

SG-Link[®]-200

Wireless Analog Input Node





LORD Sensing Systems
459 Hurricane Lane
Suite 102
Williston, VT 05495
United States of America

Phone: 802-862-6629

Fax: 802-863-4093

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

<http://www.microstrain.com>
sensing_support@LORD.com
sensing_sales@LORD.com

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1. Wireless Sensor Network Overview

The LORD Sensing 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 Sensing Lossless Extended Range Synchronized (LXRS and LXRS+) data communications protocols. Bi-directional 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 stand-alone data-acquisition equipment.



The selection of available nodes allows interface with many types of sensors, including accelerometers, strain gauges, pressure transducers, load cells, torque and vibration sensors, magnetometers, 4 to 20 mA sensors, thermocouples, RTD sensors, soil moisture and humidity sensors, inclinometers, and displacement sensors. Some nodes come with integrated sensing devices such as accelerometers. System sampling capabilities 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 SensorConnect™ and SensorCloud™ software platforms. Integration to customer systems can be accomplished using OEM versions of the sensor nodes and leveraging MSCL, an open source communication library.

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

2. Node Overview

The SG-Link-200 is a small, wireless, low-cost, three-channel analog input sensor node ready for system integration. Featuring three differential input channels and an internal temperature sensor, the SG-Link-200 enables high resolution, low noise data collection at sample rates up to 1 kHz. Users can easily program nodes for continuous, periodic burst and event-triggered sampling with SensorConnect™

Other features of the SG-Link-200 include an adjustable PGA, digital low pass filter, flash memory, and automatic strain gauge calibration using on-board shunt resistors. This wireless sensor is ideal for interfacing to many sensor types including strain gauge, pressure transducers, load cells and displacement sensors.

To acquire sensor data, the SG-Link-200 is used with a LORD Sensing WSDA gateway.



Figure 1 - SG-Link-200

2.1 Configuration Options

SG-Link-200 sensor node comes with the following configuration options.

Antenna Configuration	Factory Installed Bridge Completion	Part Number
Integrated chip antenna	Full-bridge	6308-4200
	Half-bridge, 1000 Ohms	6308-4310
	Half-bridge, 350 Ohms	6308-4330
	Half-bridge, 120 Ohms	6308-4320
	Quarter-bridge, 1000 Ohms	6308-4410
	Quarter-bridge, 350 Ohms	6308-4430
	Quarter-bridge, 120 Ohms	6308-4420
U.FL interface	Full-bridge	6308-4201
	Half-bridge, 1000 Ohms	6308-4311
	Half-bridge, 350 Ohms	6308-4331
	Half-bridge, 120 Ohms	6308-4321
	Quarter-bridge, 1000 Ohms	6308-4411
	Quarter-bridge, 350 Ohms	6308-4431
	Quarter-bridge, 120 Ohms	6308-4421

Table 1 - SG-Link-200 Configuration Options

2.2 Interface and Indicators

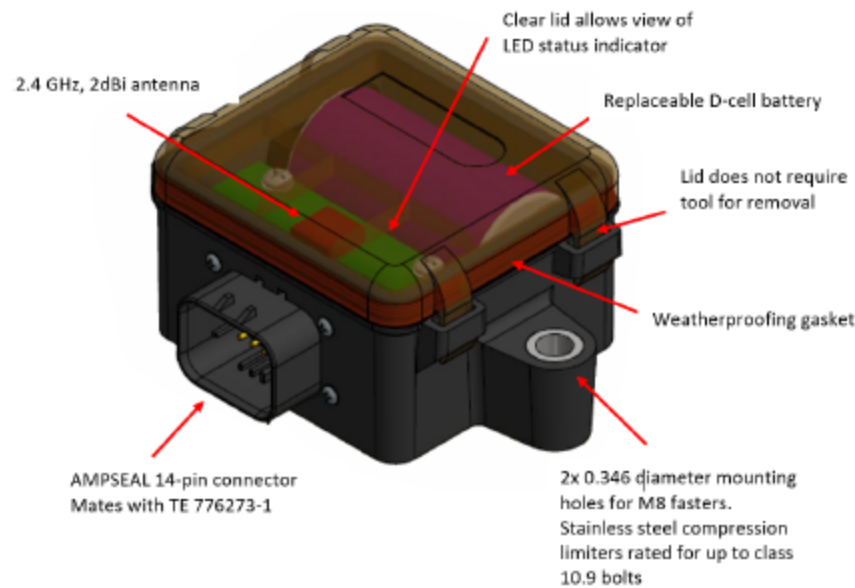


Figure 2 -
Interface and Indicators

Indicator	Behavior	Node Status
Device status indicator	OFF	Node is OFF
	Rapid green flashing on start-up	Node is booting up
	1 (slow) green pulse per second	Node is idle and waiting for a command
	1 green blink every 2 seconds	Node is sampling
	Blue LED during sampling	Node is resynchronizing
	Red LED	Built-in test error

Table 2 - Indicator Behaviors

2.3 Node Operational Modes

Sensor nodes have three operational modes: *active*, *sleep*, and *idle*. When the node is sampling, it is in active mode. When sampling stops, the node is switched into idle mode, which is used for configuring node settings, and allows toggling between sampling and sleeping modes. The node will automatically go into the ultra low-power sleep mode after a user-determined period of inactivity. The node will not go into sleep mode while sampling.

