



48 Spencer Street
Lebanon, NH 03766, USA
Tel: 603-448-1562
Fax: 603-448-3216
Email: geokon@geokon.com
<http://www.geokon.com>

Instruction Manual
Model 8800 series
GeoNet Wireless



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1. INTRODUCTION

GeoNet is a low power, wireless, data acquisition network, designed to efficiently collect data from many points. GeoNet is especially beneficial in geographically challenging locations where a wired infrastructure would be expensive, if not impossible. The system consists of a Network Supervisor, Sensor Nodes, and Agent Software. (For information regarding the installation and use of Agent Software, please see the appropriate product manual.)

Features:

- Worldwide operation at 2.4 GHz or select countries at 900 MHz (920 MHz in Australia)
- Up to 100 Nodes per network (Fewer with the use of GeoNet multiplexers, see Section 3.)
- 12 channels available
- Each Node is capable of storing more than one million data arrays
- Operates with alkaline or lithium batteries

1.1 Sensor Node

Sensor Nodes collect battery and temperature data and will read any of Geokon's vibrating wire sensors. Each Node can read one sensor by itself, or up to eight sensors when connected to a GeoNet Multiplexer.

Nodes ship with the following accessories:

- One 2.1 dBi omnidirectional antenna (For other antenna possibilities, please contact Geokon technical support.)
- Two D cell batteries
- Four desiccant packs

1.2 Network Supervisor

The Supervisor controls the network and is the aggregator of all data collected by the sensor Nodes. While the Supervisor is similar to the Nodes in that it will read battery and temperature data, it does not accommodate a vibrating wire sensor. Data stored by the Supervisor may be collected by using Agent software or any other Modbus master. (For information regarding the use of Modbus with GeoNet hardware please see Appendix D.)

Supervisors ship with the following accessories:

- Two D cell batteries
- Set of two screwdrivers, one Phillips Head and one Flat Head
- Four desiccant packs
- One firmware update cable
- One RS-232 or USB communications cable (depending on the model purchased)
- One 2.1 dBi omnidirectional antenna (For other antenna possibilities, please contact Geokon technical support.)

1.3 Network Considerations

GeoNet uses network technology that is self-configuring and self-healing. Data from the Nodes is either sent directly to the Supervisor, or it arrives via communication between the Nodes. This effectively creates a cluster tree topology. Figure 1 illustrates this concept.

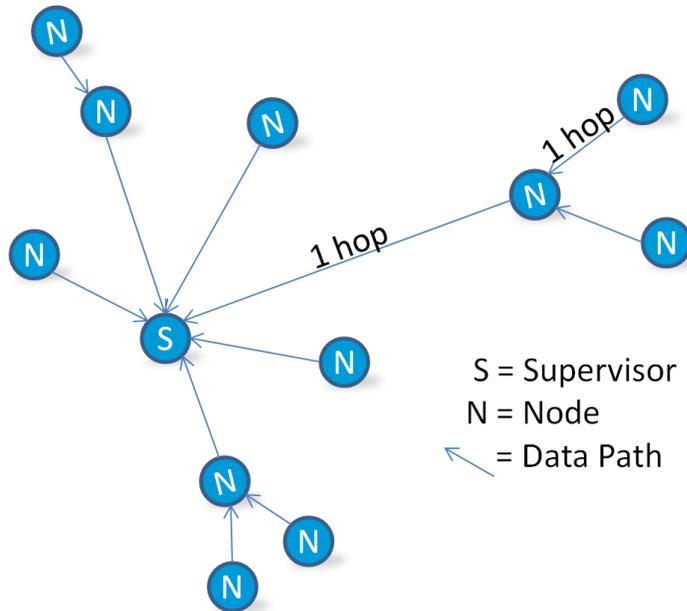


Figure 1 - Cluster Tree Network Topology

Each transmission from Node to Supervisor or Node to Node is considered one “hop”. Examples of hops are shown in Figure 1 and Figure 2. Up to four hops can be made between a Node and the Supervisor. With the ability to hop comes the ability for the Supervisor to communicate with Nodes that have not established direct radio communication. Figure 2 shows how GeoNet devices can operate around buildings or other barriers using hops.

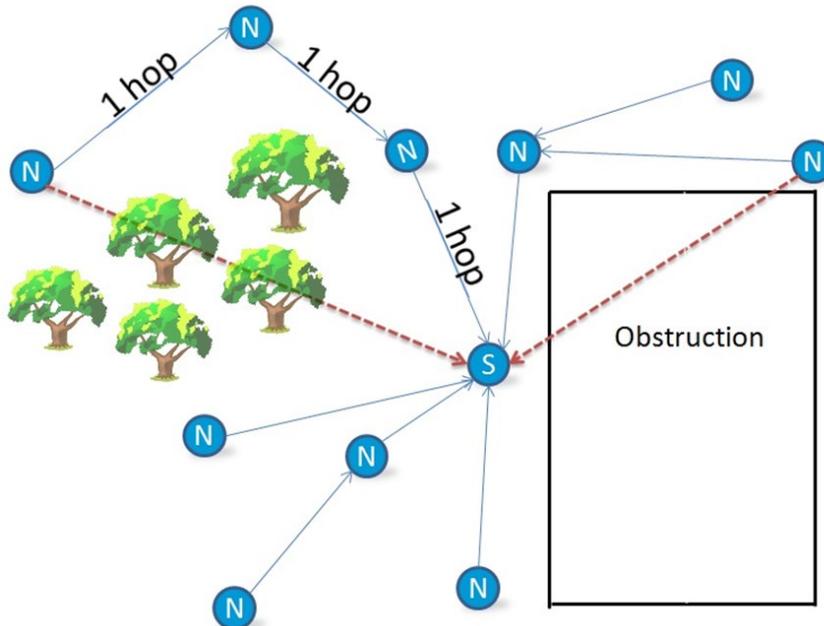


Figure 2 - Working Around Obstructions

When using GeoNet it is important to take into consideration the radio environment, and to understand the effect that obstructions have on radio signals. Obstructions between two antennas can cause reflections of the transmitted signal. When these reflections arrive at the receiving antenna, they may be in or out of phase with the signal that took a straight-line path. This reflected signal may act as constructive or destructive interference with the received signal. For optimum performance, Geokon recommends creating as much vertical space as possible between the straight-line path and obstacles, including the ground. Figure 3 illustrates what is known as the Fresnel zone.

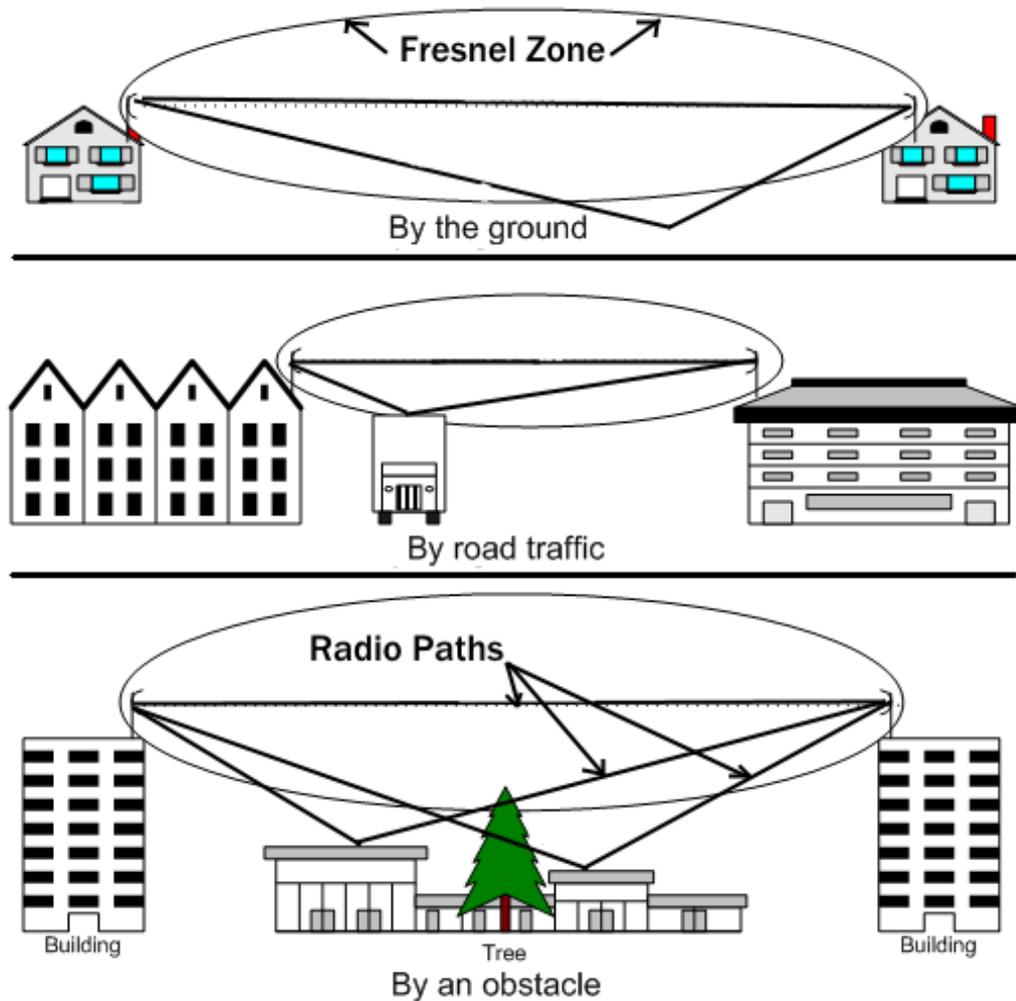


Figure 3 - Fresnel Zone

If GeoNet is deployed to a site and communication cannot be established, it may be necessary to elevate the devices, or to move them to a location where a radio link can be established. This may require extending the readout cable of the attached sensors.

Figure 4 shows examples of improper device mounting. In each case there are obstructions blocking the radio path.



Figure 4 - Examples of Radio Obstructions



CAUTION! To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended. The antenna used for this transmitter must not be co-located in conjunction with any other antenna or transmitter.

2. NETWORK INSTALLATION

See also the [GeoNet Installation Tutorial](#) available at Geokon.com

2.1 Items Needed

To install a network, begin with the Supervisor and at least one Node that is within radio range of the Supervisor.

2.2 Channel Configuration

Channels allow multiple networks to coexist in the same area. **All devices are set to communicate on channel one from the factory and do not need to be altered if operating a single network in a given area.** However, if multiple networks are within radio of one another then the devices of each network must be set to different channels.

To set the channel on a Node or Supervisor:

- 1) Open the device by unscrewing the four captive screws on the front of the enclosure. **Make sure that no dirt, water or other contaminants are allowed to enter the enclosure.**
- 2) Set the channel select dipswitches (shown in Figure 5) to one of the 12 valid positions listed in Table 1.
- 3) **Devices will only communicate with others that have been set to the same channel.** (To prevent erratic behavior, there can be only one Supervisor on a particular channel. A Supervisor with the same channel setting cannot be within radio range of any of the units of another network.)

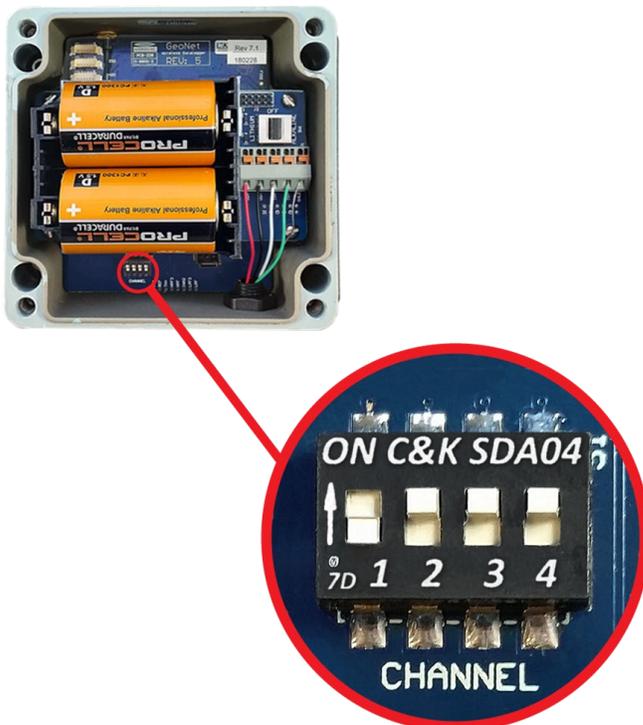


Figure 5 - Channel Select Switches

Modbus Address and Channel	1	2	3	4
1	OFF	OFF	OFF	OFF
2	ON	OFF	OFF	OFF
3	OFF	ON	OFF	OFF
4	ON	ON	OFF	OFF
5	OFF	OFF	ON	OFF
6	ON	OFF	ON	OFF
7	OFF	ON	ON	OFF
8	ON	ON	ON	OFF
9	OFF	OFF	OFF	ON
10	ON	OFF	OFF	ON
11	OFF	ON	OFF	ON
12	ON	ON	OFF	ON
13*	OFF	OFF	ON	ON

*Sensemetrics Thread compatibility mode, not for use with supervisor. See Appendix E for more information.

Table 1 - Channel Selection

2.3 Connecting Sensors

Note: For Addressable Sensor Nodes, Nodes connected to multiplexers, and Single Channel Nodes running firmware prior to version 180213 (factory installed firmware prior to Feb. 2018), all sensors should be wired/connected to the Node prior to power up.

