G-Link®-200-OEM
Wireless Accelerometer Node

LORD SENSING
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MicroStrain

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 data communications protocols. Bi-directional wireless communication between the node and gateway enables sensor data collection and configuration. 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 orientation 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 the LORD Sensing data communications protocol.

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

2. Node Overview

The G-Link-200-OEM wireless accelerometer node features an on-board triaxial accelerometer that allows high-resolution data acquisition at noise levels as low as 25 or 80 µg√Hz. The G-Link-200-OEM can output continuous waveform data, or one of four derived channels, including Velocity (IPS$_{rms}$), Amplitude (G$_{rms}$ and G$_{pk-pk}$) and Crest Factor, allowing long-term monitoring of key performance indicators while maximizing battery life. To acquire sensor data, the G-Link-200-OEM is used with a LORD Sensing WSDA gateway, and comes with the following configuration options.

G-Link-200-OEM inputs are 20-bit resolution with ± 0.1% full scale measurement accuracy. The node can log data to internal memory, transmit real-time synchronized data, and it supports event driven triggers with both pre- and post- event buffers.
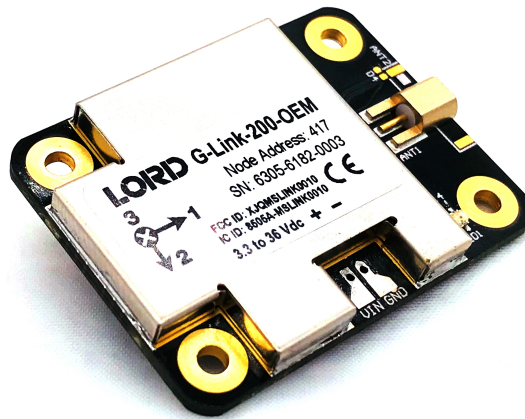
Figure 1 - G-Link-200-OEM

2.1   Configuration Options

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

Chip antenna PCB   MMCX antenna PCB   U.FL antenna PCB

MMCX IP67 antenna   MMCX Indoor antenna   U.FL flag antenna   U.FL stub antenna

Product	Model	Part Number
G-Link-200-OEM integrated chip antenna	8G 40G	6305-6002 6305-6003
G-Link-200-OEM, MMCX IP67 whip antenna	8G 40G	6305-6181 6305-6141
G-Link-200-OEM, U.FL stub antenna	8G 40G	6305-6182 6305-6142

Table 1 - G-Link-200-OEM Configuration Options

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2.2 Parts

The following parts are available for the G-Link-200-OEM
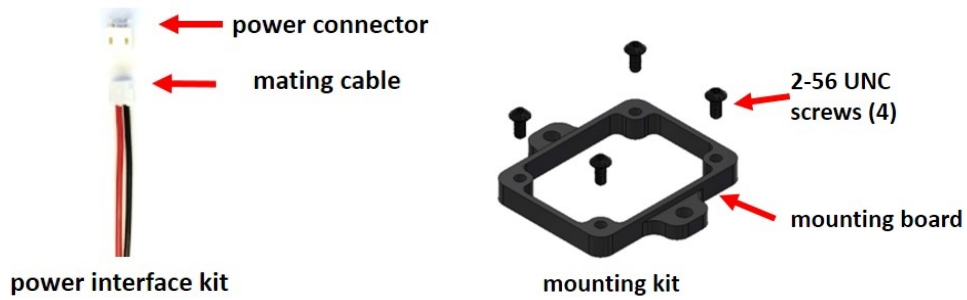
Part	Description	Part Number
Power Interface Kit	Power connector and mating cable (factory installation available at time of purchase)	6306-1030
Mounting Kit	Mounting board and 4 screws	6306-1031
MMCX indoor whip antenna	--	6306-1032
U.FL Flag antenna	--	6306-1033

Table 2 - G-Link-200-OEM Parts

2.3 Interface and Indicators
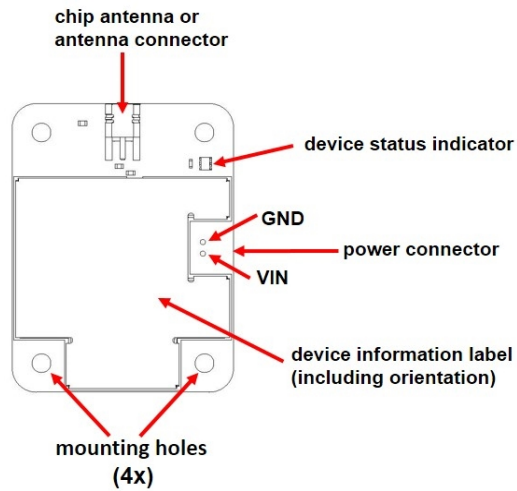
Figure 2 - Interface and Indicators

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 3 - Indicator Behaviors

2.4 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.

Active mode

- Performing user-set sampling operations

- Status indicator on node blinks green once every two seconds

NODE IS SAMPLING

set to idle   start sampling

Idle mode

- Allows toggling between sampling and sleeping modes

- Allows node configuration

- Status indicator on node pulses green at 1 Hz

NODE IS WAITING FOR A COMMAND

sleep   set to idle

Sleep mode

- Low power mode

- Checks periodically for an idle command (user-selectable interval)

- Status indicator on node blinks blue at check radio interval
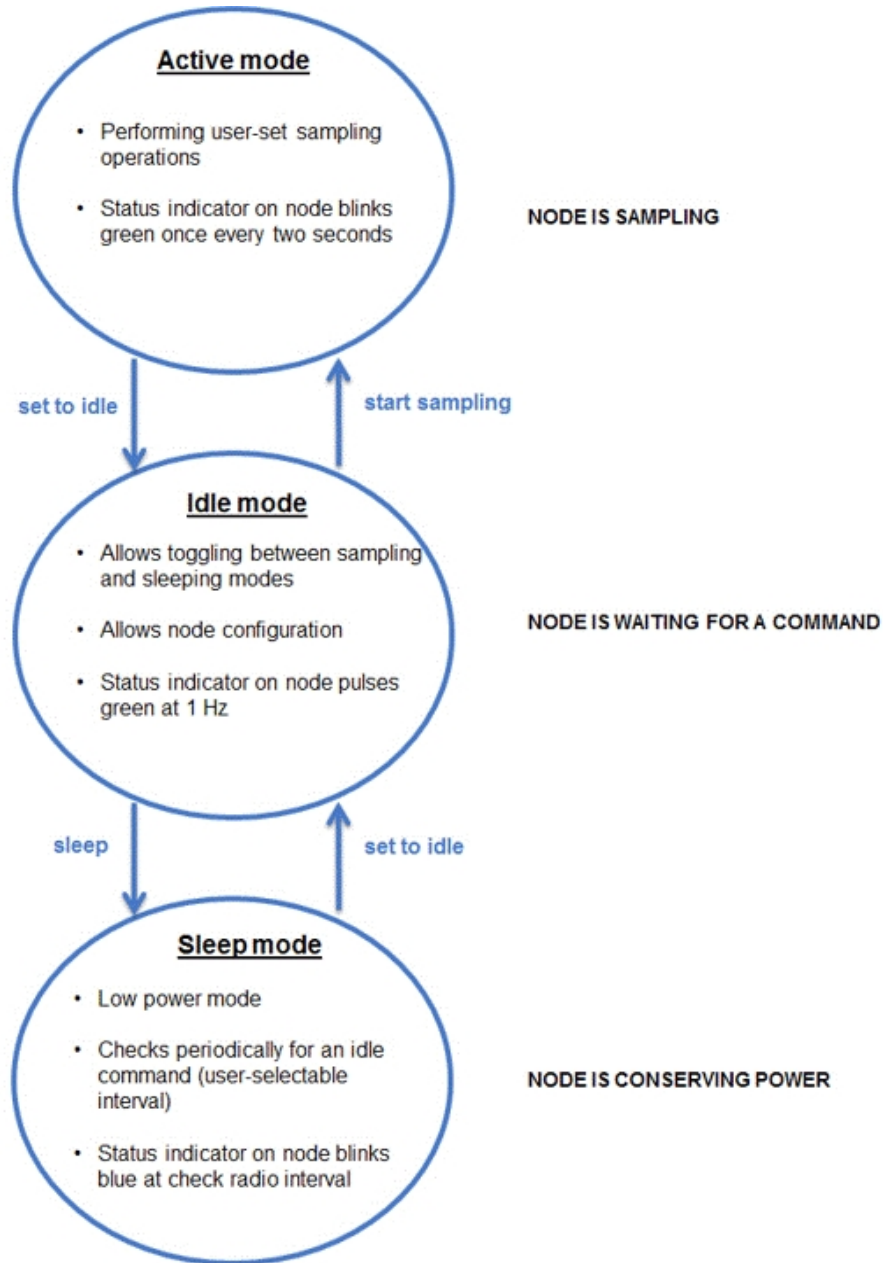
NODE IS CONSERVING POWER

