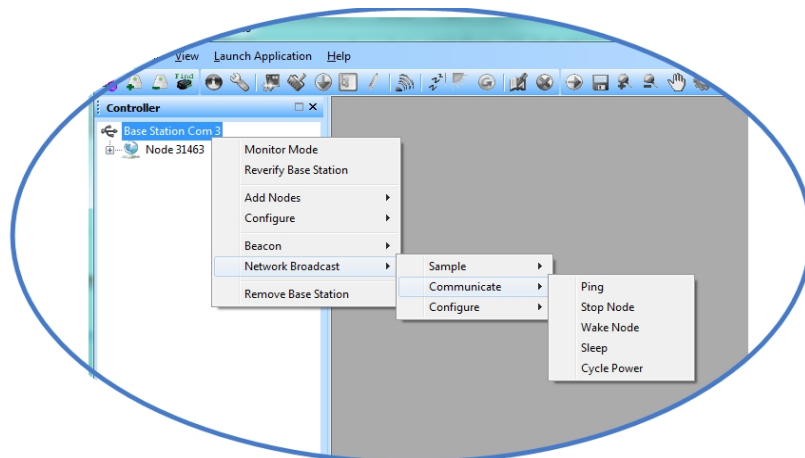


Figure 24 - Network Broadcast Commands

Configure

- Read/Write EEPROM

4.9 Using the Beacon

In synchronized sampling, the beacon feature is used to coordinate sampling and transmission timing between multiple nodes. The primary purpose is to avoid data collision, guarantee timing between samples from different nodes, and to time-stamp the data. The beacon cannot be used in any another sampling mode.

When the beacon is enabled, the gateway broadcasts a data message once every second containing a Coordinated Universal Time (UTC) time stamp, and it is used to update each node's real time clock (RTC). This continuous synchronization beacon, coupled with the accuracy of the gateway and node clocks (± 3 ppm drift), provides a node-to-node synchronization within ± 32 microseconds. The gateway receives the UTC from the host computer, so the host must be connected to a UTC time server to achieve that accuracy. There is some lag inherent in the Microsoft Windows distribution of the UTC. This dictates the overall accuracy of the time-stamp, but the synchronization times between the gateway and nodes will be consistent because of the accuracy of the embedded RTC clocks.

Nodes must be on the same transmission frequency (channel) as the gateway to receive the beacon broadcast command. When the beacon is active, the gateway device status indicator will pulse blue once per second. When the nodes connected to the gateway are in synchronized sampling mode, the network can be put to sleep by turning off the beacon and then resuming transmitting once the beacon is enabled.

It is recommended that the beacon be disabled when not performing synchronized sampling, or when not needed, to eliminate the possibility of over-the-air packet collisions which will result in lost data. It can also be disabled to avoid interference with other devices or gateways that are beaconing on the same frequency.

To enable and disable the beacon, right click on the gateway name and select the appropriate command. Alternately, the beacon can be activated from the synchronized sampling window when sampling is started, and stopped with the stop node command which can be executed when sampling is ended ([see Data Acquisition on page 17](#) and refer to the Node Commander[®] User Manual for more information). When the beacon is enabled, any node that is actively sampling in synchronized sampling mode on the same frequency as the gateway will synchronize to it automatically.

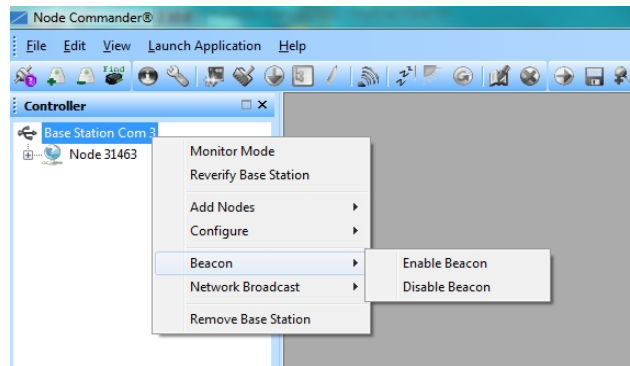


Figure 25 - Synchronized Sampling Beacon

4.10 Node Configuration and Other Settings

Node configuration is completed exclusively in Node Commander[®]. For an overview of sensor configuration and menus [see *Connect to Nodes on page 13*](#).

For additional node configuration and gateway settings not discussed in this manual, refer to the Node Commander[®] user manual ([see *Reference Information on page 52*](#)).

5. Gateway Installation

5.1 Installation Recommendations

The WSDA[®]-Base-104[®] is rated for indoor use only, unless housed in a ruggedized outdoor enclosure (purchased separately). It is designed for desktop use, although it can be mounted in any orientation as required by the application. It is recommended that it is mounted in a way that optimizes the wireless communications, typically with the antenna pointing upward. For more information see [Optimizing the Radio Link on page 34](#).

