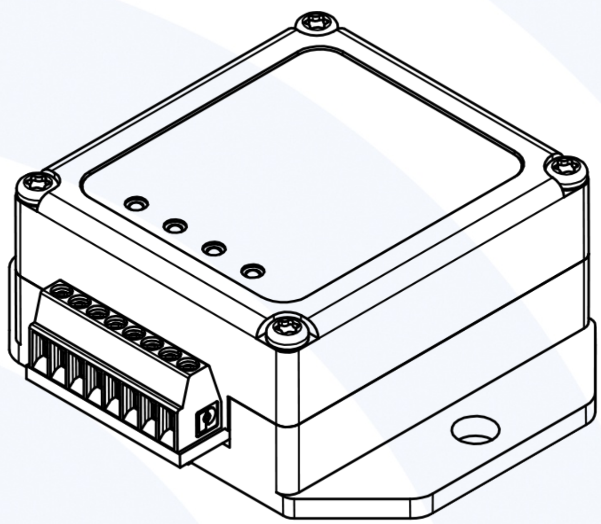
LORD USER MANUAL

SG-Link® -LXRS®

Wireless 2 Channel Analog Input Sensor Node



LORD MicroStrain®
SENSING SYSTEMS

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Document 8500-0003 Revision A

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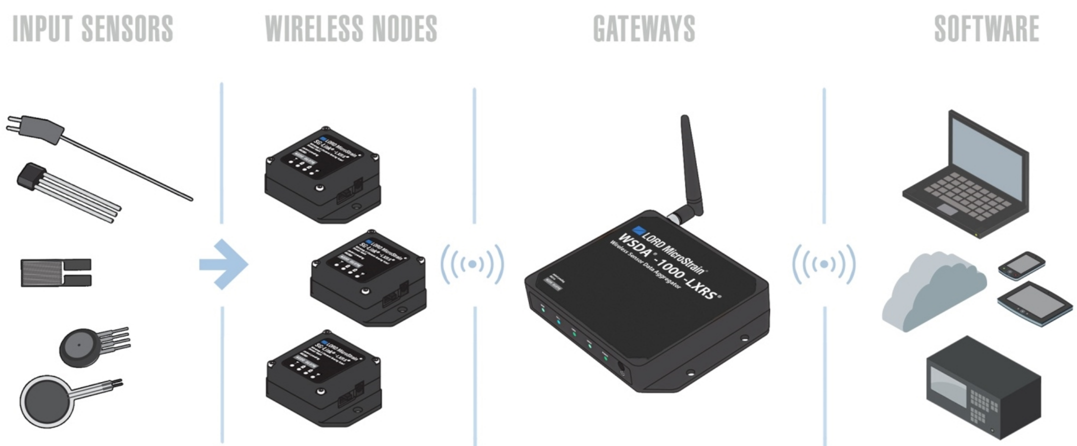
1. Wireless Sensor Network Overview

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



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

Common applications of the LORD MicroStrain® Wireless Sensor Networks are wireless strain sensor measurement, wireless accelerometer platforms, wireless vibration monitoring, wireless energy monitoring, wireless environmental monitoring, and wireless temperature monitoring.

2. Node Overview

The SG-Link® -LXRS® wireless sensor node features two analog input channels designed to accommodate a wide range of Wheatstone bridge and analog sensors including, strain, load cell, torque, pressure, acceleration, vibration, magnetic field, displacement, geophones, and more. There is one channel for single ended sensor measurement, one channel for differential sensor measurement, and an on-board internal temperature sensor.

SG-Link® -LXRS® inputs are 12-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.

To acquire sensor data, the SG-Link® -LXRS® is used with any LORD MicroStrain® data gateway, such as the WSDA® -Base and WSDA® -1000, and either the Node Commander® or SensorCloud™ software interfaces, or a user-designed program. The Node Commander® software is included with the gateways and allows configuration of the node.

Figure 1 - SG-Link® -LXRS® Wireless Sensor Node

2.1 Components List

The SG-Link® -LXRS® features an internal antenna and an integrated terminal block for attaching sensors. There are no removable parts. For a complete list of available configurations, accessories, additional system products and ordering information *see Parts and Configurations on page 85*.

Item	Description	Quantity
A	SG-Link® -LXRS® Wireless Sensor Node	1
--	User Manual, Quick Start Guide and Calibration Certificate	1 each

Table 1 - Components List

2.2 Interface and Indicators

The SG-Link® -LXRS® interfaces include 1) a power input jack for charging the internal battery, or externally powering the node 2) a power on/off switch 3) a power source selector switch and 4) a terminal block for connecting sensing devices. See *Figure 2 - Interface and Indicators*.

The indicators on the SG-Link® -LXRS® include 1) a device status indicator, 2) a battery charging indicator 3) a battery charge complete indicator and 4) a charge source indicator. The following table describes basic indicator behavior. During data acquisition, the device status indicator has other advanced behaviors (*see Device Status Indicators on page 71*).

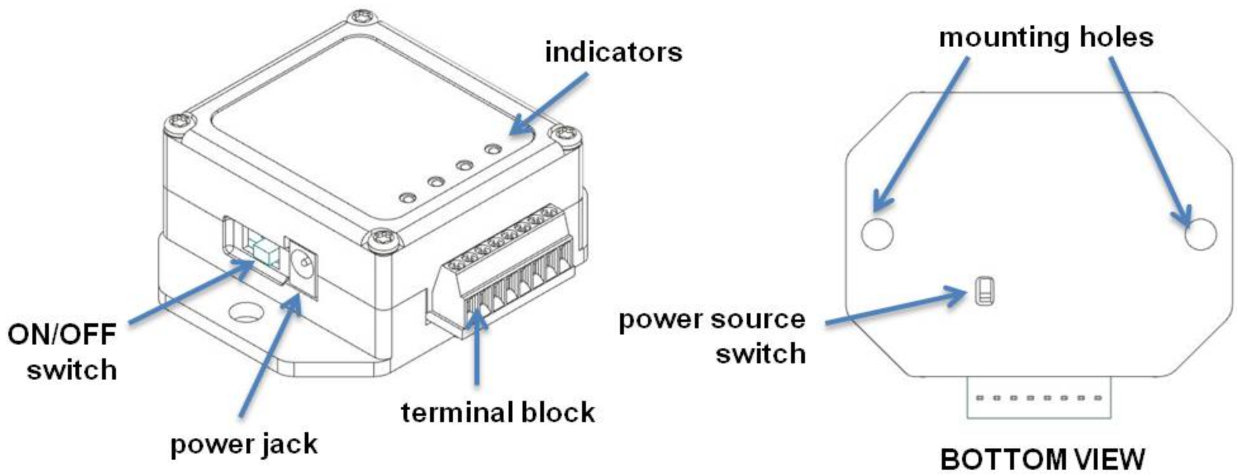


Figure 2 - Interface and Indicators

Indicator	Symbol	Behavior	Node Status
Battery charge source indicator		OFF	No power source detected
		ON green	Charging source detected
Battery charging indicator		OFF	Node not charging
		ON bright red	Node battery charging
Battery charged indicator		OFF	Node charge status unknown
		ON green	Battery fully charged
		ON green and battery charging indicator ON red	Battery fault condition, reset by unplugging power and then plugging it back in
Device status indicator		OFF	Node OFF
		Rapid flashing	Node booting up
		1 second pulse (approximate)	Node active and idle

Table 2 - Indicator Behaviors

3. System Operation Overview

WARNING

The SG-Link® -LXRS® contains an internal, rechargeable Lithium Polymer (Li-Po) battery. For important precautions see Safety Information on page 95.

To acquire sensor data, nodes are used with any LORD MicroStrain® data gateway, such as the WSDA® -Base -10*x*-LXRS™ or WSDA® -1000 - LXRS™ and a software interface.

LORD MicroStrain® has two software programs available for the Wireless Sensor Network: SensorCloud™ and Node Commander®. SensorCloud™ is a web-based data collection, visualization, analysis, and remote management platform based on cloud computing technology. SensorCloud™ provides the most complete functionality. The Node Commander® software package is also fully featured and includes all functions needed for sensor configuration and data acquisition. Node Commander® is included with all data gateways and is sufficient for the basic operations explained in this section.

In this section hardware and software setup is described, including an overview of the Node Commander® software menus required to configure a sensor connected to the node and begin data acquisition. It is intended only as a quick start guide and is not a complete demonstration of all system or software features and capabilities.

- For an example of sensor configuration and calibration routine, or for verification of system functionality, see Using the Node Tester Board on page 72.
- For instructions on connecting specific sensors, see Connecting Sensors on page 24.

NOTE

To maximize operating time, it is recommended that the SG-Link® -LXRS® internal battery be charged fully before installation. If fully discharged, it takes approximately 6 to 8 hours to achieve a full charge. For charging instructions see Charging the Node Battery on page 64.

3.1 Software Installation

To install Node Commander® on the host computer, complete the following steps:

1. Insert the CD into the host computer.

2. Follow the on-screen prompts.

NOTE

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

3.2 System Connections

To acquire sensor data the following components are needed: 1) external sensors, as applicable 2) wireless sensor node 3) data gateway 4) local or networked host computer with access to the data acquisition software, such as Node Commander® or SensorCloud™. The selection of sensors, nodes, gateways, and software is application dependent, but the basic interfaces are the same. For a connections overview refer to *Figure 3 - System Connections*.

Nodes will communicate with any gateway. Gateways with analog outputs can be connected directly to standalone data acquisition devices for data collection, however, system configuration will still occur through a digital communication interface.

Communication protocols between the gateway and host computer vary depending on which model gateway is used. For example, the WSDA® -Base -10*x* -LXRS™ gateway utilizes local serial connections to the host computer, such as RS232 and USB, and interface with the Node Commander® software. The WSDA® - 1000 - LXRS™ gateway utilizes Ethernet communications and can be used with either Node Commander® or SensorCloud™. Users can also write their own programs by utilizing the LORD MicroStrain® Wireless Sensors Network Software Development Kit.

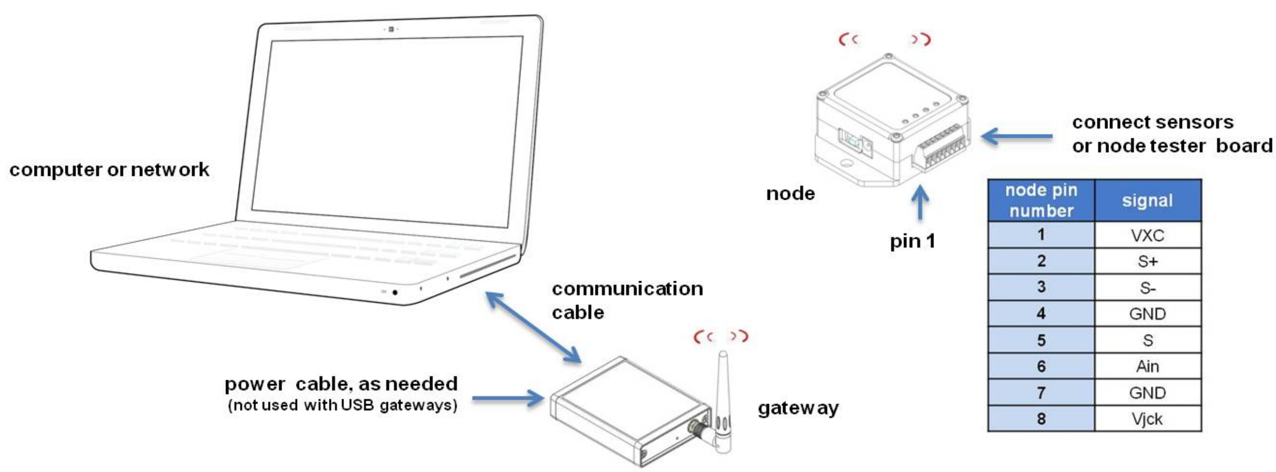


Figure 3 - System Connections

3.3 Gateway USB Communication

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

1. Open the Node Commander® software.

2. Make all hardware connections (*see System Connections on page 12*). Power is applied to the gateway through the USB connection. Verify the gateway status indicator is illuminated.

3. Open Node Commander®.

4. When connected, the gateway should appear in the Controller window automatically with a communication port assignment (*Figure 4 - USB Gateway Communication*). If it is not automatically discovered, verify the port is active.

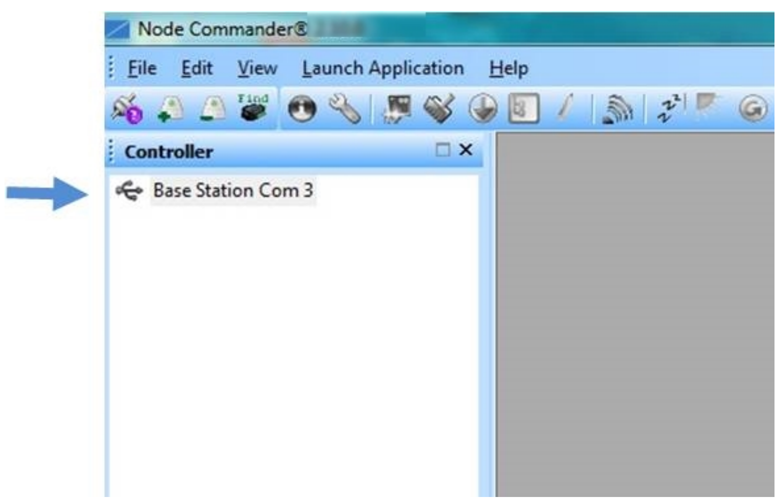


Figure 4 - USB Gateway Communication

3.4 Automatic Node Discovery

NOTE

Automatic node discovery only works in some boot-up modes, such as the normal boot mode. When the node is set for normal boot mode and powered on, the device status indicator on the node will flash rapidly and then pulse in one-second intervals thereafter. If any other indicator behavior is observed, the node may be configured for a different mode. If the node is in another boot mode, it can be bypassed by toggling the node ON/OFF switch rapidly three times and then leaving it in the ON position for normal power up.

1. After establishing communication with the gateway, right-click on the gateway name in the Controller window and select Add Node > Node Discovery.

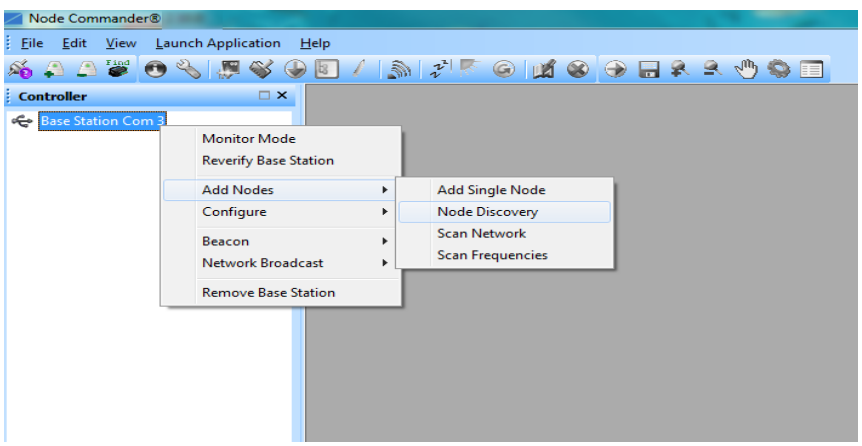


Figure 5 - Adding a Node in Node Commander®

2. Turn the node ON with the ON/OFF switch. During power-up the node will transmit a message with its operating frequency within a few seconds.

3. When the device status indicator on the node ends the rapid flash sequence and begins pulsing at one-second intervals, it has completed the normal boot-up sequence and is running in idle mode. At this point the node should be listed in the Controller window, and scanning can be stopped by selecting the Stop button in the

Node Discovery window. Additional node information can be viewed by selecting the "+" symbol next to the node name.

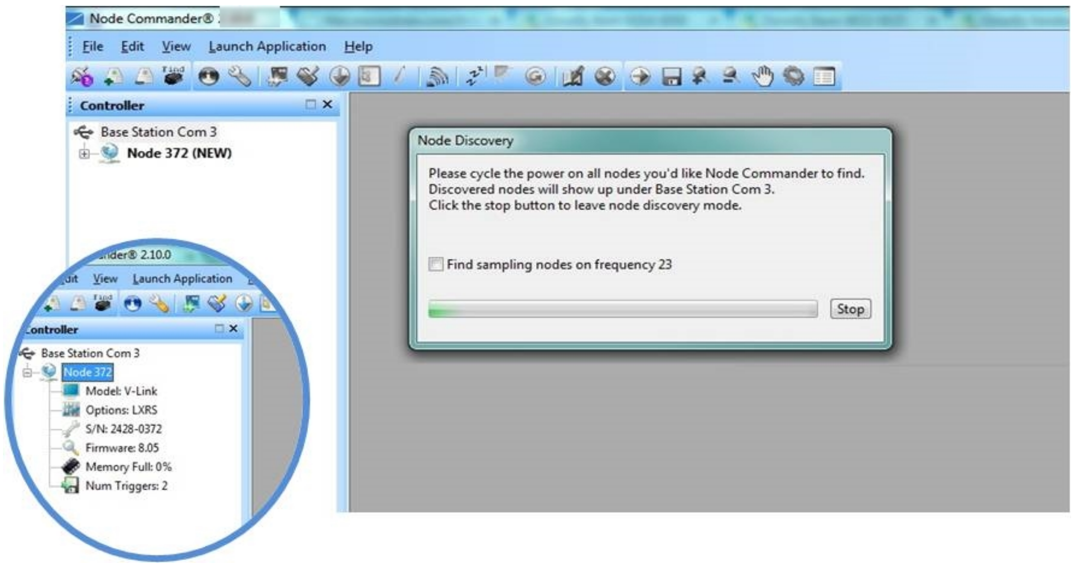


Figure 6 - Node Discovery

3.5 Channel Configuration

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

1. To enter the configuration menu, right-click on the node name, and select Configure > Configure Node. The Channels tab displays channel options available for the current node.

    a. **Channel Enabled:** indicates the channel number, and the check box is used to enable the channel and select it for sampling. The icon next to the check box describes the channel type, which is intrinsic to the node being used. In the following example: a1) analog differential channel icon, a2) analog single ended channel icon, and a3) temperature channel icon.

    b. **Current channel configuration:** The data output, units, input, and label describe how the channel is currently configured.

    c. **Configure:** Select the channel Configure button to change the channel parameters. The channel must be enabled first by selecting its adjacent check box.

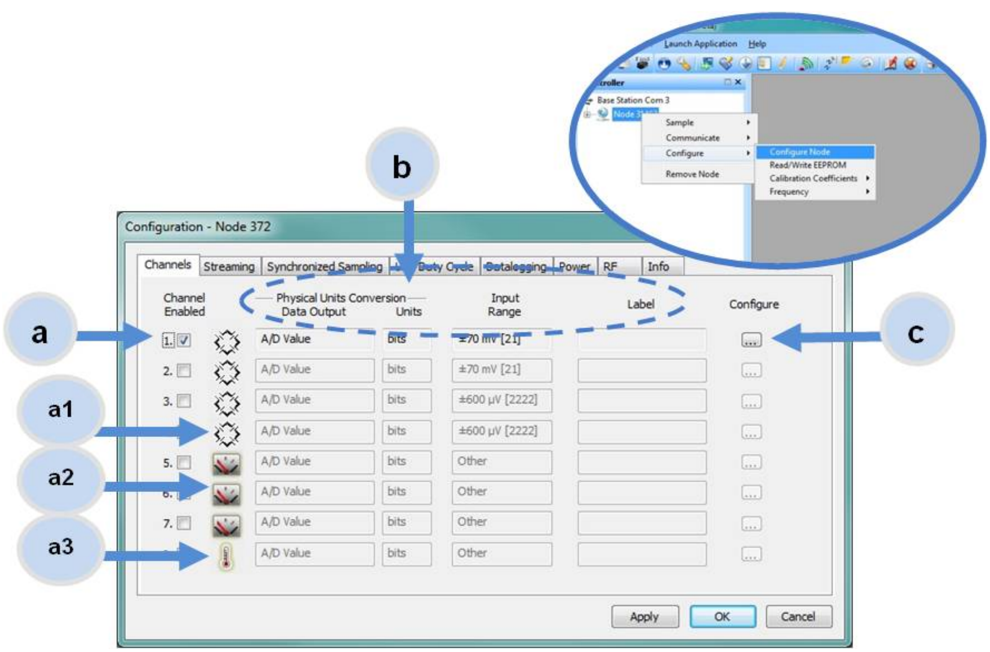


Figure 7 - Node Channels Menu

2. To enter the channel configuration menu, select the Configure button as shown in *Figure 7 - Node Channels Menu*. The channel configuration menu options change depending on the sensor type selected.

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

   b. **Channel diagram:** describes the channel electronics and data flow

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

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

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

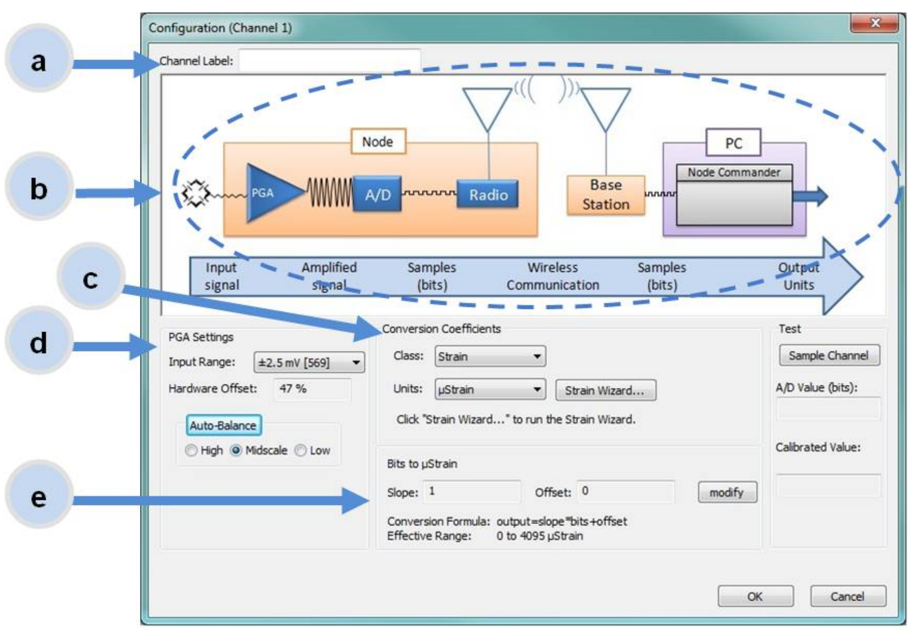


Figure 8 - Channel Setup

3.6 Data Acquisition

NOTE

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

When data acquisition is started, each of the four sampling modes has different menu options and views. Some have a settings menu before data acquisition begins and may include a data list view and/or a graph view.

