WSDA®-1500-LXRS®

Wireless Sensor Data Aggregator

LORD MicroStrain®
SENSING SYSTEMS

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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.

INPUT SENSORS   WIRELESS NODES   GATEWAYS   SOFTWARE
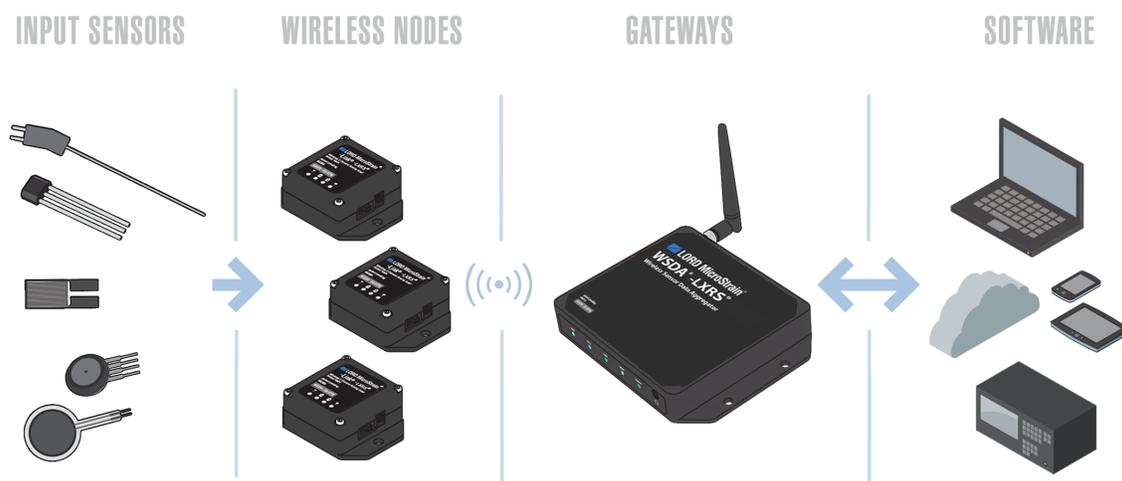
The selection of available nodes allows interface with many types of sensors, including accelerometers, strain gauges, pressure transducers, load cells, torque and vibration sensors, magnetometers, 4 to 20mA sensors, thermocouples, RTD sensors, soil moisture and humidity sensors, inclinometers, and orientation 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 periodic 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.

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2.   Gateway Overview

The WSDA®-1500-LXRS® Wireless Sensor Data Aggregator is a network gateway designed to configure, co-ordinate, and collect sensor data from LORD MicroStrain® wireless sensor nodes. The WSDA®-1500-LXRS® is Ethernet-capable and can be configured to operate with a static IP, a DHCP-enabled LAN, or as a datalogger to local memory. Secure, web-based data access and analysis is available with integration to the SensorCloud™ platform.

The WSDA®-1500-LXRS® is also capable of pushing sensor data onto a J1939-compatible CAN bus either by sending all of the sensor messages to one CAN address or by broadcasting user-selected messages onto the CAN bus.

Figure 1 - WSDA®-1500-LXRS® Wireless Sensor Data Aggregator

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2.1 Gateway Components

The WSDA®-1500- LXRS® can be purchased individually or in a starter kit. The starter kit includes everything required to operate the WSDA®-1500- LXRS® including a removable external antenna, a power supply, and cables for interfacing with the host computer or network. For a complete list of available configurations, accessories, additional system products, and ordering information .

Item	Description	Quantity
A	WSDA®-1500-LXRS® Wireless Sensor Data Aggregator	1
B	Antenna	1
C	Ethernet cable, 10 ft	1
D	Power supply and plug adapter kit	1
--	Node Commander® Software Suite, User Manual, Quick Start Guide, and WSDA® Access Certificate	1

Table 1 - Starter Kit Components

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2.2   Gateway Interface

The WSDA®-1500-LXRS® interfaces include a power input jack , a power on/off switch, an antenna connector for attaching the gateway antenna, an Ethernet jack, a multi-use (multi-port) connector, and a USB port reserved for future use.

The indicators on the WSDA®-1500-LXRS® include a several device and data status indicators, and a power indicator. The following table describes basic indicator behavior. For a complete list of all indicator behaviors *see Device Status Indicators on page 91*.
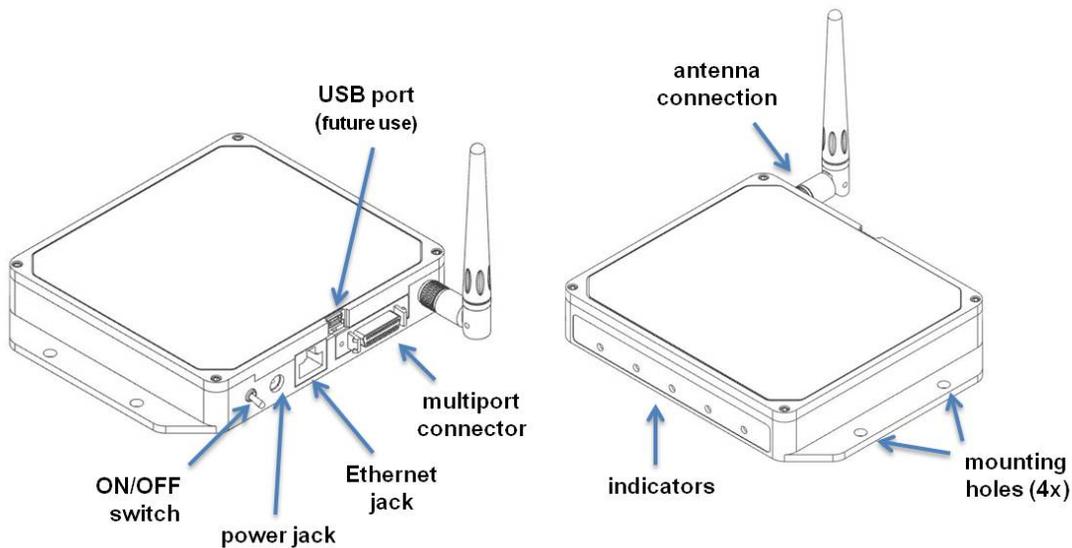
Figure 2 - Ports and Indicators

Indicator	Behavior	Node Status
POWER	OFF	Gateway is off
	ON green	Gateway is on
CLOUD	Flashing blue	Uploading data to SensorCloud™
	ON green	Web upload successful
	ON red	Web upload error
DATA	Flashing green	Receiving wireless data
	Flashing blue	Sync sampling beacon enabled
WSDA	ON green	Fully booted & idle
	Flashing blue & green	Sampling and porting data through Node Commander®

Table 2 - Basic Indicator Behaviors

3.   System Operational Overview

The gateway is the interface between LORD MicroStrain® sensor nodes and the data acquisition computer or network. 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.

Communication protocols between the gateway and host computer vary depending on which model gateway is used. Ethernet gateways have an embedded operating system and utilize a web based interface for device configuration.

LORD MicroStrain® has two software programs available for data acquisition from the wireless sensor network: SensorCloud™ and Node Commander®. SensorCloud™ is an optional web-based data collection, visualization, analysis, and remote management platform based on cloud computing technology. Node Commander® is used for configuring gateways and nodes, selecting sampling modes and parameters, initializing data acquisition, and viewing and saving data.

The operational overview describes system hardware and software setup, and the basic navigation of Node Commander® used to configure the node and begin data acquisition. A brief overview of porting data to SensorCloud™ is also included. This section is included 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. The software is provided with all gateways and is available on the LORD MicroStrain® website (*see References on page 106*).

The suite 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.

- **WSDA® Data Downloader** is used to download acquired data from the flash memory card embedded in an applicable gateway, to a host computer.

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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. For more information *see Data Handling on page 30*.

Users can also design custom programs with the open source data communications protocol (*see References on page 106*).

3.2   System Connections

To acquire sensor data the following components are needed: 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™). For a connections overview refer to *Figure 3 - System Connections* .

The sensor, node, gateway, and software selection are application-dependent, but the basic interfaces are the same. For a connections overview using the WSDA®-1500-LXRS® refer to *Figure 3 - System Connections* .

Users can also write custom programs by utilizing the LORD MicroStrain® Wireless Sensors Network Software Development Kit

Figure 3 - System Connections
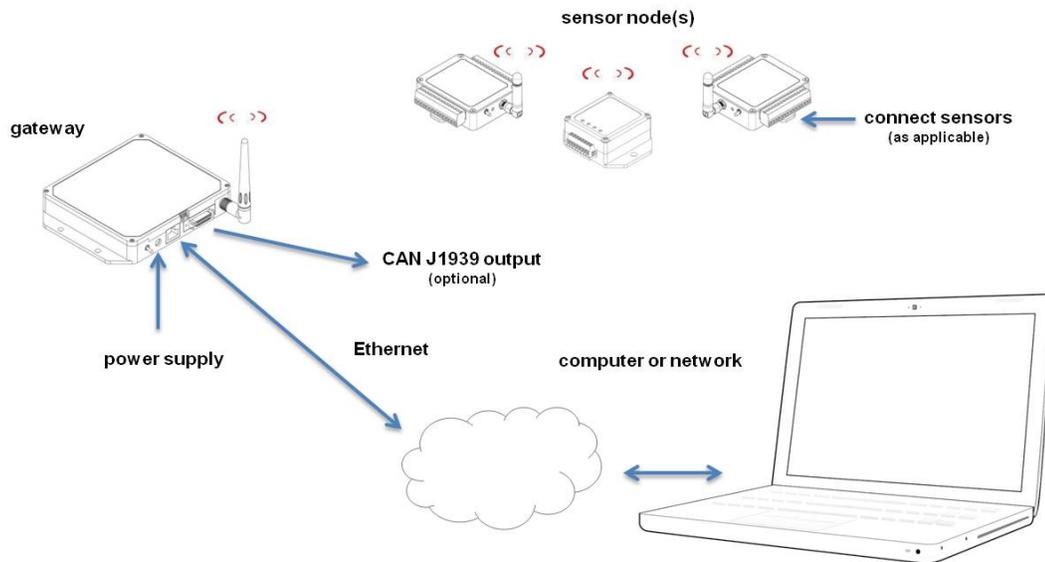
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3.3   Gateway Operation

NOTE

The default configuration of Ethernet gateways is for DHCP network connectivity. In order to change the gateway communication settings, initial connection to a DHCP-enabled network is required.

The Ethernet gateway has three primary operating sequences:

a. **Gateway configuration** in the internal gateway operating system Control Panel (accessible through Live Connect™ and any non-deprecated web browser, or directly through the browser)

b. **Node configuration and data acquisition** through Node Commander® (accessible through Live Connect™)

c. **Data acquisition, viewing, and analysis** through SensorCloud™ (accessible through a live web connection)

3.3.1   Gateway Configuration

The WSDA®-1500-LXRS® configuration Control Panel can be accessed using Live Connect™ or directly through a web browser.

To connect directly to the gateway Control Panel through a web browser, type the device's IP address into the browser address bar and press enter (*Figure 4 - Gateway Control Panel Access (Browser)*).
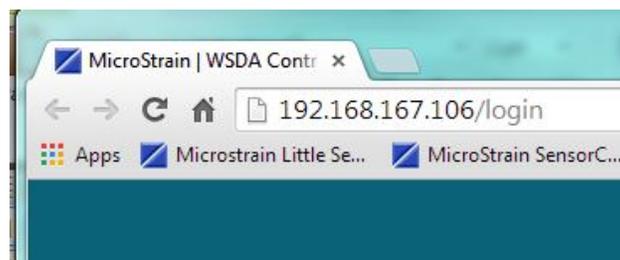
Figure 4 - Gateway Control Panel Access (Browser)

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To connect to the gateway Control Panel through Live Connect™, an initial connection to a DHCP enabled network is required.

1. Connect the host computer and gateway to the DHCP network, and apply power to the gateway. Verify the gateway status indicator shows that it is on and has completed the boot up process (*see Gateway Interface on page 10*).

2. Open Live Connect™. The gateway will be detected automatically but, depending on the network, it may take two to three minutes. Once detected, the gateway will appear on the list of discovered devices and can be identified by its name or serial number (with a WSDA® prefix) in the Device Name column (*Figure 5 - Live Connect™ Interface*).
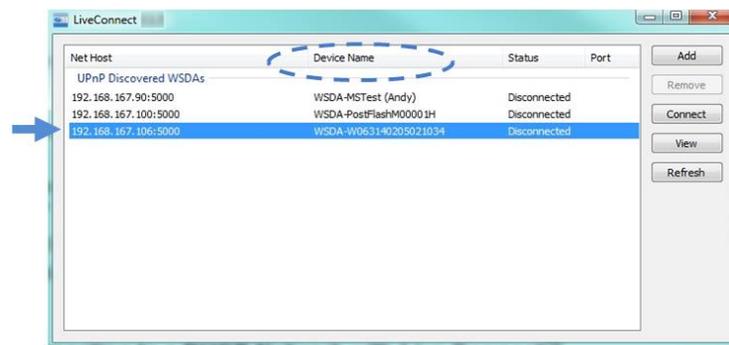
Figure 5 - Live Connect™ Interface

3. To access Control Panel through Live Connect™, highlight the device, and select the View button (*Figure 6 - Gateway Control Panel Access (Live Connect™)*).

Figure 6 - Gateway Control Panel Access (Live Connect™)

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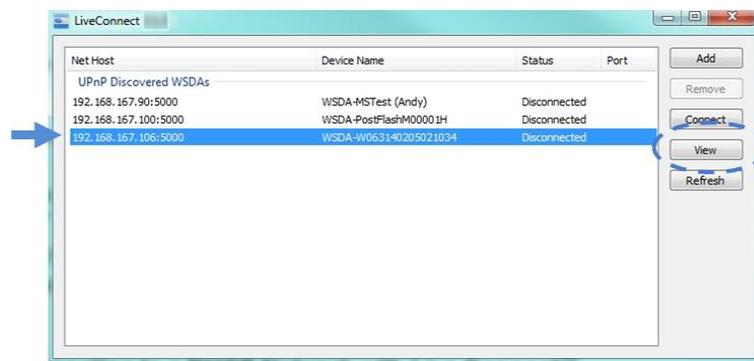
3.3.2   Gateway Control Panel

Log in to the gateway Control Panel with the default credentials:
    a.   Login: wsda
    b.   Password: wsda
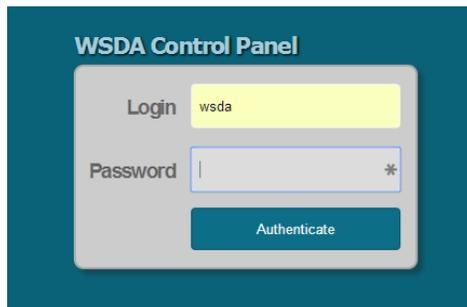
Figure 7 - Log-in to Control Panel

The default Control Panel page after log-in is the About page. This page provides general information about the device including serial number, network connection type, and system information, such as system time.

Figure 8 - Control Panel Main Menu

There is a navigation panel on the left that contains three menu categories; General, Data, and Tools (*Figure 9 - Control Panel Menus*).
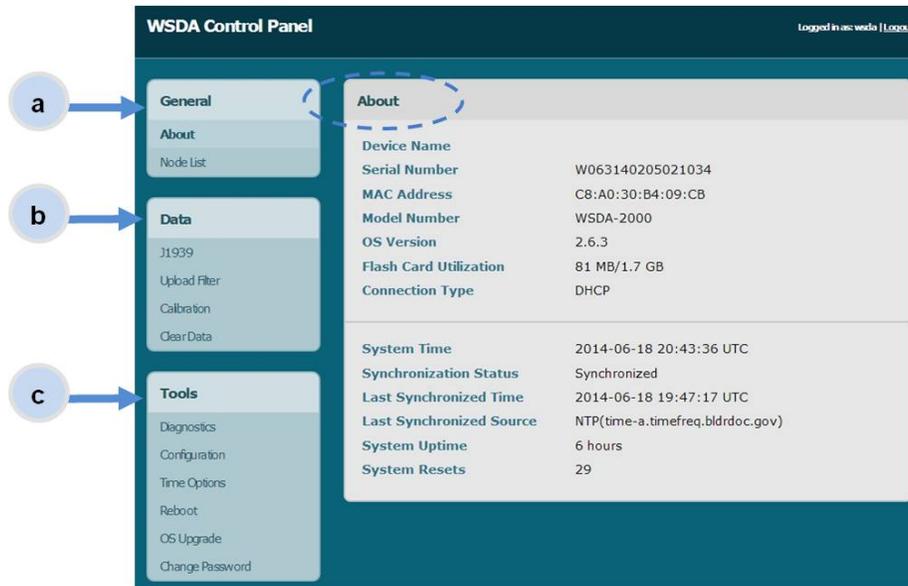
Figure 9 - Control Panel Menus

a. **General** - This category includes menu selections for information about the gateway's identity and time settings (About) and the sensor nodes it currently has data for in memory (Node List).

b. **Data** - This category includes menu selections that allow users to set which node and channel data is uploaded to SensorCloud™ (Upload Filter), set which data is pushed out the CAN J1939 port (J1939), apply calibration coefficients to data downloaded from the gateway internal memory (Calibration), and clear data from the device internal memory (Clear Data).

c. **Tools** - This category includes menu selections for troubleshooting the gateway (Diagnostics); configuring communication settings, enabling and disabling operating sequences, changing the node synchronization beacon state, and changing the gateway radio frequency (Configuration); configuring system time (Time Options); rebooting the gateway (Reboot); updating the operating system (OS Upgrade); and changing the Control Panel log-in (Change Password).

3.4   Connecting to Node Commander®

Node configuration is done in Node Commander®. The following steps provide an overview of how to access the sensor node configuration menus in Node Commander® through the gateway Live Connect™ interface. In these menus node sensing channels are configured and enabled, sampling modes are selected, and data acquisition can be initiated. There are many options for node configuration including setting the node to sample continuously, sample periodically, and to start sampling on power up. This section provides an overview on how to access the node menus and adjust basic settings. Refer to the node and the Node Commander® user manuals for additional information (*see References on page 106*).

Configuration of the sensor nodes in Node Commander® is done through the gateway and the Live Connect™ interface, and must be done initially on a DHCP enabled network.

1. Connect the host computer and gateway to the DHCP network, and apply power to the gateway. Verify the gateway status indicator shows that it is on and has completed the boot-up process (*see Gateway Interface on page 10*).