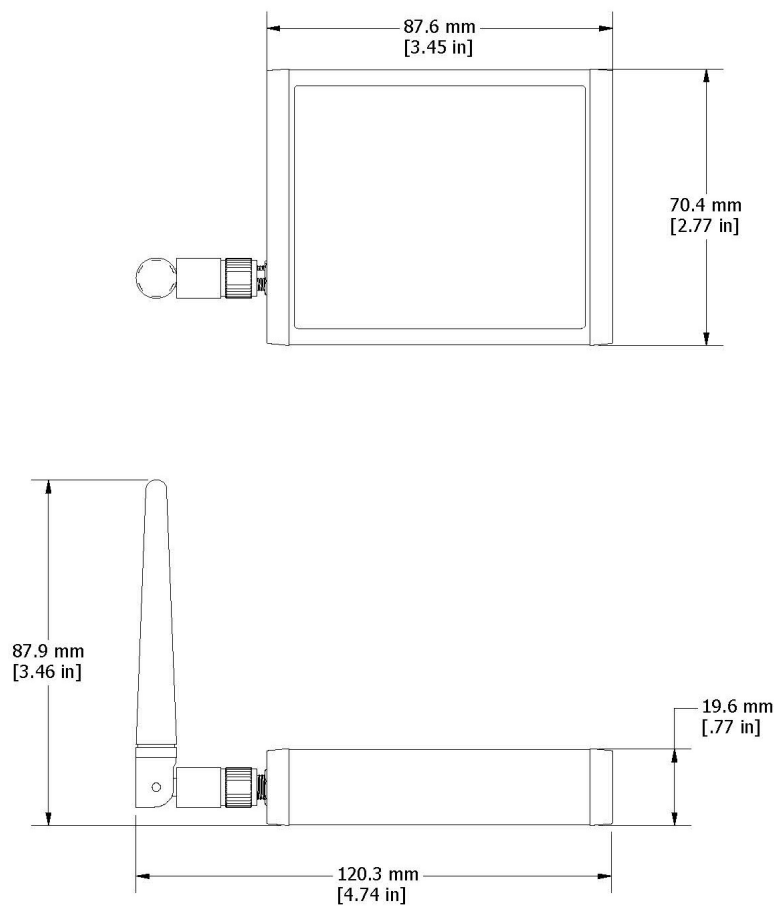


Figure 26 - Gateway Installation

5.2 Optimizing the Radio Link

In ideal conditions, the nodes and gateway can communicate up to two kilometers apart. In order to accomplish this, the node and gateway must be installed in a manner that optimizes the wireless transmission. The WSDA[®]-Base-104[®] operates at a 2.4GHz transmission frequency and comes standard with a right-angle, ¼-wave rubber whip antenna with an omni-directional radiation pattern. Using any other antenna than the one that is included with the node will void FCC compliance.

The best method for ensuring optimal radio communication is to conduct an RF survey of the installation site. This is easily accomplished in Node Commander[®] by using the range test feature to quantify the radio signal strength (RSSI) in various scenarios. [See Range Test on page 35](#) for instructions on using Node Commander[®] for measuring RSSI. The following are general guidelines for maximizing transmission range:

- **Establish Line of Sight (LOS)** between the node and gateway antennas as best as possible. Try to avoid obstructions between the antennas, such as buildings, terrain, vegetation, or other physical barriers. Increase the mounting height of the node or antenna to allow a clearer LOS path to the gateway. Height above the ground is also important because reflections off of the ground can interfere at the receiver. Generally, the higher above the ground the better.
- **Minimize Radio Frequency Interference (RFI)** such as other equipment antennas, especially those operating in the same frequency range. This includes other nodes. If other antennas are required nearby, mount them at different heights to minimize interference. Additionally, the specific node frequency is selectable within its operational range using the Node Commander[®] software. Set the devices to different transmission frequencies.
- **Minimize Electromagnetic Interference (EMI)** such as that which is generated by power transmission equipment, microwaves, power supplies, and other electromagnetic sources.
- **Metal Objects** in close proximity to either antenna, particularly ferrous metals such as steel and iron, can be problematic for wireless communications. The larger the object, the greater the influence.

5.2.1 Range Test

After establishing communication between node and gateway, use the range test feature in Node Commander® to monitor the signal strength and to optimally position the nodes, gateway, and antennas for installation. Maximum achievable range is determined by the gateway and node power settings (found in the device Configure menu) and is highly dependent on the physical environment surrounding the devices.

1. Right-click on the node header, and select Communicate > Range Test.

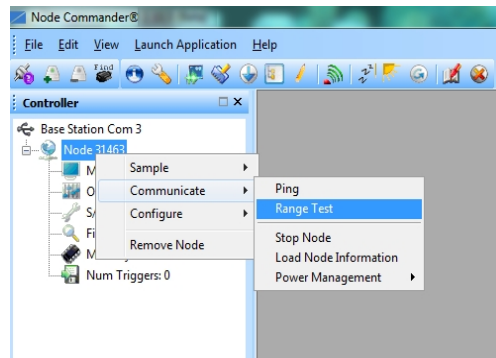


Figure 27 - Range Test Menu

2. The total RSSI range for the node and gateway is -90 to 0dBm. The higher the value (closer to zero), the better, but reliable communication can be achieved between -75 dBm and 0 dBm. The devices is still able to communicate between -90 dBm and -75 dBm, but it could be intermittent or result in data loss. Position the node and gateway antennas where the best RSSI value is observed.

