Agile-Link Wireless Base Stations
2.4 GHz USB, Analog and Serial Base Stations

MicroStrain® Micro Sensors, Big Ideas®   **www.microstrain.com**

Table of Contents

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!

Supported Firmware and Software Versions

Base Station	Firmware version	Software version
USB	2.0.7 and higher	Agile-Link™ 1.4.1 and higher
Analog	2.0.7 and higher	Agile-Link™ 1.4.1 and higher
Serial	2.0.7 and higher	Agile-Link™ 1.4.1 and higher

Table 1

Guide to Relevant Documents

Wireless Node	Document
V-Link®	Agile-Link™ Software Manual
V-Link®	V-Link® Quick Start Guide
V-Link®	V-Link® User Manual
V-Link®	Base Station User Manual
V-Link®	High Speed Streaming Quick Start Guide
SG-Link®	Agile-Link™ Software Manual
SG-Link®	SG-Link® Quick Start Guide
SG-Link®	SG-Link® User Manual
SG-Link®	Base Station User Manual
SG-Link®	High Speed Streaming Quick Start Guide
G-Link®	Agile-Link™ Software Manual
G-Link®	G-Link® Quick Start Guide
G-Link®	G-Link® User Manual
G-Link®	Base Station User Manual
G-Link®	High Speed Streaming Quick Start Guide
TC-Link®	TC-Link® Quick Start Guide (covers Node Monitor)
TC-Link®	TC-Link® User Manual
TC-Link®	Base Station User Manual

Table 2

Overview

Microstrain's 2.4 GHz base stations are designed to operate as an integral part of the Agile-Link™ high speed wireless sensor network, providing communication between the host PC, Single Board Computer or microcontroller and remote wireless nodes including V-Link®, SG-Link®, G-Link® and TC-Link®.

The **USB base station** provides a plug-and-play USB connection. It is light-weight, easily-mountable, has a small footprint and can communicate individually with any wireless node as well as issue network instructions to multiple wireless nodes.

The **Analog base station** provides a plug-and-play USB or RS-232 connection. It is a small footprint console, can be deployed as a stand-alone (without host computer) and can communicate individually with any wireless node as well as issue network instructions to multiple wireless nodes. It also can provide channelized data to analog data acquisition equipment in hybrid or legacy systems.

The **Serial base station** provides a plug-and-play RS-232 connection. It is light-weight, easily-mountable, has a small footprint and can communicate individually with any wireless node as well as issue network instructions to multiple wireless nodes.

USB Base Station

Description

The MicroStrain USB base station is a transceiver which provides a communication link between a host computer and the Agile-Link™ family of wireless nodes including V-Link®, SG-Link®, G-Link® and TC-Link®. The USB base station employs a 2.4 GHz radio with 16 selectable channels to communicate with the remote nodes. The USB base station is connected to a host computer via a USB connection and is operated with MicroStrain's Agile-Link™ software. The USB base station, under instruction from the software, wirelessly communicates with the Agile-Link™ nodes, alternately sending commands and configurations, and receiving responses and data. The USB base station sends all of the commands available to the nodes including ping, datalog, stream data, erase, read and write EEPROM, etc. The USB base station in turn receives acknowledging responses from the nodes and passes datalogging downloads, streaming data, high speed streaming data and low duty cycle data to the host computer. The USB base station is capable of maintaining communications with multiple nodes. Its broadcast mode allows the simultaneous issuance of several commands to multiple nodes.

Installation

- The USB base station is produced with a 3 foot USB cable and standard USB connector made into it.
- The USB connector may be plugged into any available USB port on the host computer.
- The USB base station receives its power from and communicates through the USB port of the host computer.

Operation

The USB base station is automatically powered when it is connected to the host computer's USB port. The blue LED on the face of the USB base station indicates its state.

Once installed and powered, the USB base station becomes a transparent communication link between the host computer and the wireless nodes. The USB base station has no other switches or jumpers to manipulate.

The Agile-Link™ software manual which can be found on the CD, our web site and under the Help menu in the Agile-Link™ software will guide you to operate the overall wireless system.

LED

The USB base station has a **blue** LED on its face. This LED indicates whether or not the base station is receiving power through the USB connection to the host computer. If the LED is not illuminated, the base station is either not plugged in or has a defective circuit. If the LED is illuminated, the base station is properly plugged into the host computer and is powered on.

Radio and Antenna

The USB base station employs a 2.4 GHz IEEE 802.15.4 Compliant and ZigBee™ Ready RF Transceiver to communicate with the Agile-Link™ V-Link®, SG-Link®, G-Link® and TC-Link® wireless nodes. The nodes contain the same transceiver. The radio complies with ETSI EN 300 328, EN 300 440 class 2, FCC CFR-47 part 15 and ARIB STD-T66. The radio is license free worldwide.

The radio is a spread spectrum radio and can be configured to operate on any of 16 separate frequencies ranging from 2.405 GHz to 2.480 GHz. The USB base station is shipped with its frequency set at 2.475 GHz (default). The Agile-Link™ family aliases these frequencies as channel 11 through channel 26 and the USB base station default setting is equivalent to channel 25.

The USB base station has a 2.4 GHz 2.2 dBi omni-directional reverse polarity-SMA "rubber duck" antenna mounted on one end of the base station enclosure.
*   Hyperlink Technologies
*   Model HG2402RD-RSF
*   http://www.hyperlinktech.com/web/hg2402rd_rsf.php

The stated range for the USB base station is up to 70 meters line-of-sight. An optional high gain antenna may be added to the base station to increase the range up to 300 meters line-of-sight.

Please review our technical note *Maximizing Wireless Communication Range* at:
http://www.microstrain.com/pdf/TechNote_2400_RangeExtendingAntennae.pdf

Power

The USB base station is powered by the USB connection to the host computer. The USB port on the host provides 5 volts DC.

Enclosure

The USB base station enclosure is flame retardant high impact plastic. It is a 2 part assembly with base and snap-fit top. It is originally manufactured by New Age Enclosures Model I-401108 and is customized to accommodate the USB cable and antenna mount. More details may be had at: http://www.newageenclosures.com/ProductInfo.aspx?productid=I-401108.

Cables

The USB base station is manufactured with a 3 foot USB cable, with strain relief made into the body of the base station enclosure and terminated with a type A USB connector. The USB cable provides power to the USB base station and communication between the host computer and the USB base station.

USB Driver

The USB connection provides for the physical communication interface between the base station and the host computer. In fact, a software driver is installed during the installation of Agile-Link™ software which makes the USB connection actually appear to the host computer's operating system as a serial port. This driver must be in place in order for the USB connection to operate. More details are available in *Appendix 2*.

Operating Temperature

The USB base station with its standard enclosure will operate between -20° C and +60° C. The enclosure limits this range.

The USB base station electronics alone will operate between -40° C and +85° C.

Extended temperature ranges may be achieved with custom enclosures. Please contact a MicroStrain Sales Engineer with your requirements.

Factory Calibration and Testing

The USB base station requires no calibration. MicroStrain provides a Functional Test Checklist with each base station to document the final testing and configuration of the device. Of particular interest will be the firmware version and radio channel setting. If you already have existing equipment, you will want to compare these parameters with your existing setup.

