User Manual
Version 1.0.3

SG-Link® OEM
Wireless Strain Node

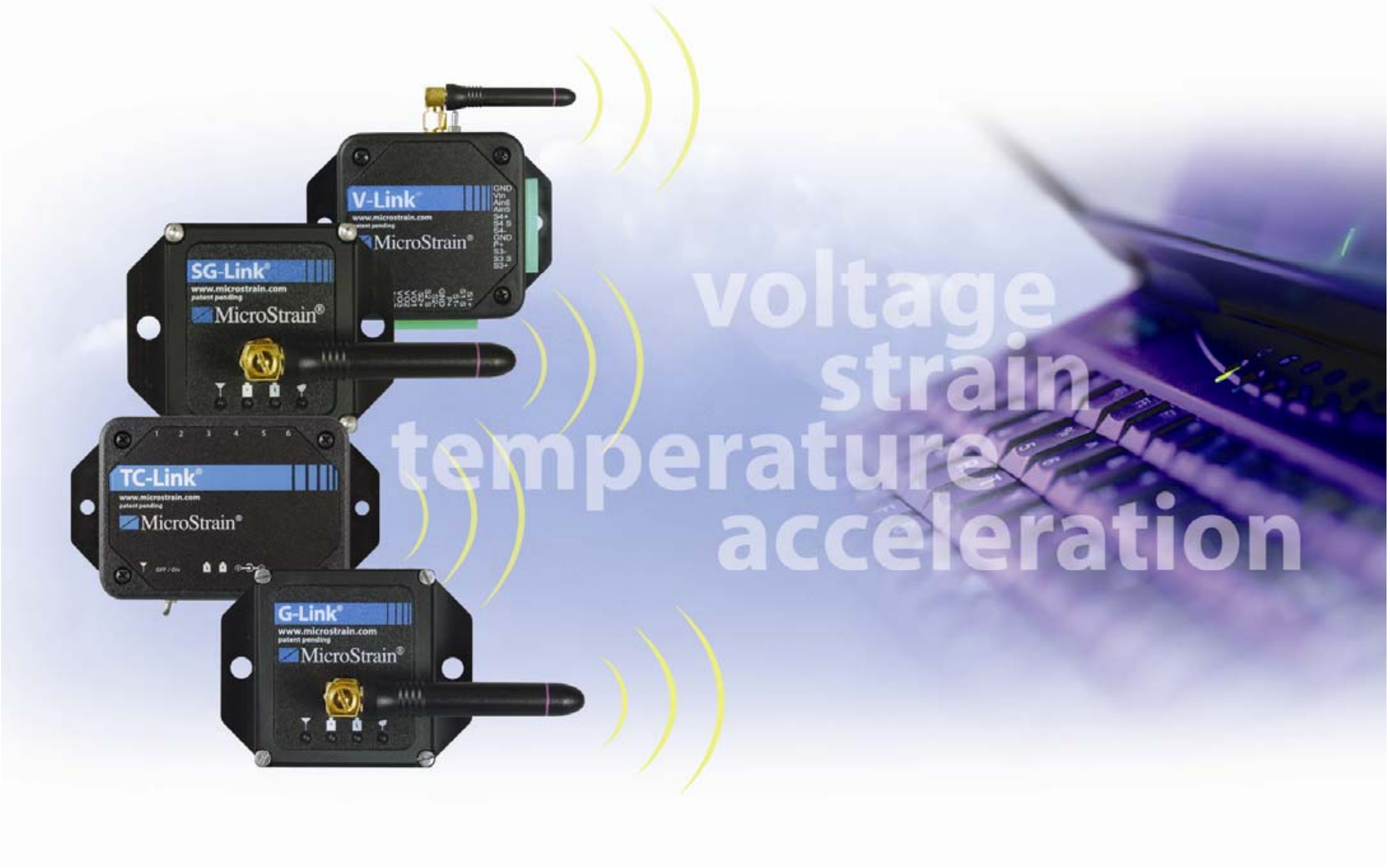
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Table of Contents

WELCOME **5**

SUPPORTED FIRMWARE AND SOFTWARE VERSIONS .ERROR! BOOKMARK NOT DEFINED.

GUIDE TO RELEVANT DOCUMENTS ....ERROR! BOOKMARK NOT DEFINED.

OVERVIEW **6**

INSTALLATION **7**

STARTER KITS, MODULES AND OPTIONS ....ERROR! BOOKMARK NOT DEFINED.

COMMON TERMS **7**

OPERATION.. **9**

BASE STATIONS **13**

- USB BASE STATION ....**ERROR! BOOKMARK NOT DEFINED.**
- ANALOG BASE STATION....................**ERROR! BOOKMARK NOT DEFINED.**
- SERIAL BASE STATION ....**ERROR! BOOKMARK NOT DEFINED.**

DIFFERENTIAL INPUT CHANNEL.. **13**

- CONNECTING A QUARTER BRIDGE STRAIN GAUGE 15
- CONNECTING A HALF BRIDGE STRAIN GAUGE 16
- CONNECTING A FULL BRIDGE STRAIN GAUGE 17
- PROGRAMMABLE GAIN 18

SINGLE ENDED INPUT CHANNEL.. **19**

TEMPERATURE SENSOR.. **21**

TERMINAL STRIP **22**

DEVICE STATUS LED.. **23**

RADIO AND ANTENNA **24**

NODE ADDRESSING **25**

SAMPLE DURATION CALCULATIONS.. **26**

TIME STAMPING.. **27**

POWER.. **28**

POWER PROFILE **28**

STANDARD PACKAGING.. **29**

OPERATING TEMPERATURE.. **30**

SAMPLING RATES **31**

- DATALOGGING 31
- STREAMING 31
- LOW DUTY CYCLE 31
- HIGH SPEED STREAMING.. 32

DATALOGGING MEMORY **33**

FACTORY CALIBRATION AND TESTING.. **34**

- CALIBRATION 34
- TESTING 34

GENERAL SPECIFICATIONS 35

MECHANICAL DRAWING 37

ELECTRICAL BLOCK DIAGRAM 38

SOFTWARE 39

STANDARD OFFERING 39
SYSTEM REQUIREMENTS 39
SOFTWARE INSTALLATION 39
DATA COMMUNICATIONS PROTOCOL 39

FCC (UNITED STATES) CERTIFICATION 41

LABELING REQUIREMENTS 41
FCC-APPROVED ANTENNAS 41

IC (INDUSTRY CANADA) CERTIFICATION 43

TRANSMITTER ANTENNAS 43

SUPPORT 44

OVERVIEW 44
WEB 44
EMAIL 44
TELEPHONE 44
SKYPE 44
RMA 45
30 DAY RETURN POLICY 46

TERMS AND CONDITIONS 47

APPENDIX 1: HOST-TO-BASE STATION COMMUNICATION 53

RS-232 53
USB 2.0 53

APPENDIX 2: DATALOGGING WITH AGILE-LINK™ SOFTWARE 54

APPENDIX 3: STREAMING WITH AGILE-LINK™ SOFTWARE 56

APPENDIX 4: LOW DUTY CYCLE WITH AGILE-LINK™ SOFTWARE 58

APPENDIX 5: HIGH SPEED STREAMING WITH HIGH SPEED STREAMING SOFTWARE ... 64

APPENDIX 6: BRIDGE COMPLETION RESISTORS..........ERROR! BOOKMARK NOT DEFINED.

Welcome

Steve Arms, President and CEO

Welcome to MicroStrain! We make tiny sensors that are used in a wide range of applications, including knee implants, civil structures, advanced manufacturing, unmanned military vehicles, and automobile engines. Our sensors have won numerous awards and we pride ourselves on being both innovative and responsive to our customer's unique requirements.

MicroStrain is based in Williston, Vermont and is a privately held corporation. Founded in 1987, our early development focused on producing micro-displacement sensors for strain measurement in biomechanics research applications. Our first sensors were designed for arthroscopic implantation on human knee ligaments; since then, we expanded our product line through continual product improvement.

We introduced a broader line of micro-displacement sensors that could withstand extreme temperatures, hundreds of millions of cycles, and complete submersion in saline. The aerospace and automotive industry found our sensing systems met their requirements and we've worked on many groundbreaking projects.

As our customer base expanded, we continued to innovate by combining multiple sensors along with advanced micro controllers to enhance system performance. We were one of the first sensor companies to add wireless capability so that low power, miniature digital sensors could communicate easily with personal computers and send data to the internet.

Our inclinometer product line was initially developed to measure angles of limbs to help re-animate the limbs of paralyzed individuals. The tiny, lightweight gyro-enhanced orientation modules that resulted from this effort found immediate acceptance for navigation & control of unmanned systems in military and exploratory robotics applications.

Sensors are literally changing our world; we're inspired to work with our customers to introduce advanced sensing technology that will enable the next generation of smarter and safer machines, civil structures, and implanted devices.

Thank you for purchasing a MicroStrain sensor!

Overview

The SG-Link® OEM is a wireless strain node and is a specialized member of MicroStrain's Agile-Link™ wireless data acquisition system. The Agile-Link™ system comprises 3 main components: 1) wireless sensor nodes which acquire and transmit strain, voltage, temperature, acceleration and/or other sensor data, 2) base stations which receive and pass the data to a host, and 3) software which operates the system.

The SG-Link® OEM provides two external measurement channels, being 1) a differential input channel (strain channel) primarily designed to support strain gauges of 350 ohm resistance or greater, and 2) a single ended input channel (analog channel) designed to support 0-3 volt sensors. The combination of the two measurement channels supports a wide range of Wheatstone bridge type and analog sensors including strain gauges, displacement sensors, load cells, torque transducers, pressure sensors, accelerometers, geophones, temperature sensors and inclinometers. The SG-Link® OEM also has an on-board temperature sensor.

SG-Link® OEM
MicroStrain®
www.microstrain.com
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3036-7020
Rev003

The SG-Link® OEM employs a 12 bit A/D converter to digitize the voltage on the differential input, single ended input and temperature channels. The digital data is passed to the on-board microprocessor, processed with the embedded algorithm, and in turn either passed to its radio for immediate transmission or saved to the 2MB on-board flash memory for later download.

Host computer software displays the data, provides analysis tools, records the data to file and allows the user to configure and actuate the system. The SG-Link® OEM may also be used with MicroStrain's Analog base station for stand-alone applications.

The SG-Link® OEM may be remotely deployed up to 70 meters (line-of-sight) from its base station.

Multiple SG-Link® OEMs may be deployed around a single base station, each transmitting its data to the base station coincidentally, with the data being passed on to the software for aggregation.

Common Terms

These terms are in common use throughout the manual:

- **Address:** Each node has a unique address from 1 to 65534 which identifies the node to the base station and software.
- **Base Station:** The transceiver base station attaches to your host computer and provides communication between the software and the node(s).
- **Bits:** The digital equivalent of voltage on the node. The node excites all sensor circuits with +3 Volts. The return from the sensor is 0 to 4096 bits representing 0 to 3 volts.
- **Broadcast:** Any of a number of commands (trigger, sleep, erase, etc.) transmitted at the same instant to multiple nodes.
- **Browse Triggers:** The software action whereby one can display and analyze the datalogging sessions in CSV format.
- **Channel Actions:** Coefficients contained on-board the node to instruct the host software to scale engineering units.
- **Configuration:** A general term applied to the node indicating the streaming or datalogging environment. The number of active channels, sampling rate, offset, hardware gain, etc. are all components of a node’s configuration.
- **Continuous:** A term used to describe a sampling session (datalogging, streaming, LDC, HSS) where the time length of the session is undefined.
- **Cycle Power:** A command transmitted to the node to re-boot the node.
- **Datalogging:** Datalogging is a node action whereby all active channels (and the sensors attached to them) are sampled and the data acquired is written to non-volatile memory on-board the node. The data is not transmitted to the base station and software during datalogging. Datalogging can either be finite (have a user defined start and end time) or continuous (continue until all datalogging memory is consumed).
- **Download:** Download is the node action whereby the node transmits all of its datalogging data to the base station and software for file saving.
- **Erase:** A command transmitted to the node to erase all datalogging sessions.
- **Finite:** A term used to describe a sampling session (datalogging, streaming, LDC, HSS) where the time length of the session is defined.
- **High Speed Streaming: High Speed Streaming** (HSS) is a node action whereby all active channels (and the sensors attached to them) are sampled and the data acquired is transmitted to the base station and software. The data is not written to non-volatile memory during HSS. HSS can either be finite (have a user defined start and end time) or continuous (continue until the power is cycled on the node). It differs from Streaming in that it offers faster data rates.
- **Low Duty Cycle:** Low Duty Cycle (LDC) is a node action whereby all active channels (and the sensors attached to them) are sampled and the data acquired is “blipped” to the base station and software. The data is not written to non-volatile

memory during LDC. LDC can either be finite (have a user defined start and end time) or continuous (continue until the power is cycled on the node).

- **Node:** The node is the wireless transceiver that carries the sensors and provides communication with the base station. The G-Link®, V-Link®, SG-Link® and TC-Link® are all nodes.
- **Ping:** A byte is transmitted by the base station to a particular node and the node responds by echoing the byte indicating communication exists between the base station and the node.
- **Plugins:** Software 'wizards' which aid in the configuration of the node's sensors.
- **Range Test:** A continuous string of pings used to validate communication between the base station 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.
- **SEDT:** Sensor Event Driven Trigger is a method whereby a ceiling or floor output threshold can be set in the node to automatically trigger datalogging.
- **Sleep:** A command transmitted to the node to set a node into sleep configuration.
- **Streaming:** Streaming is a node action whereby all active channels (and the sensors attached to them) are sampled and the data acquired is transmitted to the base station 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).
- **Sweep Rate:** A node setting which determines the number of times all active channels are sampled during a finite sampling session.
- **Trigger:** A command transmitted to the node to begin a datalogging session.
- **Wake:** A command transmitted to the node to recover a node in sleep configuration.

Operation

Let’s discuss the operation of the SG-Link® OEM and base station in conjunction with the Agile-Link™ host software.

The SG-Link® OEM has a differential input channel (strain channel), a single ended input channel (analog channel) and an on-board temperature sensor channel. The SG-Link® OEM samples these three channels using four different selectable methods. The data is either stored temporarily on-board the SG-Link® OEM or immediately transmitted to a base station, depending on the sampling method. The base station is read by the host software as data is received, and the host software displays and/or saves the data to file.

The differential input is assigned to channel 1, the single ended input is assigned to channel 4, and the on-board temperature sensor is assigned to channel 3. Channel 2 is also in place and reserved for future use; it has no use currently and should be kept inactive. The differential channel with its connected sensor is excited with 3 volts and the resultant is first passed through a 2-stage amplification (being a fixed instrumentation amplifier and a user programmable gain amplifier with programmable offset, on through an anti-aliasing filter (3dB down @ 500 Hz; low pass filters with cutoff @ 500 Hz), and into the 12 bit A-to-D converter. The single ended input with its connected sensor and the temperature sensor are excited with 3 volts and feed directly into the 12 bit A-to-D converter. The 12 bit A-to-D converter sends the 3 channels to the microprocessor. The firmware in the microprocessor processes the digital sampling into raw data and, depending on the sampling method selected, either writes the data as it is captured to the flash memory or sends the data through the serial communication interface to the radio transceiver. The transceiver in turn transmits the data to any listening base station.