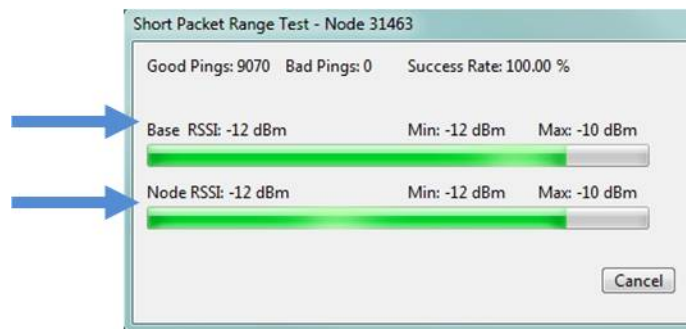
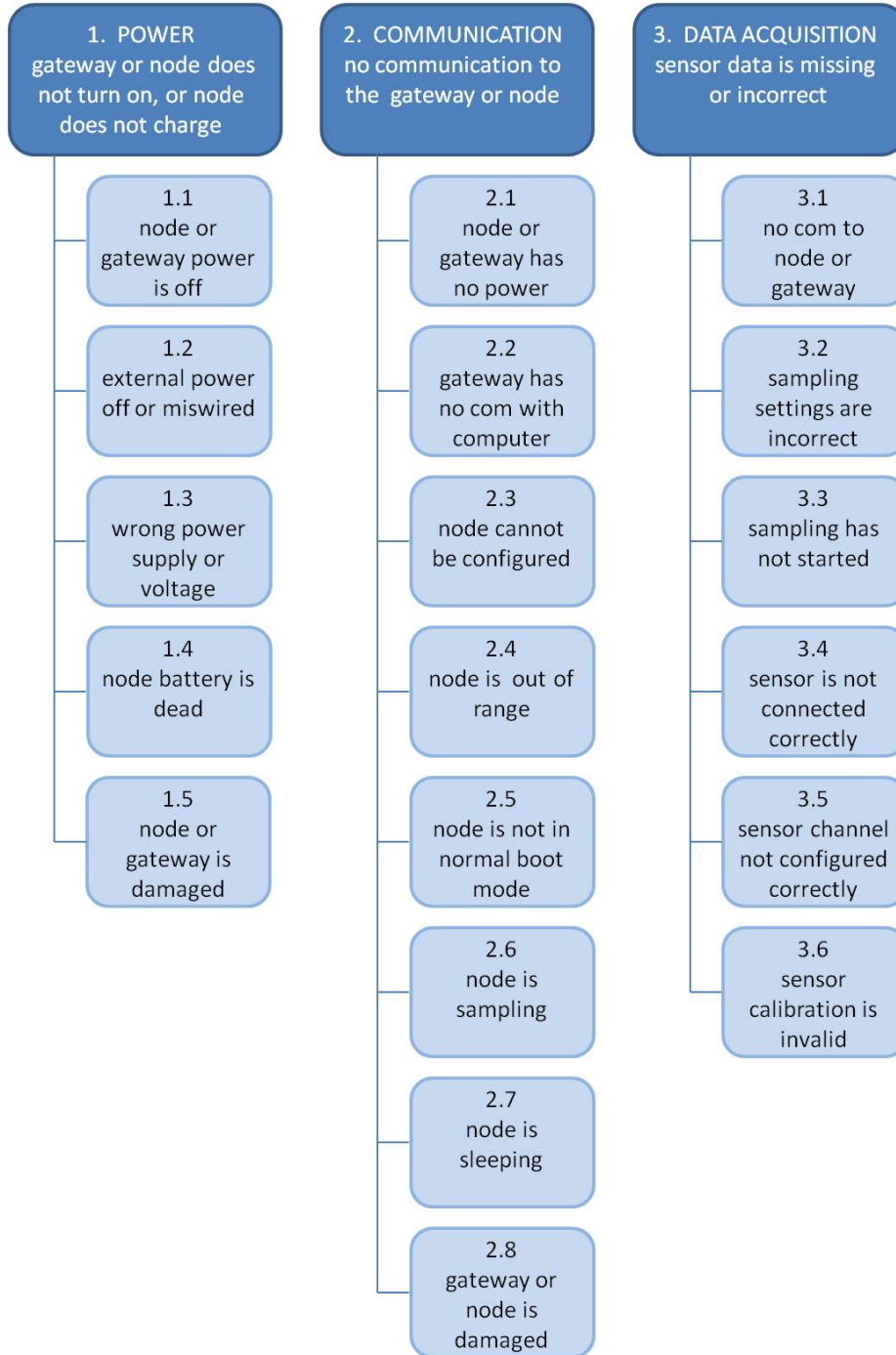


Figure 28 - Range Test Statistics

6. Troubleshooting

6.1 Troubleshooting Guide



Problem	Possible cause and recommended solution
<p>1. POWER</p> <p>gateway or node does not turn on</p>	<p>1.1 node or gateway power is off</p> <p>The status indicator LED on the device may be off. Turn the device on, and the status indicator LED should illuminate.</p>
	<p>1.2 external power is off or miswired</p> <p>Verify the device power source is connected correctly and powered on.</p>
	<p>1.3 wrong power supply</p> <p>Using a power supply other than the one specified for the device (or an external supply that is outside of the device operating range) could result in permanent damage to the device or cause it to not work properly.</p>
	<p>1.4 node battery is dead</p> <p>If the node will not power on, the node battery may need to be replaced. Contact LORD MicroStrain[®] Technical Support (See Technical Support on page 43).</p>
	<p>1.5 node or gateway is damaged</p> <p>If all power settings and connections have been verified, and the node is still unresponsive, contact LORD MicroStrain[®] Technical Support (See Technical Support on page 43).</p>
<p>2. COMMUNICATION</p> <p>no communication to the gateway or node</p>	<p>2.1 node or gateway has no power</p> <p>Verify the node and gateway have power applied and that applicable power switches are on. Power is indicated on both devices by a status indicator LED.</p>
	<p>2.2 gateway has no communication with the computer</p> <p>Verify gateway communication in the software. Check, remove, and reconnect communications and power cables as applicable.</p> <ul style="list-style-type: none"> • For serial gateways, verify that the COM port setting. • For USB gateways, verify that the drivers are installed on the computer (included with Node Commander[®]) and that the software has had sufficient time to detect it.