General Specifications

USB Base Station	MD-TxRx-2400-BASE-USB
Host communication interface	USB 2.0
Cable	3 feet
Power	Powered by host USB port
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)
Range for bi-directional RF link	70 m line-of-sight, up to 300 m with optional high gain antenna
Operating temperature	-20 to +60°C with standard enclosure. -40 to +85°C electronics only
Dimensions	102 mm x 27 mm x 24 mm without antenna, 200 mm x 27 mm x 24 mm with antenna. For dimensioned print go to www.microstrain.com
Weight	59 grams
Case	ABS plastic
Software	Agile-Link™ Windows XP® compatible

Table 3

Mechanical Drawing
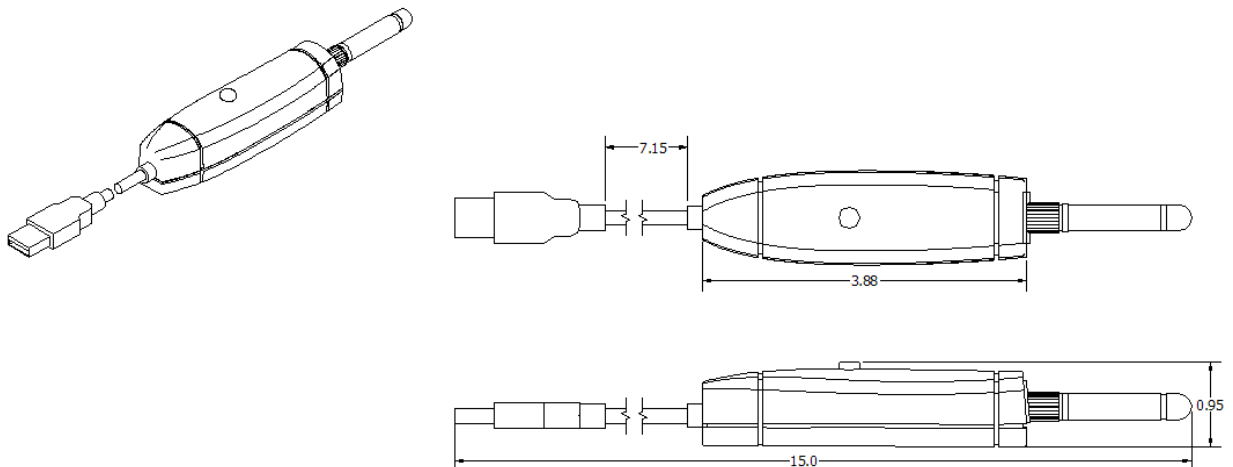
Figure 1

Analog Base Station

Description

The MicroStrain Analog base station is a transceiver which provides a communication link between a host computer and the Agile-Link™ family of wireless nodes including V-Link®, SG-Link®, G-Link® and TC-Link®. The Analog base station employs a 2.4 GHz radio with 16 selectable channels to communicate with the remote nodes. The Analog base station is connected to a host computer via a USB or an RS-232 connection and is operated with MicroStrain's Agile-Link™ software. The Analog base station, under instruction from the software, wirelessly communicates with the Agile-Link™ nodes, alternately sending commands and configurations, and receiving responses and data. The Analog base station sends all of the commands available to the nodes including ping, datalog, stream data, erase, read and write EEPROM, etc. The Analog base station in turn receives acknowledging responses from the nodes and passes datalogging downloads, streaming data, high speed streaming data and low duty cycle data to the host computer. The Analog base station is capable of maintaining communications with multiple nodes. Its broadcast mode allows the simultaneous issuance of several commands to multiple nodes. The Analog base station also features direct analog output of wireless node data on its back panel and is deployable in a stand-alone condition without need of host computer.

Installation

- The Analog base station can be powered either by an external power supply, through the USB connection to the host computer or by battery. The Analog base station is shipped with an external power supply and by default is configured for this power source. The external power supply connects to the connector labeled '6-9V' on the back panel. To reconfigure the power to the USB cable, a jumper must be switched on the Analog base station circuit board as shown in the diagram and chart following.
- The Analog base station is also shipped with a 9 volt battery. Access to the Analog base station circuit board may be gained by removing the 2 screws on the bottom of the analog base station and disassembling the 2 halves of the analog base station enclosure. Insert the battery into the battery cradle. Jumpers do not have to thrown to accommodate the battery. It is suggested that you either run the Analog base station on battery *or* external power supply/USB power. Damage will not occur if both are applied but good practice dictates either one or the other. The analog base station provides no charging circuit for the battery. If you have

occasion to return the Analog base station to the factory, you must remove the battery to insure damage does not occur during shipment thereby invalidating your warranty.

- The Analog base station can communicate with the host computer via USB or RS-232 connection. The Analog base station is shipped with a USB cable and by default is configured in USB mode. The USB cable connects to the connector labeled 'USB' on the back panel of the Analog base station. The Analog base station is also shipped with an RS-232 cable. The RS-232 cable connects to the connector labeled 'RS232' on the back panel of the Analog base station. To reconfigure the communication mode to RS-232, a jumper must be switched on the Analog base station circuit board as shown in the diagram and chart following.

- The Analog base station can output either 0-3 volts or 0-5 volts during steaming operations. The Analog base station is set by default to 0-3 volts. To reconfigure the output voltage to 0-5 volts, a jumper must be switched on the Analog base station circuit board as shown in the diagram and chart following.

- The Analog base station is shipped with a short ¼ wave antenna. The antenna nut should be made onto the antenna connector on the front panel of the Analog base station by hand with the antenna pointing straight up.

Circuit Board Layout with Jumper Configurations
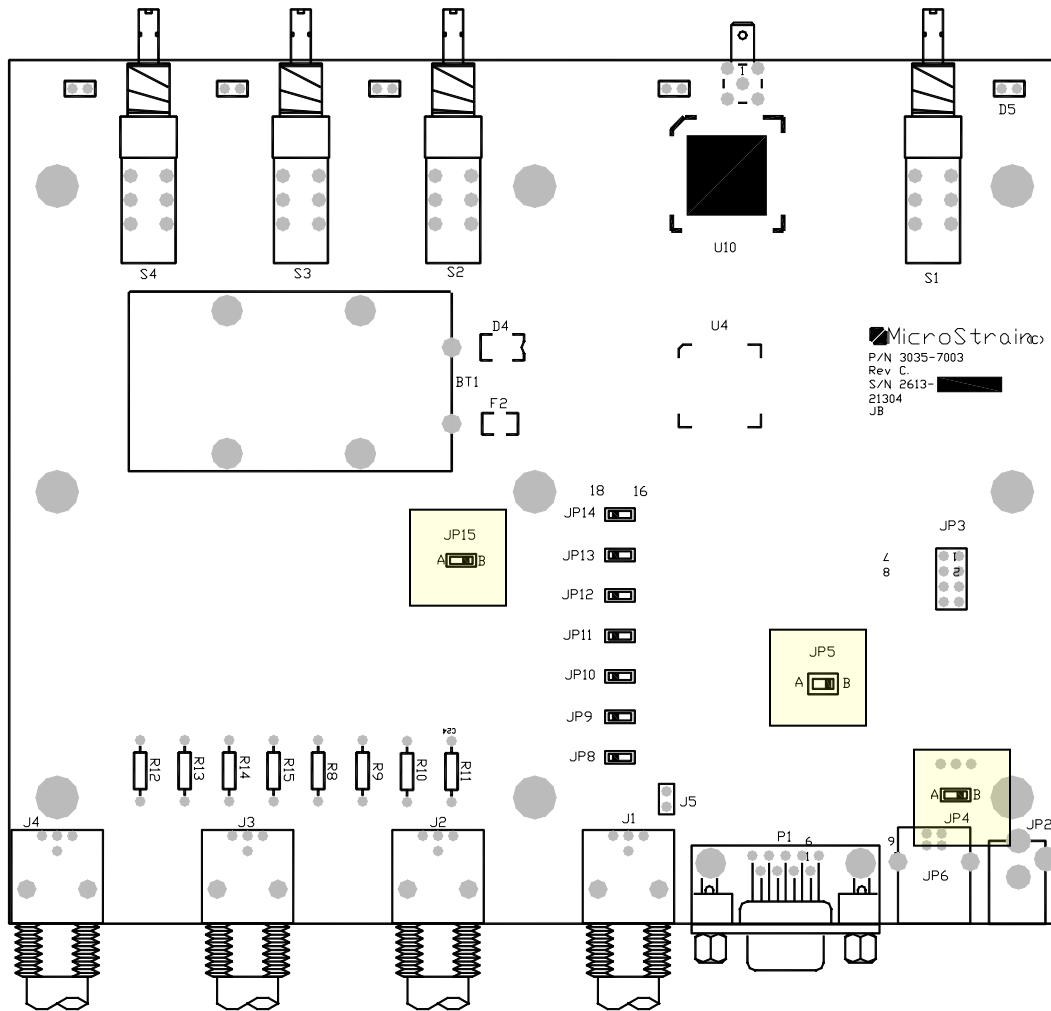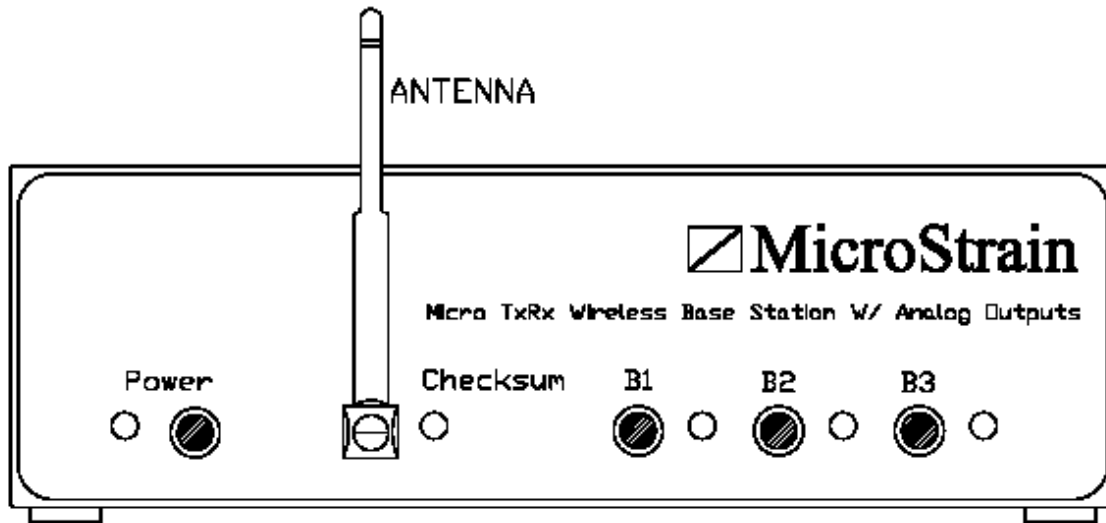
Figure 2