2.3.1 Cable Gland Models (8800-1-1_)

To wire a sensor on models featuring a cable gland:

- 1) Open the device by unscrewing the four captive screws on the front of the enclosure. **Make sure that no dirt, water or other contaminants are allowed to enter the enclosure.**
- 2) Loosen the nut on the cable fitting and remove the white plastic dowel.
- 3) Slide the transducer cable through the cable gland nut and fitting.
- 4) Wire each conductor into the terminal block by pressing down on an orange tab, inserting the bare end of the conductor into the terminal block, and then releasing the tab. (Refer to Figure 6 and Table 2 for sensor wiring information.) **To prevent the possibility of a short circuit, do not allow bare leads to touch each other during or after wiring**



Figure 6 - Terminal Connections

Position	Color	Description
VW+	RED	Vibrating Wire +
VW-	BLACK	Vibrating Wire -
TH+	WHITE	Thermistor +
TH-	GREEN	Thermistor -
SHLD	BARE	Analog Ground (shields)

Table 2 - Sensor Wiring

- 5) Gently pull on each conductor to make sure it is secure.
- 6) Tighten the cable gland nut until it firmly grips the outer jacket of the cable. **(The cable gland nut must be properly tightened to prevent water entry. Do not over-tighten, which may strip the plastic threads.)**
- 7) Gently pull on the sensor cable to make sure it is held in place by the cable gland.

2.3.2 10-pin Bulkhead Models (8800-1-2_)

Sensors are attached to the Node with a 10-pin Bulkhead connector. Align the grooves on the sensor connector (male), with the connector on the unit (female). Push the connector into place and then twist the outer ring of the male connector until it locks.

2.4 Antenna Installation

Remove the rubber cap from the antenna mount. Position the antenna on the mount and then rotate the antenna in a clockwise direction until tightened.

2.5 Battery Installation

When establishing a Network, install the D cells in the Supervisor first, followed by the Nodes. **(NOTE: When replacing batteries in an existing Network, the Supervisor must be put into deployment mode prior to removing the batteries. See Section 6.3 for more information on battery replacement.)**

Install the batteries as follows:

- 1) Open the device by unscrewing the four captive screws on the front of the enclosure. **Make sure that no dirt, water or other contaminants are allowed to enter the enclosure.**
- 2) Ensure that the battery select switch is set to the “OFF” position (Figure 7). (For units manufactured prior to June 2017, move the battery select switch to the **OPPOSITE** setting of the type of battery that will be installed.)



Figure 7 - Battery Select Switch

- 3) Install the batteries by aligning the positive (+) side of the D cells with the left side of the battery holder. Push the batteries straight down into the holder.



Figure 8 - Battery Detail

- 4) Move the battery select switch to either the “Alkaline” or “Lithium” position depending on the type of battery being used.
- 5) An LED will flash on the right side of the box indicating the unit has power.

2.6 Accessories

After the batteries have been installed, complete the following with the Supervisor and the Node:

- 1) Place the supplied desiccant packs inside the enclosure.
- 2) Make sure the cover gasket and the mating ridge on the enclosure are clean, and that the gasket is properly seated inside the groove on the cover. Place the cover on the unit.
- 3) Tighten the cover screws a little at a time, working in a diagonal pattern. Make sure the cover seals tightly and evenly.
- 4) Mount the device. The built-in mounting plate is designed to be used with U-Bolts, hose clamps, screws, bolts, etc. Devices should be mounted with the antenna pointing up. (It is not necessary to point the Node antennas in the direction of the supervisor, and vice versa.)

2.7 Deployment Mode

There are two modes of operation, deployment mode and normal mode. **The Supervisor and Nodes all enter deployment mode upon power up; do not press the status button at this time.** (For information on the function of the status button, see Section 2.8) Deployment mode allows Nodes to be added to a Network. When the Network is in deployment mode, the Network status will be indicated by the LEDs on the Supervisor every 10 seconds.

With the Supervisor and Nodes both in deployment mode they will find each other in less than three minutes (radio circumstances permitting). Once the network has been established, the Supervisor's red LED will flash simultaneously with the green LEDs on the Nodes. If the correct lights do not illuminate, or if the unit has exited deployment mode because the status button has been pressed, press the status button on the Supervisor again to restart deployment mode.

NOTE: Avoid powering down or removing the Supervisor from a working Network. If the Supervisor must be powered down or removed from the Network, put the Network in deployment mode prior to doing so.

2.7.1 Adding Nodes

While in deployment mode, Nodes may be added by simply turning them on within radio range. Any number of Nodes may be configured at one time; they do not need to be done simultaneously. When adding Nodes, start with those closest to the Supervisor. It is desirable to place the Supervisor in the center of the distribution of Nodes when possible (see Figure 9 on the following page); doing so will reduce hops, thereby reducing battery consumption.

Nodes may be moved to their install locations while the green LED is flashing. Observe the LEDs while moving the Nodes to ensure a good communication path is maintained. (After 10 minutes, the LEDs on the Nodes will stop indicating their status in order to conserve batteries. Pressing the status button on a Node will reactivate the LEDs for another 10 minutes.)

The default time a network will remain in deployment mode is one hour. When a new Node joins the network the timer will reset, extending the deployment period for another hour. If more time is needed while deploying Nodes, the default deployment timeout may be changed using Agent software.

The network will not begin collecting data until the network time has been set. This may be accomplished by using the Agent software (or other Modbus master). The default scan interval for data collection is 10 minutes.

If isolated from the rest of the network, a Node will continue to sample and store data. When communication is reestablished, it will “catch up” by sending all of the collected data to the Supervisor.

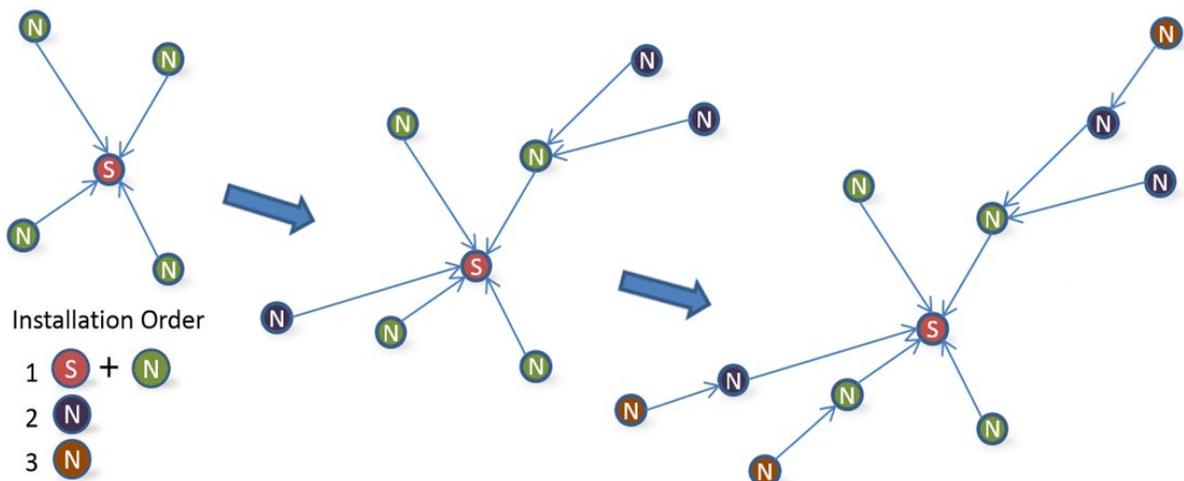


Figure 9 - Installation Order

2.8 Status Button Functionality

All GeoNet devices have red and green LED indicators to display their status. There is a reference key printed on the side of each unit, below the LEDs. When the status button is pressed, the appropriate LED indicators will briefly illuminate. Table 3 shows the meaning of the various LED indications. (When used in a Sensemetrics network, see Appendix E for the meaning of the LED indications.)

LEDs		Supervisor	Nodes
		Time set, Nodes present	Radio signal > 30%
		No Nodes present	Radio signal < 30%
		Network time not set	No radio signal

Table 3 - LED Indicator Meaning

When the status button is pressed on the Supervisor the current status of the network will be displayed briefly by the LEDs. If the network is in deployment mode at the time of the button press, the deployment mode timer will reset. If the network is not in deployment mode, it will enter deployment mode on the following radio cycle. (This could take up to six minutes, as changes to the radio settings can only occur when all the radios in the network are awake.) In

order to provide timely feedback to the user, the network parameters are set to a 10-second radio interval while the Supervisor is in deployment mode.

When the status button is pressed on a Node, the current status of the radio signal will be displayed briefly by the LEDs. The Node will then indicate the status of the radio signal after each radio transmission for a period of 10-minutes. If the Node has not yet joined the network, it will change its radio interval to approximately one second.

3. GEONET MULTIPLEXER

The GeoNet Multiplexer expands the number of vibrating wire sensors a Node can read from one to eight. Channel switching is controlled by the Node and is accomplished by solid-state (nonmechanical) circuitry. Because of the power requirements of the Multiplexer, the Node the multiplexer will be connected to **must have lithium batteries installed**.

Each Node with a Multiplexer attached uses the equivalent data of four single nodes. Since the maximum number of Nodes per Network is 100, the maximum amount of Nodes with a Multiplexer attached that may be connected to a single network is 25.

The Multiplexer is protected from environmental contaminants by a rugged, NEMA 4X enclosure, constructed from fiberglass reinforced polyester. It is also shielded from harmful radio frequencies and electromagnetic interference by a conductive gasket and internal RFI/EMI coating. An Earth Ground terminal is provided on the exterior of the enclosure to protect against lightning and other large, transient voltages.

Multiplexers ship with the following accessories:

- Four desiccant packs
- Two lithium D cells (These D cells must be installed in the Node to which the Multiplexer will be attached.)



Figure 10 - Node with Multiplexer

3.1 Installation

3.1.1 Mounting the Multiplexer

The Multiplexer is typically mounted in such a manner that the cable entries are facing downward (as shown in Figure 10 above). Attach the Multiplexer to the mounting surface by utilizing the Multiplexer's mounting plate. The mounting plate is designed to be used with hardware such as U-Bolts, hose clamps, bolts, screws, etc. (Mounting hardware is not included.)

3.1.2 Lightning Protection

Each VW (Vibrating Wire) channel is protected by a 230V gas discharge tube, followed by a high-speed protector and a transient voltage suppression diode. Each TH (Thermistor) channel is protected by a 230V gas discharge tube, followed by an inductor (lower resistance than high-speed protectors) and a transient voltage suppression diode. (See Section A.3 for complete specifications).

In order for these components to divert energy from a lightning strike safely to ground, a solid electrical connection to earth ground needs to be made. A copper grounding rod, (at least six feet in length,) should be driven into the soil to a minimum depth of three feet, as close to the Multiplexer as possible. Alternatively, any other suitable attachment to earth ground may be utilized. Connect the grounding rod to the copper grounding lug on the exterior of the Multiplexer with a large gauge wire (12 AWG or larger). This will provide a suitable path from the Multiplexer to ground in the event of a lightning strike.

3.2 Connecting Sensors

3.2.1 10-pin Bulkhead Models (8800-8-2)

Sensors are attached to the Multiplexer with 10-pin Bulkhead connectors. Align the grooves on the sensor connector (male), with the connector on the unit (female). Push the connector into place and then twist the outer ring of the male connector until it locks.

3.2.2 Cable Gland Models (8800-8-1 and 8800-8-3)

- 1) Open the Multiplexer by loosening the four captive screws on the front of the enclosure and removing the lid. **Make sure that no dirt, water, or other contaminants are allowed to enter the enclosure.**
- 2) Loosen cable gland nuts and remove the white plastic dowels. To prevent contaminants from entering the enclosure, dowels should be left inside cable fittings that will not be used.
- 3) Thread the transducer cables through the cable fittings. (For simplest cable management inside the enclosure, transducer cables should be wired sequentially, from left to right, top to bottom.)

- 4) Insert the conductors of each cable into the terminal blocks of the multiplexer by pressing down on the orange tab at the back of the terminal block, inserting the conductor, and then releasing the orange tab. See Section 3.3.3 for information on determining the correct wiring.
- 5) Tighten the nuts on the cable fittings. **This must be done to ensure that water does not enter the enclosure. Avoid overtightening as this may damage the plastic threads.**
- 6) Reinstall the cover. Ensure that the rubber gasket is properly seated in the groove on the underside of the cover. Tighten the screws a little at a time, working in a diagonal pattern; this ensures that the cover seals correctly.

3.2.3 Determining Correct Wiring

Geokon instruments with a single vibrating wire gauge should be wired according to Table 4. (As shown on channels six, seven, and eight in Figure 11.)

Position	Color	Description
VW+	RED	Vibrating Wire +
VW-	BLACK	Vibrating Wire -
TH+	WHITE	Thermistor +
TH-	GREEN	Thermistor -
SHLD	BARE	Analog Ground (shields)

Table 4 - Standard Single Gauge Wiring

To determine the correct wiring for Geokon instruments with multiple vibrating wire gauges, refer to the wiring chart(s) in the manual provided with the instrument. These types of instruments will require the use of more than one channel in the Multiplexer. For example, a five transducer Borehole Extensometer has been wired into channels one, two, three, four, and five in Figure 11. For instruments that have multiple gauges sharing a single conductor, refer to Section 3.4, “Shared Channels”.