Problem	Possible cause and recommended solution
	<ul style="list-style-type: none"> For Ethernet gateways, use Live Connect™ to verify communications on a DHCP network. Check that the extended timeouts are enabled in the Node Commander[®] Edit > Preferences menu, under Devices. Once communication has been established, the network configuration can be changed.
	<p>2.3 node cannot be configured</p> <p>Observe the node status indicator LED to determine the device's state: boot, idle, sample, or sleep. If the node is sampling or sleeping, it cannot be configured. In Node Commander[®], execute the Stop Node command to put the node in idle state, allowing configuration to occur.</p> <p>If the user inactivity timeout is set very low, the configuration menu will have to be entered quickly, before the timeout occurs, putting the node back in a sample or sleep state.</p>
	<p>2.4 node is out of range</p> <p>Perform a bench test with the node in close proximity to the gateway to verify they are operational. For range test and installation recommendations see Range Test on page 35. The system has been tested to operate with the node and gateway up to 2 km apart with clear line of sight.</p>
	<p>2.5 node is not in normal boot mode</p> <p>If the node status indicator shows the node booting in a mode other than the normal boot mode, it can be bypassed by toggling the node ON/OFF switch rapidly three times, then leaving it in the ON position for normal power up. In normal boot mode the communication can be established with automatic node discovery (or manually) once the boot process is complete and the node is in idle state. Start-up mode can then be changed in the software.</p>
	<p>2.6 node is sampling</p> <p>Observe the node status indicator LED to determine the device's state: boot, idle, sample, or sleep. If the node is sampling, it cannot be configured. In Node Commander[®],</p>

Problem	Possible cause and recommended solution
	<p>execute the Stop Node command to put the node in idle state, allowing configuration to occur.</p>
	<p>2.7 node is sleeping</p> <p>Observe the node status indicator LED to determine what state it is: boot, idle, sample, or sleep. If the node is sleeping, it cannot be configured. In Node Commander®, execute the Stop Node command to put the node in idle state, allowing configuration to occur.</p>
	<p>2.8 gateway or node is damaged</p> <p>Verify all connections, power, and settings. If available, try installing alternate nodes and gateways one at a time to see if the faulty device can be identified. If no conclusion can be determined or to send a device in for repair, contact LORD MicroStrain® Technical Support (See Technical Support on page 43).</p>
<p>3. DATA ACQUISITION sensor data is missing or incorrect</p>	<p>3.1 no communication to node or gateway</p> <p>Verify connections and power to the node and gateway. Verify they are powered on and communicating with the software. Enter a configuration menu to verify that the node can be accessed.</p>
	<p>3.2 sampling settings are incorrect</p> <p>If the sampling mode, rate, or duration are not performing as expected, enter the node configuration menu, and verify the sampling settings.</p>
	<p>3.3 sampling has not started</p> <p>If sampling is occurring, the sampling mode will be displayed next to the node name in Node Commander®. The node device status indicator will also be flashing the sampling mode code. If the node is not sampling, activate it in the software or with a sample on start up boot sequence.</p>
	<p>3.4 sensor channel not configured correctly</p> <p>Verify that the sensor is configured on the correct channel and has been enabled for data acquisition.</p>

Problem	Possible cause and recommended solution
	<p>3. sensor calibration is invalid</p> <p>External sensors come with a factory calibration value that is entered during configuration. Internal sensors are factory calibrated and should not need adjustment. The calibration data is provided with the sensor when purchased. If possible, perform a field verification of the sensors by applying known loads and comparing the measured values. In the channel configuration settings, verify that the calibration calculations are correct. Verify that the gain and offset range are correct and that the baseline offset is set with Auto Balance, as applicable. Verify that the calibration values (slope and offset) are correct. Verify that the sensor channel units are selected correctly. Verify that all parameters were written to the node channel. Recalibrate as needed.</p>

6.2 Communications Ports in Windows[®]

Serial gateways (including USB gateways) have either a standard serial or virtual communications port in Windows[®]. Windows[®] Device Manager can be used to determine what communication port the gateway is connected to.

1. Click on the Windows[®] Start icon, and select Control Panel.
2. Navigate to the System menu, and select Device Manager. The menus may appear different depending on the version of Windows and the View settings.