Figure 3 - Node Operational Modes

3. System Operation

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

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 Gateway Communication

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.
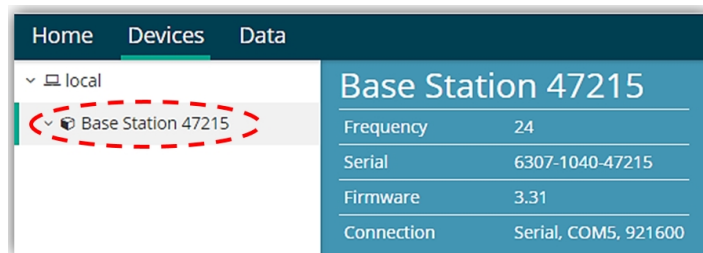
Figure 4 - USB Gateway Communication

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.

3.3.1 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 G-Link-200-OEM.
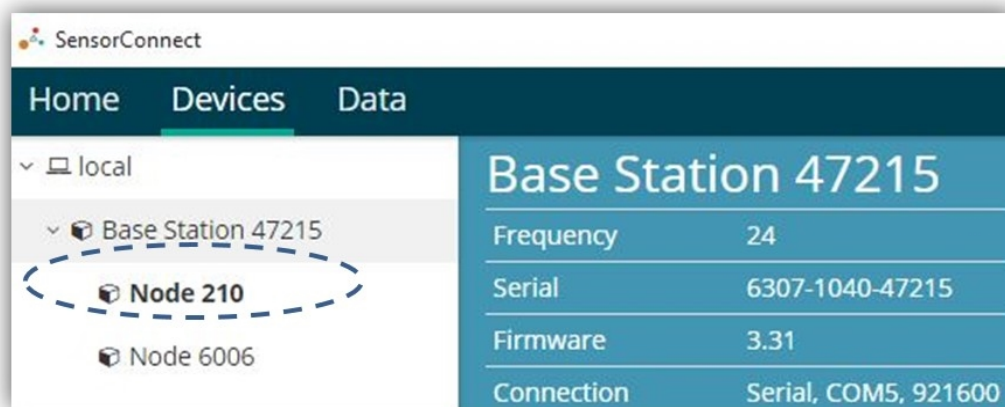
Figure 5 - Node Discovered On Same Frequency

3.3.2 Automatic Node Discovery on Different Frequency

If a red circle with a number appears next to the Base Station, the node is operating on a separate radio channel. Select the Base Station and then select the Nodes on Other Frequencies tile.
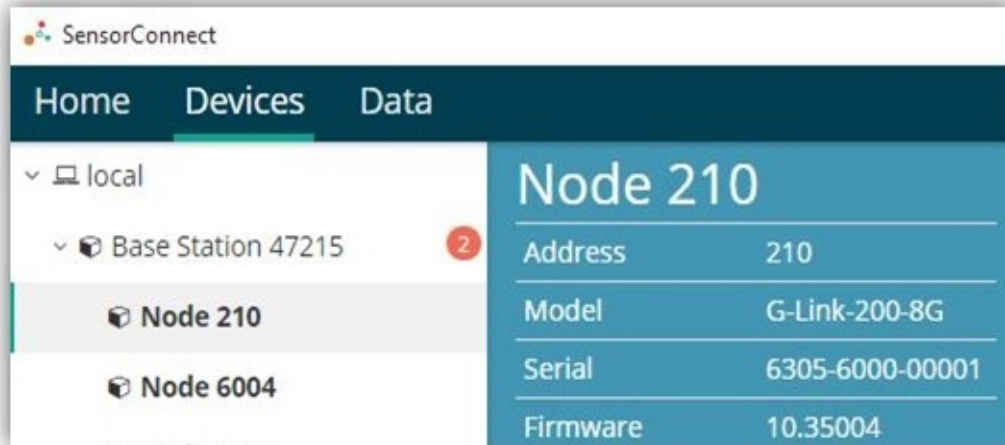
Figure 6 - Node On Other Frequency

Highlight the new node being added and select Move Node to Frequency (#).
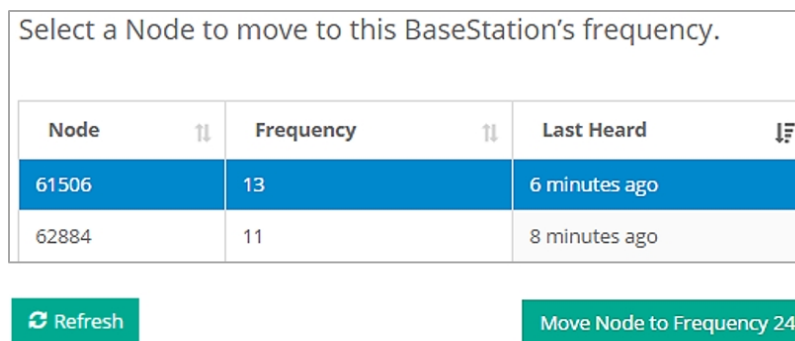
Figure 7 - Move Node

3.3.3 Manually Add Node

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

From the Base Station, select the Manual Add Node tile, enter the Node Address, last known Frequency (factory default is 15), and select Add Node.
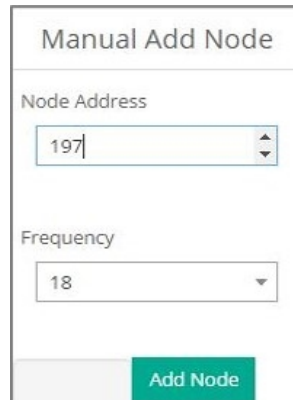
Figure 8 - Add Node By Address

If the node was successfully added, two confirmation messages will appear and it will be listed under the Base Station.
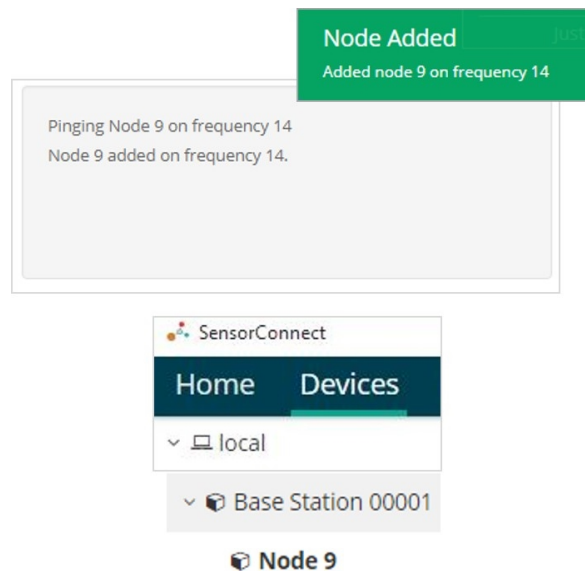
Figure 9 - Add Node Confirmation

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.