2. Open the Live Connect™ program. The gateway will be detected automatically but depending on the network, it may take 2 to 3 minutes. Once detected, the gateway will appear on the list of discovered devices and can be identified by its name or serial number (with a WSDA prefix) in the Device Name column (*Figure 10 - Live Connect™ Interface*).
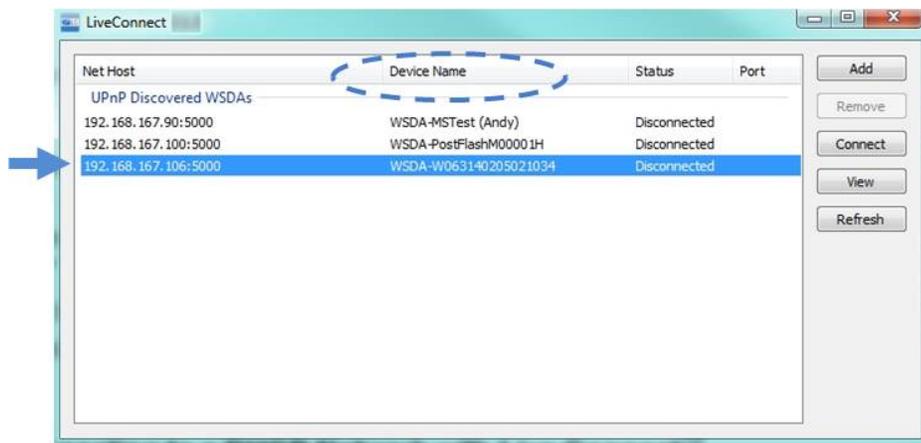
Figure 10 - Live Connect™ Interface

3. Highlight the device in Live Connect™, and select the Connect button (*Figure 11 - Connecting the Gateway to Node Commander®*). This will enable access to the Node Commander® software.
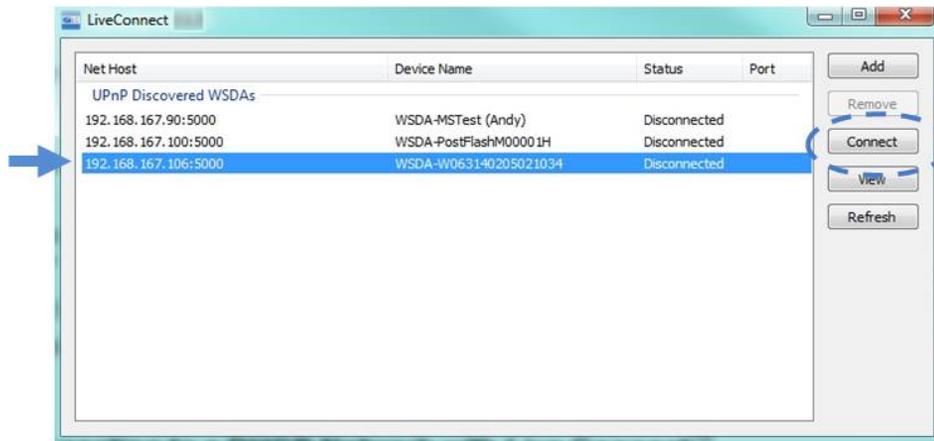
Figure 11 - Connecting the Gateway to Node Commander®

4. Once connected, a virtual serial port is assigned to the gateway and will appear in the Port column (*Figure 12 - Virtual Serial Port*).
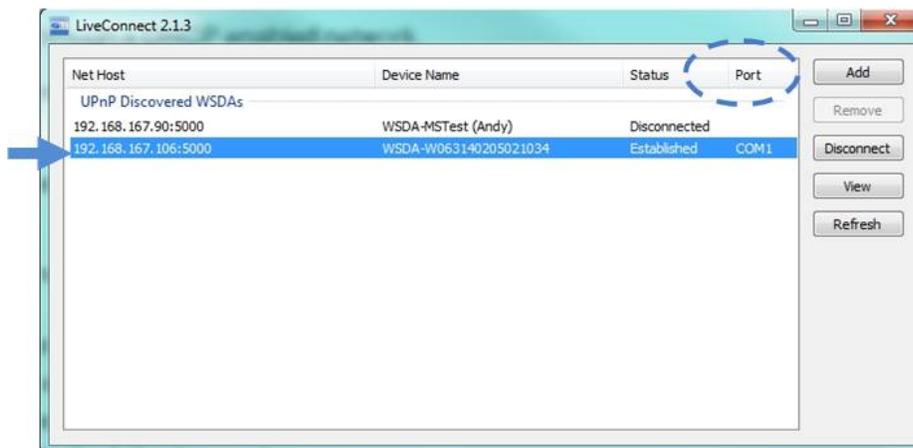
Figure 12 - Virtual Serial Port

5. Open Node Commander®.

6. The gateway will appear automatically in the Controller window with a communication port assignment.
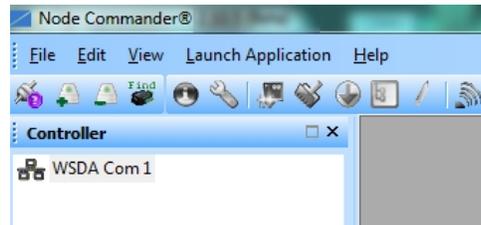
Figure 13 - Ethernet Gateway Communication

3.5   Connect to Nodes

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

3.5.1   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.

1. To add a node by address, right-click on the gateway name in the Controller window, and select Add Node > Add Single Node (*Figure 14 - Adding a Node by Address*).

2. The node address and frequency are indicated in the documentation included with the node. 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. Alternately, the Node Discovery feature can be used.

Figure 14 - Adding a Node by Address
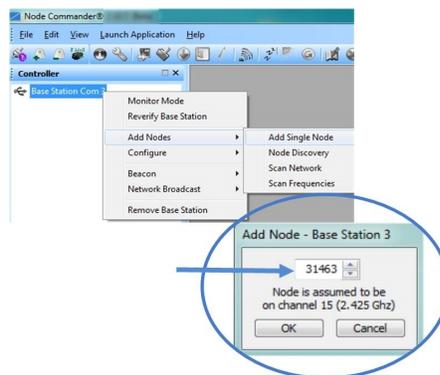
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3.5.2   Using Node Discovery

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, begin by making sure the node is 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 Guide on page 86*.

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1. Right-click on the gateway name and select Add Node > Node Discovery (*Figure 15 - Using Node Discovery*).

2. Using the power switch, turn on the node. Within a few seconds, the node will transmit a message with its operating frequency.

3. When the device status indicator on the node ends the rapid flash sequence and begins pulsing at one-second intervals, the node 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; scanning can be stopped by selecting the Stop button in the Node Discovery window.

Figure 15 - Using Node Discovery

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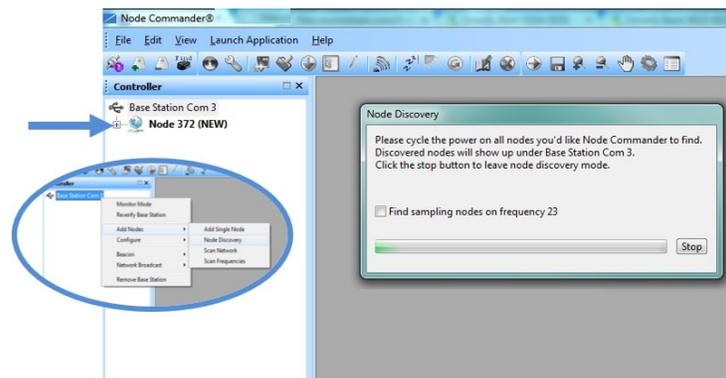
3.6   Channel Configuration

The sensor settings are stored in the node memory, and each sensor is assigned a corresponding channel number. The configuration menus will only show the channels and configuration options that are available for the type of node being used.

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 sensor 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 inherent to the node being used. In the following example (*Figure 16 - 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:** The Configure button changes the channel parameters, such as measurement units, gain and offset settings, and calibration values. The channel must be enabled first by selecting the adjacent check box.
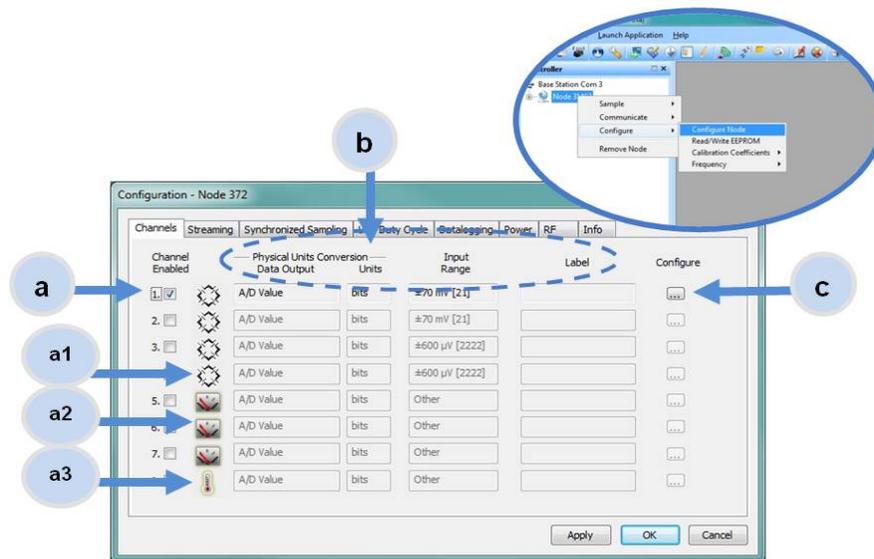
Figure 16 - Node Channels Menu

2. To enter the channel configuration menu, select the Configure button as shown in *Figure 16 - Node Channels Menu*. The menu options available on the channel configuration page varies depending on the node and sensor type selected. This is an example with a V-Link® -LXRS®.

    a. **Channel Label:** names the channel

    b. **Channel diagram:** shows channel electronics and data flow

    c. **Conversion Coefficients:** defines the type and units of the measurement being made

    d. **PGA Settings:** These settings determine what gain is applied to the sensor measurement and set the position of the no-load baseline measurement for the sensor signal. It is only available for differential input channels with gain amplifiers.

    e. **Calibration values:** includes the slope, offset, scale, and formula used to convert the sensor reading to engineering units. The slope and offset can be determined from the sensor manufacturer calibration data or through a calibration process.

Figure 17 - Channel Setup

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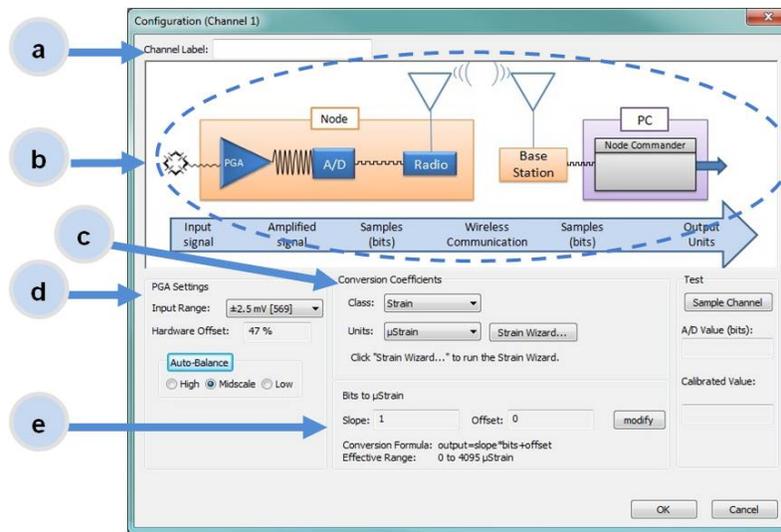
3.7 Sampling Settings

Sampling settings are accessed through the Configure Node menu. There is a tab for each sampling mode available for the particular node (*Figure 18 - Sample Settings Menu*).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 106*).
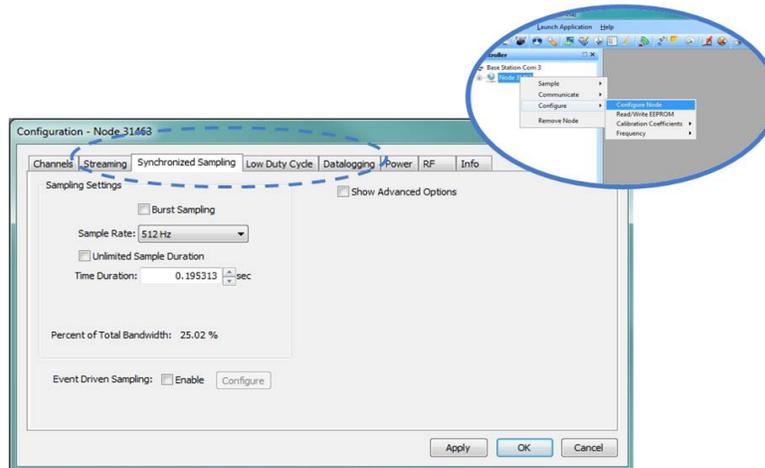
Figure 18 - Sample Settings Menu

In general, when determining what sample mode and rate is most suitable for the application, refer to the following guidelines;

- 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.

- Using the minimum required sample rate will increase battery life and minimize the allocated network bandwidth.

- Using periodic burst sampling in place of continuous sampling will increase battery life, and the longer the sample interval, the more power and network bandwidth will be saved.

For synchronized sampling, use the online calculator to evaluate network bandwidth at different sampling settings :

http://www.microstrain.com/configure-your-system

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3.8 Data Acquisition

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 19 - Starting a Sampling Session*).

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 > Synchronized Sampling.
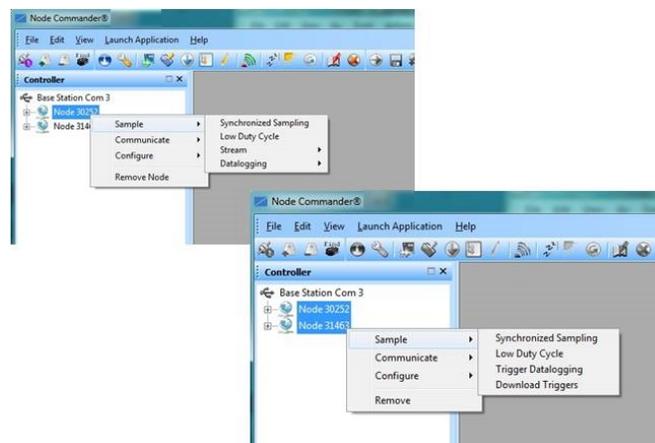
Figure 19 - Starting a Sampling Session

When a synchronized sampling session is started, the sampling menu appears and includes settings to enable optional sampling features, configure nodes, and to specify where the data will be saved. The built-in bandwidth calculator displays the total bandwidth used by the nodes selected for synchronized sampling (*Figure 20 - 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 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

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recalculates the node bandwidth. Multiple nodes can be configured together by using the Shift or Ctrl key to select them.

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.
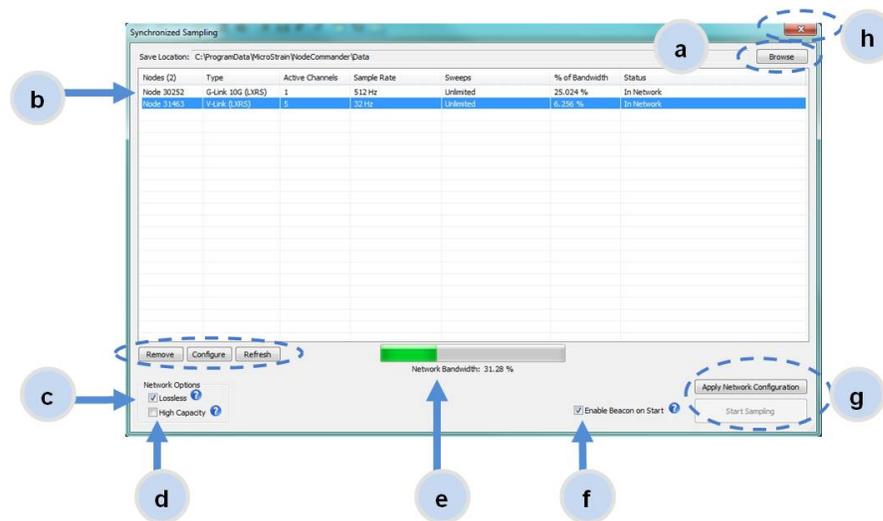
Figure 20 - Synchronized Sampling Menu

d. **High Capacity:** optimizes bandwidth and power use for nodes with slower sample rates by reducing the transmit rates. May increase data latency.

e. **Network Bandwidth:** is the total calculated bandwidth used by all the nodes. The bandwidth changes as nodes are added, removed. and settings changed.

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 (default), 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 For more information *see Using the Beacon on page 77*.

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

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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: Grid view and Graph view. Once sampling has started, the data grid view is the default view (*Figure 21 - Synchronized Sampling Data View*).
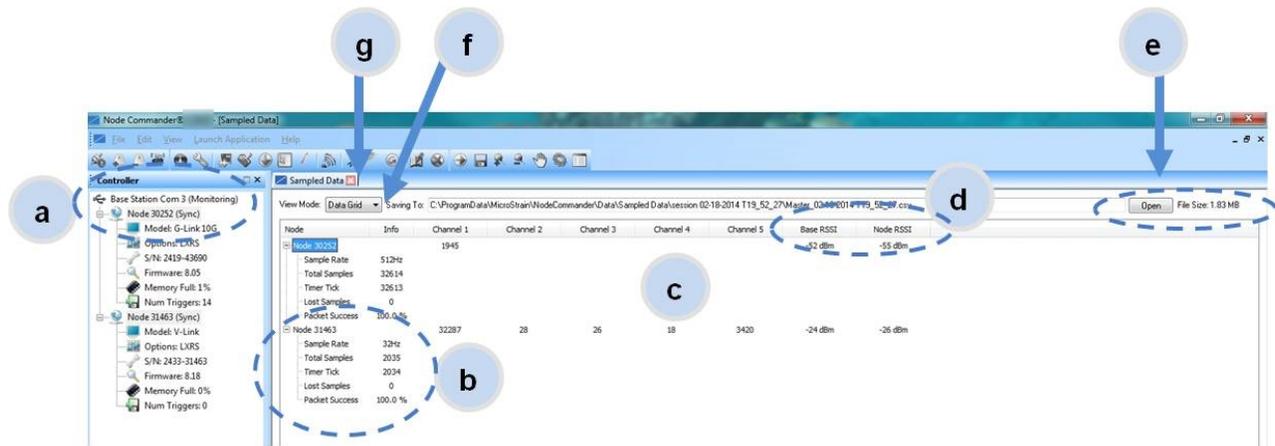
Figure 21 - Synchronized Sampling Data View

a. **Device status:** Node sampling mode and gateway status are displayed in parentheses next to the device name.

b. **Node information:** includes node serial number and sampling statistics. Right-click on the node name for more menu options such as Stop Nodes.

c. **Data:** is a display of the sampled data with each channel in its own column.

d. **Radio strength:** indicates the strength of the communication between the gateway and node. *See Range Test on page 83*.

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. **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.