Please refer to the *Electrical Block Diagram* section of this manual for a visual representation of the SG-Link® OEM, base station and host software operation. Please refer to the *Differential Input Channel* and *Single Ended Input Channel* sections of this manual for an in-depth discussion of their use and operation.

In the **DATALOGGING** sampling method, the SG-Link® OEM may be configured to sample data as fast as 2048 samples per channel per second to as slow as 32 samples per channel per second. Datalogging can be finite or continuous. In finite datalogging, a sampling duration is set and the datalogging session will last the duration once initiated. The data will be written to the memory on-board the SG-Link® OEM during the session. In continuous datalogging, the one session will last until the memory is full. Multiple finite datalogging sessions may be conducted with the SG-Link® OEM before its memory is full. No data is transmitted over the air to the base station during datalogging. When datalogging is completed (one or more sessions), the software provides for the data to be downloaded from the SG-Link® OEM through the base station. The software parses the data into CSV formatted files for further analysis.

In the **STREAMING** sampling method, the SG-Link® OEM sampling rate is directly dependent on the number of sensor channels which are active. With 1 channel active, the channel will be sampled at a rate of 736 samples per second; with 4 channels active, each channel will be sampled at a rate of 565 samples per second. Streaming duration can be finite or continuous. In finite streaming, a sampling duration is set and the streaming session will last the duration once initiated. In continuous streaming, the streaming session will last until the host software stops the session or the power is cycled on the SG-Link® OEM. The data is transmitted over the air to the base station during streaming; no data is written to the on-board memory during the session. During streaming, the software receives the data from the base station, parses, caches and displays the data and provides for the data to be saved into CSV formatted files for further analysis. Please note that the Analog base station will support streaming through its analog backplane; see the *Base Station* manual for details.

In the **LOW DATA DUTY** sampling method, the SG-Link® OEM may be configured to sample data as fast as 500 samples per channel per second to as slow as 1 sample per channel per hour. Low Duty Cycle can be finite or continuous. In finite low duty cycle, a sampling duration is set and the low duty cycle session will last the duration once initiated. In continuous low duty cycle, the low duty cycle session will last until the host software stops the session or the power is cycled on the SG-Link® OEM. The data is transmitted over the air to the base station during low duty cycle; no data is written to the on-board memory during the session. During low duty cycle, the software receives the data from the base station, parses, caches and displays the data and provides for the data to be saved into CSV formatted files for further analysis. Please note that the Analog base station will support streaming through its analog backplane; see the *Base Station* manual for details.

In the **HIGH SPEED STREAMING** sampling method, the SG-Link® OEM sampling rate is directly dependent on the number of sensor channels which are active. With 1 channel active, the channel will be sampled at the rate of 4000 samples per second; with 4 channels active, each channel will be sampled at the rate of 1000 samples per second. High Speed Streaming can be finite or continuous. In finite high speed streaming, a sampling duration is set and the high speed streaming session will last the duration once initiated. In continuous high speed streaming, the high speed streaming session will last until the host software stops the session or the power is cycled on the SG-Link® OEM. The data is transmitted over the air to the base station during high speed streaming; no data is written to the on-board memory during the session. During high speed streaming, the software receives the data from the base station, parses, caches and displays the data and provides for the data to be saved into CSV formatted files for further analysis.

Please review the *Sampling Rates* section of this manual for datalogging, streaming, low duty cycle and high speed streaming sampling rate details.

Multiple SG-Link® OEMs (nodes) and/or base stations may be operated at the same time depending on the sampling method in use.

In the **Datalogging** sampling method, you may trigger a datalogging session on any number of SG-Link® OEMs at the same instant by broadcasting a datalogging command from one base station to all the nodes. In this case, all nodes and the base station operate on the same frequency. All nodes would receive the command and independently perform their datalogging session. Each node would be downloaded separately.

In the **Streaming** sampling method, you may trigger a streaming session on up to 16 SG-Link® OEMs at the same instant by broadcasting a streaming command from multiple base stations to each base station's corresponding node. In this case, a base station would be deployed for each node and each pair would be set to a separate frequency so as not to conflict with other pairs. All nodes would receive the command and independently stream their data to the paired base station. Agile-Link™ software is capable of handling up to 4 node/base station pairs; application developers would be able to operate up to 16 pairs in this fashion. This limit of 16 results from the number of available frequencies within the band spectrum of the SG-Link® OEM radio.

In the **Low Duty Cycle** sampling method, multiple SG-Link® OEMs can share the same frequency since each node is not transmitting continuously. You may start a low duty cycle session on any number of SG-Link® OEMs at the same instant by broadcasting a low duty cycle command from one base station to all the nodes. All nodes receive the command and independently begin transmitting their low duty cycle data. The base station receives the data from all the nodes and passes it on to the host software.

It should be noted here that when using multiple nodes with one base station in low duty cycle mode, the total number of nodes that can be simultaneously sampled is dependent on the number of active channels and the sampling rate. As the number of active channels increases and/or sampling rates increase, the total number of nodes that can be sampled falls. Likewise, as the number of active channels decreases and/or sampling rates decrease, the total number of nodes that can be sampled increases.

In the **High Speed Streaming** sampling method, you may trigger a high speed streaming session on up to 16 SG-Link® OEMs at the same instant by broadcasting a high speed streaming command from multiple base stations to each base station's corresponding node. In this case, a base station would be deployed for each node and each pair would be set to a separate frequency so as not to conflict with other pairs. All nodes would receive the command and independently stream their data to the paired base station. MicroStrain's High Speed Streaming software is capable of handling only 1 node/base station pair; application developers would be able to operate up to 16 pairs in this fashion. This limit of 16 results from the number of available frequencies within the band frequency of the SG-Link® OEM radio.

The analog base station has an additional feature relating to sampling methods. It normally is configured to support up to 8 channels of data from a single node. However, it may be configured to support up to 8 nodes, that is to say, it may be configured to handle one channel of data from up to 8 individual SG-Link® OEM s. Please refer to the

Agile-Link™ Base Station manual which is contained on the Agile-Link™ CD and on our web site for detailed instructions on its use with SG-Link® OEM .

The SG-Link® OEM has an additional datalogging feature which we describe as **Sensor Event Driven Trigger (SEDT)**. In SEDT, the SG-Link® OEM may be configured to commence datalogging automatically each time a “ceiling” or “floor” sensor output is met. For example, you may set the SG-Link® OEM so that a datalogging session is triggered whenever channel 1 (the differential input channel) exceeds (goes through the ceiling of) 40 microstrain. The session will begin automatically, run its finite duration and stop. With the next 40 microstrain ceiling event, the SG-Link® OEM would again run a datalogging session automatically without manual intervention.

When the SG-Link® OEM is not sampling, it can be in one of two states: Sleep or idle. In Sleep mode, the SG-Link® OEM, on a settable interval (by default 5 seconds), momentarily awakens and listens for any commands. If a command is heard, it wakes and responds to the command; if no command is heard, it goes back to sleep. This sleep function is used to conserve battery power. In idle mode, the SG-Link® OEM is awake and listening for commands from a base station.

Several configuration/operational/test functions exist for the SG-Link® OEM; some of the more often used functions are listed below.

- A **Verify** will test whether the base station and software are communicating successfully.
- A **Ping** will test whether a single byte transmission from the base station to the node is successful.
- A **Range Test** will test whether communication is being maintained over a period of time between the base station and the node.
- A **Cycle Power** will have the effect of manually cycling the power on the node.
- **Node Discovery** allows the base station to detect any node on any frequency as it is powered on.
- **Load Node Information** reads and displays the model, serial number, firmware version and other statistics of the node.
- **Frequency** allows reading and setting of the channel on which the node is operating.
- **Read/Write EEPROM** allows direct reading and setting of parameters maintained in EEPROM.

Please see the Agile-Link™ software manual for more information on software accessible features of the SG-Link® OEM.

Differential Input Channel

The SG-Link® OEM has one differential input channel. This channel is designed to accommodate strain gauges with 350 ohm resistance or greater. The SG-Link® OEM by default is configured to support a full Wheatstone bridge installation. The SG-Link® OEM can also be ordered from the factory configured to support half and quarter bridge installations. It is important to know how your SG-Link® OEM has been configured before proceeding with use. You may wish to check your invoice or you may inspect the circuit board assembly for factory-applied completion resistors. The location of these completion resistors are described in Appendix 6 of this manual.

The SG-Link® OEM powers the differential input channel with +3 volts DC at up to 50 mA for bridge excitation. A special feature of the excitation is that it will revert to a ‘pulsed’ mode when sampling rates are below 100 Hz in order to conserve power. Programmable gain is user-adjustable and allows the bridge circuit to be amplified to suit the characteristics of the particular strain gauges in use; this gain can be set from 20 to 2560 (See *Programmable Gain* section of this manual for more details). Programmable offset is also user-adjustable and allows for the ‘zeroing’ of strain gauge output. Strain gauge bridges can have significant offset due to a number of factors including initial ohmic error in the gauge itself, installation of the gauge on a non-flat surface, initial offset error in the electronics, and small errors in the bridge completion resistors. Details of programmable gain and offset use may be found in the Agile-Link™ software manual. Further conditioning (noise reduction) is provided by an anti-aliasing filter (- 3dB down @ 500 Hz; low pass filters with cutoff @ 500 Hz).

The SG-Link® OEM differential input channel additionally contains a precision 499 Kohm (499000 ohm) resistor shunt resistor. This resistor is employed by Agile-Link™ software to perform a precise shunt calibration of the SG-Link® OEM and the Wheatstone bridge installation. Alternatively, users may either use Agile-Link™ software to perform a shunt calibration using an external precision resistor, or perform a shunt calibration using a method of their own design.

The 3 volt signal is digitized by the SG-Link® OEM’s 12-bit A/D converter, creating a 0 to 4096 ‘bit’ digital range. As explained elsewhere, the Agile-Link™ system operates digitally by resolving all sensor voltages to ‘bits’, transmitting the bits by radio to the base station, carrying the bits into host software, and finally returning these bits to volts at the software level. Agile-Link™ software further provides an on-board function (Strain Wizard) which allows engineering units (microstrain) to be output and displayed directly from the software. Please refer to the Strain Wizard Help in the Agile-Link™ software for detailed use.

In the pages following you will find wiring diagrams which detail the specifics for installing quarter, half and full bridges. Please also refer to the *Terminal Strip* section for other important details and practice.

A great way to become familiar with your new equipment is to take 15 minutes and connect your SG-Link® OEM to the SG-Link® Tester Board. The SG-Link® Tester Board, a precision instrument designed and manufactured by MicroStrain, incorporates a selectable bridge configuration (full, half, quarter) coupled with a precision shunt resistor to test the differential input channel and a 0-3 volt photocell to test the single ended input channel. Each starter kit is shipped with a Tester Board and a detailed Tester Board Quick Start Guide.

A word of caution: Strain gauges with resistance below 350 ohm, in particular 120 ohm gauges, may be used with SG-Link® OEM, although they are not recommended. The nature of 120 ohm gauges is such that temperature is a critical factor in their performance and the user should be aware of the effects of temperature on the measurements derived.

Finally, the science and use of strain gauges is a large subject. MicroStrain sales and support are always available to discuss your particular requirements.

Connecting a quarter bridge strain gauge

This example assumes the SG-Link® OEM is configured with the optional internal **quarter** bridge completion resistors. If not, the completion of the bridge (shown as internal circuitry) must be completed externally. The three wire arrangement is recommended in order to cancel thermal effects of the lead wire resistance (RL). It is strongly recommended that shielded wiring be used, as this can significantly reduce system noise. Please note that the shield of each cable must be grounded at one location only, to prevent the occurrence of ground loops. Shielded wiring can be purchased from Alphawire (part number 1122, www.alphawire.com); a sample is included with each starter kit.

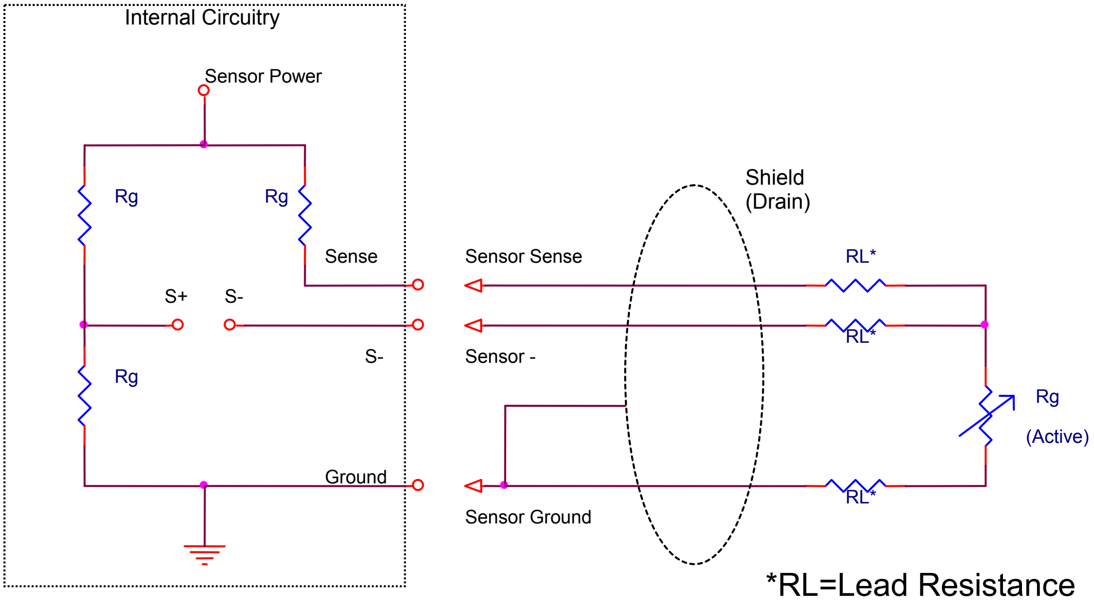

Internal Circuitry
Sensor Power
Rg
Rg
Sense
S+
S-
S-
Rg
Ground
Shield
(Drain)
Sensor Sense
Sensor -
Sensor Ground
RL*
RL*
RL*
Rg
(Active)
*RL=Lead Resistance

Figure 2

Sensor-	Sensor Sense	Ground Pin
S+ (Pin 2)	Sense (Pin 5)	GND (Pin 4)

Table 4

Connecting a half bridge strain gauge

This example assumes the SG-Link® OEM is configured with the optional internal **half** bridge completion resistors. If not, the completion of the bridge (shown as internal circuitry) must be completed externally. It is strongly recommended that shielded wiring be used, as this can significantly reduce system noise. Please note that the shield of each cable must be grounded at one location only, to prevent the occurrence of ground loops. Shielded wiring can be purchased from Alphawire (part number 1122, www.alphawire.com); a sample is included with each starter kit.