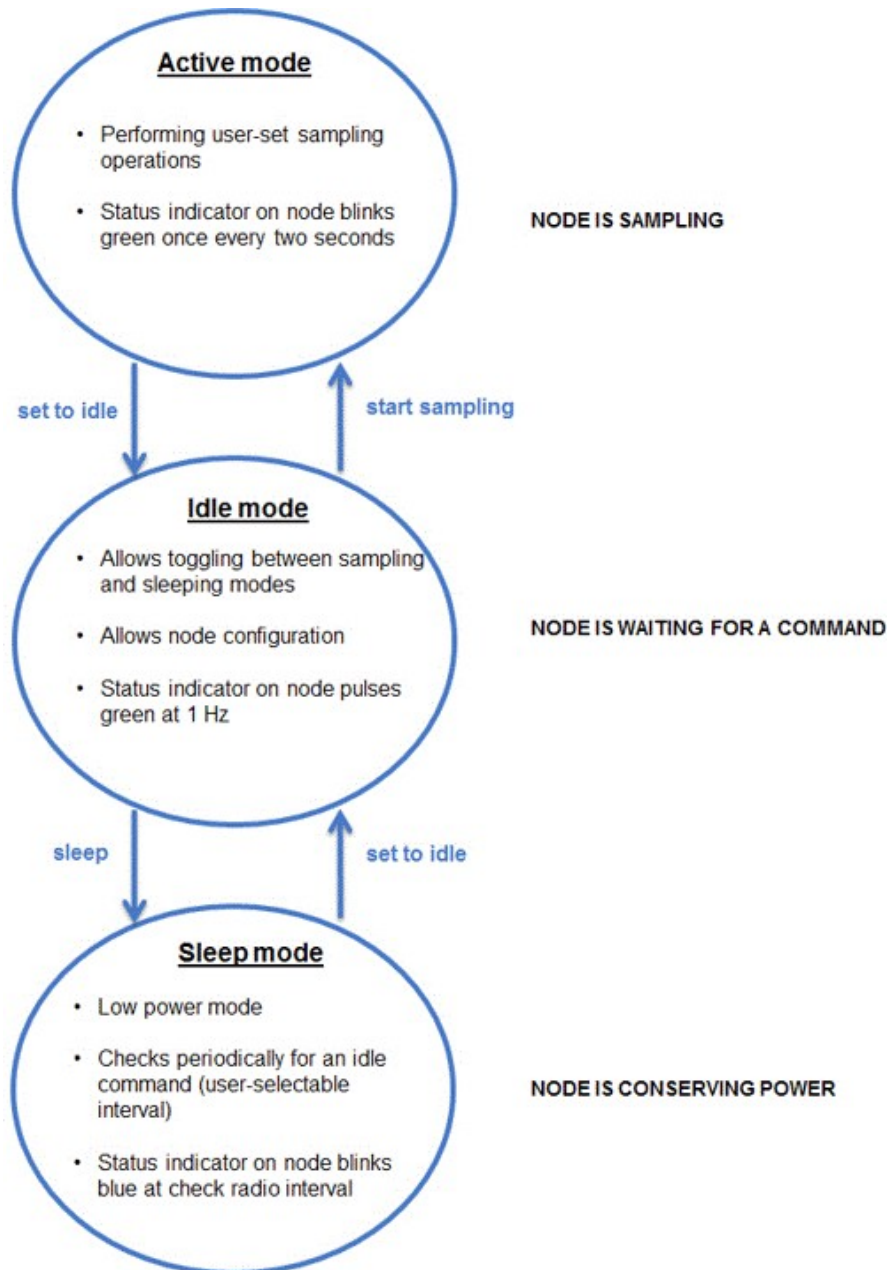


Figure 3 - Node Operational Modes

3. Connect to Gateway and Nodes

3.1 Software Installation

Install the **SensorConnect** software on the host computer before connecting any hardware. Access the free software download on the LORD Sensing website at:



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

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 go to: <http://www.sensorcloud.com/>.



3.2 Connect to Gateway

Drivers for the USB gateways are included the SensorConnect software installation. With the software installed, the USB gateway will be detected automatically whenever the gateway is plugged in.

1. Power is applied to the gateway through the USB connection. Verify the gateway status indicator is illuminated, showing the gateway is connected and powered on.
2. Open the SensorConnect™ software.
3. The gateway should appear in the Controller window automatically with a communication port assignment. If the gateway is not automatically discovered, verify the port is active on the host computer, and then remove and re-insert the USB connector.

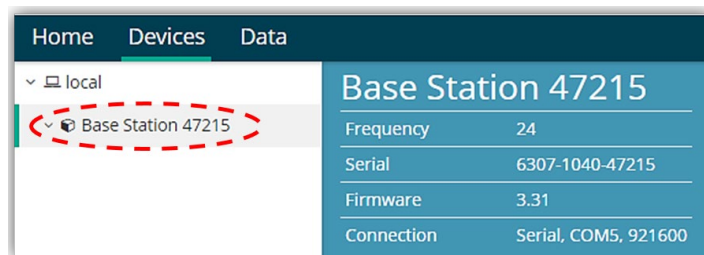


Figure 4 - USB Gateway Communication

3.3 Connect to Nodes

Several methods can be used in SensorConnect to establish communication with the nodes: the automatic node discovery on the same frequency, automatic node discovery on a different frequency, and add node manually.

i. Automatic Node Discovery on Same Frequency

If the base and node are on the same operating frequency, the node will populate below the Base Station listing when powering on the SG-Link-200.

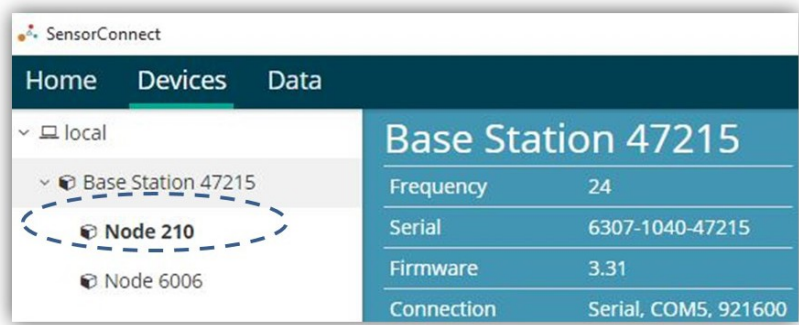


Figure 5 - Node Discovered On Same Frequency

ii. Automatic Node Discovery on Different Frequency

If a red circle with a number appears next to the Base Station, the node may be operating on a separate radio channel. Select the Base Station and then select the Nodes on Other Frequencies tile.

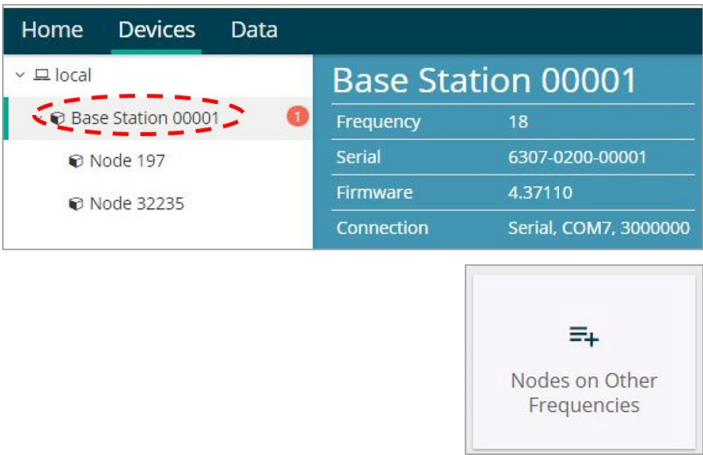


Figure 6 - Node On Other Frequency

Highlight the new node being added and select Move Node to Frequency (#).

Select a Node to move to this BaseStation's frequency.

Node	Frequency	Last Heard
61506	13	6 minutes ago
62884	11	8 minutes ago

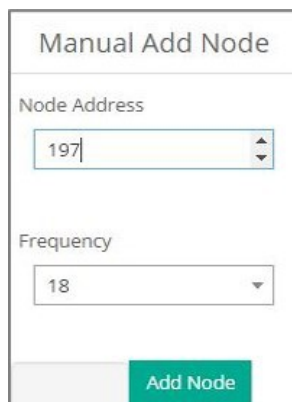
Refresh

Move Node to Frequency 24

Figure 7 - Move Node

iii. Manually Add Node

Adding a node manually requires entering the node address and its current frequency setting.



The form is titled "Manual Add Node". It contains two input fields: "Node Address" with the value "197" and "Frequency" with the value "18". Below the fields is a green button labeled "Add Node".

Figure 8 - Add Node By Address

If the node was successfully added, two confirmation messages will appear, and it will be listed under the Base Station.

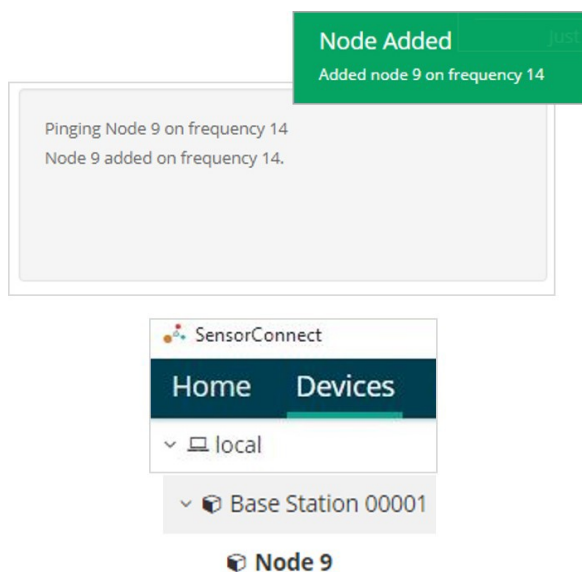


Figure 9 - Add Node Confirmation

If the node failed to be added, a failure message will appear. This means the node did not respond to the base station which could indicate the node is not in idle mode or it may be on another frequency. If "Add Node Anyway" is selected, it will associate that node with the channel entered but it is likely there will be a communication error. If the node was not in idle, move the base station to the frequency of the node and issue a "Set to Idle" command.