![LORD MicroStrain® SENSING SYSTEMS]

NOTE

When synchronized sampling is set to slower sample rates it may take several seconds after sampling is initiated for the first sample to appear.

Use the view menu to select the Graph view of the data (*see Synchronized Sampling Graph View on page 28*). Click on the node name to view the graph for that node. Click again to hide it.
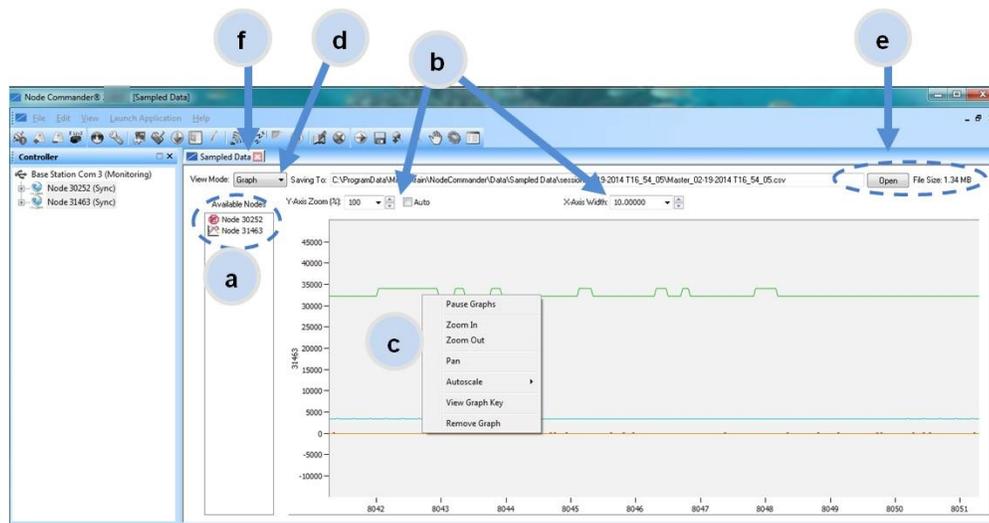
Figure 22 - Synchronized Sampling Graph View

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.

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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.

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®.

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3.9   Data Handling

Data acquired through Node Commander® is automatically saved on the host computer (*see Sensor Data Files on page 34*) and can also be viewed from the web-based SensorCloud™ portal. Saved data can be uploaded to SensorCloud™ and Ethernet gateways provide the option to automatically port the data to SensorCloud™ during data acquisition for near real-time display and aggregation. Ethernet gateways can also be configured to save data locally to internal memory for future upload to the host computer or SensorCloud™.

SensorCloud™ is based on cloud computing technology and is designed for long term collecting 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. Leveraging the open source API, SensorCloud™ can also be used to collect data from other LORD MicroStrain® sensor products or third-party systems. Basic SensorCloud™ services are available to all users free of charge (*see Connecting to SensorCloud™ on page 31*).

Figure 23 - Data Storage, Display and Processing

3.9.1   Connecting to SensorCloud™

To connect to SensorCloud go to the SensorCloud website log-in page, and enter the log-in credentials. Register as a new user if needed.

http://sensorcloud.com/log-in/

Figure 24 - SensorCloud™ Log-in or Register

The SensorCloud interface has **six main views**. When logging in as a registered user, the Device view is the default. Navigate to other views by clicking the view name at the top of the page (*Figure 25 - SensorCloud™ Menu Views*). The Data and Settings views are only available once a device is selected from the device list.

Figure 25 - SensorCloud™ Menu Views

Device - The device list shows every Ethernet gateway and API device associated with the SensorCloud account, including owned, shared, and demo devices. This view provides links to each device's SensorCloud subscription plan, configuration options, and a summary of last communications and data transactions.

Account - The account view is for logistic management of the SensorCloud account, such as changing the log-in password, accessing user email, and reviewing billing information.

CSV Uploader - The data upload feature enables data from any source (such as non-Ethernet LORD MicroStrain gateways, or third-party sensor) to be uploaded to the SensorCloud platform. The data must be in the LORD MicroStrain CSV format.

 Data - This view is only available after a device is selected. It displays data that is collected from sensor nodes or uploaded from files. Data selections are listed by node channel or a user-defined label, and can be enabled for display in the graph window. The interactive graph has navigational features such as panning, zooming, and an overview graph for single-click access to data points or ranges. There are also use and management features such as viewing the meta-data and downloading, embedding, and tagging data graphs.

Figure 26 - SensorCloud™ Data View

Settings - The settings view provides options for adding meta-data, configuring the data displays for each channel, creating alerts based on data thresholds, setting the data timezone, and more.

MathEngine® - is used to analyze sensor data. Functions include the ability to filter out frequencies, smooth out noisy data, perform math operations such as Fast Fourier Transforms

(FFTs), and more (*Figure 27 - MathEngine® View*). MathEngine® interfaces with the SensorCloud graphing view for faster processing. Users can write their own algorithms for custom applications. Refer to the MathEngine® website for more information.

http://sensorcloud.com/mathengine
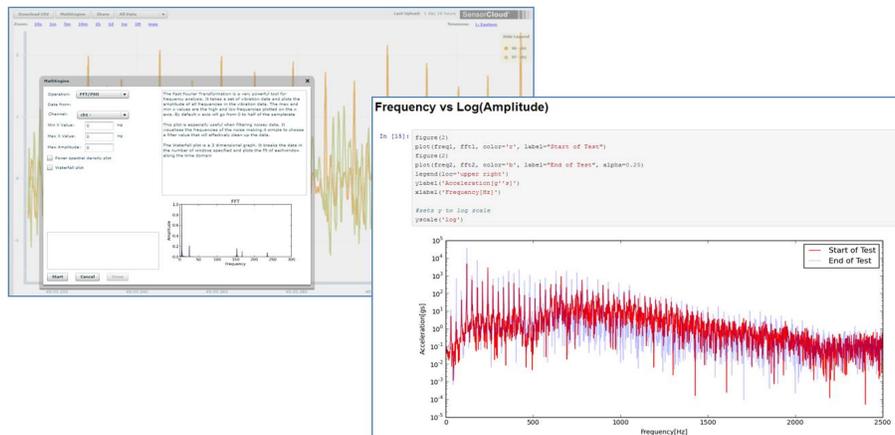
Figure 27 - MathEngine® View
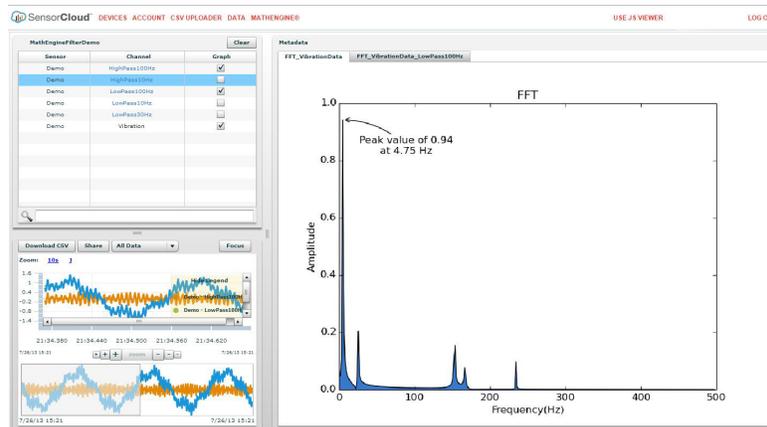
Figure 28 - FFT Graph in SensorCloud™

For more information about SensorCloud features and navigation, refer to the SensorCloud website or contact LORD MicroStrain Technical Support.

http://sensorcloud.com

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3.9.2   Sensor Data Files

Data acquired in Node Commander or downloaded from the gateway is stored in .CSV format and can be opened with Microsoft Excel, Quattro Pro, Open Office, or another CSV editors/spreadsheet program. Data in this format is easily uploaded to SensorCloud™ using the CSV Uploader. The data files can be found on the host computer in the default directory or the location specified at the beginning of the sampling session (as applicable). The files are organized in separate folders by mode and then further categorized by date, session, and/or node serial number.

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

Synchronized sampling and low duty cycle files are found in the Sampled Data folder, and **streaming data** is stored in the Streaming folder. **Datalogging files** need to be downloaded from the node to be available for viewing. They are accessed through datalogging menus as well as the File menu, and are saved in the Downloaded Triggers folder.
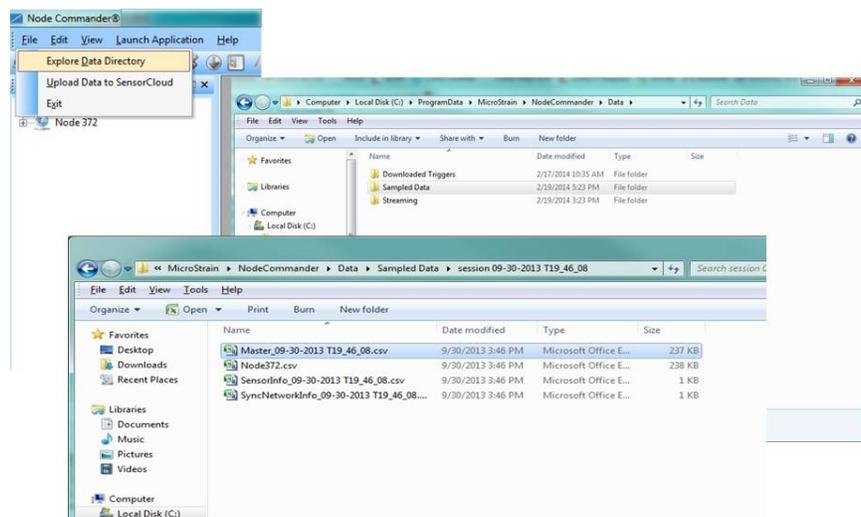
Figure 29 - Exploring Data

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.

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4. Gateway Communication

NOTE

The default configuration of Ethernet gateways is for DHCP network connectivity. In order to change the gateway communication settings initial connection to a DHCP enabled network is required.

The gateway can be configured for the following Ethernet communication schemes:

- Automatically, through a DHCP-enabled local or wide area network (*see Gateway Configuration on page 13*).

- By assigning the gateway a static IP address and connecting it directly to a host computer (*see Configuration on page 57*).

- By assigning the gateway a static IP address and connecting it to a similarly configured network (*see Configuration on page 57*).

- By connecting remotely through the SensorCloud™ web interface (*see Remote Connectivity on page 66*).

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5. Gateway Configuration

To configure the gateway, connect to Control Panel through a web browser or Live Connect™ (*see Gateway Operation on page 13*).

```
┌─────────────────────────────────────────────────────────────────┐
│                             NOTE                                  │
│                                                                   │
│   The Control Panel log-in will expire after one hour of          │
│   inactivity. Additionally information that changes frequently,   │
│   such as the System Time, Node List, and Current Data Size       │
│   are not updated automatically while logged in. The menus        │
│   are refreshed when navigating between menus, clicking on        │
│   the web browser Refresh button, logging out and back in, or     │
│   when rebooting or cycling power to the gateway.                 │
└─────────────────────────────────────────────────────────────────┘
```

There are three menu categories in gateway Control Panel: **General**, **Data**, and **Tools**. Within each category are several menus. This section describes each menu in detail to assist in configuration of the WSDA®-1500-LXRS®.

Figure 30 - Control Panel Menu Categories

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View an overview and explanations of settings in a menu by selecting the + symbol above the setting to expand the help menus.
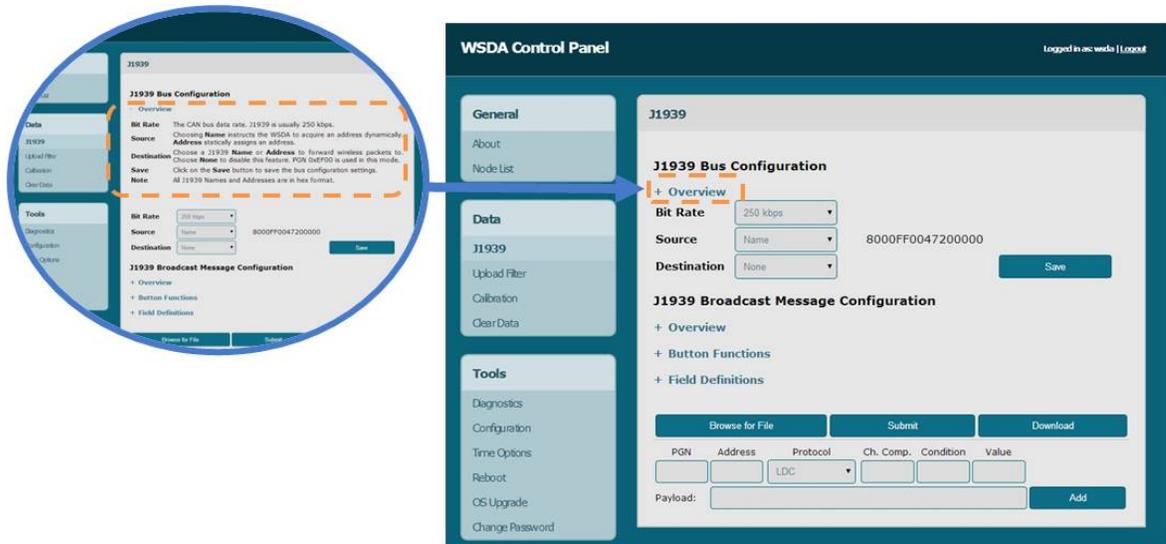
Figure 31 - Help Menus

5.1   Gateway Information

The General category provides information about the gateway identity, the wireless nodes it serves, and its current time settings. These are informational only, and no user adjustments may be made in these menus. *Table 3 - General Menus* provides a summary of the menus under the General category.

Menu	Description
About	Provides information about the gateway identity
Node List	Displays a list of wireless nodes for which the gateway is currently storing data
Time Settings	Provides time-related information

Table 3 - General Menus

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5.1.1 About the Gateway

The About menu provides information about the gateway. Each item is defined below.
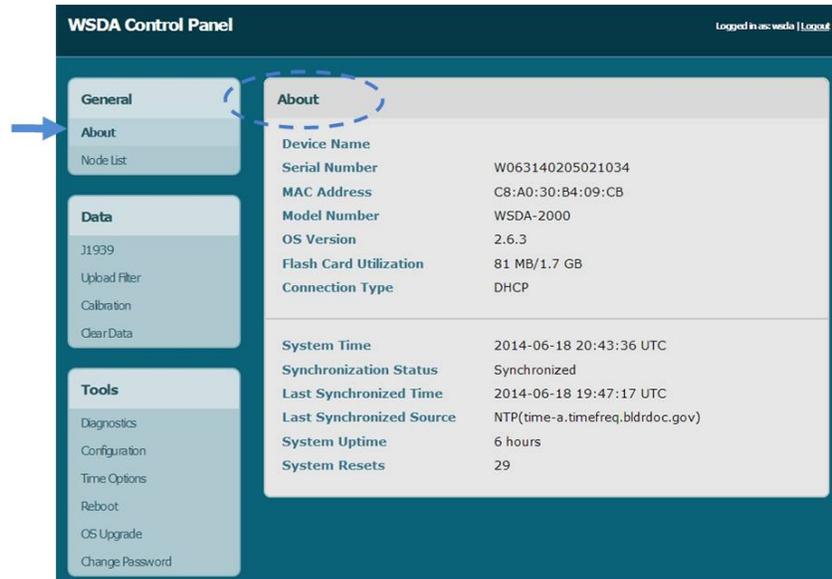
Figure 32 - About Menu

Device Name: an alias given to the WSDA®-1500-LXRS® so that it is more easily recognized in Live Connect™. By default, the device name is not assigned, and Live Connect™ will use the device serial number as an identifier. The device name can be changed in the Tool > Configuration menu (*see Configuration on page 57*).

Serial Number: an alpha-numeric identifier embedded in the WSDA®-1500-LXRS® hardware. The serial number is assigned when the gateway is manufactured.

MAC Address: an alpha-numeric identifier embedded in the network card of the WSDA®-1500-LXRS® hardware. A MAC (Media Access Control) Address is a unique identifier assigned to all Ethernet devices to manage communications on the network. The MAC address is assigned when the gateway is manufactured.

Model Number: an alpha-numeric identifier used to identify the gateway type. The model number is assigned when the gateway is manufactured.

OS Version: a numeric identifier used to identify the WSDA®-1500-LXRS® OS (Operating System) Version. The OS is the on-board software that operates the WSDA®-1500-LXRS®. All gateways are shipped with the current OS version. As new features are added,

OS updates are available from LORD MicroStrain® Technical Support (*see Technical Support on page 94*) and installed by the user through the Tools > OS Upgrade menu (*see Operating System (OS) Upgrade on page 64*).

Flash Card Utilization: the amount of memory currently consumed by data in the gateway internal memory, and the total memory capacity. Data received from sensor nodes is stored here. When capacity is reached, the flash card will begin overwriting data on a first-in, first-out basis (older data is overwritten first).

Connection Type: the type of Ethernet connection the gateway is currently configured for - DHCP or Static IP. This option and other settings can be changed in the Tools > Configuration menu (*see Configuration on page 57*).

System Time: the current UTC time on-board the WSDA®-1500-LXRS® system clock. UTC (Coordinated Universal Time) is the time standard by which the world regulates clocks and time. The system clock is normally updated from internet time servers every 12 hours. For a more detailed discussion of the system and real time clocks *see Time Options on page 61*.

Synchronization Status: the WSDA®-1500-LXRS® is considered to be Synchronized if it has successfully synchronized to one of its enabled time sources since it was booted, and before any periodic synchronization has expired. Otherwise is considered to be Not Synchronized. For a more detailed discussion of the system and real time clocks *see Time Options on page 61*.

Last Synchronized Time: the most recent time when the gateway was synchronized to a time source

Last Synchronized Source: the source from which the most recent time synchronization occurred

System Up-time: the elapsed time since the gateway was last powered on and booted up. The system up-time will be zeroed when the gateway power is cycled or it is rebooted from the Tools > Reboot menu.

System Resets: the number of times the gateway has been reset. System Resets will be incremented when the gateway power is cycled or it is rebooted from the Tools > Reboot menu. System Resets are written to non-volatile memory and is preserved through power outages.

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5.1.2 Node List

The node list displays all the wireless nodes that have data currently stored in the gateway memory. The node address is shown along with the sensor channels that were configured to transmit data to the gateway, the relative timestamp (time since the node sent its first data to the gateway), and the last timestamp (the time of the most recent node data received by the gateway).

Figure 33 - Node List

5.2   Data Options Menu

The Data category provides data handling options such as selecting which data is sent to the CAN J1939 bus, uploaded to SensorCloud™, and downloaded to a host computer. Data can also be cleared from the WSDA®-1500- LXRS® internal memory. *Table 4 - Data Menus* provides a summary of the menus under the Data category.