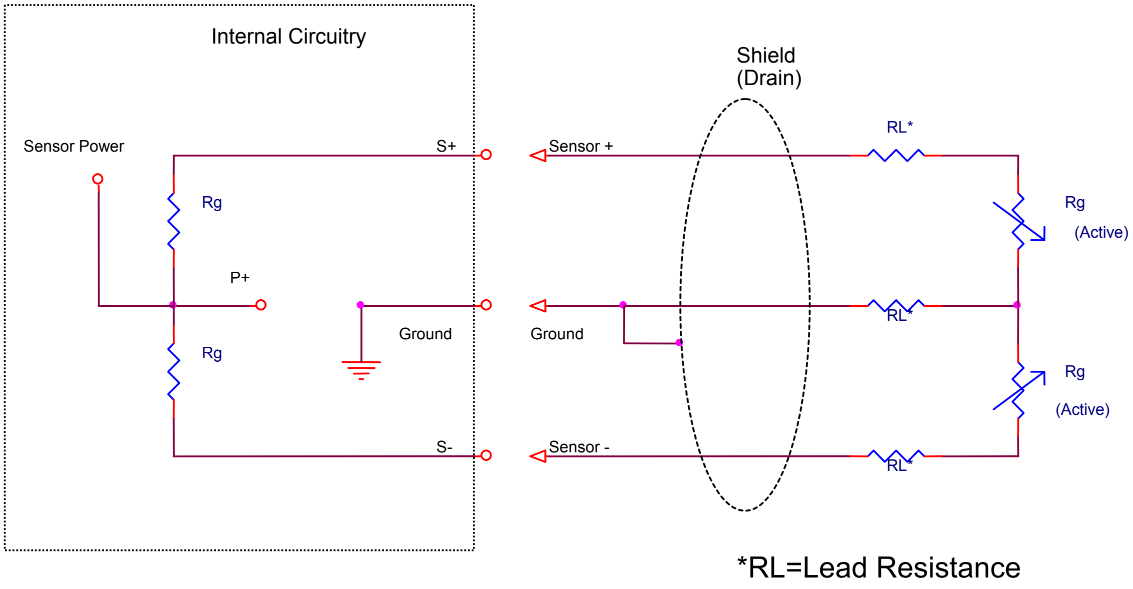

Internal Circuitry
Sensor Power
S+
Rg
P+
Ground
Rg
S-
Shield
(Drain)
Sensor +
RL*
Rg
(Active)
Ground
RL*
Rg
(Active)
Sensor -
RL*
*RL=Lead Resistance

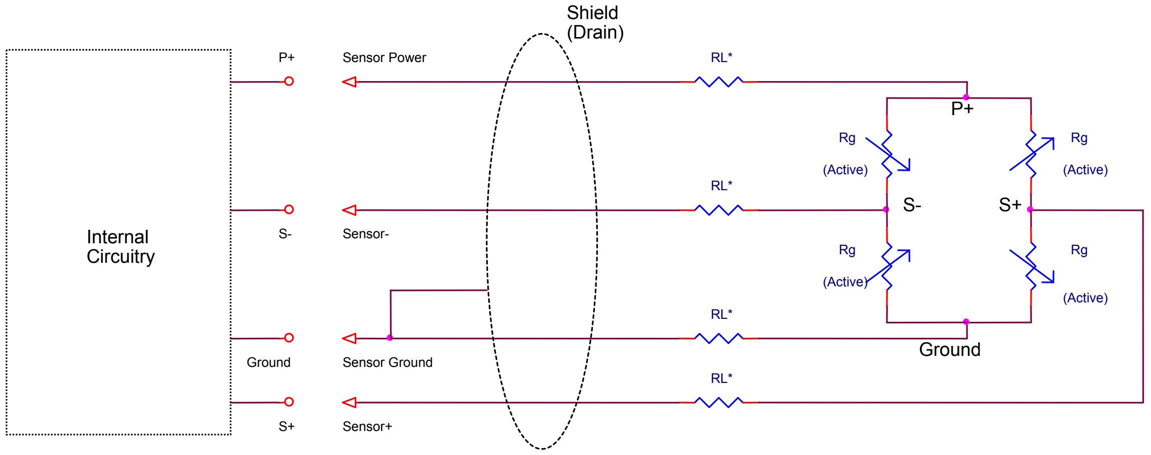
Figure 3

+Pin (Signal)	-Pin (Signal)	Ground Pin
S+ (Pin 2)	S- (Pin 3)	GND (Pin 4)

Table 5

Connecting a full bridge strain gauge

This example assumes the SG-Link® OEM is configured with the optional internal **full** bridge completion. In this arrangement, the user is responsible for all bridge completion. It is strongly recommended that shielded wiring be used, as this can significantly reduce system noise. Please note that the shield of each cable must be grounded at one location only, to prevent the occurrence of ground loops. Shielded wiring can be purchased from Alphawire (part number 1122, www.alphawire.com); a sample is included with each starter kit.


Shield
(Drain)
Internal
Circuitry
P+
Sensor Power
RL*
S-
Sensor-
RL*
Ground
Sensor Ground
RL*
S+
Sensor+
RL*
P+
Rg
(Active)
Rg
(Active)
S-
S+
Rg
(Active)
Rg
(Active)
Ground

*RL=Lead Resistance

Figure 4

P+ Pin	+ Pin (Signal)	- Pin (Signal)	Ground Pin
Vxc (Pin 1)	S+ (Pin 2)	S- (Pin 3)	GND (Pin 4)

Table 6

Programmable Gain

As indicated in the *Differential Input Channel* section, the SG-Link® OEM has a user-programmable gain that allows the bridge circuit to be amplified to suit the characteristics of the particular strain gauge in use; this programmable gain can be set from 20 to 2560.

Note: In the current Agile-Link™ software, the gain must be applied through the Read/Write EEPROM. The gain can not be applied through the Channels tab in the Configuration window as normal. Furthermore, the gain readout in the Channels tab is erroneous and should not be considered. A future revision in Agile-Link™ software will resolve this issue.

A table is presented below which details the available gain settings; the values should be written to EEPROM address 128 on the SG-Link® OEM.

Hardware Gain	Value to Write to EEPROM
20	0
40	1
80	2
160	3
320	4
640	5
1280	6
2560	7

Table 7

Single Ended Input Channel

The SG-Link® OEM has one single ended input channel. This channel will accommodate most 0-3 volt DC analog output sensors including accelerometers, pressure sensors, geophones, temperature sensors, inclinometers and the like.

The SG-Link® OEM can provide +3 volts DC up to 50 mA to the sensor. Alternatively, the sensor can be powered with +3 volts by any external constant source. In this case, the current draw of the sensor will not compromise the SG-Link® OEM, i.e., it may exceed 50 mA.

Typical wiring to the SG-Link® OEM would follow these patterns. Please refer to the *Terminal Strip* section for more details.

- If the sensor is to be powered by the SG-Link® OEM:
    - Sensor ground lead to either pin 4 or pin 7
    - Sensor signal lead to pin 6
    - Sensor power lead to pin 1
- If the sensor is to be powered externally:
    - Sensor ground lead to either pin 4 or pin 7
    - Sensor signal lead to pin 6

The 3 volt signal is digitized by the SG-Link® OEM's 12-bit A/D converter, creating a 0 to 4096 'bit' digital range. As explained elsewhere, the Agile-Link™ system operates digitally by resolving all sensor voltages to 'bits', transmitting the bits by radio to the base station, carrying the bits into host software, and finally returning these bits to volts at the software level. 0 volts = 0 bits, 2048 bits = 1.5 volts, 4096 bits = 3 volts, and so forth. To state it as a formula: 3 Volts / 4096 bits = 0.000732 volts per bit. The volts recreated on the host side can be further processed into engineering units by using the scaling provided by the sensor manufacturer. Agile-Link™ software provides an on-board function (Custom Formula) which allows for engineering units to be output and displayed directly from the software if the manufacturer's scaling formula is linear. Polynomial scaling, non-linear scaling, and so forth will have to be dealt with on a post-processing basis by the user.

In some case, users may want to use sensors which require 5 volt (or more) excitation. A voltage divider can be employed between the sensor and the SG-Link® OEM terminal strip to facilitate a 3 volt input. Caution should be exercised in such cases, as any inherent signal noise will be amplified.

The SG-Link® OEM can not be used to measure sensors which output negative voltage. The SG-Link® OEM should not be used with sensors with an impedance of greater than 5000 ohms.

A great way to become familiar with your new equipment is to take 15 minutes and connect your SG-Link® OEM to the SG-Link® Tester Board. The SG-Link® Tester Board, a precision instrument designed and manufactured by MicroStrain, incorporates a selectable bridge configuration (full, half, quarter) coupled with a precision shunt resistor to test the differential input channel and a 0-3 volt photocell to test the single ended input channel. Each starter kit is shipped with a Tester Board and a detailed Tester Board Quick Start Guide.

Users are always welcome to contact MicroStrain sales or support to discuss specific sensor applications in more detail.

Temperature Sensor

General Information

- The SG-Link® OEM has an on-board, solid state temperature sensor mounted on the surface of the circuit board.
- Specifications for this National Semiconductor Model LM60 sensor may be found at: http://www.national.com/mpf/LM/LM60.html
- The temperature sensor output is presented on channel 3 of the SG-Link®.
- The temperature sensor has a measurement range of -25˚C to +70˚C range, accuracy ± 0.5˚C (@25˚ C).

In use with Agile-Link™ software

The SG-Link® OEM temperature sensor outputs 6.25 mV/°C. The Agile-Link™ software uses and any other application should use this formula to calculate temperature:

$$Temp\left[{}^{\circ}C\right] = \frac{\left\{ BitsOut \times \left(\frac{3000\left[mV\right]}{4096\left[Bits\right]} \right) \right\} - 424\left[mV\right]}{6.25\left[\frac{mV}{{}^{\circ}C}\right]}$$

Terminal Strip

The SG-Link® OEM has an 8-pin wiring terminal strip incorporated on one edge of the circuit board. This terminal strip accommodates the differential input channel sensor connection, the single ended connection, and a power connection.

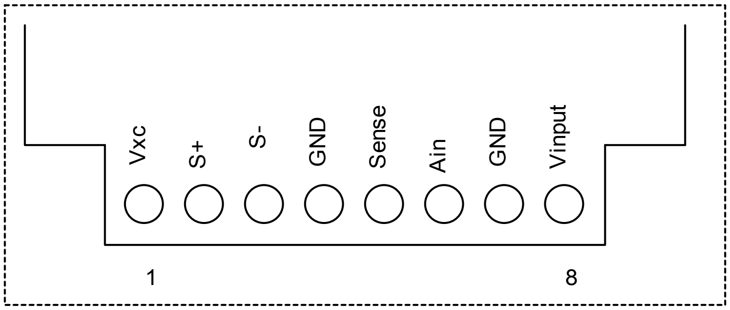


Figure 5

Pin Number	Pin Name	Pin Description
1	Vxc	3.0 volt sensor excitation.
2	S+	Positive input to the differential amplifier.
3	S-	Negative input to the differential amplifier.
4	GND	Signal ground (common with pin 7).
5	Sense	Input for three wire mode on quarter bridge strain gauges. Leave unconnected for full and half bridge strain gauge applications.
6	Ain	Analog 0-3.0 volt input.
7	GND	Input power ground (common with pin 4).
8	Vinput	Input power positive (3.2-9 volts DC).

Table 8

The SG-Link® OEM starter kit is shipped with a Phoenix-brand terminal block connector to facilitate making lead connections with the Terminal Strip. The terminal block can be easily soldered into the terminal strip to provide screw-type terminals. Specifications for the terminal block may be found at:
http://media.digikey.com/pdf/Data%20Sheets/Phoenix%20Contact%20PDFs/1725711.pdf

Device Status LED

The SG-Link® OEM has an LED indicator near the edge of the front face at DS1. The LED signals the various operating states of the SG-Link® OEM to the user.

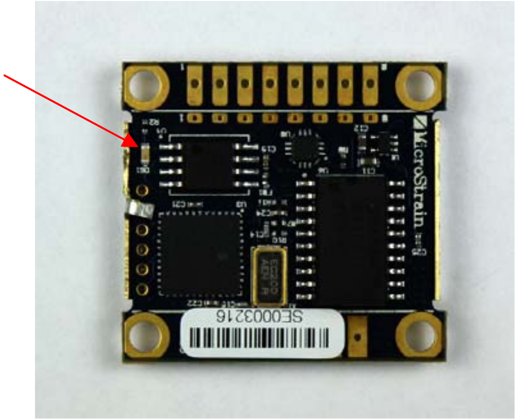


Figure 6

When the SG-Link® OEM is switched on, the green Device Status LED will rapidly flash several times and in a moment, begin 'throbbing' on and off every 1 second. The rapid flashes indicate a successful boot-up. The 'throbbing' indicates that the SG-Link® OEM is active and in an idle state.

The Device Status LED has several states during **normal** operation:

State	**LED appearance**
Booting up	Rapidly flashes 10 times when power is applied/recycled
Active and idle	'Throbbing' on and off every 1 second
Datalogging	Illuminates continuously
Streaming	Illuminates continuously
High Speed Streaming	Illuminates continuously
Low Duty Cycle	Blips on/off based on sampling rate
Ping	Blips on/off once for each ping
Range Test	Blips on/off at high rate giving appearance of continuous illumination
Read/Write EEPROM	Rapidly flashes several times
Sleep	Faint blip on/off based on Check Radio Interval

Table 9

The Device Status LED has several states during **error** operation:

State	**LED appearance**
Radio error	Blinks slowly 4 times on boot-up
On-board 2MB flash memory error	Blinks slowly 5 times on boot-up

Table 9A

Radio and Antenna

The SG-Link® OEM and its base station employ a 2.4 GHz IEEE 802.15.4 compliant radio transceiver for wireless communication. The radio is designed to comply with with ETSI EN 300 328, EN 300 440 class 2, FCC CFR-47 part 15 and ARIB STD-T66. For additional information on regulatory approvals, please see Appendix.

The SG-Link® OEM has a chip-sized, high performance monopole antenna mounted on the circuit board surface. Specifications may be found at: http://www.fractus.com/sales_documents/FR05-S1-N-0-104/DS_FR05-S1-N-0-104.pdf

The stated range for the SG-Link® OEM is up to 70 meters line-of-sight from its base station. An optional high gain antenna may be added to the base station and/or node to increase the range up to 300 meters line-of-sight.

Node Addressing

Each node has a unique address from 1 to 65534 which identifies the node to the base station and software. Typically, the factory assigns the last 4 digits of the node's serial number as the address, and changes to this address are not recommended except under special circumstances.

Address 65535 is a specialized broadcast node address. For example, if several nodes hear a command for node 65535 to start datalogging, they will all initiate datalogging simultaneously. It is extremely important that no particular node be assigned the 65535 broadcast address.

Note: The Streaming and High Speed Streaming commands in Agile-Link™ software can not use the broadcast 65535 address.

Sample Duration Calculations

Datalogging, streaming, low duty cycle and high speed streaming sampling sessions can all be set to last a finite duration, a finite amount of time. Finite sample duration is a value ranging from 100 to 65500, in increments of 100.