JUMPER CONFIGURATION CHART (Table 4)

Jumper ID	Position A	Position B	Description
JP5	RS-232	USB	Used to select RS-232 or USB communication
JP4	USB	External Power Supply	Used to select power from USB or from external power supply
JP15	0-5 Volts	0-3 Volts	Used to change the analog output level from "0-3V" to "0-5V"
JP8-JP14	NA	NA	For factory use only

Note: Access to the Analog base station circuit board may be gained by removing the 2 screws on the bottom of the Analog base station and disassembling the 2 halves of the Analog base station enclosure.

Front Panel Layout

Figure 3

Function	Description
POWER LED	Power indicator light
POWER Switch	Power switch
ANTENNA	Tuned ¼ wavelength whip antenna
CHECKSUM LED	Checksum error indicator: During streaming, this LED illuminates continuously. In the event of a checksum error, the LED will not illuminate for the duration of the packet error(s) or missing packet(s).
B1	Button 1: Pressing this button triggers the node that is assigned to B1 in the host software.**
B2	Button 2: Pressing this button triggers the node that is assigned to B2 in the host software.**
B3	Button 3: Pressing this button triggers the node that is assigned to B3 in the host software.**
LED1	Indicator LED for B1: This LED illuminates when it is actively listening for streaming data being transmitted from the node that is associated with B1.
LED2	Indicator LED for B2: This LED illuminates when it is actively listening for streaming data being transmitted from the node that is associated with B2.
LED3	Indicator LED for B3: This LED illuminates when it is actively listening for streaming data being transmitted from the node that is associated with B3.

**Only one node can be streamed at a time

Table 5

Back Panel Layout
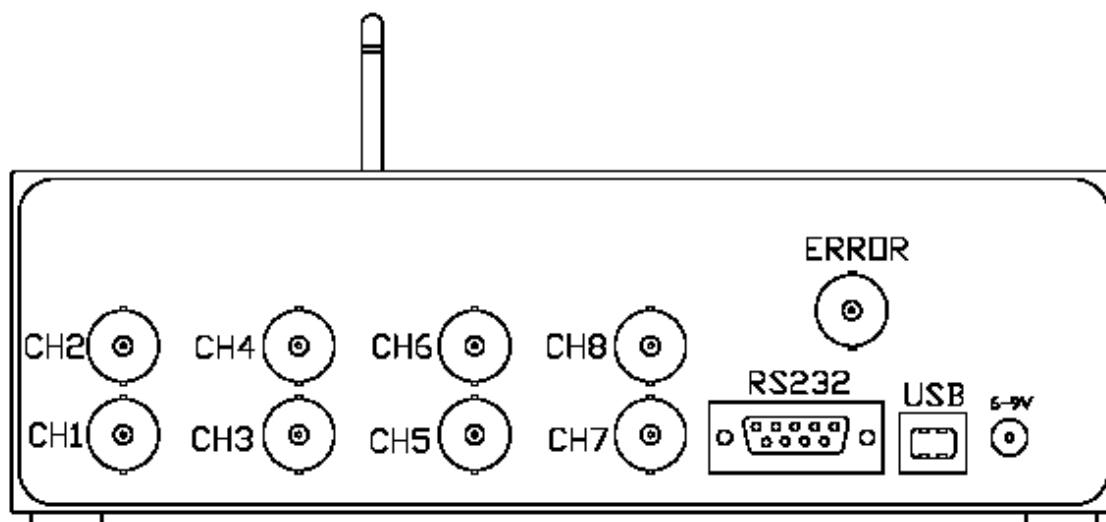
Figure 4

Signal Name	Reference	Direction	Description
CH1 – CH8	Ground	Output	Analog output channels 1-8 at either 0-3 volts (default) or 0-5 volts.
ERROR (Checksum)	Ground	Output	This line is driven high (3 volts) when a data packet containing no checksum error is present. In the event of a checksum error, the line returns to zero (0 volts) until the next packet containing no checksum error is present. This line is always 0-3 volts; it is not altered by changing between 0-3 volts or 0-5 volts output.
RS232	Ground	Input\Output	This connection provides a RS-232 link for configuration and data collection purposes between the software and the base station when JP5 is in position "A".**
USB	Ground	Input\Output	This connection provides a USB link for configuration and data collection purposes when JP5 is in position "B". It also provides power to the base station when JP4 is in position "A"**.
6-9V	Ground	Input	This connection provides a center positive DC voltage to the base station when JP4 is in position B**. This input should be no less than 6 volts DC and not more than 9 volts DC.

**See Jumper Configuration Chart

Table 6

Operation

The Analog base station may be powered-up and powered-down by depressing and releasing the Power switch on the front panel. The green LED to the left of the Power switch indicates its state.

The Analog base station passes all digital information between the wireless nodes (V-Link®, SG-Link®, G-Link® and TC-Link®) and the Agile-Link™ software including ping, erase, datalogging, streaming, high speed streaming, low duty cycle, read/write EEPROM and the like.

The Agile-Link™ software manual which can be found on the CD, our web site and under the Help menu in the Agile-Link™ software will guide you to operate the overall wireless system.

In normal streaming operation, channels 1 through 4 of the SG-Link®, channels 1 through 4 of the G-Link® and channels 1 through 8 of the V-Link® are referenced to the respective analog output channels 1 through 8 of the Analog base station. The active channels on the wireless node will determine the active analog data channels on the Analog base station. Any time the node is streamed whether finite or continuous, the Analog base station will report analog output through its analog ports on the back panel. Inactive channels will report as 0 (zero) volts.

Note: The 6 channel TC-Link does not operate with the analog side of the Analog base station.

Note: The Analog base station does not support high speed streaming on its analog side.

Refer to *Appendix 1* for detailed instructions on how to operate the Analog base station during continuous streaming.

Buttons B1, B2 and B3 on the front panel of the Analog base station can be mapped to a particular node using Agile-Link™ software. This configures the button to initiate streaming of the particular node independently of the host computer (and Agile-Link™ software). Refer to the *B1, B2 and B3 Buttons* section of this manual and the *Base Station Operations* section of the Agile-Link™ software manual for instruction on how to map these buttons.

To begin streaming using buttons B1, B2 or B3, depress and release the button. The LED (LED1, LED2 or LED3) next to the button will illuminate, signaling that the base station is listening for a particular node's streaming. If a bad packet(s) or no packet(s) is received, the Checksum LED will go off for the duration of the bad/missed packets, and the Checksum Error analog output located on the back panel of the Analog base station will output zero volts until the next valid data packet is received. When good packets are being received, the Checksum LED on the front panel will remain illuminated and the voltage will go to 3 volts on the back panel Checksum Error output.

A specialized Low Duty Cycle feature is available in the Analog base station which allows multiple nodes to each send 1 channel of data to separate analog outputs on the back plane. Up to 8 V-Link®s, SG-Link®s and/or G-Link®s can be configured to send one of their channels to the Analog base station which in turn will output that channel to a selected analog port. Please ask MicroStrain support for a technical note which details this process.

