

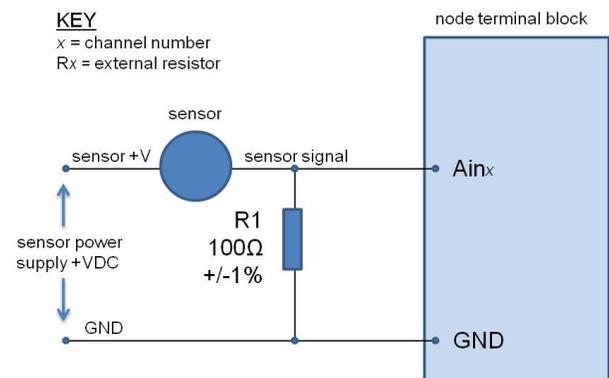
## Measuring Current with Analog Input Nodes Using a V-Link<sup>®</sup> -LXRS<sup>®</sup> or SG-Link<sup>®</sup> -LXRS<sup>®</sup> with 4 to 20 mA Sensors

### OVERVIEW

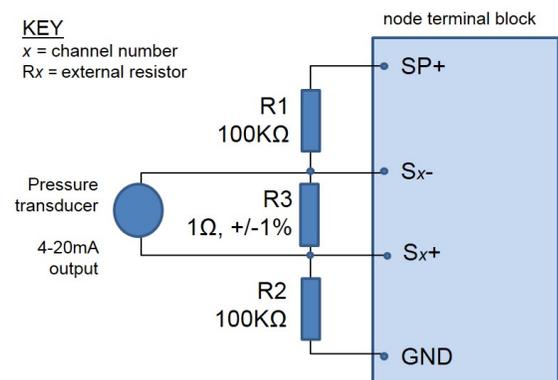
LORD MicroStrain<sup>®</sup> wireless sensor nodes with analog inputs, such as the V-Link<sup>®</sup> -LXRS<sup>®</sup> and SG-Link<sup>®</sup> -LXRS<sup>®</sup>, can be used to measure sensors with small current outputs such as 4 to 20mA sensors. Any node with single-ended or differential analog inputs can be used in this way by adding a precision sampling resistor across the input. This technical note describes design considerations and provides an example application using the V-Link<sup>®</sup> -LXRS<sup>®</sup> with a 4 to 20 mA pressure transducer.

### DESIGN CONSIDERATIONS

- Node Channel and Sensor Output Range:** Either the single-channel or differential analog input channel can be used to measure current. The single-ended option is simpler and allows less adjustment. For applications in which very small currents will be measured, the differential inputs offer better noise immunity and programmable gain settings. Available gain settings vary between node models.
- Node Resolution:** The node will have 12-bit or 16-bit resolution, depending on the model. For nodes with higher resolution, the single-ended input may be sufficient to get the desired output accuracy. For lower resolution nodes, using a differential input with gain may increase output accuracy by scaling across the input range of the node.
- Power Source:** If the sensor will be operating continuously in the 20mA range, or if multiple analogs are in use, it is recommended that an external source be used to power the sensor or the node. Typically nodes can only supply 50mA (to all sensors), so 20mA would be a significant portion of the node capacity and would drain the internal battery quickly. However for applications with lower current requirements and measurement ranges, the internal battery may be a better option to mitigate potential noise sources, especially when using differential channels.



**Figure 1 - Current Measurement with a Single-Ended Input and External Source**



**Figure 2 - Current Measurements with a Differential Input and Internal Source**

**EXAMPLE:**

**Using the V-Link® -LXRS® for 4 to 20 mA Measurements on a Differential Input Channel**

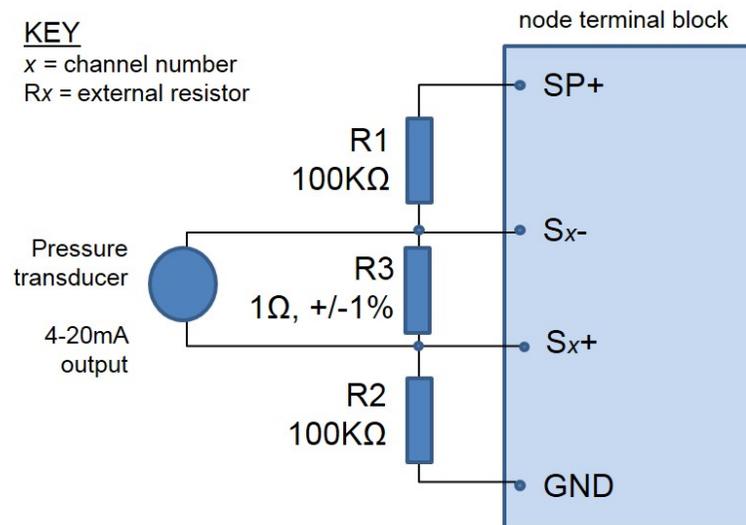
This example uses the V-Link® -LXRS® node and a 4-20 mA pressure transducer. Node Commander is used for configuration and data acquisition. Sensor excitation is provided by the internal battery to provide better noise immunity.