A datalogging example: We set the number of active channels to 3. We set the sample rate to 32. We set the sampling duration to 1000. We trigger the session. We download the session. We find that we have 1000 rows of data, with each row containing 3 channels of sensor data. We see that the session lasted ~31.25 seconds.

Another datalogging example: We set the number of active channels to 1. We set the sample rate to 1024. We set the sampling duration to 10000. We trigger the session. We download the session. We find that we have 10000 rows of data, with each row containing 1 channel of sensor data. We see that the session lasted ~9.77 seconds.

From this is becomes clear how the sampling duration can be thought of as a time setting:

- In our first example, we can divide a sampling duration of 1000 by a sample rate of 32 to equal ~31.25 seconds.
- In our second example, we can divide a sampling duration of 10000 by a sample rate of 1024 to equal ~9.77 seconds.

A streaming example: We set the number of active channels to 3. We can’t set the sample rate because that is fixed in hardware and we know it will be 617. We set the sampling duration to 10000. We start the session. We save the session. We find that we have 10000 rows of data, with each row containing 3 channels of sensor data. We see that the session lasted ~16.21 seconds. As before, 10000 sampling duration divided by 617 sample rate = ~16.21 seconds.

A low duty cycle example: We set the number of active channels to 3. We set the sample rate to 1. We set the sampling duration to 100 (100 is the minimum setting in Agile-Link™ software). We start the session. We save the session. We find that we have 100 rows of data, with each row containing 3 channels of sensor data. We see that the session lasted ~100 seconds. As before, 100 sampling duration divided by 1 sample rate = ~100 seconds.

A high speed streaming example: We set the number of active channels to 4. We can’t set the sample rate because that is fixed in hardware and we know it will be 1000. We set the sampling duration to 10000. We start the session. We save the session. We find that we have 10000 rows of data, with each row containing 4 channels of sensor data. We see that the session lasted ~10 seconds. As before, 10000 sampling duration divided by 1000 sample rate = ~10 seconds.

Time Stamping

The SG-Link® OEM node and Agile-Link™ software handle time stamping of datalogging, streaming, low duty cycle and high speed streaming data in different ways. The table below describes the various methods:

Sampling Method	**Time Stamp**	**Source**	**Clock Type**	**Stability**
Datalogging	Omitted to maximize data rate	Node	Crystal	+/-25ppm
Streaming	Omitted to maximize data rate	Node	Crystal	+/-25ppm
LDC ≤ 1 Hz(1)	16-bit counter	Node	RC	+/-10%
	Absolute time stamp	PC	Windows OS	---
LDC > 1 Hz	16-bit counter	Node	Crystal	+/-25ppm
High Speed Streaming	16-bit counter	Node	Crystal	+/-25ppm

Table 10

Notes:

(1) 16-bit counter and absolute time stamp are both applied.

Power

The SG-Link® OEM must be powered by a voltage source capable of delivering 3.2 to 9.0 volts DC, and at least 50 mA. The power must be applied through the wiring terminal strip; pins 4 or 7 GND and pin 8 Input Power (see *Terminal Strip* section of this manual). Be careful to observe correct polarity, otherwise damage may result.

The SG-Link® OEM has no power on/off switch. Power-up-and-down must be controlled externally.

Re-chargeable or non-rechargeable batteries may be used.

The SG-Link® OEM starter kit is shipped with a 9 volt battery connector and attached 8" 2-lead pigtail to facilitate battery connection to the Terminal Strip (see Terminal Strip section).

Here are some example battery life calculations:

- Streaming consumes ~25 mA. If the battery capacity is 200 mAh, the SG-Link® OEM will stream for ~8 hours before the battery is exhausted.
- Datalogging consumes ~25 mA. If the battery capacity is 200 mAh, the SG-Link® OEM will datalog for ~8 hours before the battery is exhausted.
- Sleep mode consumes ~0.5 mA. If the battery capacity is 200 mAh, the SG-Link® OEM will sleep for ~400 hours before the battery is exhausted.

Power Profile

Power consumption on the SG-Link® OEM is influenced by a wide range of variables including operating mode, sampling rate and number of active channels. A current power profile which outlines power consumption for the matrix of operating states is available at:

http://www.microstrain.com/pdf/SG-Link_PowerProfile_node_FW_4_99.pdf

Standard Packaging

The SG-Link® OEM is offered as an unenclosed circuit board as standard packaging. Please see the *Mechanical Drawings* section of this manual for dimensions.

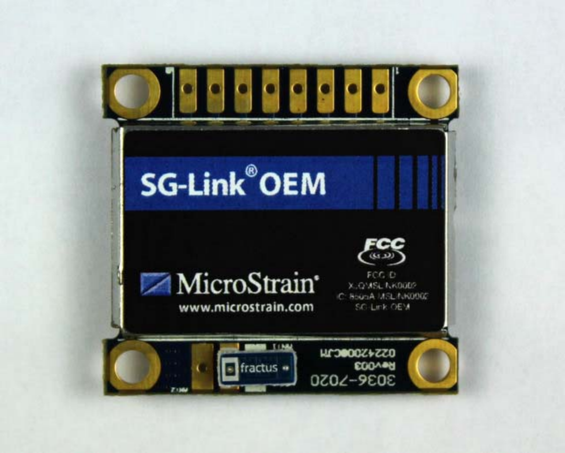


Figure 7-Front

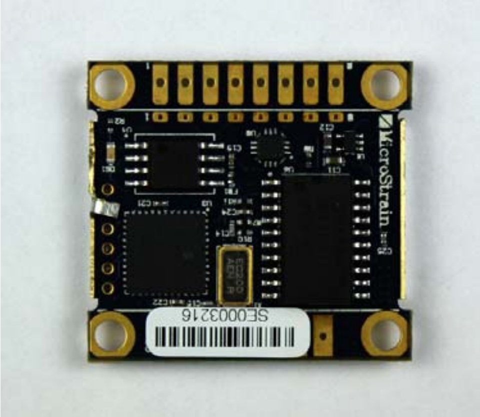


Figure 7-Back

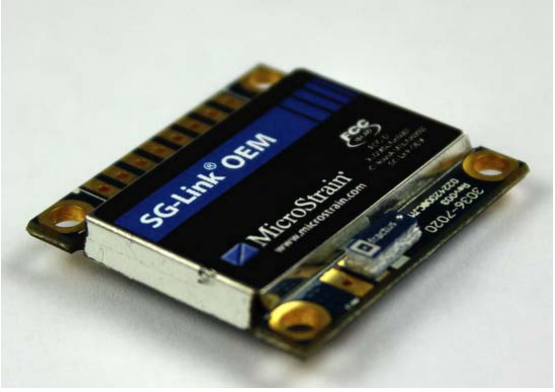


Figure 7-Ortho

Operating Temperature

The SG-Link® OEM electronics will operate between -40° C and +85° C.

Extended temperature ranges can be achieved with custom enclosures and suitable power supplies. Please contact a MicroStrain Sales Engineer with your requirements.

Sampling Rates

As described in more detail elsewhere in this manual, the SG-Link® OEM has four sampling modes, being 1) Datalogging, 2) Streaming, 3) Low Duty Cycle and 4) High Speed Streaming. Each of these modes supports a unique set of sampling rates. In Datalogging and Low Duty Cycle modes, you may choose the sampling rate for the session. In Streaming and High Speed Streaming, the sampling rate is a function of the number of active channels being sampled and may not be set by the user.

Datalogging

The sampling rate may be set to any of the following rates:

- 32 samples per active channel per second
- 64 samples per active channel per second
- 128 samples per active channel per second
- 256 samples per active channel per second
- 512 samples per active channel per second
- 1024 samples per active channel per second
- 2048 samples per active channel per second

Streaming

The sampling rate is a function of the number of active channels:

- If 1 channel is active, the sampling rate will be 736 samples per second for the channel.
- If 2 channels are active, the sampling rate will be 679 samples per active channel per second.
- If 3 channels are active, the sampling rate will be 617 samples per active channel per second.
- If 4 channels are active, the sampling rate will be 565 samples per active channel per second.

Low Duty Cycle

The sampling rate may be set to any of the following rates:

- 500 samples per second for each active channel
- 250 samples per second for each active channel
- 100 samples per second for each active channel
- 50 samples per second for each active channel
- 25 samples per second for each active channel
- 10 samples per second for each active channel
- 5 samples per second for each active channel
- 2 samples per second for each active channel
- 1 sample per second for each active channel
- 1 sample every 2 seconds for each active channel
- 1 sample every 5 seconds for each active channel
- 1 sample every 10 seconds for each active channel

- 1 sample every 30 seconds for each active channel
- 1 sample every 60 seconds for each active channel
- 1 sample every 2 minutes for each active channel
- 1 sample every 5 minutes for each active channel
- 1 sample every 10 minutes for each active channel
- 1 sample every 30 minutes for each active channel
- 1 sample every 60 minutes for each active channel

High Speed Streaming

The sampling rate is a function of the number of active channels:

- If 1 channel is active, the sampling rate will be 4,000 samples per second for the channel.
- If 2 channels are active, the sampling rate will be 2,000 samples per active channel per second.
- If 3 channels are active, the sampling rate will be 1,330 samples per active channel per second.
- If 4 channels are active, the sampling rate will be 1,000 samples per active channel per second.

Datalogging Memory

- The SG-Link® OEM contains 2 megabytes of memory reserved for storage of datalogging.
- As a bit of background, the memory is actually organized into 8,191 ‘pages’ with each page able to hold 132 data points or a total of 8,191 pages x 132 data points = ~1,081,212 data points.
- Let’s look at some sample datalogging sessions and see how they consume memory.

Example 1

- We set the SG-Link® OEM with channels 1, 2 and 3 active, with a sampling rate of 2,048 samples per channel per second and a sweep rate of 20,000 (9.77 seconds).
- This session will produce 20,000 sweeps x 3 channels = 60,000 data points.
- This session will consume 60,000 data points / 1,081,212 data points = ~5% of the datalogging memory.
- Therefore we could run 100% / 5% = ~20 consecutive finite datalogging sessions before we would have to download the data.

Example 2

- We set the SG-Link® OEM with channel 3 active, with a sampling rate of 512 samples per channel per second and a sweep rate of 10,000 (19.53 seconds).
- This session will produce 10,000 sweeps x 1 channels = 10,000 data points.
- This session will consume 10,000 data points / 1,081,212 data points = ~1% of the datalogging memory.
- Therefore we could run 100% / 1% = ~100 consecutive finite datalogging sessions before we would have to download the data.

Example 3

- We set the SG-Link® OEM with channels 1, 2 and 3 active, with a sampling rate of 1,024 samples per channel per second, with continuous datalogging enabled and memory fully erased.
- This session will produce 1,024 samples per second x 3 channels = 3,072 data points per second.
- This session will last 1,081,212 data points / 3,072 data points per second = ~352 seconds until the datalogging memory is full and the datalogging is automatically ended.

Factory Calibration and Testing

Calibration

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

Testing

The SG-Link® OEM receives a final precision test prior to being shipped. The test is conducted on both the differential input channel (strain channel) and the single ended input channel (analog channel). The SG-Link® Tester Board, a precision instrument designed and manufactured by MicroStrain, is used. The SG-Link® Tester Board incorporates a selectable bridge configuration (full, half, quarter) coupled with a precision shunt resistor to test the differential input channel and a 0-3 volt photocell to test the single ended input channel.

For field validation, the SG-Link® Tester Board is shipped with each SG-Link® OEM starter kit and may also be purchased separately.

Step-by-step instructions for the SG-Link® Tester Board may be found on the CD or on our web site at:

350 ohm
http://www.microstrain.com/pdf/docs/SG-link-350-ohm-tester-board-quick-start.pdf

1000 ohm
http://www.microstrain.com/pdf/docs/SG-link-1000-ohm-tester-board-quick-start.pdf

General Specifications

Input Channels	1 full differential input channel, 350Ω resistance or higher (with optional bridge completion), 1 single ended input (0 - 3 volts maximum), and internal temperature sensor
Temperature Sensor	-25°C to 70°C range, typical accuracy ±0.5°C (at 25°C)
Measurement Accuracy	± 0.1% typical
Resolution	± 1 bit 0.0024% ± 1 microstrain typical for 3 wire quarter bridge strain gauge
DC Bridge Excitation	+3 volts DC at 50 mA maximum (pulsed to sensors for samples rates of 100 Hz and below to conserve power)
Programmable Gain	Software programmable: 20 to 2560
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)
Data Logging Mode	Log up to 1,000,000 data points (from 100 to 65,500 samples or continuous) at 32 Hz to 2048 Hz
Sensor event driven trigger	Commence datalogging when threshold exceeded
Real-time streaming mode	Transmit real time data from node to PC - rate depends on number of active channels: 1 channel - 4 KHz, 2 channels - 2 KHz, 3 channels - 1.33 KHz
Low duty-cycle mode	Supports multiple nodes on single RF channel, total update bandwidth of 500 Hz divided by number of nodes
Synchronization between nodes	Datalogging 100 μsec ± 50 ppm. LDC mode time stamped at PC
Sample rate stability	Datalogging and LDC (mode(2Hz to 500Hz) 100 μsec ± 25 ppm (90 msec/hour) LDC mode (1 Hz to 2 samples per hour) ± 10%
Wireless 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 (2.450 to 2.490 GHz) - 16 channels
RF Data Packet Standard	IEEE 802.15.4, open communication architecture
RF Programming & Downloading	8 minutes to download full memory
Range for Bi-directional RF Link	70 m line-of-sight
Battery	Customer supplied from 3.2 to 9 volts

Table 11

Power Consumption	node only: real-time streaming - 25 mA, datalogging - 25 mA, sleeping - 0.5 mA External sensors: 350 Ω strain gauge - 8 mA, 1000 Ω strain gauge - 3 mA (add sensor consumption to above to calculate total power consumption)
Operating Temperature	-40 to +85˚C
Dimensions/Weight	Standard configurations: Potted - 31 mm x 31 mm x 7.8 mm - weight 10 grams Unpotted - 31 mm x 31 mm x 5 mm - weight 4.3 grams Unpotted - 31 mm x 21 mm x 5 mm - weight 3 grams Custom configurations available on request, for example: Unpotted - 25.4 mm diameter x 6.3 mm - weight 3.1 grams
Software	Agile-Link™ Windows XP® compatible
PC Comm	Serial port, 115.2 kBaud

Table 11 con't

Mechanical Drawing

All dimensions in mm.