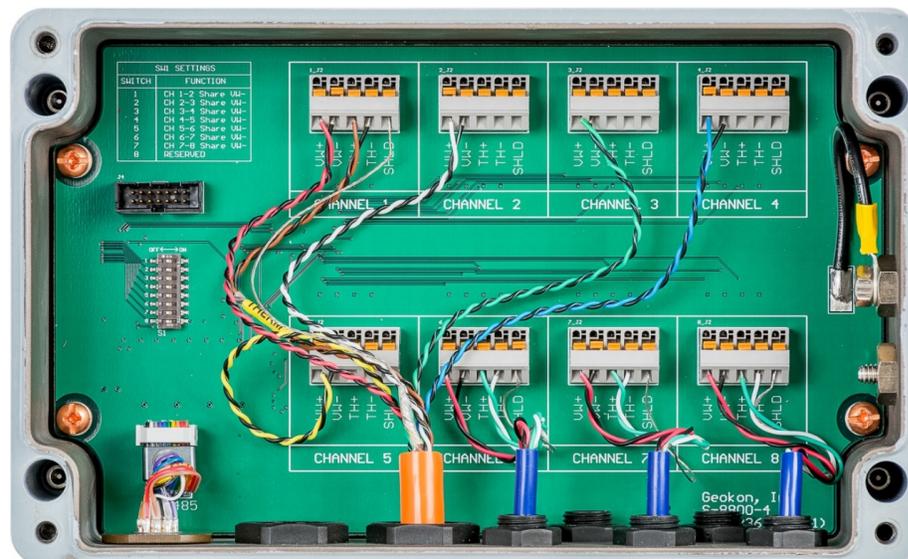


Figure 11 - Sample Wiring

3.3 Shared Channels

Some Geokon instruments utilize multiple gauges that share a single conductor for negative polarity. During normal operation, each channel of the Multiplexer consists of four signals, which are all switched together: VW+, VW-, TH+, and TH-. However, the Multiplexer can be configured to switch the VW- signal separately from the rest, allowing for configurations where multiple gauges share one common VW- signal. This shared conductor may be connected to the VW- on any of the channels to which the various gauges have been wired.

Switching of the VW- signal is controlled by an eight-position DIP switch located on the left side the circuit board. This DIP switch tells the Multiplexer which channels are sharing a common VW- signal. Use the table located on the top left corner of the circuit board (reproduced in Figure 12) to determine which of the eight switches to move to the on position based upon which channels are sharing a common VW- signal.

For example: If the VW+ conductors of a four gauge load cell were wired into channels four, five, six, and seven, then the common conductor for these gauges may be wired into the VW- of any of those four channels. Consequently, switches four, five, and six on the eight-position DIP switch would be moved to the ON position.

SW1 SETTINGS	
SWITCH	FUNCTION
1	CH 1-2 Share VW-
2	CH 2-3 Share VW-
3	CH 3-4 Share VW-
4	CH 4-5 Share VW-
5	CH 5-6 Share VW-
6	CH 6-7 Share VW-
7	CH 7-8 Share VW-
8	RESERVED

Figure 12 - DIP Switch Settings

3.4 Connecting to the Node

A Multiplexer can be added to a Node at any time; it will be detected and utilized automatically. (Ensure that the Node has **lithium** batteries installed prior to connecting the multiplexer.)

Note that Nodes connected to multiplexers will stop searching for sensors on the various channels of the multiplexer after 10 failed attempts to read a sensor, therefore it is recommended that all sensors be wired/connected to the multiplexer before connecting the multiplexer to the Node.

Connect the Node to the Multiplexer by using a model 8032-5, 10-pin to 10-pin patch cord (sold separately). Align the grooves of the connector on the cable (male), with the connector on the unit (female). Push the connector into place until seated and then twist the outer ring of the male connector until it locks into place.

4. GEONET ADDRESSABLE SENSOR NODES

Model 8800-5 and 8800-6 GeoNet Addressable Sensor Nodes are used to communicate with 6150E Addressable MEMS strings (Figure 13).



Figure 13 - 6150E Addressable MEMS and Addressable Sensor Node

Addressable Sensor Nodes function in the same manner as other Nodes, and can be installed using the previous sections in the manual. Because the Node powers the MEMS sensors **lithium batteries are required**; therefore, the power switch is on/off only and does not have the option of selecting alkaline or lithium.

4.1 Sensor Wiring

Complete **before** powering the Node.

For sensors that have a 5-pin bulkhead connector attached, align the grooves on the sensor connector (male), with the connector on the Node (female). Push the connector into place and then twist the outer ring of the male connector until it locks. For sensors with bare leads, wire the 6150E into the Node per Table 5 and Figure 14 on the following page.

Once the string has been correctly wired into the Node and the unit has been powered on, no other setup is required with the hardware. The remaining configuration is completed using the Agent software program. Refer to the Agent instruction manual for more information.

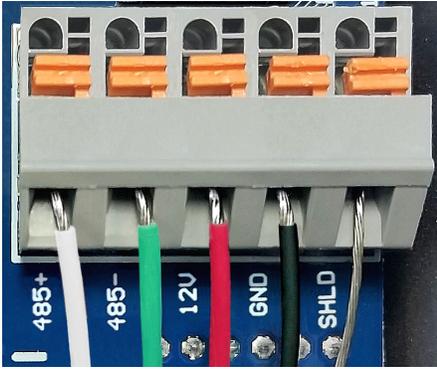


Figure 14 - Terminal Connections

Position	Color	Description
485+	WHITE	Communication RS-485+
485-	GREEN	Communication RS-485-
12V	RED	12 volt power to the string
GND	BLACK	Ground
SHLD	BARE	Analog Ground (shields)

Table 5 - Addressable Sensor Wiring

4.2 Troubleshooting Addressable Nodes

Symptom: Node does not have power

- ✓ Check the fuse located to the left of the batteries; replace if necessary.
- ✓ Make sure the 12V and GND (red and black) conductors of the 6150E are not shorted.
- ✓ Ensure that the polarity of the batteries matches the diagram on the battery holder.
- ✓ Check for secure connection between the battery terminals and holder. If a gap exists between the holder and the battery terminals, remove the batteries and bend the sides of the holder inward, then reinstall the batteries.

See Section 7 for general troubleshooting information.

5. ADD ON MODULES FOR SUPERVISOR COMPATIBILITY WITH ETHER NET AND CELLULAR MODEMS

5.1 Introduction

Model 8800-2-4A (cellular modem compatibility) and Model 8800-2-4B (Ethernet compatibility) are add-on modules for the Network Supervisor to allow the end user to easily add remote communications and data download.

Each module comprises a weather proof, 305 x 254 x 152 mm (12" x 10" x 6") enclosure, a 7Ah battery, charger, and the necessary cables to interface with an RS232 equipped GeoNet Supervisor.

When an add-on module is paired with a Network Supervisor, the Supervisor is powered by the rechargeable battery inside the module. The charge level of the battery can be monitored using the Agent software program.

5.2 Installation

Both modules are shipped with the battery unplugged and the fuse distribution board switch in the off position. To deploy the modules, the battery should be plugged into the fuse distribution board and the switch placed in the ON position. The provided black 10-Pin to 10-Pin connecting cable is used to connect the module to the Supervisor.

D-cell batteries should still be installed in the supervisor, and the battery switch moved to the appropriate battery chemistry, so that in the event the module battery level drops, the communication between the Supervisor and the Nodes will not be interrupted.

5.2.1 Setting up the 8800-2-4A (Cellular Modem Add-on)

The 8800-2-4A requires a configured modem with a static IP address. To install the modem, complete the following:

- 1) Place the modem into the modem bracket and secure it using the Velcro strap.
- 2) Plug the 9-Pin D-sub connector into the RS232 port of the modem.
- 3) Connect the modem power cable to one of the open load connections on the fuse distribution board.
- 4) Connect the coaxial cable to the cellular modem antenna bulkhead
- 5) Attached the antenna to the bulkhead on the outside of the module.

5.2.2 Setting up the 8800-2-4B (Ethernet Add-on)

The MOXA 5110A will be setup by Geokon to communicate with a GeoNet Network Supervisor, however, the end user will need to finish the setup so that it works with their network. Configure an IP address by following the instructions below. (**Note: The following steps should only be performed by your network administrator. Nport administrator (on cd) should be installed and used to configure the required IP changes.**)

- 1) Connect a computer to the MOXA 5110A via the Ethernet Port.
- 2) Open NPort Administrator and click “Search”. (By default, the MOXA 5110A IP Address “192.168.127.254” will be displayed.)
- 3) Double click on the IP Address under the configuration window.
- 4) In the configuration window, click on the Network tab.
- 5) Check the boxes next to “Modify IP address” and “Modify Netmask”, see Figure 15.

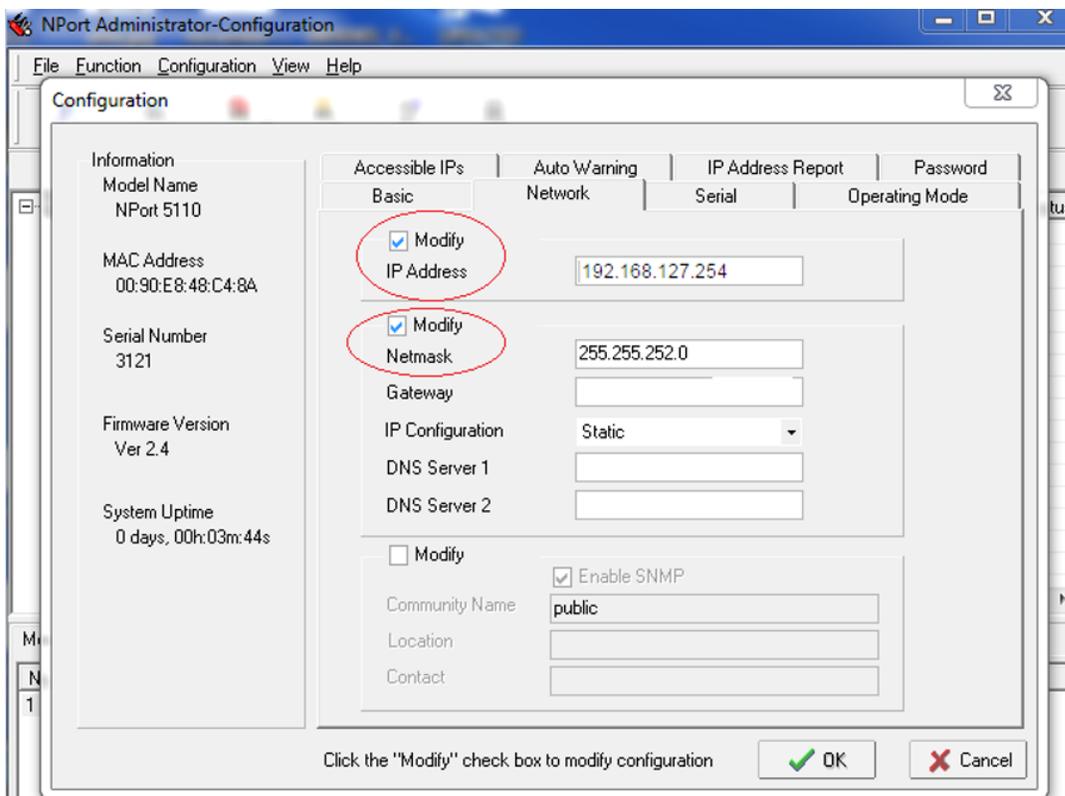


Figure 15 - Nport Configuration

- 6) Update the “IP Address”, “Netmask”, “Gateway”, and “DNS Server 1” fields to match your network. (**Note: Do not make any other changes to the settings as it may affect proper communications to the GeoNet Network Supervisor.**)

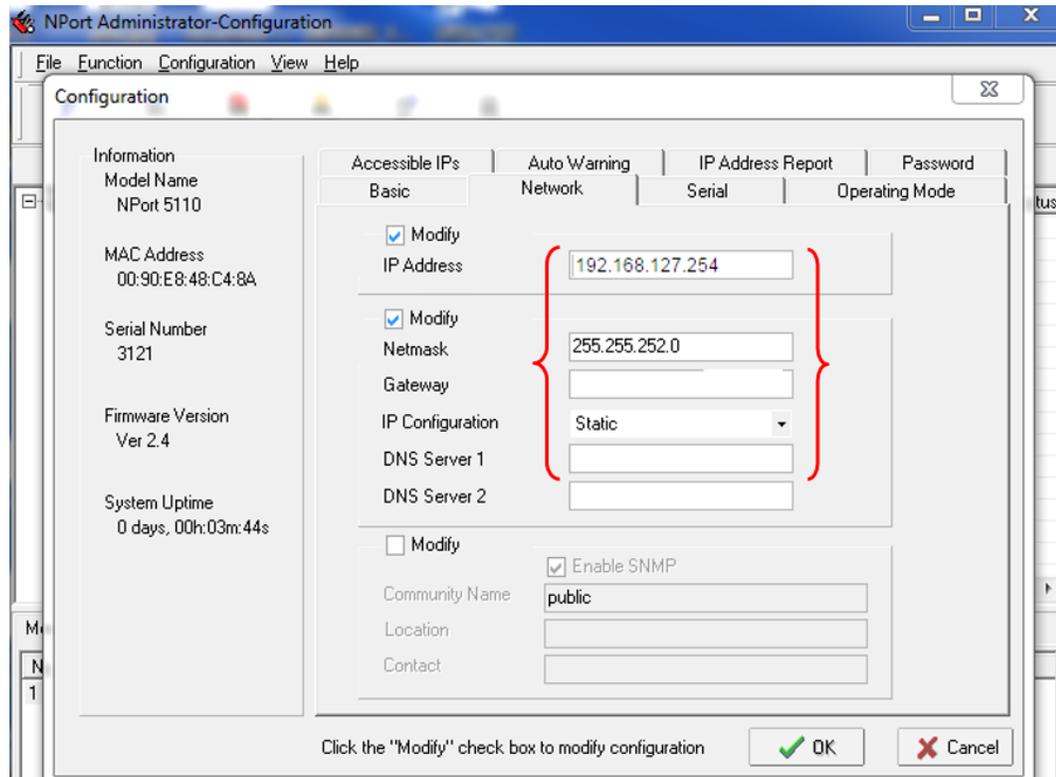


Figure 16 - Update Fields

- 7) Click OK.
- 8) Restart your MOXA Converter.
- 9) Connect the add on Module to the GeoNet supervisor.
- 10) Enter the new IP address followed by “:4001” as the “Network Address” in the Agent Software program.