The following is an example of Synchronized Sampling:

1. Right click on the node name and then Sample > Synchronized Sampling.
2. In the Synchronized Sampling window select the destination folder for the data in the Save Location field.
3. Select Apply Network Configuration, and then select Start Sampling.

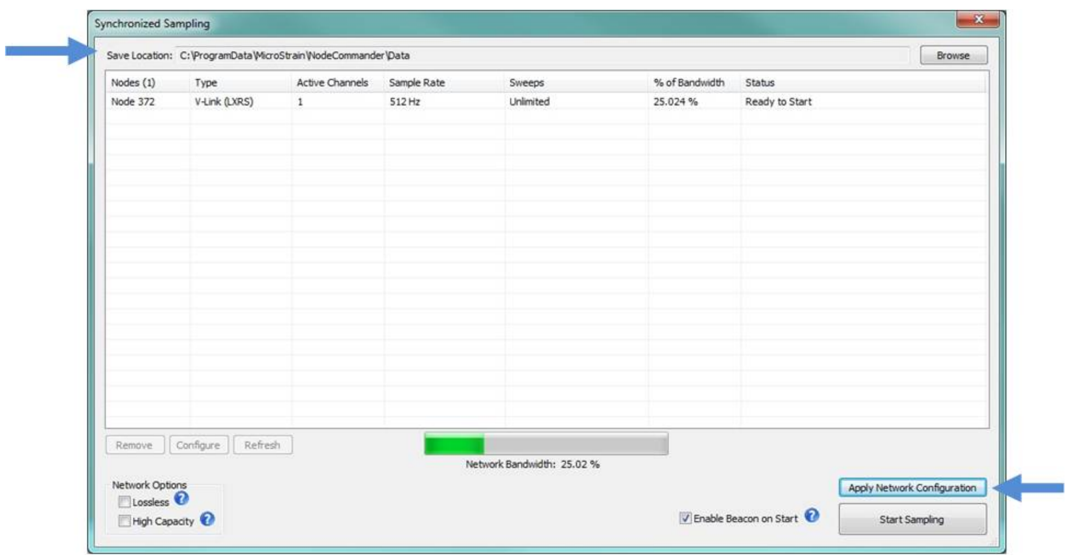


Figure 9 - Node Sampling Settings

4. Close the Synchronized Sampling window by clicking the window X in the upper right. The Sampled Data window is behind it. The default view is the Data Grid view. Use the "+" symbol next to the node heading to view the data statistics.

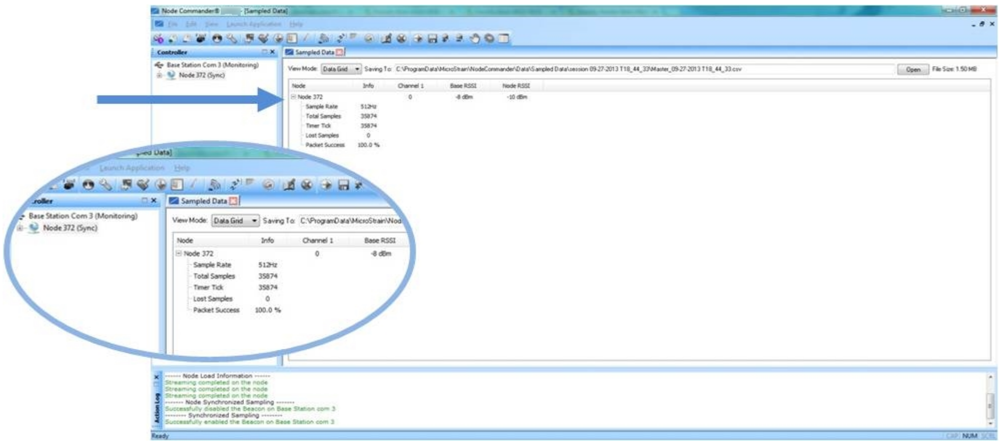


Figure 10 - Sampling Data Grid View

5. Select Graph from the View Mode field, and then click on the node name to view a graphical representation of the data.

6. To end sampling close the Sampled Data window by clicking the red and white X on the window tab, and select Exit > Stop Nodes.

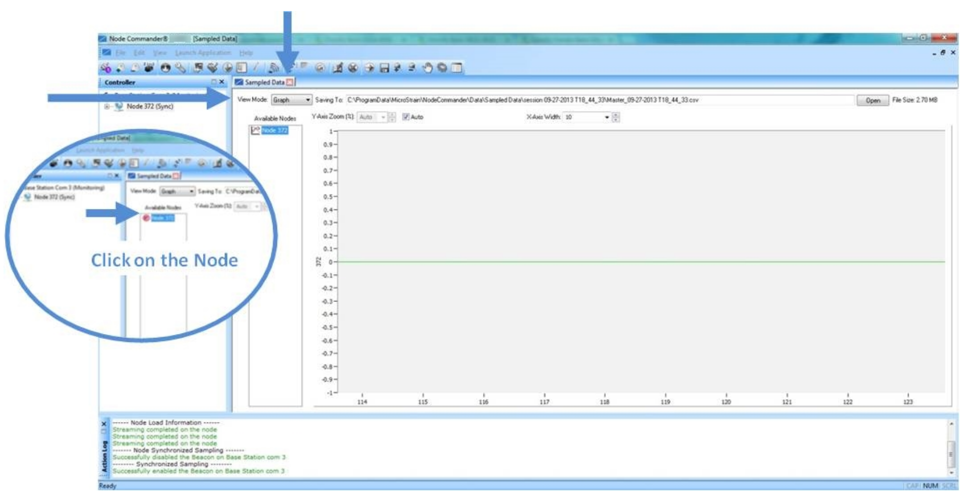


Figure 11 - Sampling Data Graph View

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3.7 Viewing Sensor Data

Acquired data is stored in CSV format and can be viewed with Microsoft Excel, Quattro Pro, Open Office, or other CSV editors and spreadsheet programs. The files can be found in the default directory or the location specified at the beginning of sampling (as applicable).

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

Use Windows® Explorer or the Node Commander® File menu to access the files. Different sampling modes will output different file types, and they will be categorized in separate folders by sampling mode and then further categorized by date, session, and/or node serial number.

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

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

Streaming data is stored in the Streaming folder.

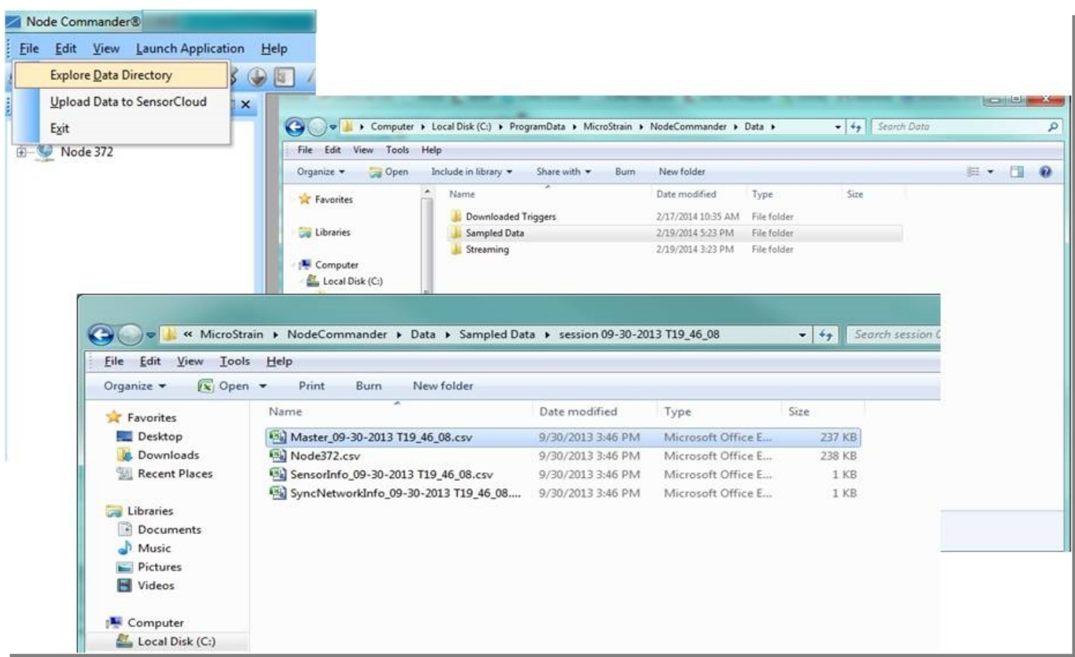

Figure 12 - Exploring Data

4. Node Installation

4.1 Mounting Recommendations

The SG-Link® -LXRS® is rated for indoor use only, unless used with a ruggedized outdoor housing. Some housings also accommodate D cell batteries, extending the battery operating capacity and duration of the node. For more information see Node Accessories on page 86 .

The node has two mounting tabs with holes for fastening. The node can be mounted in any orientation, but it is recommended that it is mounted in a way that optimizes the wireless communications. For more information see Optimizing the Radio Link on page 22.

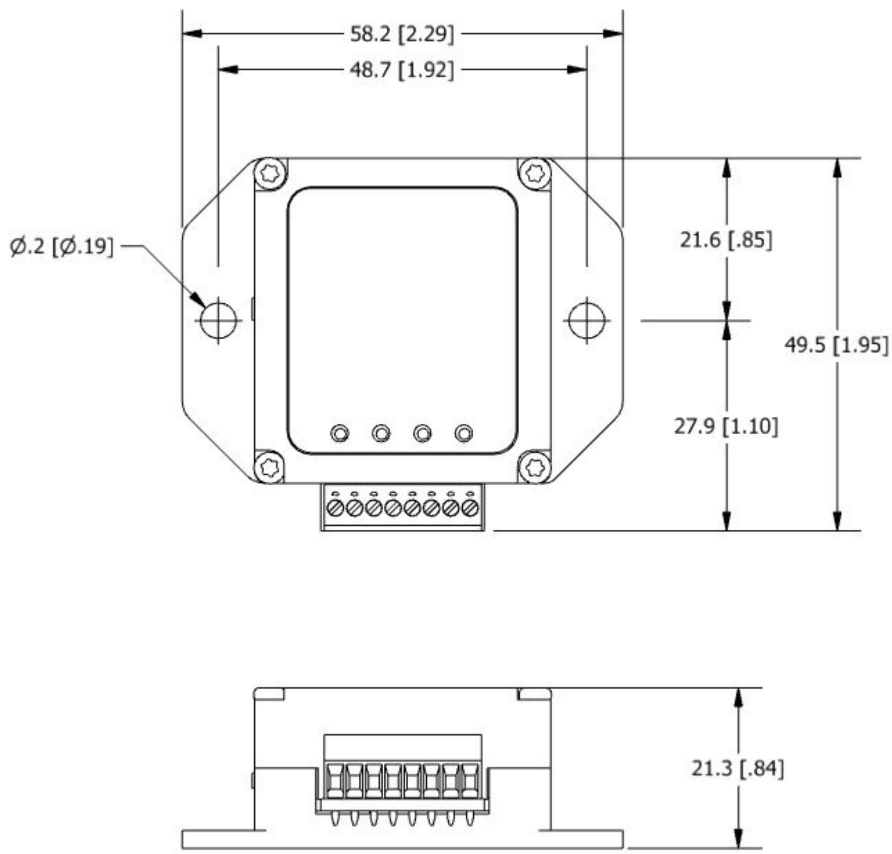

Figure 13 - Mounting the Node

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4.2 Optimizing the Radio Link

In ideal conditions, the nodes and gateway can communicate up to two kilometers apart. In order to accomplish this, the node must be installed in a manner that optimizes the wireless transmission. The SG-Link® -LXRS® operates at a 2.4GHz transmission frequency. The internal antenna has an omni-directional radiation pattern. Using any other antenna with the node will void FCC compliance.

The best method for ensuring optimal radio communication is to conduct an RF survey of the installation site. This is easily accomplished in Node Commander® by using the range test feature to quantify the radio signal strength (RSSI) in various scenarios. *See Range Test on page 23* for instructions on using Node Commander® for measuring RSSI. The following bullets are general guidelines for maximizing transmission range.

- **Establish Line of Sight (LOS)** between the node and gateway antenna as best as possible. Minimize the obstructions between them such as buildings, terrain, vegetation, or other physical barriers. Increase the mounting height of the node if it allows a clearer LOS path to the gateway.

- **Minimize Radio Frequency Interference (RFI)** such as other equipment antennas, especially those operating in the same frequency range. This includes other nodes. If other antennas are required nearby, mount them at different heights to minimize interference. Additionally, the specific node frequency is selectable within its operational range using the Node Commander® software. Set the devices to different transmission frequencies.

- **Minimize Electromagnetic Interference (EMI)** such as that generated by power transmission equipment, microwaves, switching power supplies, and other electromagnetic sources.

- **Metal Objects** in close proximity to the node, especially ferrous metals such as steel and iron, can be problematic for wireless communications. The larger the object, the greater the influence.

4.2.1 Range Test

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

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

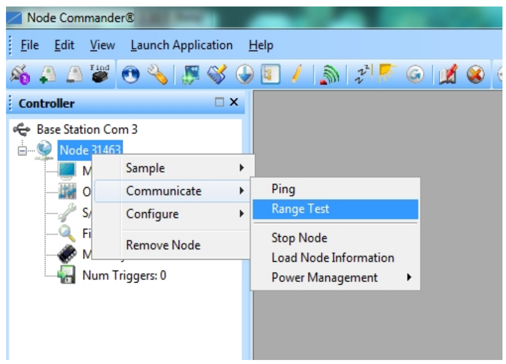

Figure 14 - Range Test Menu

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

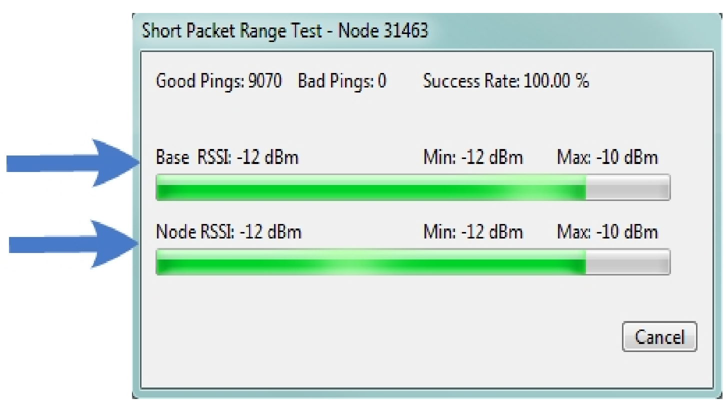

Figure 15 - Range Test Statistics

5. Connecting Sensors

> **⚠WARNING**
>
> The SG-Link® -LXRS® contains an internal, rechargeable Lithium Polymer (Li-Po) battery. For important precautions *see Safety Information on page 95*.

The SG-Link® -LXRS® wireless sensor node features two analog input channels that interface with a wide range of available sensor technologies, essentially converting them into wireless sensors. The node accommodates Wheatstone Bridge and analog sensors for applications in wireless strain gauge monitoring, such as torque, force, and pressure measurement, as well as sensors for other applications like wireless accelerometers, vibration sensors, magnetic field and displacement sensors. Environmental sensing can be achieved with wireless RTD and wireless thermocouple monitoring.

The SG-Link® -LXRS® includes one channel for single ended sensor measurement, one channel for differential sensor measurement, and an additional channel dedicated to the on-board internal temperature sensor. Differential channels may need to be factory-set to work for specific types of sensors. For information about channel configurations *see Differential Input Channels on page 29*. For ordering information *see Parts and Configurations on page 85*.

5.1 Sensor Requirements

Below are guidelines for selecting sensors for use with the SG-Link® -LXRS® . For interfacing with sensors outside of these parameters, or not included in the examples in the following sections, contact Technical Support (*see Technical Support on page 83*).

Sensor Impedance:

- Differential input sensors for a standard SG-Link® -LXRS® should have an impedance of either 350Ω or 1000Ω. Sensors that are 120Ω are not recommended. For half-bridge and quarter-bridge configurations, the node impedance value is set to match the sensor when the node is manufactured and must be specified at the time of order. For more information *see Parts and Configurations on page 85*. Custom bridge completion impedance values are available on request.

- Single ended sensor inputs must have impedance that is less than 5KΩ.

Sensor Signal Voltage:

- Differential sensor inputs include a hardware gain and offset stage before the sensor input signal is processed by the analog to digital voltage converter within the node. The combination of the gain, offset, and sensor signal voltage cannot exceed the 0 to 3VDC input range of the analog to digital converter. For more information *see Differential Input Gain and Offset on page 46*.

- Single-ended sensor signal voltages can only be positive voltages with respect to the system ground and must be between 0 and 3VDC. For single-ended sensor signal voltages outside of that range *see Measuring Voltages over Three Volts on page 35*.

Sensor Power:

- When using the internal node battery as the node power source, the total current use for all connected sensors must be less than 50mA. If more current is required, a higher capacity external power source can be used for the node or the sensor. *See Sensor Power on page 26* for information about sensor power requirement considerations and options, and *see Powering the Node on page 61* for information regrading node power options.

5.2 Wiring Recommendations

In is good practice that all sensor wiring be done with shielded cable. The shield is connected to the system ground only at one end to avoid ground loops. For sensitive small voltage signals (such as strain gauges) sensor wire leads should be of matched lengths so the lead resistance for each connection is as close to the other as possible. For long lengths of wire, a system calibration is recommended over a sensor calibration. *See Sensor Calibration on page 48*.

5.3 Sensor Power

⚠CAUTION

When using the internal node battery to power the node, total sensor current draw of more than 50mA can cause permanent damage to the node and should be avoided.

Sensors can be powered by the node or with an external power supply. The node sensor excitation voltage is 3VDC and can provide up to 50mA total on all channels. If a higher voltage or more current is required for the sensor, an appropriately sized external power supply can be used. For example, using the node battery for current intensive devices such as 4 to 20mA sensors will drain the battery quickly. For these applications, an external source is recommended for the sensor or the node. *See 0 to 3VDC Voltage Measurements on page 34* for an example of using an external source for the sensor, and *see Powering the Node on page 61* for node power information.

Drain on the battery can also be limited by selecting low resource sampling modes and low duty sampling rates, which automatically switch the node excitation voltage off after sampling. This feature can also be utilized to turn switches on and off to further control resource use. *See Using the Excitation Output as a Switch on page 37*.

External battery holders and ruggedized outdoor housings that accommodate D cell batteries are available for the SG-Link® -LXRS® and can be used to extend battery operating capacity and duration. *See Node Accessories on page 86*.

5.4 Node Channels Designations

Channel	Description	Pin Nomenclature
1	differential channel	S
2	(reserved)	--
3	on-board temperature sensor channel	--
4	single ended channel	Ain

Table 1 - Channel Designations

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5.5 Terminal Block Connections

When inserting the sensor leads into the terminal block, ensure the lead wire is being clamped under the terminal screw and not the lead insulation. If the sensor wires are a very fine gauge, folding and tinning them may be useful to provide more area for the terminal screw to make contact. Failure to provide adequate connection may result in erroneous data.

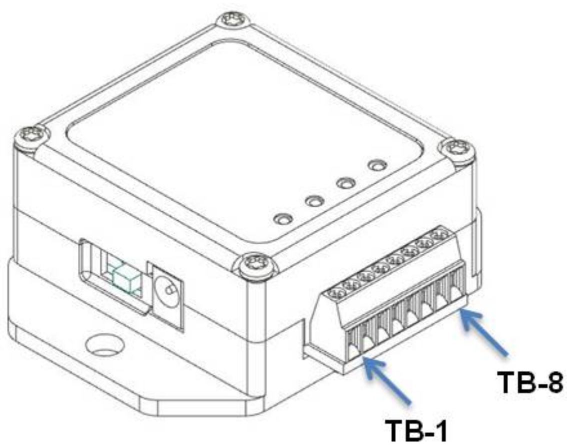


Figure 16 - Terminal Block Numbering

Node Pin Number	Signal
1	VXC
2	S+
3	S-
4	GND
5	S
6	Ain
7	GND
8	Vjck

Table 3 - Terminal Block Connections

5.6 Pin Descriptions

Signal	Description	Pin Type	Range
Vjck	**Node external power supply** An alternate to the node power jack. *See Powering the Node on page 61*.	power input	+3.6 to +9VDC sufficient current capacity for sensors
GND	**Return** For node power and sensor excitation	power return	return
VXC	**Sensor excitation** Power to external sensors. At sampling rates under 32Hz, it is only active when the node is sampling the sensors.	output	+3VDC maximum combined load on all excitation pins is 50mA.
S+	**Differential sensor input +** Positive input to the node programmable gain amplifier (PGA). Used with S-.	input	0 to +3VDC including gain and offset Wheatstone Bridge compatible sensor with 350Ω or 1000Ω input impedance recommended
S-	**Differential sensor input +** Negative input to the node programmable gain amplifier (PGA). Used with S+.		
S	**Three wire input** Used only for three wire configuration of quarter bridge strain gauge bridges. Leave unconnected for non quarter strain gauge bridge applications.	input	0 to +3VDC including gain and offset Wheatstone Bridge compatible sensor with 350Ω or 1000Ω input impedance recommended
Ain	**Single ended sensor input** Routed directly to the node analog to digital (A/D) converter. Return is node GND.	input	0 to +3VDC Less than 5KΩ

Table 4 - Node Pin Descriptions

5.7 Differential Input Channels

NOTE

Differential channels are configured at the time of manufacture with optional Wheatstone Bridge configurations and impedance values and must be connected accordingly. For available options *see Parts and Configurations on page 85*.

The differential channels provide an input for sensors with a separate analog return. The measurements are taken with respect to the analog return, instead of the system ground, in order to provide better protection for small measurements from EMI, RFI, and other sources of signal noise. The primary use of these channels is for strain gauges, pressure transducers, load cell,s and other devices that can utilize a Wheatstone Bridge configuration. The SG-Link® -LXRS® is available in standard configurations for full, half, or quarter Wheatstone Bridge operation, at various impedances. *See Differential Sensors on page 30*. Custom configurations are also available. For configuration and ordering options *see Parts and Configurations on page 85*.

The differential measurement channels provide a +3VDC excitation voltage to the sensor and measures the resulting sensor signal output. The sensor signal goes through a programmable gain amplifier (PGA) and is then processed in the node by a 12-bit analog to digital (A/D) converter over the 3VDC range. The resolution of the sensor measurement is dependent on the operating range of the sensor. If the application is such that only a small portion of the 3VDC range is being utilized, better resolution can be achieved by increasing signal amplification and by zeroing the sensor baseline in the appropriate offset biasing range.