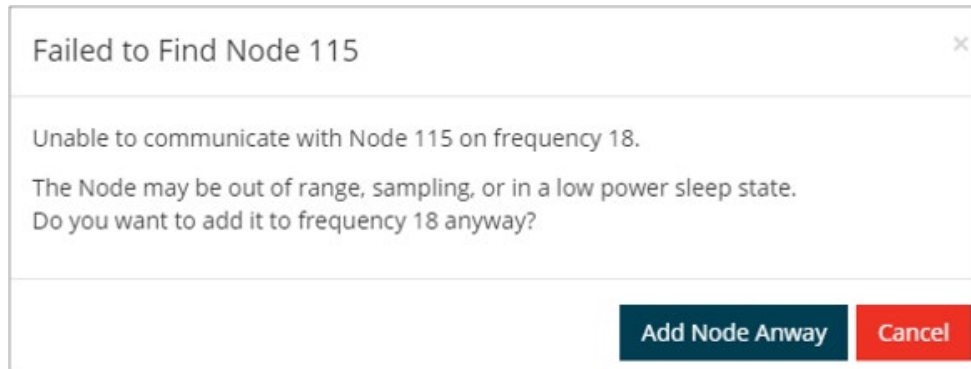


Figure 10 - Failure to Add Node

4. Wireless Sensor Configuration

4.1 Hardware Configuration

Node settings are stored to non-volatile memory and may be configured using SensorConnect. This chapter describes the user-configurable settings.

Hardware

Calibration

Sampling

Power

Excitation Voltage ?

2.5 V

Input Range ?

Channel(s)	Input Range
Differential (ch1)	<div>±19.532 mV</div>
Differential (ch2)	<div>±19.532 mV</div>
Differential (ch3)	<div>±19.532 mV</div>

Low Pass Filter ?

Channel(s)	Filter Cutoff
Differential (ch1-ch3)	<div>4,416 Hz</div>

Figure 11 - Hardware Configuration Menu

- **Excitation Voltage**- Set the voltage of the "Sensor Power" output. Use the highest voltage for best resolution. Use the lowest voltage for longer battery life and to reduce self-heating of 120-Ohm strain gauges.
- **Input Range**- Set the programmable gain amplifier (PGA) to limit the sensor input range. Increasing gain will increase signal resolution, while decreasing gain will allow a larger input range.

- **Low Pass Filter** - A SINC4 digital low pass filter is used to reduce noise. Set the filter to a high frequency for a fast settling time and longest battery life. Set the filter to a lower frequency for reduced noise at the cost of a longer settling time. Slower filter settings may not be available at the fastest sampling rates.

4.2 Calibration Configuration

Analog channels may be independently calibrated with linear calibration coefficients. Use the "Cal Tools" wizard for easy calibration for strain gauges or mV/V sensors, or output raw units such as volts and ADC counts.

Devices / Node 9004 / Wireless Node Configuration

Hardware

Calibration

Sampling

Power

Linear Calibration ?

Channel(s)		Unit	Calibration
Differential (ch1)	Cal Tools	Microstrain	$= (-8.5251e-2 \times \text{bits}) + 715144.25$
Differential (ch2)	Cal Tools	Microstrain	$= (-8.5558e-2 \times \text{bits}) + 717750.5625$
Differential (ch3)	Cal Tools	Microstrain	$= (-8.5763e-2 \times \text{bits}) + 719543.4375$

Figure 12 - Wireless Sensor Calibration Menu

4.3 Sampling Configuration

There are four user-set sampling options for the SG-Link-200, including Lost Beacon Timeout, Diagnostic Info Interval, Storage Limit Mode, and Sensor Warmup Delay in the Wireless Node Configuration > Sampling menu.

Wireless Node Configuration

Hardware	Calibration	Sampling	Power
<div style="display: flex; justify-content: space-between; padding: 10px;"> <div> <p>Lost Beacon Timeout ? <input checked="" type="checkbox"/> On</p> <p>Diagnostic Info Interval ? <input checked="" type="checkbox"/> On</p> <p>Storage Limit Mode ? Stop ▼</p> <p>Sensor Warmup Delay ? 600 μ sec(s) ▼ <input type="checkbox"/> Sensor Always On</p> </div> <div> <p>2 minute(s)</p> <p>30 second(s)</p> </div> </div>			

Figure 13 - Sampling Configuration Menu

- **Lost Beacon Timeout** - When the node is running in a synchronized network, it periodically synchronizes its time clock to a beacon broadcasted from the WSDA gateway. The Lost Beacon Timeout feature means that the node will automatically stop sampling and transmitting data after the beacon has been lost for the configured amount of time. The node will save power in this state without user intervention until the beacon returns. Within two minutes of the beacon returning, the node will automatically begin sampling and transmitting data again.
- **Diagnostic Info Interval** - At the defined transmit interval, the wireless sensor will report diagnostic information. The node will continue to transmit this diagnostic information in all operating modes, including Idle, Sleep, and Run modes. ([See Table 3- below](#)).
- **Storage Limit Mode** - The Storage Limit Mode applies when the node is datalogging to internal flash. The two available options are: 1) **Stop** - when the node fills up its flash memory, it will stop logging data. It is important to erase old data before starting new data logging sessions, and 2) **Overwrite** - when the node fills up its flash memory, new data will overwrite old data in a first-in, first-out method.
- **Sensor Warmup Delay** - Leave the sensor excitation on continuously or duty-cycle power to the sensor in order to save power. When duty cycling power to the sensors, assure the sensor signal can settle within the configured sensor warmup time. For periodic burst sampling, the node will warmup the sensor for a minimum of 1 second before the sampling burst, regardless of the configured warmup time.

The contents of the diagnostic packet may be viewed in the Data tab within SensorConnect.

Description	Data Values	Data Type	Unit
Current State	0 = Idle 1 = Deep sleep 2 = Active run 3 = Inactive run	uint8	--
Run Time	Idle	uint32	seconds
	Deep sleep	uint32	seconds
	Active run	uint32	seconds
	Inactive run	uint32	seconds
Reset Counter	--	uint16	counts
Built in Test Result	0 = no errors	uint32	--
Internal Temperature	Valid range: -40 to 125° C	sint8	Celsius
Low Battery Indicator	0 = good 1 = low 2 = critical (sensor will stop sampling)	uint8	--
External Power	0 = not connected 1 = external power connected	uint8	--
Sample Info	Sweep index	uint32	counts
	Bad sweep count	uint32	counts
Transmission Info	Total transmissions	uint32	counts
	Total retransmissions	uint32	counts
	Total dropped packets	uint32	counts
Synchronization Info	Synchronization attempts	uint32	counts
	Synchronization failures	uint32	counts
	Seconds since last synchronization	uint32	counts
Event Trigger Index	--	uint16	counts

Table 3 - Diagnostic Packet

4.4 Power

There are multiple user- set power options for the SG- Link- 200- OEM, including Default Operation Mode, User Inactivity Timeout, Check Radio Interval, and Transmit Power, in the Wireless Node Configuration > Power menu.

The screenshot displays the 'Wireless Node Configuration' window with the 'Power' tab selected. The settings are as follows:

Setting	Value
Default Operation Mode	Idle
User Inactivity Timeout	On (7200 second(s))
Check Radio Interval	10 second(s)
Transmit Power	20 dBm

Figure 14 - Node Configuration Power Menu

- **Default Operation Mode** - When power is applied, the node will enter the Default Operation Mode.
- **User Inactivity Timeout** - While in Idle mode, the node will automatically enter Sleep mode if it does not receive any commands for the selected amount of time. If Sample is selected under Default Operation Mode, the node will automatically re-enter the sample mode it performed last with all current settings. Disable User Inactivity Timeout to avoid the node automatically changing states.
- **Check Radio Interval** - While in Sleep and Sample modes, the Check Radio Interval sets the frequency the node checks the radio channel for a "Set to Idle" command. Decreasing the Check Radio Interval will shorten the amount of time it takes to wake the node into Idle mode with the cost of decreasing battery life. Increasing the Check Radio Interval could increase battery life at the cost of increasing the amount of time it takes to wake the node into its Idle mode.
- **Transmit Power** - Set the output power of the radio to a value between 0dBm to +20dBm. The output power will effect communication range and also battery life.