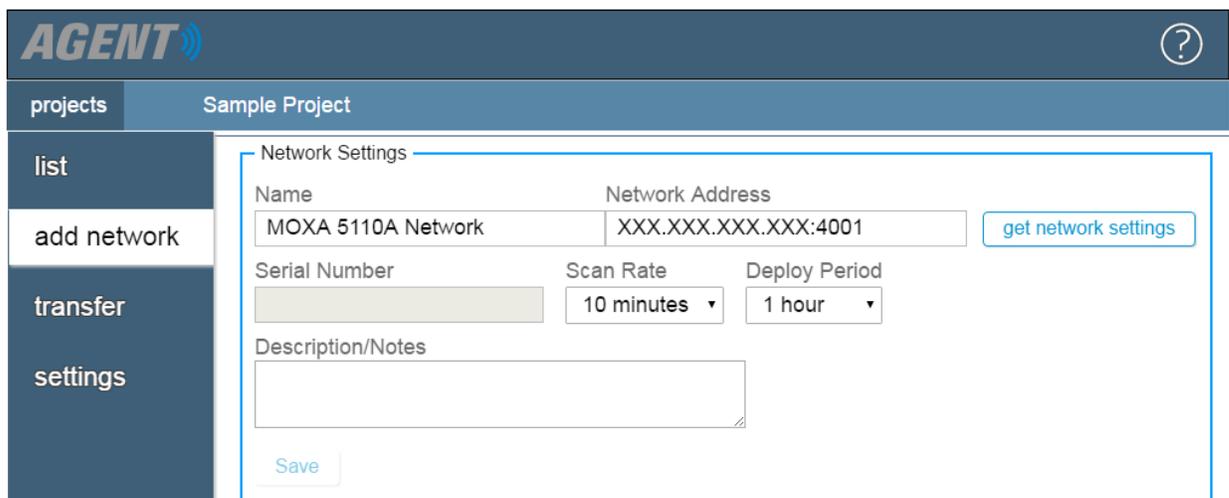


Figure 17 - Enter IP Address followed by “:4001”

6. MAINTENANCE

All GeoNet devices are designed to operate in field environments with minimal upkeep; nevertheless, there are some basic maintenance procedures that should be followed to ensure maximum reliability and functionality.

6.1 Preventing Water from Entering the Enclosures

GeoNet devices are designed to be splash proof and rain proof, but are not submersible. Devices are sealed by a gasket, which will prevent water entry, so long as the screws that hold the lid in place are properly tightened and the gasket inside the lid is properly aligned. It is also very important to make sure that all the cable fittings are securely tightened. Models that feature a 10-pin connector are equipped with a watertight cap, which must be installed when the connector is not in use.

Despite all these precautions, the Nodes may encounter leakage along the cable if the cable is cut, or if the unit is installed in an especially humid environment. In this type of environment, it is recommended that the internal desiccant packs be replaced at the necessary intervals in order to prevent condensation from corroding or shorting out the internal electronics.

6.2 Battery Life

Estimating the life of batteries in a system with as many factors, the GeoNet wireless network is difficult. Battery life is affected by temperature extremes, the radio environment (as related to retries), and the physical configuration and quantity of Nodes. Nodes that are the only communication link between other Nodes and the Supervisor will have a shorter battery life than those that have no routing responsibility.

Table 6 shows an estimate of battery life in a network of less than 20 Nodes based on the number of readings collected and sent to the Supervisor. At a one-hour scan rate or higher, with only one hop, over 1,000 days of battery life can be expected. If greater battery life is needed, a 12-volt nominal input is available. Contact Geokon technical support for help utilizing this feature.

Battery Life Estimates		
	Alkaline	Lithium
Readings Transmitted	25,000	70,000
Radio Cycles	500,000	1,400,000
Scan Rates (minutes)	Days	Days
12	208	583
20	347	972
30	521	1458
60	1042	2915

Table 6 - Battery Life

6.3 Replacing Batteries

The Network must be put into deployment mode prior to replacing the batteries in the Supervisor. (This is also best practice when replacing batteries in Nodes.)

D cell batteries should be replaced when the measured voltage of the D cells drops below 2.0 VDC (units will cease operation at ~2.0 volts). External 12 volt batteries should be replaced when the measured voltage is <11 volts. (**Note that some GeoNet models require lithium batteries, including 8800-5 & 8800-6 Addressable Sensor Nodes, any Node with an 8800-8 Multiplexer attached, and Nodes with a built in Biaxial tiltmeter.**)

All data is retained in nonvolatile flash memory. Data will not be lost even if the batteries are removed for an extended period (e.g., years).

Replace the batteries as follows:

- 1) Place the Network in deployment mode.
- 2) Open the device by unscrewing the four captive screws on the front of the enclosure. **Make sure that no dirt, water or other contaminants are allowed to enter the enclosure.**
- 3) Ensure that the battery select switch is set to the “OFF” position (Figure 7). (For units manufactured prior to June 2017, move the battery select switch to the **OPPOSITE** setting of the type of battery that will be installed.)



Figure 18 - Battery Select Switch

- 4) Install the batteries by aligning the positive (+) side of the D cells with the left side of the battery holder. Push the batteries straight down into the holder.



Figure 19 - Battery Detail

- 5) Move the battery select switch to either the “Alkaline” or “Lithium” position depending on the type of battery being used. An LED will flash on the right side of the box indicating the unit has power.
- 6) After replacing the batteries in a Node, it will need to rejoin the Network, and then the Network time must be set in Agent.

7. TROUBLESHOOTING

Listed below are a few commonly experienced problems and remedial action. These topics are also covered in the [Troubleshooting GeoNet Networks and Agent Software Tutorial](#), and the [GeoNet Troubleshooting Guide](#), both of which are available at Geokon.com. Contact the factory if additional assistance is needed.

Symptom: Unit will not respond to communications

- ✓ Wrong connection type, or incorrect port specified in Agent software.
- ✓ The internal batteries of the Supervisor may be dead. Replace the batteries.

Symptom: Vibrating wire gauge measurement reads -999999.0

- ✓ Verify that the gauge leads are wired correctly inside the Node. (Refer to the sensor manual for wiring information.)
- ✓ Check the sensor for proper operation with an independent readout, such as a GK-404 or GK-405. Sensor operation can also be checked by using an ohmmeter to measure the resistance between the vibrating wire gauge leads. Very high (megohms) or infinite resistance may indicate cable damage, very low resistance ($<20\Omega$) may indicate a short between conductors. For long cables, cable resistance can be added at approximately 14.7Ω per 1000 ft (48.5Ω per km) at 20°C . Multiply this factor by two to account for both directions.

Symptom: Vibrating wire gauge reading is unstable

- ✓ Move any sources of electrical noise away from the transducer cable, such as, generators, motors, arc welding equipment, high voltage lines, etc.

Symptom: Thermistor measurement shows -273.15 degrees Celsius

- ✓ This indicates an open circuit to thermistor leads. Verify that the thermistor leads are properly connected inside the Node. (Refer to the sensor manual for wiring information.)
- ✓ Check the thermistor for proper operation by using an ohmmeter to measure the resistance between the thermistor leads. Resistance should be between $10\text{K}\ \Omega$ and $2.4\text{K}\ \Omega$ when the ambient temperature is between 0 and $+30^\circ\text{C}$. (APPENDIX D.8.3 details the resistance versus temperature relationship.) Very high or infinite resistance may indicate cable damage, very low resistance may indicate a short between conductors

Symptom: Node has weak communication

- ✓ If the signal is consistently weak (indicated by red and green LEDs illuminated at the same time) but not intermittently red, proceed with the installation. If the signal is frequently lost (red flash) it will be necessary to improve it. Try to get the Node as high as possible, with plenty of clear space around the antenna. Extending the sensor cable may enable moving the Node to a better location. If the signal does not improve, a higher gain directional antenna may be necessary. Contact Geokon for help.

Symptom: Node will not synchronize with network

- ✓ If the red status light on a Node is flashing at 10-second intervals, it means the Node was once connected to a network, but the network is not present now, or the Supervisor has been reset, resulting in an equal, but not overlapping radio cycle. Be sure that the network is functioning in deployment mode, (red light flashing every 10 seconds on the Supervisor,) and that the channel setting is correct. Remove and replace the batteries in the Node; the Node will now look for the changed network.

Symptom: No data from node

- ✓ Be sure node is powered.
- ✓ With network in deploy mode, observe either red and green or green lights every 10 seconds on the node.
- ✓ Make sure network time is set.

Symptom: Some data present (e.g., battery/signal strength) but no vibrating wire sensor data available

- ✓ Check the sensor wire connections to the node terminal if so equipped.
- ✓ If the node has been operating without a sensor connected, it will stop trying to read a sensor after five failed scans. Set the network time or change the scan rate to re-enable the node.
- ✓ Check the sensor with an independent measurement device, like a GK-404 or GK-405.

Symptom: Green light on for one second then off for one second

Bootloader is activated, complete the following:

- 1) Remove batteries
- 2) Change channel switches to a valid setting
- 3) Reinsert batteries

Symptom: Repeating cycle of five green flashes followed by one long red flash

- ✓ Update the network firmware. If problem persists after update return the unit for repair.

Symptom: Green light flashing quickly (twice per second)

- ✓ This is a known issue. Update the network firmware to version 160816 or later

Symptom: Green and red light alternating

- ✓ Device malfunction; contact Geokon.

APPENDIX A. SPECIFICATIONS

A.1 Device Specifications

	8800-1 (Node)	8800-2 (Supervisor)	Units
Measurement Accuracy	±0.1% F.S. (400-5000 Hz)	NA	Hz
Data Memory	32		MB
Storage Capacity	1.44E+06	1.06E+06	Arrays
Temperature Range	-40 to +85		°C
Thermistor Accuracy	2% F.S.	NA	°C
Thermistor Resolution	0.1		
Communication Type	NA	USB/RS-232	
Communication	NA	115k,8-N-1	
Communication Protocol	NA	Modbus RTU	
Power Supply	D Cell Alkaline or Lithium (2x)		
Scan Interval	10-1440		Minutes
L x W x H	122 x 120 x 91 mm (4.8" x 4.7" x 3.6")		mm (in.)

Table 7 - Device Specifications

A.2 Radio Specifications

A.2.1 Models Utilizing 2.4 GHz Radios

Network	North American	International	Units
Topology	Mesh/Cluster Tree		
Radio Technology	IEEE 802.15.4 DSSS		
Radio Frequency, ISM Band	2.4		GHz
Channels	12		
Range (Indoor, Urban)	90	60	M
Range (Outdoor, line-of-sight)	1600	750	M
Transmit Power	63	10	mW
Receiver Sensitivity	-100		dBm
Network Throughput (1,2,4 hops)	78, 50, 22		kbps
Antenna (half-wave dipole)	2.1		dBm

Table 8 - 2.4 GHz Models

A.2.2 Models Utilizing 900 MHz Radios

Description	Value	Units
Topology	Mesh/Cluster Tree	
Radio Technology	IEEE 802.15.4 FHSS	
Radio Frequency, ISM Band	900-928	MHz
Channels	12	
Range (Indoor, Urban)	305	M
Range (Outdoor, line-of-sight)	6500	M
Transmit Power (N.A. / International)	250	mW
Receiver Sensitivity	-101	dBm
Network Throughput (1,2,4 hops)	78, 50, 22	kbps
Antenna (half-wave dipole)	2.1	dBm

Table 9 - 900 MHz Models

A.3 8800-8 Multiplexer Specifications

GENERAL	
Power Requirements:	2.8-3.6 VDC (regulated 3.3V provided by GeoNet Node)
Quiescent Current:	50uA
Active Current:	1.5mA typical, 10mA MAX
Operating Temperature:	-30 ° to +85 °C
MUX Cable Length:	10 ft. (max)
Dimensions:	279.4 mm x 177.8 mm x 88.9 mm (11" x 7" x 3.5")
ANALOG SWITCH	
Type:	CMOS, Solid-state
Power:	4μA (max combined current for all switches)
On Resistance:	5Ω (max)
Switching Time:	14ns
GAS DISCHARGE TUBE	
DC Breakdown Voltage:	230V
Surge Life:	100 operations (10/1000μs @ 200A)
Max Surge Current:	8 operations (8/20μs @ 5kA)
HIGH-SPEED PROTECTOR	
Trip Current:	300mA
Resistance:	7.6Ω (typical)
Response Time:	1μs (max)
TRANSIENT VOLTAGE SUPPRESSOR	
Reverse Standoff Voltage:	3.3V
Peak Pulse:	260W, 20A (8/20μs)
INDUCTOR	
Rated Current:	650mA
Inductance:	10μA
Resistance:	250mΩ

Table 10 - Multiplexer Specifications

APPENDIX B. MODELS

Model types are distinguished by their various physical connections, as well as their radio output power. Radio output options include North America, Brazil, Australia, and international.