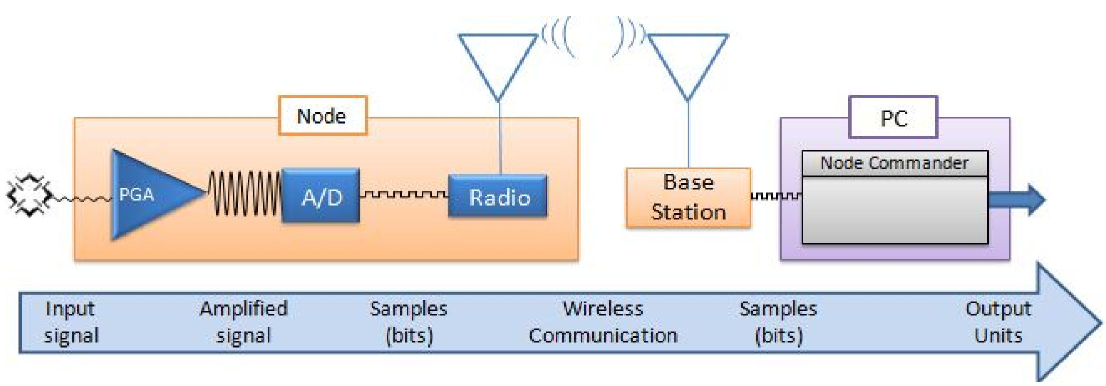


Figure 17 - Differential Channel Signal Processing

5.7.1 Differential Sensors

Sensors that are classified as differential sensors often utilize a Wheatstone Bridge configuration. These sensors are essentially a resistive load that use the bridge configuration to detect very small resistive changes and produce a precise voltage output as a result. Some examples include strain gauge elements or strain gauge-based sensors, such as some load cells and pressure transducers, as well as some soil moisture, temperature, and other sensors. For use with the SG-Link® -LXRS® , sensors with an impedance of 350Ω or 1000Ω are recommended.

Calibration in the Node Commander® software for these devices varies depending on the type of sensor and includes using the a calibration wizard for strain gauges. The following diagrams show how to connect these types of sensors. *See Sensor Calibration on page 48* for more information.

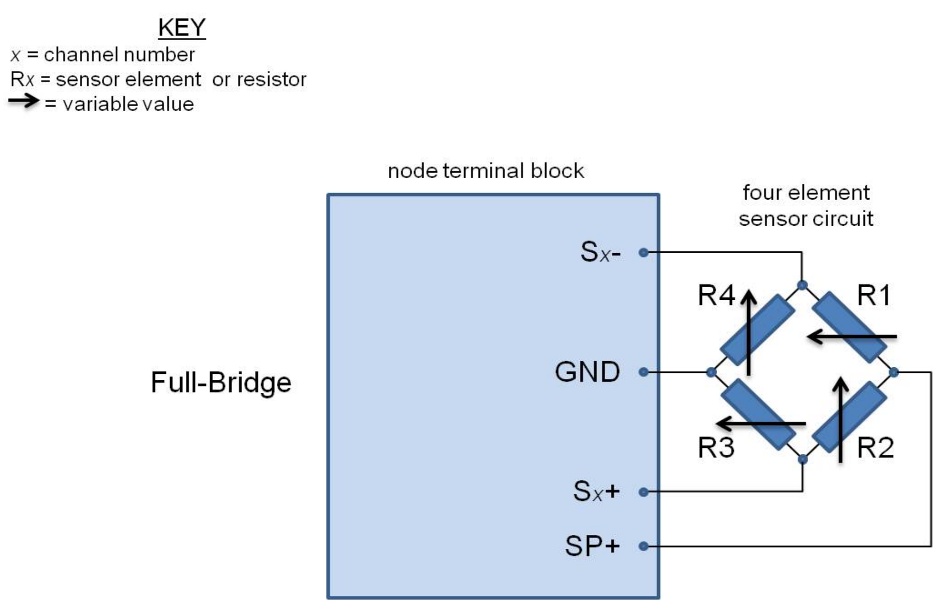


Figure 18 - Full Bridge Wiring

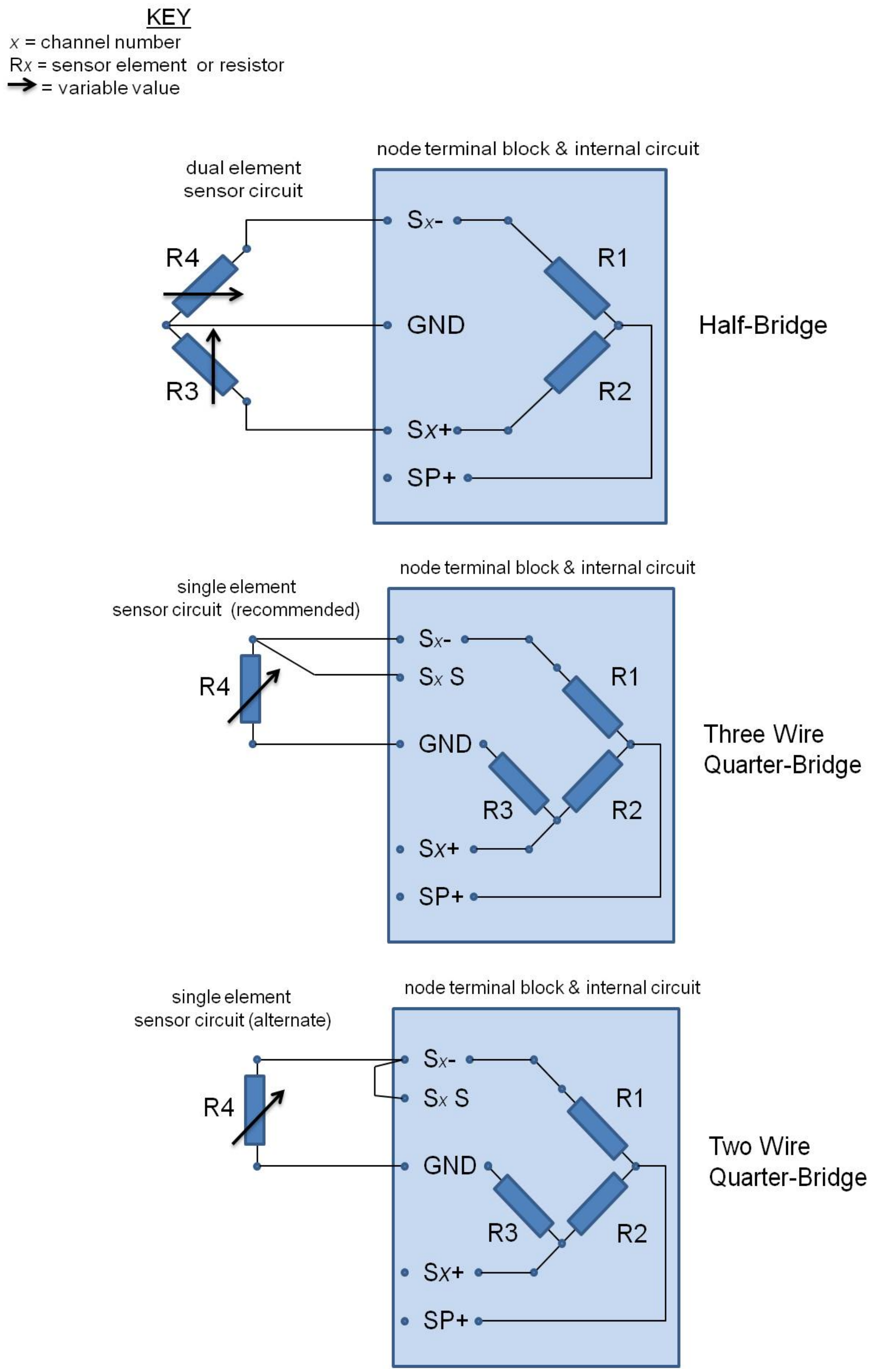


Figure 19 - Half and Quarter-Bridge Wiring

5.7.2 Measuring Small Voltages

Some sensor types that have small signal voltages (around 20mV or less) may be better measured by biasing the sensor signal to the mid range of the node input range with a voltage divider, as shown in *Figure 20 - Small Voltage Measurement*.

Channel configuration will include adjusting the gain setting accordingly in the Node Commander® software.

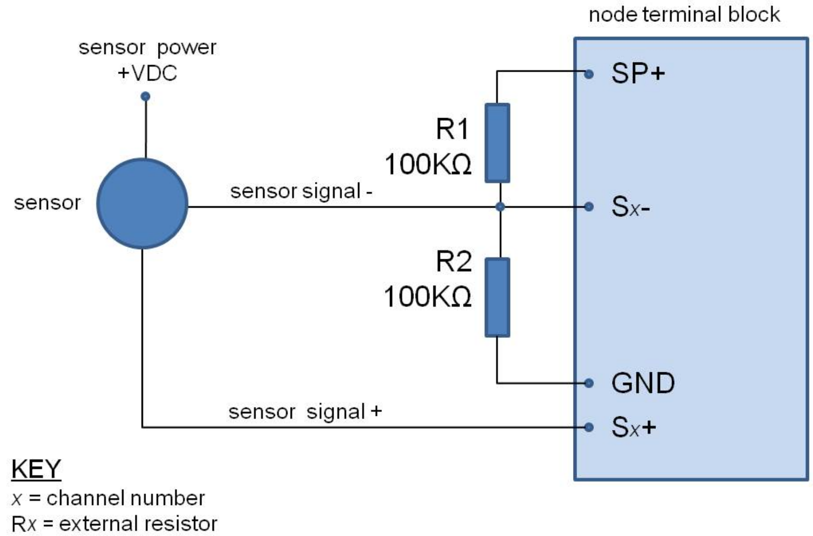


Figure 20 - Small Voltage Measurement

5.8 Single-Ended Input Channels

Single-ended channels are designed to measure voltages with reference to the system ground and can accommodate many analog sensors types including accelerometers, pressure transducers, geophones, temperature sensors, inclinometers, and more. These channels can also be used to measure reference voltages.

Sensors that operate on 3VDC can be powered with the node excitation voltage. Alternately sensors can be powered with an external source. For an example of how to connect an external supply *see 0 to 3VDC Voltage Measurements on page 34*.

The single-ended channels can measure signals from 0 to +3VDC with reference to the system ground. Sensor output must be positive going voltage in order to operate correctly with the SG-Link® -LXRS® . If the sensors output is greater than 3VDC a voltage divider can be used to decrease the scale. *See Measuring Voltages over Three Volts on page 35*. The impedance of the sensor must be less than 5KΩ.

The sensor output signal is processed in the node by a 12-bit analog to digital (A/D) converter, over the 3VDC range. The resolution of the sensor measurement is dependent on the full scale output range of the sensor. The closer it is to three volts, the more resolution will be achieved.

The following sections provide examples of how various sensors can be connected to the node. For other applications or those outside of the operating parameters listed above, contact LORD MicroStrain® Technical Support (*see Technical Support on page 83* for contact information).

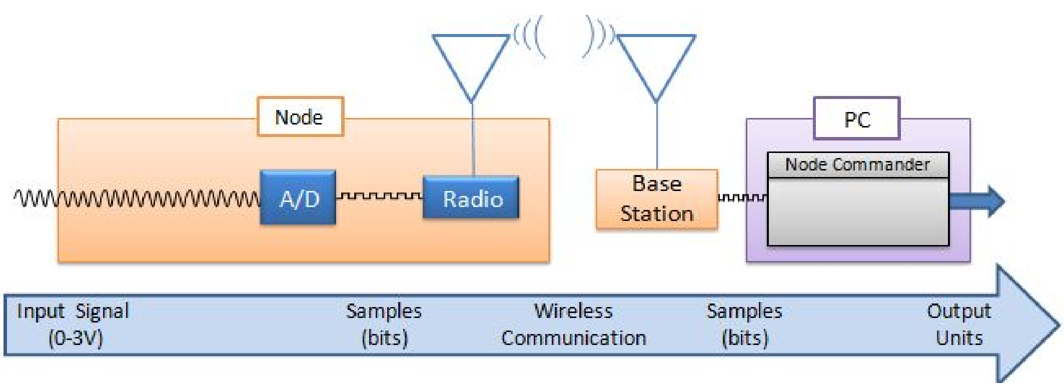


Figure 21 - Single Ended Signal Processing

5.8.1 0 to 3VDC Voltage Measurements

Sensors that operate in the 0 to 3VDC range are ideal for the node inputs. Resistive loads that are not differentially measured, such as string potentiometers, are easily measured by the node single-ended channels. Power is provided by the node excitation voltage and measured on a single-ended input, as shown below.

Reference power supply signals between 0 and 3VDC can be measured by connecting directly between the signal input pin (Ainx) and ground (GND).

Sensors that have voltage requirements outside of the range of the node excitation voltage can be powered externally with another source. The sensor output can still be connected directly to the node input as long as it is between 0 and 3VDC. For sensor outputs over 3VDC *see Measuring Voltages over Three Volts on page 35*.

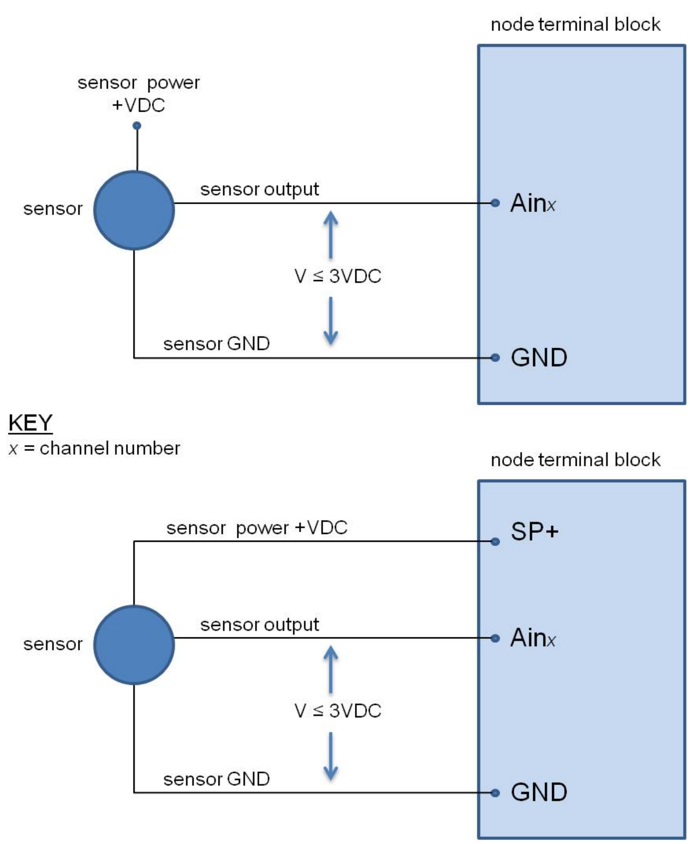
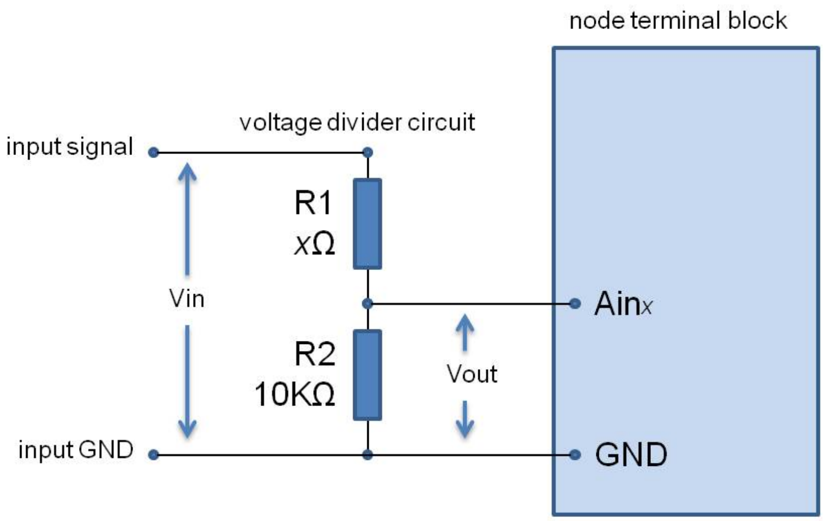


Figure 22 - 0 to 3VDC Measurements

5.8.2 Measuring Voltages over Three Volts

Voltages over three volts can be measured with the use of a voltage divider circuit. This may be necessary if a sensor is powered from an external source. The same circuit can also be used to measure reference power supplies over +3VDC.

The value of the voltage divider resistors will need to be determined, as required for the application. A 10KΩ resistor is recommended for the input to the node channel, leaving only one resistor to calculate.



CALCULATIONS:

$Vin = \text{maximum sensor output}$

$Vout \leq 3$

$R2 = 10K\Omega$

by Ohms Law;

$$Vout = Vin\left[\frac{R2}{(R1+R2)}\right] \quad \text{or} \quad R1 = \left[\left(\frac{Vin * R2}{Vout}\right) - R2\right]$$

EXAMPLE:

$Vin = 0 \text{ to } 9\text{VDC}$

$$R1 = \left[\left(\frac{9V * 10000\Omega}{3V}\right) - 10000\Omega\right] = 20K\Omega$$

<u>KEY</u>
x = channel number
R*x* = external resistor

5.8.3 Measuring Small Currents (4 to 20mA Sensors)

Sensors with small currents, such as 4 to 20mA sensors, can be used with the nodes by adding a precision sampling resistor across a single-ended input channel to the node. An example circuit is shown in *Figure 23 - Small Current Measurements*.

Because the sensor output can be as much as 20mA it is recommended that an external source be used to power the sensor. When running on the internal node battery, the node excitation can only supply 50mA to all sensors, so 20mA would be a significant portion and would drain the battery quickly. For battery life and current draw information *see Using the Internal Node Battery on page 63*. The current limitations can be mitigated by using an external power source for the sensor or the node. If using node excitation power is the best for the application, drain on the battery life can be limited by only switching the node excitation voltage on just before sampling and then turning it off afterward. This happens automatically at low duty sampling rates (32Hz or lower) and can be set up for other sample rates with external circuitry. For more information *see Using the Excitation Output as a Switch on page 37*.

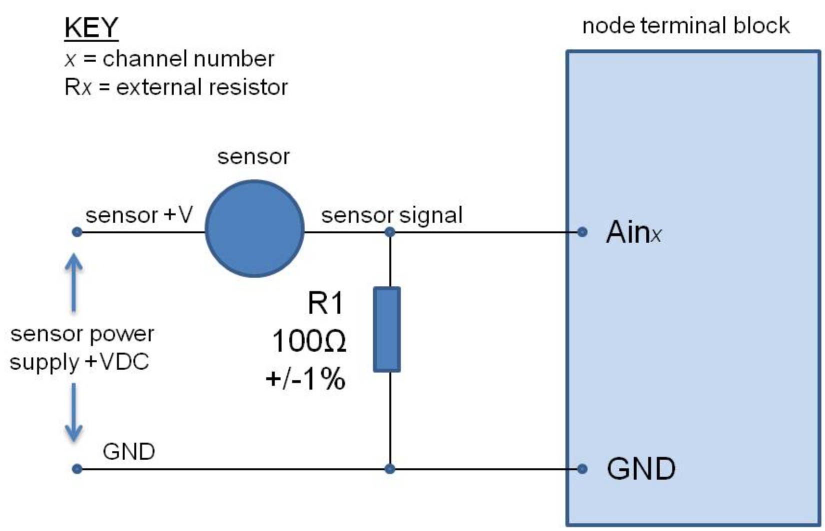


Figure 23 - Small Current Measurements

5.9 Using the Excitation Output as a Switch

At low sampling rates (under 32Hz) the node automatically switches the excitation voltage output off when the sensor is not being sampled, in order to conserve battery life. This feature can also be used in applications where a switch is desired, such as for turning sensor power on and off when the sensor is powered by the node but has a large current draw. It can also be used as a general purpose switch, such as for controlling a relay or transistor. The same limitations apply as to a sensor; the device must operate on 3VDC and not require more than 50mA when combined with all other sensor current draw. To use the excitation output in this way, connect the control line of the device (example: relay coil or NPN transistor base) to the excitation pin on the node terminal block (SP+) and reference (example: other side of the relay coil or the NPN transistor emitter) to the node ground pin (GND).

5.10 Thermocouples

Thermocouples can be used on the differential input channels by simply adding a high-impedance resistor to the input. An example circuit is shown in *Figure 24 - Connecting a Thermocouple*.

Thermocouples should be calibrated by first selecting the appropriate baseline offset range, output range, or gain and then applying know loads and calculating the slope and offset values. Using water as the known load medium (submerging the thermocouple in ice and hot water baths) is a simple method that can be used for calibration.

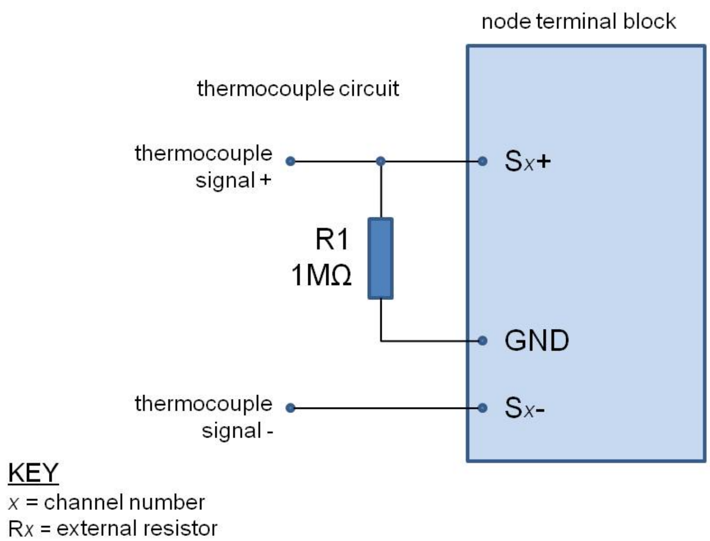


Figure 24 - Connecting a Thermocouple

5.11 On-board Temperature Sensor

- The SG-Link® -LXRS® has an on-board, solid state temperature sensor mounted on the surface of the circuit board.
- The temperature sensor output is connected to channel 3 of the SG-Link® -LXRS®
- The temperature sensor has a measurement range of -25˚C to +70˚C range with an accuracy of ± 0.5˚C @25˚C.
- The sensor is made by Texas Instruments (part number LM60). Specifications may be found on the manufacturer's website.

6. Sensor Settings

LORD MicroStrain® sensor nodes are designed to accept many sensor types. The sensor channel configuration menus includes settings for measurement units, conversion values, and gain settings.

Sensor readings can be displayed and recorded in volts, A/D value (bits), or engineering units. There are preset measurement units, as well as a user-defined field. Because the wireless sensor system is digital, the analog voltage readings from the sensors are converted into a digital equivalent value based on the volt-to-bit scale of the internal analog to digital voltage converter (A/D converter). A/D value can be read directly or further converted to engineering units by applying conversion values and a conversion formula.

Some sensors also require calibration. Calibration incorporates coefficients that normalize the sensor output to a known reference device in order guarantee accuracy of the sensor readings. For more information *see Sensor Calibration on page 48*.

6.1 Measurement Units

Sensor measurement units are set in the channel Configuration menu.

1. To enter the Configuration menu, right-click on the Node heading and select Configure > Configure Node. The Channels tab displays channel options available for the current node.