Equating Voltage with Engineering Units

The analog output of the Analog base station is a direct reconstruction of the digital voltage data arriving from the wireless node. Please review the *user manuals* for the V-Link®, SG-Link® and G-Link® to scale the analog output into engineering units.

LEDs

The Analog base station has 5 LEDs on its front panel:
- **green** Power LED
- **green** Checksum LED
- **red** B1 (button 1) LED
- **red** B2 (button 2) LED
- **red** B3 (button 3) LED

The **green** Power LED indicates whether or not the base station is receiving power from the external power supply or the internal battery.

If the LED is not illuminated:
- the external power supply is not plugged in, or
- the external power supply has a defective circuit, or
- the on/off switch is off, or
- the battery is not plugged in, or
- the battery is dead.

If the LED is illuminated:
- the external power supply is properly plugged in and delivering power, and the on/off switch is on, or
- the battery is properly plugged in and charged, and the on/off power switch is on.

The **green** Checksum LED indicates whether or not the base station is receiving good data packets during **streaming only**; it has no other purpose. The LED illuminates every time a good data packet is received; this will normally appear to the eye as continuous illumination given that the data is being received at high rates. A blinking LED, an erratic LED or an LED not illuminated are all indications of bad or no data packets. The source of this failure can be poor radio transmission between the base station and the wireless node, interference from radios other than the base station and wireless node, low or no power at the wireless node, missing antennas and the like. See *Appendix 1* in this manual for more details.

The **red** B1, B2 and B3 LEDs indicate that the base station is attempting to receive streaming data from a wireless node. See the *B1, B2 and B3 Buttons* section elsewhere in this manual and *Appendix 1*.

B1, B2 and B3 Buttons

The B1, B2 and B3 buttons allow the base station to start wireless nodes streaming, capture that streaming and to stop capturing the streaming.

The Analog base station can be operated in streaming mode away from its host computer in situations where the data generated by the wireless nodes is acquired through the analog ports on the back panel. By first connecting the base station to the host computer and configuring the base station with Agile-Link™ software, you can assign particular node addresses to each of the 3 buttons. This allows you to disconnect from the host computer, move the base station to a remote location, press a button and start a wireless node streaming its data to the base station. The data would be acquired into a third party data acquisition device (DAQ) via the analog ports of the base station.

Note: This feature only works with V-Link®, SG-Link® and G-Link®; not with TC-Link® as TC-Link® doesn't have a streaming mode.

You may also press the button after the fact to stop the base station from capturing any further data from the streaming node. As discussed in the wireless node manuals, the base station (and Agile-Link™ software) can not stop the node streaming prematurely.

For more in-depth discussion on this subject, see *Appendix 1*.

Radio and Antenna

The Analog base station employs a 2.4 GHz IEEE 802.15.4 Compliant and ZigBee™ Ready RF Transceiver to communicate with the Agile-Link™ V-Link®, SG-Link®, G-Link® and TC-Link® wireless nodes. The nodes contain the same transceiver. The radio complies with ETSI EN 300 328, EN 300 440 class 2, FCC CFR-47 part 15 and ARIB STD-T66. The radio is license free worldwide.

The radio is a spread spectrum radio and can be configured to operate on any of 16 separate frequencies ranging from 2.405 GHz to 2.480 GHz. The Analog base station is shipped with its frequency set at 2.475 GHz (default). The Agile-Link™ family aliases these frequencies as channel 11 through channel 26 and the USB base station default setting is equivalent to channel 25.

The Analog base station has a 2.4 GHz 5.5 dBi omni-directional reverse polarity-SMA "rubber duck" antenna mounted on one end of the base station enclosure.
* Hyperlink Technologies
* Model HG2405RD-RSP
* http://www.hyperlinktech.com/web/hg2405rd_rsp.php

The stated range for the Analog base station is up to 70 meters line-of-sight. An optional high gain antenna may be added to the base station to increase the range up to 300 meters line-of-sight.

Please review our technical note *Maximizing Wireless Communication Range* at:
http://www.microstrain.com/pdf/TechNote_2400_RangeExtendingAntennae.pdf

Power

The Analog base station can be powered either by 1) its USB connection to the host, 2) an external power supply or 3) an internal 9 volt battery.

The USB port on the host computer provides 5 volts DC to the Analog base station. The back panel of the base station has a port labeled "USB" which accommodates the B type USB connector from the USB cable running to the host computer.

The Analog base station is shipped with a Phihong brand external power supply Model PSA05R-090 http://www.phihong.com/assets/pdf/PSA05R.pdf . The power supply is a 'switching' supply and may receive an input from 100 to 240 Volts AC. It outputs +9 Volts DC. A set of 4 plug adapters are provided to accommodate most countries' electrical services. The back panel of the Analog base station has a port labeled "6-9V" which accommodates the external power supply barrel connector.

The Analog base station is shipped with a Panasonic brand industrial grade non-rechargeable 9 volt battery Model 6AM-6PI. The battery may be installed in a battery cradle mounted on the circuit board of the Analog base station. Access to the circuit board may be had by removing the 2 screws holding the cover. Use care in inserting/removing the battery.

Power consumption in all cases is less than 100 mA.

Note: It is suggested that you either run the Analog base station on battery *or* external power supply/USB power. Damage will not occur if both are applied but good practice dictates either one or the other.

Note: The voltage supplied by various computers via the USB port can vary from 4.75 volts to 5.25 volts. If you are using the 0-5 volts analog output, you must run either off battery or the external power supply. Running off USB can be problematic. USB is fine for 0-3 volts analog output.

Power Switch

The Analog base station has a red Power Switch on the front panel. Depress the switch to its inward detent to turn power on; depress the switch to its outward detent to power off. When the power switch is turned on, the **green** Power LED will illuminate continuously and there will be a momentary consecutive illumination of each of the other 4 LEDs on the front panel plate indicating boot-up. When the Power Switch is turned off, the **green** Power LED will no longer illuminate.

Enclosure

The Analog base station enclosure is flame retardant high impact plastic. It is a 4 part assembly with base, removable cover, front and rear panels. It is originally manufactured by Simco Model 250X86. MicroStrain remanufactures the base to accommodate the RS-232 connection, USB connection, power connection, analog ports, LEDs, power switch, launch buttons and antenna mount. More details may be had at: http://www.simco-online.com/The-Challenger-Series-c-263.html.

Cables

The Analog base station is manufactured with two physical communication interfaces: 1) a female type B USB connector and 2) a female 9-pin RS-232 connector. Both connectors are made into the base station's back panel.

Two cables are provided: 1) a 6 foot USB cable, terminated with type A USB connector on one end and type B connector on the other and 2) a 6 foot RS-232 cable, terminated with male 9-pin connector on one end and female 9-pin connector on the other.

The USB cable provides power to the USB base station and communication between the host computer and the USB base station. The RS-232 cable provides communication between the host computer and the USB base station.

BNC Connectors

The back panel of the Analog base station has 9 BNC type connectors for analog output (Channels 1 through 8 and the Checksum Error). These connectors are RFX female sockets Digikey www.digikey.com part number ARFX1064-ND and accommodate standard BNC male connectors.

USB Driver

The USB connection provides for the physical communication interface between the base station and the host computer. In fact, a software driver is installed during the installation of Agile-Link™ software which makes the USB connection actually appear to the host computer's operating system as a serial port. This driver must be in place in order for the USB connection to operate. More details are available in *Appendix 2*.

Operating Temperature

The Analog base station with its standard enclosure will operate between -20° C and +60° C. The battery (if in use) and enclosure limit this range.

The Analog base station electronics alone will operate between -40° C and +85° C.

Extended temperature ranges may be achieved with custom batteries and enclosures. Please contact a MicroStrain Sales Engineer with your requirements.

Factory Calibration and Testing

The Analog base station requires no calibration. MicroStrain provides a Functional Test Checklist with each base station to document the final testing and configuration of the device. Of particular interest will be the firmware version and radio channel setting. If you already have existing equipment, you will want to compare these parameters with your existing setup.

