Model 8910 Series

GeoNet Wireless LoRa®

Data Acquisition System

Instruction Manual



GEOKON®

©2025, GEOKON. All rights reserved.

Document Revision: B.1 | Release Date: 2/19/26

WARRANTY STATEMENT

GEOKON warrants its products to be free of defects in materials and workmanship, under normal use and service for a period of 13 months from date of purchase. If the unit should malfunction, it must be returned to the factory for evaluation, freight prepaid. Upon examination by GEOKON, if the unit is found to be defective, it will be repaired or replaced at no charge. However, the WARRANTY IS VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion or current, heat, moisture or vibration, improper specification, misapplication, misuse or other operating conditions outside of GEOKON's control. Components that wear or are damaged by misuse are not warranted. This includes fuses and batteries.

GEOKON manufactures scientific instruments whose misuse is potentially dangerous. The instruments are intended to be installed and used only by qualified personnel. There are no warranties except as stated herein. There are no other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and of fitness for a particular purpose. GEOKON is not responsible for any damages or losses caused to other equipment, whether direct, indirect, incidental, special or consequential which the purchaser may experience as a result of the installation or use of the product. The buyer's sole remedy for any breach of this agreement by GEOKON or any breach of any warranty by GEOKON shall not exceed the purchase price paid by the purchaser to GEOKON for the unit or units, or equipment directly affected by such breach. Under no circumstances will GEOKON reimburse the claimant for loss incurred in removing and/or reinstalling equipment.

Every precaution for accuracy has been taken in the preparation of manuals and/or software, however, GEOKON neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages or losses that result from the use of the products in accordance with the information contained in the manual or software.

No part of this instruction manual may be reproduced, by any means, without the written consent of GEOKON. The information contained herein is believed to be accurate and reliable. However, GEOKON assumes no responsibility for errors, omissions or misinterpretation. The information herein is subject to change without notification.

The GEOKON® wordmark and logo are registered trademarks with the United States Patent and Trademark Office.

TABLE OF CONTENTS

1. INTRODUCTION 1

1.1 8910 MODEL LIST 2

1.2 INCLUDED ACCESSORIES 2

1.3 ADDITIONAL ACCESSORIES (NOT INCLUDED) 3

2. MODELS 4

2.1 GATEWAYS 4

2.2 WIRELESS DATA LOGGERS 5

2.2.1 SINGLE-CHANNEL VIBRATING WIRE DATA LOGGER 5

2.2.2 EIGHT-CHANNEL VIBRATING WIRE DATA LOGGER 5

2.2.3 ADDRESSABLE (RS-485) DATA LOGGER 6

2.2.4 ANALOG FOUR CHANNEL DATA LOGGER 7

2.2.5 DIGITAL HIGH POWER (RS-485) DATA LOGGER 7

2.2.6 TIME DOMAIN REFLECTOMETRY DATA LOGGER 8

2.2.7 TILT DATA LOGGER 8

3. NETWORK TOPOLOGY 9

4. INSTALLATION 11

4.1 STATUS BUTTON & LED STATUS INDICATORS 11

4.2 INSTALLATION OVERVIEW 12

4.3 OPEN THE COVERS 12

4.4 INSTALL THE ANTENNAS 12

4.5 POWER THE GATEWAY 13

4.6 VERIFY NETWORK CONNECTIVITY 13

4.7 REGISTER AND CONFIGURE THE GATEWAY 13

4.7.1 CONFIGURE THE GATEWAY VIA THE API PORTAL (OVER THE NETWORK)USE THE GEOKON API PORTAL TO CONFIGURE THE GEONET GATEWAY IF REQUIRED. 14

4.7.2 CONFIGURE THE GATEWAY VIA THE GEOKON DESKTOP APPLICATION (MANUAL CONNECTION) 14

4.8 SEAL THE GATEWAY 15

4.9 EXPANDING DATA LOGGER CAPACITY (OPTIONAL) 15

4.10 MOUNT THE DEVICES 16

4.11 CONNECT AN EARTH GROUND 17

4.12 CONNECT THE SENSORS 17

4.12.1 STANDARD CABLES 17

4.12.2 TIME DOMAIN REFLECTOMETRY (TDR) CABLES 19

4.13 POWER AND CONFIGURE THE DATA LOGGERS 20
4.14 SEAL THE DATA LOGGERS 20
5. MAINTENANCE 21
5.1 WEATHER PROOFING 21
5.2 REPLACING BATTERIES 21
APPENDIX A. TROUBLESHOOTING 22
APPENDIX B. SOLAR PANEL KIT 23
B.1 SELECT A LOCATION 23
B.2 ASSEMBLE THE MOUNTING BRACKET 24
B.3 INSTALL THE MOUNTING BRACKET 24
B.4 SECURE THE SOLAR PANEL TO THE MOUNTING BRACKET 24
B.5 CONNECT THE POWER CABLE 25
B.5.1 BATTERY SWITCH 25
B.5.2 MAKING THE CONNECTION 25
APPENDIX C. SPECIFICATIONS 26
C.1 NETWORK SPECIFICATIONS 26
C.2 GENERAL SPECIFICATIONS 26
C.3 VIBRATING WIRE DATA LOGGER SPECIFICATIONS 26
C.4 DIGITAL DATA LOGGER (ADDRESSABLE AND DIGITAL HIGH POWER) SPECIFICATIONS 27
C.5 ANALOG DATA LOGGER SPECIFICATIONS 27
C.6 TIME DOMAIN REFLECTOMETRY DATA LOGGER SPECIFICATIONS 27
C.7 TILT DATA LOGGER SPECIFICATIONS 28
APPENDIX D. ANALOG CONFIGURATION AND EXAMPLES 29
D.1 CHANNEL CONFIGURATION 29
D.2 INPUT RANGE OPTIMIZATION 29
D.3 ADC VALUE TO VOLTAGE CONVERSION 30
D.4 POWER 31
D.5 SENSOR WIRING AND CONFIGURATION EXAMPLES 31
D.6 READING A 4-20 MA SENSOR (CURRENT MEASUREMENT) 32
D.7 READING A THERMISTOR (RESISTANCE MEASUREMENT) 34
APPENDIX E. TIME DOMAIN REFLECTOMETRY (TDR) SETTINGS AND PARAMETERS 35
E.1 DEFAULT SETTINGS AND PARAMETERS: 35

E.2 BASIC SETTINGS 36
E.3 PARAMETERS 37
E.3.1 EXAMPLE USE CASES 37
APPENDIX F. VIBRATING WIRE LOAD CELL WIRING 40
F.1 WIRING SINGLE LOAD CELL 40
F.2 LOAD CELL CONFIGURATION SWITCH SETTINGS 40
APPENDIX G. UNIT DIMENSIONS 41
G.1 GATEWAY (GTW) MODELS 41
G.2 SINGLE-CHANNEL (01C) AND ADDRESSABLE (ADR) MODELS 41
G.3 EIGHT-CHANNEL (08C), ANALOG (ANA), DIGITAL HIGH POWER (DHP), AND TIME DOMAIN REFLECTOMETRY (TDR) MODELS 42
G.4 TILT (TLT) MODELS 42
APPENDIX H. MOUNTING BRACKET DIMENSIONS 43
H.1 GATEWAY (GTW), EIGHT-CHANNEL (08C), ANALOG (ANA), DIGITAL HIGH POWER (DHP), AND TIME DOMAIN REFLECTOMETRY (TDR) MODELS 43
H.2 SINGLE-CHANNEL (01C) AND ADDRESSABLE (ADR) MODELS 44
H.3 TILT (TLT) MODELS 45
APPENDIX I. COMPONENTS (TYPICAL REPLACEMENT PARTS) 46
I.1 GATEWAY (GTW) MODELS 46
I.2 SINGLE-CHANNEL (01C) AND ADDRESSABLE (ADR) MODELS 47
I.3 EIGHT-CHANNEL (08C) AND ANALOG (ANA) MODELS 48
I.4 DIGITAL HIGH POWER (DHP) AND TIME DOMAIN REFLECTOMETRY (TDR) MODELS 49
I.5 TILT (TLT) MODELS 50

1. INTRODUCTION

The Model 8910 GeoNet Wireless Data Acquisition system utilizes LoRa® radio technology and consists of a gateway and wireless data loggers that transmit data collected from the connected sensors. The GEOKON gateway controls the network and is the aggregator of all the data from the data loggers in the system.

The data loggers can also operate using LoRaWAN protocol for use with LoRaWAN third-party gateways. The LoRaWAN deployment is typically done in an enterprise application and requires GEOKON to provide custom applications depending on the client specified architecture and IT security settings.

The GEOKON gateway transfers the collected data to a secure cloud-based storage platform where it can be accessed through the GEOKON OpenAPI. Data visualization software, such as the free GEOKON Agent program, can be used with the OpenAPI for data viewing and reporting. Commissioning, billing and configuration are accomplished via the easy-to-use GEOKON API Portal. The portal allows users to activate data loggers, change settings, configure sensor channels, and view current data logger status.

The API Portal can be found at api.geokon.com and the GEOKON Agent program can be downloaded at geokon.com/Software.

The system is compatible with most manufacturers' vibrating wire, RS-485 (using MODBUS protocol), and analog instruments. Sensor cables are connected through cable glands. For multi-sensor instruments such as load cells and thermistor strings, a multichannel data logger is used.

Data loggers with Time Domain Reflectometry capabilities are also available. TDR systems consist of a TDR data logger and TDR cable. This technology is used for monitoring slope stability by detecting ground movement along potential slip surfaces. A coaxial TDR cable is installed in a borehole and grouted in place; when the slope deforms, the cable bends or shears, causing measurable reflections in the TDR signal. By analyzing these reflections, engineers can identify the depth and progression (but not magnitude or rate of movement) of slope movement in real time.

Tilt data loggers are another option that combines the functionality of a biaxial tiltmeter and a GeoNet Data Logger.

Model 8960 Digital Vibrating Wire Interfaces can be connected to GeoNet Multi-Channel, Addressable, and Digital High Power Data Loggers to expand the capacity of the data logger when used to connect to vibrating wire sensors (See Section 4.9).

Rechargeable versions of the data loggers, equipped with lithium ion (or in the case of a DHP data logger, sealed lead acid) batteries, are also available.

FEATURES:

- Automated data connection to servers
- Automated calculation of engineering units via Web API integration with the GEOKON database
- Up to 8 channels
- Rugged, IP 68 rated to 1.5 m (5 feet) die-cast aluminum enclosure with pressure compensation vent to prevent condensation buildup in humid climates.
- USB-C port for firmware updates, diagnostics, and more

1.1 8910 MODEL LIST

	Model Number	Description	Network	Sensor Cable Entry
Gateway	8910-GTW	Cellular Gateway	Cellular (LTE or LTE-M)	Not Applicable
Data Logger	8910-01C	Single Channel Vibrating Wire Data Logger, rechargeable and non-rechargeable options available	Star Topology to the Gateway	PG11 Cable Gland
	8910-08C	Eight-Channel Vibrating Wire Data Logger, rechargeable and non-rechargeable options available		
	8910-ADR	Addressable Data Logger, RS-485, rechargeable and non-rechargeable options available		
	8910-ANA	Four-Channel Analog Data Logger, rechargeable and non-rechargeable options available		
	8910-DHP	Digital High Power Data Logger, RS-485, rechargeable		
	8910-TDR	Time Domain Reflectometry Data Logger, rechargeable		BNC Connector
	8910-TLT	Tilt Data Logger, rechargeable and non-rechargeable options available		Not Applicable

TABLE 1: *List of Model 8910 LoRa Data Loggers*

1.2 INCLUDED ACCESSORIES

GeoNet Product Line	Part Number	Description	Quantity
Gateways	ELC-824	Antenna	2
Rechargeable Data Loggers	ELC-1051	Antenna	1
Non-Rechargeable Data Loggers	ELC-1051	Antenna	1
	BAT-202 (Pre-installed inside the data logger)	Lithium D-Cell Batteries	2

TABLE 2: *List of Included Accessories by GeoNet Product Line*

1.3 ADDITIONAL ACCESSORIES (NOT INCLUDED)

Accessory Application	Part Number	Description
12 Volt Battery Conversion	8020-7-1	Solar Panel, 20-watt, regulated. For use with a 12V battery (customer supplied). Includes side-of-pole mounts, charge controller, and 4.5 m (15') interconnect cable with battery clips. COM-174 (purchased separately) is required.
	COM-174	USB cable for connection between the data logger and external battery.
Other	8900-SOL-10W-USB	10 Watt solar panel.
	KIT-GEONET-C-T20, including: COM-169 TLS-112 TLS-641	**Accessory Kit, including:** USB 2.0 A Male to C Male Cable 3/32" Flat Head Screwdriver T20 Torx Key

TABLE 3: *Additional Accessories (Not Included)*

2. MODELS

2.1 GATEWAYS

Gateways control the network and are the central collection point for all data recorded by the data loggers. The gateway contains internal sensors for battery, temperature, etc. Gateways do not possess sensor-reading functionality; external sensors cannot be connected to a gateway. The gateway transfers collected data to the GEOKON Cloud data storage platform via a cellular network. (GeoNet Cellular Gateways are compatible with all major LTM or LTE-CAT1 networks except Verizon.) Gateways must be connected to a solar panel or other external power supply.

Users can activate and deactivate the data transmission online via the GEOKON API Portal at api.geokon.com.



FIGURE 1: *Gateway*

2.2 WIRELESS DATA LOGGERS

Wireless data loggers collect data from external and internal sensors and transmit it to the gateway. Each data logger contains internal sensors for battery, temperature, signal strength, etc. External sensor cables are connected through cable glands. Data loggers are equipped with either D-cell or rechargeable lithium ion batteries. DHP data loggers are equipped with a sealed lead acid battery. Rechargeable data loggers must be connected to a solar panel or other external power supply.

2.2.1 SINGLE-CHANNEL VIBRATING WIRE DATA LOGGER

Single-channel vibrating wire data loggers will read one GEOKON vibrating wire gauge and integral thermistor.