Menu	Description
J1939	Enable and select what sensor data is sent out in CAN J1939 format and what method is used
Upload Filter	Select which sensor nodes and channels are uploaded to SensorCloud™
Calibration	Apply calibration conversions values and select measurement display units before downloading saved data
Clear Data	Erase data from the gateway flash memory

Table 4 - Data Menus

Nomenclature for node address, channel assignments, and other data are used in some of the Data menus. *Table 5 - Data Nomenclature* describes the required naming conventions for these assignments. Node information found in the Node List are also annotated this way (*see Node List on page 40*).

Field	Description	Nomenclature	Examples
Address	Node address assigned when the node is manufactured. Provided with the node and displayed in Node Commander® when connected	decimal number	31463
Channel **Channel List** **Payload**	Data and packet value aliases such as for node address, node channel number, radio strength, and protocol values. Channel number assignment is handled in Node Commander®. All other aliases are fixed (*see Packet Definitions on page 49*).	lower case text followed by a number. In a channel list multiple values are separated by a comma or space	ch1 ch1,ch2,ch5, bin1, rssi ch2 angleid

Table 5 - Data Nomenclature

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5.2.1   CAN J1939 Output

In addition to saving locally or uploading through an Ethernet connection, data acquired from sensor nodes can also be pushed onto a CAN J1939 bus for reactive command and control of external devices and other applications. By default the output is disabled. Enable the output in the Tools > Configuration menu *see Configuration on page 57*.

Settings

The J1939 menu includes CAN communication settings (J1939 Bus Configuration) and output messages configuration (J1939 Broadcast Message Configuration) (*see CAN J1939 Menu on page 42*).
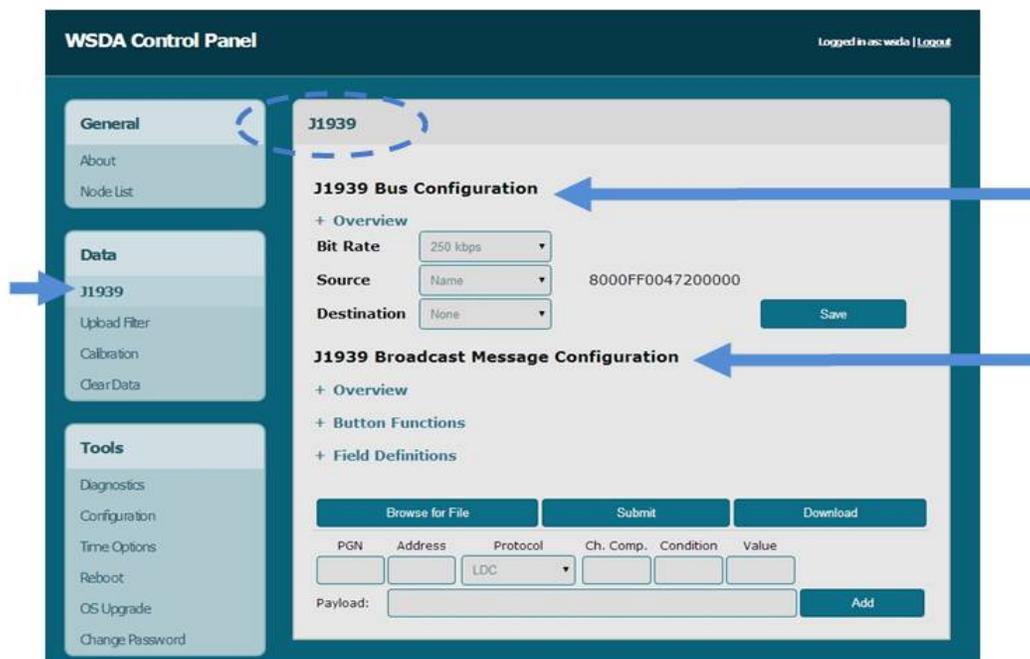
Figure 34 - CAN J1939 Menu

The bus configuration settings include the **Baud Rate**, data **Source**, and data **Destination**.

The baud rate is set as required by the host CAN bus that the gateway is integrated with. The default is 250 kilobits per second (kbps), which is typical for most applications.

NOTE

The wireless data transmit rate (between the node and the gateway) directly impacts the data bandwidth on the CAN bus. If the aggregate transmit rate of the wireless network (combined bandwidth use of active nodes) is high enough and there are other devices (besides the gateway) on the CAN bus, the bus may be overwhelmed, resulting in lost data. **The gateway settings provide no limitations to how much data is pushed onto the bus.** If there are no other devices on the CAN bus, this is not an issue, however it is up to the user to determine the amount of data the bus can handle from each device. Increasing the CAN bus baud rate and adjusting sensor sampling settings, such as reducing sample rates and period, can be used to alleviate CAN bus bandwidth limitations. Using the broadcast message data distribution method and reducing the sensor data that is sent to the bus can also be effective.

The Source setting refers to where the data is coming from, as in, how the WSDA®-1500-LXRS® will be recognized and addressed on the CAN bus (*Figure 35 - Data Source Setting*).

- By setting the source to **Name**, the gateway will acquire an address dynamically by requesting it in sequential order, within the dynamic address range, until no other device contests it (*Table 6 - WSDA®-1500-LXRS® J1939 Values*).

- By setting the source to **Address**, the user can assign a static address within the gateway address range (*Table 6 - WSDA®-1500-LXRS® J1939 Values*). This address is typed in the field next to the Source field, in place of the name.

Figure 35 - Data Source Setting

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With either setting the gateway will be identified by the name assigned to it when manufactured (which is displayed to the left of the Source selection menu). This name provides the host CAN bus with information about the device that determines its data priority relative to other devices on the bus (*Table 6 - WSDA®-1500-LXRS® J1939 Values*).

Description	Range
J1939 name **(assigned when manufactured)**	0x8000FF0047200000
J1939 bus bit rate (user setting)	250 kbps (default), 500 kbps, 1 Mbps
J1939 dynamic address range **(Source set to Name)**	0x80 to 0xCF
J1939 static address range **(Source set to Address)**	0x00 to 0xFF
Destination specific PGN **(Destination set to Name or Address)**	0xEF00
Broadcast message PGN range **(Destination set to None)**	0xFF00 to 0xFFFF

Table 6 - WSDA®-1500-LXRS® J1939 Values

The Destination setting refers to how the sensor data will be received on the CAN J1939 bus and the desired method of sensor data distribution. Sensor data can be pushed onto the bus either by sending all of the sensor messages to one CAN device (destination-specific), or by broadcasting user-selected messages onto the entire CAN bus (broadcast).

- **Destination-specific messages** can be sent to either a CAN device Address or device Name. Set Destination to either Name or Address and then type in the device name or address (as applicable) into the Source field in hexadecimal format. These are the only setting required for this type of messaging.

- For **broadcast messages**, the Destination is set to None and the user-designated messages are constructed either in J1939 Broadcast Message Configuration window or in a text file that is uploaded from the menu.

To change any of the settings, select from the drop down menus for each one and then select the Save button to save the selected settings (*Figure 35 - Data Source Setting*).

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Broadcast Message Structure

The broadcast message uses the Society of Automotive Engineers (SAE) Parameter Group Name (PGN) structure for the CAN J1939 data header, and the LORD MicroStrain® Wireless Sensor Networks Data Communications Protocol structure for the sensor data (*see Reference Information on page 106*). A message structure overview is provided in *Table 7 - Broadcast Message Format*, and in more detail below as required.

Field	Description	Format	Range
PGN	SAE CAN J1939 header	hexadecimal	0xFF00 to 0xFFFF
Address	sensor node address	decimal	1 to 65534
		hexadecimal	0x0001 to 0xFFFE
Protocol	packet protocol based on sensor sampling mode	category name	LDC, Synchronized, Histogram
		hexadecimal	0x04, 0x0A, 0xA0
		decimal designation	4, 10, 160
Payload	list of packet alias values	text separated by spaces	(example:ch1 ch2)
Ch Comp	channel for conditional formula	text	(example:ch1)
Condition	condition for conditional formula	mathematical operator	<, >, =
Value	threshold for conditional formula	single precision floating point	decimals within format constraint

Table 7 - Broadcast Message Format

PGN: (Packet Group Name) unique hexadecimal packet identifier

Address: is the numerical address of the sensor node the data to be sent is from. The node address is assigned when the node is manufactured. The number is provided with the node and displayed in Node Commander® when connected.

Protocol: is the sensor data packet protocol used in each sampling mode. For example Low Duty Cycle, Synchronized Sampling, and Histogram data formats are currently supported. The protocol is designated by its name in the J1939 menu or by the decimal or hexadecimal equivelents in the text file.

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Payload: Payload are the data values to include in the packet. They are listed by name in the sequence they will be sent. If the requested value cannot be found (for example, if the nomenclature is wrong) the defined J1939 packet will not be sent. The payload nomenclature and byte count follow the channel designations described in the sampled packet definition (*see Packet Definitions on page 49*).

Ch Comp, Condition and Value: Use these fields to create a condition for which packets will be sent onto the CAN bus. Ch Comp (Channel Compare) is the data source for the condition formula, and the Condition and Value define what mathematical operation to apply to it.

To **enter the broadcast messages** in the J1939 menu, type in the appropriate field. When the PNG field is selected, the Payload field will appear. If all values for the message are to be included, leave the Ch. Comp, Condition and Value fields blank . Select Apply at the end of the row to save the message designations. Once all designations are entered, click the Submit button to save the configuration (*Figure 34 - CAN J1939 Menu*). To save the configuration for future use, download to a file using the Download button.
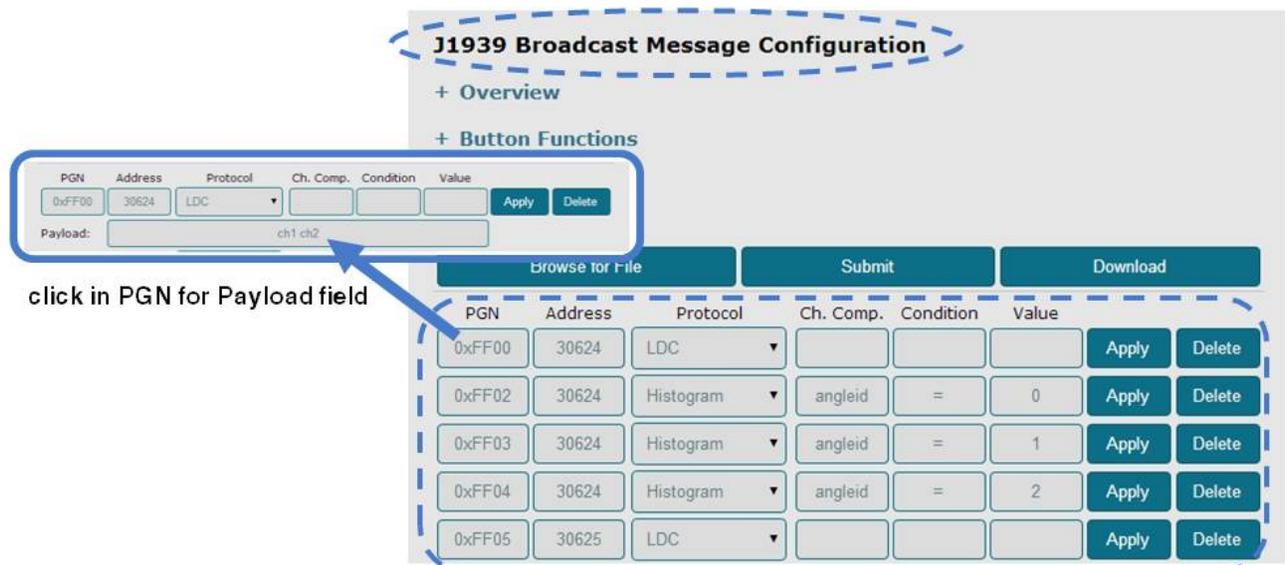
Figure 36 - Broadcast Message Menu Example

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To **use a text file**, structure the data in the following format. Leave fields blank if all values are to be included.

[*PGN*]
NodeAddress=*value*
Protocol=*value*
Variant=*value*
Payload=*value*
Condition=*channel name*:*operator*:*value*

EXAMPLE:

Node 31463 was sampled in low duty cycle mode. Sensors are connected to channel 1, channel 2, and channel 3. For channels 1 and 3 all data measurements will be sent to the CAN bus. For the sensor on channel 2, only data values over 1.8 will be sent.

[0xFF00]
NodeAddress=31463
Protocol=4
Payload=ch1 ch3

[0xFF01]
NodeAddress=35
Protocol=4
Payload=ch2
Condition=ch2:>:1.8

Once created, save the text file and then upload it to the gateway by clicking the Browse for File button in the J1939 menu. Navigate to the file, click OK, and then click the Submit button to save the configuration (*Figure 37 - Upload Configuration File*).

Figure 37 - Upload Configuration File

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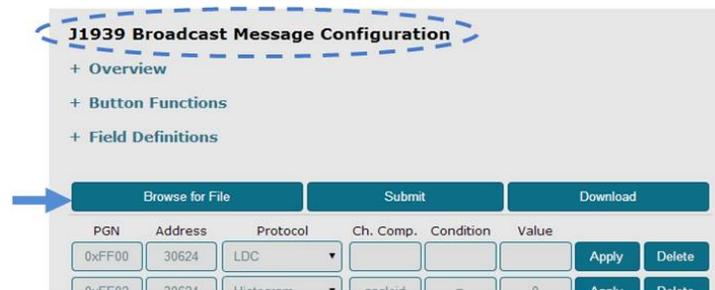
Host Bus Integration

Data packets received from the sensor nodes will be passed onto the J1939 CAN bus as received. An integrity check is made before sending the packet over the bus, but no other process is applied before wrapping the data in the J1939 protocol. The receiving CAN J1939 must be capable of responding to Transport Protocal Connection Management (TP.CM). Only one sensor data packet will be sent in each TP.CM exchange.

The destination will need to understand the LORD MicroStrain® Wireless Sensor Networks Data Communications Protocol for Low Duty Cycle (LDC), Synchronized Sampling, and Histogram packets (*see Packet Definitions on page 49*). Because J1939 only supports payloads of 8 bytes, sensor data packets will be broken up into multiple J1939 packets as required. In this scenario 7 bytes of sensor data packets are sent with a 1 byte J1939 sequence number to indicate its position in the string of sensor data. This is done automatically and will appear seamless on the receiving end. All the destination device needs to understand is the LORD MicroStrain® packet structure of each sensor data packet in order to determine how to parse the incoming data (*see Packet Definitions on page 49*).

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Packet Definitions

The following tables summarize the sampled data packet structure in the LORD MicroStrain® Wireless Sensor Networks Data Communications Protocol . All data is in big endian format unless otherwise noted. Refer to the LORD MicroStrain® Wireless Sensor Networks Data Communications Protocol Manual for more information (*see Reference Information on page 106*).

Low Duty Cycle (Protocol 4)

Description	Hex Value	Value Alias	Number of Bytes	Data Type*
Start of packet	0xAA	sop	1	uint8
Delivery stop flag	0x07	delflags	1	uint8
App data type (data protocol)	0x04	appdatatype	1	uint8
Node address	0x1 to 0xFFFE	nodeaddress	2	uint16
Payload length	0x2 to 0x6A	payloadlength	1	uint8
App ID	0x02	appid	1	uint8
Channel mask	0x0 to 0xFF	channelmask	1	uint8
Sample rate	0x1 to 0x7B	samplerate	1	uint8
Data type	0x1 to 0x4	datatype	1	uint8
Timer tick	0x0 to 0xFFFF	tick	1	uint16
Channel data	0x0 to 0xFFFFFFFF	(examples: ch1, ch2, ch8)	4	uint16, uint32, float
Node radio signal strength indicator (RSSI)	0x0 to 0xFF	rssi	1	uint8
Base Station radio signal strength indicator (RSSI)	0x0 to 0xFF		1	uint8
Checksum	0x0 to 0xFFFF		2	uint16

*Data type values
uint8 = 1 byte unsigned integer
uint16 = 2 byte unsigned integer
uint32 = 4 byte unsigned integer
float = 4 byte float

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Synchronized Sampling (Protocol 10)

Description	Value	Value Alias	Number of Bytes	Data Type*
Start of packet	0xAA	sop	1	uint8
Delivery stop flag	0x07	delflags	1	uint8
App data type* (data protocol)	0x0A	appdatatype	1	uint8
Node address	0x1 to 0xFFFE	nodeaddress	2	uint16
Payload length	0x02 to 0x6A		1	uin8
Sample mode	0x1 to 0x2	samplemode	1	uint8
Channel mask	0x0 to 0xFF	channelmask	1	uint8
Sample rate	0x1 to 0x7B	samplerate	1	uint8
Data type	0x1 to 0x4	datatype	1	uint8
Sweep tick	0x0 to 0xFFFF	tick	2	uint16
UTC timestamp (seconds)	0x0 to 0xFFFFFFFF	utcseconds	4	uint32
UTC timestamp (nanoseconds)	0x0 to 0xFFFFFFFF	utcnanoseconds	4	uint32
Channel data	0x0 to 0xFFFFFFFF	(examples: ch1, ch2, ch8)	4	uint16, uint32, float
Node radio signal strength indicator (RSSI)	0x0 to 0xFF	noderssi	1	uint8
Base Station radio signal strength indicator (RSSI)	0x0 to 0xFF	rssi	1	uint8
Checksum	0x0 to 0xFFFF		2	uint16

*Data type values
uint8 = 1 byte unsigned integer
uint16 = 2 byte unsigned integer
uint32 = 4 byte unsigned integer
float = 4 byte float

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Histogram (Protocol 160)

Description	Value	Value Alias	Number of Bytes	Data Type
Start of packet	0xAA	sop	1	uint8
Delivery stop flag	0x07	delflags	1	uint8
App data type* (data protocol)	0x04	appdatatype	1	uint8
Node address	0x1 to 0xFFFE	nodeaddress	2	uint8
Payload length	0x--	payloadlength	1	uint8
App ID	0xA0	appid	1	uint8
Angle ID	0x0 to 0x2	angleid	1	uint8
Mode	0x0 to 0x1	mode	1	uint8
Bin size	0x----	binsize	2	uint16
Bin lower bound	0x----	binlowbound	2	uint16
Data set ID number	0x----	dataid	2	uint16
Uptime	0x----	uptime	4	uint32
Angle	0x----	angle	4	float
Life	0x----	life	4	float
Binned data		bin1, bin2, bin3, …. bin19, bin20, bin21	84	uint32
LQ1	0x0 to 0xFF	lqi	1	uint8
Radio signal strength indicator (RSSI)	0x0 to 0xFF	rssi	1	uint8
Checksum	0x0 to 0xFFFF		2	

Histogram packets values

Byte 9 (Mode): 0=normal, 1=idle

Byte 10-11 (Bin Size): Size of each bin (in engineering units)

Byte 12-13 (Bin Lower Bound): Start of bin 1 (in engineering units)

Byte 14-15 (Data Set ID #): Each data set ID is used for 3 sets of binned data

Byte 16-19 (Uptime): 1 count is 1/32 second

Byte 20-27 (Angle): Floating point angle in radians

Byte 28-111(Binned data): Binned data consists of 21 bins. Each bin is represented by a 4 byte unsigned integer

5.2.2   SensorCloud™ Upload Filter

By default, the WSDA®-1500-LXRS® uploads all sensor data stored in the gateway memory to SensorCloud™. The Upload Filter function allows the user to filter which node data is to be uploaded.
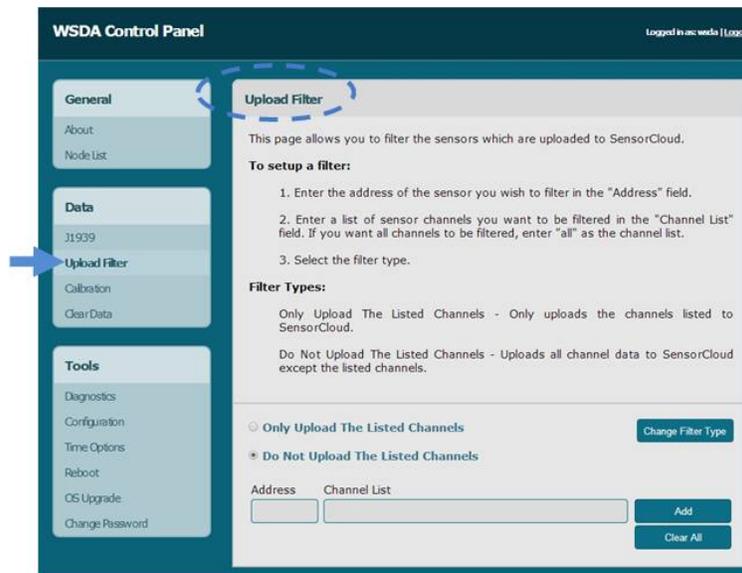
Figure 38 - Data Upload Filter

The Upload Filter menu describes how to set up a filter. Nodes and node channels can be collectively set to be included (Only Upload the Listed Channels) or excluded (Do Not Upload the Listed Channels) by using the Change Filter Type button. For address and channel nomenclature *see Data Options Menu on page 41*. The Upload Filter can be set before or after data upload has been initiated. If data has already been received from the node, refer to the Node List to verify which node and channel data has been saved. Use the Clear All button to delete all node filters.