General Specifications

Analog Base Station	MD-TxRx-2400-BASE-AU
Host communication interface	USB 2.0, RS232, 115.2 KBaud
Cable	6 foot cable with male/female USB connectors and 6 foot cable with male/female DB9 connectors
Power	Powered by host USB port, external 6-9 volt VDC power source (6 VDC 500 mA adapter included) or 9 volt internal battery
Analog outputs	Supports one wireless node with up to 8 channels or 8 wireless nodes with 1 channel. Provides 0 to 3 or 0 to 5 volt referenced output (user selectable) and checksum channel
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
Range for bi-directional RF link	70 m line-of-sight, up to 300 m with optional high gain antenna
Operating temperature	-20 to +60°C with standard enclosure. -40 to +85°C electronics only
Dimensions	200 mm x 66 mm x 156 mm without antenna. For dimensioned print go to www.microstrain.com
Weight	878 grams
Case	ABS plastic
Software	Agile-Link™ Windows XP® compatible

Table 7

Mechanical Drawing
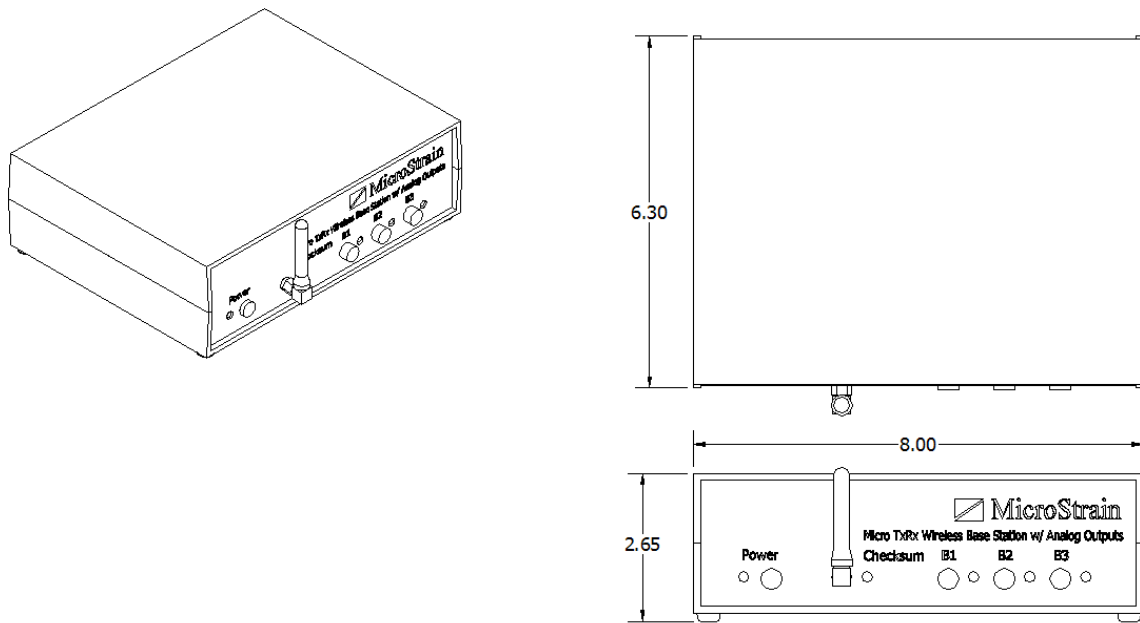
Figure 5

Serial Base Station

Description

The MicroStrain Serial base station is a transceiver which provides a communication link between a host computer and the Agile-Link™ family of wireless nodes including V-Link®, SG-Link®, G-Link® and TC-Link®. The Serial base station employs a 2.4 GHz radio with 16 selectable channels to communicate with the remote nodes. The Serial base station is connected to a host computer via an RS-232 connection and is operated with MicroStrain's Agile-Link™ software. The Serial base station, under instruction from the software, wirelessly communicates with the Agile-Link™ nodes, alternately sending commands and configurations, and receiving responses and data. The Serial base station sends all of the commands available to the nodes including ping, datalog, stream data, erase, read and write EEPROM, etc. The Serial base station in turn receives acknowledging responses from the nodes and passes datalogging downloads, streaming data, high speed streaming data and low duty cycle data to the host computer. The Serial base station is capable of maintaining communications with multiple nodes. Its broadcast mode allows the simultaneous issuance of several commands to multiple nodes.

Installation

- The Serial base station is shipped with a 6 foot standard RS-232 cable. The male DB-9 end connects to the Serial base station; the female DB-9 end connects to the host computer.
- The Serial base station is shipped with an external power supply. The male barrel connector plugs into the female barrel connector on the side of the Serial base station enclosure and the prong end plugs into the appropriate electrical source.
- The Serial base station is also shipped with a 9 volt battery. The battery may be installed by removing the 4 screws on the cover and inserting the battery into the battery cradle. It is suggested that you either run the serial base station on battery *or* external power supply. Damage will not occur if both are applied but good practice dictates either one or the other. The Serial base station provides no charging circuit for the battery. **Note:** If you have occasion to return the Serial base station to the factory, you must remove the battery to insure damage does not occur during shipment thereby invalidating your warranty.
- The Serial base station is shipped with a short ¼ wave antenna. The antenna nut should be made onto the antenna connector on the side of the serial base station by hand with the antenna pointing straight up.

Operation

The Serial base station may be powered-up and powered-down by flipping the Power switch on the side of the enclosure (up towards label is on; down is off). The green LED to the right of the Power switch indicates its state.

Once installed and powered, the Serial base station becomes a transparent communication link between the host computer and the wireless nodes. The Serial base station has no other switches or jumpers to manipulate.

The Agile-Link™ software manual which can be found on the CD, our web site and under the Help menu in the Agile-Link™ software will guide you to operate the overall wireless system.

LED

The Serial base station has a **green** LED on its face. This LED indicates whether or not the base station is receiving power from the external power supply or the internal battery.

If the LED is not illuminated:
- the external power supply is not plugged in, or
- the external power supply has a defective circuit, or
- the Power switch is off, or
- the battery is not plugged in, or
- the battery is dead.

If the LED is illuminated:
- the external power supply is properly plugged in and delivering power, and the Power switch is on, or
- the battery is properly plugged in and charged, and the Power switch is on.

Radio and Antenna

The Serial base station employs a 2.4 GHz IEEE 802.15.4 Compliant and ZigBee™ Ready RF Transceiver to communicate with the Agile-Link™ V-Link®, SG-Link®, G-Link® and TC-Link® wireless nodes. The nodes contain the same transceiver. The radio complies with ETSI EN 300 328, EN 300 440 class 2, FCC CFR-47 part 15 and ARIB STD-T66. The radio is license free worldwide.

The radio is a spread spectrum radio and can be configured to operate on any of 16 separate frequencies ranging from 2.405 GHz to 2.480 GHz. The Serial base station is shipped with its frequency set at 2.475 GHz (default). The Agile-Link™ family aliases these frequencies as channel 11 through channel 26 and the Serial base station default setting is equivalent to channel 25.

The Serial base station has a 2.4 GHz 2.2 dBi omni-directional reverse polarity-SMA "rubber duck" antenna mounted on one end of the base station enclosure.

- Hyperlink Technologies
- Model HG2402RD-RSF
- http://www.hyperlinktech.com/web/hg2402rd_rsf.php

The stated range for the Serial base station is up to 70 meters line-of-sight. An optional high gain antenna may be added to the base station to increase the range up to 300 meters line-of-sight.

Please review our technical note *Maximizing Wireless Communication Range* at: http://www.microstrain.com/pdf/TechNote_2400_RangeExtendingAntennae.pdf

Power

The Serial base station can be powered either by an external power supply or an internal 9 volt battery.

The Serial base station is shipped with a Phihong brand external power supply Model PSA05R-090 http://www.phihong.com/assets/pdf/PSA05R.pdf . The power supply is a 'switching' supply and may receive an input from 100 to 240 Volts AC. It outputs +9 Volts DC. A set of 4 plug adapters are provided to accommodate most countries' electrical services. The sidewall of the Serial base station has a port to accommodate the external power supply.

The Serial base station is shipped with a Panasonic brand industrial grade non-rechargeable 9 volt battery Model 6AM-6PI. The battery may be installed in a battery cradle mounted on the circuit board of the Serial base station. Access to the circuit board may be had by removing the 4 screws holding the cover. Use care in inserting/removing the battery.

Note: There is no charging circuit for the battery and the external power supply does not charge the battery when applied.

Note: It is suggested that you either run the Serial base station on battery *or* external power supply. Damage will not occur if both are applied but good practice dictates either one or the other.

Enclosure

The Serial base station enclosure is flame retardant ABS plastic. It is a 2 part assembly with base and removable cover. It is originally manufactured by Polycase® Model LP-35FMB. MicroStrain remanufactures the base to accommodate the RS-232 connection, LED, Power switch and antenna mount. More details may be had at: http://www.polycase.com/item/lp-35f.html.