FIGURE 2: *Single-Channel VW Data Logger*

2.2.2 EIGHT-CHANNEL VIBRATING WIRE DATA LOGGER

Eight-channel vibrating wire data loggers will read up to eight GEOKON vibrating wire gauges and integral thermistors.



FIGURE 3: *Eight-Channel VW Data Logger*

An eight-channel data logger can be configured as follows:

Maximum Number of Gauges	Maximum Number of Load Cells
Eight	One 3-gauge **and** one 4-gauge load cell Two 3-gauge **or** two 4-gauge load cells One 6-gauge load cell *Refer to Appendix F for load cell wiring tables*

TABLE 4: *Eight-Channel VW Data Logger Gauge/Load Limits*

2.2.3 ADDRESSABLE (RS-485) DATA LOGGER

Addressable data loggers are compatible with GEOKON Digital Addressable MEMS products and are capable of reading up to 64 GEOKON MEMS sensors (90 sensors, with the data logger powered via external 12 V power supply). With custom firmware, they are also capable of reading non-GEOKON sensors that utilize RS-485 MODBUS communication protocol.



FIGURE 4: *Addressable Data Logger*

2.2.4 ANALOG FOUR CHANNEL DATA LOGGER

Analog data loggers contain a single 4-channel analog interface board, this analog interface provides measurement of up to 4 analog sensors with 16-bit resolution. Typical sensors that may be read with this interface include 0-5 V, 4-20 mA (2-Wire or 4-Wire), thermistors, and mV/V (load cells).



FIGURE 5: *Analog Four-Channel Data Logger*

2.2.5 DIGITAL HIGH POWER (RS-485) DATA LOGGER

Digital High Power (DHP) data loggers are compatible with GEOKON Digital Addressable MEMS products. Data loggers are capable of reading up to 250 GEOKON MEMS sensors. With custom firmware, they are also capable of reading non-GEOKON sensors that utilize RS-485 MODBUS communication protocol. DHP data loggers are equipped with a rechargeable battery and must be connected to a solar panel or other external power supply.



FIGURE 6: *Digital High Power Data Logger*

2.2.6 TIME DOMAIN REFLECTOMETRY DATA LOGGER

Time Domain Reflectometry data loggers analyze the reflections of an installed TDR cable. TDR systems provide a cost-effective, durable, and automated means of detecting slope instability, and are often used in combination with inclinometers and piezometers to provide a comprehensive assessment of slope performance and early warning of failure.



FIGURE 7: *Time Domain Reflectometry Data Logger*

2.2.7 TILT DATA LOGGER

Tilt data loggers contain an integrated tiltmeter sensor. The two axes of the tiltmeter have a range of ±90° (the calibrated range is ±30°), based on a starting position of 0° (antenna pointing up).

Tilt data loggers have two serial numbers, one for the tilt data logger and one for the internal tiltmeter.

Note: Tilt data loggers do not possess sensor-reading functionality; external sensors cannot be connected.



FIGURE 8: *Tilt Data Logger*

3. NETWORK TOPOLOGY

The Model 8910 GeoNet Wireless Data Acquisition utilizes LoRa radio technology. The system topology takes the form of a star network. All data loggers communicate directly with the gateway.

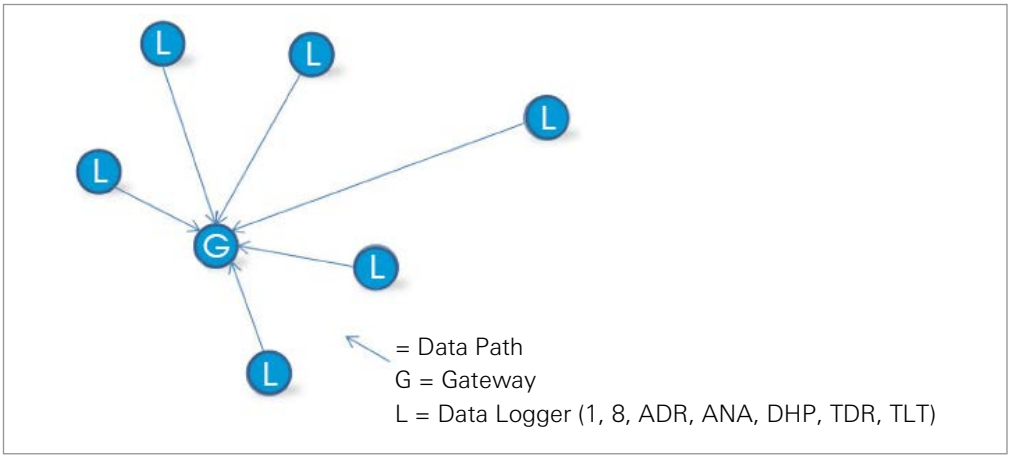


FIGURE 9: *Star Network Topology*

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

The Fresnel zone is the geographic area between the sending antenna and the receiving antenna. Objects in the Fresnel zone can cause reflections of the transmitted signal. When these reflections arrive at the receiving antenna, they may be out of phase with the signal that took a straight-line path, and this can weaken the straight-line signal.

For optimum performance, GEOKON recommends creating as much vertical space as possible between the straight-line path and obstacles, including the ground.

Fresnel zone must be at least 60% obstruction-free to ensure optimal wireless communication. The Figure 10 illustrates the Fresnel zone.

Caution! To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 20 cm (7.9") 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.

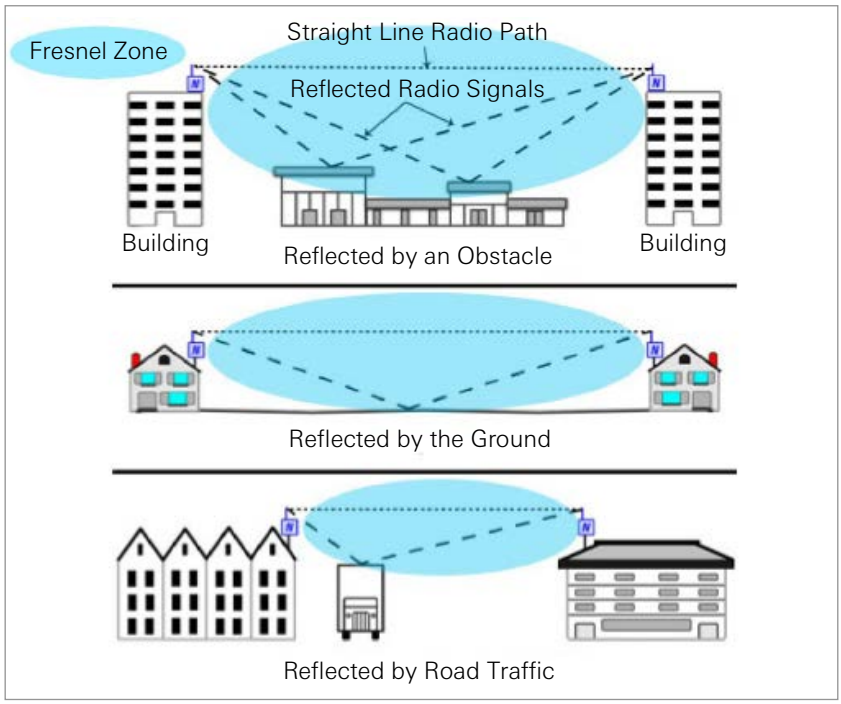


FIGURE 10: *Fresnel Zone*

4. INSTALLATION

4.1 STATUS BUTTON & LED STATUS INDICATORS

All GeoNet devices have red and green LED indicators to display their status. When pressed, the status button triggers the appropriate LED indicators to briefly illuminate.

Table 5 shows the meaning of the various LED indications.

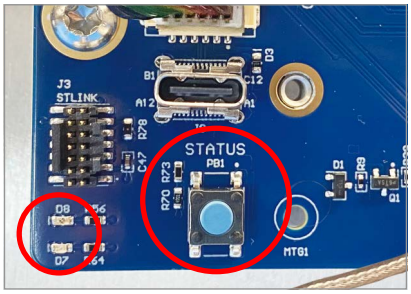


FIGURE 11: *LED Location (Left) and Status Button (Right)*

LED Indicators		Gateway	Data Loggers
Green		Time set, Data Loggers present	Good radio signal (>30%)
Green	Red	Time set, no Data Loggers present	Marginal radio signal (<30%)
	Red	Network time not set	No radio signal

TABLE 5: *LED Indicator Meaning*

When the status button is pressed on the gateway, the LEDs briefly display the network status. 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. To provide timely feedback to the user, the network parameters are set to a 10-second radio interval.

When the status button is pressed on a data logger, the LEDs briefly display the radio signal status. The data logger will indicate the status of the radio signal after each radio transmission for a period of 10 minutes. If a data logger has not yet joined the network, it will change its radio interval to approximately one second and search for an available network.

Device	Status Button Action	Function
Gateway	Press and release	✓ Take a reading and send existing data immediately ✓ Display device status
Data Logger	Press and release	✓ Display the current status ✓ Indicate signal strength every radio cycle for 10 minutes

TABLE 6: *Status Button Functions*

4.2 INSTALLATION OVERVIEW

Skipping or omitting steps, or performing them out of order, could complicate the installation of your network.

A general overview of the installation is shown in the steps below. Each step is described in detail in the sections that follow.

1. Open the covers
2. Install the antennas
3. Power the gateway
4. Verify network connectivity
5. Register and configure the gateway
6. Seal the gateway
7. Expanding data logger capacity (optional)
8. Mount the devices
9. Connect an earth ground
10. Connect the sensors
11. Power and configure the data loggers
12. Seal the data loggers

4.3 OPEN THE COVERS

Open the covers of all devices in the network by wedging open the latch on the right-hand side. (If needed, use a flathead screwdriver for leverage.) Unscrew the two Torx screws beneath the latch with a Torx key (purchased separately). Open the cover.

Important! Ensure that no dirt, water, or other contaminants enter the enclosure.

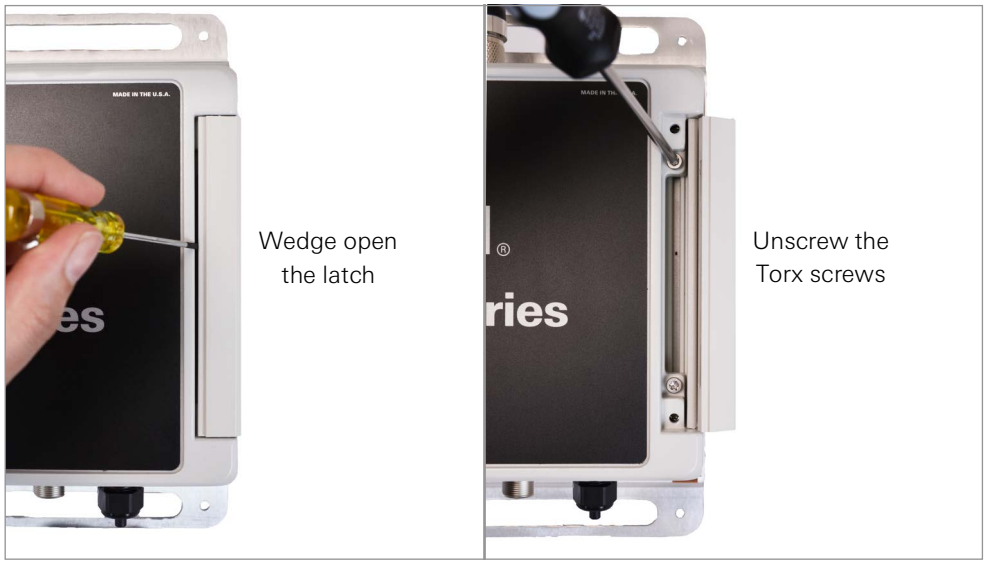


FIGURE 12: *Open the Cover*

4.4 INSTALL THE ANTENNAS

Remove the rubber caps from the antenna mounts. Position the antennas on the mounts and then rotate the antennas in a clockwise direction until tightened.

Note: Do not cross thread the antenna. The O-ring on the bottom of the antennae must be flush with the enclosure to prevent water entry.

4.5 POWER THE GATEWAY

For ease of installation, it is highly recommended that the gateway be powered before any of the data loggers.

Connect the gateway to an external power source via a USB-C connector (purchased separately) (see Appendix B for solar panel installation).

Move the battery switch (Figure 13) to the ON position. (The battery switch is located on the battery board inside the enclosure.) The green battery LED will flash twice, indicating the unit has power.

Green LED	Blue LED	Charge State
Off	Off	No Power
On	On	Bulk
Off	On	Absorption
On	Off	Float (Fully Charged)

TABLE 7: *Battery Board LED Indicator Meaning*

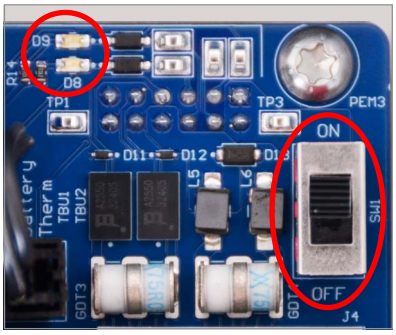


FIGURE 13: *Gateway Battery LED Location (Left) and Switch (Right)*

4.6 VERIFY NETWORK CONNECTIVITY

Gateways will set the network time automatically when they connect to the network.* (Cellular gateways will normally connect to the network within approximately five minutes.)

Verify the network connection has been made by pressing the status button. The status LEDs should flash both green and red. If only the red LED flashes, wait several minutes and then check again.

Note: *GeoNet Cellular Gateways are compatible with all major networks except Verizon.

4.7 REGISTER AND CONFIGURE THE GATEWAY

Register the gateway by entering the Serial Number in the GEOKON API portal: api.geokon.com. Select the option to activate network service.

Configuring the gateway is optional and only required if the factory settings (see below) need to be modified. A gateway can be configured either through the Network using the GEOKON API portal, or through manual connection using the Logger Config software.