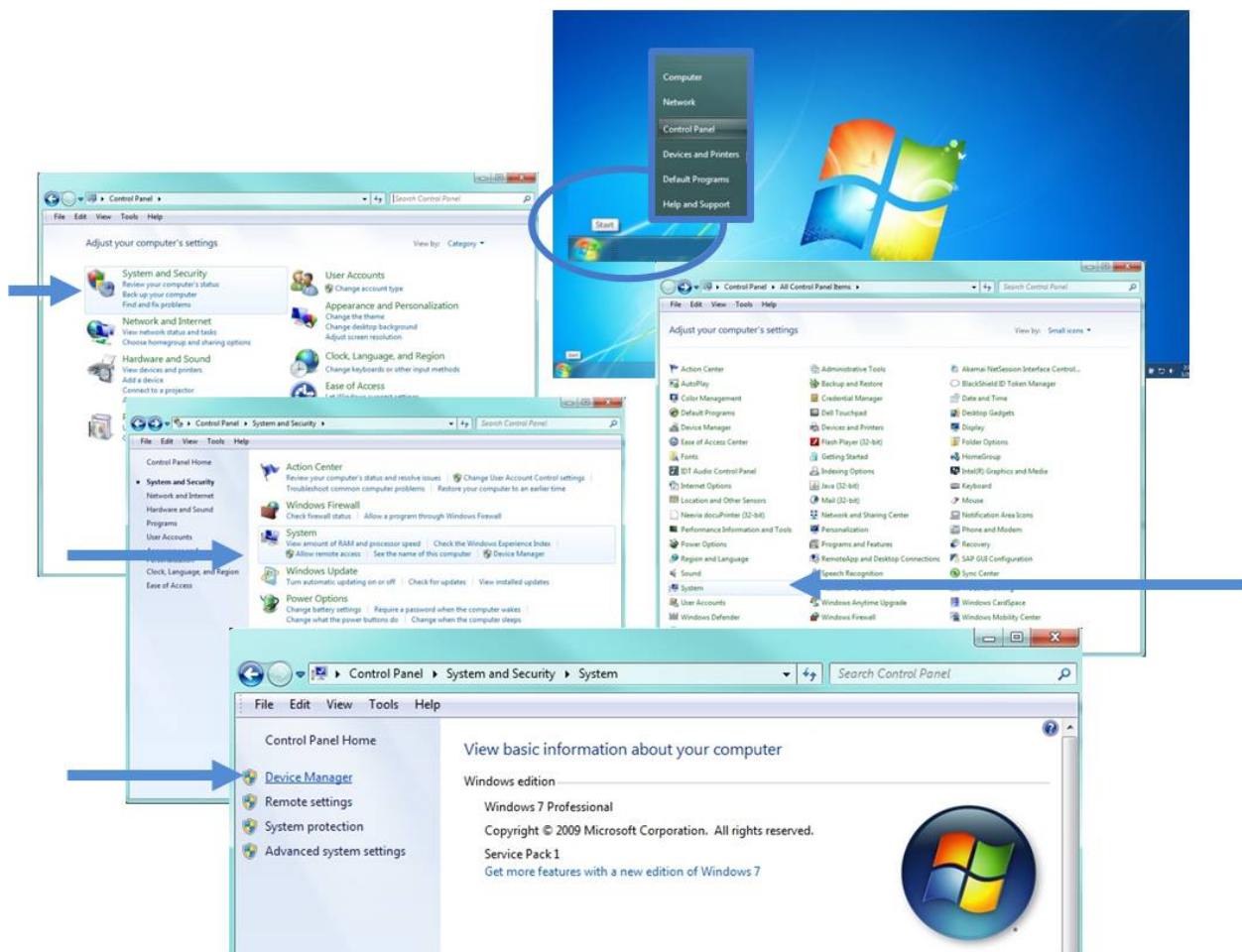


Figure 29 - Windows[®] System Menu

3. In Device Manager, expand the view for Ports (COM and LPT). Active COM ports will appear on this list with the COM port number. A USB gateway will be displayed as USB to UART Bridge (COM X). A serial gateway will be attached to the Communications Port (COMX). An Ethernet gateway will be connected to a Virtual Serial port (COMX). If no port is listed, the port is not recognized by the computer, and no gateway communication can be established.

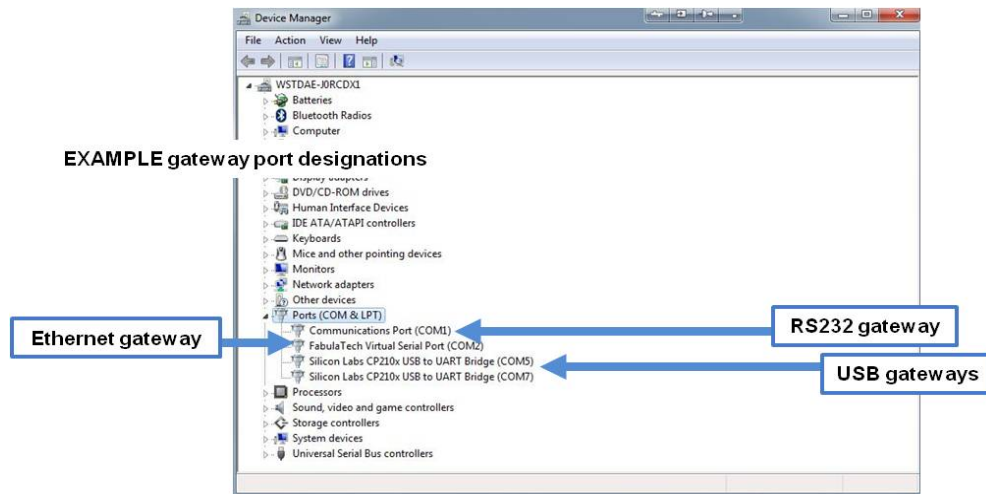


Figure 30 - Windows[®] Device Manger Menu

6.3 Technical Support

There are many resources for product support found on the LORD MicroStrain® website, including technical notes, FAQs, and product manuals.

http://www.microstrain.com/support_overview.aspx

For further assistance our technical support engineers are available to help with technical and applications questions.