B.1 Supervisor

Supervisor model types are distinguished by radio output, as well as their physical connection to a PC.

B.1.1 RS-232 (8800-2-1_ and 8800-4-1_)

Connects to a PC running the Agent program or other Modbus RTU master via an RS-232 cable.

Model #	PC Connection	Frequency	Region
8800-2-1A	RS-232	2.4 GHz	North America
8800-2-1B	RS-232	2.4 GHz	International
8800-4-1A	RS-232	900 MHz	North America
8800-4-1B	RS-232	900 MHz	Brazil
8800-4-1C	RS-232	920 MHz	Australia

Table 11 - RS-232 Supervisor Models

B.1.2 USB (8800-2-2_ and 8800-4-2_)

Connects to a PC running the Agent program or other Modbus RTU master via a USB cable. The Supervisor will be powered from the USB bus when plugged into the PC.

Model #	PC Connection	Frequency	Region
8800-2-2A	USB	2.4 GHz	North America
8800-2-2B	USB	2.4 GHz	International
8800-4-2A	USB	900 MHz	North America
8800-4-2B	USB	900 MHz	Brazil
8800-4-2C	USB	920 MHz	Australia

Table 12 - USB Supervisor Models

B.2 Node

Node model types are distinguished by radio output, as well as their sensor connection options.

B.2.1 Gland Seal (8800-1-1_ and 8800-3-1_)

For use with sensors cables with stripped and tinned ends. The sensor cable passes through an external cable gland and is wired into the terminal block according to Section 2.3.1.

Model #	Cable Connection	Frequency	Region
8800-1-1A	Cable Gland	2.4 GHz	North America
8800-1-1B	Cable Gland	2.4 GHz	International
8800-3-1A	Cable Gland	900 MHz	North America
8800-3-1B	Cable Gland	900 MHz	Brazil
8800-3-1C	Cable Gland	920 MHz	Australia

Table 13 - Gland Seal Node Models

B.2.2 Bulkhead (8800-1-2_ and 8800-3-2_)

For use with sensor cables that have a male, 10-pin bulkhead connector attached. The sensor cable is connected to the Node via an external female, 10-pin bulkhead connector (see Section 2.3.2).

Model #	Cable Connection	Frequency	Region
8800-1-2A	10-Pin Bulkhead	2.4 GHz	North America
8800-1-2B	10-Pin Bulkhead	2.4 GHz	International
8800-3-2A	10-Pin Bulkhead	900 MHz	North America
8800-3-2B	10-Pin Bulkhead	900 MHz	Brazil
8800-3-2C	10-Pin Bulkhead	920 MHz	Australia

Table 14 - 10-Pin Bulkhead Node Models

B.3 Multiplexer

Multiplexer model types are distinguished by their sensor connection options.

B.3.1 Gland Seal (8800-8-1 and 8800-8-3)

For use with sensor cables that have stripped and tinned ends. The sensor cables pass through external cable glands and are wired into the terminal blocks according to Section 3.3.2.

Model #	Connection Type	Cable Glands	
		Size	Qty
8800-8-1	Cable Gland	4 mm to 7.8 mm (0.16" to 0.31")	8
8800-8-3	Cable Gland	4 mm to 7.8 mm (0.16" to 0.31")	5
		9.9 mm to 14.2 mm (0.39" to 0.56")	2

Table 15 - Gland Seal Multiplexer Models

B.3.2 Bulkhead (8800-8-2)

For use with sensor cables that have a male, 10-pin bulkhead connector attached. The sensor cables are connected to the Multiplexer via external female, 10-pin bulkhead connectors (see Section 3.3.1).

Model#	Connection Type
8800-8-2	10-Pin Bulkhead

Table 16 - 10-Pin Bulkhead Multiplexer Models

B.4 Addressable Sensor Nodes

Addressable Sensor Nodes are used to read Addressable MEMS sensors. Model types are distinguished by radio output, as well as their sensor connection options.

B.4.1 Gland Seal (8800-5-1_ and 8800-6-1_)

For use with sensors cables with stripped and tinned ends. The sensor cable passes through an external cable gland and is wired into the terminal block according to Section 4.1.

Model #	Cable Connection	Frequency	Region
8800-5-1A	Cable Gland	2.4 GHz	North America
8800-5-1B	Cable Gland	2.4 GHz	International
8800-6-1A	Cable Gland	900 MHz	North America
8800-6-1B	Cable Gland	900 MHz	Brazil
8800-6-1C	Cable Gland	920 MHz	Australia

Table 17 - Gland Seal Addressable Sensor Node Models

B.4.2 Bulkhead (8800-5-2_ and 8800-6-2_)

For use with sensor cables that have a male, 5-pin bulkhead connector attached. The sensor cable is connected to the Node via an external female, 5-pin bulkhead connector

Model #	Cable Connection	Frequency	Region
8800-5-2A	5-Pin Bulkhead	2.4 GHz	North America
8800-5-2B	5-Pin Bulkhead	2.4 GHz	International
8800-6-2A	5-Pin Bulkhead	900 MHz	North America
8800-6-2B	5-Pin Bulkhead	900 MHz	Brazil
8800-6-2C	5-Pin Bulkhead	920 MHz	Australia

Table 18 - 5-pin Bulkhead Addressable Sensor Node Models

APPENDIX C. CONNECTOR PINOUTS

C.1 Transducer Cable Connections

C.1.1 Cable Gland, Models 8800-1-1_ and 8800-3-1_

Terminal Strip Position	Description	Cable Wire Color
VW+	Vibrating Wire +	RED
VW-	Vibrating Wire -	BLACK
TH+	Thermistor +	WHITE
TH-	Thermistor -	GREEN
S	Analog Ground (shields)	BARE WIRE

Table 19 - Transducer Cable Connections (Gland Seal)

C.1.2 10-Pin Bulkhead, Models 8800-1-2_ and 8800-3-2_

10 Pin Bulkhead	Internal Wire Color	Description	Cable Wire Color
A	Brown	Vibrating Wire +	RED
B	Red	Vibrating Wire -	BLACK
C	Orange	Thermistor +	WHITE
D	Yellow	Thermistor -	GREEN
E	Green	Analog Ground (shields)	BARE WIRE
F	Blue	+VCC Supply	N/A
G	Violet	Digital Ground	N/A
H	Grey	Mux Reset	N/A
J	White	Mux Clock	N/A
K	Black	Digital Ground	N/A

Table 20 - Transducer Cable Connections (10-Pin Bulkhead)

C.2 Communication Connections

C.2.1 RS-232, Models 8800-2-1_ and 8800-4-1_

10 Pin Bulkhead	Internal Wire Color	Description	Connection
A	Brown	GND	J1-1
	Green		J1-5
B	Red	RX	J1-2
C	Yellow	TX	J1-4
J	Red and Black (twisted pair)	12V Aux In (Red)	J3-1
K		GND (Black)	J3-2

Table 21 - Communication Connections (RS-232)

C.2.2 USB, Models 8800-2-2_ and 8800-4-2_

10 Pin Bulkhead	Internal Wire Color	Description	J9
A	Red	+5V	2
B	Orange	D-	3
C	Yellow	D+	4
D	Brown	GND	1
	Green		5

Table 22 - Communications Connections (USB)

APPENDIX D. MODBUS

D.1 Protocol

The Supervisor protocol is Modbus RTU. Information about Modbus can be found here:
<http://www.modbus.org/specs.php>

D.2 Supported Modbus Commands

Modbus was originally developed for communicating with programmable logic controllers. Many Modbus commands do not make sense with respect to modern embedded devices. GeoNet Supervisors utilizes four commands:

- (0x03) Read Holding Registers
- (0x04) Read Input Registers
- (0x06) Write Single Register
- (0x10) Write Multiple Registers

D.3 Connections Settings

115.2 kbps, eight data bits, one stop bit, no parity, no flow control.

D.4 Special Considerations for GeoNet

GeoNet is an ultra-low-power network. More than 99% of the time, the devices that comprise the network are in deep sleep. Master devices must recognize busy responses and retry. On first communication, a busy response is almost a certainty. The Supervisor will stay awake for one minute after the last communication to be more responsive if subsequent requests are made.

D.5 System Info Table

The system info table provides basic metadata as well as the network time. A newly powered network will not start acquiring data until the time has been set. This can be accomplished with Agent software or by writing the time to addresses 0xE20-0xE22. The time does not persist through battery replacement.

Address (hex)	R/W	Data	Type
0xE00	R	Firmware Version	uint16_t
0xE01	R	Hardware Version	uint16_t
0xE02	R	Debug Version	uint16_t
0xE09	R	Configuration	bitfield
0xE0A	R	Alarm Minutes	uint16_t
0xE0B	R	Minutes	uint16_t
0xE0C	R	Temp Command Code	NA
0xE0D	R	Channel	uint16_t
0xE0E	R	RTC Calibration	uint16_t
0xE0F	R	Serial Number LSW	uint32_t
0xE11	R	Serial Number MSW	
0xE11	R/W	Modbus Timeout (seconds)	uint16_t
0xE12	R/W	Scan Rate (minutes)	uint16_t
0xE13	R/W	Time Zone Offset Minutes	int16_t
0xE14	R/W	Seconds / Minutes	uint8_t/uint8_t
0xE15	R/W	Hour / Day	uint8_t/uint8_t
0xE16	R/W	Month / Year	uint8_t/uint8_t
0xE17	R/W*	Address MSW (only used on reads)	uint16_t

Table 23 - System Info and Settings

D.6 Node Tables

Every Node that successfully joins the network will be represented in the Node tables that begin at 0xE7D. There are 100 tables, each with 20 registers. There will never be any gaps in the table. This is done so that the master device may build a list of Nodes by reading the tables until an unpopulated table is encountered. An empty Node will have a serial number of zero.

Node	Modbus Address	Description	Address	R/W	Data	Type
0	0xE7D	Supervisor Data	0xE91	R	Node Id [0] LSW	uint64_t
1	0xE91	Node 1	0xE92	R	Node Id [1]	
2	0xEA5	Node 2	0xE93	R	Node Id [2]	
3	0xEB9	Node 3	0xE94	R	Node Id [3] MSW	
4	0xECD	Node 4	0xE95	R	code/index	uint8_t/uint8_t
5	0xEE1	Node 5	0xE96	R	Node SN [0] LSW	uint32_t
6	0xEF5	Node 6	0xE97	R	Node SN [1] MSW	
7	0xF09	Node 7	0xE98	R	Second/Minute	uint8_t/uint8_t
..	0xE99	R	Hour / Day	uint8_t/uint8_t
96	0x15FD	Node 96	0xE9A	R	Month/ Year	uint8_t/uint8_t
97	0x1611	Node 97	0xE9B	R	Channel 0	*
98	0x1625	Node 98	0xE9C	R	Channel 1	*
99	0x1639	Node 99	0xE9D	R	Channel 2	*
			0xE9E	R	Channel 3	*
			0xE9F	R	Channel 4	*
			0xEA0	R	Channel 5	*
			0xEA1	R	Channel 6	*
			0xEA2	R	Channel 7	*
			0xEA3	R	Channel 8	*
			0xEA4	R	Channel 9	*

Table 24 - Node Table Detail

Data can be collected from the Node tables at a query interval equal to or less than the scan interval. Readings will appear in the Node tables as soon as they are successfully communicated from each Node to the Supervisor. The contents of channel zero through channel nine depends on the code at offset four (address 0xE95 in this example).

It is possible to miss data if only querying the Node tables. If two successive data packets for a particular Node arrive, only the second one will be stored in the Node table, regardless of the time stamps.