GEONET 8910 GATEWAY AND DATA LOGGER FACTORY SETTINGS:

- **Mode -** Star (for operation with GeoNet Gateways sending data to the GEOKON Cloud)
- **Region -** US915 (see LoRa Alliance reference for application frequency settings for your region) https://lora-alliance.org/wp-content/uploads/2020/11/rp_2-1.0.1.pdf.
- **Channel -** Gateways are set sequentially on channels 1-4 (channels 1-4 allow for data loggers to automatically configure using the seek setting). Channels 5-8 are user selectable and gateways and data loggers need to be manually set.
- **Seek -** Default on for data loggers. Allows the data logger to connect to the closet gateway set to an auto-configurable channel (ie. Ch 1-4).

For most applications the gateways should be deployed on auto-configured channels (1-4), and data loggers should be deployed in "seek" mode. This allows for a rapid network deployment and allows for load balancing of the network traffic across the radio frequency band. In some cases where it is desired to have specific data loggers to connect to specific gateways, or if there are multiple API user accounts with gateways in the same range of the radios, user selectable channels may be desired. Multiple gateways can be set on the same channel and the data loggers will still load balance between gateways.

If configuring Model 8910-TDR Time Domain Reflectometry or Model 8910-ANA Analog Data Loggers, refer to Section 4.7.2.

Note: For LoRaWAN applications additional gateway/network settings are required from the network administrator.

4.7.1 CONFIGURE THE GATEWAY VIA THE API PORTAL (OVER THE NETWORK)USE THE GEOKON API PORTAL TO CONFIGURE THE GEONET GATEWAY IF REQUIRED.

Select the appropriate gateway settings from the dropdown menus under the ISM Config section. Select **Update ISM Config**.

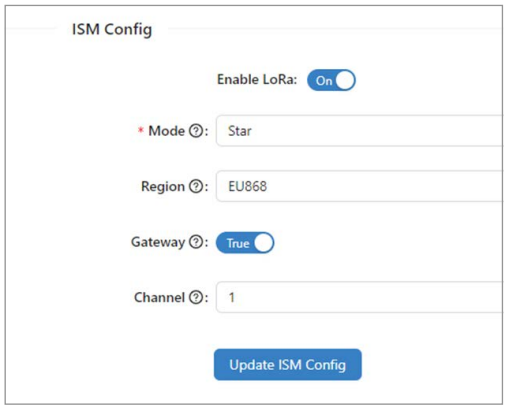


FIGURE 14: *Configuring Using the API Portal*

4.7.2 CONFIGURE THE GATEWAY VIA THE GEOKON DESKTOP APPLICATION (MANUAL CONNECTION)

Connect the gateway to a laptop with a USB-C connector (purchased separately).

Download and launch a VCP driver, this will allow the gateway/data logger to be recognized through the USB port on a computer:

https://www.silabs.com/developers/usb-to-uart-bridge-vcp-drivers?tab=downloads

Download and launch the GEOKON Desktop application:

https://apps.microsoft.com/detail/9P05ZLF7JTHJ

If configuring a Model 8910-ANA Analog Data Logger, refer to Appendix D.

If configuring a Model 8910-TDR Time Domain Reflectometry Data Logger, refer to Appendix E for settings and parameters.

Select **Settings** and select the appropriate gateway settings from the dropdown menus. Select **Apply Settings** (Figure 15).

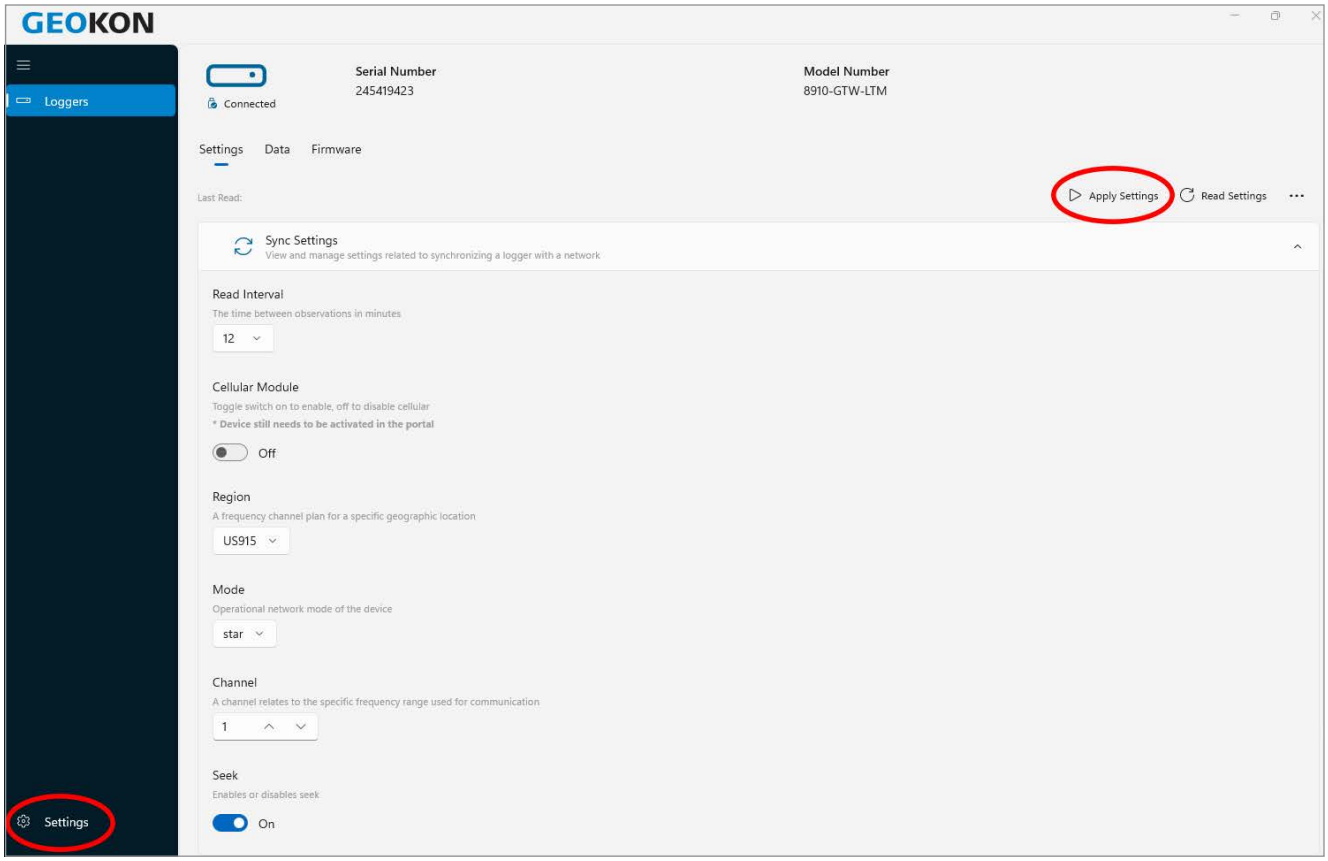


FIGURE 15: *Configuring Using the GEOKON Desktop Application*

4.8 SEAL THE GATEWAY

1. Make sure the cover gasket and the mating ridge on the enclosure are clean.
2. Close the cover and tighten the two Torx screws.
3. Push the latch firmly closed onto the cover.
4. Record the serial number of the gateway. (The serial numbers are used for identification purposes in the API portal and Agent software.)

4.9 EXPANDING DATA LOGGER CAPACITY (OPTIONAL)

Model 8960 Digital Vibrating Wire interfaces can be connected to GeoNet Multi-Channel, Addressable, and Digital High Power Data Loggers to expand the capacity of the data logger. Multiple VW interfaces can be daisy-chained together to bus the data to a single data logger. The bus limit is 32 units or 64 Channels.

Refer to the Model 8960 Instruction Manual (geokon.com/8960-Series) for information on how to connect a data logger to an interface, how to address the interfaces, and other applicable steps. To get immediate software recognition the interfaces must be connected before the data logger has been powered on.

4.10 MOUNT THE DEVICES

GeoNet mounting brackets are designed to be used with U-bolts, hose clamps, screws, etc. Mount all devices vertically, with the antenna pointing up. GEOKON recommends a mounting height of at least 2 m (6.5'). Lower than 2 m may compromise performance. As a rule, higher is usually better.

Select the mounting location with care. Certain mounting configurations can hinder or even completely block wireless signal transmission or can introduce electrical noise to the signal. (Large structures, such as walls, buildings, hills, etc. can block and/or reflect RF signals. See Section 3 for more information.)

Note: A high Received Signal Strength Indicator (RSSI) level does not guarantee trouble-free communication.

Examples of incorrect mounting configurations are shown in the following figures. Figures are for reference use only.

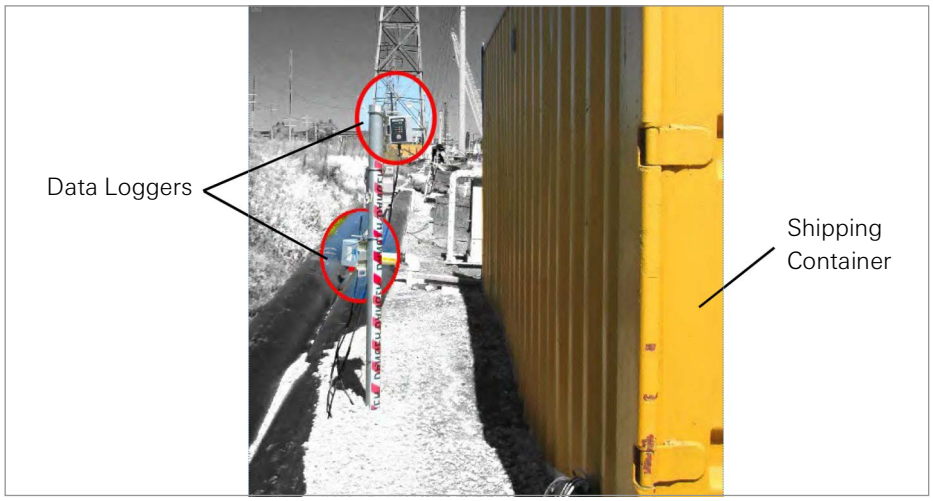


FIGURE 16: *Installing Near a Large or Metallic Object*

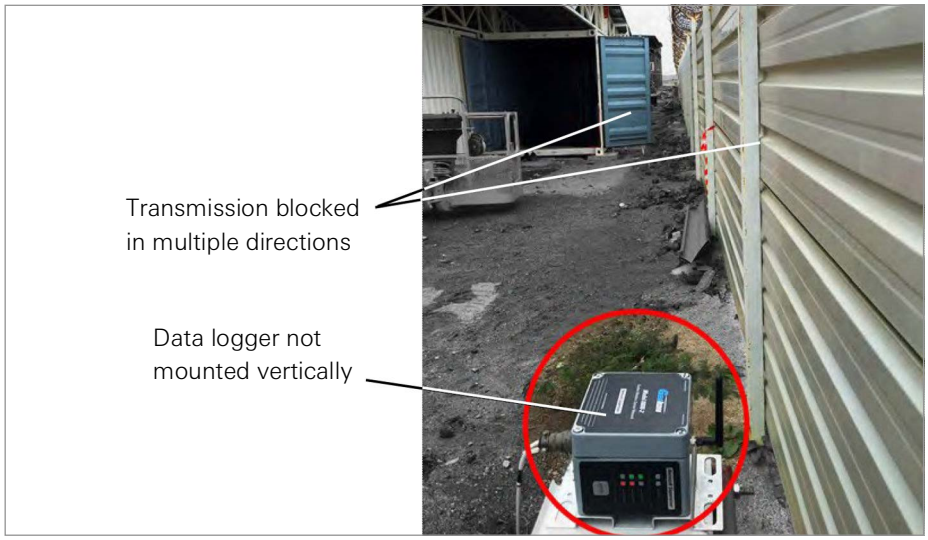


FIGURE 17: *Installing Close to Buildings or Fences/Walls, and/or Horizontally*

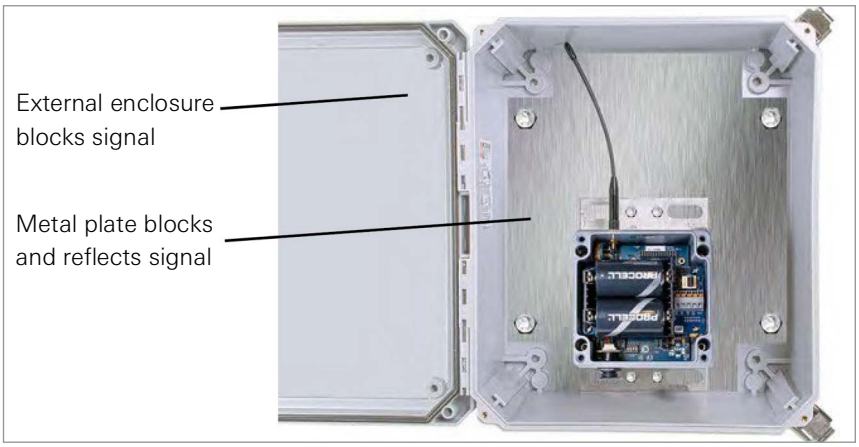


FIGURE 18: *Mounting onto a Metal Plate and/or Inside an Enclosure*

4.11 CONNECT AN EARTH GROUND

Properly grounding GeoNet devices will lessen the chance of them being damaged from nearby lightning strikes or other large transient voltages. Each vibrating wire (VW) channel is protected by a 230V gas discharge tube, followed by a high-speed surge protector and a transient voltage suppression diode. Each thermistor (TH) channel is protected by a 230V gas discharge tube, followed by an inductor (lower resistance than high-speed surge protectors) and a transient voltage suppression diode.

For these components to safely divert lightning energy to ground, a solid electrical connection to earth ground is required. All GeoNet devices can be grounded by connecting a suitable earth ground to the mounting bracket. Some GeoNet devices can also be grounded via the copper ground lug on the bottom of the enclosure.

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 device as possible. Connect the grounding rod to the mounting bracket or the copper grounding lug on the exterior of the device with a 12 AWG or larger wire. This will provide a path from the device to earth ground in the event of a lightning strike. Alternatively, any other suitable earth ground attachment may be used.