NOTE

The Change Filter Type function affects all nodes in the filter list. When applied, it sets all nodes in the list and cannot be used for individual nodes.

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5.2.3   WSDA® Data Downloader Calibration Coefficients

The Calibration feature allows the user to specify coefficients for converting between engineering units with a linear relationship, and to correct for sensor biases in sensor data saved in the gateway memory.

The coefficients are applied when data is downloaded from the gateway to a host computer using the WSDA® Data Downloader and are in addition to any conversion values assigned to the sensor channel during node configuration (*see Channel Configuration on page 22* as well as the applicable node User Manual). This feature is particularly useful for porting collected data into third party applications like Microsoft Excel, custom software, or data analytic software when different coefficients are desired than what was used when the data was acquired.
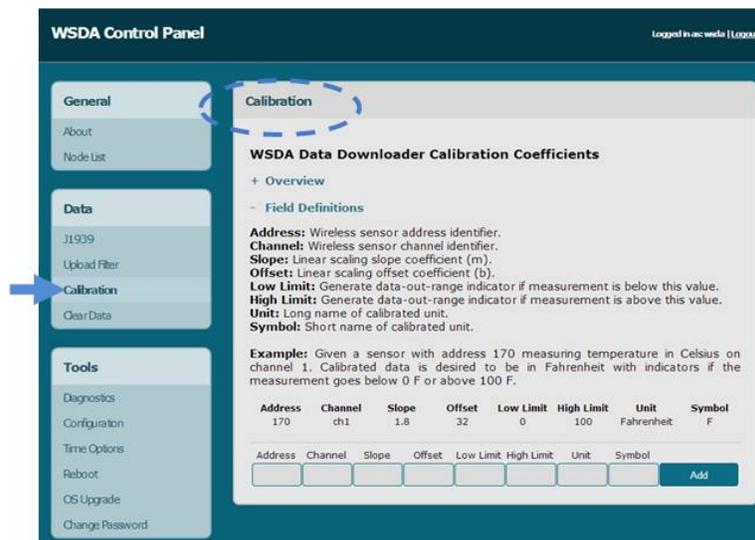
Figure 39 - Calibration Menu

The data to apply the coefficients to is designated by entering the source node address and channel numbers. For the nomenclature used for the address and channel *see Data Options Menu on page 41*. The coefficient values are entered for the designated channels. The values for each are described below and are also available in the calibration help menus accessible by clicking the + symbol next to Field Definitions (*Figure 39 - Calibration Menu*). To use the Calibration feature, click the Add button after entering the desired values in each field.

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Address: sensor node address

Channel: sensor channel on the designated node

The calibration conversion formula assumes a linear relationship between the original units (such as A/D bits) and new engineering units (such as), and it is expressed mathematically as $y=mx+b$, where y is the engineering units at a given point (measurement), m is the slope of the line that represents the linear ratio, x is the original unit value at a given point, and b is a unit conversion offset (in the case of unit conversions) or the fixed zero load offset of the sensor (in the case of measurement calibration coefficients). Negative values may be entered for any coefficient.

Slope: is the linear scaling slope coefficient. The slope is the ratio of original units to new engineering units (EU), and it is used to convert the sensor measurements. The slope conversion value will vary depending on the engineering units desired. For example if the original unit is A/D values (bits), and the desired engineering units are acceleration in g-force, the slope conversion would describe how many bits equal one unit of g-force (bits/g). Mathematically, the slope is m in the formula $y = mx + b$.

Offset: is the linear scaling offset coefficient, and it is typically the starting output value of the sensor with no load applied (in the original units). Mathematically, the offset is b in $y = mx + b$.

Low Limit: optional data threshold value that will generate a data-out-range indicator if measurement is below the value

High Limit: optional data threshold value that will generate a data-out-of-range indicator if measurement is above the value

Unit: user defined long name of calibrated unit

Symbol: user defined short name of calibrated unit

EXAMPLE:

Sensor node 34163 is measuring temperature in degrees Celsius on channel 1. Calibrated data is desired to be in Fahrenheit with indicators if the measurement goes below 0 F or above 100 F. The conversion for Celsius to Fahrenheit is: $F = C*1.8 + 32$ ($y = mx + b$)

Address	Channel	Slope	Offset	Low Limit	High Limit	Unit	Symbol
34163	ch1	1.8	32	0	100	Fahrenheit	F

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5.2.4   Clear Stored Data

The Clear Data feature is used to erase all sensor node data from the gateway's internal memory. Before erasing, the user should confirm that all data has been transmitted to SensorCloud™. The Current Data Size display indicates the amount of data currently stored in the memory.

To clear data click the Clear All Data button, and the data will be erased.

Figure 40 - Clear Data Menu

5.3   Gateway Tools Menu

The Tools menus provide the user a means to configure, troubleshoot, and update the WSDA®-1500-LXRS® settings. *Table 8 - Tools Menus* provides a summary of the menus under the Tools category.

Menu	Description
Diagnostics	Reports results of periodic diagnostic checks
Configuration	Gateway settings adjustments such as communications configuration, device naming, and enabling and disabling of gateway features
Time Options	Configuration options related to how the gateway retrieves and uses time
Reboot	Restart and reinitialize the gateway without cycling power
OS Upgrade	Update the operating system software on the gateway
Change Password	Change the user name and the password required at log-in to the gateway Control Panel

Table 8 - Tools Menus

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5.3.1 Diagnostics

The diagnostics feature is used to troubleshoot the WSDA®-1500-LXRS®. The diagnostics window displays a report from the gateway internal log file. The log records the diagnostic checks from three possible sources of error: the timing engine, SensorCloud™ data upload, and the data logger. These diagnostic checks are performed once at every power up and then periodically as the gateway is in on. If errors are reported in the Diagnostics menu, contact LORD MicroStrain® Technical Support (*see Technical Support on page 94*).
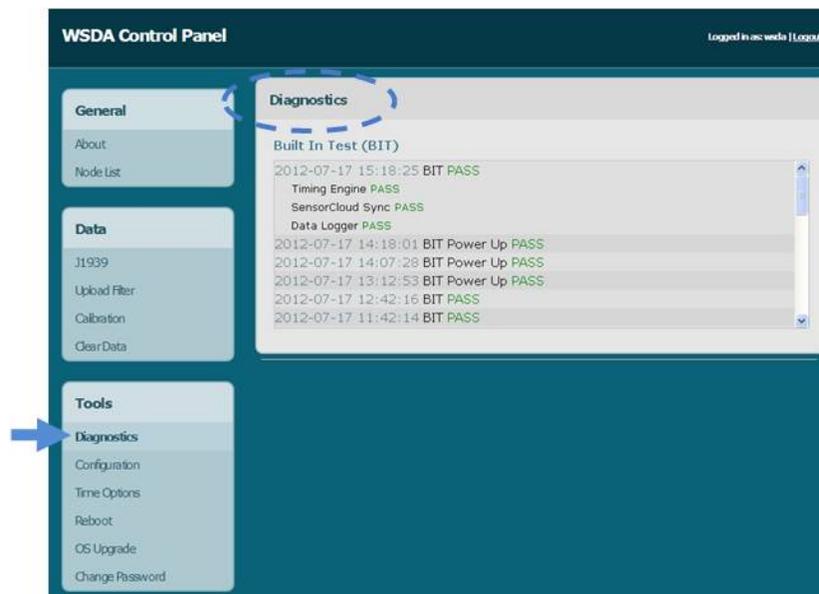
Figure 41 - Diagnostics Menu

NOTE

If SensorCloud™ Data Upload, J1939, or Data Logging are disabled (in the Tools > Configuration menu) they will not be checked during the diagnostics routine.

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5.3.2   Configuration

The Configuration menu allows the user to set parameters associated with WSDA®-1500-LXRS® operation. The settings include configuring the communication settings, enabling and disabling operating sequences, changing the node synchronization beacon state, and changing the gateway wireless node communication frequency. Each setting is described below in detail.
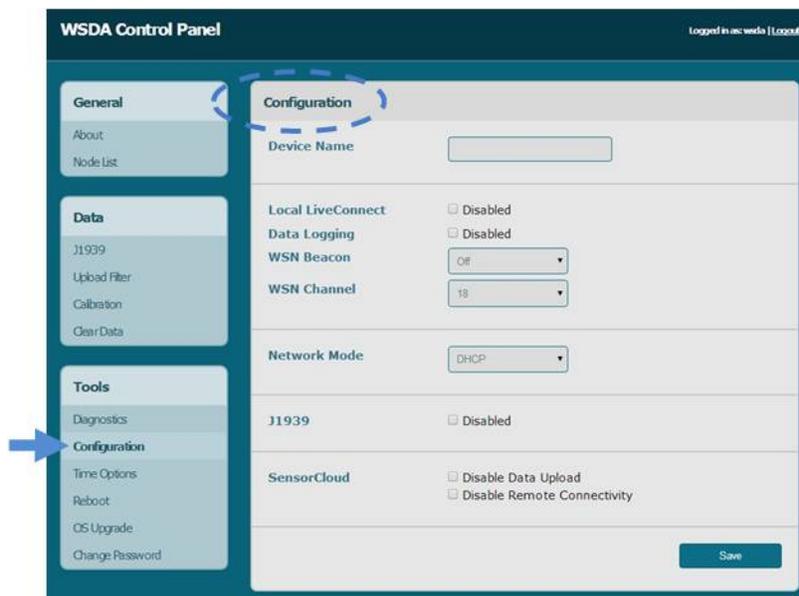
Figure 42 - Configuration Menu

Device Name: The device name in an alias given to the WSDA®-1500-LXRS®, so it is more easily recognized. By default, the device name is not assigned. To enter a name, type it into the field and click the Save button.

Local Live Connect™: The Local Live Connect™ setting allows users to disable Live Connect™ on the local network. This is important if data security is a concern. Disabling Live Connect™ prevents other users on the network from accessing the data stream . If Live Connect™ is disabled it will not be available for connecting to Node Commander® unless done remotely through SensorCloud™ (*see Remote Connectivity on page 66*). The default is for Live Connect™ to be enabled.

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Data Logging: Data logging saves acquired data to the gateway internal memory, and also makes it available to the CAN J1939 Bus, SensorCloud™, and a host computer through Live Connect™. Disabling data logging will prevent data only from being stored in the gateway internal memory and from being uploaded to SensorCloud™. The data will still be available to Node Commander® through Live Connect™ and for the CAN J1939 bus. The default setting is that all data logging is enabled. When data logging is enabled the gateway waits for time synchronization (*see Time Options on page 61*), sets the node synchronization beacon, sets the gateway wireless node communication frequency, and then begins logging data.

WSN Beacon: The beacon is used to precisely coordinate node data acquisition and data transmission in the wireless sensor network (WSN) during synchronized sampling (*see Using the Beacon on page 77*).

WSN Channel: The channel setting refers to the wireless sensor network (WSN) transmission frequency between the gateway and the node. There are 14 available 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.

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This setting can also be set temporarily in Node Commander® (*See Transmit Frequency on page 73*), but will default to the Control Panel setting when the gateway is powered off or rebooted. To change the frequency the gateway will use on boot-up, us the Control Panel Setting. The default setting is Channel 15 (2.425 GHz).

Network Mode: The network mode determines whether the gateway has a dynamic or a static IP address, which is used to identify it on the network. A dynamic, or DHCP network, automatically assigns the gateway an IP address. The static IP setting allows manual assignment of the IP address. A static IP address is required if the network does not have a DHCP server or if the gateway will be connected directly to a host computer and not used on a network. The default setting is for a DHCP network.

If Static IP is selected, additional menu settings will appear (*Figure 43 - Static IP Settings*). The **Static IP Address** is the IP Address to which the gateway will be assigned. This cannot be the network address or the broadcast address of the subnet. The **Static Subnet Mask** defines the range that the gateway can communicate (on the subnet). For example, if the gateway IP Address is 192.168.0.100, and the subnet mask is 255.255.255.0 the gateway can communicate with all addresses between 192.168.0.0 and 192.168.0.255. The **Static Gateway** option allows users to define an address the gateway can communicate with outside of its subnet. This requires the gateway to be able to access the internet on a static network.

Figure 43 - Static IP Settings

To setup the host computer for direct communications with the gateway, the host computer IP address must be changed so that it has the same subnet as the gateway. The gateway subnet in the example above is the first three sets of numbers in the IP address (192.168.0). The last set of numbers (100 in the example) will be the unique identifier for each device on the network (the gateway, computer, and other devices will each have a different number).

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To change the IP address on a computer with a Window operating system, try the following steps:

1. Find the active Local Area Connection. Go to the Control Panel, and click on the Network Connections folder.

2. Right-click on the active Local Area Connection, and select properties.

3. Scroll down, and double-click on Internet Protocol (TCP/IP).

4. In the window select Use the Following IP Address.

5. Enter the subnet into the field entitled IP Address, and add a fourth number. It can be any number between 0 and 255, except the number that the gateway or any other device on the network is using.

6. In the Subnet Mask field, enter 255.255.255.0.

7. Save and exit the menus. Setup is complete.

J1939: The J1939 CAN output allows sensor data to be pushed out to a user-designed J1939 CAN bus through the WSDA®-1500-LXRS® multi-port connector. For more information *see CAN J1939 Output on page 42*. The default setting is for the J1939 output to be enabled.

SensorCloud: The SensorCloud™ feature allows enabling and disabling of the transmission of sensor data from the gateway internal memory to the web-based SensorCloud™ database. It also allows remote access to the gateway Control Panel through Live Connect™ (*see Remote Connectivity on page 66*). When enabled the gateway will upload newly received data to SensorCloud™ at two minute intervals. In other words, it will transmit new data, wait two minutes, and then transmit any additional new data. The overall transmission time varies with sampling settings, quantity of data, and internet connection speeds.

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5.3.3 Time Options

The Time Options menu allows configuration options related to how the gateway retrieves and uses time. The WSDA®-1500-LXRS® has two on-board clocks: the System Clock and the Real Time Clock (RTC). The purpose of the System Clock is to provide the operating system with a time source. The purpose of the Real Time Clock is to provide time updates to the System Clock and to provide a reference for the node synchronization beaconing function.

During normal operation, the WSDA®-1500-LXRS® synchronizes time from enabled time sources starting with the most accurate. On boot-up, the WSDA®-1500-LXRS® will try to get a new time. If it is unable to, it will check to see if it already has a non-expired time from the first source. If not it will move on to the next source. During boot-up the WSDA®-1500-LXRS® must successfully synchronize time before it can begin data acquisition. Once synchronization has occurred, the WSDA®-1500-LXRS® will continue to query the time source every hour, however synchronization is not required to continue data acquisition. Manually setting time on the WSDA®-1500-LXRS® will immediately override any synchronization attempts and allow data acquisition to start.
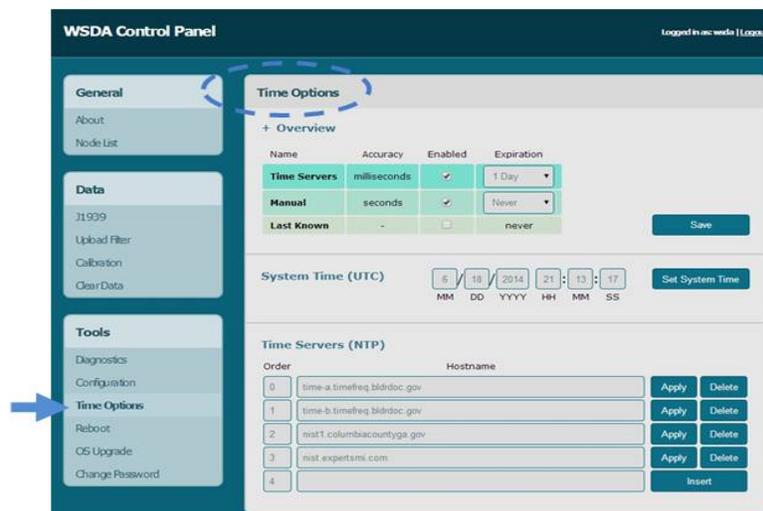
Figure 44 - Time Options Menu

The WSDA®-1500-LXRS® can synchronize its system time from four different **time sources**: Network Time Protocol (NTP) time servers, manual user entry, the last known time reference, or from an attached device with GPS.

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- **Time servers** allows the WSDA®-1500-LXRS® to synchronize with external servers that provide the NTP service. A list of time servers is provided and can be modified by the user. This option requires connection to a NTP server and is the most accurate time source (with the exception of GPS).