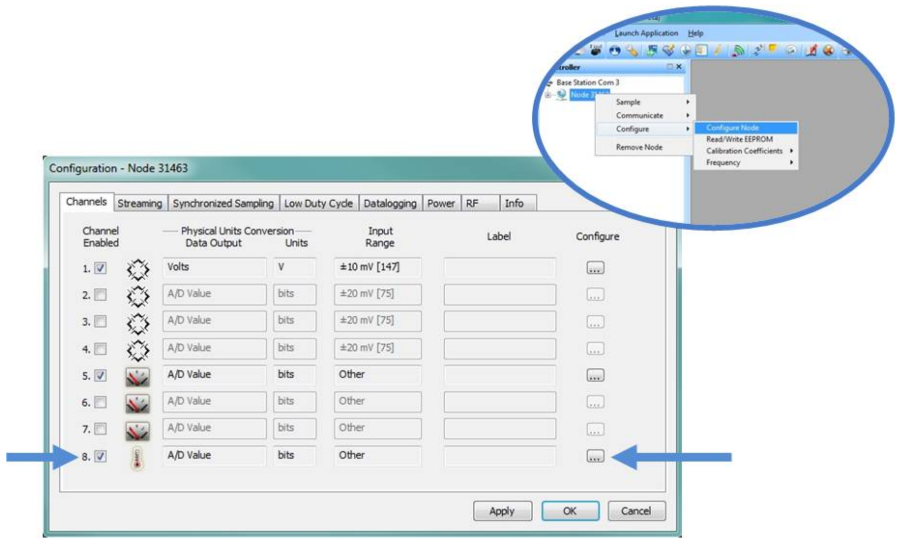


Figure 25 - Channel Configuration Menu

2. Select the type of measurement from the Class menu, and then select Units.

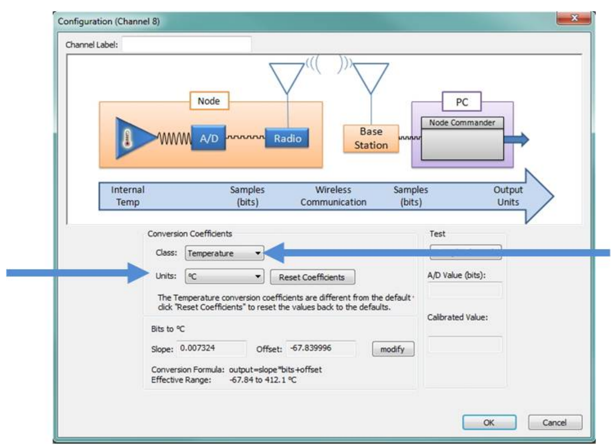


Figure 26 - Select Sensor Units

6.2 Conversion Values

The conversion values include the slope, offset, gain, scale, and formula used to convert the sensor A/D value to engineering units. The A/D value (bits) are the digital representation of the sensor voltage output. The type of sensor, channel, and desired engineering units determine what conversion values are available. The values are entered through the Node Commander® software and saved in the node memory for the applicable node channel.

NOTE

In order to report accurate readings, many sensors require calibration. Calibration coefficients normalize the sensor output to a known reference device and are often expressed in the measurement unit conversion values. Calibration accounts for the slight variations between sensor elements, wiring, system electronics, sensor mounting, and environmental conditions.

The conversion values can be determined mathematically from the sensor sensitivity specifications, from the sensor manufacturer calibration data, or through a calibration process. Calibration incorporates coefficients that normalize the sensor output to a known reference device in order guarantee accuracy of the sensor readings, especially when making small or precise measurements. *See Sensor Calibration on page 48* for more information. Not all sensors require calibration.

Conversion Formula: The default formula assumes a linear relationship between the A/D value (bits) and engineering units and is expressed mathematically as $y=mx+b$, where y is the engineering units at a given point (measurement), m is the slope of the line that represents the linear ratio, x is the A/D value at a given point, and b is the fixed zero load offset of the sensor.

Slope: The slope is the ratio of A/D value (bits) to engineering units (EU) that is used to convert the sensor measurements, or bits per EU. The slope conversion value will vary depending on the engineering units desired. For example, if the units are a measurement of force in pounds, the desire slope conversion would describe how many bits equal one pound (bits/pound). Mathematically, the slope is m in the formula $y = mx + b$.

Offset: The offset value is the starting output value of the sensor with no load applied. Mathematically, the offset is b in the formula $y = mx + b$.

Effective Range: Once the formula, slope, and offset values are applied, the sensor measurement range, in engineering units, is calculated. This is the effective range and is based on the resolution of the node. For example, a 16-bit node will have 65536 A/D values and a 12-bit node will have 4096 A/D values. The number of A/D values per EU (slope), multiplied by the total number of A/D values, minus the offset, determines the effective EU range of the sensor. The effective range does not take gain or offset scale into consideration.

Input Range (Gain): This sets the amplification of the signal within the node and is only available for channels with differential inputs and gain amplifiers.

Offset Scale (with Auto Balance): This feature is only available for channels with differential inputs, and assigns the position and value of the no load measurement of the sensor. The offset scale level adjusts the operating window of the sensor measurements in reference to the entire range. For example, in mid scale the sensor no load measurement will be placed in the middle of the range, providing 50% of the range for positive readings and 50% of the range for negative readings. Once the scale level is selected, the Auto Balance procedure is used to assign the actual sensor no-load measurement to the designated scale.

- Low is for positive-going signals (zero at 25% of total range).
- High is for negative-going signals (zero at 75% of total range).
- Midscale is for and positive and negative-going signals (zero at 50% of range).

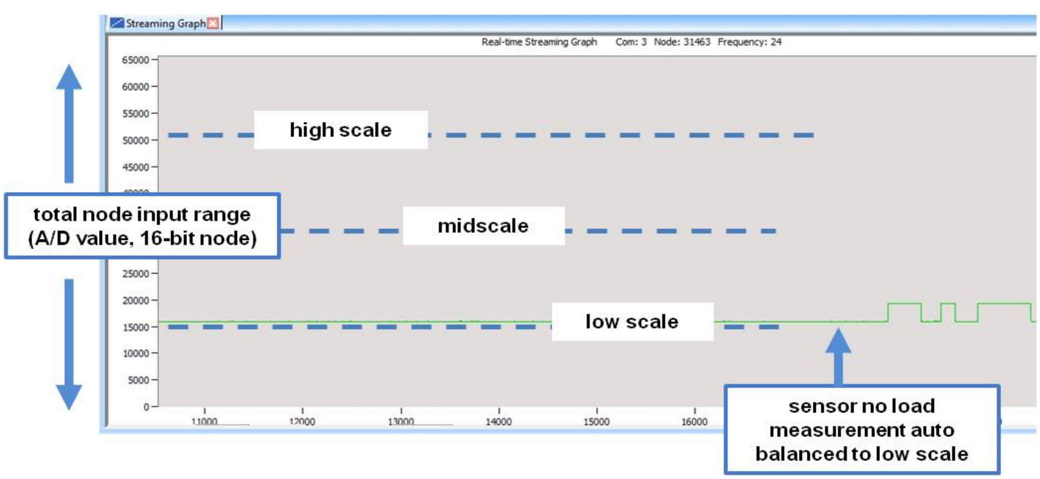


Figure 27 - Offset Scale Setting

The conversion values can be entered in two menus. The channel Configuration menu has more options than the Calibration Coefficients menu, but both are acceptable ways to enter the values and formulas.

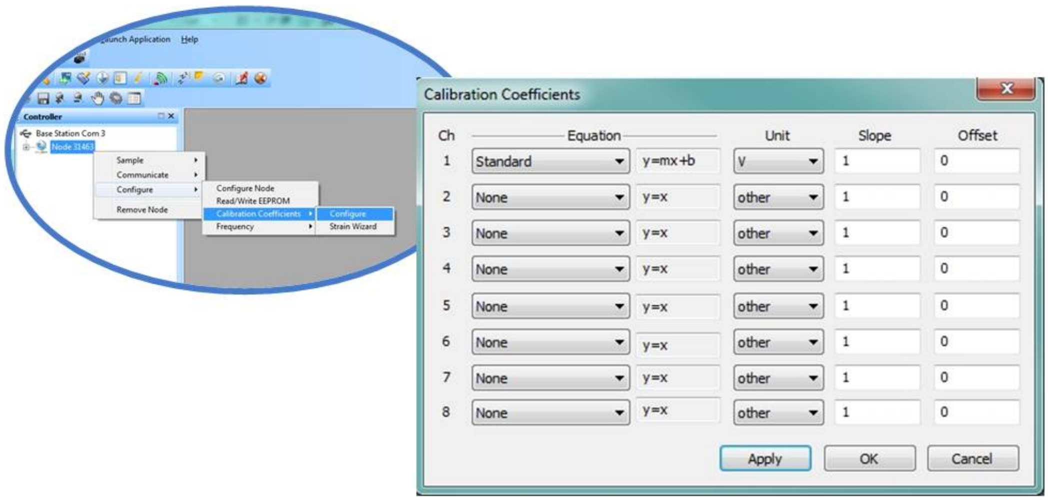


Figure 28 - Abbreviated Conversion Values Menu

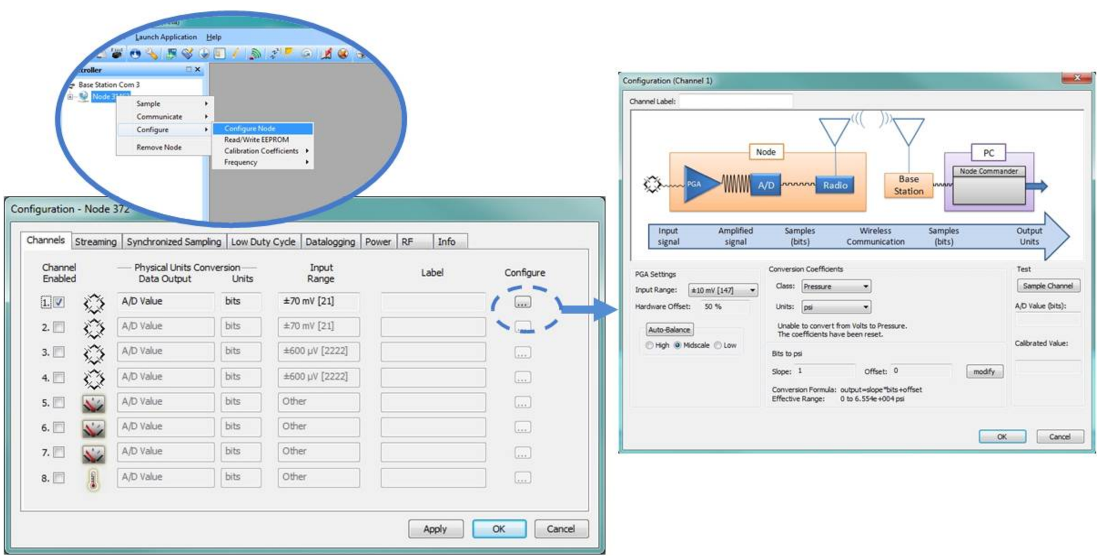


Figure 29 - Advanced Conversion Values Menu

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6.2.1 Calculating a Linear Slope

A data analysis tool, such as Microsoft Excel, can be used determine the slope of a linear relationship between sensor output A/D value (bits) and engineering units. This is not a calibration, unless a calibrated reference device is used to measure the applied loads. For information and examples for determining calibrations coefficients *see Sensor Calibration on page 48* .

Here is an example, using Excel:

1. Open a blank spreadsheet.

2. Enter the A/D value (bits) measurements and applied load in the desired engineering units in two columns. Enter A/D value is in the left column (*x*-axis value) and the applied load in the right (*y*-axis value).

3. From the Insert menu, select Chart > Scatter. Select the preferred format.

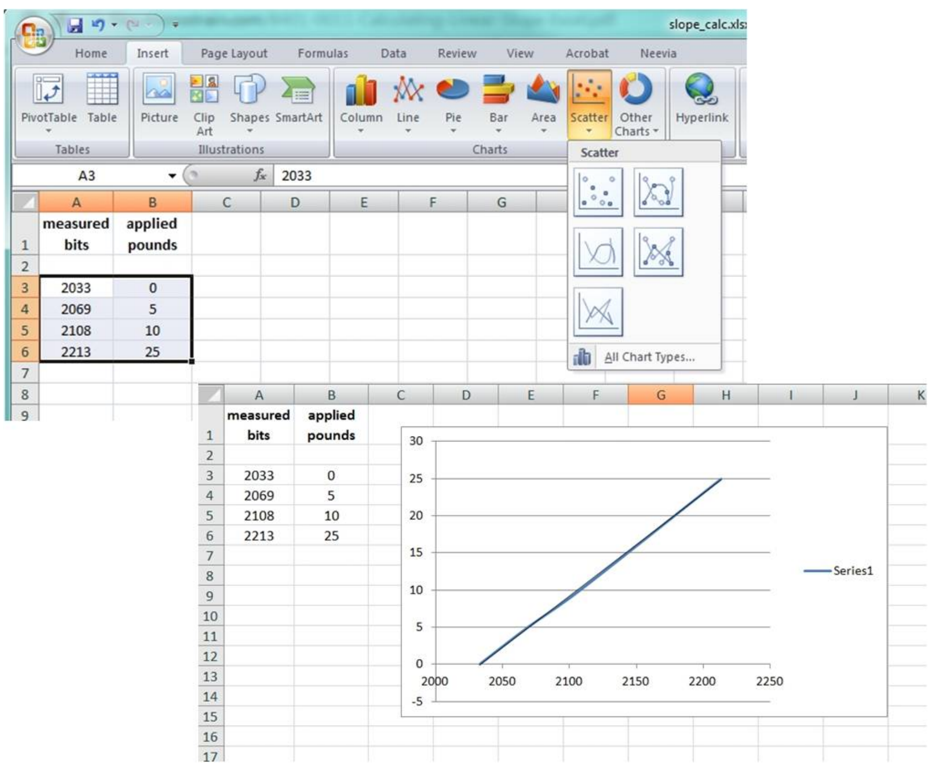

Figure 30 - Generate a Scatter Chart

4. Right-click on the graphed line, and select Add Trendline.

5. Designate the line as Linear, and check the option to Display the Equation on the chart.

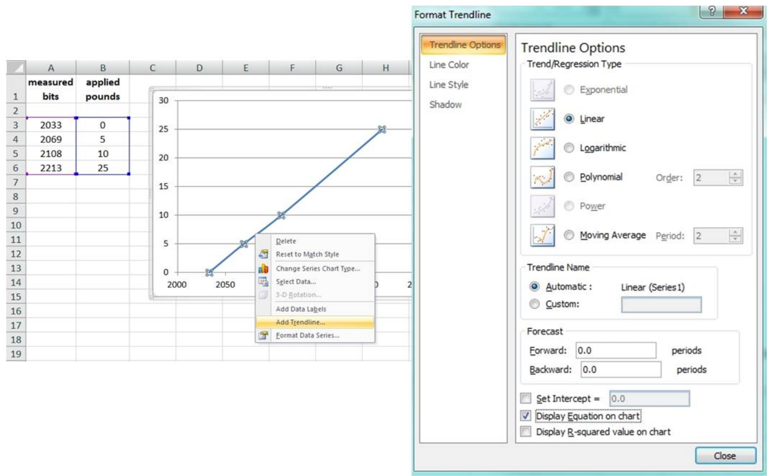

Figure 31 - Plot Trendline

6. The formula of the line is *y=mx+b*, where *y* is the engineering units at a given point (measurement), *m* is the slope of the line that represents the linear ratio, *x* is the A/D value at a given point, and *b* is the fixed zero load offset of the sensor. Enter the slope and offset as the conversion values for the sensor channel under the applicable engineering units. In this example, enter 0.1338 for the slope and -282.36 for the offset for the pounds units conversion values on the measured channel.

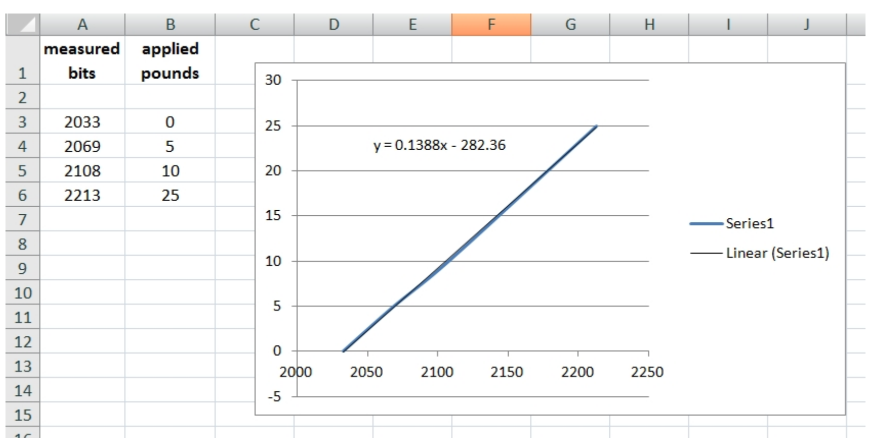

Figure 32 - Slope and Offset Values

6.2.2 Differential Input Gain and Offset

The combination of the gain, offset, and sensor signal cannot exceed the 0 to 3VDC input of the analog to digital converter within the node. *See Example Gain and Offset Calculations on page 47*.

- **Resolution:** Applying gain to the sensor signal can be used to maximize the measurement resolution. The more of the range that is used, the more digital counts are available to measure the signal, which typically means higher resolution measurements. Limitations to the gain adjustment are the sensor's measurement capabilities and the 0 to 3V input range of the node. The signal produced after gain is applied to the sensor at full scale must not exceed the input range of the node.

- **Offset Scale:** The scale setting positions the no-load measurement of the connected sensor within the 0 to 3V range of the node input. The range of A/D counts that corresponds with the 0 to 3V node input depends on the resolution of the node. For example, a 12-bit node will have a full scale bit range of 4096 and a 16-bit node will have a full scale bit range of 65535. A mid-range setting positions the baseline offset in the middle of the range (1.5V or full scale bits*1/2) and is used for sensors with negative and positive going signals. The low-range setting positions the baseline offset in the bottom quarter range (75mV or full scale bits*1/4) and is used for sensors with mostly positive going signals. The high-range setting positions the baseline offset in the top quarter of the range (2.25V or full scale bits *3/4) and is used for mostly negative going signals.

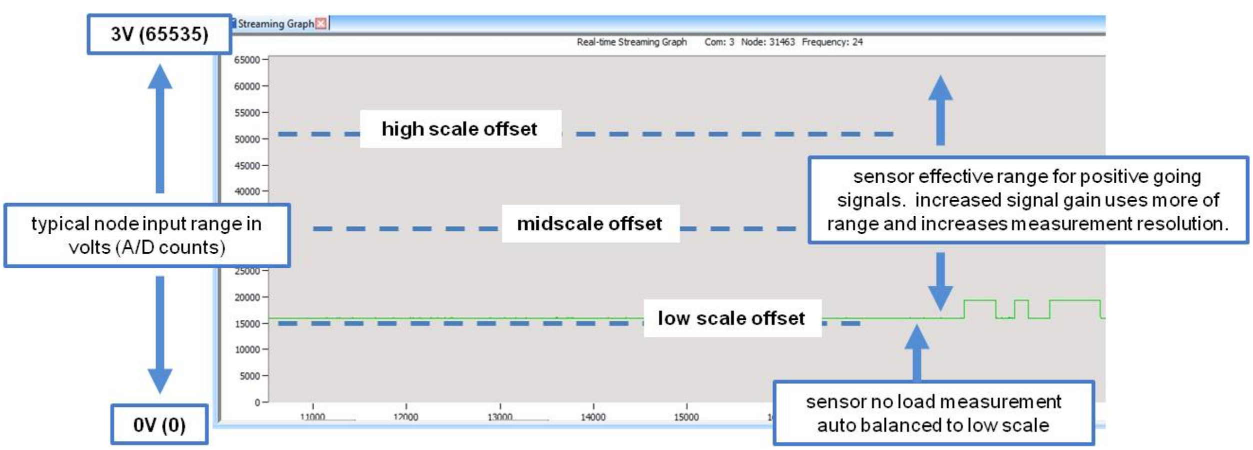

Figure 33 - Differential Input Resolution and Offset (16-bit Node)

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Example Gain and Offset Calculations

EXAMPLE 1:

Sensor signal range: 0 to 50mV
Gain setting: 21
Baseline offset range setting: Mid-range

Calculations:

50mV * 21 = 1.05V (maximum voltage of sensor signal with gain)
1.05V + 1.5V = 2.55V (maximum input voltage to node with gain and offset)

Calculated node input over sensor range: 1.5 to 2.55V

This is a good setting because the node input voltage is within the 0 to 3V range.

EXAMPLE 2:

Sensor signal range: 0 to 50mV
Gain setting:30
Baseline offset range setting: Low-range

Calculations:

50mV * 30 = 1.5V (maximum voltage of sensor signal with gain)
1.5V + 75mV = 2.25V (maximum input voltage to node with gain and offset)

Calculated node input over sensor range: 75mV to 2.25V

This may be a better setting than in Example 1 because the gain is higher, which could increase the resolution of the measurement. The node input voltage is still within the 0 to 3V range.

EXAMPLE 3:

Sensor signal range: 0 to 50mV
Gain setting:75
Baseline offset range setting: Low-range

Calculations:

50mV * 75 = 3.75V (maximum voltage of sensor signal with gain)
3.75V + 75mV = 4.5V (maximum input voltage to node with gain and offset)

Calculated node input over sensor range: 75mV to 4.5V

This setting will not work because the node input voltage is outside of the 0 to 3V range.

6.3 Sensor Calibration

Many sensors require calibration coefficients to accurately report measurements. Methods for determining the calibration coefficients depend on the type of sensor measurement and application. The Node Commander® software facilitates multiple calibration methods. Calibration calculators for some applications are also available by contacting LORD MicroStrain® Technical Support. *See Technical Support on page 83*.

- **Sensor manufacturer's specifications or calibration:** The slope and offset values, or the data to derive them, are provided with the sensor by the manufacturer to prove its accuracy and describe expected voltage output. Some sensors are calibrated individually, while others are manufactured to a standard sensitivity value (plus or minus some tolerance), which is provided in the device specifications.
- **Sensor lab calibration:** If the manufacturer's calibration is not available or outdated, calibration of the sensor can be performed with calibrated equipment in a controlled environment. The calibration equipment and process will typically be traceable to an industry standard, such as NIST or ASTM in the United States. Fixed loads are applied to the sensor while the sensor output is recorded. The load is applied or measured by a calibrated reference device. The known load value from the calibrated device is then plotted against the measured output of the sensor to determine the calibration slope and offset. In Node Commander® this can be accomplished by taking sensor readings while applying the known loads.