Failed to Find Node 9 ×

Unable to communicate with Node 9 on frequency 20.

The Node may be out of range, sampling, or in a low power sleep state.
Do you want to add it to frequency 20 anyway?

Add Node Anyway   **Cancel**
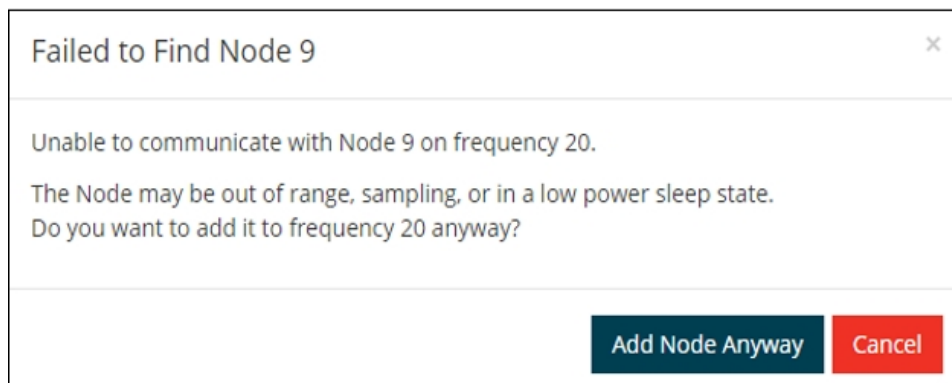
Figure 10 - Failure to Add Node

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.

Figure 11 - Node Configuration Menu

- **Input Range** - Set the accelerometer range to fit the application. Available ranges are .±2.048 g, ±4.096 g, and ±8.192 g for the 8g node or ±10.24 g, ±20.48 g, and ±40.96 g for the 40g node

- **Low Pass Filter and Group Delay -** The accelerometer provides two filter stages for limiting bandwidth and maintaining excellent noise performance. The first stage is an analog, fixed frequency, anti-aliasing filter with -3 dB attenuation at 800 Hz, and 6.18 dB attenuation at 1500 Hz. The second is a user adjustable digital decimation filter. The decimation filter allows low-pass filtering between 26 Hz to 800 Hz on each channel independently. To minimize aliasing, it is recommended that users set the low pass filter to a frequency ¼ that of the sample rate or less.

Group Delay is the time delay of the signal amplitude imparted by the low pass filter. *See Table 4 - below* for group delay values corresponding to the low pass filter configuration.

Low Pass Filter (Hz) at -3 dB	Group Delay (ms)
800	0.88
418	1.51
209	2.75
104	5.27
52	10.31
26	20.38

Table 4 - Group Delay

- **High Pass Filter -** The accelerometer contains an optional high-pass filter which is disabled by default. The high-pass filter corner frequency is effected by the low pass filter setting. When enabled, the high pass filter -3 dB point will be equal to the corresponding low pass filter value as shown in Table 2 below.

Low Pass Filter (Hz)	Resulting High Pass Filter (Hz)
800	2.48
418	1.24
209	2.48
104	1.24
52	0.62
26	0.31

Table 5 - High Pass Filter Values

4.2 Calibration Configuration

Each node is calibrated at the factory and stores its linear calibration coefficients in nonvolatile memory. These coefficients are applied by the node when the node is outputting data in "floating point" format. The coefficients are applied automatically by SensorConnect when the node is outputting data in signed 16-bit or signed 24-bit formats. For the available data types, the calibration coefficients are applied as follows:

- Float (4 Bytes): Calibration applied by node
- Int24 (3 Bytes): G-force = value * slope + offset
- Int16 (2 Bytes): G-force = 64 * value * slope + offset

Figure 12 - Wireless Sensor Calibration Menu

4.3 Sampling Configuration

There are three user-set sampling options for the G-Link-200-OEM, including Lost Beacon Timeout, Diagnostic Info Interval, and Storage Limit Mode, in the Wireless Node Configuration > Sampling menu.
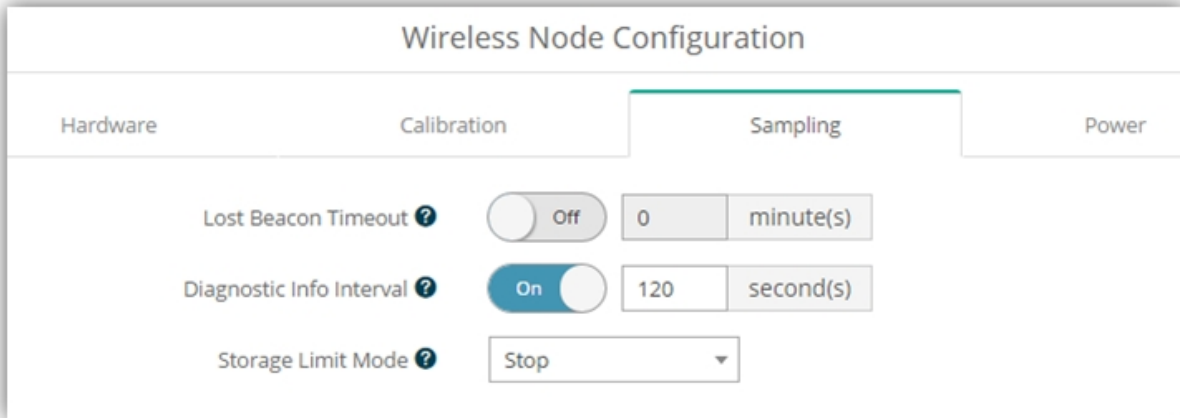
Figure 13 - Sampling Configuration Menu

- **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 6 - 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.

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 6 - Diagnostic Packet

4.4 Power

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

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 G-Link-200-OEM, including from a single node, a network of nodes, or restarting the last used sampling mode, by pressing and holding the start button until the LED light turns blue.

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

	Node	Channels	Sampling	Data Type ❷
✓	210	3 Channels	512 Hz for 0.195 seconds bursting every 60 seconds	int24 (3 bytes)

Network Settings: ✓ Synchronized ❷   ✓ Lossless ❷   ☐ High Capacity ❷

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.

	Node	Channels	Sampling	Data Type ❷	Log/Transmit ❷	% Total	Status
✓	210	3 Channels	512 Hz for 0.195 seconds bursting every 60 seconds	int24 (3 bytes)	Log	0.00%	✔ Ok
✓	6004						▼ Failed to Communicate ⟳
✓	6006						▼ Failed to Communicate ⟳
✓	5555	3 Channels	64 Hz continuously	float (4 bytes)	Transmit	12.50%	✔ Ok

Figure 16 - Network of Nodes Sampling

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5.2   Network Options

There are three network settings available for the G-Link-200-OEM: Synchronized, Lossless and High Capacity.