- **Manual time** synchronization utilizes a time entered by the user. Enter the time in the System Time field, and select the Set System Time button.

- **Last Known** synchronizes to the last time recorded on the WSDA®-1500-LXRS®. This could be from the internal Real Time Clock (RTC) or a file on the gateway.

- **GPS** allows the WSDA®-1500-LXRS® to synchronize with a compatible external GPS device for extremely accurate time.

NOTE

Using GPS as a time source is only available in the Time Options menu when a GPS integrated device, such as a LORD MicroStrain® GPS enabled inertial sensor, is connected to the WSDA®-1500-LXRS® customization serial port. For more information refer to *see Recommended Sensors on page 97* or contact LORD MicroStrain® Technical Support (*see Technical Support on page 94*).

To select the time source check the Enabled check-box next to the source name in the Time Sources menu. Each time source also has an accuracy field and an expiration field. Accuracy is fixed and dependent on the source. Expiration represents how long the time synchronization is valid for, and it is set by the user.

System Time displays the current time being used by the gateway. Time can be manually entered by typing directly into the field and selecting the Set System Time button. This function is normally used when no other time source (Time Servers, GPS, etc.) is available. If the time is set forward more than an hour from the host computer, the Control Panel web session will be expired and the user will have to log in again.

The **Time Servers** selections allows the user to set which time servers the gateway uses to synchronize time, and in what order it attempts to do so. The time servers are displayed in a list with the first server, order 0, being the first server checked. The time server must support

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NTP for the gateway to use it. The WSDA®-1500-LXRS® comes pre-configured with some known time servers.

To insert a new time server, fill in the last line Order column with the numerical order to place the time server in the list. Next enter the host name of the time server in the Hostname column. Click the Insert button.

To delete a time server locate the time server in the list, and click the Delete button next to it.

To change the order of an existing time server locate the time server on the list, and enter the new order number in the Order column. Click Apply. Other servers with the same numerical designation will automatically be moved.

5.3.4   Reboot

The Reboot option allows the user to restart and reinitialize the gateway without cycling power.

To reboot the WSDA®-1500-LXRS®, select the Reboot button. A three stage boot-up sequence will start, as described in *Table 9 - Reboot Indicators*. The boot-up process will take between two and three minutes. Once booted, log in into the Control Panel as normal.

Stage	Indicator Behavior		
	CLOUD	**WSDA**	**POWER**
Initial Power On	ON red	ON red	ON green
Booting Up	ON red	flashing blue	ON green
Fully Booted	ON green and/or flashing blue	ON green	ON green

Table 9 - Reboot Indicators

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5.3.5   Operating System (OS) Upgrade

Periodically, new versions of the WSDA®-1500-LXRS® operating system will be released to add features or make other updates to the system. On the recommendation of LORD MicroStrain® Technical Support, gateways can be upgraded to the latest available operating system to take advantage of these new features or to correct operating issues. Updates may be found on the LORD MicroStrain® website (*see Technical Support on page 94*).
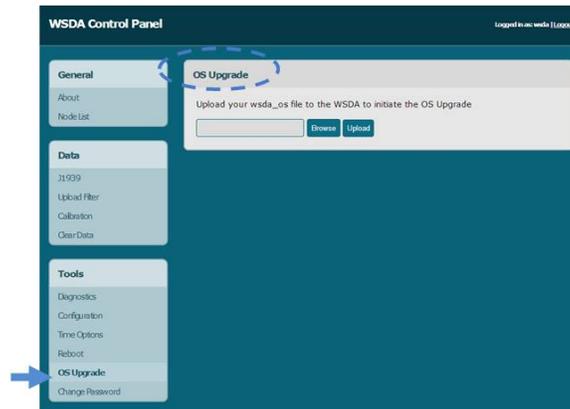
Figure 45 - OS Upgrade Menu

1. Download the upgrade file from the LORD MicroStrain® website or LORD MicroStrain® Technical Support.

2. As needed, extract the contents of the zip file into a folder on the computer. Verify there is a file with a .wsda_os extension.

3. Select the OS Upgrade button in the gateway Control Panel.

4. Select the Browse button, and navigate to the folder containing the update file provided (example: firmware_v2.3.3.wsda_os).

5. Select the Open button, and then Upload. There are two parts to the upgrade: the upload and the actual upgrade. Once the upload reaches 100%, the status bar will reset and begin the upgrade process status. The entire upgrade can take fifteen to twenty minutes.

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5.3.6   Change Password

The Change Password feature is used to change the username and the password required at log-in to the WSDA®-1500-LXRS® Control Panel.

The default username and password are:
  a. Login: wsda
  b. Password: wsda

Enter the current username and password and then the new password twice and select Submit.
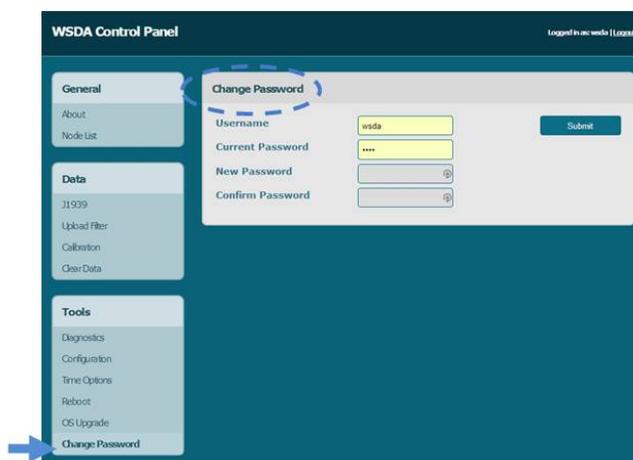
Figure 46 - Change Password Menu

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5.   Remote Connectivity

Some SensorCloud™ data plans allow remote access to the WSDA®-1500-LXRS® through the SensorCloud™ web interface. This allows access to the gateway Control Panel (including data downloading) and to Live Connect™ and Node Commander® for remote configuration of gateways and nodes. Data downloading from the gateway memory is also available in this way. Access is obtained through a secure web interface, although local installations of Live Connect™ and Node Commander® are required on the host computer to access the nodes.

To begin, log in to SensorCloud™ (*see Connecting to SensorCloud™ on page 31*).

Access the Control Panel Remotely

1. While in SensorCloud™ open the Devices menu, and select the device Configuration link (*Figure 47 - Gateway Configuration*).
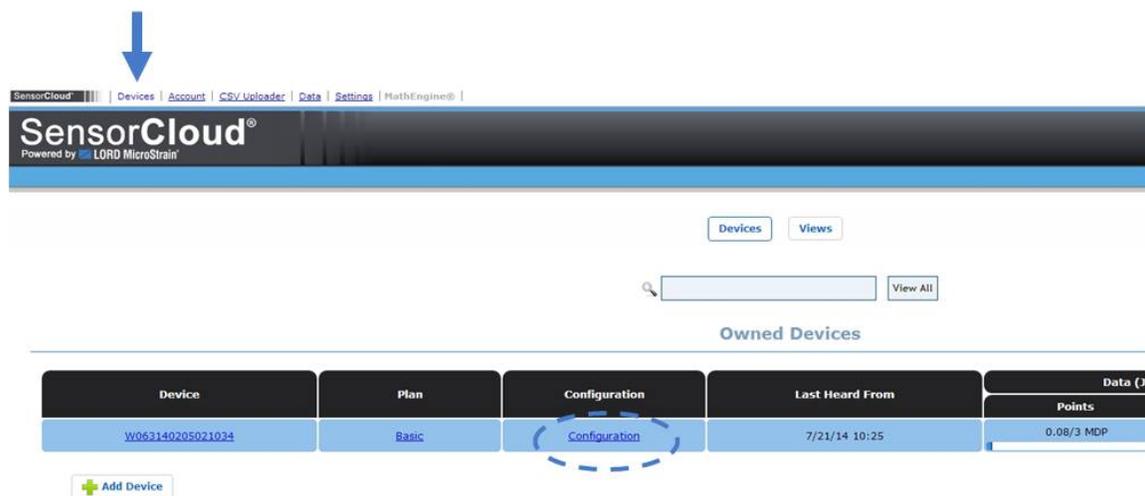
Figure 47 - Gateway Configuration

2. Select the Control Panel button (*Figure 48 - Device Control Panel Access*). If it is not present, the SensorCloud™ account does not include the feature and must be upgraded.

3. Log in to the Control Panel when prompted. All Control Panel features are now available (*see Gateway Configuration on page 36*).

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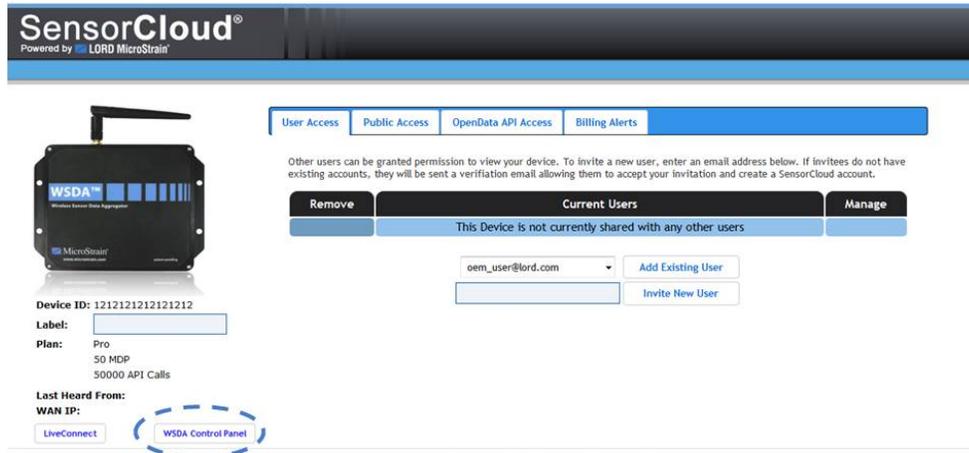
Figure 48 - Device Control Panel Access

Download Data Remotely

1. To remotely download data from the gateway memory, connect to the gateway Control Panel as described above.

2. Copy the URL from the browser address bar when in Control Panel (*Figure 49 - Control Panel URL*).

3. Open the WSDA® Data Downloader program and paste the address into the WSDA URL field.

4. Enter the log-in credentials for Control Panel, and select Connect to WSDA.

5. Enter SensorCloud™ credentials when prompted, and use WSDA® Data Downloader as normal (*see WSDA® Data Downloader on page 80*).

Figure 49 - Control Panel URL

Access Live Connect™ Remotely

1. In the device configuration menu, select the Live Connect™ button (*Figure 50 - Device Live Connect™ Access*). If the button is not present, the SensorCloud™ account does not include the feature and must be upgraded.
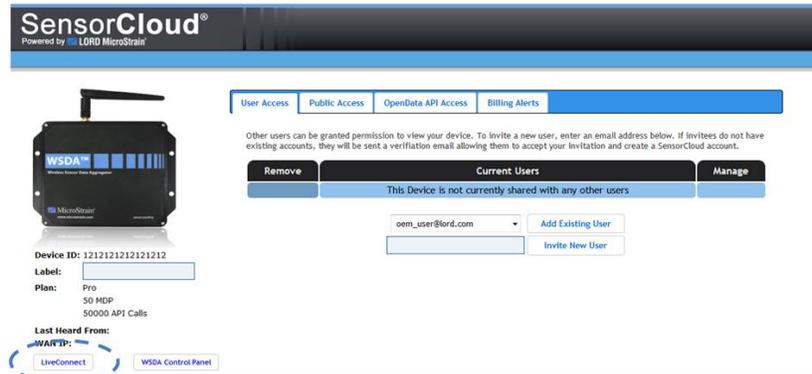
Figure 50 - Device Live Connect™ Access

2. When the button is selected a file download (info.live_connect) will begin. Open the file when the download is complete, and Live Connect™ will open automatically. The device will appear in the Live Connect™ window under User Defined WSDA's (*Figure 51 - Remote Live Connect™ Connection*).

3. Use Live Connect™ to connect to the gateway control panel (*see Gateway Control Panel on page 15*) or to Node Commander® (*see Connecting to Node Commander® on page 17*) as normal.

Figure 51 - Remote Live Connect™ Connection

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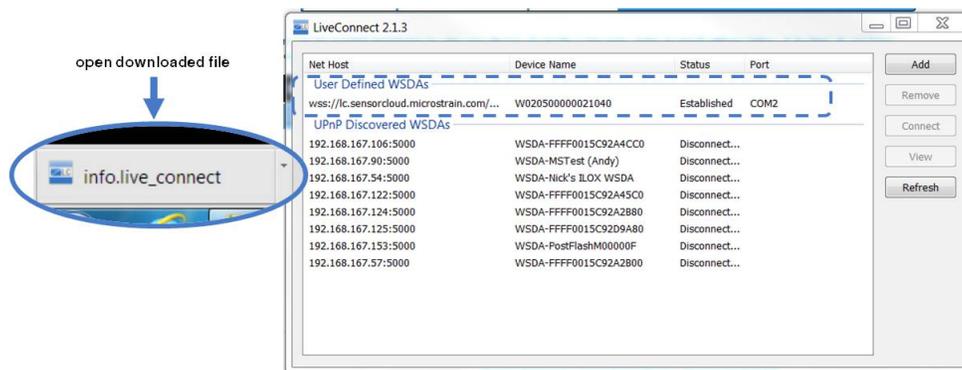
6.   Using Node Commander®

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 an overview of Node Commander® node and data acquisition menus and access through Live Connect™, *see Connecting to Node Commander® on page 17*. For detailed settings information, refer to the Node Commander® User Manual (*see References on page 106*).

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 52 - Gateway Communication* shows an Ethernet gateway that is communicating on ComPort 1, with the corresponding menu and a serial gateway that is not connected.
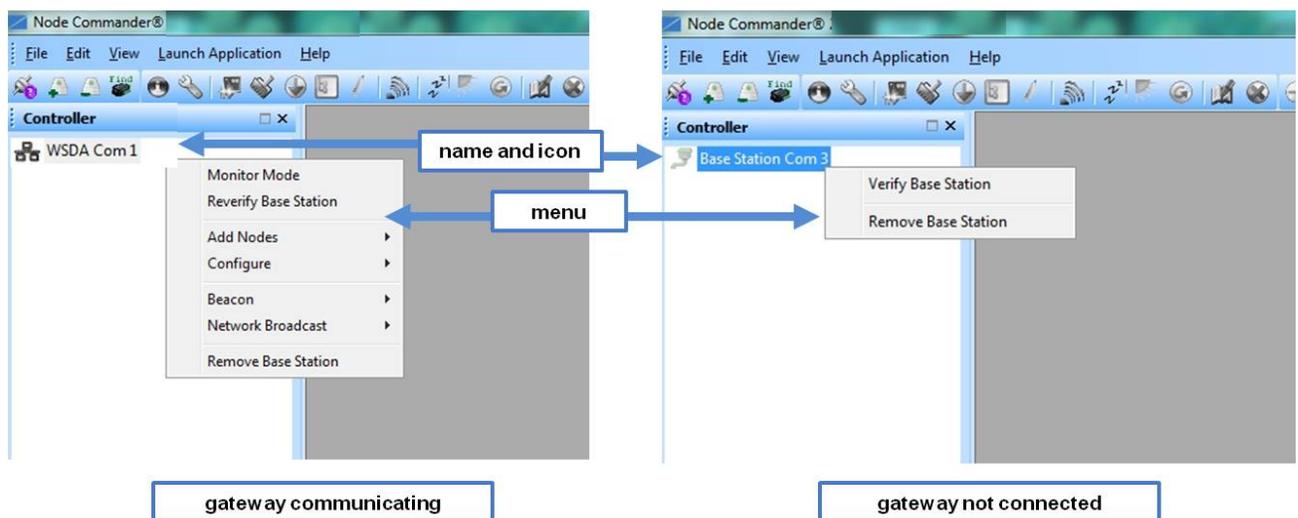
Figure 52 - Gateway Communication

6.1 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.
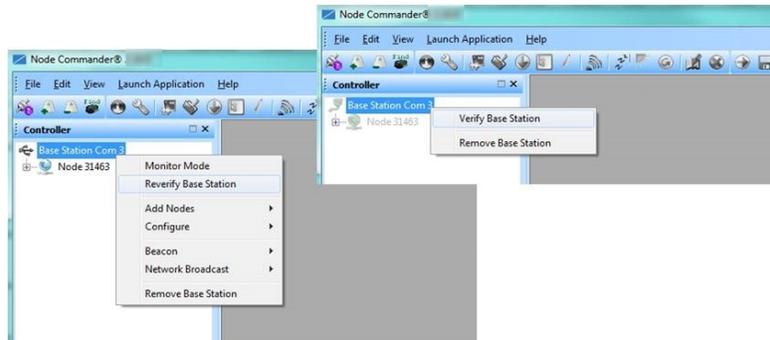
Figure 53 - Verify Gateway Communication

6.2 Gateway 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 54 - Communication Timeout*). This feature can also be used if communication to the node is intermittent.

Figure 54 - Communication Timeout

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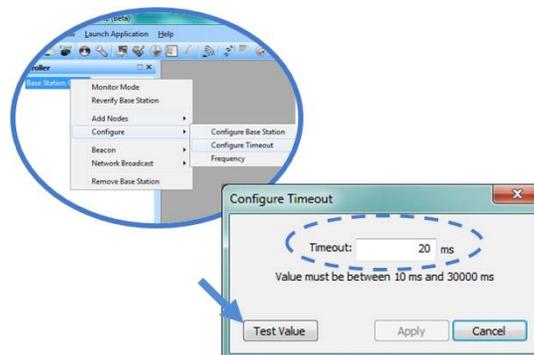
6.3 Removing a Gateway

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 55 - Removing Gateways

6.4 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 .
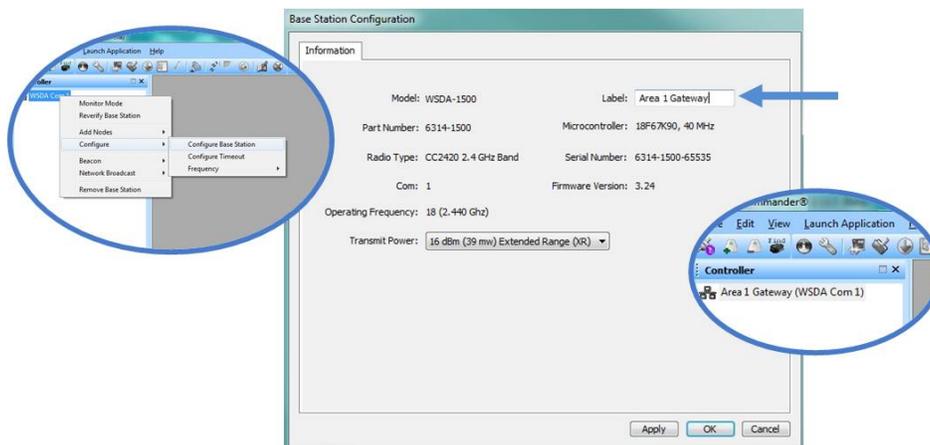
Figure 56 - Gateway Information and Name

6.5   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 83*).