4.12 CONNECT THE SENSORS

Note: Data Loggers will stop trying to read an empty channel after two attempts. The data logger will read all channels at the top of every hour and will resume sampling when it detects a sensor. (Reset the data logger to initiate an immediate retry.)

4.12.1 STANDARD CABLES

For ease of wiring, sensor cables should be inserted into the cable glands on multi-channel data loggers in order from left to right and wired into the VW terminal blocks in sequence, starting with channel one.

To connect a sensor:

1. Loosen the nut on the cable fitting and remove the black plastic dowel.
2. Slide the sensor cable through the cable gland nut and fitting.
3. Connect the cable leads to the terminal block by holding down an orange tab, inserting the lead, and then releasing the tab. The wiring order is shown in the tables and figure below.

Important! To prevent a short circuit, do not allow the cable leads to touch each other during or after wiring.

Single/Multiple Channel Vibrating Wire Data Logger		
Position	**Color**	**Description**
VW+	RED	Vibrating Wire+
VW-	BLACK	Vibrating Wire-
TH+	WHITE	Thermistor+
TH-	GREEN	Thermistor-
SHD	BARE	Analog Ground (Shield)

TABLE 8: *Vibrating Wire Data Logger Wiring*

Addressable and DHP (RS-485) Data Logger		
Position	**Color**	**Description**
485+	WHITE	RS-485 Data+
485-	GREEN	RS-485 Data-
12V	RED	12 Volt Bus
GND	BLACK	Bus Ground
SHD	BARE	Analog Ground (Shield)

TABLE 9: *Addressable and DHP (RS-485) Data Logger Wiring*

Analog Data Logger		
Position	**Color**	**Description**
Vin+	No universal color code	Sensor Signal+
Vin-		Sensor Signal-
Exc+		Excitation Voltage+
Exc-		Excitation Voltage-
SHD	BARE	Analog Ground (Shield)

TABLE 10: *Analog Data Logger Wiring*

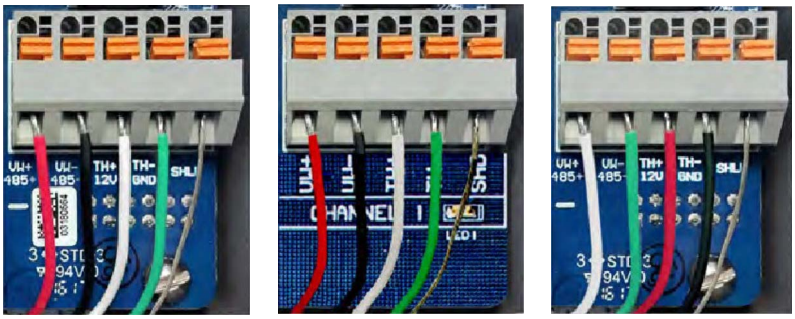


FIGURE 19: *Terminal Connections*

4. Pull gently on each conductor to ensure it is secure.
5. 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 overtighten, as this might strip the plastic threads.
6. Pull gently on the gauge cable to ensure it is held in place by the cable gland.
7. Repeat these steps for each gauge cable to be connected.
8. **Analog Data Loggers Only:** Confirm the selector switch (located under the terminal block, see Figure 20) is set to the appropriate mode for the sensor being read. See Appendix D for examples on wiring and selector switch configuration.

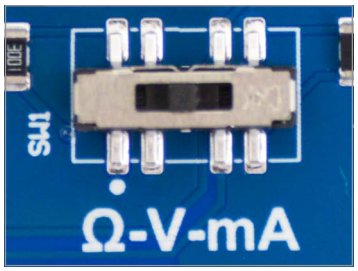


FIGURE 20: *Analog Mode Selector Switch*

4.12.2TIME DOMAIN REFLECTOMETRY (TDR) CABLES

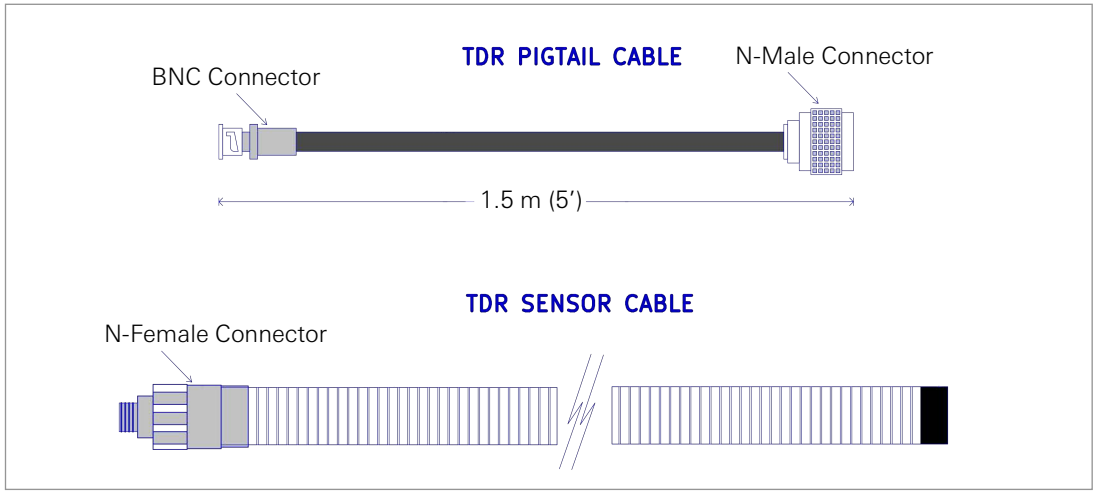


FIGURE 21: *TDR Cable Connections*

1. Install the TDR pigtail cable onto the TDR sensor cable using the N-male and N-female connectors.
2. Install the TDR pigtail cable to the TDR data logger using the BNC connector.



FIGURE 22: *Cable Connections to TDR Data Logger*

4.13 POWER AND CONFIGURE THE DATA LOGGERS

For ease of installation, it is recommended that the gateway be powered before any of the data loggers.

If using D-cell batteries, align the positive (**+**) side of the batteries with the **+** indicator in the battery holder. Push the batteries straight down into the holder.

If equipped with a rechargeable sealed lead-acid battery, connect the data logger to an external power source with the provided USB-C connector, or connect to a solar panel (See Appendix B for solar panel installation).

Move the battery switch (Figure 23) into the ON position. (The battery switch is located on the battery board inside the enclosure.) The green battery LED will flash twice, indicating the unit has power.

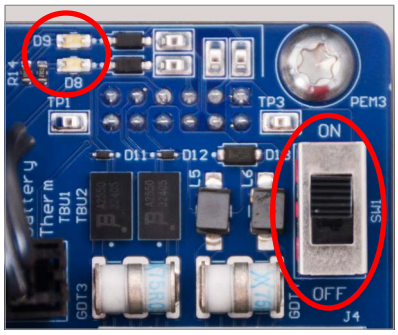


FIGURE 23: *Data Logger Battery Switch*

The data logger will join the network approximately 30 seconds after power up, as indicated by the status LED(s) on the data logger flashing in unison with the gateway.

Repeat the above procedure with the other data loggers in the network. Verify that the status LED indicators on the data loggers and the gateway are flashing green only. This may take several minutes depending on network configuration.

If communication cannot be established it may be necessary to elevate the devices or their antennas, 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.

To configure the data loggers, if required, refer to Section 4.7.1 or Section 4.7.2.

4.14 SEAL THE DATA LOGGERS

1. Record the serial number of the data loggers and the attached sensors. For multiple-channel data loggers, also record the channel to which each sensor has been connected. (The serial numbers are used for identification purposes in the API portal and Agent software.)
2. Make sure the cover gasket and the mating ridge on the enclosure are clean.
3. Close the cover and tighten the two Torx screws.
4. Push the latch firmly closed onto the cover.

Note: Make sure any unused openings are plugged with the provided dowel and the cable gland nut is tightened.

5. MAINTENANCE

5.1 WEATHER PROOFING

GeoNet devices are designed to be splash proof, rain proof, and are IP 68 rated to 1.5 m (5 feet). The enclosures are sealed by a gasket. The gasket will only prevent water entry if it is properly aligned inside the lid, the screws that hold the lid in place are properly tightened, and the latch is closed.

Always mount the devices so that the cable entries are on the bottom. Ensure the cable gland fittings are securely tightened and that the black plastic dowels provided are used to plug cable entries which are not in use.

Despite these precautions, the data loggers may encounter leakage along the cable if the cable is cut, or if the unit is installed in an especially humid environment.

5.2 REPLACING BATTERIES

Replace D cell batteries when their measured voltage drops below 3.0 - 2.9 VDC.

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

Replace the batteries as follows:

1. Open the data logger cover. Make sure that no dirt, water, or other contaminants are allowed to enter the enclosure.
2. Set the battery select switch to the OFF position.
3. Remove the existing batteries.
4. Install the new batteries by aligning the positive (+) side of the D cells with the (+) indicator in the battery holder. Push the batteries straight down into the holder.
5. Move the battery select switch to the ON position. The green status LED inside the enclosure will flash twice, indicating the unit has power. Once the data logger reconnects to the network, the green LED will blink every 10 seconds in unison with the LED inside the gateway.

APPENDIX A. TROUBLESHOOTING

For troubleshooting help, please visit geokon.com/Technical-Support.

APPENDIX B. SOLAR PANEL KIT

The GEOKON Solar Panel Kit enables you to power a gateway, digital high power, time domain reflectometry, or other rechargeable data logger in an area that has no access to mains / domestic power.

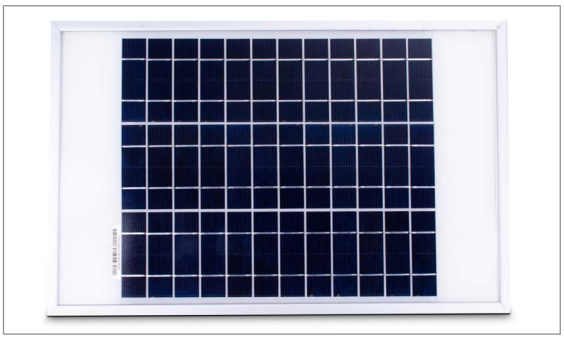


FIGURE 24: *Solar Panel 8900-SOL-10W-USB*

Inside the kit box are the following:

- One envelope containing technical documents and instructions
- One mounting bracket
- One solar panel complete with power regulation circuitry and power cable



FIGURE 25: *Solar Panel Kit Box Contents*

Install the solar panel by following the steps listed below. Each step is described in detail in the sections that follow.

1. Select a location for the solar panel.
2. Assemble and adjust the mounting bracket to the proper angle.
3. Install the mounting bracket onto the mounting surface or pole.
4. Secure the solar panel to the mounting bracket.
5. Turn on the gateway/data logger and connect the power cable.

B.1 SELECT A LOCATION

Choose a location for the solar panel that is clear of obstructions and anything that might cast a shadow on the panel.

B.2 ASSEMBLE THE MOUNTING BRACKET

When assembling the two sections of the mounting bracket, be sure to set the sections to the desired angle before tightening the nuts. The angle of the mounting bracket will dictate the angle of the solar panel.

- Ensure the angle is at least 10 degrees, to aid in water control.
- In general, choose the best angle for the latitude of your location.
- Mounting on a horizontal surface will require a reverse configuration of the two sections compared to mounting vertically, as shown below.

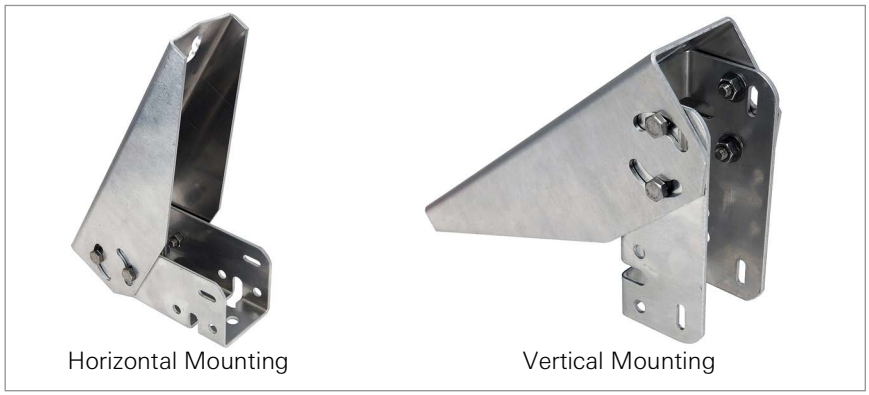


FIGURE 26: *Mounting Options*

B.3 INSTALL THE MOUNTING BRACKET

Mount the bracket on a flat surface (roof, wall, etc.) using locally supplied bolts or lag screws. If mounting to a pole, use locally supplied U-bolts and retaining clamps.

B.4 SECURE THE SOLAR PANEL TO THE MOUNTING BRACKET

Use the included nuts and screws to secure the solar panel to the mounting bracket. Use the centrally located holes provided for this purpose on the back of the solar panel.

Note: Be sure to mount the solar panel with the cable coming out the bottom of the panel, as shown below.