Figure 17 - Network Settings Menu

- **Synchronized -** By selecting Synchronized, all nodes in the network will periodically synchronize their time clocks to a beacon that is broadcasted by the **WSDA gateway**. Each beacon contains a UTC timestamp, allowing nodes to timestamp 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.

  If Synchronized is deselected, the node will not require a beacon time source and will transmit a data transmission for each measurement sweep. The user should deselect Synchronized if, either low latency, or the lowest possible power at slow sample rates, is required.

- **Lossless -** The user can achieve near lossless data collection in most environments through the use of 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. And upon receiving the data packet, an acknowledgment is sent from the **WSDA gateway** that is providing the beacon. 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.

The Lossless feature is only available when Synchronized is enabled. Disable Lossless if the application requires consistent latency or can tolerate lost data.

- **High Capacity -** Enabling high capacity allows larger network sizes and potentially longer battery life, at the cost of increased latency. This is accomplished by decreasing the minimum allowed output rate from 1 transmission per second to 1 transmission every 16 seconds.

5.3   Raw Waveform Channels

There are two options for data output from the G-Link-200-OEM, including raw waveform channels and derived data channels. The raw channels provide waveform data directly from the sensor.
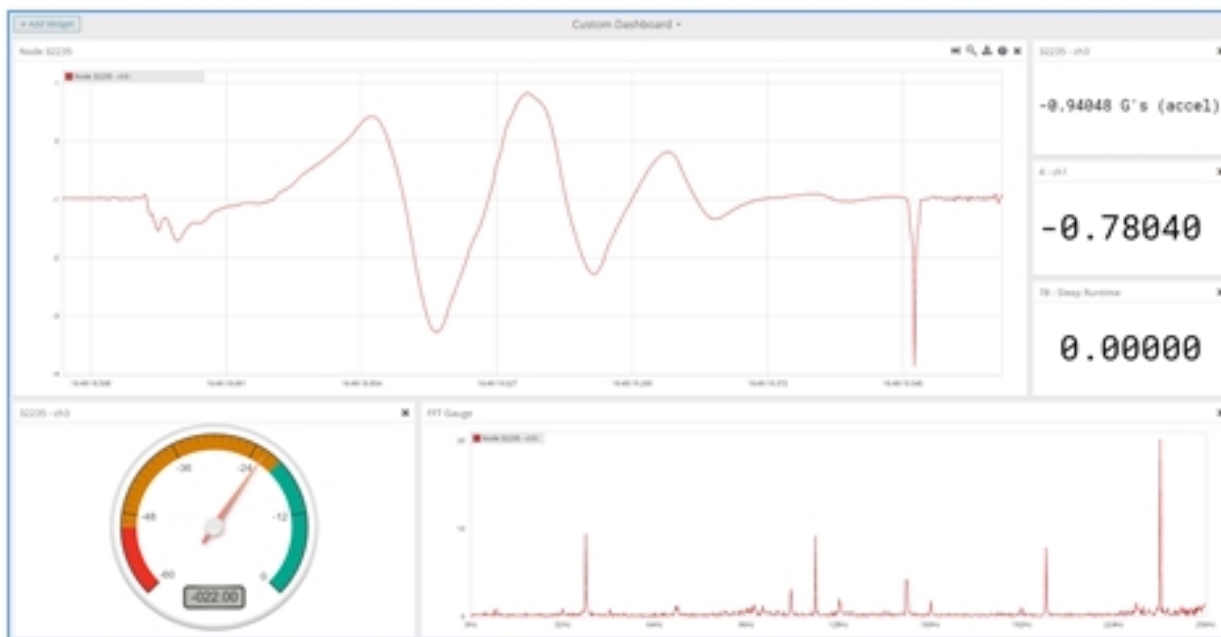
Figure 18 - Raw Data Output

5.4   Derived Output Channels

There are four derived data channels available for the G-Link-200-OEM. Using these data channels for vibration analysis allows the ability to extend battery life while reducing data. Each operation is performed on a window of data from the specified accelerometer axis. 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 Channel Variables on page 23*)

- **RMS** is calculated by accumulating the mean squared of each chunk, dividing by the number of chunks in the window, and taking the square root.

- **Crest Factor** is calculated by taking the absolute maximum value from the window and dividing by the RMS of the window.

- **Peak to Peak** is calculated by subtracting the smallest value from the window from the largest value.

- **IPS G-Link-200-OEM Only**

The RMS of the IPS is calculated by determining a cubic spline of a chunk, analytically integrating the cubic spline, taking the RMS of the cubic spline integral, and multiplying by 386.2197 to convert from Gs to in/sec^2.

Firmware < 10.36231

The RMS of the IPS is calculated by accumulating the mean of the squares of the integral of the chunk, dividing by the number of chunks in the window, taking the square root, and multiplying by 386.2197 to convert from Gs to in/sec^2.

Name	Description
F	Window of sampled data
F_j	Chunk of sampled data
J	Number of chunks in the window
K	Number of samples in the window
N	Number of samples in the chunk

Table 7 - Derived Channel Variables

5.4.1 Windows

When performing a derived calculation on sampled data a window is used to provide a rate to transmit derived calculations and a range of time to derive from. The length of a window in time is a single period of the derived rate and is given the timestamp of the first sample of the next window.

Given a sample with a timestamp of t and a derived period of p, the timestamp of the derived window it belongs to is defined below.

- Burst Mode - when the node is bursting, the window covers the entire burst instead of the derived rate. Given a sample with a timestamp of t, a burst period of p, and a burst duration of d, the timestamp of the derived window it belongs to is defined below.
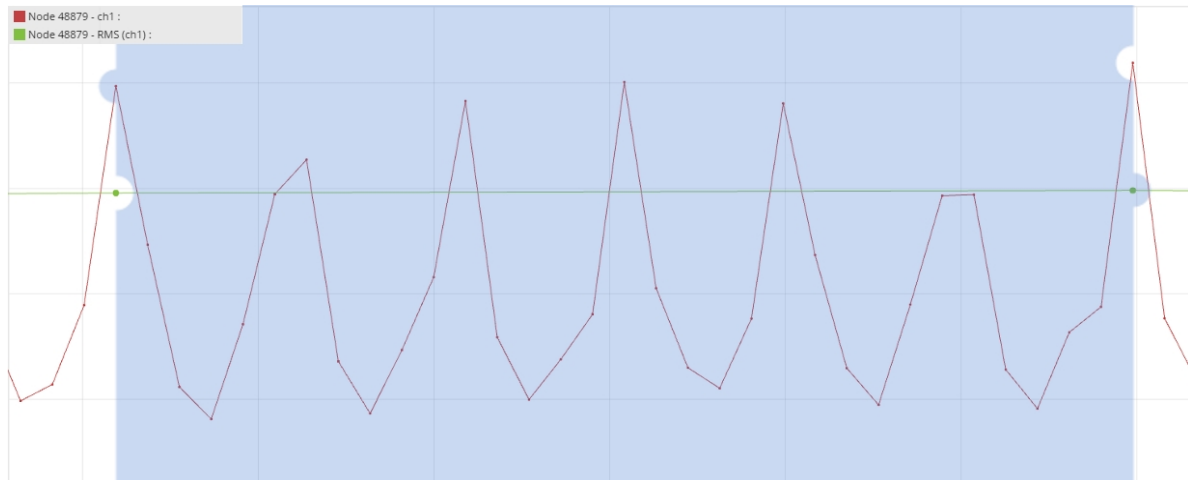
Figure 19 - Derived Data Window

NOTE

A window must contain at least 32 samples. For continuous this means that the derived period must be at least 32 times as long as the sample period. Burst is not limited by this restriction because the minimum burst size is 100 samples.