Sensor wiring, tolerances in system electronics, and differences in mounting techniques are examples of systemic variables that can influence the sensor readings. Sensors that are making small measurements or are otherwise sensitive to these slight differences may benefit from a system calibration. The following techniques are system calibrations:

- **System shunt calibration (internal and external):** This option is only available for Wheatstone bridge-type sensors (such as strain gauges) and utilizes a calibration wizard in Node Commander®. In the shunt calibration process, an internal or external precision resistor is used to load part of the sensor bridge while the sensor remains unloaded. The bridge output is measured and used as a loaded calibration point for the sensor. In addition to the no-load value it can be used to derive the calibration slope and offset. The internal shunt resistor is suitable for most applications, however an external shunt may be beneficial in high gain scenarios.

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- **System field calibration:** The field calibration is a similar methodology to the sensor lab calibration. Known loads are applied to the sensor while the sensor output is recorded. The load is applied or measured by a reference device. In this scenario, the sensor may be installed in final field configuration, and the load may be applied with the actual stimulus that the sensor will be monitoring. The known load value from the reference device is then plotted against the measured output of the sensor to determine the calibration slope and offset. In Node Commander® this can be accomplished by taking sensors readings while applying the known loads.

6.3.1 EXAMPLE: Lab or Field Calibration

The lab and field calibrations use similar methodology. *See Sensor Calibration on page 48*. The primary difference is the traceability and calibration environment. Lab calibrations are performed in controlled environments with traceable equipment and procedures. Field calibrations are more improvised, although calibrated equipment can still be used to improve accuracy.

NODE:V-Link® -LXRS® ,16 bit (65536 A/D values)

CHANNEL TYPE: differential analog input, 0 to 3VDC input range

SENSOR TYPE: load cell

SENSOR PARAMETERS: application voltage range: +/-20mV

This is the expected output voltage of the sensor based on the range of force being measured in the application and the sensitivity of the sensor (V/engineering units)

DESIRED OUTPUT: engineering units (EU), force (lbs)

PROCEDURE:

1. Open Node Commander®, and establish communication with the gateway and node (*see System Operation Overview on page 10*).
2. Right-click on the node heading and select Configure > Configure Node. Select the check-box for Channel 1, which is where the strain gauge is connected, and then select the Configure button.

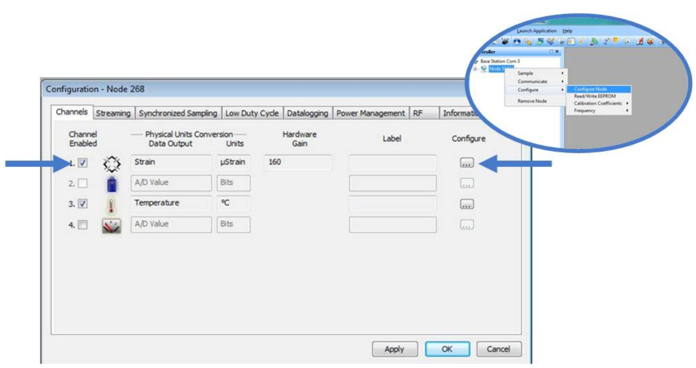

Figure 34 - Node Configuration Menu

3. Use the following settings (*Figure 35 - Channel Settings*):

   a. **Conversion Coefficients, Class:** A/D value

   b. **Conversion Coefficients, Units:** bits

   c. **PGA Settings, Hardware Gain:** 104

   d. **PGA Setting:** Midscale (for positive and negative going signals)

4. Select the Auto Balance button to tare the no-load value of the strain gauge. Click OK to apply the node settings and exit configuration.

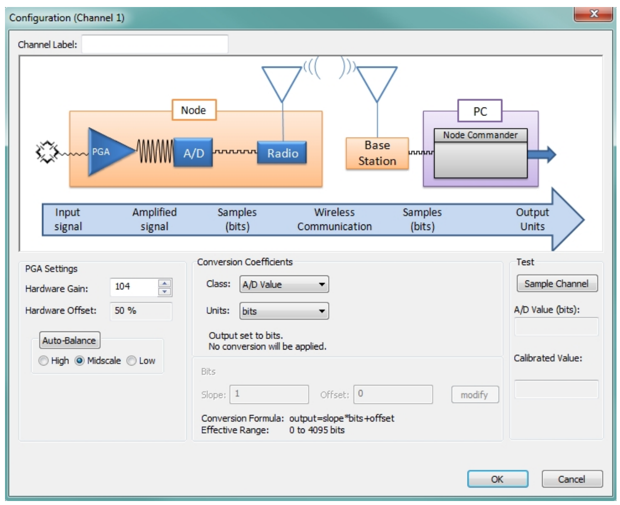

Figure 35 - Channel Settings

5. Right-click on the node heading, and then Sample > Stream > Start.

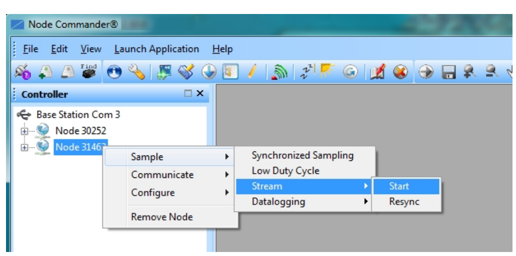

Figure 36 - Start Node Streaming

6. The streaming graph shows the bit output of the channel.

7. Using a calibrated tool (or some other way of applying and measuring a known load) and apply loads to the sensor at a number of intervals over the expected range of use. At each of the calibration intervals, record the applied force and the corresponding sweep value on the y–axis of the graph (the A/D value output of the sensor).

    a. Zoom in and out on the graph by un-checking the Auto Y-Axis Zoom box, and then right clicking on the graph and selecting Zoom In. Draw a box around the desired area to zoom in on.

    b. Adjust the Y-Axis Width from the field next to the Y-Axis Zoom.

    c. End sampling by clicking the red X box on the Streaming Graph tab.

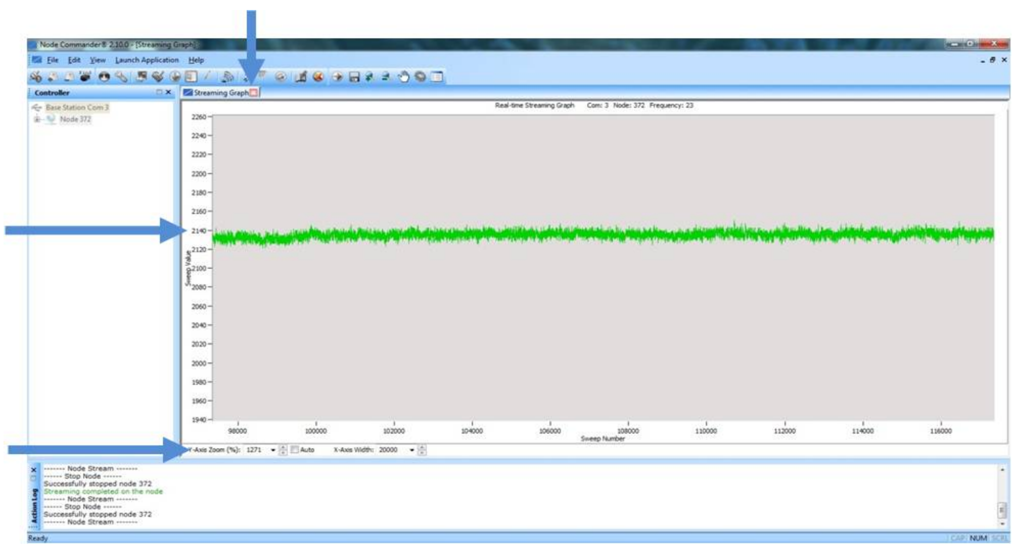

Figure 37 - Node Sampling

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8. After making all measurements, calculate a slope from the data using the formula *y=mx+b* in a data analysis program, such as Microsoft Excel. *See Calculating a Linear Slope on page 44*.

9. Return to the Node Configuration screen for the sensor channel, and select the Conversion Coefficients Class and Units, and enter the Slope and Offset values derived in the data analysis program.

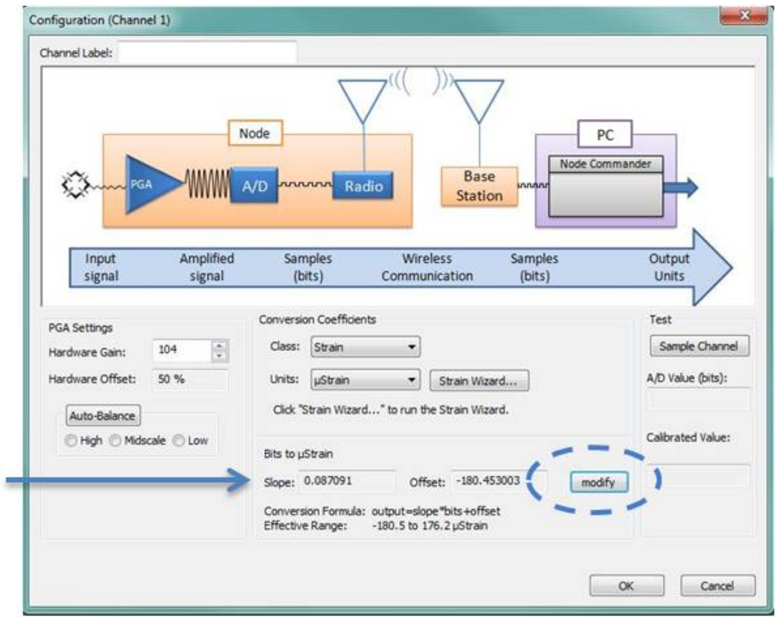


Figure 38 - Enter Calibration Values

10. Save the values, and exit configuration. This is the end of a lab calibration.

11. For field calibrations, bbegin node data streaming again with no load on the sensor.

12. Observe the value in the stream graph. If the stream is not at zero, return to the channel configuration menu, and adjust the offset by increasing or decreasing the value.

13. Once the offset has been zeroed, verify the calibration by applying known loads on the sensor throughout the load range, observing and verifying the measurement in engineering units.

6.3.2 EXAMPLE: Manufacturer Calibration

NODE: V-Link® -LXRS® ,16 bit (65536 A/D values)

CHANNEL TYPE: differential analog input, 0 to 3VDC input range

SENSOR TYPE: pressure transducer, voltage output, positive going

SENSOR PARAMETERS:

From the manufacturer calibration sheet included with the sensor;

sensor range: 0-250 psi
sensor zero load output: 0.0032 VDC
sensor full scale output (FSO) with 10V excitation: 86.07mV

From the application parameters;

sensor excitation in application: 3V supply from the node

DESIRED OUTPUT: engineering units (EU), psi

CALCULATIONS:

Because the sensor will be powered from the node with 3V, and the sensor manufacturer calibrated it a 10V, the manufacturer full scale output (FSO) value needs to be scaled to 3V.

(3V/10V) * 86.07mV = 25.82mV

Select a gain and offset scale value appropriate for the sensor. Because the signal is positive going in this example application, the low offset scale will provide the largest range. With the low offset selected, the effective input range of the node is 75mV to 3V (2.25V) (*see Differential Input Gain and Offset on page 46*). Calculate the highest gain possible by dividing the actual input range by the sensor FSO.

2.25V/25.82mV = 87

The closest gain setting below optimal gain for a V-Link® -LXRS® is 75 (+/-20mV). Using a higher gain value would exceed the input voltage capacity of the node when the sensor is at higher pressures. This selection makes sense because the approximate input range designation for a gain of 75 is +/-20mV (a 40mV delta minus 10mV for the low offset), which is close to the FSO range of the sensor.

Multiply the sensor FSO by the gain setting to get the sensor voltage after amplification.

75 * 25.82mV = 1.9365V

Scale the (gained) sensor input voltage/EU ratio to the node input voltage/EU ratio to determine the equivalent node FSO value (*x*).

1.9365V/250psi=3V/x
(250psi * 3V)/1.9365V = x = 387. 3psi

The node converts voltage inputs to A/D values. For a 16-bit node, there are 65536 A/D values over the 3V input range. Divide the node EU FSO by the A/D value to get the ratio, or slope, of EU to A/D value.

387.3 psi/65536 bits = 0.00591 = slope

Once the slope is entered, the sensor offset value can be measured in a data sampling session, such as streaming. Sample the sensor channel with no load applied, and read the EU value. Enter this as a negative value for the offset in order to have it subtracted from readings.

6.3.3 EXAMPLE: Internal Shunt Calibration

NODE: V-Link® -LXRS® ,16 bit (65536 A/D values)

CHANNEL TYPE: differential analog input, 0 to 3VDC input range

SENSOR TYPE: strain gauge, Wheatstone Bridge, full bridge configuration

SENSOR PARAMETERS: application voltage range: +/-2mV

This is the expected output voltage of the strain gauge based on the range of strain being measured in the application and the sensitivity of the gauge (volts/strain).

DESIRED OUTPUT: engineering units, microstrain

PROCEDURE:

1. Open Node Commander®, and establish communication with the gateway and node. (*See System Operation Overview on page 10*.)
2. Right-click on the node name, and select Configure > Configure Node.
3. Select the check-box for Channel 1, which is where the strain gauge is connected, and then select the Configure button.

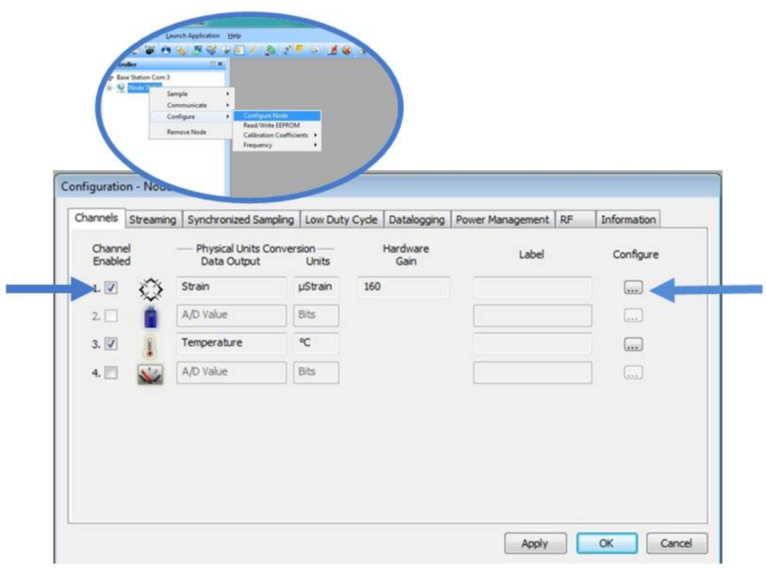


Figure 39 - Node Configuration Menu

4. Use the following settings;

    a. **Conversion Coefficients, Class:** Strain

    b. **Conversion Coefficients, Units:** uStrain

    c. **PGA Settings, Hardware Gain:** 104

    d. **PGA Setting:** Midscale (for positive and negative going signals)

5. Select the Auto Balance button to tare the no-load value of the strain gauge. Observe the value returned for the Auto Balance value.

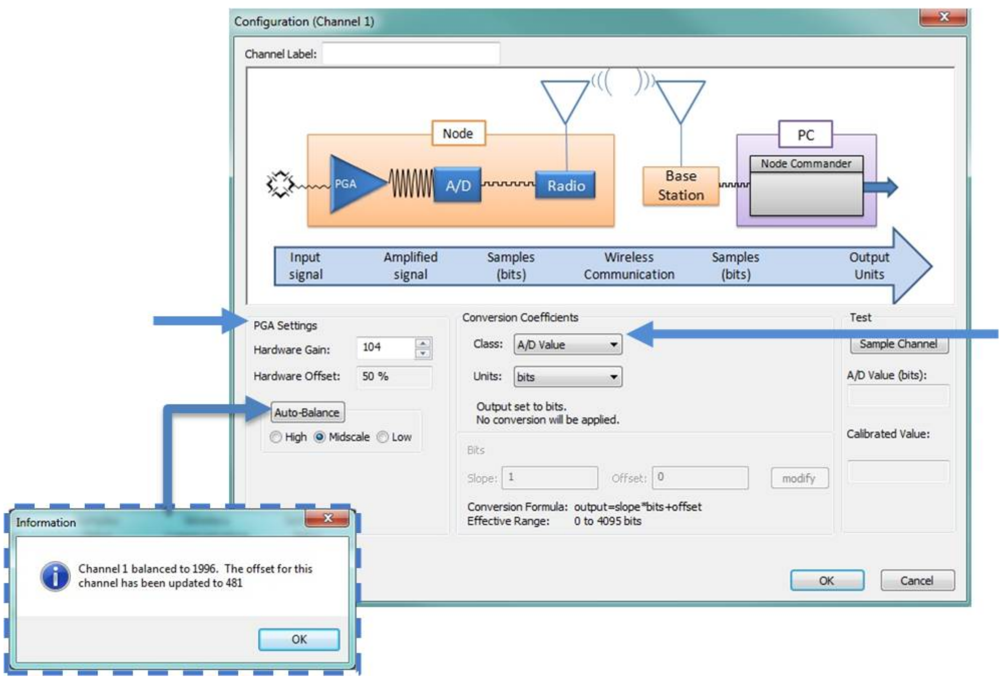


Figure 40 - Channel Settings

6. Select the Strain Wizard.

7. Select the appropriate Bridge Type and click Next.

8. Select Use the Strain Measurement Wizard and click Next.

9. Set the following parameters:

   a. **Number of Active Gauges:** number of a strain elements connected (for example: 4 for a full-bridge, and 2 for a half-bridge)

   b. **Gauge Factor:** ratio of mechanical strain to electrical output (a gauge specification).

   c. **Gauge Resistance:** Enter the strain gauge ohm value (a gauge specification).

   d. **Shunt Resistance:** 499000 ohms

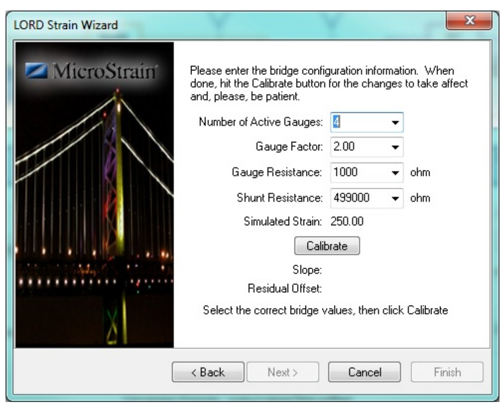


Figure 41 - Strain Wizard Settings

NOTE

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

LORD MicroStrain® SENSING SYSTEMS

10. Select Calibrate.

11. Verify the calibration looks as shown in *Figure 42 - Strain Gauge Calibration*. The green line represents the output of the strain gauge. With no load applied it should sit near the Auto Balance baseline value, represented by the red dashed line. During calibration, a shunt resistance (selected on the Parameters page) is applied across the strain bridge, shown by the square pulse on the output. The Offset value, shown with the dashed blue line, is the average output value of the pulse and should sit across the top of the pulse. If the gauge has not had to time to equilibrate before sampling, or if varying environmental factors exist, spikes in the gauge output may occur and affect the Baseline and Offset values. If this occurs, the Offset and Baseline values can be adjusted to clip the spikes in the output values. Adjust them as needed, and select Accept when completed.

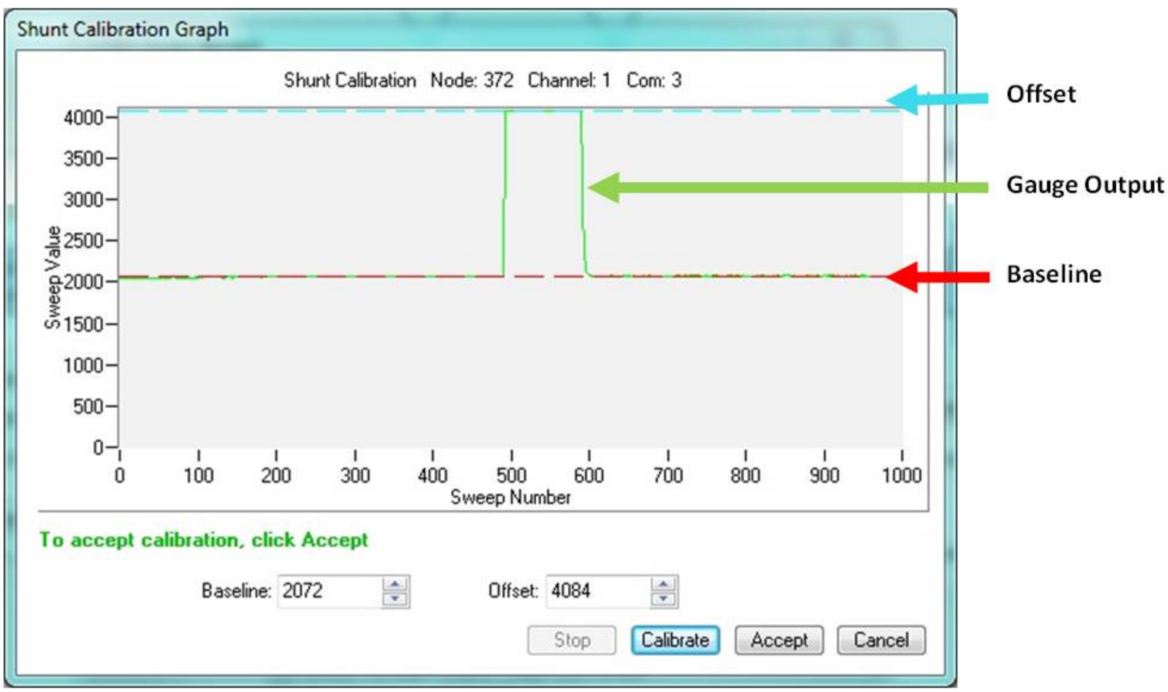


Figure 42 - Strain Gauge Calibration

12. Select Finish to end the Strain Wizard. Note the slope and offset values have been calculated automatically.

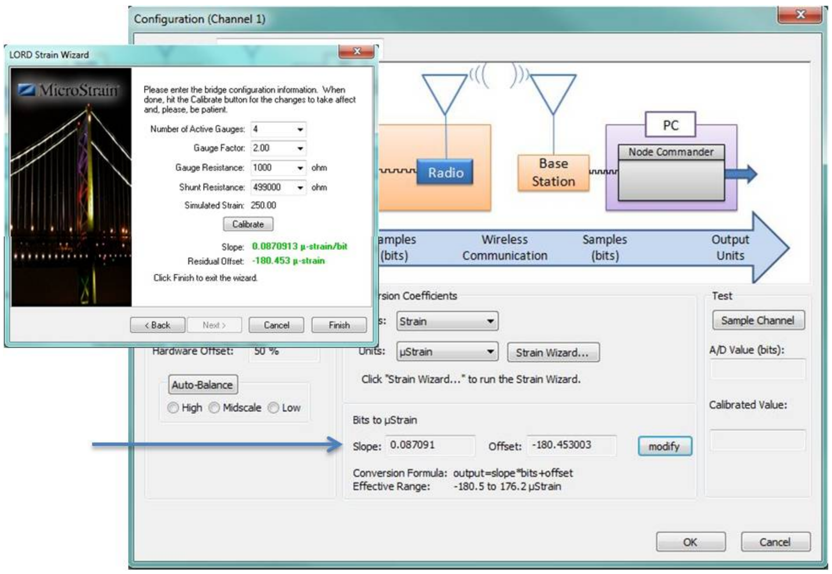


Figure 43 - Completed Strain Wizard

13. Select OK to exit the Channel Configuration window.

14. In the Node Configuration window, select Apply to write the configuration and calibration values to the node.

15. Select OK to exit.

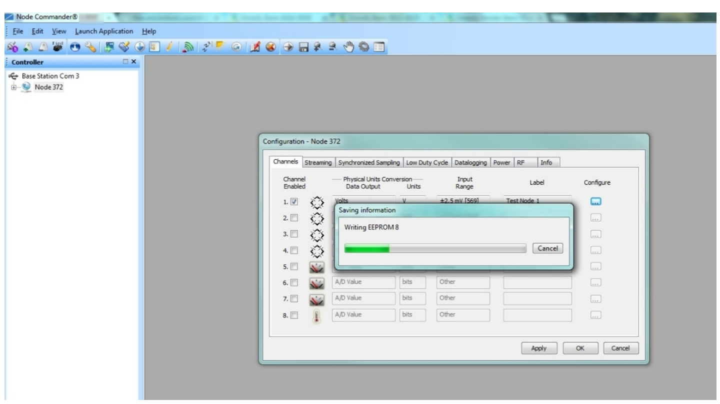


Figure 44 - Apply Node Settings

7. Powering the Node

⚠WARNING

Apply only the input voltage range specified for the node in the polarity indicated. Failure to do so could result in personal injury and permanent damage to the node. For important safety considerations *see Safety Information on page 95*.