Address	R/W	Data	Type
0xE91	R	Node Id [0] LSW	uint64_t
0xE92	R	Node Id [1]	
0xE93	R	Node Id [2]	
0xE94	R	Node Id [3] MSW	
0xE95	R	code/index	uint8_t/uint8_t
0xE96	R	Node SN [0] LSW	uint32_t
0xE97	R	Node SN [1] MSW	
0xE98	R	Second/Minute	uint8_t/uint8_t
0xE99	R	Hour / Day	uint8_t/uint8_t
0xE9A	R	Month/ Year	uint8_t/uint8_t
0xE9B	R	Channel 0	*
0xE9C	R	Channel 1	*
0xE9D	R	Channel 2	*
0xE9E	R	Channel 3	*
0xE9F	R	Channel 4	*
0xEA0	R	Channel 5	*
0xEA1	R	Channel 6	*
0xEA2	R	Channel 7	*
0xEA3	R	Channel 8	*
0xEA4	R	Channel 9	*

Code	0xD0	Type
LSW	Status (Config)	bitfield
MSW	Battery	uint16_t
LSW	Signal Strength %	uint16_t
MSW	Node Temp	uint16_t
LSW	Reading	IEEE-754 single
MSW		
LSW	Thermistor	uint16_t
MSW	Aux Bat	uint16_t
LSW	Firmware Version	uint16_t
MSW	Array Number	uint16_t

Table 25 - Channel Detail (Single Channel Node)

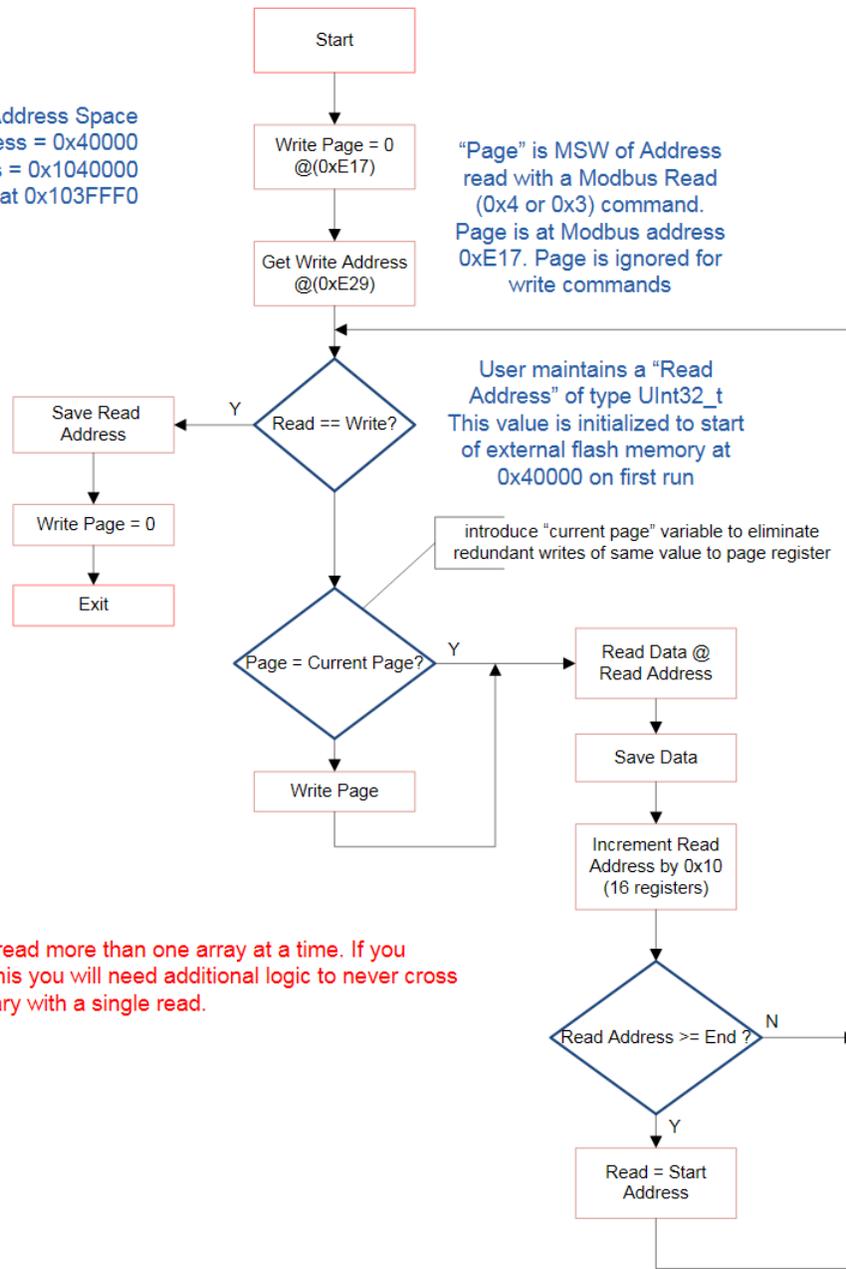
Readings that fall on odd times (not on the scan interval) will have zero as the data array number to distinguish them from normal readings. When a Node first joins the network with a valid scan rate and time, it will take a reading at the top of the next minute, regardless of the scan rate. These readings may fall on odd times.

D.7 Extended Memory

When using Multiplexers, only Node data with code 0xD0 will reside in the Node data table (Table 24 on the previous page). To access all historical data, Modbus masters must be programmed to read the extended memory in the Supervisor. Extended memory is divided up into 1,048,576 readings of 16 registers (32 bytes) each. Data read from external flash needs to be treated according to the code stored in the first byte of the first register.

The 16 register reading detail is shown in Table 26. The first external memory data array starts at Modbus register 0x40000 (Page = 4, Address = 0) and the last at 0x103FFF0 (Page = 0x103, Address = 0xFFFF0).

External Flash Address Space
 Start Address = 0x40000
 End Address = 0x1040000
 Last array starts at 0x103FFF0



You may also read more than one array at a time. If you choose to do this you will need additional logic to never cross a page boundary with a single read.

Figure 20 - External Flash Read Flow Diagram

R/W	Data	Type
R	code/index	uint8_t/uint8_t
R	Node SN [0] LSW	uint32_t
R	Node SN [1] MSW	
R	Second/Minute	uint8_t/uint8_t
R	Hour / Day	uint8_t/uint8_t
R	Month/ Year	uint8_t/uint8_t
R	Channel 0	*
R	Channel 1	*
R	Channel 2	*
R	Channel 3	*
R	Channel 4	*
R	Channel 5	*
R	Channel 6	*
R	Channel 7	*
R	Channel 8	*
R	Channel 9	*

Code	0xD0	0xD1	0xD2	0xD3	Type
LSW	Status (Config)	Reading1	Reading4	Reading7	IEEE-754 single
MSW	Battery				
LSW	Signal Strength %	Reading2	Reading5	Reading8	IEEE-754 single
MSW	Node Temp				
LSW	Reading	Reading3	Reading6	NA	IEEE-754 single
MSW	Reading			NA	
LSW	Thermistor	Thermistor1	Thermistor4	Thermistor7	uint16_t
MSW	Aux Bat	Thermistor2	Thermistor5	Thermistor8	uint16_t
LSW	Firmware Version	Thermistor3	Thermistor6	NA	uint16_t
MSW	Array Number	NA	NA	NA	uint16_t

Table 26 - Data Array Details (EXT Memory)

D.8 Conversions

The following equations can be used to obtain real numbers for the various sensors.

D.8.1 Battery Voltage

$$v=5*\left(\frac{Raw}{16383}\right)$$

Raw = value from table

v = volts

D.8.2 Board Temperature

$$mV=2.5*\left(\frac{Raw}{16383}\right)*1000$$

$$T=\frac{T_b-\sqrt{(T_b^2-4T_a(T_c-mV))}}{2T_a}+30^\circ$$

Raw = value from table

mV = millivolts

$$T_a = -0.00262 \frac{mV}{C^2}$$

$$T_b = 8.194 \text{ mV}/C^\circ$$

$$T_c = 1324 \text{ mV}$$

T = Temperature (C°)

D.8.3 Thermistor

$$R_{TH}=\frac{3,000\Omega*16383}{Raw}-6,000\Omega \quad \text{For legacy models (first generation)}$$

$$R_{TH}=3,000\Omega*\left(\frac{1024}{Raw}-1\right) \quad \text{For 8XXX-XX-XXX-XXX models (second generation)}$$

$$T=\frac{1}{A+B \ln R_{TH}+C (\ln R_{TH})^3}-273.15^\circ C$$

Raw = value from table

R_{TH} = thermistor resistance Ω

$$A = 1.4051e-3$$

$$B = 2.369e-4$$

$$C = 1.019e-7$$

T = Temperature (C°)

D.9 Data Types

uint8_t = unsigned 8 bit integer

int8_t = signed 8 bit integer

uint16_t = unsigned 16 bit integer

int16_t = signed 16 bit integer

uint32_t = unsigned 32 bit integer

int32_t = signed 32 bit integer

uint64_t = unsigned 64 bit integer

int64_t = signed 64 bit integer

IEEE-754 = single precision

APPENDIX E. SENSEMETRICS MANAGEMENT PLATFORM

GeoNet Wireless nodes are compatible with the Sensemetrics sensor management platform. This combination of technologies greatly expands the ways in which data can be collected remotely, with “plug and play” connectivity and with the ability to be displayed in near real-time on a user-friendly, browser-based data platform. Figure 21 shows a network configuration pairing GeoNet wireless devices with Sensemetrics’ sensor management platform. No GeoNet supervisor is necessary in this configuration.

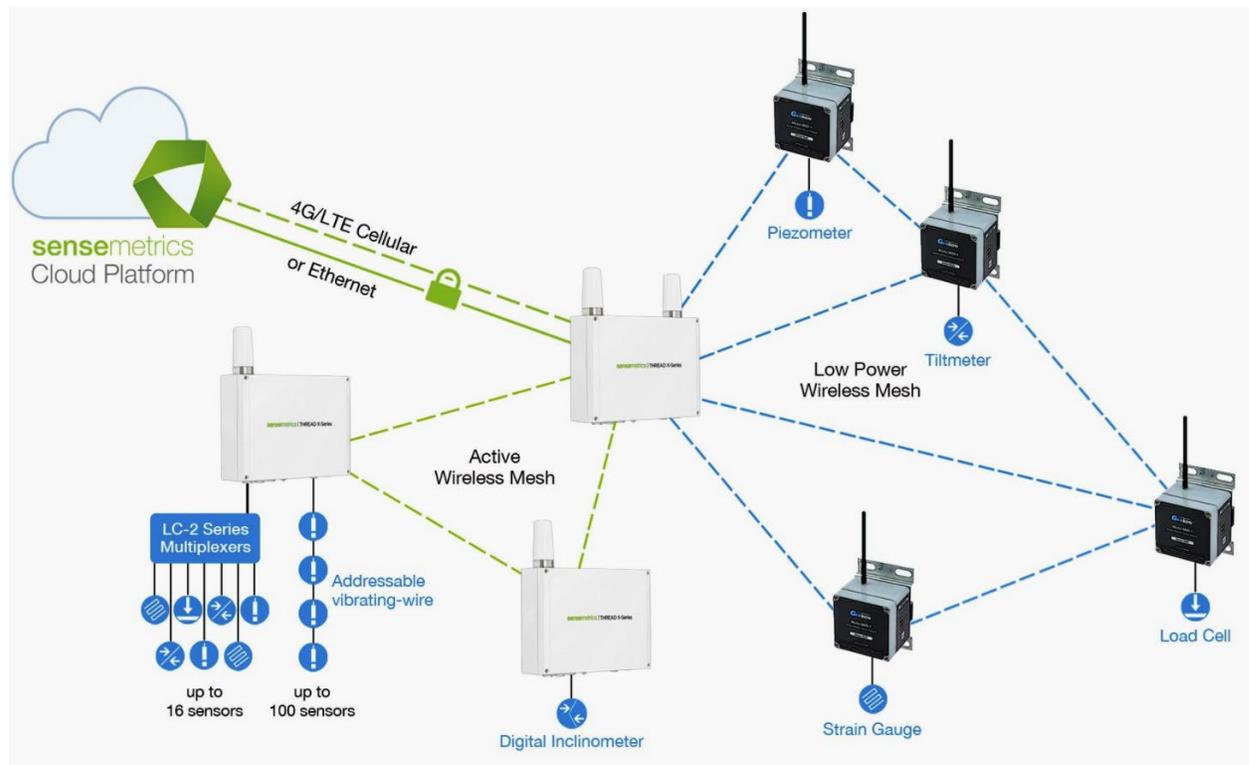
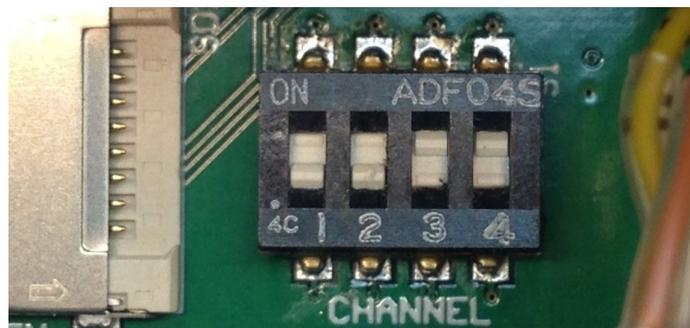


Figure 21 - Example Network Configuration

E.1 Channel Configuration

The channel select dipswitch must be set as shown in below in order to communicate with the Sensemetrics portal. For more information on channel configuration, see Section 2.2.



Switch #	1	2	3	4
Setting	OFF	OFF	ON	ON

Figure 22 - Channel Setting for Sensemetrics Compatibility Mode

E.2 Status Button

When the status button is pressed, nodes indicate their connection status with the network by briefly illuminating the LED indicators located above the status button. A red flash means the node has not yet discovered and joined the network. A green flash means the node has joined the network and is operating. A node with a green flash will be present in the portal. With an “always on” thread, nodes should join and be present in the portal within a couple of minutes, provided they are within radio range.

A node with a red flash may be out of radio range of the Sensemetrics gateway (thread) or the thread may be in low power mode. When adding a node to network, threads should be in “always on” mode for the fastest deployment. Threads may be switched back to the desired mode once all the devices are accounted for. The mode of the thread is controlled in the “Modify Thread Connection” dialog in the portal.

APPENDIX F. FIRMWARE UPDATE

WARNING! Performing a firmware update on a Node will reset the Node memory. **Retrieve all data from the Network prior to performing a firmware update.**

F.1 Procedure

- 1) **Put the Network in deployment mode** (see Section 2.7).
- 2) Power off the Network Supervisor by moving the battery select switch to the “OFF” position (Figure 23), or by disconnecting the external battery. (For units manufactured prior to June 2017, which do not have an OFF position, remove the D cells from the battery holder.)