**1. Connect the Sensor**

**NOTE**

Differential inputs can be factory-configured for various bridge completion and impedance values. For this application, the standard full-bridge configuration is assumed. For other configurations contact LORD MicroStrain Technical Support.

- a. Connect the pressure transducer to a differential analog input, as shown in [Figure 3 - Small Current Measurements for Differential Inputs](#). Use resistors with tolerances of < 1% or with measured values within 1% of each other (in the case of R1 and R2) to ensure measurement accuracy.
- b. Measure and record the actual value of R3.



**Figure 3 - Small Current Measurements for Differential Inputs**

## 2. Configure and Balance the Node Input

- a. Establish communication with the node using Node Commander<sup>®</sup>.
- b. Open the configuration menu for the channel to which the sensor is connected, and use the following settings (*Figure 4 - Channel Configuration Menu*). The conversion coefficients are the units in which the measurements will be displayed. For this step the units are set to A/D bits. The hardware gain and auto-balance settings are determined by the anticipated output range of the sensor, and the node input voltage range (typically 0 to 3 Vdc). In this example, the expected maximum output of the sensor is 20 mA. Using Ohms Law across the sampling resistor, the maximum output voltage can be determined ( $20 \text{ mA} * 1\Omega = 20 \text{ mV dc}$ ). Selecting the +/- 20 mV [75] input range setting provides a 40 mV window for the sensor measurements, which effectively scales the sensor output to the node input (maximizing resolution) but does not come close to exceeding the input limits. Additionally, setting Auto-Balance to low offsets the no-current output at the low end on the node input range, which is appropriate for positive going measurements. For more information and examples on selecting these settings, refer to the node's user manual.

**Conversion Coefficients, Units: A/D**

**Conversion Coefficients, Class: bits**

**PGA Settings, Input Range: +/-20 m [75]**

**Auto-Balance Setting: Low**

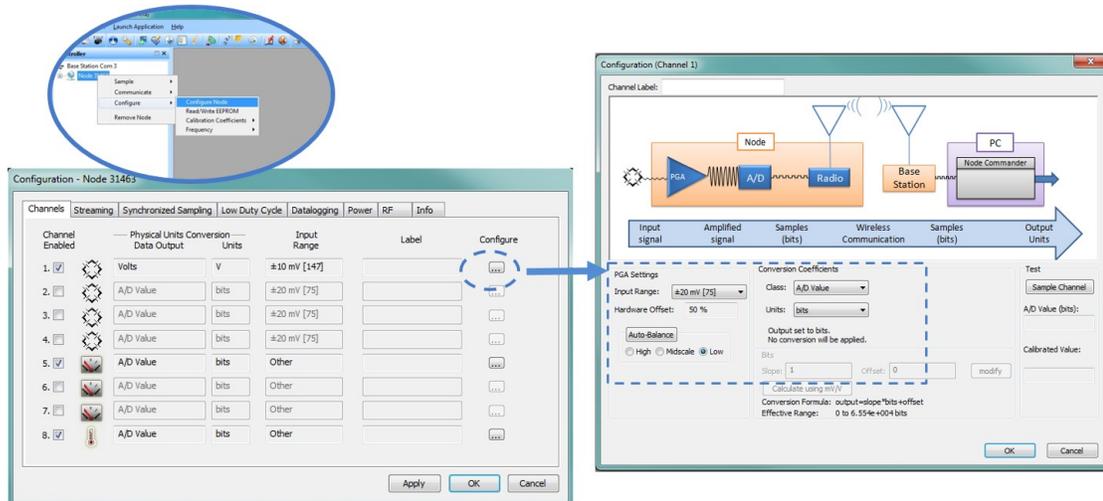
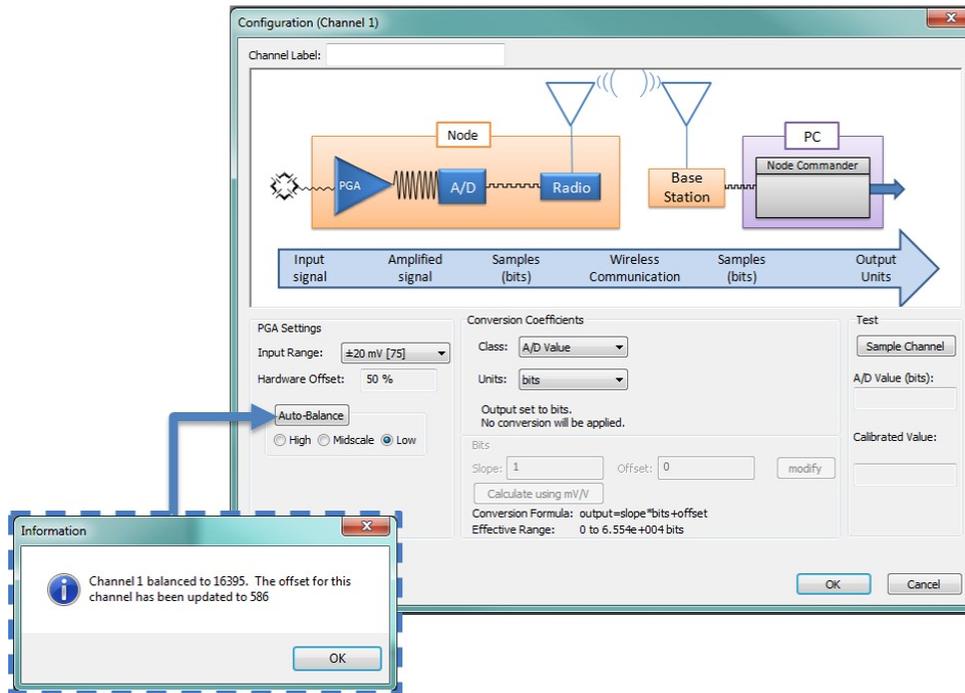