The node can be powered with the internal battery or an external source. These sources cannot be used simultaneously. When the node is manufactured, the switch is set to operate using the internal battery.

External battery holders and a ruggedized outdoor housing that accommodates two D cell batteries are available for the SG-Link® -LXRS® and can be used to extend battery operating capacity and duration. For more information *see Node Accessories on page 86*.

7.1 Selecting the Power Source

There is user-accessible switch to select the power source. The following steps describe how to change between internal battery operation and an external power source:

⚠WARNING

The SG-Link® -LXRS® contains an internal, rechargeable Lithium Polymer (Li-Po) battery. For important precautions see Safety Information on page 95.

1. Verify the node power switch is in the OFF position and no external power is applied.

2. Use a small flat head screwdriver to push the recessed switch fully to the desired position, as indicated in Figure 45 - Power Source Selection. The figure shows the node configured for an internal power source.

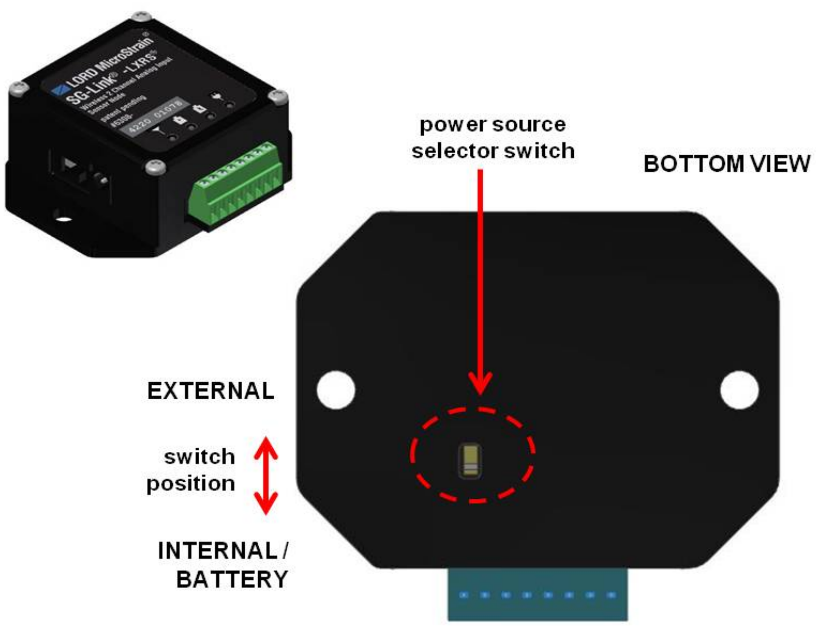


Figure 45 - Power Source Selection

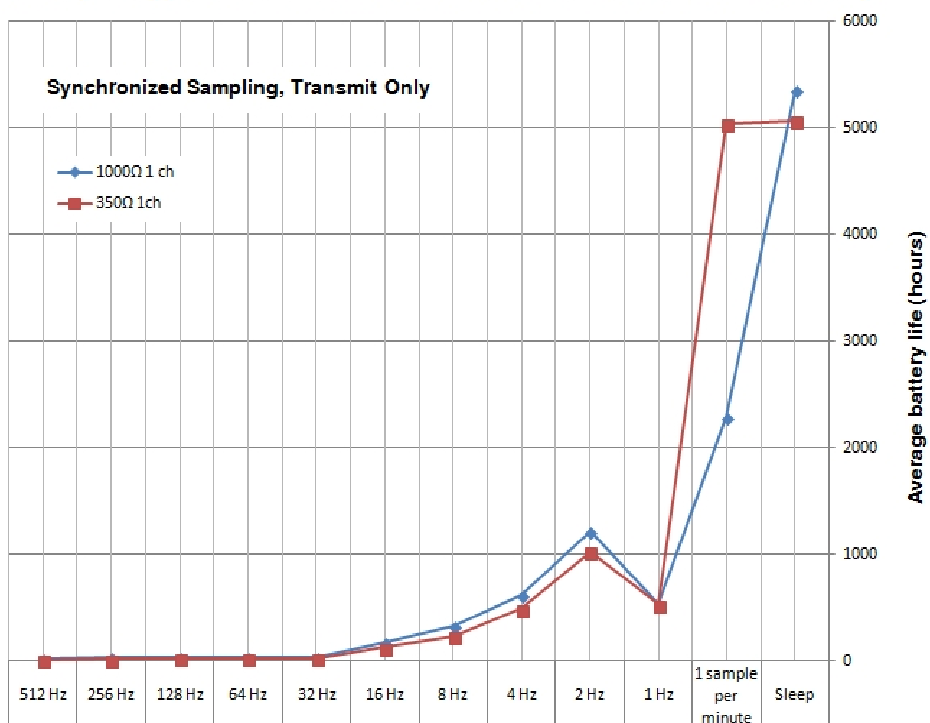
7.2 Using the Internal Node Battery

⚠WARNING The SG-Link® -LXRS® contains an internal, rechargeable Lithium Polymer (Li-Po) battery. For important precautions see Safety Information on page 95.

When the internal node switch is set for internal power, the node is powered by a rechargeable 250mAH lithium polymer battery. The battery is not user-serviceable.

Node battery life is highly dependent on the number and type of sensors connected, as well as operational parameters such as sample mode and rate. More active channels and higher sample rates equate to decreased battery life. The following graph shows an example approximation of the battery life for a SG-Link® -LXRS® with different strain gauge sensor configurations over a range of sample rates operating in Synchronized Sampling mode. For additional SG-Link® -LXRS® power specifications see Power Profile on page 93.

Battery life approximation for the SG-Link® - LXRS® 250mAH internal battery



	512 Hz	256 Hz	128 Hz	64 Hz	32 Hz	16 Hz	8 Hz	4 Hz	2 Hz	1 Hz	1 sample per minute	Sleep
1000Ω 1 ch	17	28	38	39	40	178	330	621	1,210	531	2,281	5,354
350Ω 1ch	12	16	19	19	20	125	229	487	1,019	531	5,037	5,069

Sample Rate

7.3 Charging the Node Battery

⚠WARNING

Use only the power supply specified for the node to charge the battery. Using a power supply above the rated voltage could cause personal injury and permanent damage to the node. For important safety considerations *see Safety Information on page 95*.

NOTE

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

1. Plug the node power supply into the node, and into a 120/240VAC, 50/60Hz AC power source. Use only the power supply specified for the node. Use the supplied power plug adapters, as needed.

2. Monitor the status of the charge indicators. For indicator meaning *see Device Status Indicators on page 71*. Continue charging until the indicator turns green to indicate a completed charge. Charging takes approximately 6-8 hours from a full discharge.

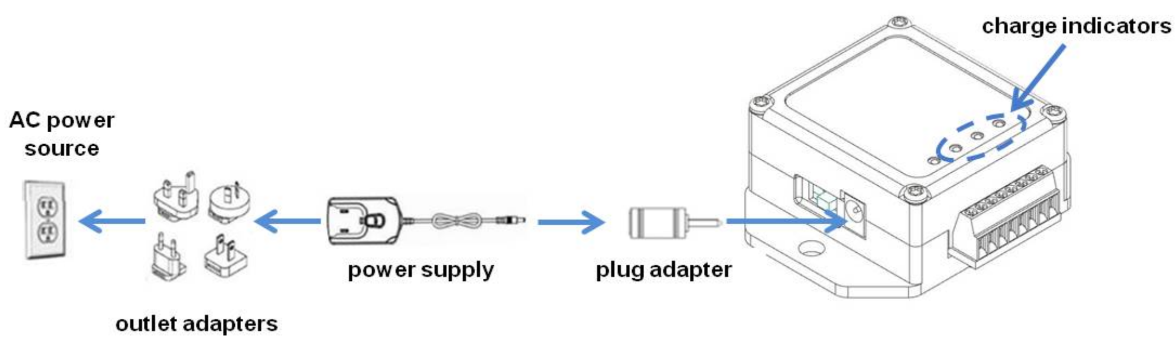


Figure 46 - Node Charging

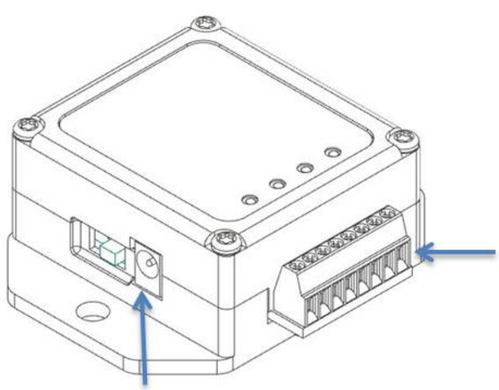
7.4 Connecting an External Power Supply

⚠WARNING

Apply only the input voltage range specified for the node in the polarity indicated. Failure to do so could result in personal injury and permanent damage to the node. For important safety considerations *see Safety Information on page 95*.

When the internal node switch is set for external power, the node may be directly powered by the power supply specified for charging the node, or another regulated AC to DC power supply with the appropriate output parameters. It can also be powered by an external battery or other regulated DC supply. The supply must deliver a stable voltage between 3.2V and 9.0VDC and be capable of sourcing at least 50mA. Power supplies over 9VDC, such as vehicle batteries, can be used by installing a step- down regulator (for SG-Link® -LXRS® power use specifications *see Power Profile on page 93*). External battery holders and ruggedized outdoor housings that accommodates D cell batteries are available for the SG-Link® -LXRS® . *See Node Accessories on page 86*.

External power is applied through either the power supply jack or the terminal block connectors. Do not connect both. Observe connection polarities or the node may be damaged.



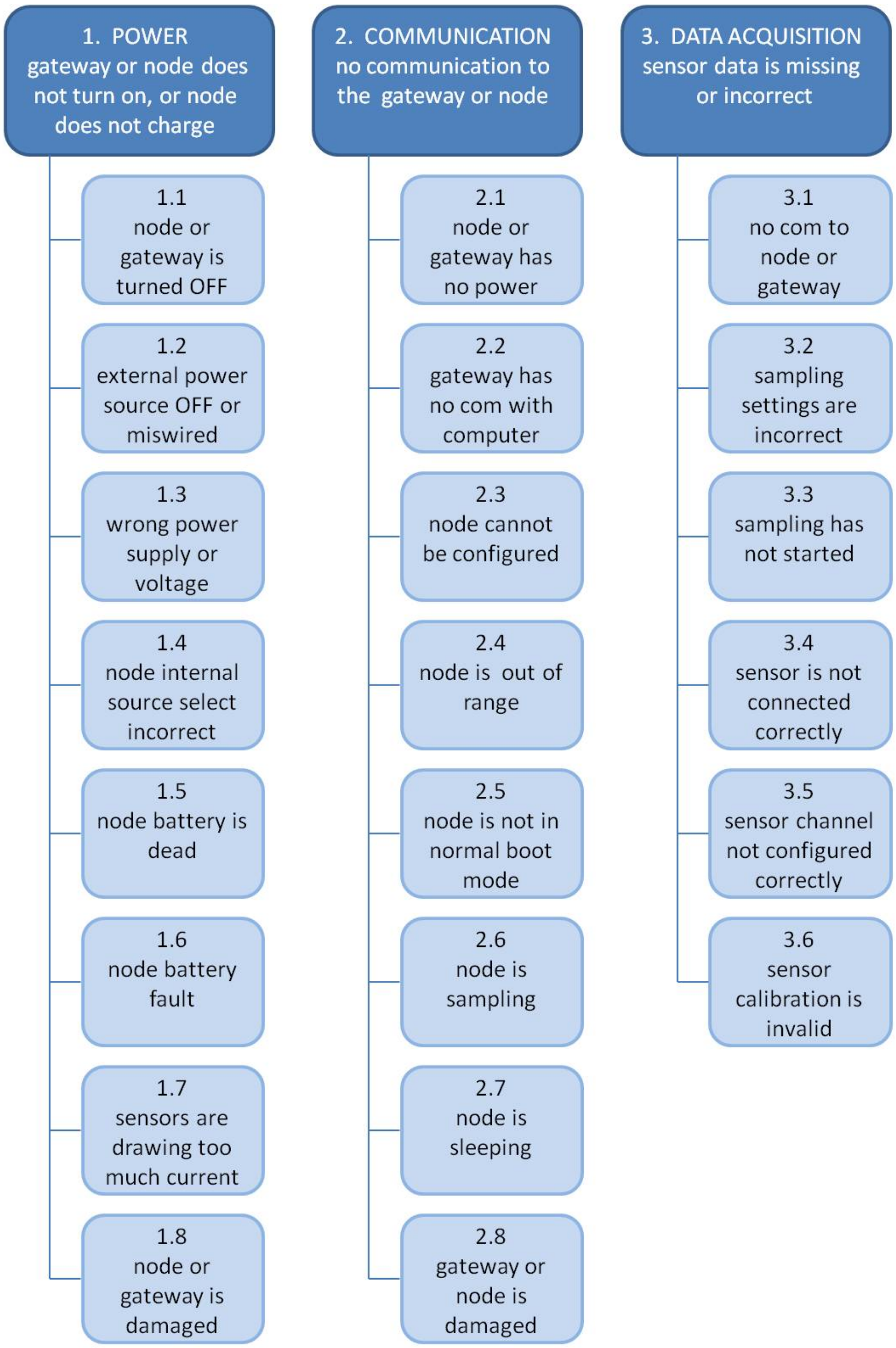
terminal block number	signal
7	GND
8	Vjck

power jack pin	signal
center	Vjck
barrel	GND

Figure 47 - External Power Connections

8. Troubleshooting

8.1 Troubleshooting Guide



LORD MicroStrain® SENSING SYSTEMS

Problem	Possible cause and recommended solution
1. POWER **gateway or node does not turn on, or node does not charge**	**1.1 power switch is off** The status indicator LED on the device will be off. Turn the device on, and the status indicator LED should illuminate.
	1.2 external power is off or miswired Verify the device power source is connected correctly and turned on.
	1.3 wrong power supply Using a power supply other than the one specified the device or an external supply that is outside of the device operating range could result in permanent damage to the device or cause it to not work properly.
	1.4 node internal source select switch is set incorrectly When the node is manufactured, it is set to internal battery operation, but it can be configured to accept an external source. When set to an external source, the battery cannot be charged.
	1.5 node battery is dead If the node power source selector is set to internal and the node will not power on, attempt to charge the node battery. If the battery needs to replaced, contact LORD MicroStrain® Technical Support (*See Technical Support on page 83*).
	1.6 node battery fault If the battery charge indicator on the node is only dimly illuminated when charging is attempted, a battery fault condition has occurred. Unplug power and then plug it back in. The indicator should turn on brightly, indicating charging.
	1.7 sensors are drawing too much current The node battery can only supply a limited amount of power to the connected sensors. If an over-current condition occurs, the node will shut down. Consider powering the node or sensors with an external source.

Problem	Possible cause and recommended solution
	1.8 node or gateway is damaged If all power settings and connections have been verified, and the node is still unresponsive, contact LORD MicroStrain ® Technical Support (*See Technical Support on page 83*).
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 applicable power switches are on. Power is indicated on both devices by a status indicator LED.
	2.2 gateway has no communication with the computer Verify gateway communication in the software. Check, remove, and reconnect communications and power cables as applicable. • For serial gateways, verify the COM port setting. • For USB gateways, verify the drivers are installed on the computer (included with Node Commander®) and that the software has had sufficient time to detect it. • For Ethernet gateways, use Live Connect™ to verify communications on a DHCP network. Check that the extended timeouts are enabled in the Node Commander® Edit > Preferences menu, under Devices. Once communication has been established the network configuration can be changed.
	2.3 node cannot be configured Observe the node status indicator LED to determine what state it is in: boot, idle, sample, or sleep. If the node is sampling or sleeping, it cannot be configured. In Node Commander®, execute the Stop Node command to put the node in idle state and allow configuration to occur. If the user inactivity timeout is set very low, the configuration menu will have to be entered quickly, before the timeout occurs, putting the node back in a sample or sleep state.

Problem	Possible cause and recommended solution
	2.4 node is out of range Perform a bench test with the node and gateway in close proximity to verify they are operational. For range test and installation recommendations *see Range Test on page 23*. The system has been tested to operate with the node and gateway up to 2km apart with clear line of sight.
	2.5 node is not in normal start-up mode If the node status indicator shows the node booting in a mode other than the normal boot mode, it can be bypassed by toggling the node ON/OFF switch rapidly three times, then leaving it in the ON position for normal power up. In normal boot mode the conmmunication can be established with automatic node discovery or manually once the boot process is complete and the node is in the idle state. Start up mode can then be changed in the software.
	2.6 node is sampling Observe the node status indicator LED to determine what state it is in: boot, idle, sample, or sleep. If the node is sampling, it cannot be configured. In Node Commander®, execute the Stop Node command to put the node in idle state, allowing configuration to occur.
	2.7 node is sleeping Observe the node status indicator LED to determine what state it is: boot, idle, sample, or sleep. If the node is sleeping, it cannot be configured. In Node Commander®, execute the Stop Node command to put the node in idle state, allowing configuration to occur.
	2.8 gateway or node is damaged Verify all connections, power, and settings. If available, try installing alternate nodes and gateways one at a time to see if the faulty device can be identified. If no conclusion can be determined, or to send a device in for repair, contact LORD MicroStrain® Technical Support (*See Technical Support on page 83*).

Problem	Possible cause and recommended solution
3. DATA ACQUISITION **sensor data is missing or incorrect**	**3.1 no communication to node or gateway** Verify connections and power to the node and gateway. Verify they are powered on and communicating in the software. Enter a configuration menu to verify that the node can be accessed.
	3.2 sampling settings are incorrect If the sampling mode, rate, or duration are not performing as expected, enter the node configuration menu, and verify the sampling settings.
	3.3 sampling has not started If sampling is occurring, the mode will be displayed next to the node name in Node Commander®. The node device status indicator will also be flashing the sampling mode code. If the node is not sampling, activate it in the software or with a sample on start up boot sequence.
	3.4 sensor is not connected correctly Verify sensors connections and wiring. For non standard connections contact LORD MicroStrain® Technical Support (*See Technical Support on page 83*).
	3.5 sensor channel not configured correctly Verify that the sensor is configured on the correct channel and has been enabled for data acquisition.
	3.6 sensor calibration is invalid If possible, perform a field verification of the sensors by applying known loads and comparing the measured values. In the channel configuration settings, verify that the sensor channel units are selected correctly. Verify that the calibration calculations are correct. Verify that the gain and offset range are correct and that the baseline offset is set with Auto Balance, as applicable. Verify that the calibration values (slope and offset) are correct. Verify that all parameters were written to the node channel. Recalibrate as needed.

8.2 Device Status Indicators

The following is a complete list of the SG-Link® -LXRS® status indicators.

Indicator	Symbol	Behavior	Node Status
Battery charge source indicator		OFF	No power source detected
		ON green	Charging source detected
Battery charged indicator	+	OFF	Node not charging
		ON bright red	Node battery charging
Battery charged indicator	+	OFF	Node charge status unknown
		ON green	Battery fully charged
		ON green and battery charging indicator ON red	Battery fault condition, reset by unplugging power and then plugging it back in
Device status indicator		OFF	Node OFF or sleeping
		OFF, with occasional flash	Node sleeping with radio check intervals enabled
		Ten rapid flashes	Node booting normally and sending out a status message.
		1 second pulse (approximate)	Node active and idle
		Continuously ON	Node logging or streaming data
		Pulses at sample rate	Node sampling in low duty cycle
		Pulses for each ping	Node sending out communication requests
		Pulses at very high speed	Node being range tested
		Several rapid pulses	Node EEPROM is being read or written
		Four slow pulses when power is initially applied	Fault condition
		Five slow pulses when power is initially applied	Fault condition

Table 5 - Device Status Indicators

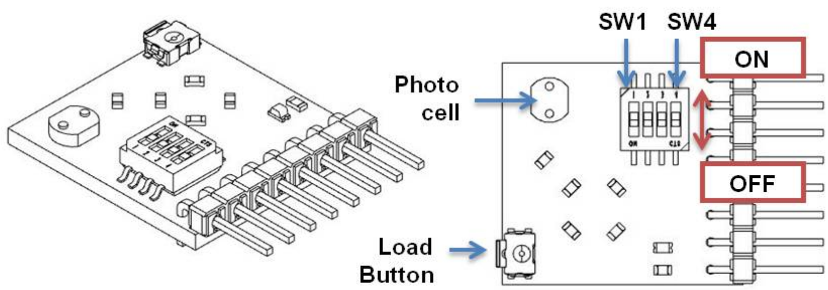
8.3 Using the Node Tester Board

The node tester board is used to verify node and network functions before sensors are connected, or for diagnostic purposes. The node tester board provides a fixed load so system functions can be verified including basic operations not related to the sensor, such as communication and sampling. A fixed load is applied to the differential input by pressing the load button. The SG-Link® -LXRS® also features a photo cell that can be used to apply a variable load the single-ended channel. Adjust the load by changing the amount of light on the face of the photo cell.

There are various impedance value node tester boards available, depending on the node it is being used with. *See Parts and Configurations on page 85* for configuration options and part numbers. *Table 6 - Tester Board Configuration* describes the strain gauge load settings available. This setting must match the type of node channel that is being tested. For example if the node is a quarter-bridge node, the setting on the tester board must be the same. The configuration chart is also printed on the underside of the board.