5. Wireless Sensor Sampling Configuration

5.1 Start Collecting Data

There are several ways to collect data from the SG-Link-200, including from a single node, a network of nodes, or restarting the last used sampling mode

- **Single node** - From Devices, select Node address > Sample > Apply and Start Network to begin collecting data from a single wireless sensor.

Network Settings: <input checked="" type="checkbox"/> Synchronized ? <input checked="" type="checkbox"/> Lossless ?				
<input checked="" type="checkbox"/>	Node	Channels	Sampling	Data Type ?
<input checked="" type="checkbox"/>	1003	1 Channel ▾	1 Hz continuously ▾	float (4 bytes) ▾

Figure 15 - Single Node Sampling

- **Network of Nodes** - From Devices, select > Base Station > Sampling Network > Nodes to be sampled > Apply and Start Network to start collecting data from a network of wireless sensors.

<input checked="" type="checkbox"/>	Node	Channels	Sampling
<input checked="" type="checkbox"/>	1003	1 Channel ▾	1 Hz continuously ▾
<input checked="" type="checkbox"/>	2003	1 Channel ▾	1 Hz continuously ▾
<input checked="" type="checkbox"/>	2005	1 Channel ▾	1 Hz continuously ▾

Figure 16 - Network of Nodes Sampling

5.2 Network Options

There are two network protocols available for the SG-Link-200, LXRS and LXRS+. These feature node-to-node synchronization of 50us, and unmatched lossless wireless sensor network data throughput. MicroStrain Sensing created these specifically for applications such as flight test and heavy machinery monitoring, where large amounts of raw data are generated, and node synchronization is important. The principal difference between the two protocols is that LXRS+ sacrifices communications range, in favor of a 4x greater network bandwidth.

- **Synchronized** - All nodes in the network will periodically synchronize their time clocks to a beacon that is broadcast each second by the **WSDA gateway**. Each beacon contains a UTC timestamp, allowing nodes to align their collected data within an accuracy of +/- 50 us. Each node will also buffer data and transmit this data in time-slots allocated prior to sampling. Using time-slots assures the transmissions will not “collide”, or corrupt each other. It also provides a means for efficiently scaling the size of the network to allow as much data throughput as possible.
- **TDMA Networking**- The user can achieve near lossless data collection in most environments using data buffering, radio acknowledgments, and retransmissions. Each node buffers collected data and timestamps to an internal 2 Mbit FIFO buffer. For each transmission, data is pulled from this buffer. The node will retransmit data until this acknowledgment is received. Inherent overhead in the transmission scheduling protocol assures the node time to recover from periods of poor radio communication. **This feature allows lossless performance** in environments where the node achieves as low as 50% packet error rate. It also allows for operation in situations where the gateway and node move in and out of range of each other.

More detail on network topology and data handling will be found in a technical brief, “LXRS and LXRS+ Wireless Sensor Protocol”, which will be found under documentation for each wireless product on the MicroStrain website.

5.2 Derived Output Channels

There are three derived data channels available for the SG-Link-200. Using these data channels for trend monitoring allows the ability to extend battery life while reducing data. Each operation is performed on a window of data from the specified sensor channel, where the window size is equal to the output period of derived channel. The timestamp associated with each sweep is that of the last data point collected within that window. The derived data output rate must be at least 32 times slower than the sample rate. ([See Derived Output Channels on page 25](#))

- **Mean** is calculated by averaging all of the measurements taken within the window.
- **RMS** is calculated by squaring the mean of all measurements taken within the window and taking the square root.
- **Peak to Peak** is calculated by subtracting the smallest value from the window from the largest value.

5.4 Sampling Operations Options

The three sampling options for the SG-Link-200 are Continuously, Limited or Event Triggered.

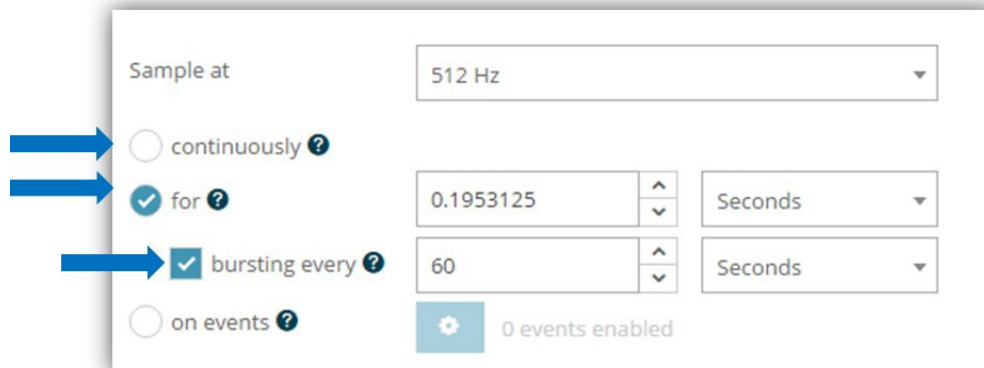


Figure 18 - Sampling Operations Menu

- **Continuous** - Collect data continuously at the configured sample rate. All data is transmitted and/or logged to flash memory until a Set to Idle command is received.
- **Limited** - Automatically stop sampling and return to Idle mode after the configured time duration is met.
- **Event Triggered** - The node will collect data continuously, but only transmit/log the data if one of the configured threshold conditions has been met. When the condition is met, all active sensor channels will transmit/log both pre- and post-event data. This option allows for longer battery life, reduced data sets, and increased network size.

Sampling

1024 Hz on 1 event

⏮

Pre Duration:

500ms

Post Duration:

1000ms

Total:

1500 of 16521 ms

☒

Channel

ch1

Type

ceiling >

Value

1

G's (accel)

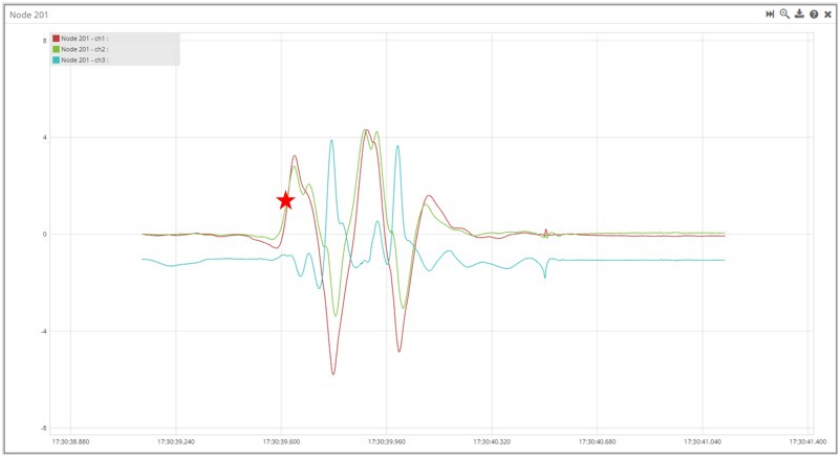


Figure 19 - Event Triggered Sampling

5.5 Output Operation

There are three options for managing data acquired from the SG-Link-200. The user can transmit collected data, log the data to flash memory, or do both.

Network Settings: ☒ Synchronized ? ☒ Lossless ?

<input checked="" type="checkbox"/>	Node	Channels	Sampling	Data Type ?	Log/Transmit ?
<input checked="" type="checkbox"/>	1003	1 Channel ▾	1 Hz continuously ▾	float (4 bytes) ▾	<div>Transmit ▾ Log Transmit Log and Transmit</div>

Network: OK

0.78%

Figure 20 - Data Outputs

6. Data Handling

Data acquired through SensorConnect is automatically saved on the host computer. Saved data can be uploaded to SensorCloud. 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 Sensing sensor products or third-party systems. Basic SensorCloud services are available to all users free of charge at: <http://www.sensorcloud.com/>.