Cables

The Serial base station is manufactured with a female 9-pin RS-232 connector made into its sidewall. A 6 foot RS-232 cable, terminated with male 9-pin connector on one end and female 9-pin connector on the other is provided with the Serial base station. The RS-232 cable provides communication between the host computer and the USB base station.

Operating Temperature

The Serial base station with its standard enclosure will operate between -20° C and +60° C. The battery (if in use) and enclosure limit this range.

The Serial base station electronics alone will operate between -40° C and +85° C.

Extended temperature ranges may be achieved with custom batteries and enclosures. Please contact a MicroStrain Sales Engineer with your requirements.

## Factory Calibration and Testing

The Serial base station requires no calibration. MicroStrain provides a Functional Test Checklist with each base station to document the final testing and configuration of the device. Of particular interest will be the firmware version and radio channel setting. If you already have existing equipment, you will want to compare these parameters with your existing setup.

General Specifications

Serial Base Station	MD-TxRx-2400-BASE-232
Host communication interface	RS232, 115.2 KBaud
Cable	6 foot cable with male/female DB9 connectors
Power	Powered by external 6-9 volt VDC power source (6 VDC 500 mA adapter supplied) or 9 volt internal battery
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
Range for bi-directional RF link	70 m line-of-sight, up to 300 m with optional high gain antenna
Operating temperature	-20 to +60°C with standard enclosure. -40 to +85°C electronics only
Dimensions	133 mm x 84mm x 36 mm without antenna. For dimensioned print go to www.microstrain.com
Weight	170 grams
Case	ABS plastic
Software	Agile-Link™ Windows XP® compatible

Table 8

Mechanical Drawing
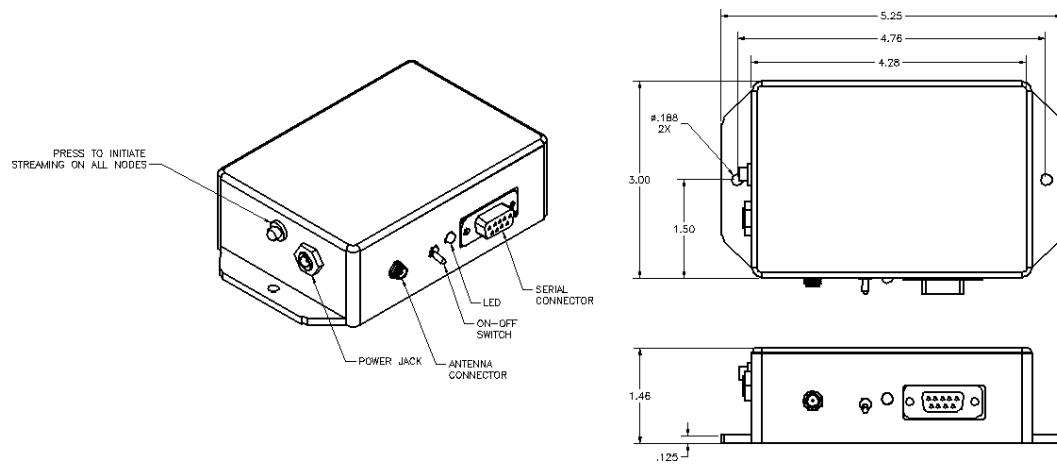
Figure 6

Software

Standard Offering

All base stations are shipped with a CD containing Agile-Link™ software, High Speed Streaming software and TC-Link® Node Monitor software. These three softwares together support all capabilities of the base stations 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, High Speed Streaming software or TC-Link® Node Monitor software, your computer must have the following minimum specifications:

- 300 MHz microprocessor
- Microsoft® Windows XP SP2 operating system
- CD-ROM drive
- Video resolution 800 X 600
- 16MB video card
- Minimum of 16MB of memory
- Minimum of 15MB 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.
    - o This installation places the Agile-Link™ software on your PC as well as required base station drivers. See *Appendix 2* for more details.
    - o Agile-Link™ is designed for use with 2.4 GHz V-Link®, SG-Link® and G-Link®.
    - o Agile-Link™ software should not be used to operate the TC-Link® but it must be installed to configure the TC-Link®'s base station.
- The High Speed Streaming software is designed for use with the 2.4 GHz V-Link®, SG-Link® and G-Link®.
    - o If you intend to use High Speed Streaming, install the software from the CD menu.
    - o High Speed Streaming software is not for use with the TC-Link®.
    - o Refer to the *High Speed Streaming Quick Start Guide* for specialized details.
- The TC-Link® Node Monitor software is designed for use with the 2.4 GHz TC-Link®.
    - o If you intend to use TC-Link® Node Monitor, install the software from the CD menu.

- o TC-Link® Node Monitor software is not for use with the V-Link®, SG-Link® and G-Link®.
- A *Quick Start Guide* for your particular wireless node (2.4 GHz V-Link®, SG-Link®, G-Link® or TC-Link®) is provided on the CD to get you up and running.

Data Communications Protocol

Customers and/or developers wishing to customize the base stations are encouraged to purchase 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 Agile-Link™ family of wireless sensors including V-Link®, SG-Link®, G-Link® and TC-Link®. 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
- Ping node
- Read node EEPROM
- Write node EEPROM
- Download node datalogging page
- Erase node datalogging pages
- Trigger node datalogging
- Stream node sensor data
- Sleep/Wake node
- Read node single sensor
- Set analog base station
- Broadcast to nodes
- Cycle power
- Set radio frequencies/features
- Specialized TC-Link® commands
- High speed streaming
- Stop node
- Low duty cycle

Sample applications demonstrating most protocol commands are provided with fully-commented source code and a compiled executable for Microsoft® C++ 6.0, Microsoft® Visual Studio C++ .NET 7.1, Microsoft® VB 6.0, 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 CD with one license for use.

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 supersedes 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 legal 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 Products for any reason within thirty (30) days of the date of shipping from MicroStrain. To qualify for credit or refund (excluding shipping, duties or taxes), Buyer must contact MicroStrain 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.

6. **Export Regulations.** 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.

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 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 ANUFACTURED 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.

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 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 Hardware during the 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 Hardware need not be new or have an identical make, model or part. MicroStrain may in its sole discretion replace the defective Hardware (or any part thereof) with any reconditioned Product that MicroStrain reasonably determines

is substantially equivalent (or superior) in all material respects to the defective Hardware. Repaired or replacement Hardware will be warranted for the remainder of the original 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 Hardware, the price paid by the original purchaser for the defective Hardware will be refunded by MicroStrain upon return to MicroStrain of the defective Hardware. All Hardware (or part 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 hardware and software of MicroStrain's 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 Hardware 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 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 nonconforming.

14. **What Is Not Covered**. This limited warranty provided by MicroStrain does not cover: Products, if in MicroStrain's 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 act 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.

15. **Copyright Statement**. No part of this publication or documentation accompanying this Product may be reproduced in any form or by any means or used to make any derivative such as translation, transformation, or adaptation without permission from MicroStrain as stipulated by the United States Copyright Act of 1976, as amended. Contents are subject to change without prior notice. Copyright© 2005 by MicroStrain, Inc. All rights reserved.

16. **Choice of Law.** These terms and any agreement between MicroStrain and buyer shall be interpreted in accordance with the laws of the State of Vermont, USA, but with regard to its choice of law provisions. Any action to enforce any such terms shall be in the courts of 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 License 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 license 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 License 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.

Appendix 1: Continuous Streaming on an Analog base station

Purpose

The purpose of this appendix is to explain how continuous streaming works on an Analog base station. In addition, this appendix discusses instances in which one would want to use the continuous streaming option, complications that may arise when a user uses continuous streaming when it's not applicable, and some tips and tricks for using the continuous streaming with Agile-Link™ software.

For the duration of this appendix, any reference to base station can be construed as a reference to an Analog base station unless explicitly noted.

Summary

Continuous streaming on the Analog base station is intended for users who wish to stream their wireless node(s) continuously. Because the Analog base station can only receive one stream, the user may only continuously stream one node at a time on a radio frequency that matches that of the base station. Having multiple nodes on the same frequency streaming at the same time will cause an exceptionally high number of false checksums and render streaming from the nodes useless.