NOTE

The switches may come with a protective film covering them. Simply peel the film off to access the switches.



Configuration	SW 1 position	SW 2 position	SW 3 position	SW 4 position
Full Bridge	ON	ON	ON	OFF
Half Bridge	OFF	OFF	ON	OFF
Quarter Bridge	OFF	OFF	OFF	ON

Table 6 - Tester Board Configuration

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The following steps describe an example of how to use the tester board to sequence through the primary functions of the node and the wireless system. If the results indicated in the final steps are achieved, the system is fully operational for measuring a full bridge strain gauge. Other scenarios can be tested as needed.

1. Set the jumpers for Full Bridge operation, using a small flat head screw driver to fully push the switch into the desired position.

2. Verify the node is powered off and unplugged.

3. Plug the node tester board into the node in the orientation shown, and screw the board in place.

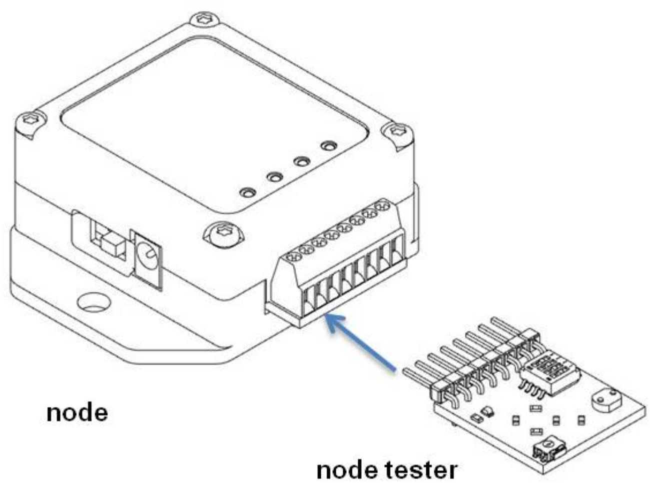

Figure 48 - Node Tester Board Installation

4. If not already completed, set up the Wireless Sensor Network equipment and install the Node Commander® software. *See System Operation Overview on page 10*.

5. Launch theNode Commander® software, and establish communications with the gateway and node.

6. Enter the node channel configuration menu by right-clicking on the node heading in Node Commander® and selecting Configure > Configure Node, and then the Channels tab.

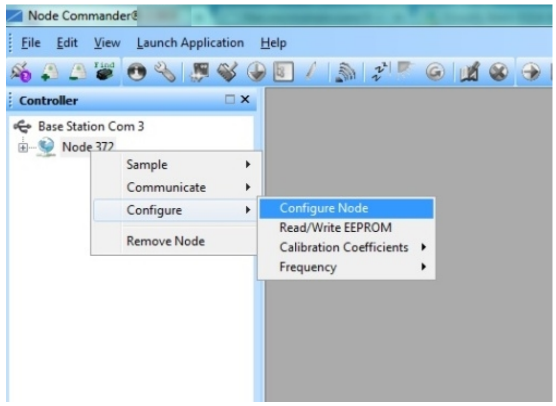

Figure 49 - Node Configuration Menu

7. Select the check box for Channel 1, which is where the Node Tester Board is installed, and then select Configure.

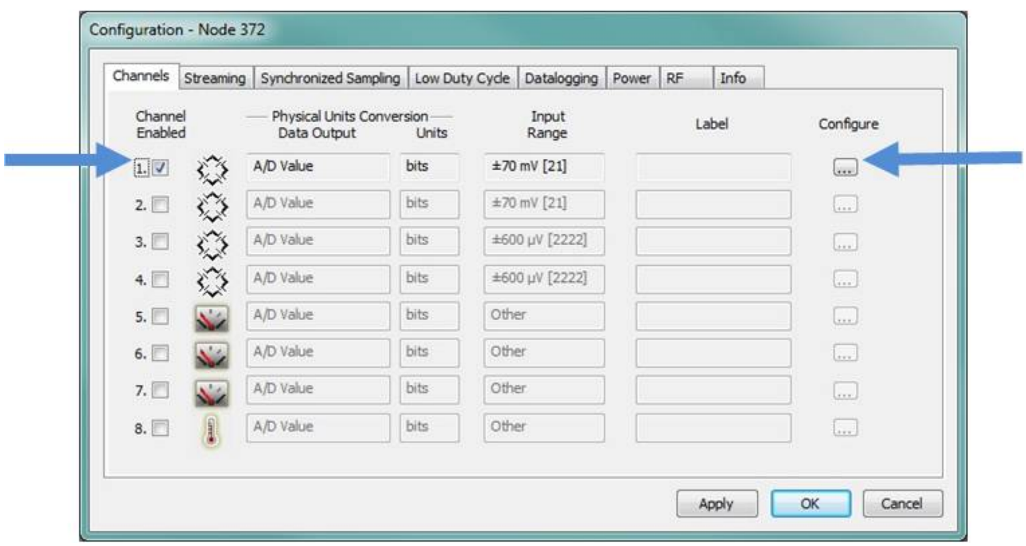

Figure 50 - Node Channel Configuration

8. Use the following settings for the node tester board.

    a. **Conversion Coefficients, Units:** uStrain

    b. **Conversion Coefficients, Class:** Strain

    c. **PGA Settings, Input Range:** +/-2.5mV

    d. **PGA Setting:** Midscale

9. Select the Auto Balance button to tare the no load value of the tester board.

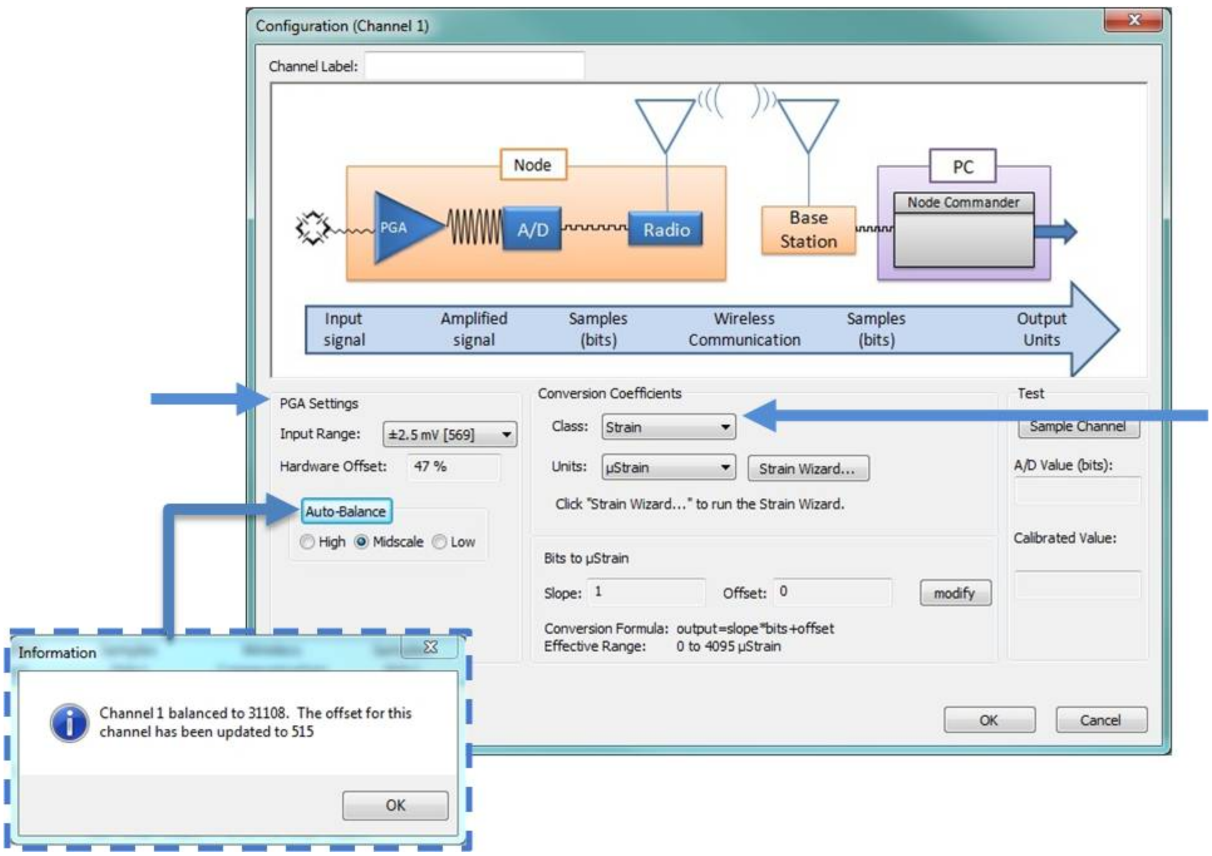

Figure 51 - Channel Settings

10. Select the Strain Wizard.

11. Select Full Bridge for the Bridge Type and click Next.

12. Select Use the Strain Measurement Wizard, and click Next.

13. Set the following for the Node Tester Board
    a. **Number of Active Gauges:** 4
    b. **Gauge Factor:** 2
    c. **Gauge Resistance:** Enter the node tester board ohm value.
    d. **Shunt Resistance:** 499000 ohms

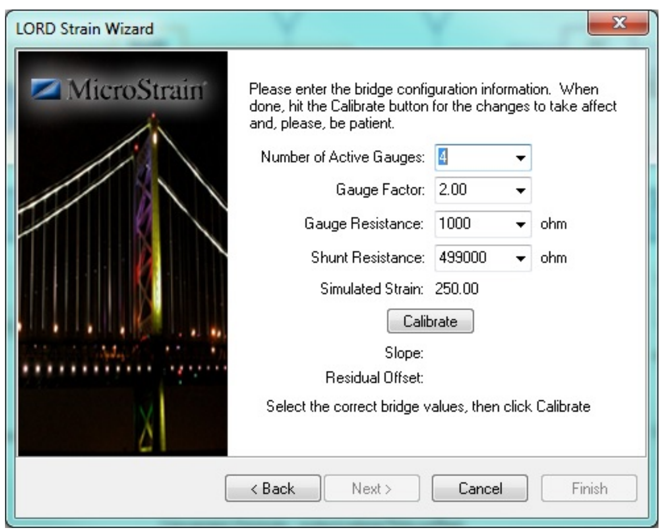

Figure 52 - Strain Wizard Settings

14. Select Calibrate.

15. Verify the calibration looks as shown in *Figure 53 - Strain Gauge Calibration*. The green line represents the output of the strain gauge. With no load applied it should sit near the Auto Balance baseline value, as shown, and is represented by the red dashed line. During calibration, a shunt resistance (selecting on the Parameters page) is applied across the strain bridge, shown by the square pulse on the output. The Offset value, shown with the dashed blue line, is the average output value of the pulse and should sit across the top of the pulse. If the gauge has not had to time to equilibrate before sampling, or varying environmental factors exist, spikes in the gauge output may occur and affect the Baseline and Offset values. If this occurs, the Offset and Baseline values can be adjusted to clip the spikes in the output values. Adjust them as needed, and select Accept when completed.

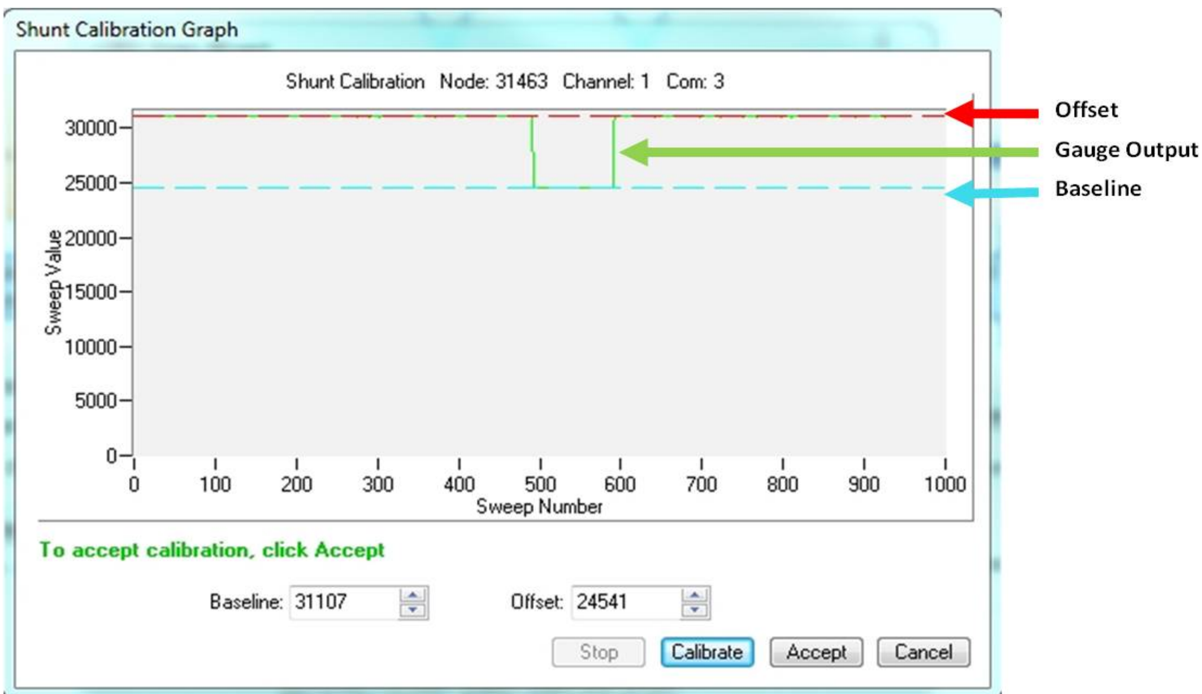

Figure 53 - Strain Gauge Calibration

16. Select Finish to end the Strain Wizard. Note that the slope and offset values have been calculated.

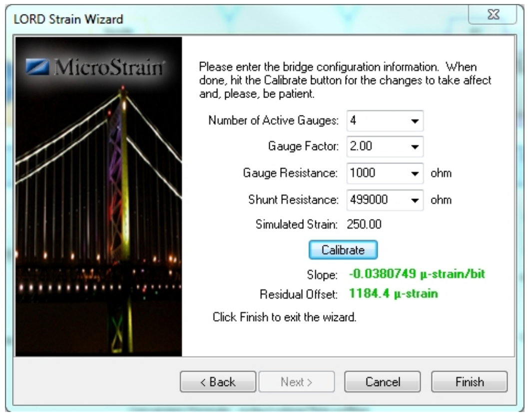

Figure 54 - Completed Strain Wizard

17. Select OK to exit the channel Configuration window.

18. In the Node Configuration window, select the Streaming tab. Uncheck Continuous Streaming, and set the Time Duration to 15 seconds.

19. Select Apply to write configuration and calibration values to the node. Select OK to exit.

NOTE

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

NOTE

There are many sampling options available in the Node Commander® software. The following describes just one option, for illustrative purposes.

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20. Right-click on the Node heading and then select Sample > Stream > Start.

21. As soon as Start is selected, the node will start collecting data for a duration of 15 seconds. During that time, press and release the load button on the node tester board to shunt the resistive load on and off. Verify the result is as shown in the figure below. The pulse value should equal tester board ohm value. Testing is complete.

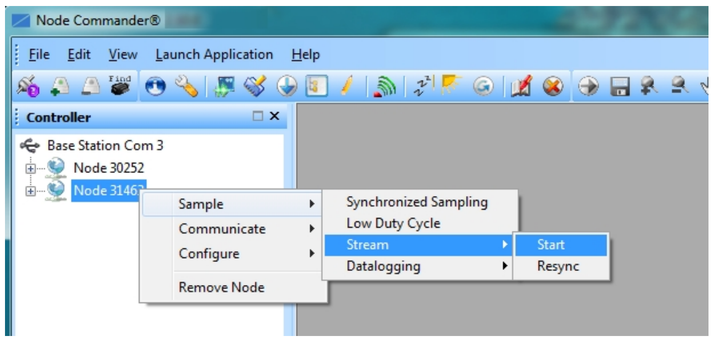

Figure 55 - Node Sampling Menu

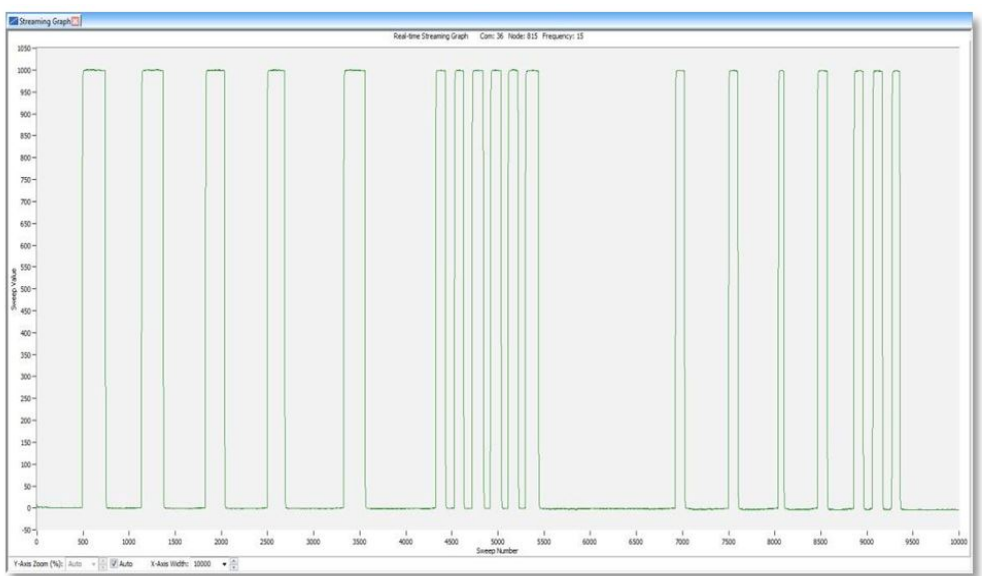

Figure 56 - Node Tester Output Stream

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8.4 Updating Node Firmware

Under the recommendation of LORD MicroStrain® Technical Support Engineers, nodes can be upgraded to the latest available firmware to take advantage of new features or correct operating issues. Node Commander® version 2.7.0 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 MicroStrain® website. *See Technical Support on page 83* for contact and website information.

1. Download the LXRS® Firmware Upgrade file from the LORD MicroStrain® 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 Node Commander® , and establish communication between the node and gateway as normal.

4. Press and hold F1 on the computer keyboard. While holding F1, right-click the node name, and a drop-down menu will appear.

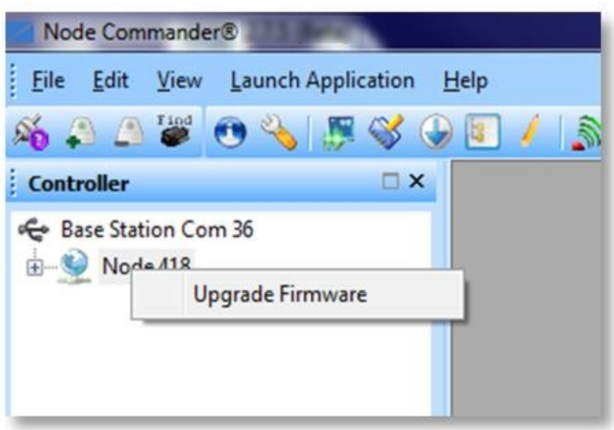


Figure 57 - Update Node Firmware

5. Release the F1 key.

6. Click Upgrade Firmware, and the Node Firmware Upgrade window will appear.

7. Click Browse, and navigate to the downloaded .zhex file.

8. Click Write, and the upgrade sequence will begin. When complete, "Upgrade Success" will appear in the Status column.

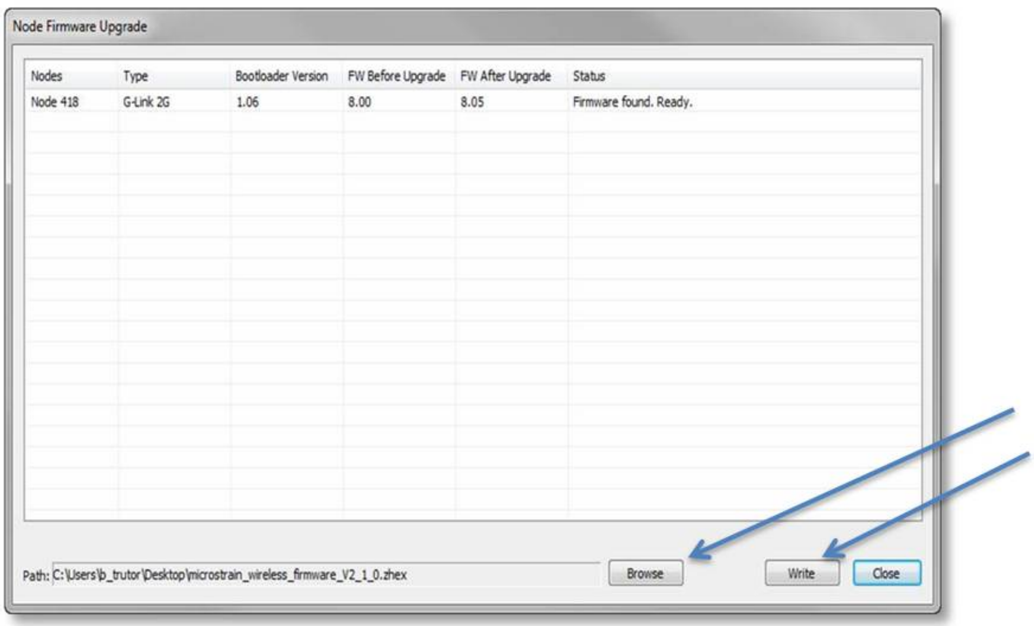


Figure 58 - Upgrade Firmware Window

8.5 Repair and Calibration

The SG-Link® -LXRS® has no components which require factory calibration and certification.

General Instructions

In order to return any LORD MicroStrain® product, you must contact LORD MicroStrain® 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 authorization (RMA#) clearly printed on the outside of the package. Removable batteries should be removed and packaged in separate protective wrapping. Please have the LORD MicroStrain® model number and serial number as well as your name, organization, shipping address, telephone number, and email. Normal turn-around for RMA items is 7 days from receipt of item by LORD MicroStrain®.

Warranty Repairs

LORD MicroStrain® 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 MicroStrain® will repair or replace, at its discretion, a defective product if returned to LORD MicroStrain® within the warranty period. This warranty does not extend to any LORD MicroStrain® 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 MicroStrain®.

Non-Warranty Repairs

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

8.6 Technical Support

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

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

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

Technical Support

sensing_support@LORD.com

Phone: 802-862-6629
Toll Free: 800-449-3878
Fax: 802-863-4093
SKYPE: microstrain.wireless.support

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

9. Maintenance

There are no user-serviceable parts on the SG-Link® -LXRS® .

10. Parts and Configurations

10.1 Standard Nodes

For the most current product information, custom, and OEM options not listed below, refer to the LORD MicroStrain® website or contact the LORD MicroStrain® Sales Department.