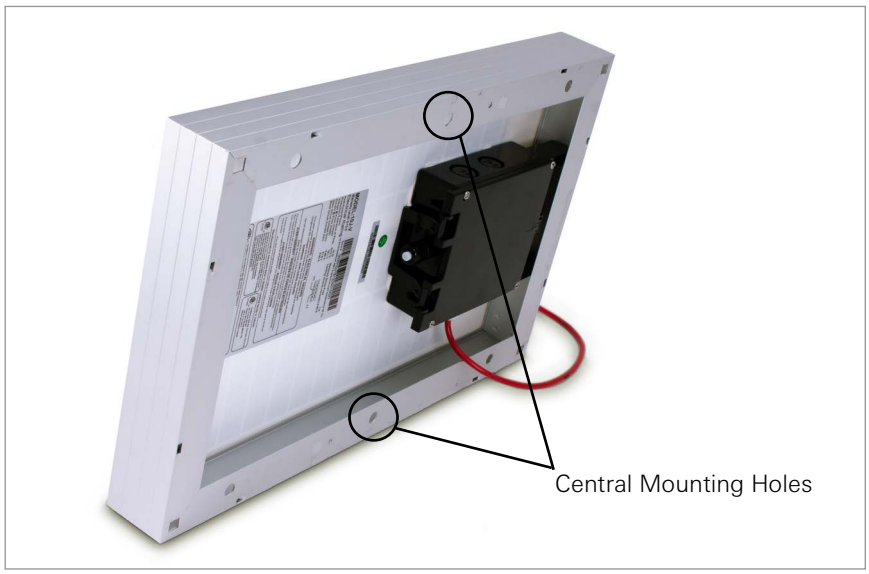


FIGURE 27: *Centrally Located Mounting Holes*

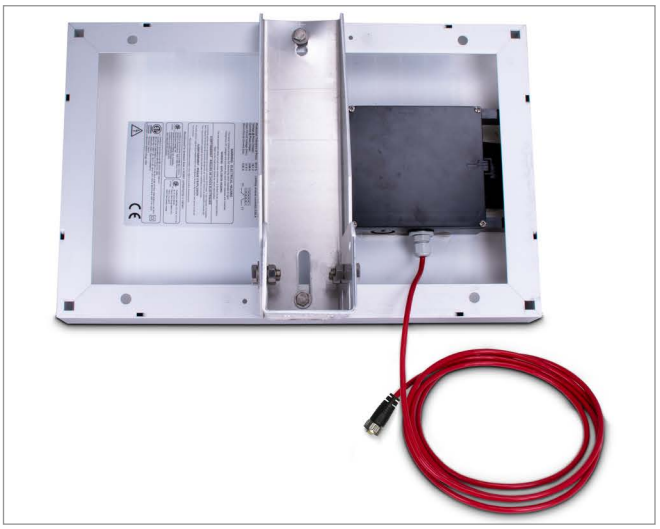


FIGURE 28: *Mounting Brackets Fastened Centrally*

B.5 CONNECT THE POWER CABLE

B.5.1 BATTERY SWITCH

Before connecting the power cable, be sure you have set the battery switch to the ON position.

B.5.2 MAKING THE CONNECTION

Remove the plastic cap from the cable connector, then attach it to the USB-C plug on the data logger.

Note: Be sure to implement a drip loop, as indicated in the previous figure, to prevent water ingress through the power connector.

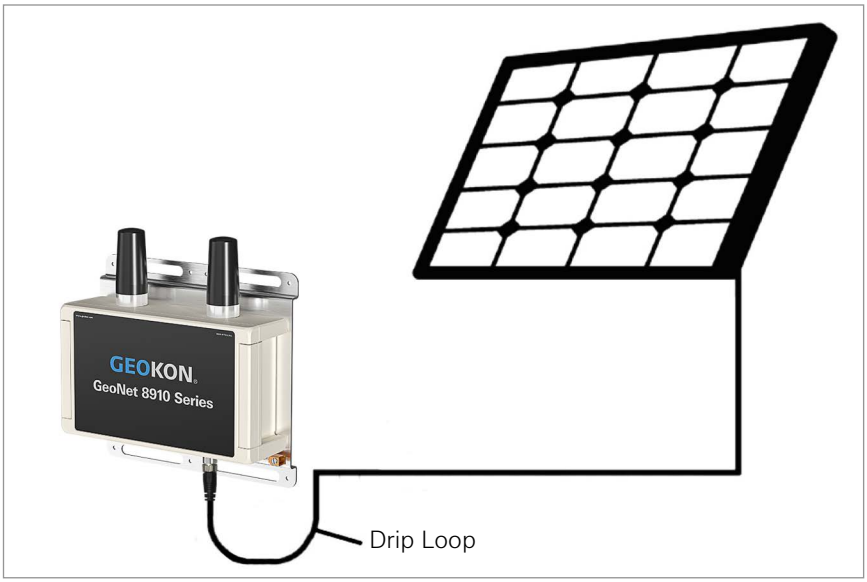


FIGURE 29: *Solar Panel with Model 8910 Gateway*

APPENDIX C. SPECIFICATIONS

C.1 NETWORK SPECIFICATIONS

Topology	Star
Radio Technology	LoRa / LoRaWAN
Radio Frequency, ISM Band	868-928 MHz (user selectable masking by region)
Channels	8 (4 auto configurable)
Range[1]	Up to 20 km in rural open areas with line of site Up to 5 km in urban areas.
Gateway Data Transmission Interval	Min: 10 minutes; Max: 1 day

TABLE 11: *Network Specifications*

Note:

[1] Outdoor, clear line-of-Sight. Depends on operating frequency.

C.2 GENERAL SPECIFICATIONS

Power Supply	GTW, DHP, and TDR models: Internal sealed lead acid (SLA) battery pack, 4V, 10 Ah / 5-24V external All other models: 2x D cell, lithium, / 5-24V external
Operating Temperature	-40 °C to +85 °C (range varies by power source) (TDR model -20 °C to 70 °C) (TLT model max of +65 °C)
Temperature Accuracy	±0.5 °C
Direct Connection Type	USB
Enclosure Material	Die-cast aluminum, IP 68 rated to 1.5 m (5 feet)
Enclosure Dimensions	See Appendix G

TABLE 12: *General Specifications*

C.3 VIBRATING WIRE DATA LOGGER SPECIFICATIONS

Trueness	0.082 Hz
Frequency Precision	±0.146 Hz (99% CI)
Frequency Resolution	±0.002 Hz
VW Frequency Range	400-6500 Hz

TABLE 13: *Vibrating Wire Data Logger Specifications*

C.4 DIGITAL DATA LOGGER (ADDRESSABLE AND DIGITAL HIGH POWER) SPECIFICATIONS

MEMS Sensor Limits	Non-rechargeable ADR: 32 sensors Rechargeable ADR: 64 sensors (90 sensors, with the sensor string powered via external 12 V power supply) DHP: 250 sensors
Communication Protocol	RS-485 Modbus

TABLE 14: *Digital Data Logger (Addressable and Digital High Power) Specifications*

C.5 ANALOG DATA LOGGER SPECIFICATIONS

Channels	4
Input Type	mV, V, mA, Ω
Input Range	0 – 150 mV, 0 – 500 mV, 0 – 1 V, 0 – 5 V, 0 – 10 V, 0 – 15 V, ±150 mV, ±500 mV, ±1 V, ±5 V, ±10 V, ±15 V, ±20 mA, 0 – 20 mA, 4 – 20 mA
Voltage Mode Accuracy	±0.1% or better
Current Mode Accuracy	±0.2% or better
Resolution	16-bit
Zero Drift	±6 µV/°C
Span Drift	±25 ppm/°C (typical)
CMR @ 50/60 Hz	92 dB min.

TABLE 15: *Analog Data Logger Specifications*

C.6 TIME DOMAIN REFLECTOMETRY DATA LOGGER SPECIFICATIONS

Pulse Generator Output	0 - 5 V
Output Impedance	50 ohm
Pulse Length	Variable (1 - 70 ns)
Waveform Averaging	1
Range	4000 m 100% VOP
Resolution	15 cm x VOP/100
Current	250 mA During Measurement
Pigtail Cable	50 ohm RG-8X 84% VOP Coaxial
Sensor Cable	50 ohm 1/2" 88% VOP Coaxial

TABLE 16: *Time Domain Reflectometry Data Logger Specifications*

C.7 TILT DATA LOGGER SPECIFICATIONS

Range[1]	±90°
Resolution[2]	0.00025° (0.004 mm/m)
Precision[3]	±0.0075° (±0.13 mm/m)
Nonlinearity	±0.005° across ±30° range (±0.09 mm/m)
Temperature Dependent Uncertainty	±0.001° across ±5° angular range (±0.016 mm/m) ±0.0016° across ±15° angular range (±0.026 mm/m) ±0.0026° across ±30° angular range (±0.042 mm/m)
Axes	2

TABLE 17: *Tilt Data Logger Specifications*

Note:

[1] Calibrated Range: ±30°

[2] 99% confidence interval (i.e., 99 out of 100 individual readings fall within this tolerance).

[3] Includes random walk (changes between consecutive readings that have no discernible cause) and seismic noise during testing.

APPENDIX D. ANALOG CONFIGURATION AND EXAMPLES

D.1 CHANNEL CONFIGURATION

Using the Geonet Desktop application, each analog input channel may be configured for the sensor being monitored:

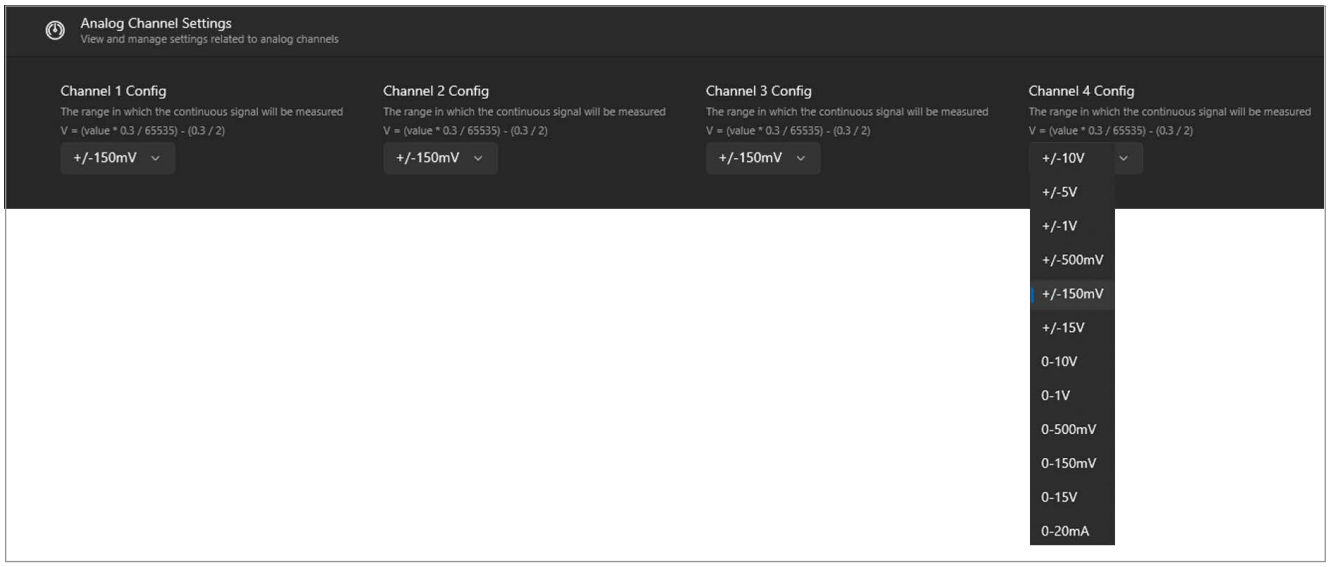


FIGURE 30: *Input Configuration Selections*

D.2 INPUT RANGE OPTIMIZATION

The 8910 Analog Data Logger contains a 16-bit Analog to Digital Converter (ADC). This ADC may be scaled using Channel Configuration so that the 16-bit range (65536 discrete values) is optimized for the attached sensor.

When configuring an input channel, for highest resolution it is best to use the input range that is closest to - but not less than - the analog sensor's output range:

Channel Input Range	Resolution
± 10 V	305 µ V
± 5 V	153 µ V
± 1 V	30.5 µ V
± 500 mV	153 µ V
± 150 mV	4.58 µ V
± 15 V	458 µ V
0 - 10 V	153 µ V
0 - 1 V	15.3 µ V
0 - 500 mV	7.63 µ V
0 - 150 mV	2.29 µ V
0 - 15 V	229 µ V
0 - 20 mA	0.305 µ A

TABLE 18: *Analog Channel and Resolution*

For example, suppose you have a sensor that has an output voltage range of 0 to 500 mV. For maximum resolution the preferred input range is 0-500 mV (Single Ended):

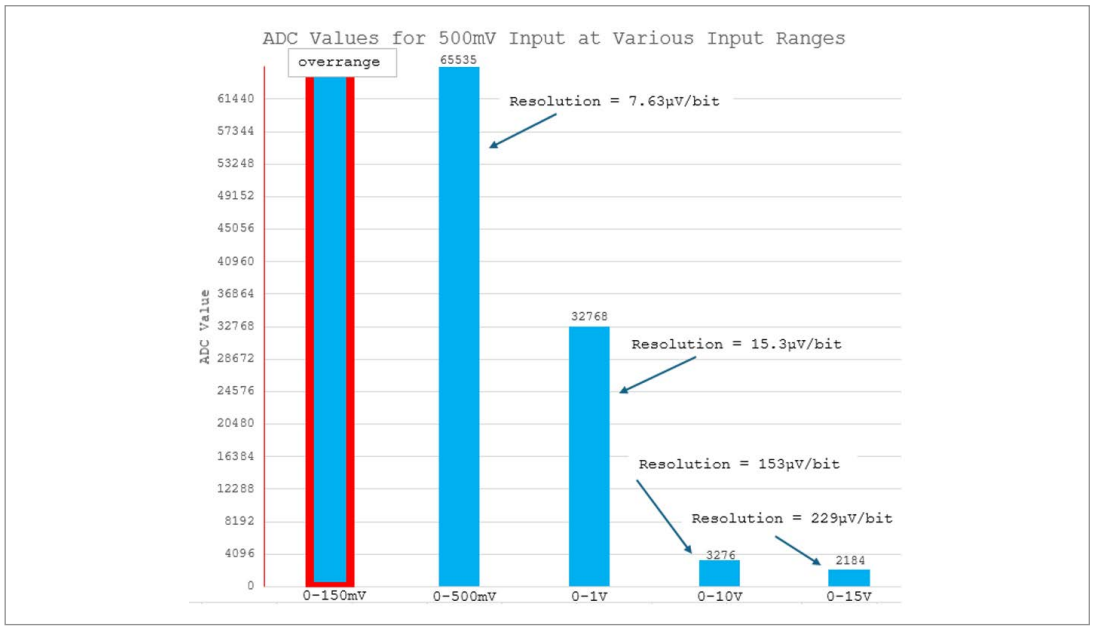


FIGURE 31: *ADC Values for 500 mV Input at Various Input Ranges*

Note that sensor output voltages exceeding 500 mV will result in an overrange of the ADC. Any voltage greater than 500 mV will read as 65535. Any voltage less than 0 V will read as 0 (underrange).