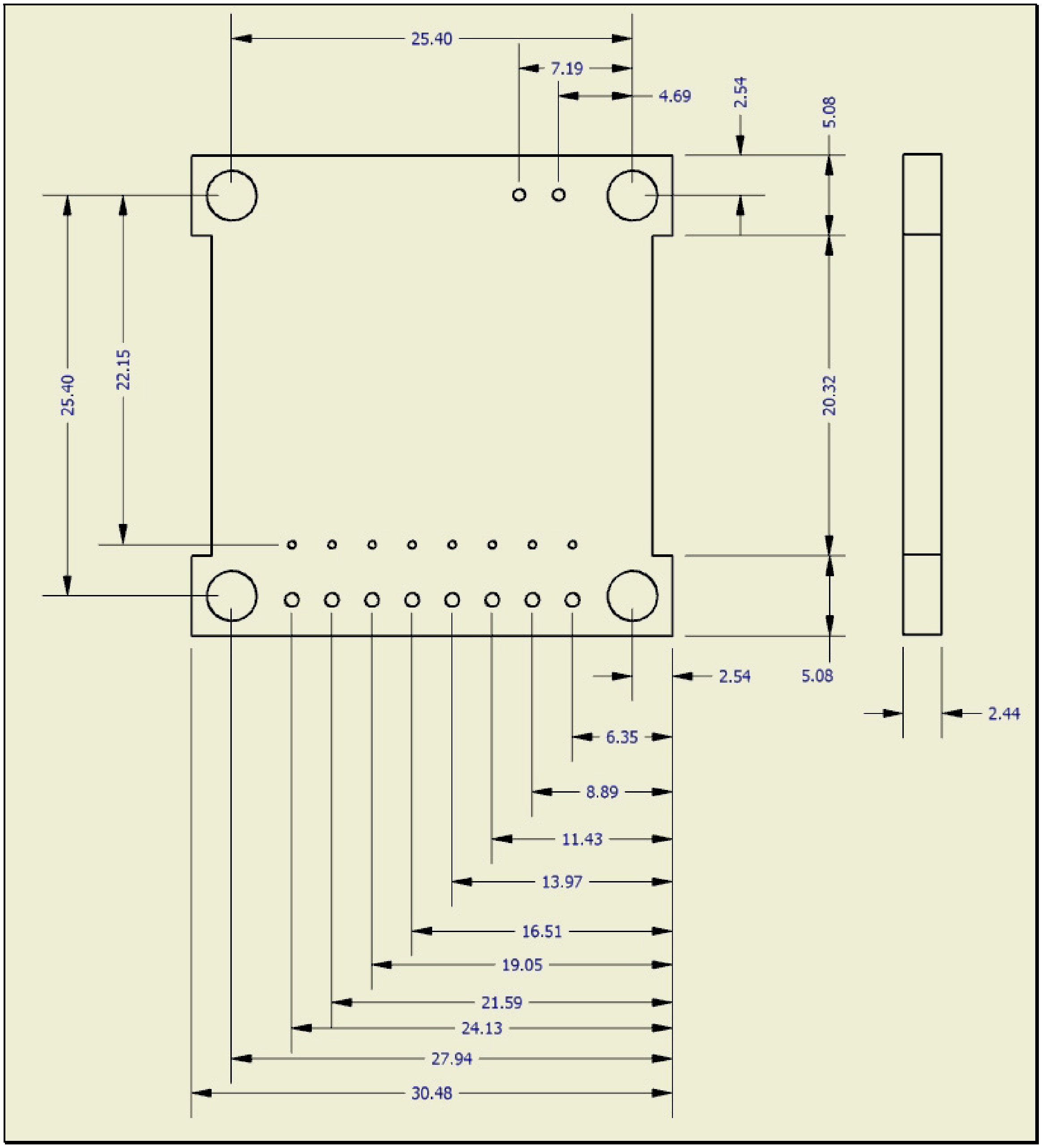
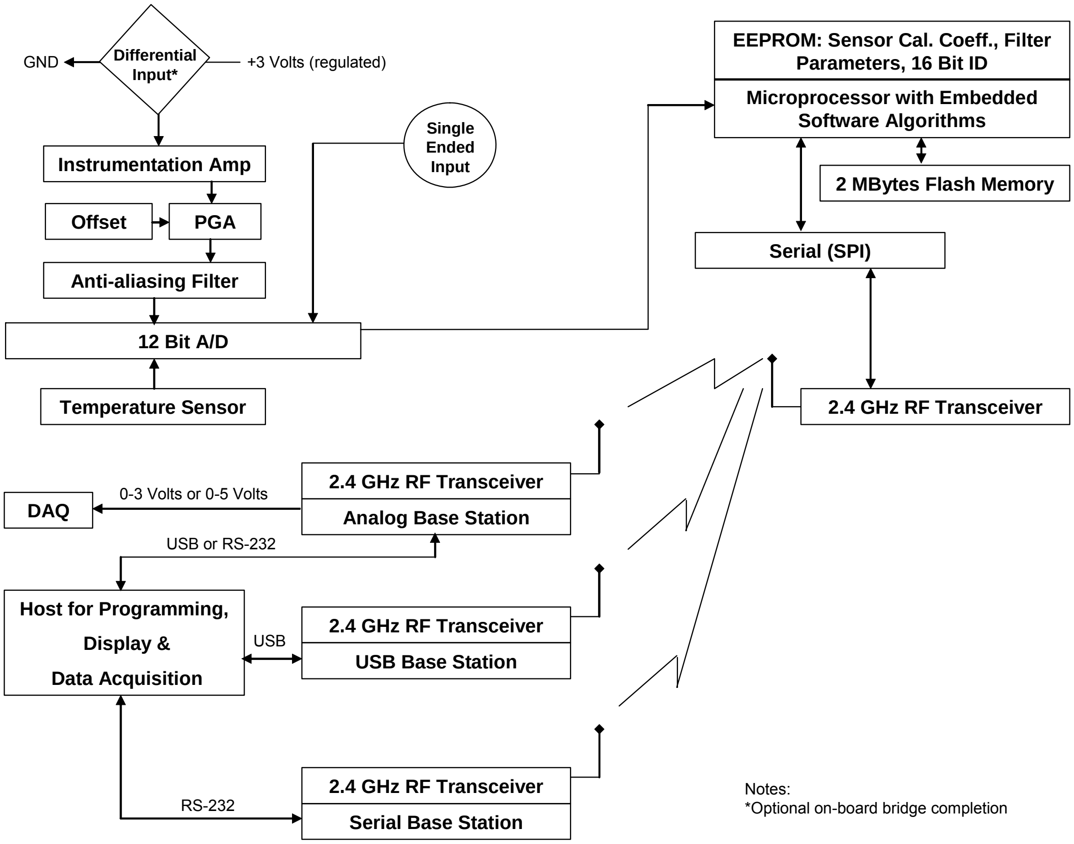

25.40
7.19
4.69
2.54
5.08
25.40
22.15
20.32
2.54
5.08
2.44
6.35
8.89
11.43
13.97
16.51
19.05
21.59
24.13
27.94
30.48

Figure 8

Electrical Block Diagram


GND
Differential Input*
+3 Volts (regulated)
Instrumentation Amp
Offset
PGA
Anti-aliasing Filter
12 Bit A/D
Temperature Sensor
Single Ended Input
EEPROM: Sensor Cal. Coeff., Filter Parameters, 16 Bit ID
Microprocessor with Embedded Software Algorithms
2 MBytes Flash Memory
Serial (SPI)
2.4 GHz RF Transceiver
DAQ
0-3 Volts or 0-5 Volts
2.4 GHz RF Transceiver
Analog Base Station
USB or RS-232
Host for Programming, Display & Data Acquisition
USB
2.4 GHz RF Transceiver
USB Base Station
RS-232
2.4 GHz RF Transceiver
Serial Base Station

Notes:
*Optional on-board bridge completion

Figure 9

Software

Standard Offering

All V-Link®, SG-Link®, SG-Link® OEM and G-Link® starter kits are shipped with a CD containing Agile-Link™ software and High Speed Streaming software. These two softwares support all capabilities of the V-Link®, SG-Link®, SG-Link® OEM and G-Link® including datalogging, streaming, low duty cycle, high speed streaming, configuration, data download, data file saving, real-time sensor display and other features.

System Requirements

To use the Agile-Link™ software or High Speed Streaming software, your computer must have the following minimum specifications:

- 1 GHz CPU
- Microsoft® Windows XP Professional SP2 operating system
- CD-ROM drive
- Video resolution 800 X 600
- 32MB video card
- Minimum of 256MB of memory
- Minimum of 50MB of free hard disk space for application
- Microsoft®-compatible mouse

Software Installation

- Place the Agile-Link™ CD in your CD-ROM drive and follow the on-screen instructions to install MicroStrain's Agile-Link™ software.
    - This installation places the Agile-Link™ software on your PC as well as required base station drivers. See *Appendix 2* for more details.
    - Agile-Link™ is designed for use with 2.4 GHz V-Link®, SG-Link®, SG-Link® OEM and G-Link®.
- The High Speed Streaming software is designed for use with the 2.4 GHz V-Link®, SG-Link®, SG-Link® OEM and G-Link®.
    - If you intend to use High Speed Streaming, install the software from the CD menu.
    - Refer to the *High Speed Streaming Quick Start Guide* for specialized details.
- A *Quick Start Guide* for your particular wireless node (2.4 GHz V-Link®, SG-Link®, SG-Link® OEM or G-Link®) is provided on the CD to get you up and running.

Data Communications Protocol

Customers and/or developers wishing to customize the Agile-Link™ family of wireless nodes and base stations are provided with the Agile-Link™ 2.4 GHz Software Development Kit (SDK). The Agile-Link™ 2.4 GHz Software Development Kit (SDK) is designed for use with the 2.4 GHz V-Link®, SG-Link®, SG-Link® OEM , G-Link®, USB Base Station, Serial Base Station and Analog Base Station. The SDK provides a complete Data Communications Protocol manual as well as code samples for C++, VB and LabVIEW.

The SDK is designed to provide the application builder with all the necessary protocol commands and responses to build robust wireless sensor applications for the Agile-Link™ wireless sensor network.

The Data Communications Protocol manual details these commands:

- Ping base station
- Read base station EEPROM
- Write base station EEPROM
- Short ping
- Read node EEPROM
- Write node EEPROM
- Download page
- Erase session data
- Trigger datalogging session
- Initiate real-time streaming
- Initiate sleep mode
- Read single sensor
- Auto-balance channel
- Long ping
- Initiate low duty cycle
- Initiate high-speed streaming
- Stop node
- …and more

Sample applications demonstrating most protocol commands are provided with fully-commented source code and a compiled executable for Microsoft® Visual Studio C++ .Net 7.1, Microsoft® VB 6.0, Microsoft® VB.NET 2003, Microsoft® VB.NET 2005 and LabVIEW® 7.1. The source code contains only objects native to the particular IDE with no third party controls added. The SDK is shipped on the CD with one license for use.

FCC (United States) Certification

The SG-Link® OEM module complies with Part 15 of the FCC rules and regulations. Compliance with the labeling requirements, FCC notices and antenna usage guidelines is required. In order to operate under MicroStrain's FCC Certification, OEMs/integrators must comply with the following regulations:

Labeling Requirements

The SG-Link® OEM module is labeled with its FCC ID number XJQMSLINK0002. If this FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display the following label referring to the enclosed module:

Contains FCC ID: XJQMSLINK0002
This device complies with Part 15 of the FCC Rules.
Operation is subject to the following two conditions:

1. **this device may not cause harmful interference and**
2. **this device must accept any interference received, including interference that may cause undesired operation.**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: Re-orient or relocate the receiving antenna, Increase the separation between the equipment and receiver, Connect equipment and receiver to outlets on different circuits, or Consult the dealer or an experienced radio/TV technician for help.

FCC-approved Antennas

This device has been designed and tested to operate with the antennas listed below:

- Internal Chip Antenna (Fractus FR05-S1-N-0-102)

Important Notes

The SG-Link-OEM Module has been certified by the FCC for use with other products without any further certification (as per FCC section 2.1091). Modifications not expressly approved by MicroStrain could void the user's authority to operate the equipment.

If the SG-Link-OEM module is integrated with an unintentional radiator, the OEM/integrator is responsible for testing compliance of the unintentional radiator (FCC section 15.107 & 15.109) before declaring compliance of their final product to Part 15 of the FCC Rules.

If using the SG-Link-OEM module in portable applications (module antenna is less than 20cm from the human body during device operation), the integrator or end user is responsible for passing additional SAR (Specific Absorption Rate) testing based on FCC rules 2.1091 and FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields, OET Bulletin and Supplement C. The testing results will be submitted to the FCC for approval prior to selling the integrated unit. The required SAR testing measures emissions from the module and how they affect the person.

IC (Industry Canada) Certification

The SG-Link® OEM module is labeled with its IC ID number. If this IC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display the following label referring to the enclosed module.

Contains Model: SG-Link® OEM, IC: 8505A-MSLINK0002

Integrator is responsible for its product to comply with IC ICES-003 & FCC Part 15, Sub. B - Unintentional Radiators. ICES-003 is the same as FCC Part 15 Sub. B and Industry Canada accepts FCC test report or CISPR 22 test report for compliance with ICES-003.

Transmitter Antennas

This device has been designed to operate with the antennas listed below:

- Internal Chip Antenna (Fractus FR05-S1-N-0-102)

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Support

Overview

- MicroStrain is committed to providing timely, knowledgeable, world-class support to its customers.
- We are open 24 X 7 through our web portal.
- We make every attempt to respond to your email the same business day.
- We are always available by telephone during business hours.
- We provide in-depth FAQs, manuals, quick start guides and technical notes.
- Firmware and software upgrades are made available on-line as they become available.
- Code samples in several languages are posted to aid your development.
- We support our customers as we would want to be supported.

Web

Our home page is at URL: www.microstrain.com
Our support page is at URL: http://www.microstrain.com/support_overview.aspx

Email

MicroStrain's Support Engineers make every attempt to respond to emails requesting product support within the same business day. The more detail you can provide, the quicker we will be able to understand your issues and find solutions. Data files, pictures, screen grabs, etc. are all very helpful in generating a well-thought-out solution.

Please email us at: support@microstrain.com

Telephone

MicroStrain's Support Engineers are available by phone Monday through Friday 9:00AM to 5:00PM local time. When calling MicroStrain, indicate to the receptionist that you are calling for product support and you will be promptly routed to a Support Engineer. Please have your equipment ready to test. Every attempt will be made to solve issues while you are on the line.

1.800.449.DVRT(3878) Toll Free in US
1.802.862.6629 telephone
1.802.863.4093 fax

Local time = GMT -05:00 (Eastern Time US & Canada)

SKYPE

MicroStrain's Support Engineers are available by SKYPE Monday through Friday 9:00AM to 5:00PM local. SKYPE name: **microstrain.wireless.support**

RMA

Warranty Return

As described in our 1 Year Warranty contained in the Terms and Conditions stated elsewhere in this manual, MicroStrain will incur for its own account any cost to repair/replace a MicroStrain product covered under the warranty.

Non-warranty Return

All non-warranty repairs/replacements will receive a minimum charge. The minimum charge for standard wireless, displacement and orientation products is US$75.00. The minimum charge for non-standard or custom products is US$150.00. If the repair/replacement charge exceeds the minimum, the minimum is folded into the total repair/replacement cost.

General Instructions

In order to return any MicroStrain product, you must contact us for a Return Merchandise Authorization number (RMA#). Call toll free (800) 449 3878 to obtain an RMA# from a MicroStrain representative.