5.4.2 Chunks

Windows can encompass thousands of samples, but a node can only operate on a finite number of samples at a time, so the node chunks up data to run derived calculations. Chunk size is defined below where p is the derived period, d is the burst duration, and is the maximum chunk size. Maximum chunk size can change between nodes depending on how many resources are available for derived calculations. The G-Link-200-OEM has a max chunk size of 256 samples.

- Continuous -
- Burst-
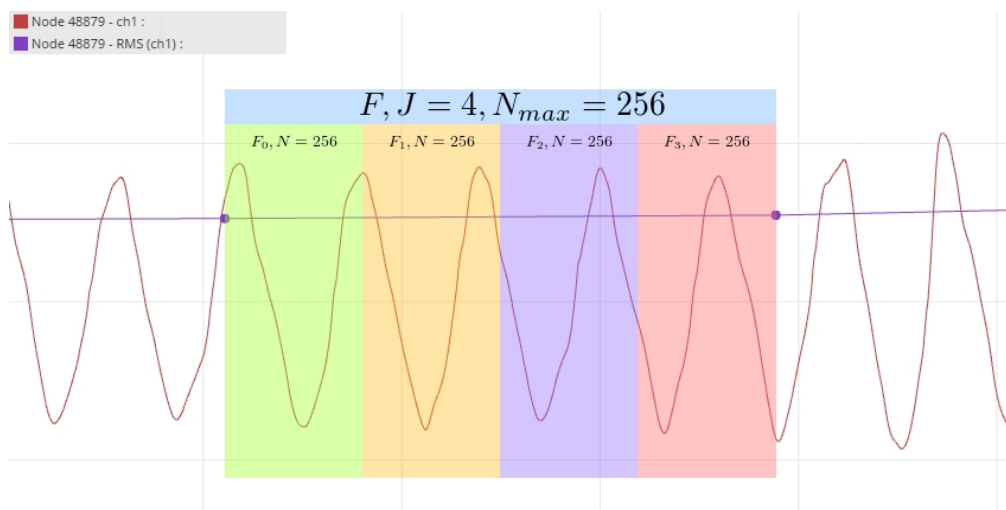
Figure 20 - Derived Data Chunks

5.4.3 Under-sampling

Under-sampling happens when there are not enough samples to accurately calculate a value for a derived channel. The user should pick a window size that contains at least two periods of the lowest rate input signal to be measured. The more information that can be included in the derived calculation the more accurate the calculation will be.

For derived channels that use Fourier transforms on raw data, such as IPS, the chunk size will limit the input frequency range rather than the window size. If the chunk size is at its maximum size the only way to gain accuracy for lower frequencies is to reduce the sample rate.

5.4.4 Incoherence

Derived channels are most accurate when the window time is a multiple of the period of the input signal, meaning that the window is coherent with the input signal. When the window is not coherent with the input signal, the window will end up with a fraction of a period of the input signal at the end, which will skew the derived calculation for the window in some cases. Inaccurate derived values due to incoherence can be mitigated by using a larger window size. The more input signal periods sampled within a window the more accurate the calculation will be.

5.5 Sampling Operations Options

There are four sampling operations options for the G-Link-200-OEM, including Continuous, Limited, Periodic Burst, and Event Triggered.
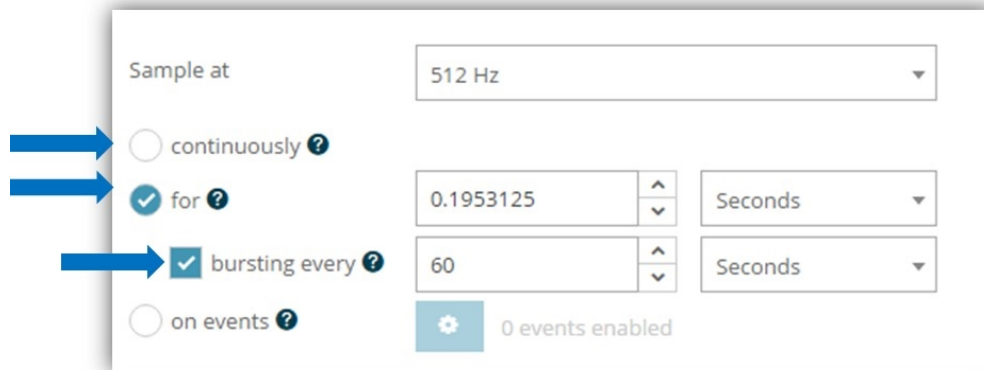
Figure 21 - Sampling Operations Menu

- **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.
- **Periodic Burst -** Perform short sampling bursts at periodic intervals. This operation allows longer battery life and increased network sizes in applications where continuous monitoring is not required.

- **Event Triggered -** Collect data continuously at a fixed sample rate. However, only transmit and/or log the data if one of the configured threshold conditions has been met. When the condition is met, all active sensor channels will transmit and/or log both pre- and post-event data. The benefits of this operation mode include increased battery life, reduced data sets, and increased network size.

Figure 22 - Event Triggered Sampling

5.6 Output Operation

There are three options for managing data acquired from the G-Link-200-OEM. The user can transmit collected data, log the data to flash memory, or do both.
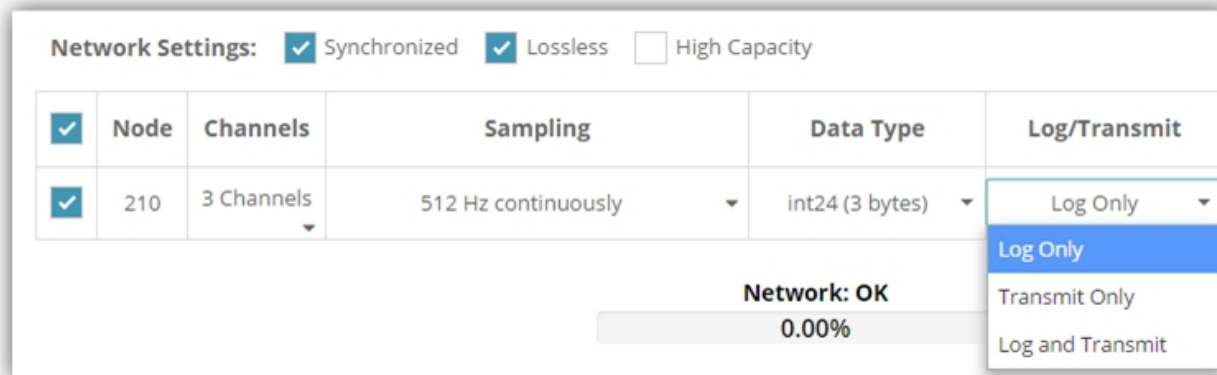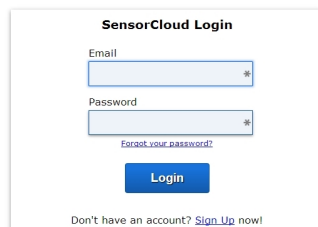
Figure 23 - Data Outputs

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/.