6.1 SensorCloud

6.1.1 Connect to SensorCloud

Go to the SensorCloud website and select sign-in to enter the log-in credentials, or register as a new user if needed: <http://www.sensorcloud.com/>

SensorCloud Login

Email

Password

[Forgot your password?](#)

Login

Don't have an account? [Sign Up](#) now!

Figure 21 - SensorCloud Log-in or Register

6.1.2 Navigating Menus

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 22 - SensorCloud Menu Views*). The Data and Settings views are only available once a device is selected from the device list.

SensorCloud

DEVICESACCOUNTCSV UPLOADERDATASETTINGSMATHEngine®

LOG OUT

Device lists – select a device to access Data and Settings menus

Owned Devices

DEVICE	PLAN	CONFIGURATION	LAST HEARD FROM	DATA (JUN 18 - JUL 18) USAGE	TOTAL STORAGE
New Device OAP10025E0H709H	Basic Uncreated	Configuration		Transactions: 0.00K/25K Monthly Storage: 0.00/10 MDP	0.00 MDP
W063140205021034	Basic Uncreated	Configuration	7/21/14 11:30	Transactions: 0.00K/25K Monthly Storage: 0.00/10 MDP	1.88 MDP

Add Device

Shared Devices

DEVICE	CONFIGURATION	LAST HEARD FROM
MSTest (andy) FFFF013C91C7AB0	Configuration	7/15/15 12:02
CalFrac - Heavy Loading Run Up 9-4-13 OAP100C090H4URZ	Configuration	

Demo Devices

DEVICE	LAST HEARD FROM
Demo Structure OAP10039T2K5PD4X	7/14/15 14:36

Figure 22 - 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 Sensing gateways, or third-party sensor) to be uploaded to the SensorCloud platform. The data must be in the LORD Sensing 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 23 - SensorCloud Data View

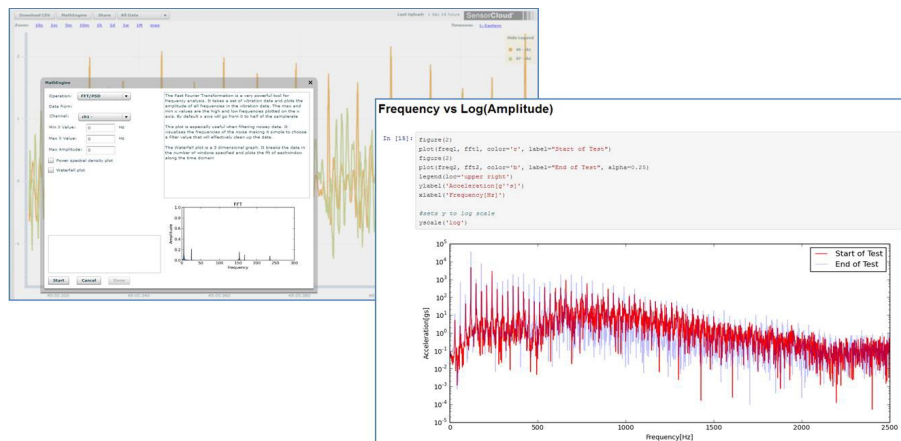


Figure 24 - MathEngine® View

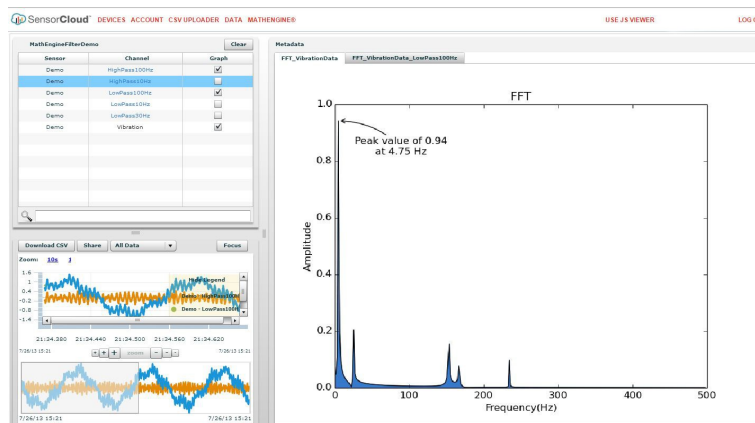


Figure 25 - FFT Graph in SensorCloud

6.2 SensorConnect

6.2.1 Using Dashboards and Widgets

Collected data is viewed on the Data page through the creation of dashboards and widgets. Think of dashboards as individual pages and widgets as an illustration on the page. Create multiple data widgets on each dashboard to display sampled data as a time-series graph, text chart, or a simple gauge that only displays the most current reading. This format provides an easy way to organize many sensors and networks, and it allows the information to be displayed in the most appropriate layout.

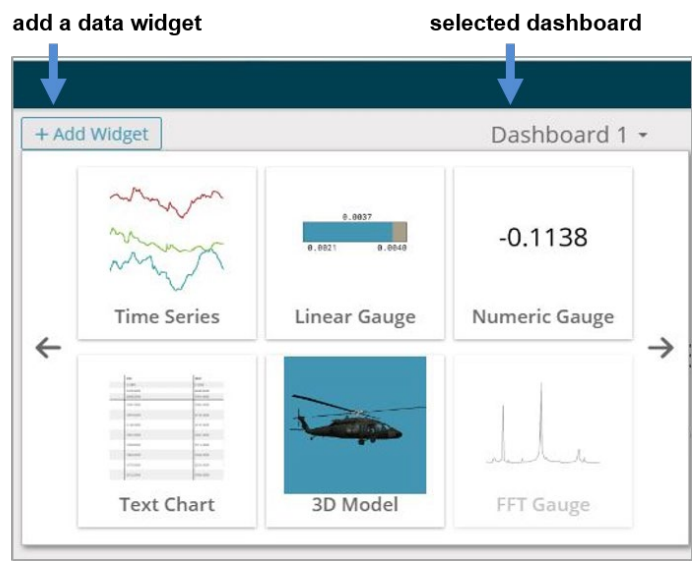


Figure 26 - Viewing Data

6.2.2 Navigating Graphs

Use the mouse along with the shift and control keys inside the graph window to adjust the data view.

Control	Action
Mouse wheel	Zoom in/out on x-axis
Shift + mouse wheel	Zoom in/out on y-axis
Mouse double-click	Zoom to extends
Shift + mouse left-click, drag left/right	Zoom window left/right
Shift + mouse left-click, drag up/down	Zoom window up/down
Ctrl + mouse left-click, drag	Zoom box

Table 6 - Graph View Controls

6.2.3 Widgets Options

The widget configuration menu is different for each type of widget but typically includes sensor or channel selections and widget settings such as titles and legends.

After adding a widget, left click to select and configure it in the Channels and Settings left sidebar menu. Under Channels, the channel(s) for the widget can be enabled and disabled.