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.

MicroStrain is not responsible for shipping costs (from and to the customer) or damage on returned items. Units to be returned should be packed carefully. Please be advised that packages sent by normal US Postal Service cannot be tracked to ensure delivery. Since MicroStrain cannot provide credit for a return without confirming its receipt, we recommend that you use a delivery service that can be tracked and or insured.

Normal turn-around for RMA items is 7 days from receipt of item by MicroStrain.

30 Day Return Policy

All stock product orders from MicroStrain may be returned within 30 days for a full refund. In order to return or exchange all or part of your order, you must contact us for a Return Merchandise Authorization number (RMA#). Call toll free (800) 449 3878 to obtain an RMA# from a MicroStrain representative.

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. Return requests must be made within 30 days of the receipt date. All free items must be returned together with purchased items in order to receive a full refund. Any shipping and/or handling charges on the original order cannot be refunded. At our discretion, we may levee a restocking fee of 15% of the cost of items returned.

MicroStrain is not responsible for shipping costs or damage on returned items. Units to be returned should be packed carefully. Please be advised that packages sent by normal US Postal Service cannot be tracked to ensure delivery. Since MicroStrain cannot provide credit for a return without confirming its receipt, we recommend that you use a delivery service that can be tracked and or insured.

A 30 Day Return must be initiated by receiving an RMA from MicroStrain.

Terms and Conditions

1. Acceptance of MicroStrain Inc's. Terms and Conditions. By placing an order with MicroStrain, Inc. ("MicroStrain"), Buyer agrees to be bound by these Terms and Conditions of Sale and Software License, if applicable. MicroStrain will not be bound by any of other terms and conditions, regardless of whether Buyer tenders terms and conditions with an order or otherwise and these terms and condition of sale prevail over any conflicting or additional terms of any quote, order, previous agreement, acknowledgment or similar communications between the parties. These Terms and Conditions supersede all prior or contemporaneous oral or written communications, proposals and representations with respect to its subject matter. The term "Products" includes collectively all physical products, Software and Embedded Software (as defined herein).

2. Pricing. All prices are quoted in US dollars, unless otherwise explicitly stated and are valid for ninety (90) days. You shall be responsible for the payment of all shipping charges, costs of freight, taxes, import fees, insurance, duties, value added taxes, and the like. Our minimum order is one hundred ($100.00) dollars, excluding all additional charges, including shipping, taxes and the like.

3. Payment: Payment shall be made in advance, in U.S. dollars, by credit card, bank draft or letter of credit, unless otherwise agreed in writing by MicroStrain. At the sole discretion of MicroStrain, credit terms of net 30 days up to a pre-approved limit may be offered to buyer. A late payment charge of one and a half (1.5%) percent per month, or the maximum percentage rate permitted by law, if lower, shall be charged on all past due balances. Buyer agrees to pay all costs incurred by MicroStrain including, but not limited to, collection fees, court costs and attorney fees, associated with collection of past-due balance.

4. Shipping Terms. All Products delivered to you by us, shall be F.O.B. our distribution center, with risk of loss passing to you upon our delivery of the Products to a common carrier. MicroStrain will arrange payment for shipping and insurance with the carrier, but such costs are the responsibility of Buyer. Delivery times quoted are estimates only and MicroStrain shall not be liable for delays in delivery.

5. Acceptance & Returns. Shipments shall be deemed to have been accepted by the buyer upon receipt of shipment. Any discrepancy in shipment quantity must be reported within five (5) days of receipt of shipment. Buyer may return starter kits or evaluation units for any reason within thirty (30) days of the date of shipping from MicroStrain. All other returns shall be subject to a restocking fee of the greater of twenty-five (25%) percent of the invoiced amount of the returned products or one hundred ($100.00) dollars. To qualify for a credit or refund (excluding shipping, duties or taxes), Buyer must contact MicroStrain in writing for a Return Merchandise Authorization (RMA). All Product returns shall comply with MicroStrain's Return Merchandise Authorization (RMA) policies. Custom Products and modifications of standard Products are not eligible for return. All returns must be shipped by Buyer to MicroStrain C.I.F. our distribution center as provided in the RMA policies provided by MicroStrain.

6. Compliance with Laws, Rules & Regulations. i.) Products sold may be exported from the United States of America only in accordance with US Export Administration Regulations and diversion contrary to US law is prohibited. Buyer acknowledges that it is eligible to receive Products under US law and agrees to abide by all export or re-export restrictions. ii.) Buyer acknowledges and recognizes that Buyer shall be wholly responsible for compliance with any laws, rules and regulations pertaining to the use of any Product(s) which is incorporated into a Buyer product should such governmental approval be required for research, testing or commercial use.

7. Software License. The following terms and conditions are applicable to either MicroStrain software delivered with a Product, the software portion of the Product (“Software”) or software which is embedded in a Product (“Embedded Software”). MicroStrain grants to Buyer a non-exclusive paid-up license to use one copy of the Software on one computer, subject to the following provisions: Except as otherwise provided in this Software License, applicable copyright laws shall apply to the Software and Embedded Software. Title to the medium on which the Software is recorded or stored is transferred to Buyer, but not title to the Software or the Embedded Software. Buyer may use Software on a multi-user or network system only if either, the Software is expressly labeled to be for use on a multi-user or network system, or one copy of the Software is purchased for each node or terminal on which Software is to be used simultaneously. Buyer shall not use, make, manufacture, or reproduce copies of Software or Embedded Software. Buyer may use a copy of the Software on one computer, and is permitted to make additional copies of the Software only for backup or archival purposes. Customer is expressly prohibited from disassembling or reverse engineering the Software or Embedded Software. All copyright notices shall be retained on all authorized copies of the Software and Embedded Software.

8. Limited Warranty. MICROSTRAIN WARRANTS i) ALL PRODUCTS (EXCEPT SPARE PARTS OR REPLACEMENT PARTS AND SPARE KITS) FOR A PERIOD OF ONE (1) YEAR, AND ii) ALL SPARE PARTS OR REPLACEMENT PARTS AND SPARE KITS FOR A PERIOD OF NINETY (90) DAYS, WHICH ARE MANUFACTURED BY MICROSTRAIN SHALL BE FREE FROM MATERIAL DEFECTS IN WORKMANSHIP AND MATERIALS FROM THE DATE OF DELIVERY TO THE CUSTOMER. THIS WARRANTY EXTENDS ONLY TO THE ORIGINAL CUSTOMER OF MICROSTRAIN, AND IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE, AND OF ALL OTHER OBLIGATIONS AND LIABILITIES OF ANY KIND OR CHARACTER WHICH MAY OTHERWISE APPLY. EXCEPT FOR THE WARRANTY DESCRIBED HEREIN, MICROSTRAIN EXPRESSLY DISCLAIMS ALL WARRANTIES OF MERCHANTABILITY OF THE GOODS OR OF FITNESS FOR ANY PURPOSE. THERE ARE NO OTHER WARRANTIES EXPRESS OR IMPLIED EXCEPT THOSE SPECIFICALLY PROVIDED FOR HEREIN. BY

ACCEPTING THE PRODUCTS FROM MICROSTRAIN, THE BUYER ACKNOWLEDGES AND AGREES: i) THAT THE INHERENT VALUE OF THE PRODUCTS ARE UNRELATED TO THE VALUE OR COST OF ANY PROPERTY IN CONNECTION WITH WHICH THE PRODUCTS MAY BE USED AND THAT MICROSTRAIN MAKES NO WARRANTY THAT THE PRODUCTS WILL AVERT, DETECT OR PREVENT OCCURRENCES OR THE CONSEQUENCES THEREFROM WHICH THE PRODUCTS ARE DESIGNED TO DETECT OR AVERT, OR THAT THE PRODUCTS MAY NOT BE COMPROMISED, DISABLED OR CIRCUMVENTED; ii) THAT MICROSTRAIN HAS MADE NO CONTRARY REPRESENTATIONS OR WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, TO OR FOR THE BENEFIT OF CUSTOMER; and, iii) THAT ANY NUMBER OF CAUSES MAY CAUSE A “FALSE ALARM” OR “FALSE READING” FROM MICROSTRAIN’S PRODUCTS, AND THAT MICROSTRAIN DOES NOT WARRANT AGAINST SUCH FALSE RESULTS. BUYER REPRESENTS, WARRANTS AND INDEMNIFIES MICROSTRAIN FOR ANY AND ALL LIABILITY PERTAINNG TO THE USE OF PRODUCTS INCORPORATED INTO OR OTHERWISE USED IN A BUYER PRODUCT.

9. Limited Software Warranty. MicroStrain warrants that, the software portion of the Product (“Software”), where applicable, will substantially conform to MicroStrain’s then current functional specifications for the Software, as set forth in the applicable documentation, from the date of original retail purchase of the Software for a period of ninety (90) days (“Software Warranty Period”), provided that the Software is properly installed on approved hardware and operated as contemplated in its documentation. MicroStrain further warrants that, during the Software Warranty Period, the magnetic media on which MicroStrain delivers the Software will be free of physical defects. MicroStrain’s sole obligation shall be to replace the non-conforming Software (or defective media) with software that substantially conforms to MicroStrain’s functional specifications for the Software or to refund at MicroStrain’s sole discretion. Except as otherwise agreed by MicroStrain in writing, the replacement Software is provided only to the original licensee, and is subject to the terms and conditions of the license granted by MicroStrain for the Software. Software will be warranted for the remainder of the original Software Warranty Period from the date or original purchase. If a material non-conformance is incapable of correction, or if MicroStrain determines in its sole discretion that it is not practical to replace the non-conforming Software, the price paid by the original licensee for the non-conforming Software will be refunded by MicroStrain; provided that the non-conforming Software (and all authorized copies thereof) is first returned to MicroStrain. The license granted respecting any Software for which a refund is given automatically terminates.

10. Limitation of Liability. IN NO EVENT SHALL THE MICROSTRAIN BE LIABLE FOR SPECIAL, DIRECT, INDIRECT, INCIDENTAL OR CONSEQUENCIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF PROFIT OR OPPORTUNITY, OR SIMILAR DAMAGES WHICH MAY ARISE IN CONNECTION WITH ANY OF MICROSTRAIN’S PRODUCTS. BUYER’S SOLE AND EXCLUSIVE REMEDY SHALL IN NO EVENT EXCEED THE REPAIR, REPLACEMENT OR COST OF THE SPECIFIC PRODUCT PURCHASED FROM MICROSTRAIN AS PROVIDED IN THE WARRANTY PERIOD.

11. Warranty Repair. MicroStrain’s sole obligation shall be to repair or replace the defective Product during the applicable Warranty Period at no charge to the original owner or to refund at MicroStrain’s sole discretion. Such repair or replacement will be rendered by MicroStrain. The replacement Product need not be new or have an identical make, model or part. MicroStrain may in its sole discretion replace the defective Product (or any part thereof) with any reconditioned Product, or similar Product, that MicroStrain reasonably determines is substantially equivalent (or superior) in all material respects to the defective Product. Repaired or replacement Products will be warranted for the remainder of the original applicable Warranty Period from the date of original purchase. If a material defect is incapable of correction, or if MicroStrain determines in its sole discretion that it is not practical to repair or replace the defective Product, the price paid by the original purchaser for the defective Product will be refunded by MicroStrain upon return to MicroStrain of the defective Product. All Products (or parts thereof) that is replaced by MicroStrain, or for which the purchase price is refunded, shall become the property of MicroStrain upon replacement or refund.

12. Non-Applicability of Warranty. The Limited Warranty provided hereunder for Products will not be applied to and does not cover any refurbished product and any Product purchased through an inventory clearance or liquidation sale or other sales in which MicroStrain, the sellers, or the liquidators expressly disclaim their warranty obligation pertaining to the Product and in that case, the Product is being sold "As-Is" without any warranty whatsoever including, without limitation, the Limited Warranty as described herein, notwithstanding anything stated herein to the contrary.

13. Submitting A Claim. The customer shall return the Product to the original purchase point based on its return policy. In case the return policy period has expired and the Product is within warranty, the customer shall submit a claim to MicroStrain as follows: i) The customer must submit with the Product as part of the claim a written description of the Product defect or Software nonconformance in sufficient detail to allow MicroStrain to confirm the same; ii) The original Product owner must obtain a Return Material Authorization (“RMA”) number from MicroStrain and, if requested by MicroStrain, provide written proof of purchase of the Product (such as a copy of the dated purchase invoice for the Product) before the warranty service is provided; iii) After an RMA number is issued, the defective Product must be packaged securely in the original or other suitable shipping package to ensure that it will not be damaged in transit, and the RMA number must be prominently marked on the outside of the package. Do not include any manuals or accessories in the shipping package. MicroStrain will only replace the defective portion of the Product and will not ship back any accessories; iv) The customer is responsible for all in-bound shipping charges to MicroStrain. No Cash on Delivery (“COD”) is allowed. Products sent COD will either be rejected by MicroStrain or become the property of MicroStrain. Products shall be fully insured by the customer. MicroStrain will not be held responsible for any packages that are lost in transit to MicroStrain. The repaired or replaced packages will be shipped to the customer via UPS Ground or any common carrier selected by MicroStrain, with shipping charges prepaid. Expedited shipping is available if shipping charges are prepaid by the customer and upon request; v) Return Merchandise is to be shipped to MicroStrain, Inc. at the address indicated below; vi) MicroStrain may reject or return any Product that is not packaged and shipped in strict compliance with the foregoing requirements, or for which an RMA number has not been obtained or is not visible from the outside of the package. The Product owner agrees to pay MicroStrain’s reasonable handling and return shipping charges for any Product that is not packaged and shipped in accordance with the foregoing requirements, or that is determined by MicroStrain not to be defective or non-conforming.

14. What Is Not Covered. This Limited Warranty provided by MicroStrain does not cover: Products, if in MicroStrain’s sole and exclusive judgment, have been subjected to abuse, accident, alteration, modification, tampering, negligence, misuse, faulty installation, lack of reasonable care, repair or service in any way that is not contemplated in the documentation for the Product, or if the model or serial number has been altered, tampered with, defaced or removed; Initial installation, installation and removal of the Product for repair, and shipping costs; Operational adjustments covered in the operating manual for the Product, and normal maintenance; Damage that occurs in shipment, due to acts of God, failures due to power surge, and cosmetic damage; Any hardware, software, firmware or other products or services provided by anyone other than MicroStrain; or, Products that have been purchased from inventory clearance or liquidation sales or other sales in which MicroStrain, the sellers, or the liquidators expressly disclaim their warranty obligation pertaining to the Product. Repair by anyone other than MicroStrain will void this Warranty.

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16. Choice of Law. These terms and any agreement between MicroStrain and buyer shall be interpreted in accordance with the substantive laws of the State of Vermont, USA, and without regard to its choice of law provisions. Any action to enforce any such terms shall be exclusively in the courts of competent jurisdiction in Chittenden County, Vermont. Any legal action between MicroStrain and buyer shall be decided by a court, acting without a jury.

17. Disclaimer of U.N. Sale of Goods. The United Nations Convention on Contracts for the International Sale of Goods is specifically disclaimed.