Similarly, sensors that have a differential (±) output range have the same requirements. Suppose you have a sensor that outputs ±1 V:

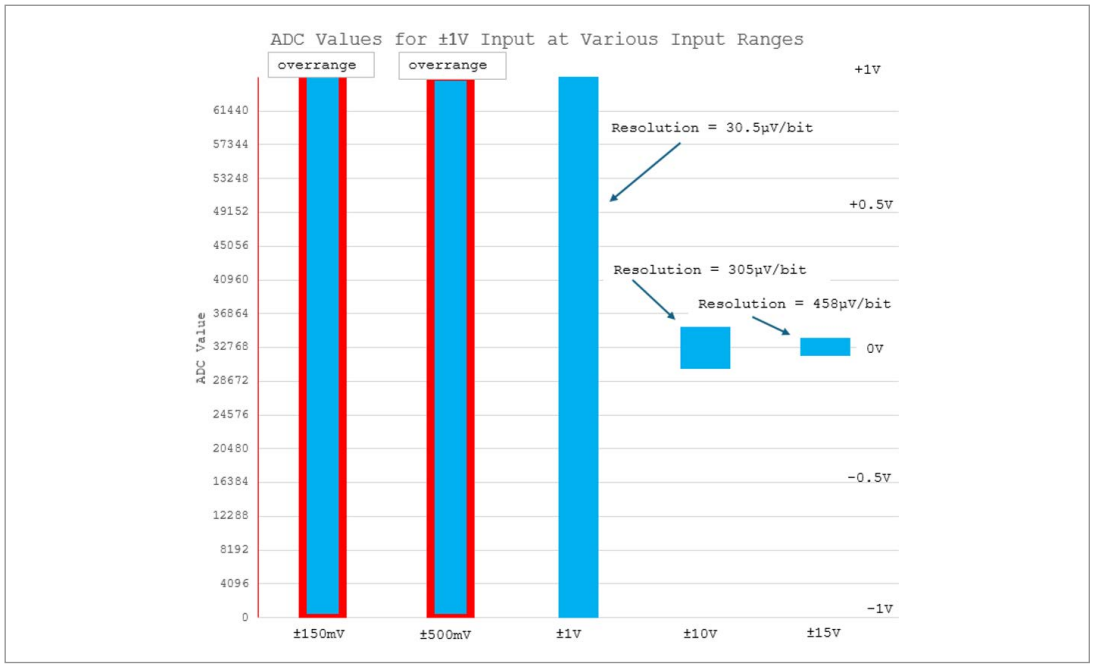


FIGURE 32: *ADC Values for ±1 V Input at Various Input Ranges*

Note that sensor output voltages exceeding ±1 V will result in an overrange/underrange of the ADC. Any voltage greater than +1 V will read as 65535, and any voltage less than -1 V will read as 0.

D.3 ADC VALUE TO VOLTAGE CONVERSION

The voltage output by the sensor is converted to a 16-bit value by the ADC. This 16-bit value can be converted back to voltage with the following formulas:

SINGLE ENDED SENSORS (0-15V, 0-10V, 0-1V, 0-500MV, 0-150MV)

Value = ADC 16-bit value

Range = ADC Input Range (V)

Resolution = 65535

$$V = Value \times \frac{Range}{Resolution}$$

EQUATION 1: *Voltage Conversion for Single Ended Sensors*

Example:

Value = 16384

Range = 0-10 V (10 V)

The conversion from the 16-bit value to voltage is:

$$V = 16384 \times \frac{10}{65535}$$

$$V = 2.500\ V$$

DIFFERENTIAL SENSORS (+/-15V, +/-10V, +/-5V, +/-1V, +/-500MV, +/-150MV)

Value = ADC 16-bit value

Range = ADC Input Range (V)

Resolution = 65535

$$V = Value \times \frac{Range}{Resolution} - \frac{Range}{2}$$

EQUATION 2: *Voltage Conversion for Differential Sensors*

Example:

Value = 8192

Range = +/-5 V (10 V)

The conversion from the 16-bit value to voltage is:

$$V = 8192 \times \frac{10}{65535} - \frac{10}{2}$$

$$V = -3.75\ V$$

D.4 POWER

Power (12V nominal) is provided to each sensor by way of EXC+/EXC- for each channel.

D.5 SENSOR WIRING AND CONFIGURATION EXAMPLES

Model 3400-2 or 3400-3 Semiconductor Piezometers (connected to channel 1):

Sensor Type	Positions and Wire Colors					Switch Setting	Channel Configuration
	Vin+	Vin-	Exc+	Exc-	SHD		
Model 3400-2 (0-5 V)	White	White's Black	Red	Red's Black	BARE	V	0-10 V
Model 3400-3 (4-20 mA)	Black	N/C	Red	N/C	BARE	mA	0-10 V

TABLE 19: *Wiring Example for Model 3400-2 or 3400-3 Semiconductor Piezometers*

Model 3400-1 Semiconductor Piezometer with thermistor (connected to channels 1 and 2):

Sensor Type	Positions and Wire Colors					CH1 Switch Setting	CH1 Channel Configuration
	CH1 Vin+	CH1 Vin-	CH1 Exc+	CH1 Exc-	CH1 or CH2 SHD		
Model 3400-1 (0-100 mV)	White	White's Black	Red	Red's Black	BARE	V	±150 mV
	CH2 Vin+	CH2 Vin-	CH2 Exc+	CH2 Exc-		CH2 Switch Setting	CH2 Channel Configuration
	Green	Green's Black	N/C	N/C		Ω	0-15 V

TABLE 20: *Wiring Example for Model 3400-1 Semiconductor Piezometer*

Model 3800-1 Thermistor Probe (connected to channel 1):

Sensor Type	Positions and Wire Colors					Switch Setting	Channel Configuration
	Vin+	Vin-	Exc+	Exc-	SHD		
Model 3800-1-1	TH+	TH-	N/C	N/C	BARE	Ω	0-15 V

TABLE 21: *Wiring Example for Model 3800-1 Thermistor Probe*

D.6 READING A 4-20 MA SENSOR (CURRENT MEASUREMENT)

Current measurements are possible by installing the 4-20 mA device (2-wire or 4-wire) between the input channel's Vin+ and Vin- terminals and setting the channel's Ω-V-mA switch to the **mA** position.

2-WIRE 4-20 MA SENSOR

Connect the sensor's power wire to the channel's EXC+ terminal.

Connect the sensor's output wire to the channel's Vin+ terminal.

Setting the Ω-V-mA switch to the mA position connects the 4-20 mA output internally across a 125 Ω precision resistor:

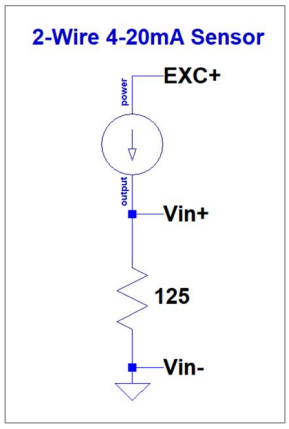


FIGURE 33: *2-Wire 4-20 mA Sensor*

Setting the Input Channel to 0-10 V, current is then calculated:

1. Measure Vin+.
2. Determine the 4-20 mA current: $I(4-20\ mA) = \frac{Vin+}{125\ \Omega}$

Example:

- A 2-Wire 4-20 mA sensor is connected between CH1 EXC+ and Vin+

- The Ω-V-mA switch for CH1 is set to the mA position
- CH1 is configured as 0-10 V
- The voltage measured at CH1 Vin is 2.5 V
- The current is calculated:

$$I(4-20\ mA) = \frac{2.5\ V}{125\ \Omega}$$

$$I(4-20\ mA) = 0.2\ A = 20\ mA$$

4-WIRE 4-20MA SENSOR

Connect the sensor's power wire to the channel's EXC+ terminal.

Connect the sensor's GND wire to the channel's EXC- terminal.

Connect the sensor's output+ wire to the channel's Vin+ terminal.

Connect the sensor's output- wire to the channel's Vin- terminal.

Setting the Ω-V-mA switch to the mA position connects the 4-20 mA output internally across a 125 Ω precision resistor:

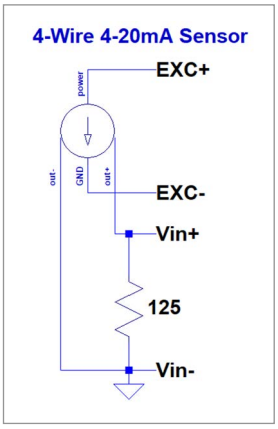


FIGURE 34: *4-Wire 4-20mA Sensor*

Setting the Input Channel to 0-10 V, current is then calculated:

1. Measure Vin+.
2. Determine the 4-20 mA current: $I(4-20\ mA) = \frac{Vin+}{125\ \Omega}$

Example:

- A 4-Wire 4-20 mA sensor is connected as above at CH1
- The Ω-V-mA switch for CH1 is set to the mA position
- CH1 is configured as 0-10 V
- The voltage measured at CH1 Vin is 0.6 V
- The current is calculated:

$$I(4-20\ mA) = \frac{0.6\ V}{125\ \Omega}$$

$$I(4-20\ mA) = 0.0048\ A = 4.8\ mA$$

D.7 READING A THERMISTOR (RESISTANCE MEASUREMENT)

Resistance measurements are possible by installing the resistance device (i.e. thermistor) between the input channel's Vin+ and Vin- terminals and setting the channel's Ω-V-mA switch to the Ω position.

Setting the Ω-V-mA switch to the Ω position connects the thermistor internally to the Excitation Voltage (12 V) via a 3 kΩ precision resistor:

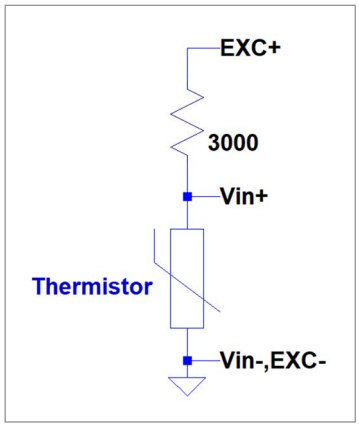


FIGURE 35: *Thermistor*

Setting the Input Channel to 0-15 V, resistance is then calculated:

1. Measure the excitation voltage EXC+.
2. Measure Vin+.
3. Determine the excitation current: $\mathrm{Iexc} = \frac{\mathrm{EXC+} - \mathrm{Vin+}}{3000}$
4. Determine the resistance: $\mathrm{R} = \frac{\mathrm{Vin+}}{\mathrm{Iexc}}$

Example:

- A thermistor is connected between CH1 Vin+ and Vin-
- The Ω-V-mA switch for CH1 is set to the Ω position
- CH1 is configured as 0-15 V
- The voltage measured at CH1 Vin is 7.2 V
- The resistance is calculated:

$$\mathrm{Iexc} = \frac{12\ \mathrm{V} - 7.2\ \mathrm{V}}{3000}$$

$$\mathrm{Iexc} = 0.0016\ \mathrm{A}$$

$$\mathrm{R} = \frac{7.2\ \mathrm{V}}{0.0016\ \mathrm{A}}$$

$$\mathrm{R} = 4500\ \Omega$$

APPENDIX E. TIME DOMAIN REFLECTOMETRY (TDR) SETTINGS AND PARAMETERS

E.1 DEFAULT SETTINGS AND PARAMETERS:

- Distance: 60 m
- Channel Number: CH 1
- Pulse Width: 20 nS
- VOP: 84%
- Gain: 0db (5)
- ROI Threshold: 50
- ROI Window: 3
- Suppression Scale: 100

If the default settings and parameters need to be modified, select **Settings** and change as needed. See a breakdown of the settings and parameters in the following sections below. When complete, select **Apply Settings** (Figure 36).