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

Table 10 - Transmit Power Settings

The transmit power setting for the gateway is found in the gateway Configure Base Station menu.
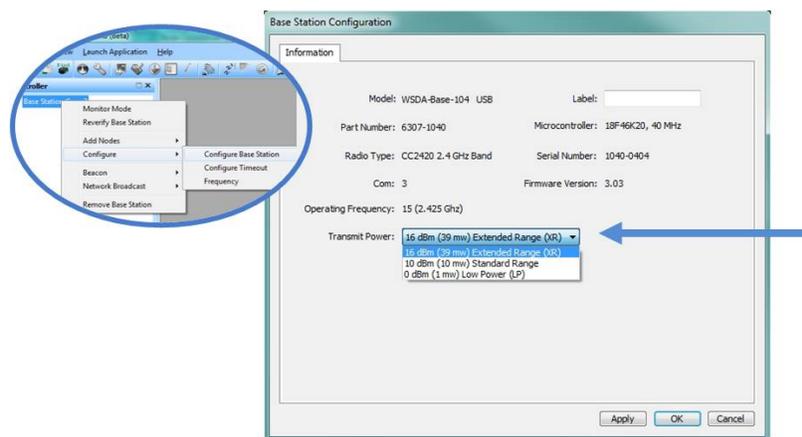
Figure 57 - Transmit Power Setting

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6.6   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.
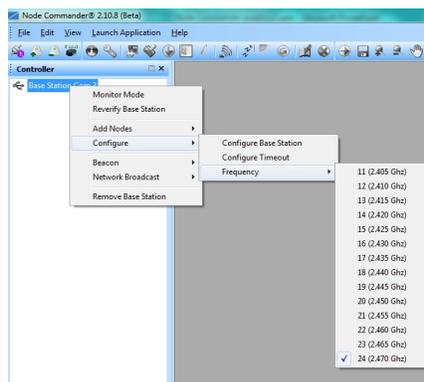
Figure 58 - Gateway Frequency

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NOTE

Setting the transmit frequecy using Node Commander® is temporary for Ethernet gateways and will revert back to the frequency setting selected in the gateway Control Panel when the gateway is powered off or rebooted (*see Gateway Configuration on page 13* for how to change the frequency setting in Control Panel)

6.7   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. All nodes on that frequency will automatically be displayed.

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

Figure 59 - Monitor Mode

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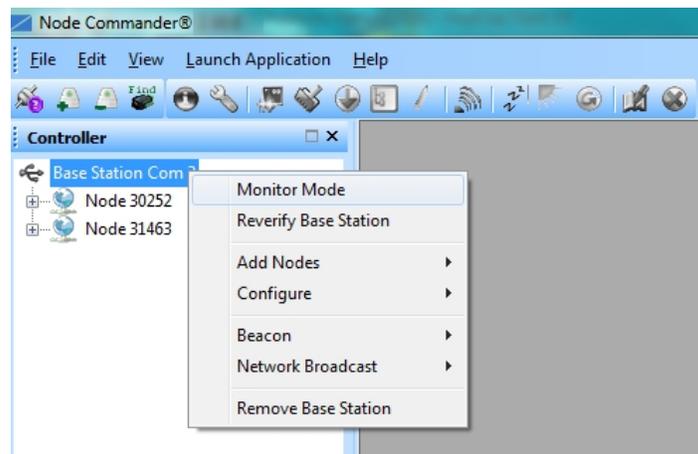
6.8   Network Broadcast

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

Configure
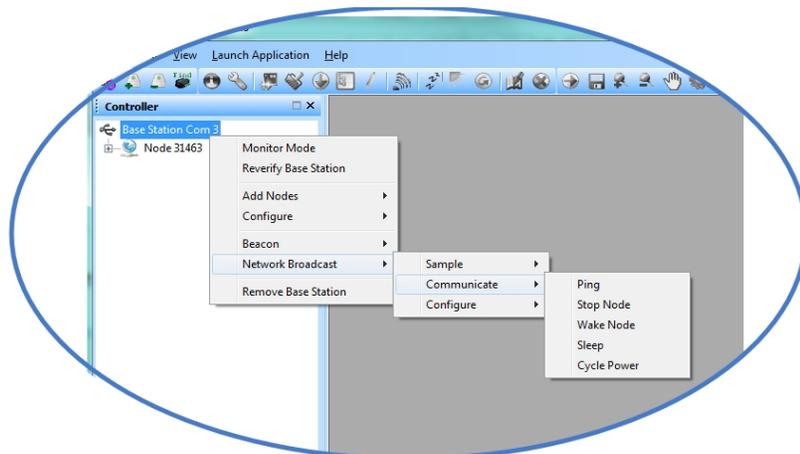
- Read/Write EEPROM

Figure 60 - Network Broadcast Commands

6.9   Node Configuration

Node configuration is completed exclusively in Node Commander®. For an overview of sensor configuration and menus *see Connecting to Node Commander® on page 17*.

For additional node configuration, refer to the Node Commander® user manual (*see Reference Information on page 106*).

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6.   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. Any node that is actively sampling in synchronized sampling mode on the same frequency as the gateway will synchronize to it automatically if the beacon is activated.

To avoid interference with other devices it is recommended that the beacon be disabled when not in use. Do not operate multiple gateways on the same frequency.

To enable and disable the beacon using the gateway control panel *see Configuration on page 57*. 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 25* and refer to the Node Commander® User Manual for more information).

6.10   System Bandwidth in Synchronized Sampling

When using synchronized sampling all nodes in the wireless network are queried and given time slots of various lengths based on their configuration (# of channels, sample rate, etc.). Nodes will only transmit data during these time slots, therefore eliminating over-the-air data

collisions. The total time available for node transmissions is defined by the system bandwidth. Because the system bandwidth is finite, only a fixed number of nodes can be supported when using synchronized sampling. The number of nodes is largely dependent on node configuration, as each consumes part of the bandwidth. Use the online network bandwidth calculator to determine the bandwidth capacity for a particular system configuration: http://www.microstrain.com/configure-your-system

6.11 Synchronized Sampling with Multiple Gateways

If there are multiple gateways in the system, a Global Positioning System (GPS) time source can be used to synchronize time between the gateways. Only gateways with attached GPS devices, such as a LORD MicroStrain® GPS or GNSS-enabled inertial sensor, will have this option (*see Recommended Sensors on page 97*). The gateway-to-gateway synchronization for systems using the GPS time source is on the order of micro-seconds.

Another option available on the WSDA® -1500 - LXRS® gateway is to use an NTP time reference from the internet. As there is lag inherent to using the internet to get a NTP time, it is not recommended for synchronizing multiple gateways. This option would have a gateway- to- gateway synchronization on the order of 10's of milliseconds. A good compromise would be to use of a local NTP time reference. This would reduce the gateway-to-gateway lag to milliseconds. For information on how to adjust the times settings *see Time Options on page 61*.

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7. Data Processing

Data acquired through Node Commander® is automatically saved on the host computer (*see Sensor Data Files on page 34*). Data can also be uploaded or automatically ported to the LORD MicroStrain®SensorCloud™ web platform for near-real time display, monitoring, data storage, and analysis (*Figure 61 - 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 *see Data Handling on page 30*.

Figure 61 - Data Visualization and Analysis

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7.1   WSDA® Data Downloader

The WSDA® Data Downloader is included with the Node Commander® Software Suite and allows the user to download sensor data stored in the WSDA® - 1500 - LXRS® gateway memory to a host computer. The data will be in CSV format. Only the sensor channels selected will be downloaded into the CSV file. Data can also be erased from the gateway memory in this menu.

Open the WSDA® Data Downloader by running it from the Windows® Start menu. Enter the gateway IP address and log-in information. The IP address can be determined in Live Connect™, and the log-in credentials are the same as for logging into the gateway Control Panel (*see Gateway Overview on page 8*).

The WSDA® Data Downloader has four main features; the ability to select and download sensor data, apply calibration coefficients to the data prior to downloading (from the Control Panel Calibration menu settings, *see WSDA® Data Downloader Calibration Coefficients on page 53*), combine all downloaded data into one file, and clear the data from the gateway memory (*Figure 62 - WSDA® Data Downloader*). How long it takes to download depends on the amount of data selected.
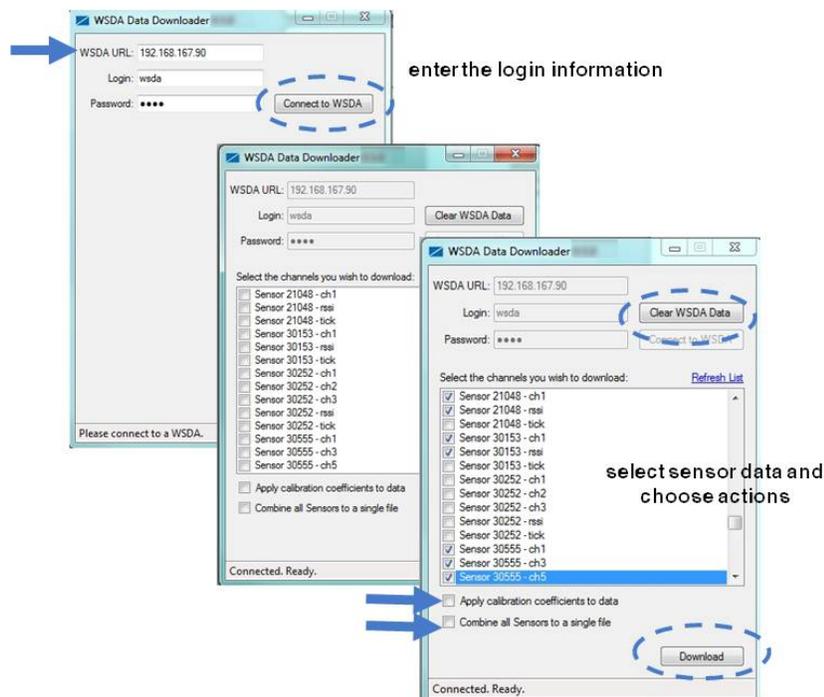
Figure 62 - WSDA® Data Downloader

8.   Gateway Installation

8.1   Installation Recommendations

The WSDA®-1500-LXRS® is rated for indoor use only, unless housed in a ruggedized outdoor enclosure. A ruggedized version of the WSDA®-1500-LXRS® is available from LORD MicroStrain®. For more information *see Parts and Configurations on page 96*.

The gateway has two mounting tabs with holes for fastening (*Figure 63 - Gateway Installation*). It can be mounted in any orientation, but 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 82*.
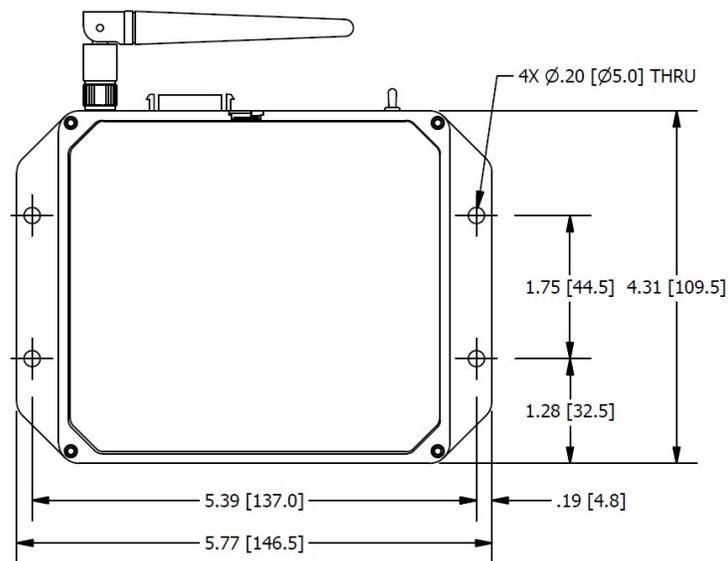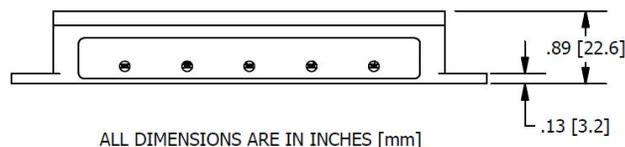
Figure 63 - Gateway Installation

8.2   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®-1500-LXRS® 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. The antenna has a joint in the middle that allows it to be rotated and aimed. 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. 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.

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8.2.1   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.
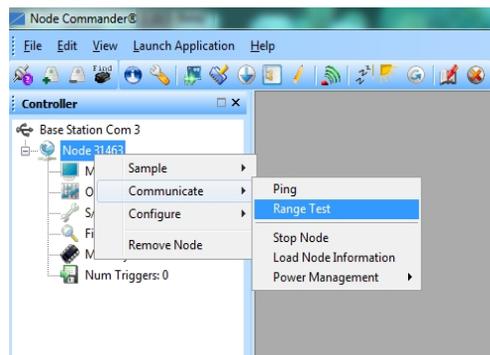
Figure 64 - Range Test Menu

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.
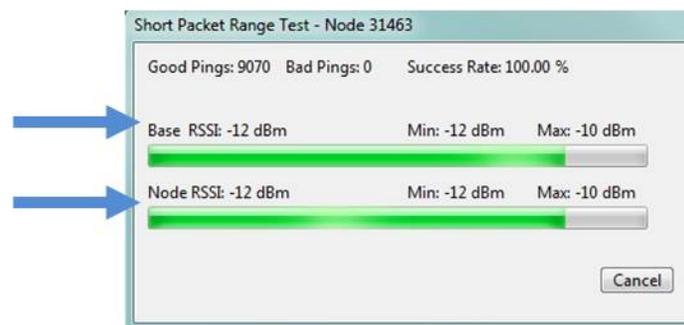
Figure 65 - Range Test Statistics

8.3 Multi-port Connector Interface

The WSDA®-1500-LXRS® multi-port connector is currently only used for CAN J1939 output connections and customized RS232 options, such as for use with LORD MicroStrain® inertial sensors. The remaining are used during manufacturing, or are reserved for future use. For mating connector information and pre-made cable assemblies *see Gateway Accessories on page 96*.
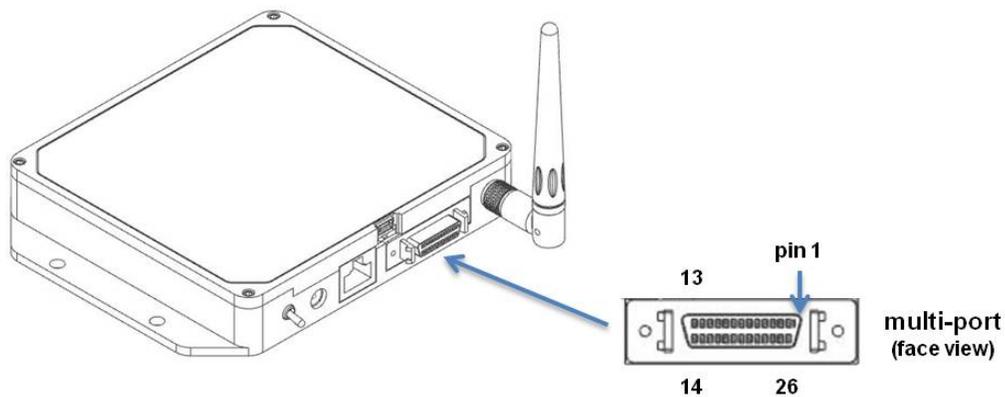
Pin Number	Signal	Pin Number	Signal
1	(future use)	14	(future use)
2	(reserved)	15	+5V
3	+5V	16	(future use)
4	(reserved)	17	Tx
5	GND	18	+5V
6	(future use)	19	Rx
7	(future use)	20	GND
8	(not used)	21	1 PPS Out
9	(future use)	22	1 PPS In
10	GND	23	CAN High
11	(future use)	24	CAN Low
12	(future use)	25	(future use)
13	+5V	26	(future use)

Table 11 - Multi-port Pin Designations

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8.4 Gateway Power Supply

> **⚠WARNING**   Apply only the input voltage range specified for the gateway. Failure to do so could result in personal injury and permanent damage to the gateway (*see Safety Information on page 104*).

Power required for the gateway to operate is applied through the gateway power supply connector (*Figure 66 - Gateway Power Supply*). The gateway starter kit includes a power supply and AC outlet adapters for use in various countries. It is recommended this power supply be used (or another regulated AC-to-DC power supply with the appropriate output parameters, *see Operating Specifications on page 101*). Observe connection polarities, or the gateway may be damaged.

power connector

power connector pin	signal
center	Vjck
barrel	GND

Figure 66 - Gateway Power Supply

LORD MicroStrain®
SENSING SYSTEMS
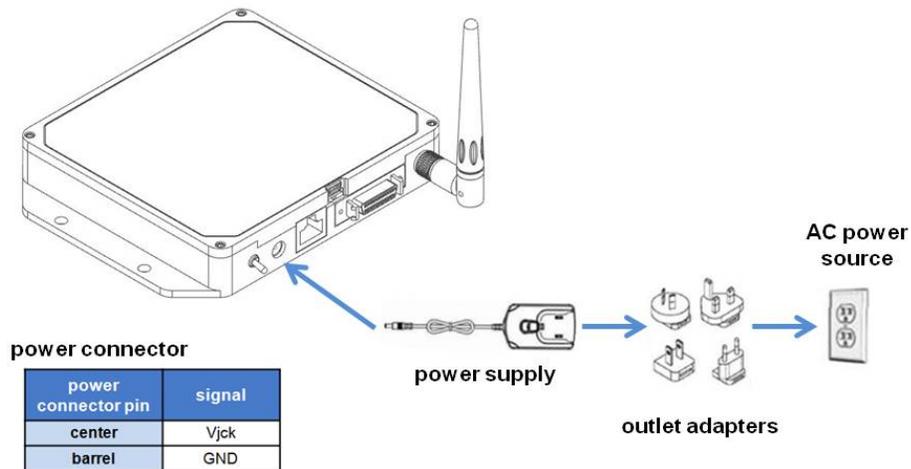
9.   Troubleshooting

9.1   Troubleshooting Guide

1. POWER	2. COMMUNICATION	3. DATA ACQUISITION
gateway or node does not turn on, or node does not charge	no communication to the gateway or node	sensor data is missing or incorrect
1.1 node or gateway power is off	2.1 node or gateway has no power	3.1 no com to node or gateway
1.2 external power off or miswired	2.2 gateway has no com with computer	3.2 sampling settings are incorrect
1.3 wrong power supply or voltage	2.3 node cannot be configured	3.3 sampling has not started
1.4 node battery is dead	2.4 node is out of range	3.4 sensor is not connected correctly
1.5 node or gateway is damaged	2.5 node is not in normal boot mode	3.5 sensor channel not configured correctly
	2.6 node is sampling	3.6 sensor calibration is invalid
	2.7 node is sleeping	
	2.8 gateway or node is damaged	

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Problem	Possible cause and recommended solution
1. POWER **gateway or node does not turn on**	**1.1 node or gateway power is off** The status indicator LED on the device may be off. Turn the device on, and the status indicator LED should illuminate.
	1.2 external power is off or miswired Verify the device power source is connected correctly and powered on.
	1.3 wrong power supply 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.
	1.4 node battery is dead 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 94*).
	1.6 node battery fault If the battery charge indicator on the node is only dimly illuminated when charging is attempted, a battery fault condition has occurred. Unplug power, and then plug it back in. The indicator should turn on brightly, indicating charging.
	1.7 sensors are drawing too much current The node battery can only supply a limited amount of power to the connected sensors. If an over-current condition occurs, the node will shut down. Consider powering the node or sensors with an external source.
	1.58 node or gateway is damaged 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 94*).
	2.1 node or gateway has no power

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Problem	Possible cause and recommended solution
2. COMMUNICATION **no communication to the gateway or node**	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.
	2.2 gateway has no communication with the computer Verify gateway communication in the software. Check, remove, and reconnect communications and power cables as applicable. • 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. • 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.
	2.3 node cannot be configured 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. 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.
	2.4 node is out of range 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 83*. The system has been tested to operate with the node and gateway up to 2 km apart with clear line of sight.