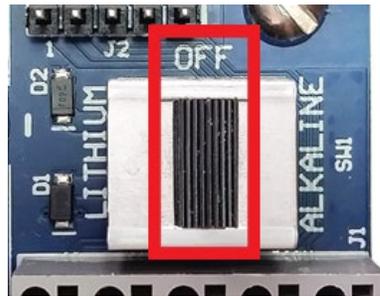


Figure 23 - Battery Selector Switch in OFF Position

- 3) Ensure that the unit is completely discharged of electrical potential by pressing the status button repeatedly until no LED lights flash.
- 4) **For RS-232 Supervisors:**
 - a. Connect the *COM-108* (RS-232 cable) to the 10-pin connector on the Supervisor.
 - b. Connect the *8001-7* (USB to RS-232 adapter) to the *COM-108*.
 - c. Connect the *8001-7* to the PC. Figure 24 shows the completed connection.

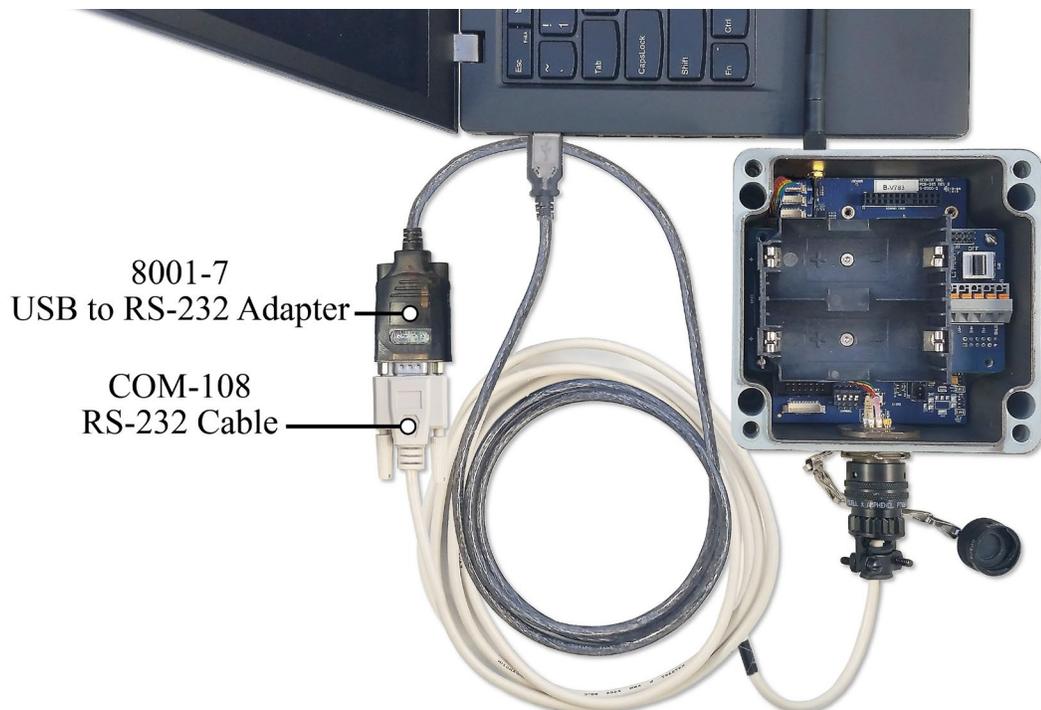


Figure 24 - Cable Connection

For all other Nodes/Supervisors:

- a. Connect the *B8800-5* (update cable) to the “RS232” connector on the bottom circuit board (Figure 25).

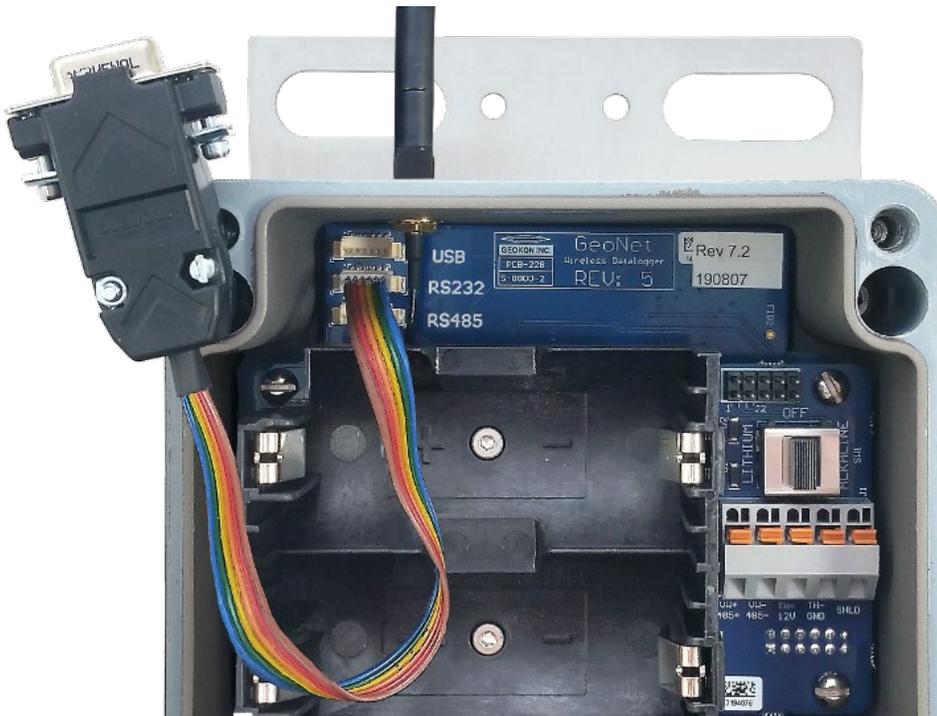


Figure 25 - RS-232 Connector Detail

- b. Connect the *B8800-5* update cable to the *8001-7* cable (USB to RS-232 adapter).
- c. Connect the *8001-7* cable to the computer. Figure 26 shows the completed connection.

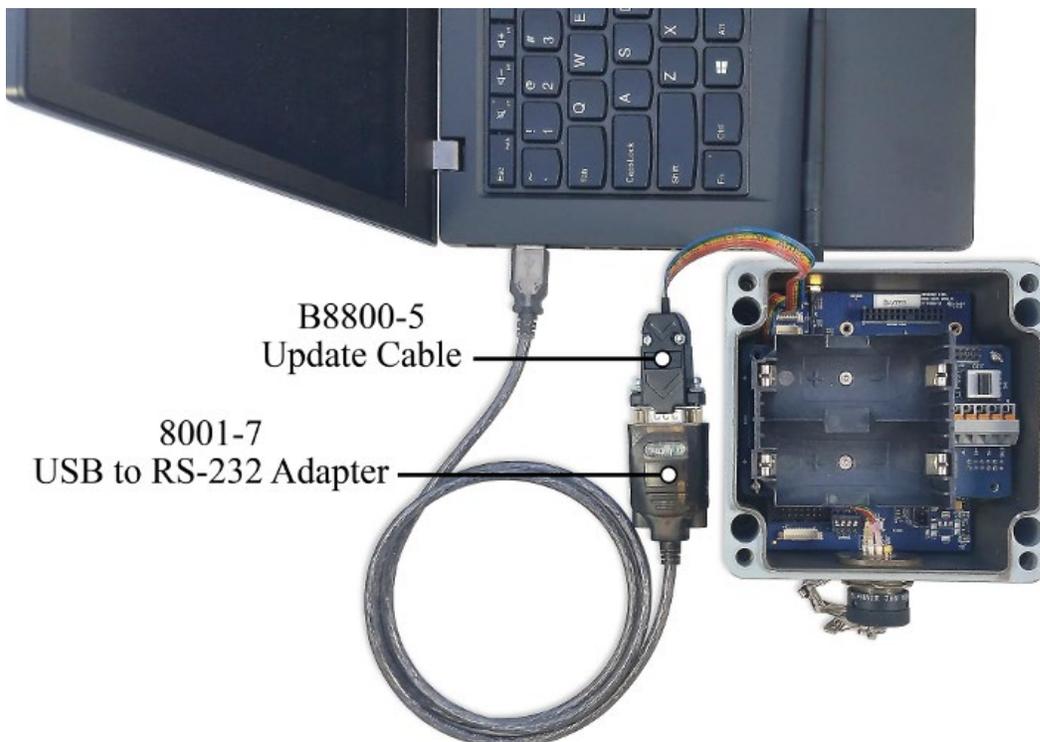


Figure 26 - Update Cable Detail

- 5) Move all channel select dipswitches to the “On” position (Figure 27).



Figure 27 - Channel Selector Switch

- 6) Move the battery select switch to either the “Alkaline” or “Lithium” position depending on the type of battery being used. Reconnect the external battery if equipped. (For units manufactured prior to June 2017 reinstall the D cell batteries into the unit.)
- 7) The green LED indicator on the right side of the unit will begin to flash in one-second intervals.
- 8) Download the “8800 GeoNet Firmware Update Package” from geokon.com/Software.
- 9) Right click on the downloaded file and choose “Extract All...” (Figure 28).

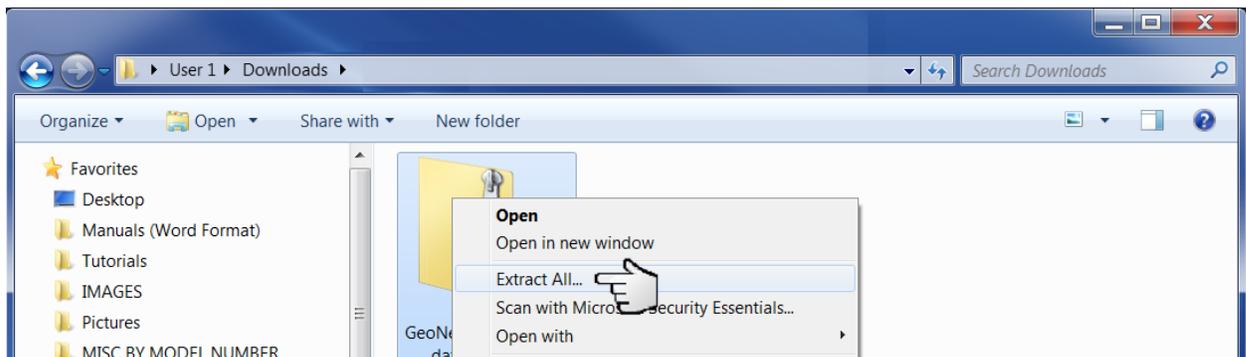


Figure 28 - Run “GeoNetUpdateUtility.exe”

- 10) When prompted click “Extract All” (Figure 29).



Figure 29 - Choose “Extract All”

11) Select a destination for the files and then click “Extract” (Figure 30).

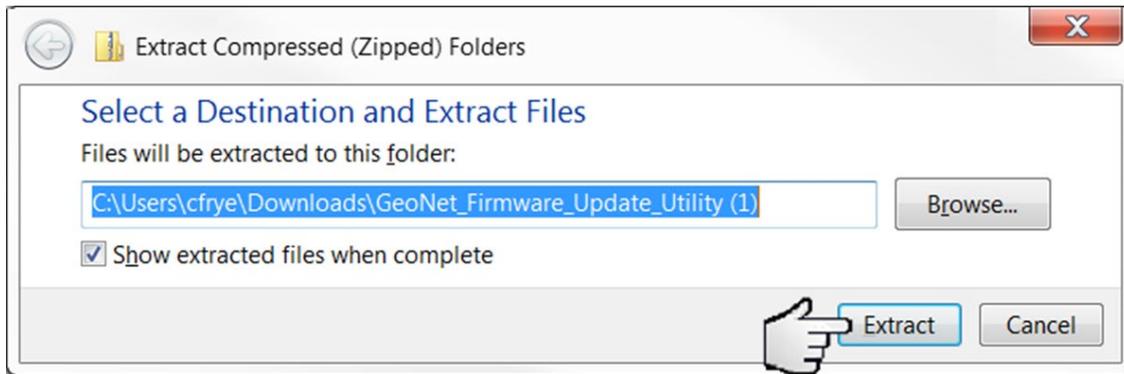


Figure 30 - Select Destination, then Click Extract

12) Open “GeoNetUpdateUtility.exe” (Figure 31). If a security warning appears click “Run”.

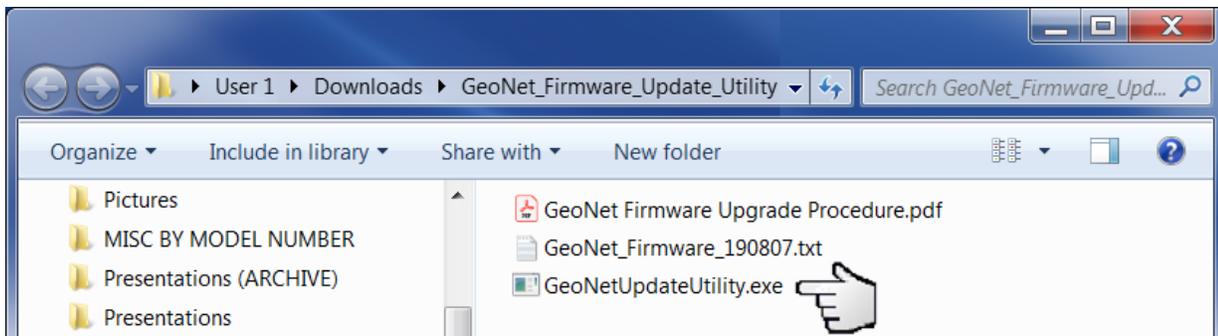


Figure 31 - Open the GeoNet Update Utility Application

13) Click “Select File” (Figure 32).