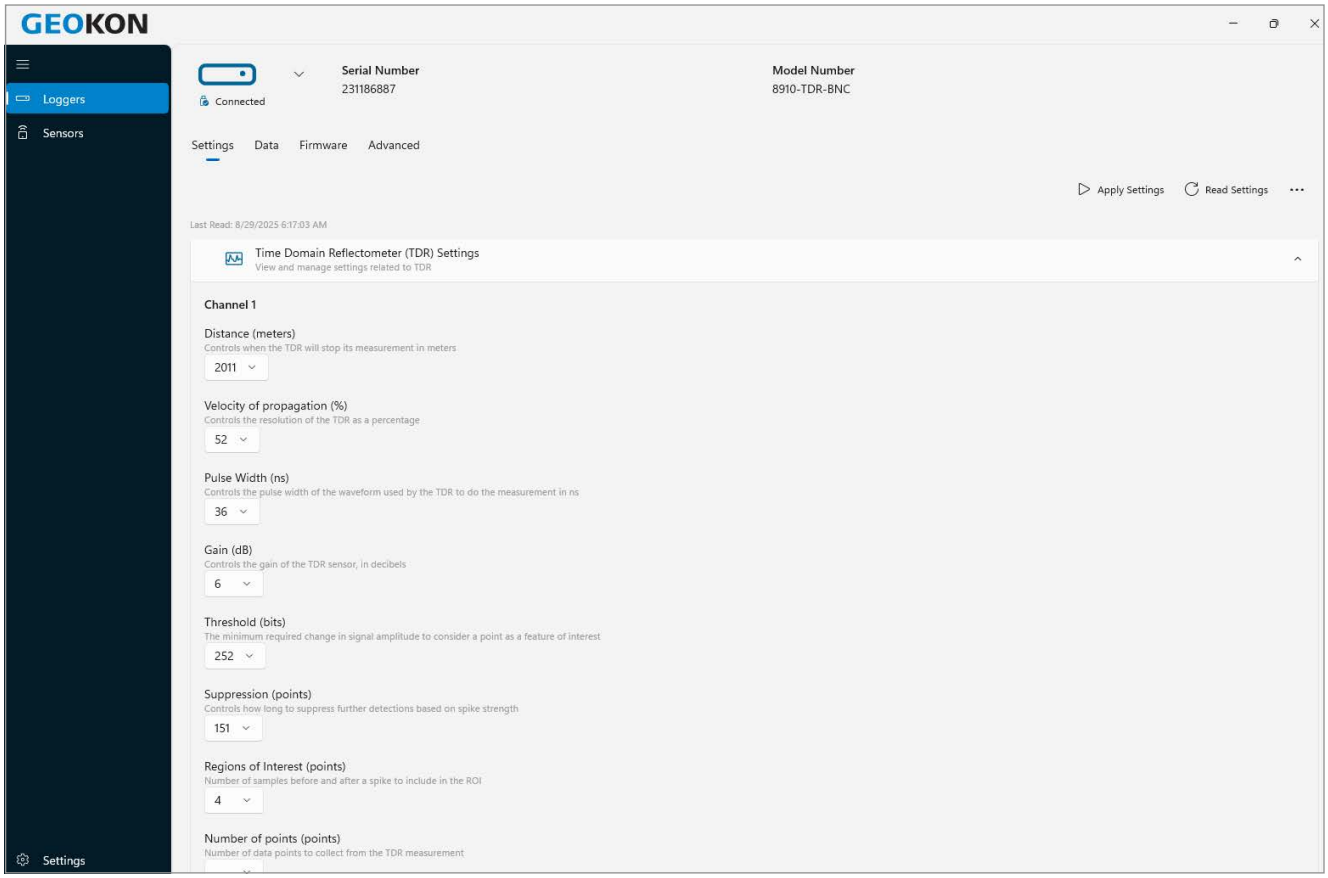


FIGURE 36: *Configuring a TDR Data Logger Using the GEOKON Desktop Application*

E.2 BASIC SETTINGS

		Type	Description	Example	Notes
Settings	DISTANCE	Distance (meters)	Sets the **maximum cable length** to analyze. The TDR uses this to size its sampling buffer and control timing.	**DISTANCE 60** configures the TDR to look for reflections within **60 meters** of cable length.	You must set a realistic length before triggering a measurement. Too short: will clip late reflections. Too long: reduces resolution and wastes buffer space.
	CHANNEL NUMBER	Integer (0-based index)	Selects which measurement channel to use (if multiple channels are present on the device).	**CHNUM 0** selects channel 1	TDRs default to **CHNUM 1** aka channel 2. On multi-channel models, this setting must be set appropriately before measurement.
	PULSE WIDTH	Time (nanoseconds)	Configures the width (duration) of the test pulse emitted by the TDR.	**PULSEWIDTH 10** emits a 10 ns pulse	**Narrower pulses** give **better resolution** but **less energy** (lower amplitude). **Wider pulses** increase signal strength but **blur** closely spaced reflections. Common values: 5 ns - 100 ns depending on cable type and length.
	VELOCITY OF PROPAGATION (VOP)	Percentage (1-100)	Specifies the **signal propagation speed** as a percentage of the speed of light.	**VOP 84** means signals travel at **84% of the speed of light**, or ~252,000 km/s.	VOP depends on cable type (e.g., RG-58: ~66, Cat6: ~72-78). Accurate VOP is critical for **distance-to-fault accuracy**. Typically measured using a known-length reference cable.
	GAIN	Integer (10db to -10db)	Controls the amplifier gain for reflected signals. Schema maps 0→10 db and 10 → -10 db, each integer decrementing the gain by 2 db.	**GAIN 3** changes the gain to 4 db.	Too low: weak reflections may not register. Too high: amplifier may saturate, obscuring fine detail. Select based on cable length, expected reflection strength, and signal attenuation.

TABLE 22: *TDR Basic Settings*

E.3 PARAMETERS

The Model 8910-TDR Data Logger uses three key tuning parameters to control how the TDR signal processing tool detects regions of interest (ROIs) in the dataset. Each parameter allows the operator to adjust how sensitive the algorithm is to changes in the signal, how wide the regions of interest are, and how often multiple nearby spikes are detected.

		Code	Description	Guidelines	Notes
Parameters	**ROI THRESHOLD**	**tdr_threshold**	Defines the minimum required change in signal amplitude to consider a point as a spike or feature of interest.	**Higher value =** Only sharp, large spikes are detected (fewer ROIs). **Lower value =** More sensitive to minor signal changes (more ROIs, possibly including noise).	**Recommended tuning:** Use a high value (e.g., 500–1000) to isolate only the largest reflections. Use a low value (e.g., 50–200) to detect smaller impedance changes or noise.
	ROI WINDOW	**tdr_roi_window**	Defines the number of samples before and after a spike to include in the ROI.	**Larger window =** More context, may include multiple features. **Smaller window =** Tighter regions, lower risk of overlap.	ROI spans **2 × tdr_roi_window** samples total.
	SUPPRESSION SCALE	**tdr_suppression**	Controls how long to suppress further detections based on spike strength. Suppression duration: **suppression_window = max (MIN_SUPPRESSION, min (MAX_SUPPRESSION, diff / SUPPRESSION_SCALE)**	**Lower scale =** Stronger suppression after large spikes. **Higher scale =** Weaker suppression, more detections.	The minimum suppression is **2 x tdr_roi_window**. This is to avoid point duplication.

TABLE 23: *TDR Parameter Settings*

E.3.1 EXAMPLE USE CASES

Goal	Suggested Settings
Detect only the largest spike	**tdr_threshold = 1000 , tdr_roi_window = 2 , tdr_suppression = 50**
Detect all meaningful spikes	**tdr_threshold = 50 , tdr_roi_window = 2 , tdr_suppression = 200**
High sensitivity in noisy signal	**tdr_threshold = 25 , tdr_roi_window = 4 , tdr_suppression = 300**
Suppress closely packed reflections	**tdr_threshold = 100 , tdr_roi_window = 3 , tdr_suppression = 100**

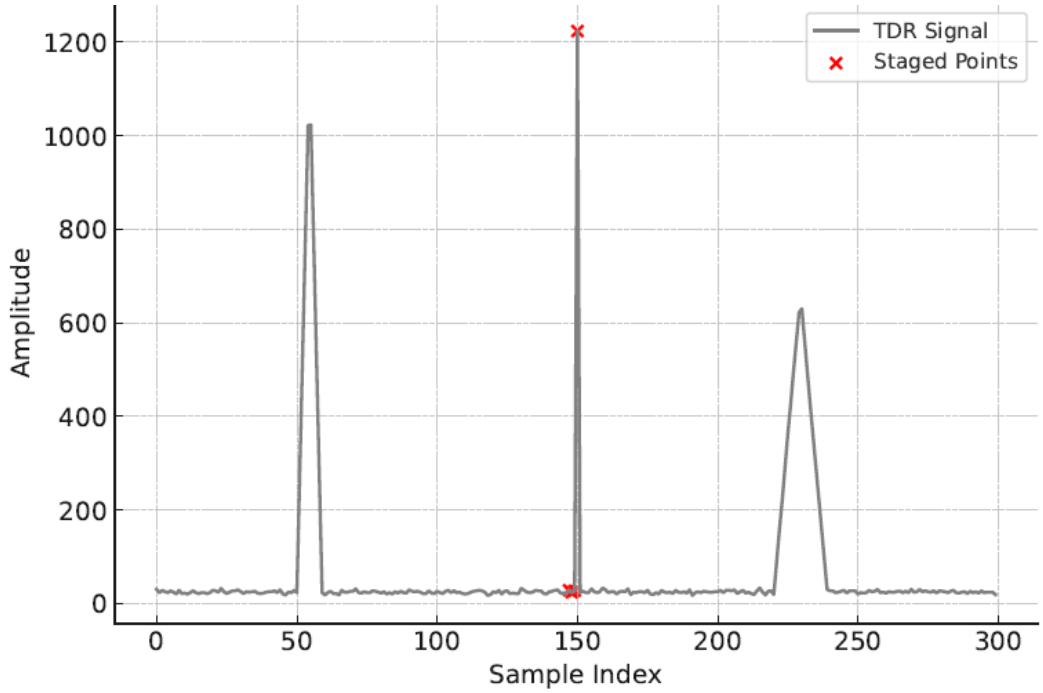
TABLE 24: *Example Use Cases*

Tips:

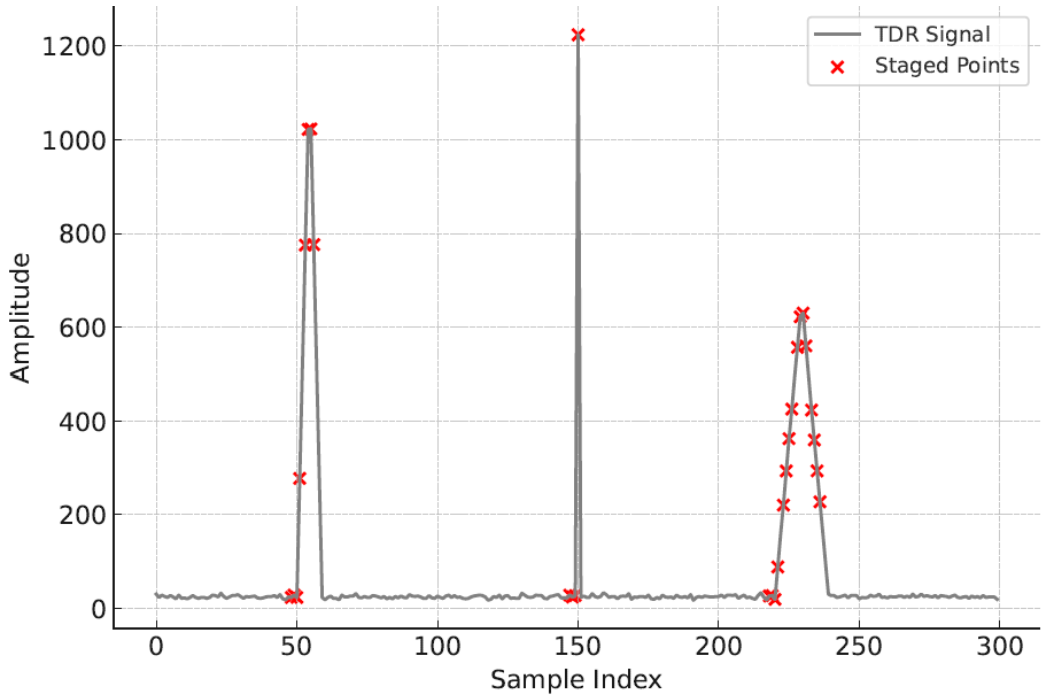
- Always visualize your staging results to validate detection behavior.
- Adjust one parameter at a time when tuning for best results.
- Use larger **tdr_suppression** when detecting multiple spikes per trace is important.

Below are four resulting graphs based on the example goals and settings shown in Table 24.