To alleviate any confusing instances it is advised that the user only enable continuous streaming on the Analog base station when the node is also in a state of continuous streaming. Furthermore, the user should only enable continuous streaming on the base station as a final step to setting up their test. In other words, when initially setting up, perform all initial tests with the nodes streaming for a finite amount of time (i.e., the node isn't set to continuous stream) with continuous streaming turned off on the base station. This is important as it reduces the number of variables that may cause problems when running initial tests. If the user's tests succeed with finite streaming and enabling continuous streaming produces unusual results, it helps the user locate where the problem is occurring.

How It Works

The Analog base station works without an attached computer with the assistance of three buttons on the front of the base station itself. These buttons are labeled B1, B2, and B3. When continuous streaming is disabled, striking any one of these buttons causes the base station to send a streaming signal to the desired node. To be more specific, the steps for starting a stream on the base station are as follows:

The user pushes either button B1, B2, or B3. For this example, we'll assume B1. The Analog base station reads its EEPROM address that corresponds to B1 to obtain the node address with which it is to initiate a stream. For this example, we'll assume the node address is 100.

Next, the Analog base station attempts to read an EEPROM location on node 100 to read the channel mask. The channel mask must be read so that the base station knows which analog outputs are active. This read is important because the node's streamed data does not contain the channel mask at any point in time. Without knowing the channel mask, the analog base station would not know the correct analog outputs to use.

Next, the base station sends a streaming command to node 100 and node 100 begins streaming data back to the base station. The base station, knowing which channels are active, parses the incoming stream and outputs the data to the analog outputs.

The image below shows a graphical representation of the above explanation.
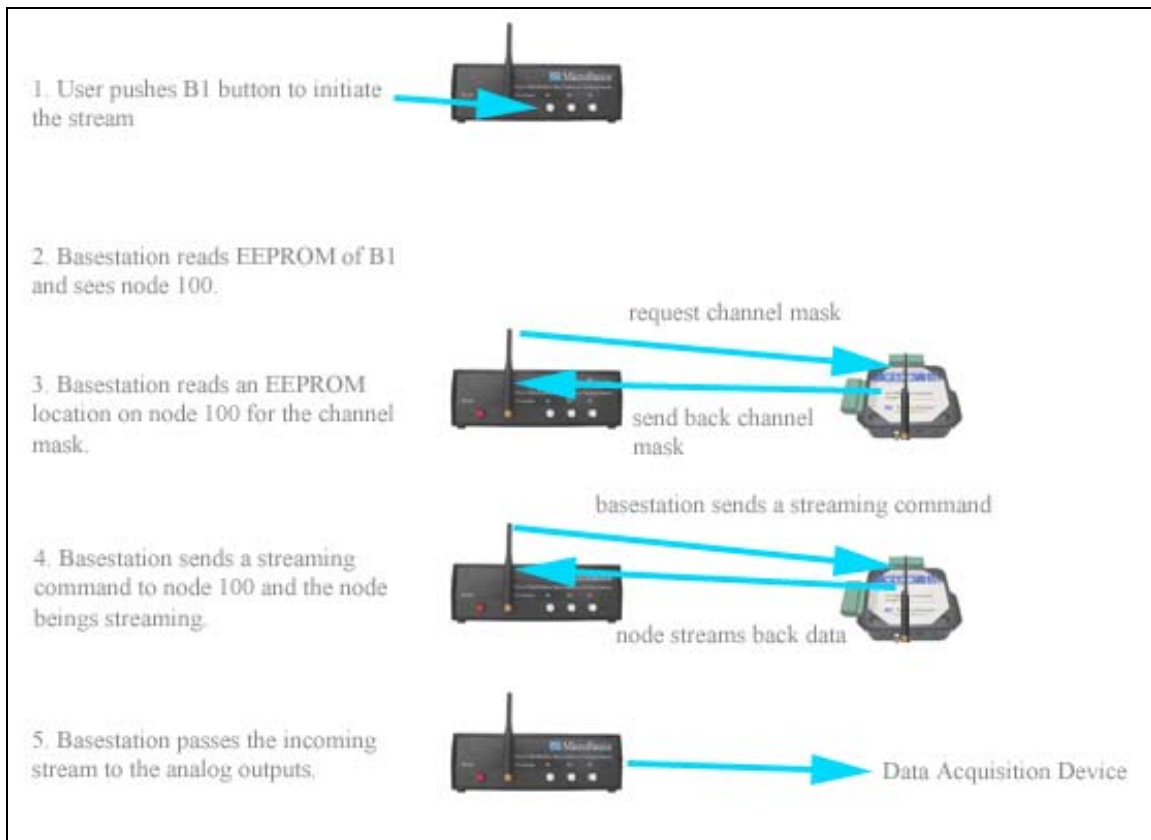
As this document later explains, step 3 is the critical difference between the base station being in a non-continuous streaming state and a continuous streaming state.

When continuous streaming is disabled, there are four methods the analog base station uses to stop listening for a stream initiated from a button push. Note that none of these methods stop the node from streaming. These methods are listed below with an explanation.

End of Stream Flag – When the node is in a finite streaming state, it will send a certain consecutive number of bytes that signals it has completed its streaming session. Upon receiving these bytes, the base station will stop listening for an incoming stream.

B3 Cancel Button – The base station will stop listening for a stream when the B3 button is pushed. The B3 button only acts as a cancellation method when the base station is in a streaming state. This means that if the base station is not in a streaming state, the B3 button will act in the same way as the B1 and B2 buttons; attempting to initiate a stream with its corresponding node.

PC Comm – Should the user also have their base station plugged into a computer, one can stop the base station by sending a single byte to the base station. From Agile-Link™ software, this means attempting to communicate with the base station or any node who is a child of that base station.

Dropout Detection – The base station will stop listening to a stream if a good sweep is not received from the node within a certain amount of time. For example, this could be caused by radio interference being introduced into the system or the base station failing to receive the end of stream flag from the node.
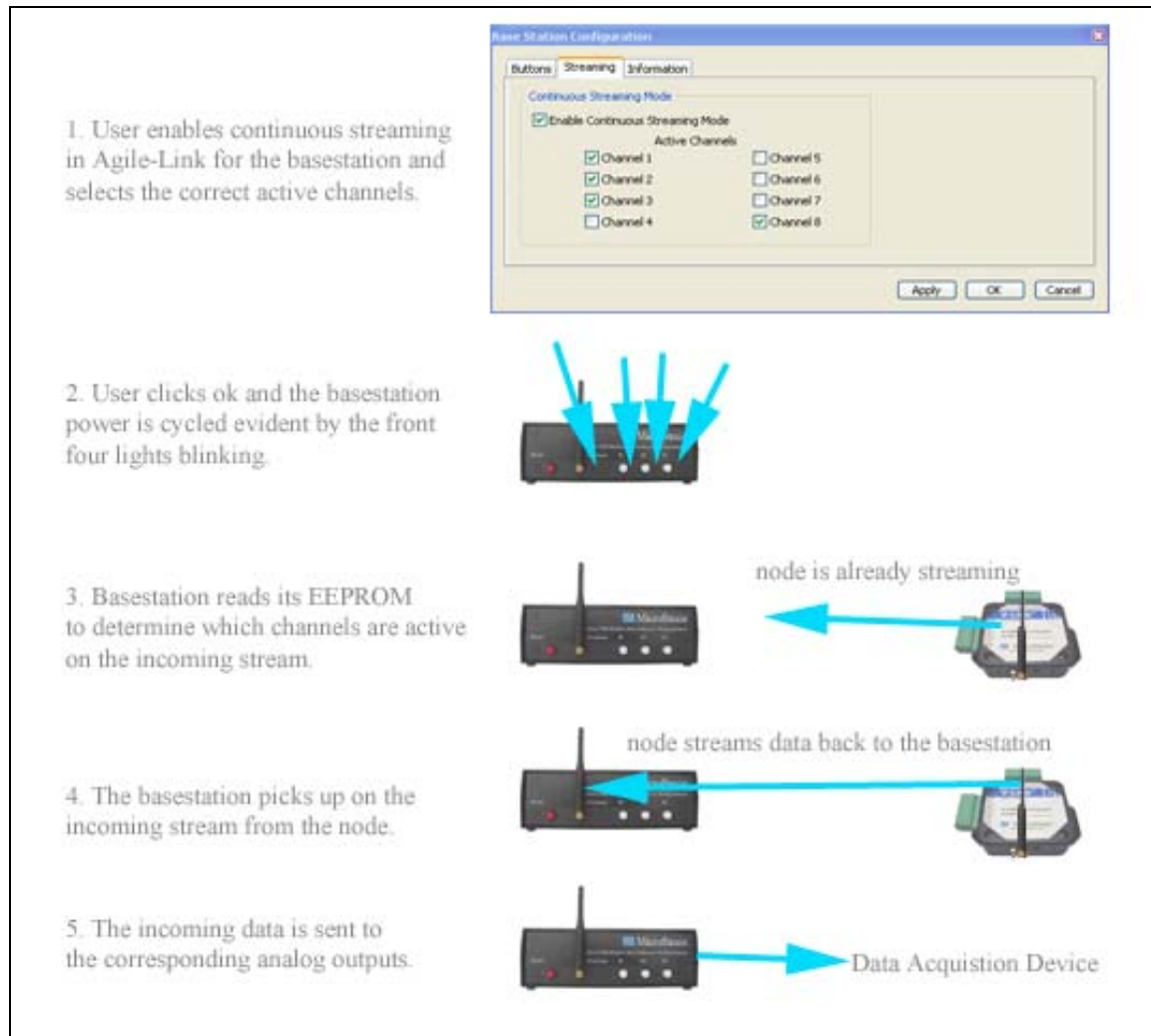
Enabling continuous streaming on the base station acts in a slightly different fashion. The following conditions must be met for continuous streaming work correctly:
- The desired node must be streaming when the base station has continuous streaming enabled.
- The base station must have its power cycled to begin listening for a stream. When enabling continuous streaming in Agile-Link™ software, hitting the Apply or OK buttons will automatically cause the base station to cycle its power.