SensorCloud Login

Email

Password

Forgot your password?

Login

Don't have an account? Sign Up now!

Figure 24 - SensorCloud Log-in or Register

6.0.1 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/

Figure 25 - SensorCloud Log-in or Register

6.0.2 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 26 - SensorCloud Menu Views*). The Data and Settings views are only available once a device is selected from the device list.

Figure 26 - 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 27 - SensorCloud Data View
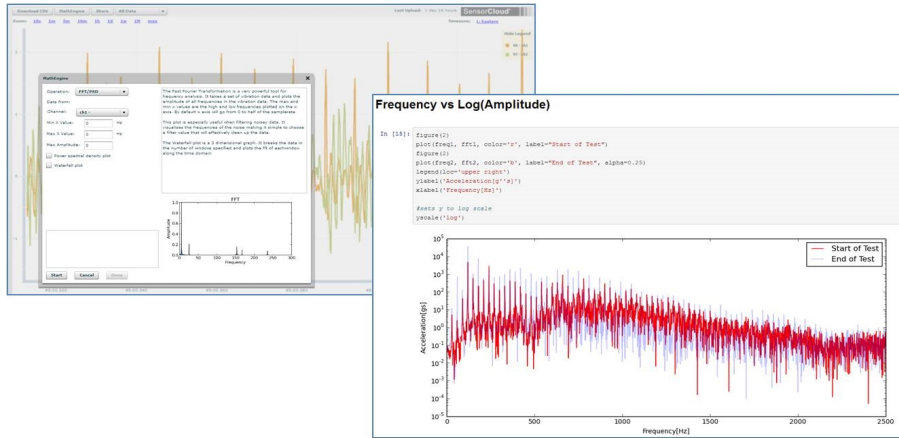
Figure 28 - MathEngine® View
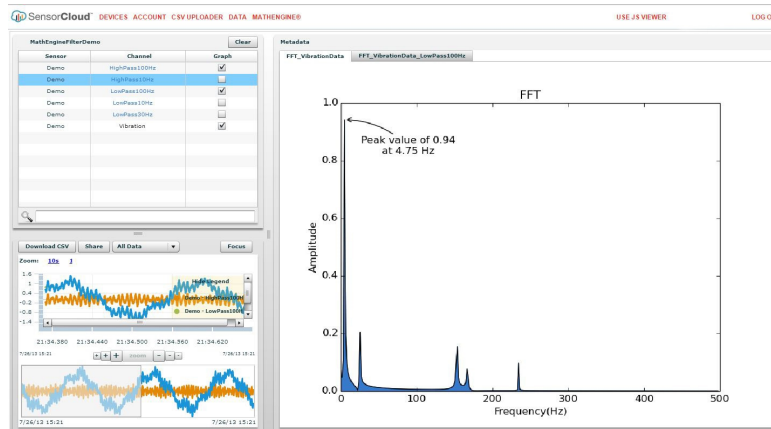
Figure 29 - FFT Graph in SensorCloud

6.1 SensorConnect

6.1.1 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.
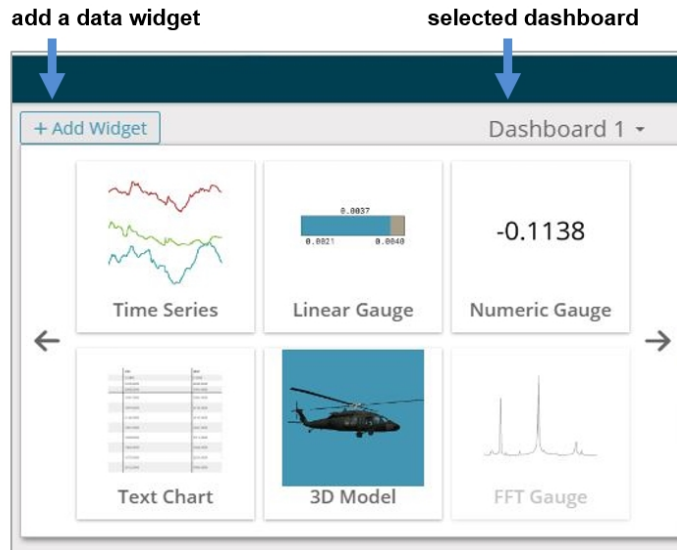
Figure 30 - Viewing Data

6.1.2 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 8 - Graph View Controls

6.1.3 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.
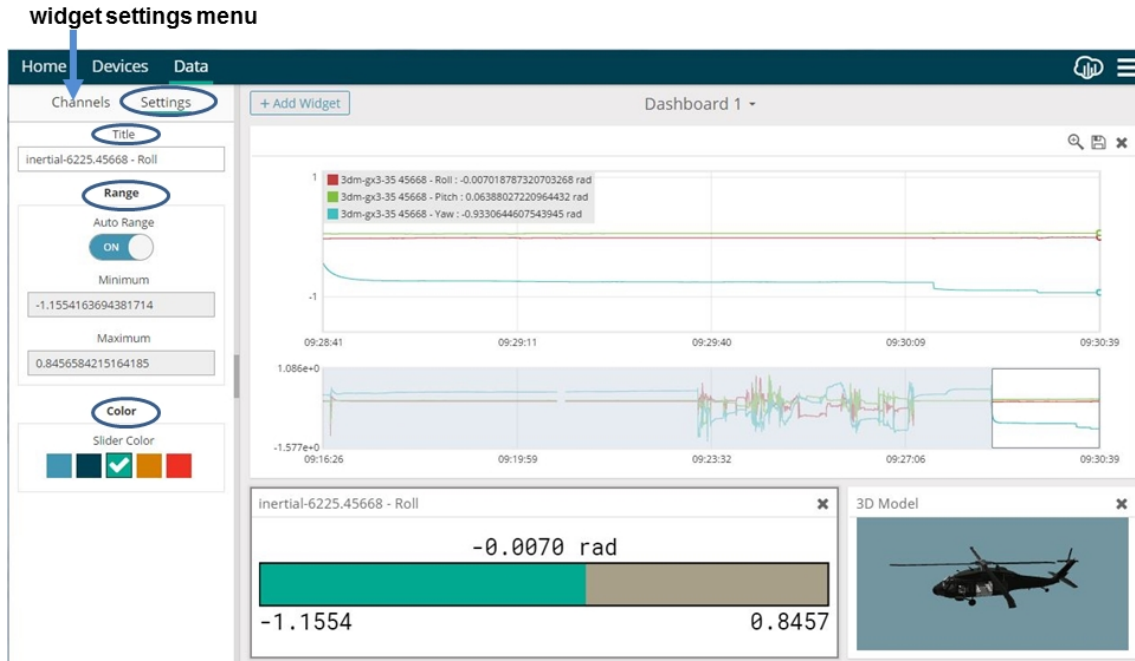
Figure 31 - Widget Settings Menu

6.1.4 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 35*).