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Problem	Possible cause and recommended solution
	2.5 node is not in normal boot mode 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.
	2.6 node is sampling 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®, execute the Stop Node command to put the node in idle state, allowing configuration to occur.
	2.7 node is sleeping 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.
	2.8 gateway or node is damaged 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 94*).
3. DATA ACQUISITION **sensor data is missing or incorrect**	**3.1 no communication to node or gateway** 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.
	3.2 sampling settings are incorrect

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Problem	Possible cause and recommended solution
	If the sampling mode, rate, or duration are not performing as expected, enter the node configuration menu, and verify the sampling settings.
	3.3 sampling has not started 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.
	3.4 sensor channel not configured correctly Verify that the sensor is configured on the correct channel and has been enabled for data acquisition.
	3. sensor calibration is invalid 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.

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9.2   Device Status Indicators

The following is a complete summary of the WSDA®-1500-LXRS® status indicators.

Indicator	Behavior	Node Status
POWER	OFF	Gateway is off
	ON green	Gateway is on
CLOUD	OFF	Gateway is off
	Flashing blue	Uploading data to SensorCloud™
	ON green	Web upload successful
	ON red	Web upload error or gateway is booting up
ACT	--	(future use)
DATA	OFF	Gateway is off or no data being received
	Flashing green	Receiving wireless data
	Flashing blue	Sync sampling beacon
	Flashing red	Another gateway beacon detected on the same frequency
	ON green	No data being received
WSDA	OFF	Gateway is off
	ON blue	Initial power and boot-up
	ON green	Fully booted & idle
	Flashing blue & green	Sampling and porting data through Node Commander®
	Flashing blue	User-prompted firmware upgrade in process or in initial power and boot-up phase
	ON red	In initial power and boot-up phase or user-prompted firmware upgrade failed

Table 12 - Device Status Indicators

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9.3   Communications Ports in Windows®

Serial gateways (including USB gateways) have either a standard serial or virtual communications port in Windows®. Windows®Device Manage 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 Manger. The menus may appear different depending on the version of Windows and the View settings.
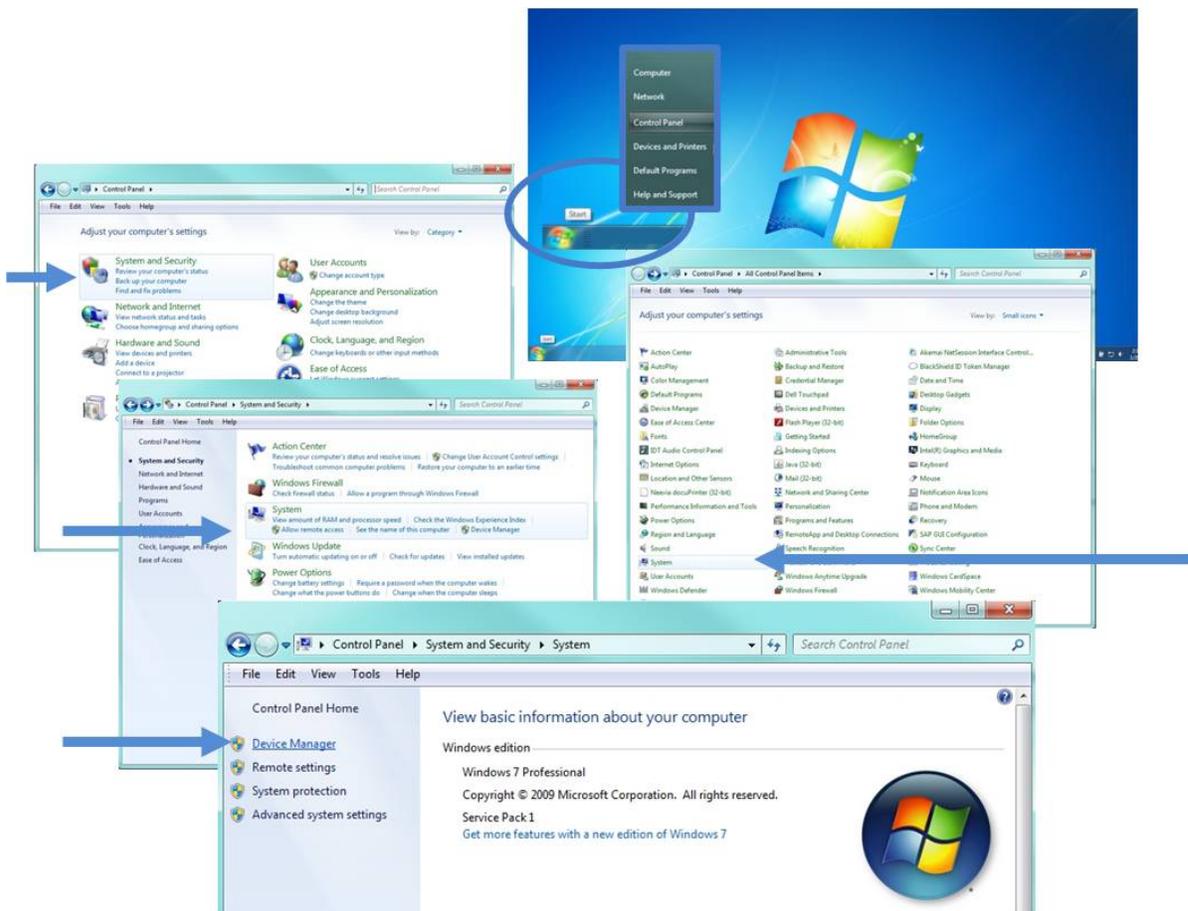
Figure 67 - Windows® System Menu

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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 (COM*X*). An Ethernet gateway will be connected to a Virtual Serial port (COM*X*). If no port is listed, the port is not recognized by the computer, and no gateway communication can be established.
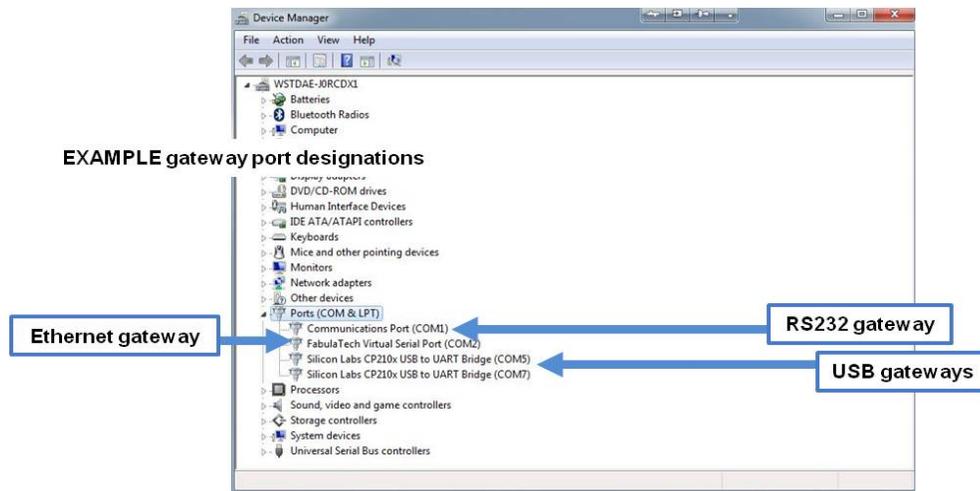
Figure 68 - Windows® Device Manger Menu

9.4   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.

<div align="center">

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)

</div>

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10.   Maintenance

There are no user-serviceable parts on the WSDA®-1500-LXRS®. For device service and repair contact LORD MicroStrain® Technical Support (*see Technical Support on page 94*). Opening the device will void the product warranty.

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11. Parts and Configurations

11.1 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-1500-SK	Ethernet Data Gateway Starter Kit	**6314-1500**

Configuration Options (specify at time of order)

- **LORD MicroStrain® inertial sensor capable:** a different operating system is installed on the gateway to enable this feature, and to add GPS as an option in the time synchronization menu.

11.2 Gateway Accessories

Description	LORD MicroStrain® Part Number
Rugged outdoor enclosure with wired connector ports	**call for information**
Power supply for WSDA®-1500-LXRS®	**9011-0032**
Power supply plug adapter kit	**9011-0022**
Standard whip antenna (FCC compliant)	**9010-0049**
Multi-port cable with flying leads	**call for information**
Multi-port cable with CAN bus connector	**call for information**
Multi-port cable with inertial sensor connector	**call for information**
Ethernet cable (10 feet long)	**9022-0025**

Table 13 - Gateway Accessories

Description	Manufacturer	Part Number
26 pin male AMPLIMITE connector		5749621-2
connecter shell	TE Connectivity	749608-2
insertion tool		58430-1

Table 14 - Multi-port Mating Connector

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11.3　Recommended Sensors

Many sensors can be used with the WSDA®-1500-LXRS®. The following are sensors manufactured by LORD MicroStrain® and are supported for use with the WSDA®-1500-LXRS®. For help with other sensor applications contact Technical Support (*see Technical Support on page 94*).

Model	Description	LORD MicroStrain® Part Number
3DM-GX3-15	Inertial Measurement Unit	6227-xxxx (various)
3DM-GX3-25	Attitude Heading and Reference System	6223-xxxx (various)
3DM-GX3-35	Attitude Heading and Reference System	6225-xxxx (various)
3DM-GX3-45	GPS Aided Inertial Navigation System	6228-xxxx (various)

Table 15 - LORD MicroStrain® Sensors

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11.4   Wireless System Equipment

Model	Description	LORD MicroStrain® Part Number
--	Node Commander® Software	6301-0300
--	SensorCloud™ Software Subscription (contact LORD MicroStrain® Sales)	--
WSDA-BASE-104	USB Gateway	6307-1040
WSDA-BASE-102	RS232 Serial Output Gateway	6307-1020
WSDA-BASE-101	Analog Output Gateway	6307-1010
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-Pro	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 16 - Wireless System Equipment

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11.5   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)

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12. Specifications

12.1 Physical Specification
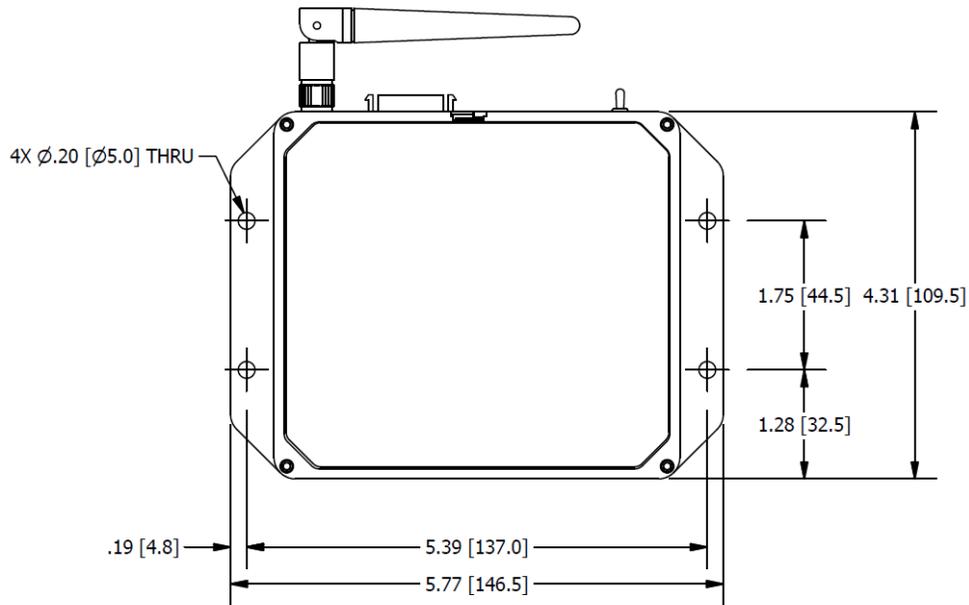
ALL DIMENSIONS ARE IN INCHES [mm]
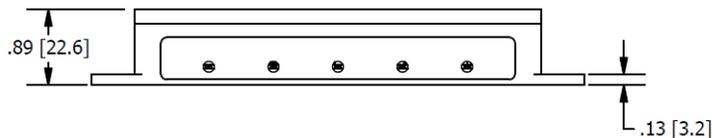
ALL DIMENSIONS ARE IN INCHES [mm]

Dimensions:	147 mm x 110 mm x 23 mm without antenna
Weight:	346 grams with antenna
Enclosure Environmental Rating:	General purpose indoor
	(IP67/NEMA4X rated enclosure available)

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12.2   Operating Specifications

Parameter	Specifications
General	
Processor	ARM® Cortex™ A8, 1 GHz
Operating system	Linux
Connectivity	Ethernet IEEE 802.3 10/100 Mbps, IEEE 802.15.4 wireless, J1939 CAN (output only)
Internet standards	HTTP, HTTPS,TCP/IP, UPnP
IP assignment	IPV4 Static or DHCP
Data storage memory	4 G bytes Micro SD (optional upgrade to 8 GB or 16 GB)
Time synchronization	Network time protocol (NTP), Real time clock (RTC), last used, manual entry
CAN J1939 Output	
J1939 Bit Rate	250 K bps, 500 K bps, 1 M bps
J1939 Source	Static or dynamic via SAE Name
J1939 Destination	Static or SAE Name
J1939 Modes	Tunnel data to destination using PGN 0xEF00, or broadcast data values using PGNs 0xFF00 – 0xFFFF
Standard bus termination	120 Ω
Sampling	
Supported node sampling modes	Synchronized, low duty cycle, continuous, periodic burst, event-triggered, and datalogging
Synchronization beacon interval	1 Hz beacon provides ± 32 µsec 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	
Wireless communication range	Outdoor/line-of-sight: 2 km(ideal)*, 800 m (typical)** Indoor/obstructions: 50 m (typical)**
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
Power consumption	2900 mW (max), 2300 mW (typ) @ 12 V dc
Operating temperature	-40 °C to +85 °C
MTBF	408,000 hours (Telcordia method, SR332)
Physical Specifications	
Dimensions	147 mm x 110 mm x 23 mm without antenna
Weight	346 grams
Enclosure material	Black anodized aluminum
Integration	
Connectors	RJ45 jack, 26 pin multi-port, 2.1mm power jack
Communications cable	Ethernet (CAT6 cable included in starter kit)
Compatible sensor nodes	All LXRS® sensor nodes, all legacy 2.4 GHz nodes
Firmware	Firmware and OS upgradeable through web interface
Software	SensorCloud™,SensorConnect™, Node Commander®, WSDA® Data Downloader, Live Connect™, Windows XP/Vista/7 compatible

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Parameter	Specifications
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

*Measured with antennas elevated, no obstructions, and no RF interferers.
**Actual range varies depending on conditions such as obstructions, RF interference, antenna height, & antenna orientation.

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12.3   Radio Specifications

The WSDA®-1500-LXRS® Wireless Sensor Data Aggregator 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.

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13. 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. Throughout the manual, ANSI Z535 standard safety symbols are used to indicate a process or component that requires cautionary measures.

13.1 Power Supply

The WSDA®-1500-LXRS® Wireless Sensor Data Aggregator is powered by an external AC power supply.

⚠WARNING   **⚠CAUTION**   **NOTICE**

Apply only the input voltage and frequency range specified for the WSDA®-1500-LXRS®. Connect to a power source that is near the device, is accessible, and adheres to all national wiring standards. Compliance with wiring standards is assumed in the installation of the power source and includes protection against excessive currents, short circuits, and ground faults. Failure to do so could result in personal injury and permanent damage to the device. For details on how to connect the power supply *see Gateway Power Supply on page 85*.

13.2 ESD Sensitivity

The WSDA®-1500-LXRS® 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.

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13.3   Disposal and Recycling

The WSDA®-1500-LXRS® contains internal batteries, printed circuit boards, and electronic components. These items are known to contain toxic chemicals and heavy metals that are harmful to humans health and the environment. Disposal is subject to federal and local laws. Do not discard the device or batteries in the trash. Follow proper electronic and battery waste disposal protocol, as dictated by federal and local authorities. Some states also have programs for extracting reusable parts for recycling.

14. References

14.1 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
Online Wireless Network Calculator	http://www.microstrain.com/configure-your-system
SensorCloud™ Overview	http://www.sensorcloud.com/system-overview
MathEngine® Overview	http://www.sensorcloud.com/mathengine
LORD MicroStrain® Wireless Sensors Network Software Development Kit	http://www.microstrain.com/wireless/sdk
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
SAE CAN J1939 Protocol	http://store.sae.org/j1939/contents/
NIST Calibration Procedures	http://www.nist.gov/calibrations/
ASTM Testing Procedures	http://www.astm.org/Standard/standards-and-publications.html

Table 17 - Related Documents

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14.2   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 which the node is sampled for a fixed window of time (burst), and then repeats that window at set intervals. The burst duration and time between bursts is configurable. Same as periodic burst sampling.

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.

Continuous Sampling: a mode of operation in which the node is sampled continuously until stopped, or continuously for a fixed amount of time.

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.

Event-Based Sampling: a mode of operation in which the node sampling is started when a sensor measurement value (threshold) is achieved.

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.

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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

Periodic Burst Sampling: a mode of operation in which the node is sampled for a fixed window of time (burst), and then repeats that window at set intervals. The burst duration and time between bursts is configurable. Same as burst sampling.

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.

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