Figure 4 - Channel Configuration Menu

- c. Setup the node to tare the zero-current output value by shorting the channel inputs (S+ to S-) with a jumper. Leave the jumper in place.
- d. Select the Auto Balance button ([Figure 5 - Channel Settings](#)). An information window will appear indicating the channel has been auto-balanced. In this example, the auto-balance and offset value (16395 and 586, respectively) are typical for a 16-bit node set to the low end of the input scale. A 12-bit node would be ~1024 with a similar offset.
- e. Record the offset value.
- f. Click OK, and the window will disappear.



**Figure 5 - Channel Settings**

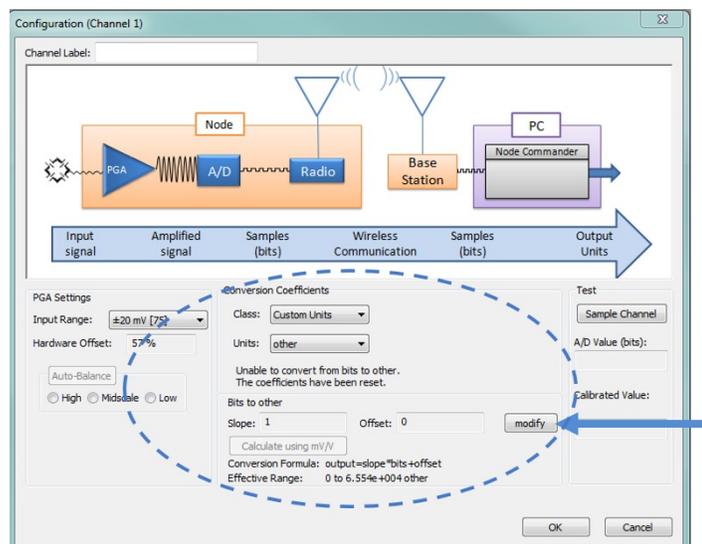
### 3. Determine Conversion Values

- a. For each gain setting on the V-Link<sup>®</sup> -LXRS<sup>®</sup> differential input channels there is a corresponding mV/bit relationship ([Table 1 - V-Link<sup>®</sup> -LXRS<sup>®</sup> Slope Values for Gain Setting](#)). Find the appropriate slope value from the table, and divide it by the sampling resistor value to get mA/bit. In this example  $0.0006104 \text{ mV/bit} / 1\Omega = 0.0006104 \text{ mA/bit}$ .
- b. Calculate the offset by multiplying the record bit value from the Auto-Balance routine by the slope value, in mA/bit. In this example,  $0.0006104 \text{ mA/bit} * 586 \text{ bits} = 0.3576944 \text{ mA offset}$ .

Gain	Input range	Slope (12-bit)	Slope (16-bit)
21	+/- 70 mV	0.0348772 mV/bit	0.0021798 mV/bit
30	+/- 50 mV	0.0244141 mV/bit	0.0015259 mV/bit
75	+/- 20 mV	0.0097656 mV/bit	0.0006104 mV/bit
147	+/- 10 mV	0.0049825 mV/bit	0.0003114 mV/bit
291	+/- 5 mV	0.0025169 mV/bit	0.0001573 mV/bit
569	+/- 2.5 mV	0.0012872 mV/bit	0.0000805 mV/bit
1214	+/- 1 mV	0.0006033 mV/bit	0.0000377 mV/bit
2222	+/- 600 uV	0.0003296 mV/bit	0.0000206 mV/bit
3799	+/- 350 uV	0.0001928 mV/bit	0.0000120 mV/bit
13074	+/- 100 uV	0.0000560 mV/bit	0.0000035 mV/bit

**Table 1 - V-Link® -LXRS® Slope Values for Gain Setting**

- c. In the channel configuration screen set the conversion coefficients to Custom Units and Other, and then select the Modify button to enter the calculated slope and offset values (*Figure 6 - Entering Conversion Values*).
- d. Select Lock to save these values. Exit the channel configuration screen.
- e. Remove the jumper on channel inputs S+ to S- and begin sampling as normal. With no load applied to the sensor the output should read 4 mA since that is the low end of the sensor range.



**Figure 6 - Entering Conversion Values**