Figure 32 - Time Series Widget Menu

6.1.5 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.
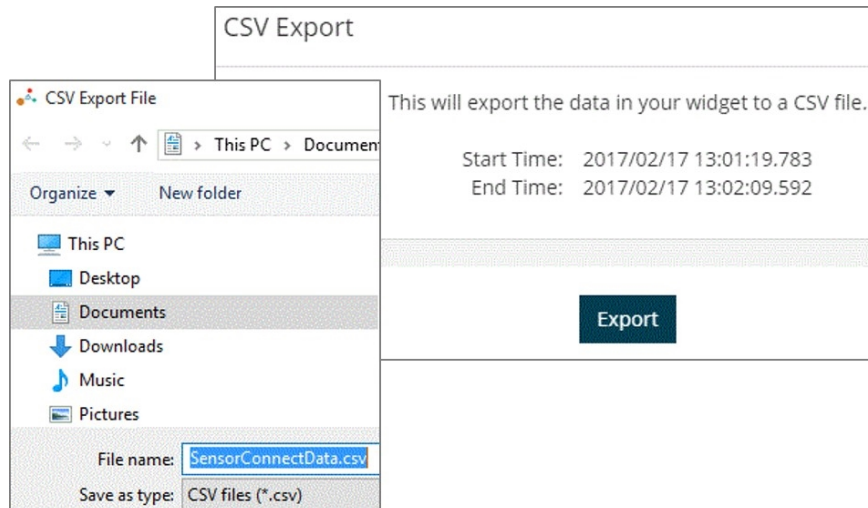
Figure 33 - Exporting Data

7. Installation

7.1 Mounting Recommendations

The G-Link-200-OEM is rated for indoor use only, unless housed in a ruggedized outdoor enclosure.

There are 4 mounting holes on the G-Link-200-OEM for 2-56 UNC screws.

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 Optimizing the Radio Link on page 38*.
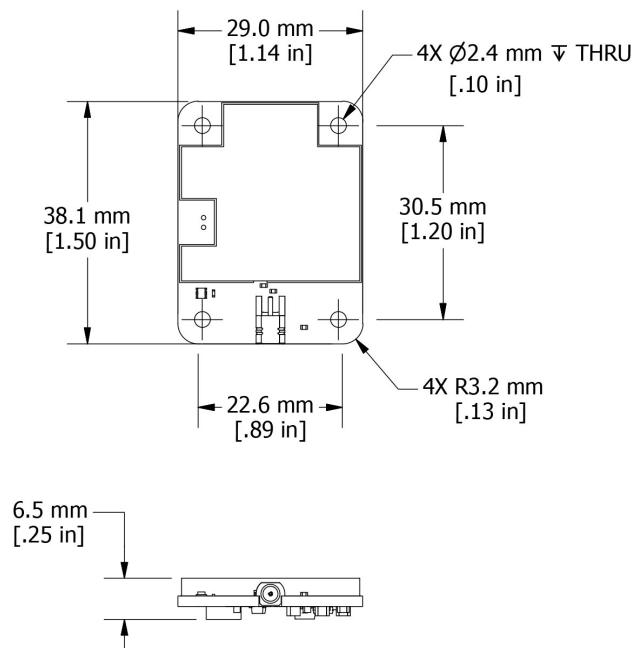
Figure 34 - Mounting the Node
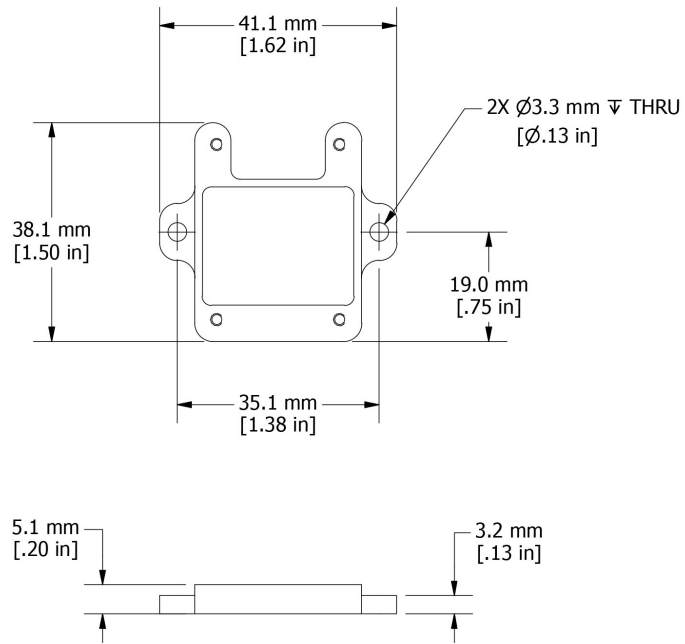
Figure 35 - Installing the Mounting Board

7.2 Optimizing the Radio Link

> **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 39* 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.

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7.2.1 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.

1. Select the node name > Range Test
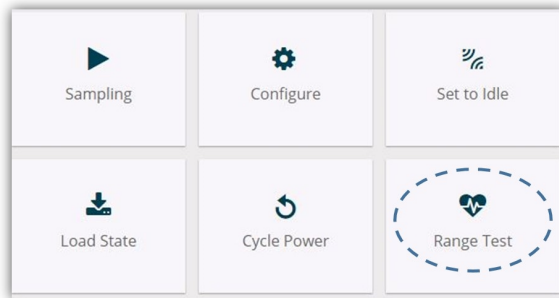
Figure 36 - Range Test Menu

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.
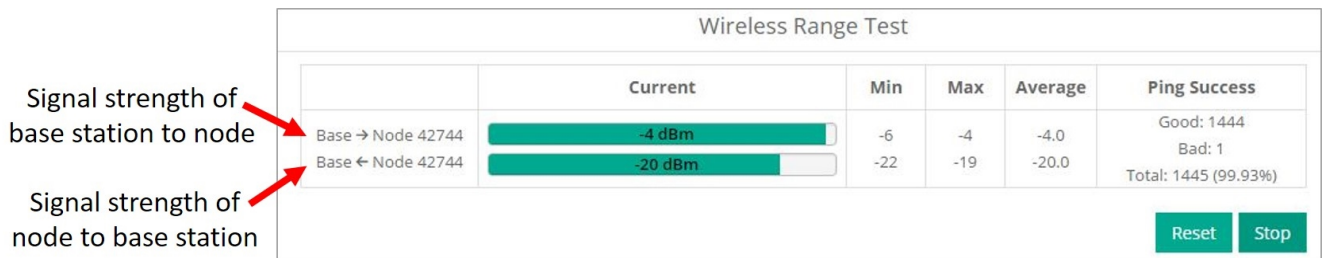
Figure 37 - Range Test Statistics

7.3   Data Type

There is a 20-bit ADC on the G-Link-200-OEM. However, users may select the data type that is reported. Floating point should be selected in most applications and where nodes must send measurements in units of g-force. Int16 or Int24 may be selected for applications requiring maximum network bandwidth or longer battery life.
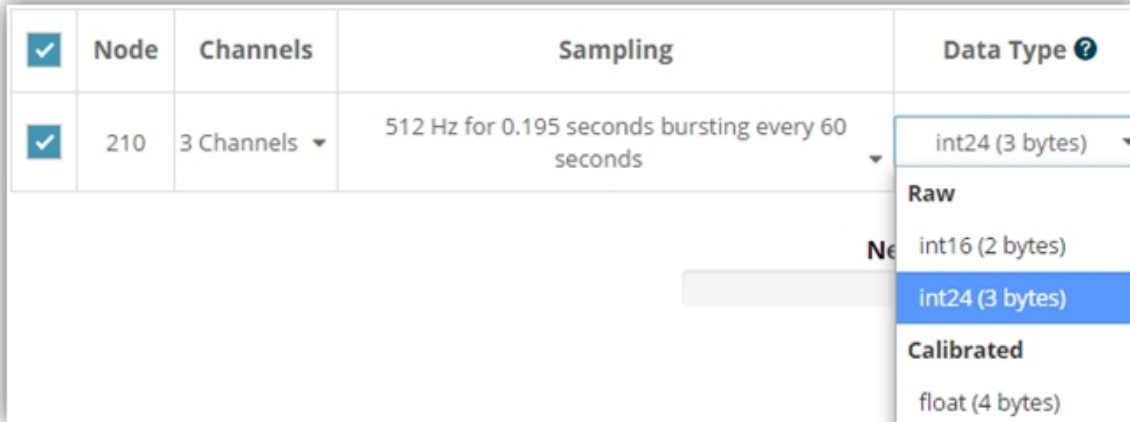
Figure 38 - Data Type Menu