Technical Support

sensing_support@LORD.com

Phone: 802-862-6629

Fax: 802-863-4093

SKYPE: microstrain.wireless.support

Live Chat is available from the website during business hours:
9:00 AM to 5:00 PM (Eastern Time US & Canada)

7. Maintenance

There are no user-serviceable parts on the WSDA[®]-Base-104[®]. For device service and repair contact LORD MicroStrain[®] Technical Support ([see *Technical Support on page 43*](#)).

8. Parts and Configurations

8.1 Standard Models

For the most current standard, custom, and OEM product options, refer to the LORD MicroStrain® website or contact the LORD MicroStrain® Sales Department.

Model Number	Description	LORD MicroStrain® Part Number
WSDA-Base-104-LXRS	Wireless USB Base Station	6307-1040
WSDA-Base-102-LXRS	Wireless RS232 Base Station	6307-1020
WSDA-Base-101-LXRS	Wireless Analog Base Station	6307-1010

8.2 Gateway Accessories

Description	LORD MicroStrain® Part Number
Standard whip antenna (FCC compliant)	9010-0049
USB cable, Micro-B, 1 meter long	9022-0029
Node charging power supply	9011-0024
Node power supply international plug adapters	9011-0009
Node Commander® software flash drive	8200-0021

Table 4 - Gateway Accessories

8.3 Wireless System Equipment

The following system parts are available for use with the WSDA®-Base-104®. For the most current standard, custom, and OEM product options, refer to the LORD MicroStrain® website or contact the LORD MicroStrain® Sales Department. [See Product Ordering on page 47.](#)

Model	Description	LORD MicroStrain® Part Number
--	Node Commander® Software	6301-0300
--	SensorCloud™ Software Subscription (contact LORD MicroStrain® Sales)	--
G-Link-LXRS	Wireless Accelerometer Node	various models
G-Link2-LXRS	Wireless Accelerometer Node	various models
SG-Link-LXRS	Wireless 2-Channel Analog Input Sensor Node	various models
SG-Link-OEM	Wireless 2-Channel Analog Input Sensor Node	various models
SG-Link-RGD	Ruggedized Wireless Analog Sensor Input Node	various models
V-Link-LXRS	Wireless 7-Channel Analog Input Sensor Node	various models
TC-Link-LXRS	Wireless Thermocouple Node	various models
DVRT-Link-LXRS	Wireless Displacement Sensor Node	various models
ENV-Link-Mini-LXRS	Wireless Environmental Sensor Node	various models
Watt-Link-LXRS	Wireless Energy Monitoring Sensor Node	various models
RTD-Link-LXRS	Wireless RTD Sensor Node	various models
IEPE-Link -LXRS	Wireless IEPE Accelerometer Node	various models

Table 5 - Wireless System Equipment

8.4 Product Ordering

Products can be ordered directly from the LORD MicroStrain[®] website by navigating to the product page and using the Buy feature.

<http://www.microstrain.com/wireless>

For further assistance, our sales team is available to help with product selection, ordering options, and questions.

Sales Support

sensing_sales@LORD.com

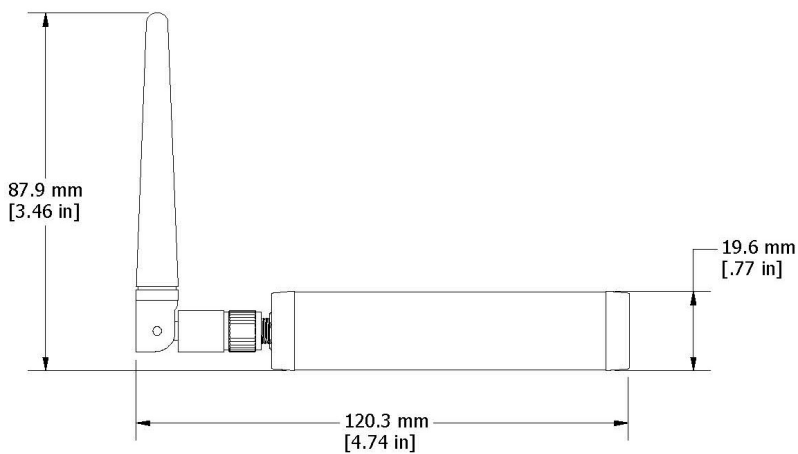
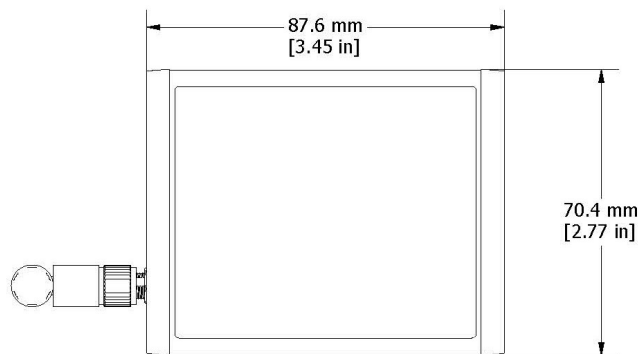
Phone: 802-862-6629