The example below assumes the two conditions above are met. Without these conditions being met, continuous streaming on the analog base station will not work successfully. Specifically, we'll assume that node 100 is streaming continuously.
- The user enables continuous streaming in Agile-Link™ software. Upon enabling continuous streaming, the user also selects which channels are active on node 100. If the user selects the wrong channels, continuous streaming on the base station will not work and analog outputs will be wrong as explained later.
- The user clicks the OK button on the configuration screen and the power on the analog base station is cycled.
- After the power is cycled, the base station immediately sees that continuous streaming is enabled and reads the EEPROM address corresponding to the channels it should assume are active.
- The base station listens for an incoming stream. It does not care which node it is listening for, just that there is a stream and that the channels active on the node are the same as those in the EEPROM on the base station.
- The incoming streamed data is sent out the analog outputs that correspond to the active channels recorded in the base station's EEPROM.

The image below shows a graphical representation of the above explanation.

As earlier noted, the main difference between the normal mode of operation and continuous streaming on the base station is how the base station determines which channels are active. When continuous streaming is disabled, the base station attempts to read an EEPROM location on the node to obtain the active channels. When continuous streaming is enabled the base station reads its own EEPROM to obtain which channels are active.

The reasons the base station needs a record of which channels are active on the continuously streaming node when continuous streaming is active on the base station is due to the following:

The base station needs to know to which analog outputs to send data. At no point in the stream are the active channel numbers sent over the air. The base station cannot detect a node's stream and request that it also send the active channel mask because streaming nodes have their radios shut off for receiving commands until their streaming completes.

As long as the list of active channels on the base station matches the active channels on the node and the node is streaming, continuous streaming on the base station will work without a problem.

To stop the base station from listening for a stream while in continuous streaming mode, the user only has two options. These two options are the B3 cancel button and the PC Comm described above. This means the user can stop the base station by hitting the B3 button or sending a single byte to the base station. Note that these options do not cause the node to actually stop streaming.

Tips and Tricks

Piggybacking on a stream with Agile-Link™ software

It is possible to initiate a stream on the Analog base station and watch the stream through Agile-Link™ software. This is possible because the Analog base station always processes both the digital and analog sides of the streaming data. It does not matter if the Analog base station is in a state of continuous streaming or not.

To piggyback on a stream through Agile-Link™ software, right-click on the desired node and select Stream->Resync as shown in the figure below.
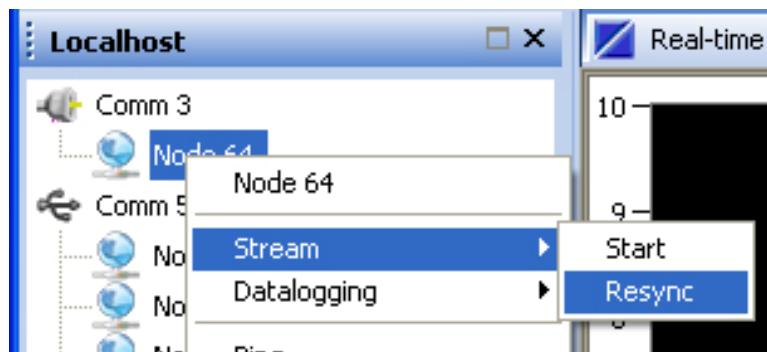
A dialog box similar to the one below will appear. You will need to select which channels are active on the node. Selecting the matching active channels is important for the same reason the Analog base station needed to know the active channels in advance; there's no way to ask the node which channel's are active. In addition, it is extremely important to select the "Sync from analog button stream" checkbox. If this is not selected, a byte will be sent to the base station and it will be knocked out of its listening mode. This is analogous to the PC Comm cancellation method described above.
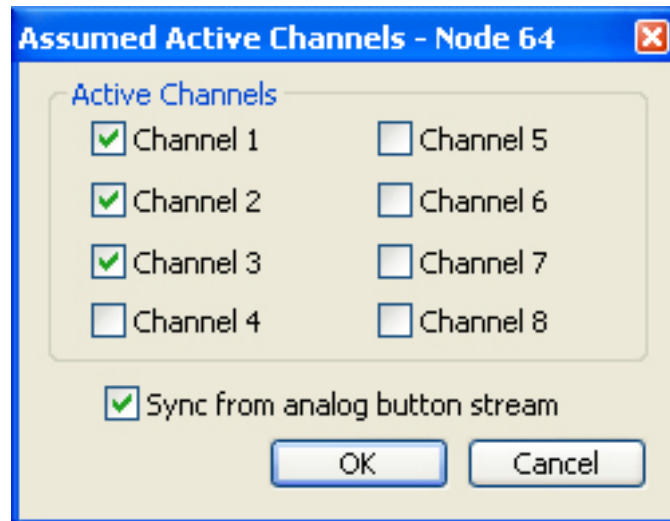
After all configurations are correct, select the OK button. If the base station is currently intercepting a stream, it will show the results in the Agile-Link™ software graphing window.

Troubleshooting

Analog outputs do not seem to be sending data
The reason no analog output may be coming out of the base station is because the active channels recorded in the Analog base station are wrong or there is no streaming over the air. This is most easily detected by viewing the Checksum LED on the front panel of the Analog base station.

The first thing to try is to turn off continuous streaming on the base station by right-clicking the base station in Agile-Link™ software, selecting Configure-> Streaming. Uncheck "Enable Continuous Streaming Mode" and click OK. Make sure the node is available for communications and attempt to stream the node through Agile-Link™ software. If streaming succeeds, attempt to stream the node using its corresponding button on the Analog base station. If the Analog base station puts out voltage it is very likely that the base station thinks the wrong channels are active. Attempt to configure the node through Agile-Link™ software and verify that the active channels on the node match those on the Analog base station.

If any of the above options fail, make sure both devices are communicating correctly. There is always the chance of a dead battery, external radio interference, etc.

The Analog base station is sending data to the wrong analog outputs while in continuous streaming
This is most commonly the result of the base station having the correct number of incoming channels, but the wrong channels are active. To remedy this, cycle the node's power such that streaming does not continue. Through Agile-Link™ software, select the desired node, right-click it, select Configure, and make note of which channels are active.

Right-click on the Analog base station, select Configure->Streaming tab. Make sure that the active channels match the active channels on the node.

<u>The Checksum LED stays off while in continuous streaming mode on the base station</u>
This can be caused by any number of things. The most likely is that the node isn't streaming anything. Turn off continuous streaming and attempt to communicate with the node and stream it from within Agile-Link™ software.

Another possibility is that the number of active channels on the Analog base station is wrong. The base station can correctly parse an incoming stream; however, it uses the EEPROM to determine which channels are active. If the number of channels being streamed does not match the number of active channels that the base station thinks are being streamed, the Checksum LED will remain off. At this point, the user should disable the continuous streaming, cycle the power on the node, and check to make sure that both devices have the same active channels.

Appendix 2: 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