18. Force Majeure. Except for the obligations to make payments, neither party shall be bound to meet any obligation if prevented from doing so as a consequence of force majeure. If a situation of force majeure lasts for more than ninety (90) days, the Parties shall be entitled to terminate this Agreement by canceling it in writing, without any rights to compensation of damages or refunds.

19. No Assignment. This Agreement, and any Licenses or the Software may not be assigned, sublicensed, leased, sold or otherwise transferred without prior written consent from MicroStrain, and any unauthorized transfer is null and void. This agreement and any licenses granted is personal to you and can be used for personal or internal business use only and may not be used on behalf of a client or customer.

20. Notice. All notifications and communications relating to this Agreement shall be made by the parties to the other party, in writing and shall be signed by a person duly authorized to provide such notice.

21. Entire Agreement. This Agreement shall constitute the entire Agreement between buyer and MicroStrain and shall not be modified or rescinded, except in writing, signed by buyer and MicroStrain. The provisions of this Agreement supersede and precede all prior oral and written quotations, communications, agreements and understandings of the parties. Products and services rendered by MicroStrain are done so only in accordance with these Terms and Conditions of Sale. If any provisions within these terms and conditions are found to be invalid by any court having competent jurisdiction, the invalidity of such provisions shall not affect the validity of the remaining provisions of these terms and conditions, which shall remain in full force and effect.

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Appendix 1: Host-to-Base Station Communication

RS-232

Communication between the Serial base station or the RS-232 interface of the Analog base station *and* the host computer is via a standard RS-232 connection as shown in the RS-232 Signals Definition and RS-232 Asynchronous Character Format tables.

RS-232 Signals Definition

Signal	**Name**	**Direction**	**Function**
TxD	Transmit Data	Host to Base Station	Asynchronous Serial Data from Host
RxD	Receive Data	Base Station to Host	Asynchronous Serial Data to Host
GND	Signal Ground	N/A	Signal Ground Reference

RS-232 Asynchronous Character Format	
Baud Rate	115.2K
Parity	None
Data Bits	8
Stop Bits	1

USB 2.0

Communication between the USB base station or the USB interface of the Analog base station *and* the host computer is via a USB 2.0 compliant connection using a Silicon Laboratories CP2101 USB-to-UART Bridge chip on the base station supported by Silicon Laboratories Virtual Communications Port (VCP) drivers installed on the host PC.

Reference is made to the following Silicon Laboratories documents:
CP2101 Single-Chip USB to UART Bridge Product Brief
CP2101 Data Sheet

Appendix 2: Datalogging with Agile-Link™ software

Datalogging

- Datalogging allows you to sample each sensor (each channel) on a node from 32 samples per channel per second to 2048 samples per channel per second. Sensor data is written to memory on the node as it is sampled; no transmission occurs to the base station. After the datalogging session has completed, data is downloaded and saved to file by Agile-Link™ software. Analysis is conducted thereafter on the resulting data files. Please review the *Sampling Rates* section of this manual for sampling rate details.

Operating one node in datalogging mode

- A datalogging session should be started by setting your configuration.
- Establish communication with the node and right-click to get the drop-down menu.
- Click Configure. The Configuration window will appear.
- Click the Channels tab. Check boxes to enable SG-Link® OEM’s channels 1, 3 and 4. Uncheck the channel 2 box to disable the temperature channel. Leave the Offset scroll boxes for channel 1 at the default value of 512 (mid-scale). Leave the Hardware Gain text box at the default value of 104. Click Apply.
- Click the Datalogging tab. Uncheck box for Continuous Datalogging. Uncheck box for Enable Sensor Event Driven Trigger. Enter the value 1000 into the Sweeps scroll box. Enter the value 256Hz in the Sample Rate drop-down. Note that a datalogging session of approximately 3.9 seconds has been set. Click Apply. Click OK.
- Click View in the menu bar. Click Channel Actions. The Channel Actions windows will appear.
- Click the Resync button. Channel 1 will now have the Strain action in place indicating that the SG-Link® OEM will output engineering units in microstrain.
- Click the small red X in the upper right corner of the Channel Actions window to close the window.
- Right-click on the node icon/label and a pop-up menu will appear.
- Click Datalogging. Click Erase. A confirming message box will appear. Click Yes. A progress bar will appear and disappear. This indicates that the datalogging memory of the node was successfully erased.
- Right-click on the node icon/label and a pop-up menu will appear.
- Click Datalogging. Click Trigger Session. A progress bar will appear and disappear. This indicates that a datalogging session was successfully triggered.
- Right-click on the node icon/label and a pop-up menu will appear.
- Click Datalogging. Click Download. A progress bar will appear and disappear. This indicates that all datalogging sessions were successfully downloaded.
- Note: Any number of datalogging sessions can be run consecutively before downloading. Please review the *Datalogging Memory* section of this manual for capacity details.

- Right-click on the node icon/label and a pop-up menu will appear.
- Click Datalogging. Click Browse Triggers. The Trigger Browser window will appear.
- Click the + sign to the left of the trigger label (example: July 20, 2007 09:36:07) and Trigger 1 will appear. Highlight Trigger 1 and click the Open Trigger. The data in Trigger 1 will be displayed in spreadsheet format (assuming you have Microsoft® Excel installed). This indicates that the data from Trigger 1 was successfully saved to file on your PC.
- Close the spreadsheet. Click OK on Trigger Browser window.

Operating several nodes in datalogging mode (broadcast method)

- Establish communication with several nodes on the same frequency under one base station.
- Configure each node individually for a datalogging session as described in the *Operating one node in datalogging mode* section above. Normally all nodes would be set to the same sample rate, sweep rate, channel actions, etc. for any given session but there is no requirement to do this.
- Right-click the base station and a drop-down menu appears.
- Click Broadcast and the broadcast menu appears.
- Click Erase. A confirming message box will appear. Click Yes. A progress bar will appear and disappear. This indicates that the datalogging memory of the all the nodes was successfully erased.
- Click Broadcast and the broadcast menu appears.
- Click Trigger. The trigger datalogging command will be broadcast to all nodes. The activity LED on the nodes or elapsed time should be observed to determine when the datalogging session has ended. There is no individual response to Agile-Link™ from the nodes when they are completed datalogging.
- Note: Any number of datalogging sessions can be run consecutively before downloading. Please review the *Datalogging Memory* section of this manual for capacity details.
- Proceed to download datalogging from each node individually as described in the *Operating one node in datalogging mode* section above. Broadcast does not allow downloading of several nodes coincidentally.

Appendix 3: Streaming with Agile-Link™ software

Streaming

Streaming allows you to sample each sensor (each channel) on a node at rates as high as 736 samples per channel per second. Sensor data is transmitted to the base station as it is sampled (in real-time) and is collected, displayed and saved by Agile-Link™ software. Please review the *Sampling Rates* section of this manual for sampling rate details.

Operating one node in streaming mode

- A streaming session should be started by setting your configuration. It is assumed that a strain gauge has been applied to channel 1, the Strain wizard has been run, and no strain is being applied to the gauge.
- Establish communication with the node and right-click to get the drop-down menu.
- Click Configure. The Configuration window will appear
- Click the Channels tab. Check the box to enable SG-Link® OEM's channel 1. Uncheck the channel 2, 3 and 4 boxes to disable the unused, temperature and single ended channels. Leave the Offset scroll boxes for channel 1 at the default value of 512 (mid-scale). Leave the Hardware Gain text box at the default value of 104. Click Apply.
- Click the Streaming tab. Uncheck box for Continuous Streaming. Enter the value 5000 into the Sweeps scroll box. Note that a streaming session of approximately 6.79 seconds has been set. Click Apply. Click OK.
- Click View in the menu bar. Click Channel Actions. The Channel Actions windows will appear.
- Click the Resync button. Channel 1 will now have the Strain action in place indicating that the SG-Link® OEM will output engineering units in microstrain.
- Click the small red X in the upper right corner of the Channel Actions window to close the window.
- Right-click on the node icon/label and a pop-up menu will appear.
- Click Stream. Click Start. The node will start streaming strain in engineering units (microstrain) and display channel 1 as an advancing plot on the Real-time Graph. The Y-axis will auto-scale engineering units and will report channel 1 (green) at or near 0 microstrain. The channel plots will continue along the X-axis until 5000 sweeps (~6.79 seconds) has elapsed. This indicates that the node is successfully streaming its sensor data.
- Move your mouse pointer within the black area of the Real-time Graph. Right-click and a pop-up menu will appear.
- Click Save Stream. A Save As dialog box appears. Accept or modify the File Name for the CSV file that will be saved. Click Save. The dialog box will disappear. This indicates that the streaming data was successfully saved to file on your PC.

Operating up to 4 nodes in streaming mode (broadcast method)

- Establish communication with up to 4 nodes, each paired with a separate base station and each pair on a different frequency.
- Configure each node individually for a streaming session as described in the *Operating one node in streaming mode* section above. Normally all nodes would be set to the same sweep rate, channel actions, etc. for any given session but there is no requirement to do this.
- Hold down the SHIFT key and click each node once to highlight it.
- Release the SHIFT key. Make sure that only nodes are highlighted; not base stations.
- Right-click on any of the highlighted nodes and a drop-down menu appears.
- Click Stream and the nodes will begin streaming data to separate graphs.
- When the streaming ends, move your mouse pointer within the black area of each Real-time Graph. Right-click and a pop-up menu will appear.
- Click Save Stream. A Save As dialog box appears. Accept or modify the File Name for the CSV file that will be saved. Click Save. The dialog box will disappear. This indicates that the streaming data was successfully saved to file on your PC. Do the same for each node/graph.

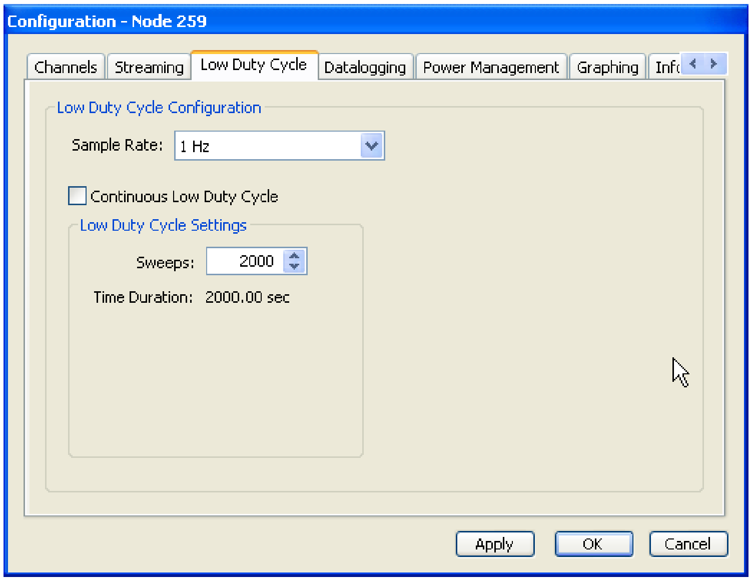
Appendix 4: Low Duty Cycle with Agile-Link™ software

Low Duty Cycle

Low Duty Cycle (LDC) allows you to sample each sensor (each channel) on a node from 500 Hz to 1 sample per hour. Sensor data is ‘blipped’ to the base station and collected, displayed and saved by Agile-Link™ software in real-time. Please review the *Sampling Rates* section of this manual for sampling rate details.

Operating one node in LDC

- Low Duty Cycle use should be started by setting your configuration.
- Establish communication with the node and right-click to get the drop-down menu.
- Click Configure and the Configuration window opens.
- Click the Channels tab and apply, as you normally would, the active channels, etc.
- Now click the Low Duty Cycle tab.
- Set the Sample Rate drop-down box to 1Hz, 1 sample per second. *Note:* You may select any of a number of sampling rates ranging from 500 Hz to 1 sample per hour.
- For finite LDC, uncheck the Continuous Low Duty Cycle checkbox.
- Set the Sweeps numscroll to 200, 200 samples over 200 seconds. *Note:* You may select any number of sweeps ranging from 100 to 65500.
- Click Apply.
- Or…
- For continuous LDC, check the Continuous Low Duty Cycle checkbox.
- The Sweeps value is disregarded.
- Click Apply.
- Click OK to close the Configuration window.



Configuration - Node 259

Low Duty Cycle Configuration

Sample Rate: 1 Hz

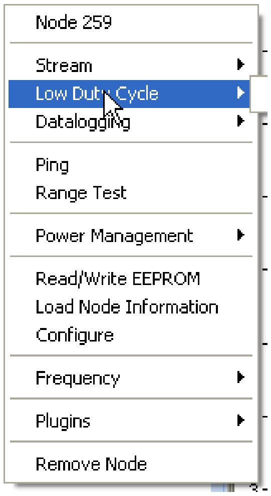
☐ Continuous Low Duty Cycle

Low Duty Cycle Settings

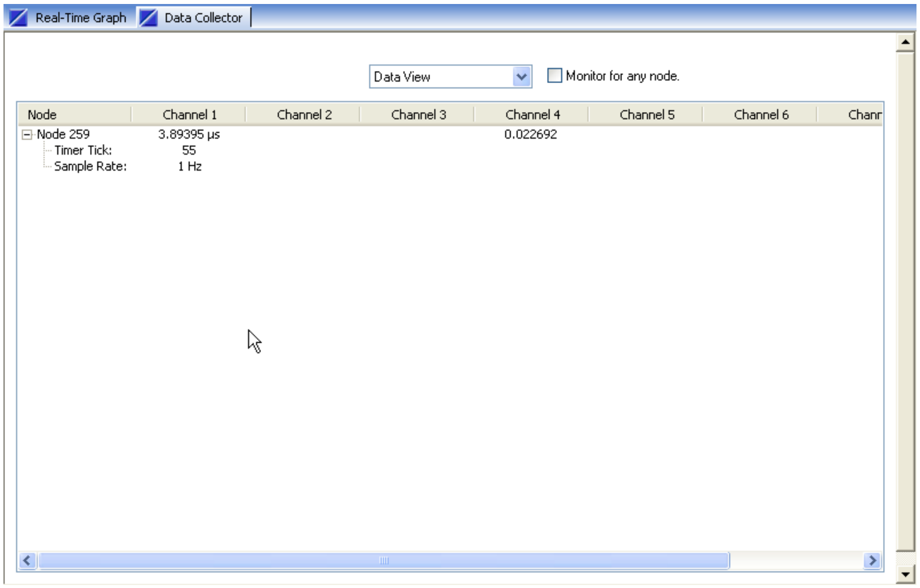
Sweeps: 2000

Time Duration: 2000.00 sec

- If you plan to acquire data in engineering units, you should proceed to setting Channel Actions.
- Click View.
- Click Channel Actions.
- The Channel Actions window appears.
- Click Resync to set existing calibrations to the active channels or manually Setup each channel from here. When completed, click the red X in the upper right hand corner of the Channel Actions window to close it.
- To proceed to Low Duty Cycle, right-click the node and the drop-down menu will appear.
- Click Low Duty Cycle.