Fax: 802-863-4093

9:00 AM to 5:00 PM (Eastern Time US & Canada)

9. Specifications

9.1 Physical Specification



Dimensions: 120.3 mm x 70.4 mm x 87.9 mm

Weight: 123 grams

Enclosure Environmental Rating: General purpose indoor

9.2 Operating Specifications

Parameter	Specifications
General	
Connectivity	USB 2.0 virtual serial communication @ 921,600 bps
Sampling	
Supported node sampling modes	Synchronized, low duty cycle, continuous, periodic burst, event-triggered, and datalogging
Synchronization beacon interval	1 Hz beacon provides ± 32 μ sec node-to-node synchronization
Synchronization beacon stability	± 3 ppm
Network capacity	Up to 2000 nodes per RF channel (and per gateway) depending on the number of active channels and sampling settings. Refer to the system bandwidth calculator: http://www.microstrain.com/configure-your-system
Operating Parameters	
Radio frequency (RF) transceiver carrier	2.405 to 2.470 GHz direct sequence spread spectrum over 14 channels, license-free worldwide, radiated power programmable from 0 dBm (1 mW) to 16 dBm (39 mW); (low power option available for use outside the U.S.A. - limited to 10 dBm (10 mW))
RF communication protocol	IEEE 802.15.4
RF range	70 m to 2 km line of sight with RF power setting
Power source	USB port: 5 V dc standard
Power consumption	Idle: 45.7 mA; Eight active node channels operating at 256 Hz low duty cycle: 65.6 mA
Operating temperature	-40 °C to +85 °C (electronics) -30 °C to +70 °C (enclosure/antenna)
Physical Specifications	
Dimensions	88 mm x 70 mm x 20 mm without antenna
Weight	123 grams
Enclosure material	Black anodized aluminum
Integration	
Connectors	Micro-USB
Communications cable	USB standard to USB micro-B (3 foot cable included in starter kit)
Compatible sensor nodes	All LXRS [®] sensor nodes, all legacy 2.4 GHz nodes
Firmware	Firmware upgradeable through software interface
Software	SensorCloud [™] , Node Commander [®] , WSDA [®] Data Downloader, Live Connect [™] , Windows XP/Vista/7 compatible
Software development kit (SDK)	Data communications protocol available with EEPROM maps and sample code (OS and computing platform independent) http://www.microstrain.com/wireless/sdk
Regulatory compliance	FCC (U.S.), IC (Canada), CE, ROHS

9.3 Radio Specifications

The WSDA[®]-Base-104[®] USB Base Station employs a 2.4GHz IEEE 802.15.4 compliant radio transceiver for wireless communication. The radio is a direct-sequence spread spectrum radio and can be configured to operate on 14 separate frequencies ranging from 2.405 GHz to 2.470 GHz. Following the 802.15.4 standard, these frequencies are aliased as channels 11 through 24. For all newly manufactured nodes, the default setting is 2.425 GHz (channel 15).

For standard models, radiated transmit power is programmable from 0 dBm (1 mW) to 16 dBm (39 mW). A low-transmit power option is available (for use in Europe and elsewhere) and is limited to 10 dBm (10 mW).

The radio complies with FCC Part 15 (USA) and IC (Canada) regulations. The radio is license-free worldwide. Using antennas and transmission equipment other than what is provided may void FCC compliance.

10. Safety Information

This section provides a summary of general safety precautions that must be understood and applied during operation and maintenance of components in the LORD MicroStrain[®] Wireless Sensor Network.

10.1 ESD Sensitivity

The WSDA[®]-Base-104[®] is susceptible to damage and/or disruption of normal operation from Electrostatic Discharge (ESD), particularly during data acquisition.

CAUTION NOTICE



ESD damage can occur when the device is touched, especially at the device interfaces such as the antenna and connectors. Use proper grounding techniques when handling. If an ESD event occurs, and operation has been interrupted, reset the device by cycling power to it and/or restarting the operational mode in the system software.

11. References

11.1 Reference Information

Many references are available on the LORD MicroStrain® website including product user manuals, technical notes, and quick start guides. These documents are continuously updated, and new applications are added. They may provide more accurate information than printed or file copies.

Document	Where to find it
SensorCloud™ Overview	http://www.sensorcloud.com/system-overview
MathEngine® Overview	http://www.sensorcloud.com/mathengine
Product Datasheets	http://www.microstrain.com/wireless/sensors
Product Manuals and Technical Notes	http://www.microstrain.com/support/docs
Product Application Notes	http://www.microstrain.com/applications
NIST Calibration Procedures	http://www.nist.gov/calibrations/
ASTM Testing Procedures	http://www.astm.org/Standard/standards-and-publications.html
LORD MicroStrain® Wireless Sensors Network Software Development Kit	http://www.microstrain.com/wireless/sdk

Table 6 - Related Documents

11.2 Glossary

These terms are in common use throughout the manual:

A/D Value: the digital representation of the analog voltages in an analog-to-digital (A/D) conversion. The accuracy of the conversion is dependent on the resolution of the system electronics; higher resolution produces a more accurate conversion. Also referred to as "bits".