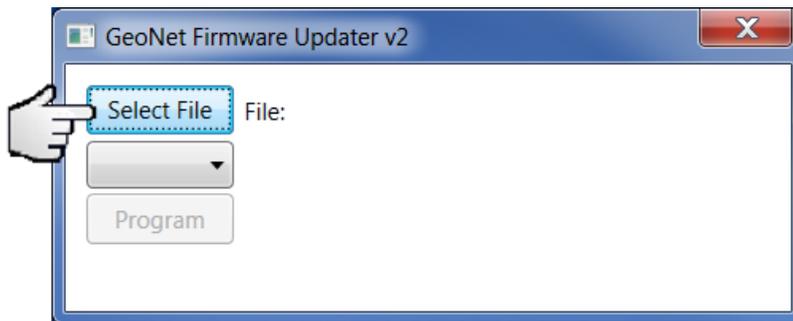


Figure 32 - Click on “Select File”

14) Double click on the .txt firmware file (Figure 33). (Firmware files are named in the following format: “GeoNet_Firmware_YYMMDD.txt”, where YY is the last two digits of the year, MM is the month, and DD is the day of the month.)

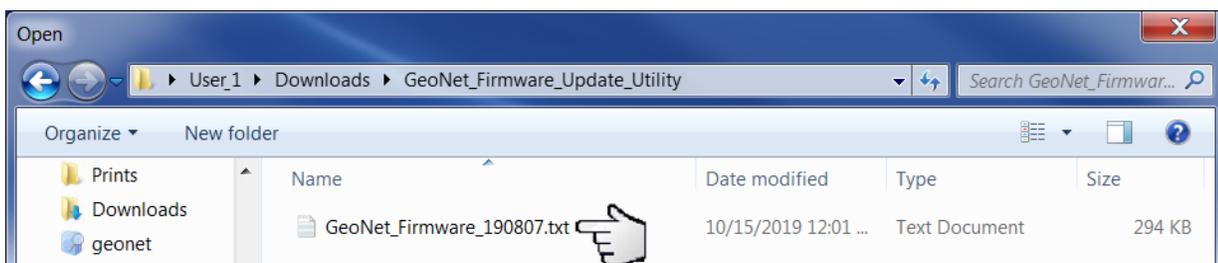


Figure 33 - Double Click on Firmware Text File

- 15) Using the drop-down box below the “Select File” button, select the correct serial port for the 8001-7 cable (Figure 34). To identify which serial port the unit is connected to, complete the following:
- Unplug the 8001-7 cable from the PC.
 - Go to the “Control Panel” then open “Device Manager”.
 - Click on the triangle to the left of “Ports (COM & LPT)” to expand the list.
 - Once the cable is plugged in the port will appear in the list.

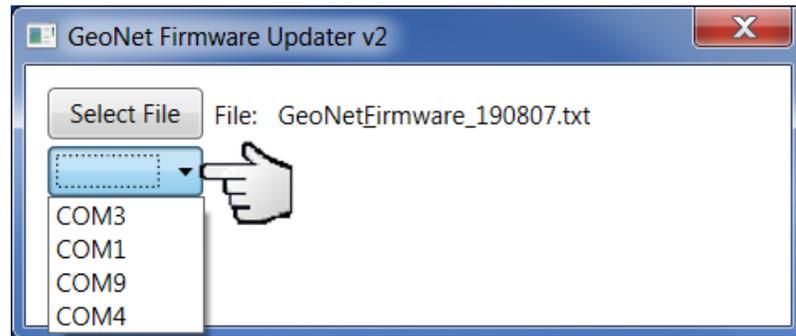


Figure 34 - Select COM Port

- 16) Click “Program” (Figure 35).

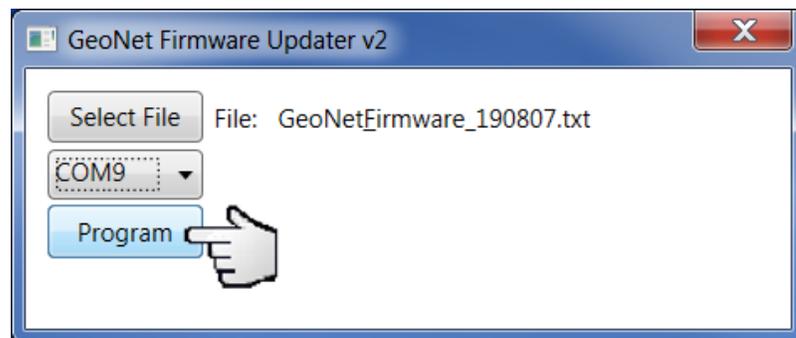


Figure 35 - Update Progress

- 17) A progress bar will appear. The update process will normally take one to two minutes.
- 18) Once the update has finished, power off the unit by moving the battery select switch to the “OFF” position, or by disconnecting the external battery. (For units manufactured prior to June 2017, which do not have an OFF position, remove the D cells from the battery holder.)
- 19) Ensure the unit is completely discharged of electrical potential by pressing the status button repeatedly until no LED lights flash.
- 20) Return the channel select dip switches to the desired channel setting.
- 21) Move the battery select switch to either the “Alkaline” or “Lithium” position depending on the type of battery being used. Reconnect the external battery if equipped. (For units manufactured prior to June 2017, reinstall the D cells into the unit.)
- 22) Repeat the above process with all the Nodes in the Network.

The firmware update is now complete.

F.2 Troubleshooting

- ✓ Make sure the green light is flashing on and off in one second intervals.
- ✓ The *B8800-5* multicolored update ribbon cable must be used on all units with the exception of the RS-232 version supervisor.
- ✓ Updates should be done using the Geokon provided *8001-7* USB to RS232 adapter. Other adapters and native serial ports have been unreliable.
- ✓ Make sure the batteries are fresh.

F.3 Change Summary for Firmware Versions

Version (Most recent at top)	Changes Instituted
191023	<ul style="list-style-type: none"> • Prevent concurrent flash writes or erasures to protect flash integrity. • Verify newly-written flash metadata matches RAM master. Rewrite metadata if difference detected. • Load prior record into RAM during bootup if newer metadata in flash is corrupted. • Stop sampling supervisor every minute. • Update supervisor signal strength regularly.
190807	<ul style="list-style-type: none"> • Provisions GeoNet for "airplane mode", silencing radio for logger-only operation.
190502	<ul style="list-style-type: none"> • Corrected fault that prevented sensemetrics threads from reading MUX boards.
190311	<ul style="list-style-type: none"> • Fixes intermittent addressable discovery of drop 1 • USB lock up corrected
190125	<ul style="list-style-type: none"> • Log data from Addressable Temperature Sensors (3810A) and Addressable Vibrating Wire Readers (8020-30). • Simplified keypad operation. • Corrected defects that impeded prompt radio network connections. • Augmented power control and battery monitoring
181025 through 180228	<ul style="list-style-type: none"> • Single Channel: VW is never disabled • MUX: VW channel disabled after 10 failed reads • MEMS: MEMS drops disabled after 10 failed reads
180213 through 170818	<ul style="list-style-type: none"> • Single Channel: VW is never disabled • MUX: VW channel disabled after 10 failed reads
Prior to 170818	<ul style="list-style-type: none"> • Single Channel: VW is disabled after 5 failed reads • MUX: VW is disabled after 5 failed reads

APPENDIX G. CERTIFICATIONS


República Federativa do Brasil
Agência Nacional de Telecomunicações

Certificado de Homologação
 (Intransferível)

Nº 01752-17-03045

Validade: Indeterminada
 Emissão: 22/05/2017

Requerente: G5 INSTRUMENTOS GEOTÉCNICOS IMPORTADORA E EXPORTADORA GEOKON, INC. LTDA.
Fabricante: SPENCER STREET LEBANON - NEW HAMPSHIRE
 NICOLAU MAEDER Nº661 ALTO DA GLÓRIA ESTADOS UNIDOS DA AMÉRICA
 80030330 CURITIBA PR

Este documento homologa, nos termos da regulamentação de telecomunicações vigente, o Certificado de Conformidade nº TÜV 16.0545, emitido pelo TÜV Rheinland Brasil. Esta homologação é expedida em nome do solicitante aqui identificado e é válida somente para o produto a seguir discriminado, cuja utilização deve observar as condições estabelecidas na regulamentação de telecomunicações.

Tipo: Categoria: Antena
Transceptor de Radiação Restrita - II

Modelo - Nome Comercial (s):
 8800-1

Características técnicas básicas:

Faixa de Frequências Tx (MHz)	Potência Máxima de Saída (W)	Designação de Emissões	Tecnologias	Tipo de Modulação
902,0 a 907,5	0,20701	255KG9D	SALTO EM FREQUÊNCIA	FSK
915,0 a 928,0	0,20701	255KG9D	SALTO EM FREQUÊNCIA	FSK
920,0 a 929,0	0,23678	290KG9D	SALTO EM FREQUÊNCIA	FSK
902,0 a 907,5	0,24266	360KG9D	SALTO EM FREQUÊNCIA	GFSK
915,0 a 928,0	0,24266	360KG9D	SALTO EM FREQUÊNCIA	GFSK

Ensaio de SAR não aplicável.

Observações:
 Este produto destina-se ao uso profissional, manuseado por pessoal devidamente qualificado, não sendo destinado ao uso do público em geral para acesso a serviço de telecomunicações de interesse coletivo.

Na instalação do produto devem ser observadas as condições de uso conforme estabelecido no Regulamento sobre Equipamentos de Radiocomunicação de Radiação Restrita.

A validade deste certificado está vinculada à vigência da homologação ANATEL 03727-12-01209, relativa ao módulo modelo XBee Pro S3B, já homologado e incorporado ao produto.

Constitui obrigação do fabricante do produto no Brasil providenciar a identificação do produto homologado, nos termos da regulamentação de telecomunicações, em todas as unidades comercializadas, antes de sua efetiva distribuição ao mercado, assim como observar e manter as características técnicas que fundamentaram a certificação original.

As informações constantes deste certificado de homologação podem ser confirmadas no SCH - Sistema de Gestão de Certificação e Homologação, disponível no portal da Anatel. (www.anatel.gov.br).

Marcos de Souza Oliveira
 Gerente de Certificação e Numeração



República Federativa do Brasil
Agência Nacional de Telecomunicações

Certificado de Homologação (Intransferível)

Nº **01759-17-03045**

Validade: Indeterminada
Emissão: 22/05/2017

Requerente: **G5 INSTRUMENTOS GEOTÉCNICOS IMPORTADORA E EXPORTADORA - GEOKON, INC.**
Fabricante: **SPENCER STREET LEBANON - NEW HAMPSHIRE**
NICOLAU MAEDER Nº661 ALTO DA GLÓRIA - ESTADOS UNIDOS DA AMÉRICA
80030330 CURITIBA PR

Este documento homologa, nos termos da regulamentação de telecomunicações vigente, o Certificado de Conformidade nº TÜV 16.0546, emitido pelo TÜV Rheinland Brasil. Esta homologação é expedida em nome do solicitante aqui identificado e é válida somente para o produto a seguir discriminado, cuja utilização deve observar as condições estabelecidas na regulamentação de telecomunicações.

Tipo - Categoria: **Transceptor de Radiação Restrita - II**

Modelo - Nome Comercial (s):
8800-2

Características técnicas básicas:

Faixa de Frequências Tx (MHz)	Potência Máxima de Saída (W)	Designação de Emissões	Tecnologias	Tipo de Modulação
902,0 a 907,5	0,20701	255KG9D	SALTO EM FREQUÊNCIA	FSK
915,0 a 928,0	0,20701	255KG9D	SALTO EM FREQUÊNCIA	FSK
920,0 a 928,0	0,23878	290KG9D	SALTO EM FREQUÊNCIA	FSK
902,0 a 907,5	0,24266	360KG9D	SALTO EM FREQUÊNCIA	GFSK
915,0 a 928,0	0,24266	360KG9D	SALTO EM FREQUÊNCIA	GFSK

Ensaio de SAR não aplicável.

Observações:
Este produto destina-se ao uso profissional, manuseado por pessoal devidamente qualificado, não sendo destinado ao uso do público em geral para acesso a serviço de telecomunicações de interesse coletivo.

Na instalação do produto devem ser observadas as condições de uso conforme estabelecido no Regulamento sobre Equipamentos de Radiocomunicação de Radiação Restrita.

A validade deste certificado está vinculada à vigência da homologação ANATEL 03727-12-01209, relativa ao módulo modelo XBee Pro S3B, já homologado e incorporado ao produto.

Constitui obrigação do fabricante do produto no Brasil providenciar a identificação do produto homologado, nos termos da regulamentação de telecomunicações, em todas as unidades comercializadas, antes de sua efetiva distribuição ao mercado, assim como observar e manter as características técnicas que fundamentaram a certificação original.

As informações constantes deste certificado de homologação podem ser confirmadas no SCH - Sistema de Gestão de Certificação e Homologação, disponível no portal da Anatel. (www.anatel.gov.br).

Marcos de Souza Oliveira
Gerente de Certificação e Numeração