- **Float (4 Bytes) -** The node applies calibration coefficients locally and reports measurements as floating point values.
- **Int24 (3 Bytes) -** The node sends its 20-bit measurements as signed 24-bit values. Data collection software such as **SensorConnect** must apply the calibration coefficients using the following equation:

G-force = value * slope + offset

- **Int16 (2 Bytes) -** The node sends its 20-bit measurements as signed 16-bit values. Data collection software such as **SensorConnect** must apply the calibration coefficients using the following equation:

G-force = value * 64 * slope + offset

8. Troubleshooting

8.1 Troubleshooting Guide

1. POWER node or gateway does not power on	2. COMMUNICATION no communication to node or gateway	3. DATA ACQUISITION sensor data is missing	4. ERROR INDICATOR Red LED present on start up (built-in-test error)
1.1 no power is applied	2.1 node or gateway has no power	3.1 node is not in sampling mode	4.1 error on startup
1.2 power source miswired	2.2 node is out of range	3.2 node is out of range	4.2 low power
1.3 wrong voltage	2.3 node is not in idle mode	3.3 beacon is lost	4.3 node is damaged
1.4 node is damaged		3.4 low power	

	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 51*).
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 39*.
	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.
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 the diagnostic for a low battery flag.
4.	**4.1 error on startup** Power down node for 10 seconds and repower.

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	Possible cause and recommended solution
ERROR INDICATOR Red LED present on start up	**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 51*).

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. *See Technical Support on page 51* for contact and website information.

1. Download the Firmware Upgrade file from the LORD Sensing website.
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

9.1   Physical Specifications
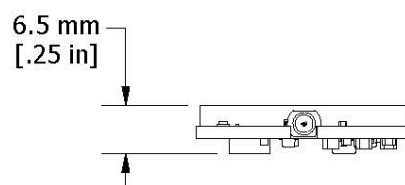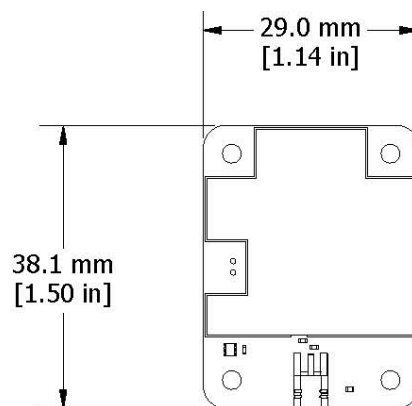
Dimensions:	38.1 mm x 6.5 mm x 29 mm
Mounting:	4 x 2-56 UNC
Weight:	8.17 grams
Conformal Coating:	Humiseal 1B31

9.2 Operating Specifications

Specifications

Accelerometer Channels		
	8 _g_	**40 _g_**
Measurement range	±2 g, ±4 g, or ±8 _g_ configurable	±10 _g_, ±20 _g_, or ±40 _g_ configurable
Noise density	25 µg/√ Hz	80 µg/√ Hz
0 _g_ offset	±25 mg (±2 _g_)	±50 mg (±10 _g_)
0 _g_ offset vs temperature	±.1 mg/ °C (typical), ±.15 mg/ °C (maximum)	±0.5 mg/ °C (typical), ±0.75 mg/ °C (maximum)
Integrated sensors	Triaxial MEMS accelerometer, 3 channels	
Accelerometer bandwidth	DC to 1 kHz	
Resolution	20-bit	
Scale factor error	< 1% full-scale	
Cross axis sensitivity	1%	
Sensitivity change (temperature)	±0.01%/° C	
Anti-aliasing filter	1.5 kHz (-6 dB attenuation)	
Low-pass digital filter	26 to 800 Hz - configurable	
High-pass digital filter	Off to 2.5 Hz - configurable	
Integrated Temperature Channel		
Measurement range	- 40 °C to 85 °C	
Accuracy	±0.25 °C (over full range)	
Sampling		
Sampling modes	Continuous, periodic burst, event triggered	
Output options	Acceleration, Derived channels: Velocity (IPSrms), Amplitude (Grms and Gpk-pk) and Crest Factor	
Sampling rates	1 sample/hour to 4096 samples/second	
Sample rate stability	±5 ppm	
Network capacity	Up to 128 nodes per RF channel (bandwidth calculator:) http://www.microstrain.com/configure-your-system	
Node synchronization	±50 µsec	
Data storage capacity	16 M Bytes (up to 8,000,000 data points)	
Operating Parameters		
Wireless communication range	Outdoor/line-of-sight: 2 km (ideal)*, 800 m (typical)** Onboard antenna: 1 km (ideal)*, 400 (typical)** Indoor/obstructions: 50 m (typical)**	
Antenna	Surface mount or External through MMCX or U.FL connector	
Radio frequency)RF) transceiver carrier	License-free 2.405 to 2.480 GHz with 16 channels	
RF transmit power	User-adjustable 0 dBm to 20 dBm. Restricted regionally	
Power source	3.3 - 36 V dc to solder pads	
ESD	±4000 V (Applies to VIN, GND, Antenna, and shield)	
Operating temperature	-40 °C to +85 °C	
Physical Specifications		
Dimensions	38.1 mm x 29.0 mm x 6.5 mm	
Mounting	(4) 2- 56 UNC	
Weight	8.17 grams	
Conformal coating	Humiseal 1B31	
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 (European Union), JET (Japan)

*Actual range varies with conditions
**Measured with antennas elevated, no obstructions, no RF interferers.

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.

10.1   Powering the Node

The power source is an external supply within the 3.3- 36 V dc.

> **⚠CAUTION**
>
> The G- Link - 200- OEM is susceptible to damage and/or disruption of normal operation from Electrostatic Discharge (ESD). ESD may cause the device to reset, which may require user intervention to continue data acquisition.

10.2   Disposal and Recycling

⚠WARNING   **⚠CAUTION**   **NOTICE**

The G- Link$^{®}$ - 200- OEM 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.

10.3   Radio Specifications

Radio Specifications

The G- Link- 200- OEM 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).

G-Link-200-OEM
FCC ID: XJQMSLINK0010
IC ID: 8505A-MSLINK0010

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.

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11. References

Technical Support

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)

11.1 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
SensorCloud Overview	http://www.sensorcloud.com/
SensorCloud Pricing	http://sensorcloud.com/pricing
MathEngine® Overview	http://www.sensorcloud.com/mathengine
SensorConnect Overview & Download	http://www.microstrain.com/software/sensorconnect
LORD Sensing Wireless Sensors Network Software Development Kit	https://github.com/LORD-MicroStrain/SensorCloud
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 9 - Related Documents

12.   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. 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.