Base Station: The base station is the transceiver that attaches to the host computer and provides communication between the software and the node(s). It is also referred to as a "gateway".

Burst Sampling: a mode of operation in synchronized sampling that takes momentary high sample rate readings with configurable time durations and intervals

Calibration: to standardize a measurement by determining the deviation standard and applying a correction (or calibration) factor

Configuration: a general term applied to the node indicating how it is set up for data acquisition. It includes settings such as sampling mode and rate, number of active channels, channel measurement settings, offsets, hardware gain, and calibration values.

Coordinated Universal Time (UTC): the primary time standard for world clocks and time. It is similar to Greenwich Mean Time (GMT).

Cycle Power: a command transmitted to the node to reboot it, either through a hardware or software switch

Data Acquisition: the process of collecting data from sensors and other devices

Data Logging: the process of saving acquired data to the system memory, either locally on the node or remotely on the host computer

DHCP (network): Dynamic Host Configuration Protocol is the standardized networking protocol used on Internet Protocol (IP) networks, which automatically configures devices that are attached to it by assigning and configuring the device IP address.

EMI: Electromagnetic Interference is an inductive or radiated disturbance that can create signal degradation on electrical signals, including loss of data.

ESD: Electrostatic Discharge is the sudden flow of electricity that can occur between two charged objects of different potential that come in contact or in close proximity of each other. Static electricity is a common source of ESD.

Firmware: the code that is programmed onto a microcontroller or similar device in an embedded system. It includes device operation commands, conditions, memory allocation, and many other tasks.

Gateway: The gateway is a transceiver that attaches to the host computer and provides communication between the software and the node(s). It is also known as a “base station”.

Host (computer): The host computer is the computer that orchestrates command and control of the attached devices or networks.

LED: Light Emitting Diode is an indicator light that is used in electronic equipment.

LOS (Line of Sight): is used in radio communications to describe the ideal condition between transmitting and receiving antennas in a radio network. As stated, it means the antennas are in view of each other with no obstructions.

LXRS[®]: Lossless Extended Range Synchronized is the proprietary LORD MicroStrain[®] data communications protocol used in the wireless sensor network.

Node: The node is the wireless transceiver that the sensor(s) is connected to, providing communication with the gateway. The G-Link[®] -LXRS[®], V-Link[®] -LXRS[®], and SG-Link[®] -LXRS[®] are examples of nodes manufactured by LORD MicroStrain[®].

Node Tester board: The Node Tester board is a device designed by LORD MicroStrain[®] that can be plugged into nodes to test their functionality.

Offset: When describing a mathematically-linear relationship, the offset is the value where the line that represents the relationship in a graph crosses the y-axis. The equation of a straight line is: $y = mx + b$, where x is the x-axis coordinate, y is the y-axis coordinate, m is the slope and b is the offset.

Oversampling: In signal processing, oversampling is a technique used to achieve increased signal resolution and better noise immunity by recording readings at a higher frequency than the output of the device being measured. In analog-to-digital conversion, the higher the oversampling rate, the better the recreated analog signal.

Packet: unit of sampled data

Ping: a byte transmitted by the gateway to the node. The node responds by echoing the byte, indicating communication exists between the node and gateway.

Range Test: a continuous string of pings used to validate communication between the gateway and the node over distance and obstruction

Real Time Clock (RTC): a computer clock that keeps track of the current time

RFI: Radio Frequency Interference is a disturbance in an electrical circuit due to electromagnetic induction or radiation.

RSSI: Received Signal Strength Indication is a measurement of the transmission power in a radio signal. It is measured in decibels with reference to 1 milliWatt (dBm).

RS232: a serial data communications protocol

Sensor: a device that physically or chemically reacts to environmental forces and conditions, producing a predictable electrical signal

Sleep: a command transmitted to the node to put it into sleep configuration

Sampling: the process of taking measurements from a sensor or device

Sampling Mode: the type of sampling that is being utilized, such as event-triggered, continuous, or periodic. The nodes have several sampling modes that employ these types of sampling.

Sampling Rate: the frequency of sampling

Slope: When describing a mathematically linear relationship, the slope is the steepness of the line that represents that relationship on a graph. The equation of a straight line is: $y = mx + b$, where x is the x-axis coordinate, y is the y-axis coordinate, m is the slope, and b is the offset.

Streaming: Streaming is a sampling mode in which all active channels (and the sensors attached to them) are measured, and the acquired data is transmitted to the gateway and software. The data is not written to non-volatile memory during streaming. Streaming can either be finite (have a user defined start and end time) or continuous (continued until the power is cycled on the node).

Synchronized Sampling: a sampling mode that automatically coordinates all incoming node data to a particular gateway. This mode is designed to ensure data arrival and sequence.

Transmission rate: the number of data packets per transmission window, measured in seconds. Depending on the sampling mode and settings it will be between 1 and 64 packets/second.

Transmission window: the time allowed for one data transmission at the automatically determined transmission rate

USB: Universal Serial Bus, a serial data communications protocol

WSN: Wireless Sensor Network describes a distribution of sensors and data acquisition equipment that autonomously monitors environmental characteristics, such as temperature, pressure, and strain.