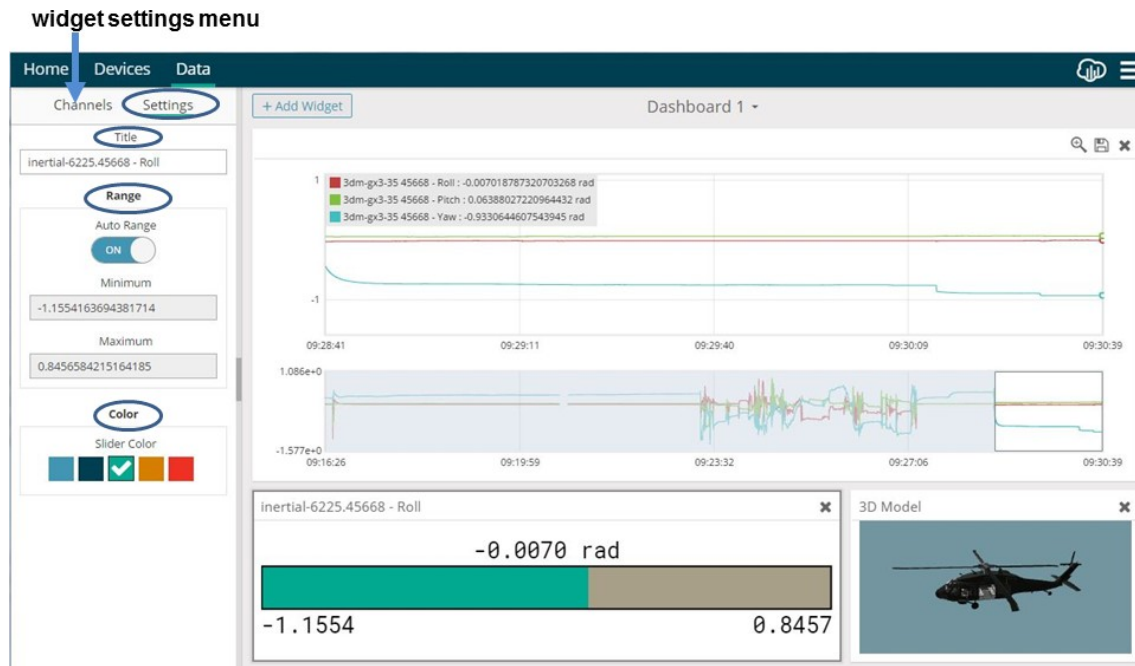


Figure 27 - Widget Settings Menu

6.2.4 Time Series Widget Menu

The Time Series Widget menu has two features to help optimize sensor data collection for export to a .csv file. *Snap to Latest* captures the most recent data and *Zoom* isolates specific events from a larger data sample ([see Exporting Data Files on page 34](#)).



Figure 28 - Time Series Widget Menu

6.2.5 Exporting Data Files

To export data to a .csv file, select the Export Data button on the Time Series widget > Export > name the document > save to the preferred location on the host computer.

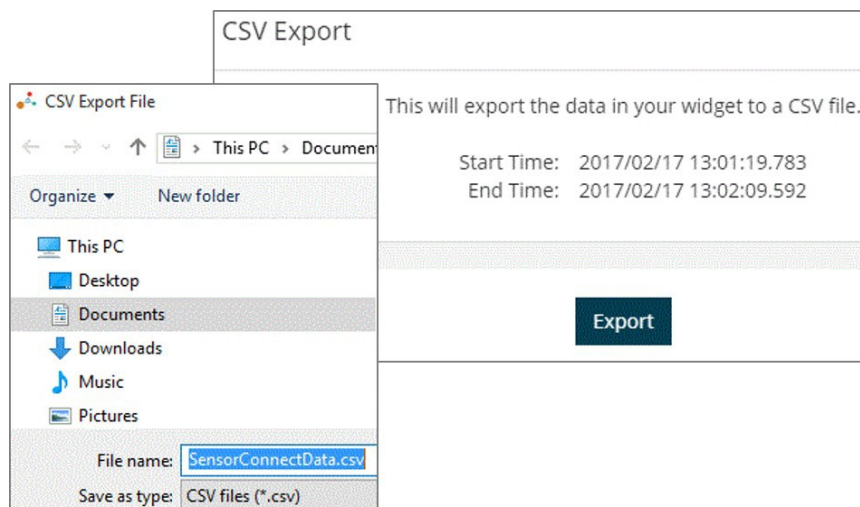


Figure 29 - Exporting Data

7. Installation

7.1 Mounting Recommendations

There are 2 clear-fit mounting holes on the SG-Link-200 for M8 fasteners.

The node can be mounted in any orientation, but it is recommended that it is mounted in a way that optimizes wireless communications. For more information, [see NOTE on page 36](#).

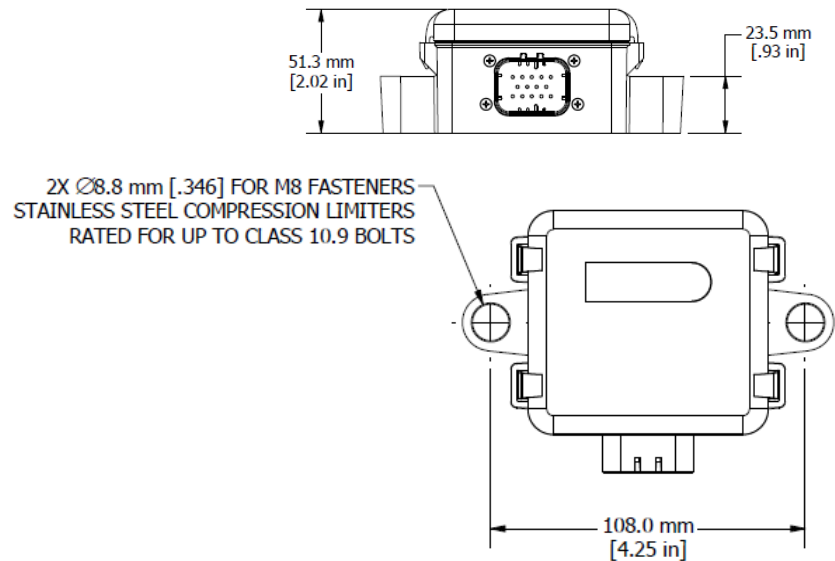


Figure 30 - Mounting the Node

NOTE

In the event of communication difficulties, it may be necessary to disable WIFI on the host computer, or use a USB extender when collecting data.

The best method for ensuring optimal radio communication is to conduct an RF survey of the installation site. This is easily accomplished in SensorConnect by using the range test feature to quantify the radio signal strength (RSSI) in various scenarios. [See Range Test on page 37](#) for instructions on using SensorConnect for measuring RSSI. The following are general guidelines for maximizing communication range:

- **Line of Sight (LOS)** between the node and gateway. Try to avoid obstructions such as buildings, terrain, vegetation, or other physical barriers.
- **Increase the Mounting Height** of the node 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)** from other wireless devices, especially those operating in the same frequency range. This includes other nodes and 2.4 GHz WIFI routers. If other wireless devices are required nearby, mount them at different heights to minimize interference. Additionally, a different radio frequency may be selected using SensorConnect software.
- **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.

7.2 Range Test

After establishing communication between node and gateway, use the range test feature in SensorConnect to monitor the signal strength and to optimally position the nodes, gateway, and antennae 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.

7.1.1.1 Select the node name > Range Test

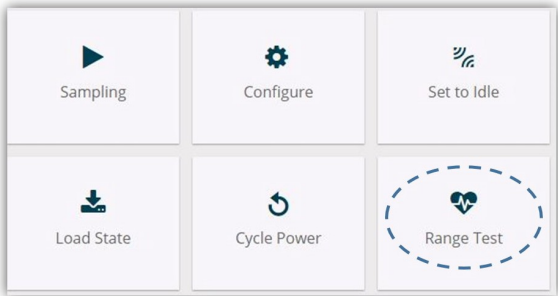


Figure 31 - Range Test Menu

7.1.1.2 RSSI is a measure of signal strength between the node and the base station. A higher RSSI value (closer to zero), will result in better node to base station communication. Reliable communication can be achieved with a signal strength greater than -75 dBm, in the absence of radio frequency interference. Position the node and gateway antennas where the best RSSI value is observed.