Model Number	Description	LORD MicroStrain® Part Number
SG-LINK-LXRS	• One differential analog channel • One single ended analog channel • Internal temperature sensor	**6308-3000**

Configuration Options (specify at time of order)

- **Full-bridge configuration** on differential channels.
- **350Ω or 1000Ω half-bridge** completion on differential channels.
- **350Ω or 1000Ω quarter-bridge** completion on differential channels.
- **High g-force** option. Node operates in gravitational forces in excess of 550 g.

10.2 Node Accessories

The following parts are available for use with the SG-Link® -LXRS® . For the most current product information refer to the LORD MicroStrain® website or contact the LORD MicroStrain® Sales Department. *See Product Ordering on page 89*.

Description	LORD MicroStrain® Part Number
Power supply for SG-Link® -LXRS®	**6302-1000**
IP66/NEMA4 rated rugged outdoor enclosure for SG-Link® -LXRS®	**6309-3000**
IP66/NEMA4 rated rugged outdoor enclosure for SG-Link® -LXRS® with two D cell battery capacity	**6309-4000**
IP66/NEMA4 rated rugged outdoor enclosure for SG-Link® -LXRS® with three D cell battery capacity	**6309-5000**
Magnetic mounting strips for outdoor enclosure	**6302-4000**
350Ω node tester board	**6309-6000**
1000Ω node tester board	**6309-7000**
Inductive remote power starter for nodes	**6303-0300**
D cell battery tray for use with wireless nodes (indoor use)	**6302-0200**
AA cell battery tray for use with wireless nodes (indoor use)	**6302-0300**
Lithium D cell battery 19 Ah capacity	**6302-0000**
Lithium AA cell battery 2 Ah capacity	**6302-0100**

Table 7 - Node Accessories

10.3 Wireless System Equipment

Model	Description	LORD MicroStrain® Part Number
WSDA-1000-SK	Ethernet Data Gateway Starter Kit	**6314-0051**
WSDA-BASE-104-SK	USB Gateway Starter Kit	**6307-1041**
WSDA-BASE-102-SK	RS232 Gateway Starter Kit.	**6307-1021**
WSDA-BASE-101-SK	Analog Gateway Starter Kit	**6307-1011**
WSDA-1000	Ethernet Data Gateway	**6314-0050**
WSDA -RGD	Ethernet Data Gateway (ruggedized to MILS-STD-461F/MIL-STD 810F)	**6314-1050**
WSDA-BASE-104	USB Gateway	**6307-1040**
WSDA-BASE-102	RS232 Serial Output Gateway	**6307-1020**
WSDA-BASE-101	Analog Output Gateway	**6307-1010**
--	Node Commander® Software	**6301-0300**
--	Replacement USB cable	**9022-0029**
--	Replacement serial cable	**4005-005**
--	USB Gateway cable extender	**6307-0900**
G-Link-LXRS	Wireless Accelerometer Node	**various models**
G-Link2-LXRS	Wireless Accelerometer Node	**various models**
SG-Link-LXRS	Wireless 2-Channel Analog Input Sensor Node	**various models**
SG-Link-OEM	Wireless 2-Channel Analog Input Sensor Node	**various models**
SG-Link-RGD	Ruggedized Wireless Analog Sensor Input Node	**various models**
V-Link-LXRS	Wireless 7-Channel Analog Input Sensor Node	**various models**
TC-Link-LXRS	Wireless Thermocouple Node	**various models**
DVRT-Link-LXRS	Wireless Displacement Sensor Node	**various models**
ENV-Link-Mini-LXRS	Wireless Environmental Sensor Node	**various models**
Watt-Link-LXRS	Wireless Energy Monitoring Sensor Node	**various models**
RTD-Link-LXRS	Wireless RTD Sensor Node	**various models**

Table 8 - Wireless System Equipment

10.4 Warranty Information

Warranty

LORD MicroStrain® 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 MicroStrain® agrees to repair or replace, at its sole discretion, a defective product if returned to LORD MicroStrain® within the warranty period and accompanied by proof of purchase. This warranty does not extend to any LORD MicroStrain® products which have been subject to misuse, alteration, neglect, accident, incorrect wiring, mis-programming or to 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 MicroStrain®. This warranty does not cover any incidental or consequential damages and is in lieu of all other warranties expressed or implied. No representative or person is authorized to assume for us any other liability in connection with the sale of our products. Some states do not allow limitations on how long an implied warranty lasts, and/or the exclusion or limitation of incidental or consequential damages, so the above limitations and exclusions may not apply to the original customer.

Terms and Conditions of Sale

Please refer to the LORD MicroStrain® website Support page for complete Terms and Conditions of product sales.

Terms and Conditions of Service

Please refer to the LORD MicroStrain® website Support page for complete Terms and Conditions of product service.

Trial System

To enable customers to try our products risk-free, LORD MicroStrain® offers a 30-day return policy on the purchase of a starter kit. In order to take advantage of this offer, a purchase order or payment for the starter kit is required when the order is placed. If the product is not suited to the application, the product may be returned within 30 days from the date of receipt for a full refund (excluding shipping and handling), as long as the product is unaltered and undamaged. Items can only be returned after LORD MicroStrain® has issued an Return Material Authorization (RMA). Items must be packed to withstand shipping, sent via freight, and pre-paid. LORD MicroStrain® will inspect the items returned and issue a refund or credit once the items have been examined and are deemed to be unaltered or undamaged. Non-standard or custom products may only be returned with approval and a re-stocking penalty may be assessed. A 30-Day Return must be initiated by receiving a RMA from LORD MicroStrain®.

10.5 Product Ordering

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

http://www.microstrain.com/wireless

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

Sales Support

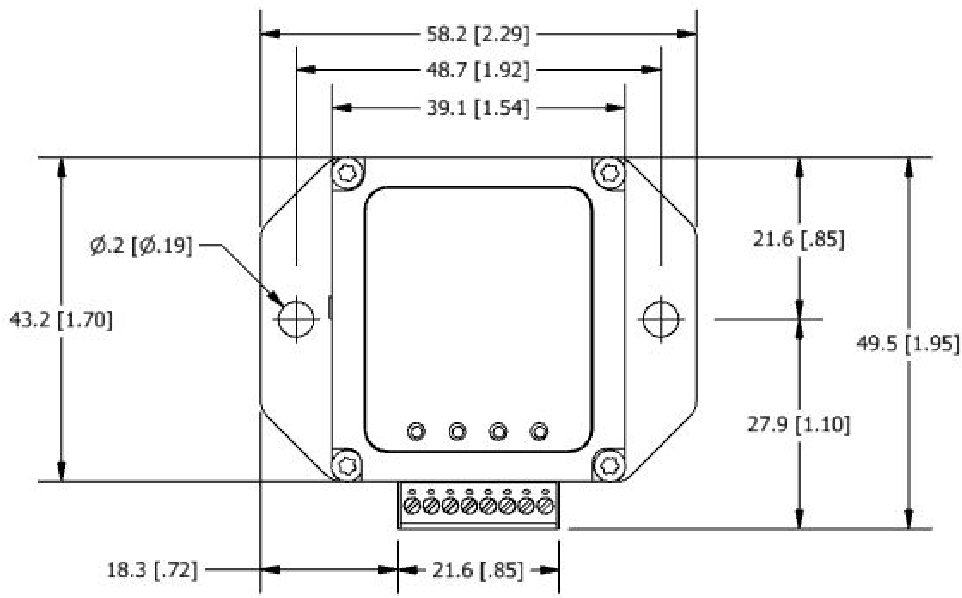
sensing_sales@LORD.com

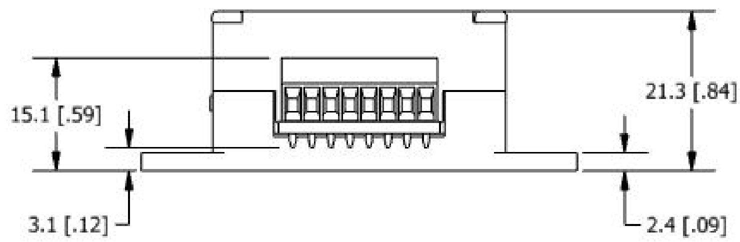
Phone: 802-862-6629
Toll Free: 800-449-3878
Fax: 802-863-4093

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

11. Specifications

11.1 Physical Specifications





Dimensions:	58 mm x 50 mm x 21 mm
Weight:	42 grams
Enclosure Environmental Rating:	General purpose indoor (IP67/NEMA4X rated enclosure available)

LORD MicroStrain® SENSING SYSTEMS

11.2 Operating Specifications

Parameter	Specification
Input channels	2 input channels: 1 full differential, 350 Ω resistance or higher (with optional bridge completion), and 1 single ended inputs (0-3 volts maximum), plus an internal temperature sensor
Temperature sensor	-40 °C to 70 °C range, typical accuracy ±2 °C (at 25 °C)
Anti-aliasing filter bandwidth	-3 dB cutoff at 250 Hz (factory adjustable)
Measurement accuracy	± 0.1% full scale typical
Resolution	1 bit: 0.024% 1 microstrain typical for 3 wire full-bridge strain gauge when used in accordance with LORD MicroStrain® recommendations.
DC bridge excitation	+3VDC, 50mA maximum across all channels (pulsed to sensors for sample rates of 32 Hz and below to conserve power)
Programmable gain	software programmable for differential input channels from 104 to 1800 (can be reduced with custom configuration)
Programmable offset	software programmable
Analog to digital (A/D) converter	successive approximation type, 12 bit resolution
Data storage capacity	2 megabytes (approximately 1,000,000 data points)
Sampling modes	synchronized, armed datalogging, streaming, low duty cycle
Synchronized sampling rates	1 Hz - 512 Hz
Synchronized sampling mode network capacity	transmit real time data from node to PC - rate depends on number of active channels and transmitting nodes. sample rates and # of channels are configurable. For example; 3 nodes, 1 channel, 512 Hz, 15 nodes, 1 channel, 256 Hz 31 nodes, 1 channel, 128 Hz 63 nodes, 1 channel, 64 Hz
Synchronization between nodes	± 32µsec with 10 second beacon interval
Synchronization rate stability	± 3ppm
Armed datalogging sampling rate	1 channel enabled: 32 Hz to 4096 Hz; 2 or more channels enabled: 32 Hz to 2048 Hz
Streaming sampling rates	1 channel enabled: 736 Hz; 3 channels enabled: 617 Hz per channel; 8 channels enabled: 424 Hz per channel
Low duty cycle sampling rates	512 Hz to 1 sample per 60 minutes
Event driven monitoring	user-definable event threshold trigger, 200K bytes pre- event recording
Shunt calibration	channel 1, internal shunt calibration resistor 499 KΩ
Radio frequency (RF) transceiver carrier	2.4 GHz direct sequence spread spectrum, license free worldwide (2.405 to 2.470 GHz) over 14 channels, radiated power programmable from 0dBm (1mW) to 16dBm (39mW); European models limited to 10dBm (10mW)
RF data packet standard	IEEE 802.15.4, open communication architecture
RF data downloading	8 minutes to download full memory
Range for bi-directional RF link	programmable communication range from 70 meters to 2 kilometers
Status LED's	AC power, battery charging, battery charged, node status
Power	internal: 3.7 volt 250mAh lithium ion rechargeable battery; external: +3.2 to +9.0VDC
Power consumption	see power profile
Operating temperature	-20 ˚C to +60 ˚C with standard internal battery and enclosure, extended temperature range optional with custom battery and enclosure, -40 ˚C to +85˚C for electronics only
Maximum acceleration limit	500 g standard (high g option available)
Dimensions	58 mm x 50 mm x 21 mm6 in. x 2.85 in. OD, 1.4 in. ID (for 1.38 in. shaft)
Weight	42 grams1 pound

Parameter	Specification
Enclosure material	ABS plastic
Environmental rating	indoor use only, unless used with housing
ROHS	compliant
Compatible gateways	all WSDA®-Base and WSDA®-1000
Software	SensorCloud™ Node Commander® Windows XP/Vista/7 compatible
Software development kit (SDK)	includes data communications protocol, EEPROM maps and sample code (OS and computing platform independent)
FCC ID	XJQMSLINK0001
IC ID	8505A-MSLINK0001

Table 9 - Operating Specification

11.3 Power Profile

Node power use is highly dependent on the number and type of sensors connected and operational parameters such as sample mode and rate. More active channels and higher sample rates equate to increased power use. Below is an example approximation of the power use of a SG-Link® -LXRS® with different strain gauge sensor configurations over a range of sample rates operating in Synchronized Sampling mode. This chart can be used to approximate external node power source requirements. For SG-Link® -LXRS® internal battery life specifications *see Using the Internal Node Battery on page 63*.

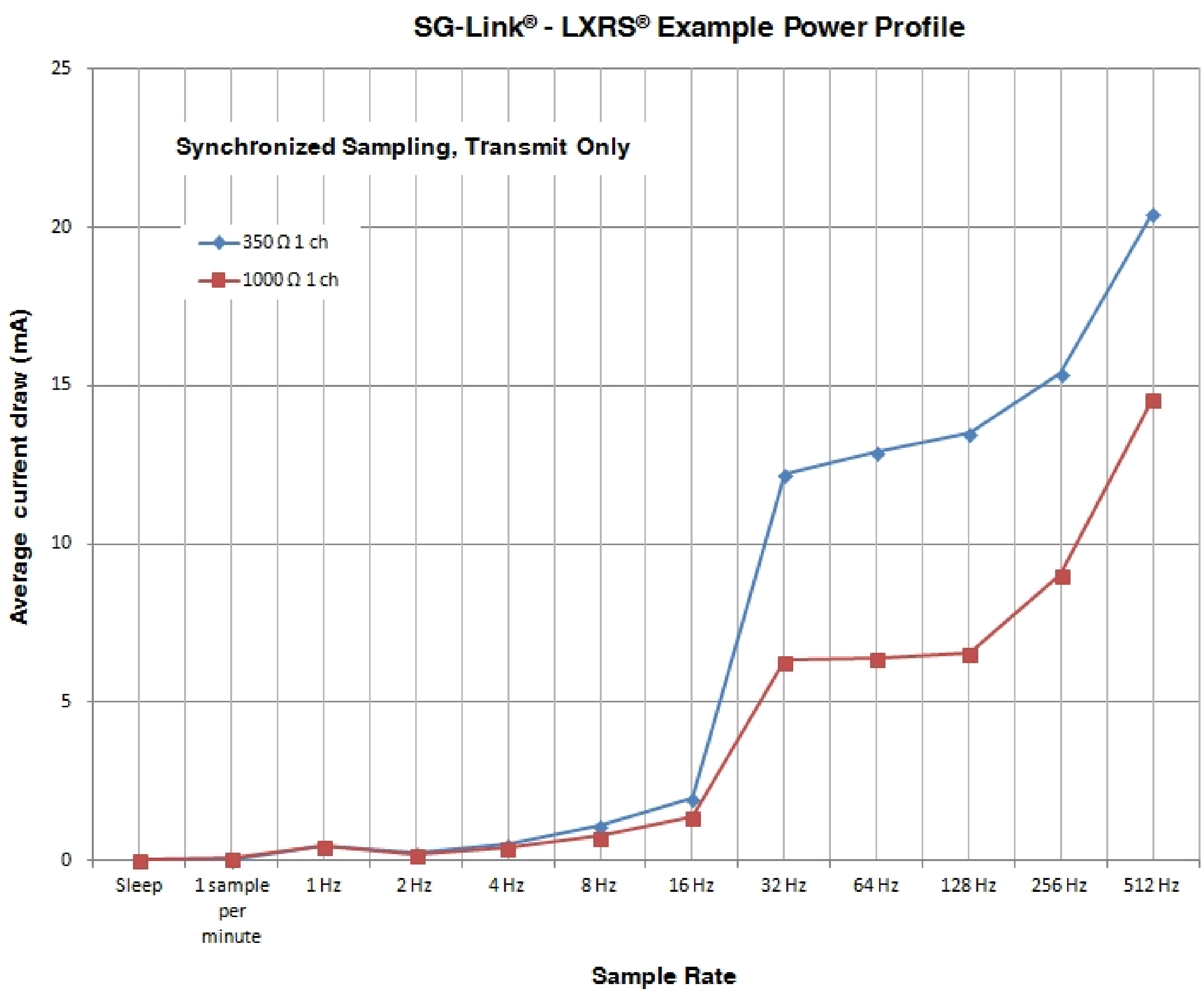


Figure 59 - Example SG-Link® -LXRS® Power Profile

11.4 Radio Specifications

The SG-Link® -LXRS® Wireless Sensor Node employs a 2.4GHz IEEE 802.15.4 compliant radio transceiver for wireless communication. The radio is a direct-sequence spread spectrum radio and can be configured to operate on 14 separate frequencies ranging from 2.405 GHz to 2.480GHz. Following the 802.15.4 standard, these frequencies are aliased as channel 11 through channel 24. For all newly manufactured nodes, the default setting is equivalent to 2.425GHz (channel 15).

For standard models, radiated transmit power is programmable from 0dBm (1mW) to 16dBm (39mW). For European models transmit power is limited to 10dBm (10mW).

The radio complies with ETSI EN 300 328, EN 300 440 Class 2, FCC CFR-47 Part 15 and ARIB STD-T66. The radio is license-free worldwide. Using antennas and transmission equipment other than what is provided with the node may void FCC compliance.

NOTE

- The gateway can automatically manage nodes operating on different frequencies by using the Node Discovery feature in Node Commander®. In this routine, the gateway listens for node broadcasts on the frequency channel it is set to. If the node is in normal boot up mode, it will provide the broadcast when it is initially powered on and broadcast on all channels. As long as the node is powered on after activating the Node Discovery feature, the gateway will link to it and remember the channel setting for future node queries.

- Manually setting the node and gateway frequency channels to match is required in some applications. For example, when sending broadcast messages from the gateway to multiple nodes (including the synchronized sampling beacon), all nodes must be on the same channel as the gateway to receive the broadcast. Assigning channels is also a good idea when multiple gateways are attached to one host computer, or when other wireless equipment is nearby and frequency or transmission interference may occur.

12. Safety Information

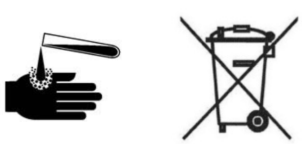
This section provides a summary of general safety precautions that must be understood and applied during operation and maintenance of components in the LORD MicroStrain® Wireless Sensor Network. Throughout the manual, ANSI Z535 standard safety symbols are used to indicate a process or component that requires cautionary measures.

12.1 Battery Hazards

⚠WARNING ⚠CAUTION NOTICE

The SG-Link® -LXRS® Wireless Sensor Node contains an internal, rechargeable Lithium Polymer (Li-Po) battery. Li-Po batteries are a fire and explosion hazard. Do not store or operate the node at temperatures above 212°F (100°C). Do not disassemble, short circuit, crush, puncture, or otherwise misuse the battery.

When recharging the node internal battery, use only the power supply specified for node charging, and follow the instructions. *See Charging the Node Battery on page 64*. Applying a voltage above the input range may result in dangerous battery conditions or cause permanent damage to the node.



Li-Po batteries contain toxic chemicals that are harmful to humans and the environment. Disposal is subject to federal and local laws. Do not discard the battery or the node in the trash. Follow proper battery disposal protocol, or contact LORD MicroStrain® Technical Support for information on extracting the battery or returning the product for proper recycling and disposal.

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12.2 User Configurable Power Settings

The SG-Link® -LXRS® Wireless Sensor Node can be powered by either the internal battery, or an external source. There is user-accessible switch to select the source. The default setting for this switch is for internal battery operation and charging. *See Selecting the Power Source on page 62*.

⚠CAUTION **NOTICE**


Connecting an external power source when the node is set to internal power could result in injury or permanent node damage. For details on how to adjust the switch setting *see Connecting an External Power Supply on page 65*.

- If the node is set to use an external source and the charging power supply is plugged in, it will power the node from the power supply and not charge the battery. It will continue to use the internal battery.
- If the node is set to internal, and an external power supply other than the one used for charging is plugged in, several things could happen. If it is a power supply that is in the operating range of the charging circuit, it may charge the battery. If it is below the range of the charging circuit, nothing will happen. If the applied voltage is above the range of the charging circuit, damage to the node will likely occur and personal injury may result.
- When under battery operation there is a limit to how much current the node can provide to sensors. If the node is in an over current condition it will shut off until the cause is removed. Using an external power source for the node or sensor can mitigate this issue.

13. References

13.1 Related Documents

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

Document	Where to find it
Product Datasheets	http://www.microstrain.com/wireless/sensors
Product Manuals and Technical Notes	http://www.microstrain.com/support/docs
Product Application Notes	http://www.microstrain.com/applications
NIST Calibration Procedures	http://www.nist.gov/calibrations/
ASTM Testing Procedures	http://www.astm.org/Standard/standards-and-publications.html

Table 10 - Related Documents

13.2 Glossary

These terms are in common use throughout the manual:

A/D Value: the digital representation of the analog voltages in an analog to digital (A/D) conversion. The accuracy of the conversion is dependent on the resolution of the system electronics. Higher resolution produces a more accurate conversion.

ASTM: The Association of Standards and Testing is a nationally-accepted organization for the testing and calibration of technological devices

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".

Bits: the digital equivalent of voltage on the node

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

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

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

Cycle Power: a command transmitted to the node to re-boot 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.

Differential (signal): is a method of transmitting electrical signals in which they are paired together as a differential pair and measured with reference to each other only. This method makes the pair less susceptible to electrical noise.

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

Firmware: the code that is programmed onto a microcontroller or similar device in an embedded system that 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 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 they are in view of each other with no obstructions.

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

NIST: The National Institute of Standards and Testing is a nationally-accepted organization for testing and calibration of technological devices.

Node: The node is the wireless transceiver that the sensor(s) are connected to, providing communication with the gateway. The G-Link® -LXRS®, V-Link® -LXRS®, and SG-Link® -LXRS® are all 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 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.

Ping: A byte is transmitted by the gateway to the node, and the node responds by echoing the byte, indicating communication exists between them.

PGA: A Programmable Gain Amplifier is an electronic device used to amplify small electrical signals.

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

Read/Write EEPROM: commands transmitted to the node to read or write parameters stored in the node's operating system

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

Resolution: in digital systems, the resolution is the number of bits or values available to represent analog values or information. For example, a 12-bit system has 4096 bits of resolution and a 16-bit system has 65536 bits.

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. The units are decibels per meter (dBm).

RS232: a serial data communications protocol

Sensor: a device that physically or chemically reacts to environmental forces and conditions and produces a predictable electrical signal as a result

Sleep: a command transmitted to the node to set a node 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

Single Ended: electrical signals that are measured with reference to a system ground

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 data acquired 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 (continue until the power is cycled on the node).

USB: Universal Serial Bus, a serial data communications protocol

Wheatstone Bridge: an electrical circuit used to measure unknown electrical resistances

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