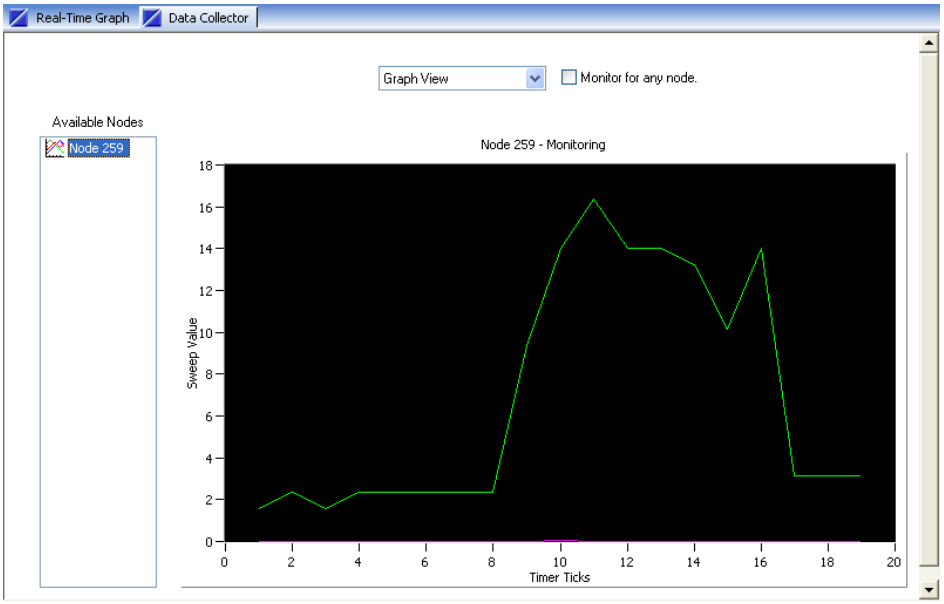

Node 259
Stream
Low Duty Cycle
Datalogging
Ping
Range Test
Power Management
Read/Write EEPROM
Load Node Information
Configure
Frequency
Plugins
Remove Node

- Click Start and Low Duty Cycle begins sampling and displaying.
- A Data Collector window is spawned in the graphing area.

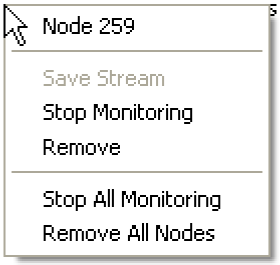

Real-Time Graph
Data Collector
Data View
☐ Monitor for any node.

Node	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Chanr
⊟ Node 259	3.89395 µs			0.022692			
Timer Tick:	55						
Sample Rate:	1 Hz						

- As Low Duty Cycle samples are received from the node, their values will be displayed by channel. If engineering units have been applied by Channel Actions, the units will display in those units; otherwise all values will be in raw bits.
- Click the + sign to the left of the node and a tree of information will display indicating current Timer Tick (read Sweep) and the current Sampling Rate.
- Select Graph View from the drop-down above the channel headers and the Low Duty Cycle graphing window will appear.
- Click the node in the Available Node frame and a real-time graph will appear and graph the samples as they arrive.


Real-Time Graph
Data Collector
Graph View
☐ Monitor for any node.
Available Nodes
Node 259
Node 259 - Monitoring
Sweep Value
18
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
Timer Ticks

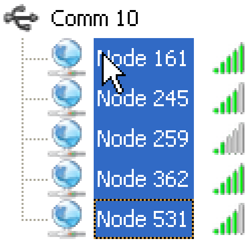
- Select Data View from the drop-down above the channel headers and the Low Duty Cycle data window will reappear.
- In finite Low Duty Cycle, sampling will progress until the number of sweeps set in the Configuration has been reached.
- *Note:* The Agile-Link™ software does not signal the user when a finite LDC session has completed. It will continue to monitor for any samples coming from the node. The user by observation of the Data View, observation of the activity LED on the node, etc. must intervene to continue.
- By right-clicking on the node in the Data Collector window, you receive various menu items.


Node 259
Save Stream
Stop Monitoring
Remove
Stop All Monitoring
Remove All Nodes

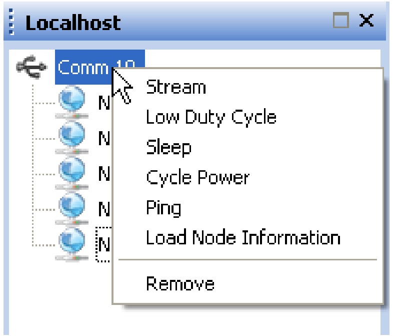
- To stop Low Duty Cycle sampling, click Stop Monitoring.
- To save the Low Duty Cycle session to file, click Save Stream. A ‘Save As’ window will appear allowing you to name and save the session data. Click OK.
- To close the Data Collector window, click its upper right hand X.
- To return to normal node operations, right-click the node in the Localhost frame to get its main menu.
- *Note:* If you are using continuous Low Duty Cycle sampling or want to prematurely stop a finite Low Duty Cycle sampling, you may do so using the Stop Monitoring and Save Stream software functions. However, the node will continue to operate in Low Duty Cycle mode (and not be able to communicate normally) until you cycle its power. After cycling, you will again be able to communicate normally with the node.

Operating multiple nodes in LDC

- As was stated above, operating multiple nodes in Low Duty Cycle should be started by individually setting each node’s configuration and Channel Actions.
- Multiple nodes can be started in Low Duty Cycle at the same instant.
- Press and hold down the Ctrl key.
- Click each node that you want to include in the session.

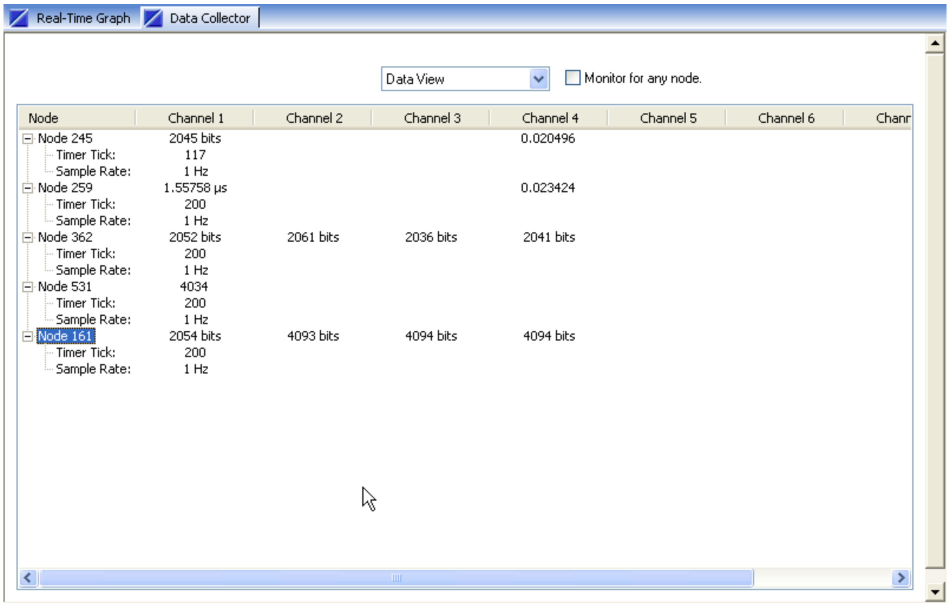


- Release the Ctrl key.
- Right-click the base station and a menu will appear.



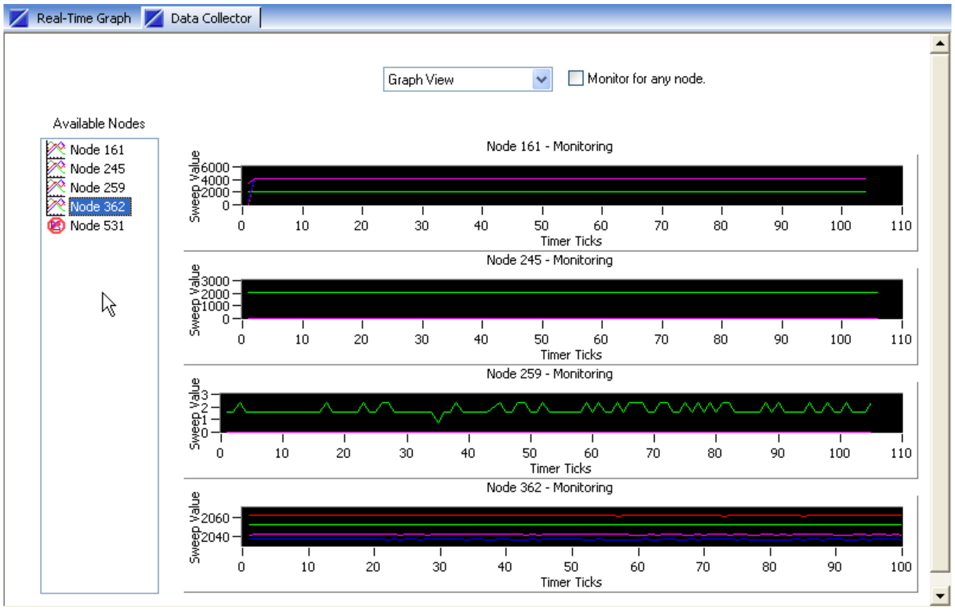
- Click Low Duty Cycle. All nodes that were selected will now begin LDC and will all be sampled by the software.
- *Note:* The nodes will commence at the same instant and although each node runs independently, the nodes will have near real-time synchronization subject to very small error as a result of their individual clock crystals.

- *Note:* Alternatively, all nodes assigned to a base station can be started at the same time. Right-click the base station and click LDC Monitor Node. A Data Collector window will spawn and all nodes will automatically start Low Duty Cycle.
- As before, a Data Collector window is spawned in the graphing area and all nodes being captured are displayed.

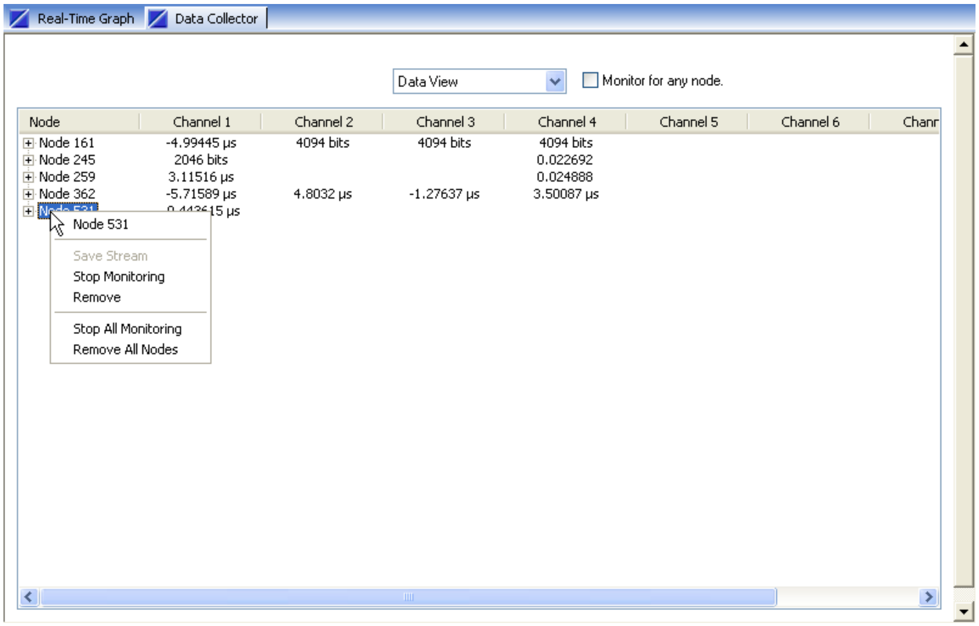

Real-Time Graph
Data Collector
Data View
☐ Monitor for any node.

Node	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Chanr
⊟ Node 245	2045 bits			0.020496			
Timer Tick:	117						
Sample Rate:	1 Hz						
⊟ Node 259	1.55758 µs			0.023424			
Timer Tick:	200						
Sample Rate:	1 Hz						
⊟ Node 362	2052 bits	2061 bits	2036 bits	2041 bits			
Timer Tick:	200						
Sample Rate:	1 Hz						
⊟ Node 531	4034						
Timer Tick:	200						
Sample Rate:	1 Hz						
⊟ Node 161	2054 bits	4093 bits	4094 bits	4094 bits			
Timer Tick:	200						
Sample Rate:	1 Hz						

- Click Graph View and the graphing window appears.
- Click the nodes you want to graph in the Available Nodes frame. A limit of 4 graphs on-screen is enforced.


Real-Time Graph
Data Collector
Graph View
☐ Monitor for any node.
Available Nodes
Node 161
Node 245
Node 259
Node 362
Node 531
Node 161 - Monitoring
Sweep Value
6000
4000
2000
0
0 10 20 30 40 50 60 70 80 90 100 110
Timer Ticks
Node 245 - Monitoring
Sweep Value
3000
2000
1000
0
0 10 20 30 40 50 60 70 80 90 100 110
Timer Ticks
Node 259 - Monitoring
Sweep Value
3
2
1
0
0 10 20 30 40 50 60 70 80 90 100 110
Timer Ticks
Node 362 - Monitoring
Sweep Value
2060
2040
0 10 20 30 40 50 60 70 80 90 100
Timer Ticks

- Return to the Data View, right-click any of the nodes and the menu appears. You can deal with individual nodes as before to Stop Monitoring and/or to Save Stream. You may also click Stop All Monitoring to stop sampling all the nodes at once. ***To return to normal operations, all nodes must be stopped.***
- *Note:* The Monitor For Any Node checkbox can be utilized to collect all nodes transmitting LDC or to limit collection to only those nodes selected. Likewise, the Remove Node or Remove All Nodes menu items can be used to throttle collection.
- To close the Data Collector window, click its upper right hand X.



Data View ☐ Monitor for any node.

Node	Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6	Chanr
Node 161	-4.99445 µs	4094 bits	4094 bits	4094 bits			
Node 245	2046 bits			0.022692			
Node 259	3.11516 µs			0.024888			
Node 362	-5.71589 µs	4.8032 µs	-1.27637 µs	3.50087 µs			
Node 531	0.443615 µs						

Additional Notes

- In the case of multiple nodes, Low Duty Cycle is not expected to and will not deliver every data sample that is transmitted. Contention occurs and the more nodes you add and the higher sampling rates that you apply add to the overall loss of packets.
- A time stamp based on host time writes out with each row of data in files saved from sessions 1 Hz or slower.

Appendix 5: High Speed Streaming with High Speed Streaming software

High Speed Streaming

High Speed Streaming allows you to sample each sensor (each channel) on a node at rates as high as 4000 samples per channel per second. Sensor data is transmitted to the base station as it is sampled (in real-time) and is collected, displayed and saved by the High Speed Streaming software. Please review the *Sampling Rates* section of this manual for sampling rate details.

Operating one node in high speed streaming mode

Please refer to the High Speed Streaming Quick Start Guide which is contained on the Agile-Link™ CD and on our web site.