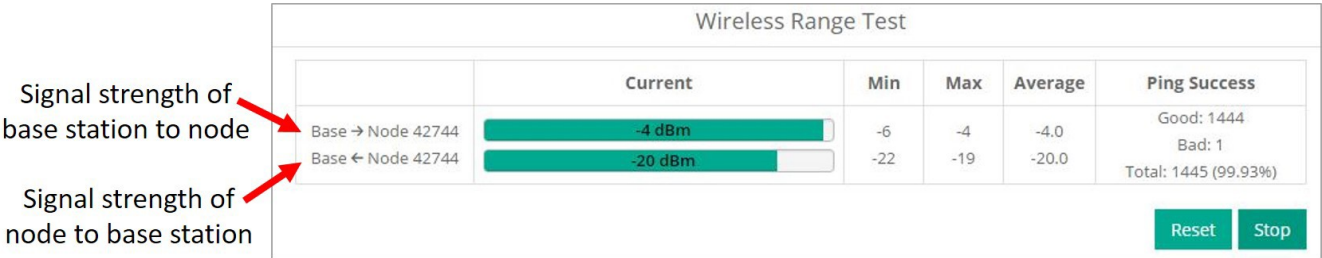
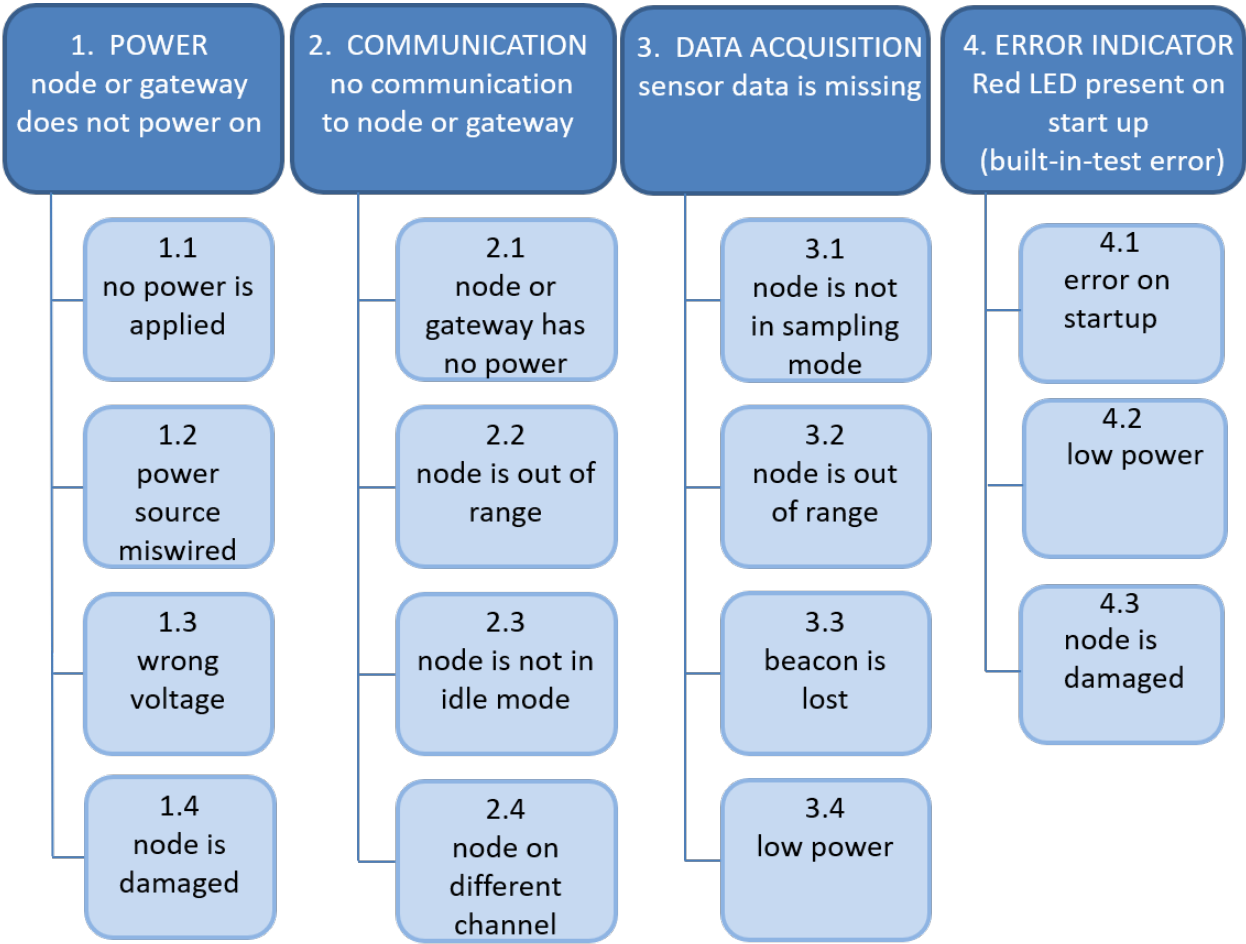


Figure 32 - Range Test Statistics

8. Troubleshooting

8.1 Troubleshooting Guide



	Possible cause and recommended solution
1. POWER gateway or node does not power on	1.1 no power is applied The status indicator LED on the device may be off. Apply power to device, and the status indicator LED should illuminate.
	1.2 power source miswired Verify the device power source is connected correctly and power is applied.
	1.3 wrong voltage Using a power 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 is damaged If all power settings and connections have been verified, and the node is still unresponsive, contact LORD Sensing Technical Support (See Technical Support on page 48).
2. COMMUNICATION no communication to the gateway or node	2.1 node or gateway has no power 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 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 37 .
	2.3 node is not in idle mode Perform Set to Idle command from software. Let it run for up to 30 seconds to see if the node can be reached.
	2.4 node is on a different channel Click on the base station and then Nodes on Other Frequencies and select the node to move to same frequency as the base station.
3. DATA ACQUISITION sensor data is missing	3.1 node is not in sampling mode Observe the diagnostic data for “node state” to see if the node is in IDLE, SLEEP, or RUN mode.
	3.2 node is out of range Observe RSSI in the diagnostic data to assure signal strength is adequate. Increase transmit power to maximum or move gateways closer if out of range.
	3.3 beacon is lost during synchronized sampling The node will stop sampling if it cannot find the beacon. Assure the beacon is enabled on the WSDA gateway, and the node is in good communication range.
	3.4 low power The node will stop sampling if it detects low battery. Observe

	Possible cause and recommended solution
	the diagnostic for a low battery flag.
4. ERROR INDICATOR Red LED present on start up	4.1 error on startup Power down node for 10 seconds and repower.
	4.2 low power Replace battery or power source and repower node.
	4.3 node is damaged If Red LED persists after all power settings and connections have been verified, there is damage to the node Contact LORD Sensing Technical Support for assistance (see Technical Support on page 48).

8.2 Updating Node Firmware

Under the recommendation of LORD Sensing Technical Support Engineers, nodes can be upgraded to the latest available firmware to take advantage of new features or correct operating issues. SensorConnect version 5.0.0 or greater can be used to update any mXRS or LXRS node or gateway firmware to the most current version. Updates are found on the [LORD Sensing website](#) product page under the Downloadstab.

1. Download the Firmware Upgrade file from the [LORD Sensing website](#) product page under the Downloadstab.
2. Once downloaded, extract the contents of the .zip file into a folder on the computer. Verify there is a file with a .zhex extension.
3. Launch SensorConnect, and establish communication between the node and gateway as normal.
4. Select the Node address > Upgrade Firmware > select Browse > select the Firmware Upgrade file > Start Upgrade

8.3 Repair and Calibration

General Instructions



In order to return any LORD Sensing product, you must contact LORD

Sensing Sales or Technical Support to obtain a Return Merchandise Authorization number (RMA). All returned merchandise must be in the original packaging including manuals, accessories, cables, etc. with the RMA number clearly printed on the outside of the package. Removable batteries should be removed and packaged in separate protective wrapping. Please provide the LORD Sensing model number and serial number as well as your name, organization, shipping address, telephone number, and email. Normal turn-around for RMA items is seven days from receipt of item by LORD Sensing.

Warranty Repairs



LORD Sensing warrants its products to be free from defective material and workmanship for a period of one (1) year from the original date of purchase. LORD Sensing will repair or replace, at its discretion, a defective product if returned to LORD Sensing within the warranty period. This warranty does not extend to any LORD Sensing products which have been subject to misuse, alteration, neglect, accident, incorrect wiring, mis-programming, or use in violation of operating instructions furnished by us. It also does not extend to any units altered or repaired for warranty defect by anyone other than LORD Sensing.

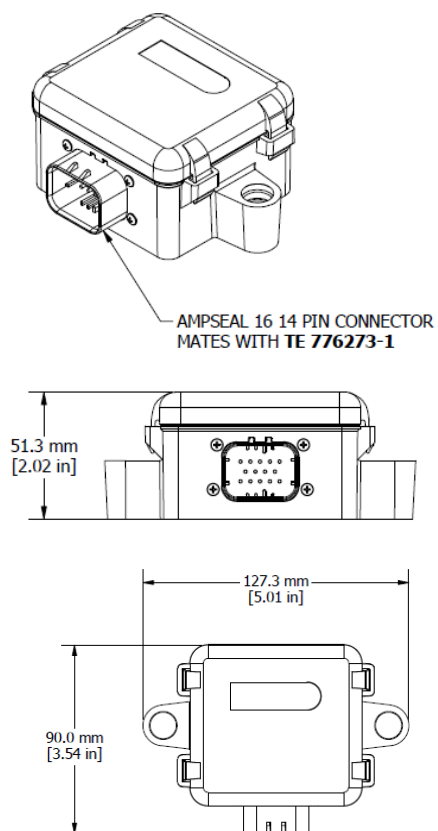
Non-Warranty Repairs



All non-warranty repairs/replacements include a minimum charge. If the repair/replacement charge exceeds the minimum, LORD Sensing will contact the customer for approval to proceed beyond the minimum with the repair/replacement.

9. Specifications

a. Physical Specifications



Dimensions: 41.3 mm x 29 mm x 5.9 mm
Weight: 235 grams, 326 grams w/battery

b. Operating Specifications

Analog Input Channels	
Sensor input channels	3 differential
Sensor excitation output*	Configurable 1.5 or 2.5 V (100 mA)
Measurement range	0 to Excitation voltage (1.5 or 2.5 V)
Adjustable gain	1 to 128
ADC resolution	24 bit
Noise (Gain = 128)	1 μ Vp-p to 20 μ Vp-p (filter selection dependent)
Noise (Gain = 1)	15 to 250 μ Vp-p (filter selection dependent)
Temperature stability	0.172 μ V/ $^{\circ}$ C (typical)
Digital filter**	Configurable SINC4 low pass filter for reducing noise
Strain calibration	Onboard shunt resistor for deriving linear strain calibration coefficients
Shunt calibration resistor	499k Ohm (\pm 0.1%)
Integrated Temperature Channel	
Measurement range	-40 $^{\circ}$ C to 85 $^{\circ}$ C
Accuracy	\pm 0.25 $^{\circ}$ C
Sampling	
Sampling modes	Continuous, periodic burst, event triggered
Output options	Analog: Calibrated engineering units, adc counts and derived channels (mean, RMS and peak-peak)
Sampling rates	1 S/hr to 1024 SPS (1 - 2 channels) 1 S/hr to 512 SPS (3 channels)
Sample rate stability	\pm 5 ppm
Network capacity	Up to 128 nodes per RF channel (bandwidth calculator) www.microstrain.com/configure-your-system
Node synchronization	\pm 50 μ sec
Data storage capacity	16 MB (up to 8,000,000 data points)
Operating Parameters	
Wireless range	Onboard antenna: 1 km (ideal), 400 m (typical) Indoor/obstructions: 50 m (typical)
Radio frequency (RF)	License-free 2.405 to 2.480 GHz (16 channels)
RF transmit power	User-settable 0 dBm to 20 dBm (restricted regionally)
Power input range	Battery: 3.6 V Lithium D-cell 1.5 V Alkaline D-cell*** External Input Power: 4.0 - 36 VDC
Battery lifetime	https://microstrain.com/wireless/sg-link-200 for details
Operating temperature	-40 $^{\circ}$ C to +85 $^{\circ}$ C
Mechanical Shock Limit	1000g/1.5ms
ESD	4 kV
Physical Specifications	
Sensor Interface	AMPSEAL 14-pin connector with 1.3 mm contacts
Mounting	2 x M8
Ingress Protection	IP68, 3.0m for 30 mins
Enclosure Material	PBT base, polycarbonate lid, stainless steel compression limiters
Dimensions	3.536" x 5" x 2.02" (89.8 x 127 x 51.3 mm)
Weight	326 grams (with battery), 235 grams (without battery)
Integration	
Compatible gateways	All WSDA gateways
Software	SensorCloud, SensorConnect, Windows 7, 8, & 10 compatible
Software development kit	http://www.microstrain.com/software/mscl
Regulatory compliance	FCC (USA), IC (Canada), CE, RoHS (EU), MIC (Japan)

10. Safety Information

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

a. Powering the Node

The power source is an external supply within 3.3 - 30 V dc.

b. ESD Sensitivity

The SG-Link-200 is intended to be integrated into an application appropriate housing to protect it from environmental elements, impact, and electrostatic discharge (ESD), which can disrupt operation or damage PCB.

c. Disposal and Recycling

**NOTICE**

The SG-Link®-200 contains 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 in the trash. Follow proper electronic and battery waste disposal protocol, as dictated by federal and local authorities. Some states have programs for extracting reusable parts for recycling.

d. Radio Specifications

The SG-Link-200 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 16 separate frequencies ranging from 2.405 GHz to 2.480 GHz. Following the 802.15.4 standard, these frequencies are aliased as channels 11 through 26. For all newly manufactured nodes, the default setting is 2.425 GHz (channel 15).

SG-Link-200-OEM
FCC ID: XJQMSLINK0011
IC ID: 8505A-MSLINK00 11

This device complies with Part 15 of the United States FCC Rules, and Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions: 1) This device may not cause interference, and 2) This device must accept any interference, including interference that may cause undesired operation of the device. Changes or modifications, including antenna changes not expressly approved by LORD Corporation could void the user's authority to operate the equipment.

Cet appareil est conforme à la Partie 15 des Règles de la FCC des États-Unis et aux RSSS exempts de licence d'Industrie Canada. Le fonctionnement est soumis aux deux conditions suivantes: 1) Cet appareil ne doit pas causer d'interférences et 2) Cet appareil doit accepter toute interférence, y compris les interférences pouvant entraîner un fonctionnement indésirable de l'appareil. Les changements ou modifications, y compris les changements d'antenne non expressément approuvés par LORD Corporation, pourraient annuler l'autorisation de l'utilisateur d'utiliser l'équipement.

11. References

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

<http://www.microstrain.com/support/documentation>

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

Technical Support

sensing_support@LORD.com

Phone: 802-862-6629

Fax: 802-863-4093

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

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)

Product Ordering

Products can be ordered directly from the LORD Sensing 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)

a. Related Documents

Many references are available on the LORD Sensing 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://sensorcloud.com/?onlyCalc=true
Product Datasheets	http://www.microstrain.com/wireless/sensors
Product Manuals and Technical Notes	http://www.microstrain.com/support/documentation
Product Application Notes	http://www.microstrain.com/applications
NIST Calibration Procedures	http://www.nist.gov/calibrations/
ASTM Testing Procedures	http://www.astm.org/Standard/standards-and-publications.html

Table 7 - Related Documents

12. Glossary

These terms are used 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. Also referred to 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/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 sampled 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 antennae are in view of each other with no obstructions.

LXRS: Lossless Extended Range Synchronized is the proprietary LORD Sensing data communications protocol used in the wireless sensor network.

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

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

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

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

Packet: unit of sampled data.

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. Also referred to 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 is 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.