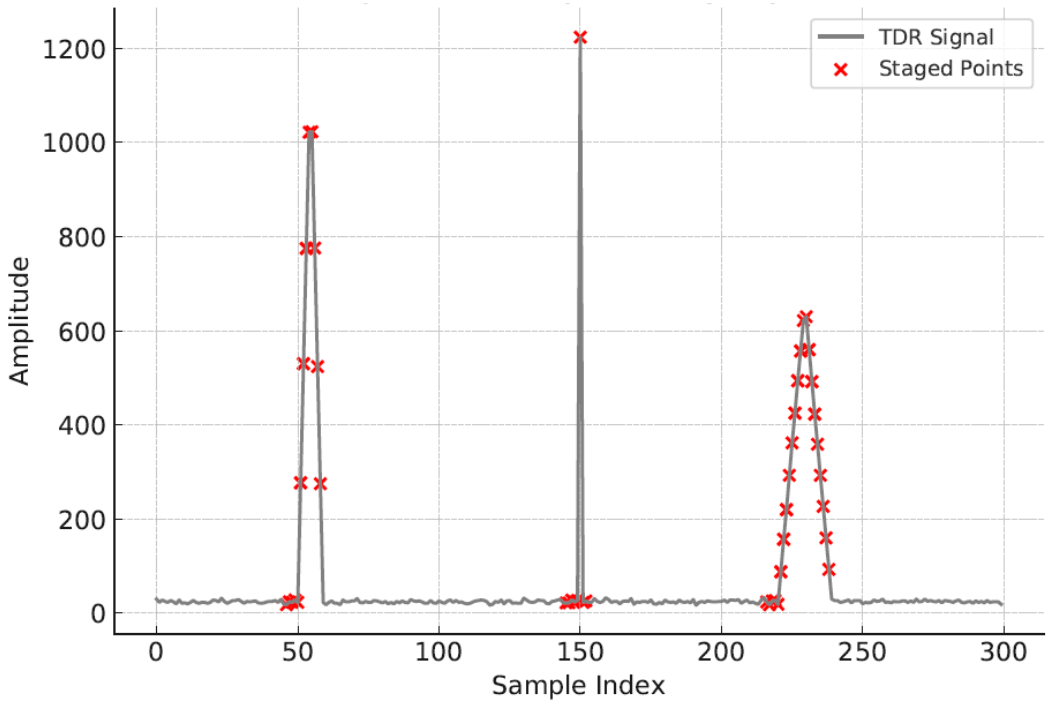
DETECT ONLY THE LARGEST SPIKE



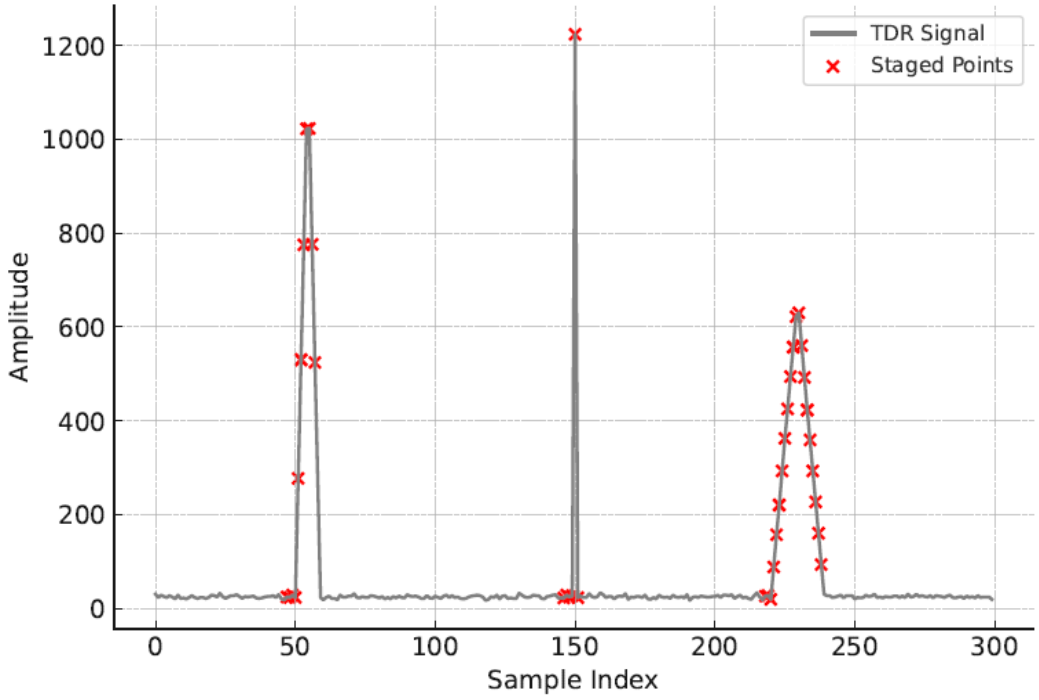
DETECT ALL MEANINGFUL SPIKES



HIGH SENSITIVITY IN NOISY SIGNAL



SUPPRESS CLOSELY PACKED REFLECTIONS



APPENDIX F. VIBRATING WIRE LOAD CELL WIRING

F.1 WIRING SINGLE LOAD CELL

8CH Interface[1]	Function	3-Gauge Load Cell Violet Cable	4-Gauge Load Cell Violet Cable	6 Gauge Load Cell Orange Cable
Channel 1 VW+	Gauge #1	Red	Red	Red
Channel 2 VW+	Gauge #2	Red's Black	Red's Black	Red's Black
Channel 3 VW+	Gauge #3	White	White	White
Channel 4 VW+	Gauge #4	NC	White's Black	White's Black
Channel 5 VW+	Gauge #5	NC	NC	Green
Channel 6 VW+	Gauge #6	NC	NC	Green's Black
Channel 1 SHD	Shield	All Shields	All Shields	All Shields
VW- Channels[2]	Common	White's Black[3]	Green	Blue
Channel 1 TH +	Thermistor	Green[3]	Blue	Yellow
Channel 1 TH -	Thermistor	Green's Black	Blue's Black	Yellow's Black

TABLE 25: *Single Load Cell Wiring*

Note:

[1] Where second Load Cell is being included, retain relative channel position count up from channel 5.

[2] Common "VW-" between all channels associated with each VW Load Cell

[3] White's black and Green wires are switched on GEOKON three-gauge VW load cells prior to serial number 3313.

F.2 LOAD CELL CONFIGURATION SWITCH SETTINGS

POS 1	POS 2	POS 3	Configuration
OFF	OFF	OFF	Std. No Load Cell
ON	OFF	OFF	One 3-Gauge Load Cell
OFF	ON	OFF	One 4-Gauge Load Cell
ON	ON	OFF	Two 3-Gauge Load Cells, second starting at channel 5
OFF	OFF	ON	Two 4-Gauge Load Cells, second starting at channel 5
ON	OFF	ON	One 3-Gauge Load Cell & One 4-Gauge Load Cell starting at channel 5
OFF	ON	ON	One 4-Gauge Load Cell & One 3-Gauge Load Cell starting at channel 5
ON	ON	ON	One 6-Gauge Load Cell

TABLE 26: *Load Cell Configuration Switch Settings*

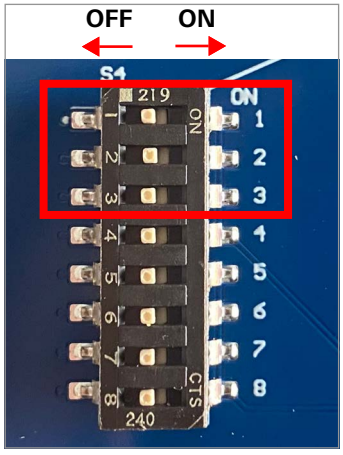


FIGURE 37: *Load Cell Configuration Switch*

APPENDIX G. UNIT DIMENSIONS

Note: Dimensions shown below are in inches.

G.1 GATEWAY (GTW) MODELS

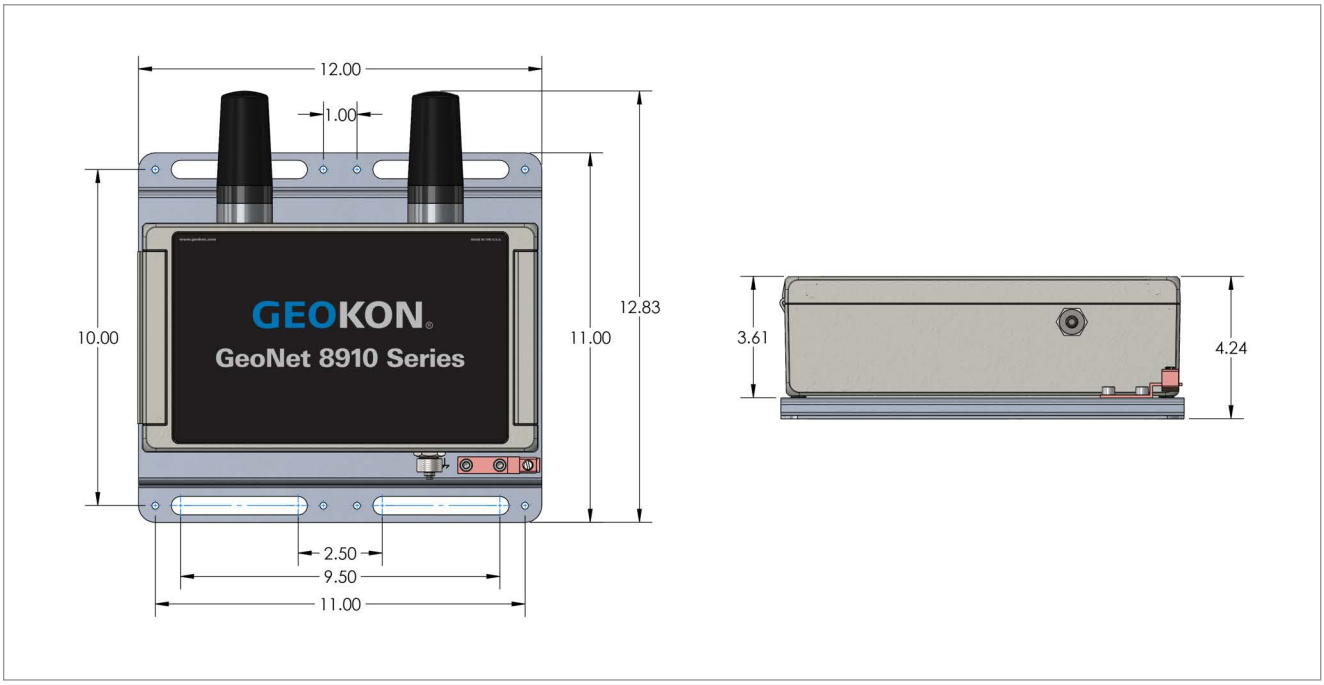


FIGURE 38: *Gateway (GTW) Models*

G.2 SINGLE-CHANNEL (01C) AND ADDRESSABLE (ADR) MODELS

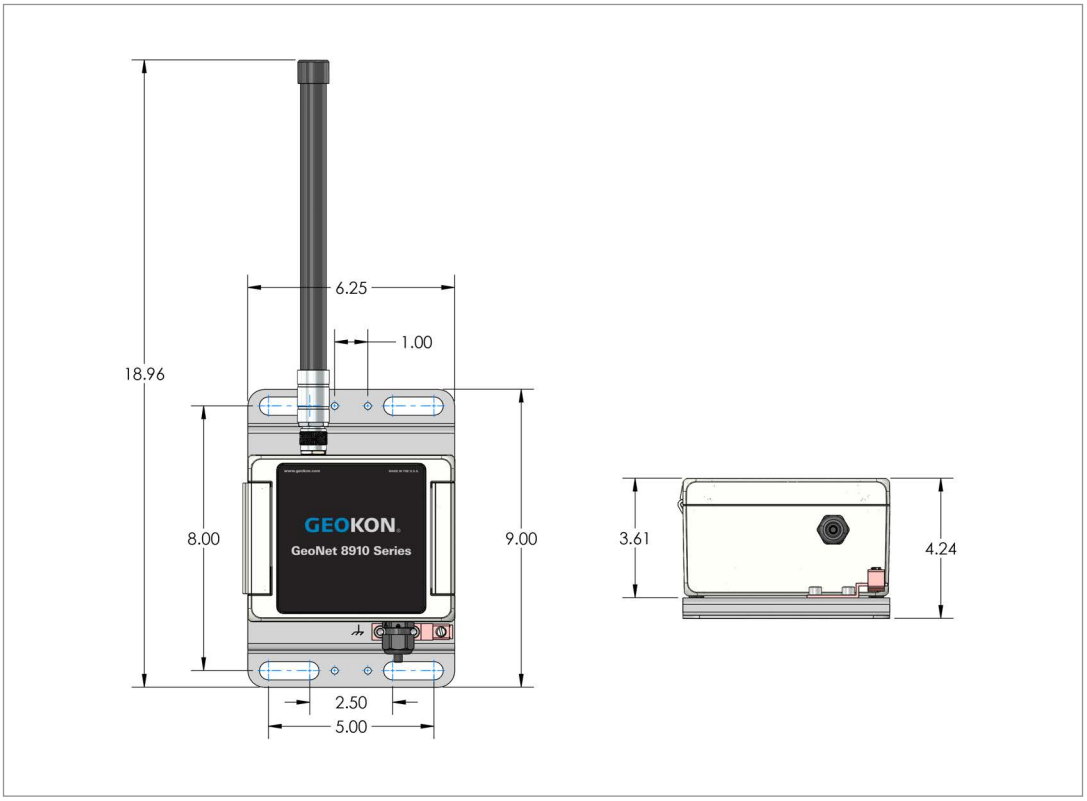


FIGURE 39: *Single-Channel (01C) and Addressable (ADR) Models*

G.3 EIGHT-CHANNEL (08C), ANALOG (ANA), DIGITAL HIGH POWER (DHP), AND TIME DOMAIN REFLECTOMETRY (TDR) MODELS



FIGURE 40: *Eight-Channel (08C), Analog (ANA), Digital High Power (DHP), and Time Domain Reflectometry (TDR) Models*

G.4 TILT (TLT) MODELS

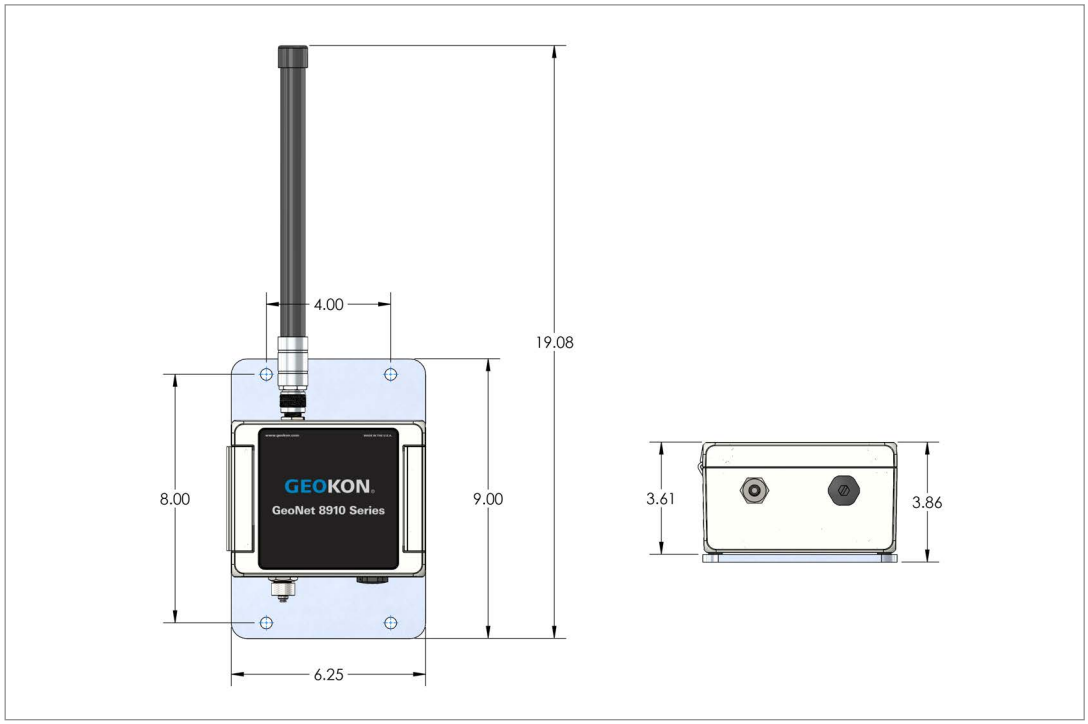


FIGURE 41: *Tilt (TLT) Models*

APPENDIX H. MOUNTING BRACKET DIMENSIONS

Note: Dimensions shown below are in inches.

H.1 GATEWAY (GTW), EIGHT-CHANNEL (08C), ANALOG (ANA), DIGITAL HIGH POWER (DHP), AND TIME DOMAIN REFLECTOMETRY (TDR) MODELS

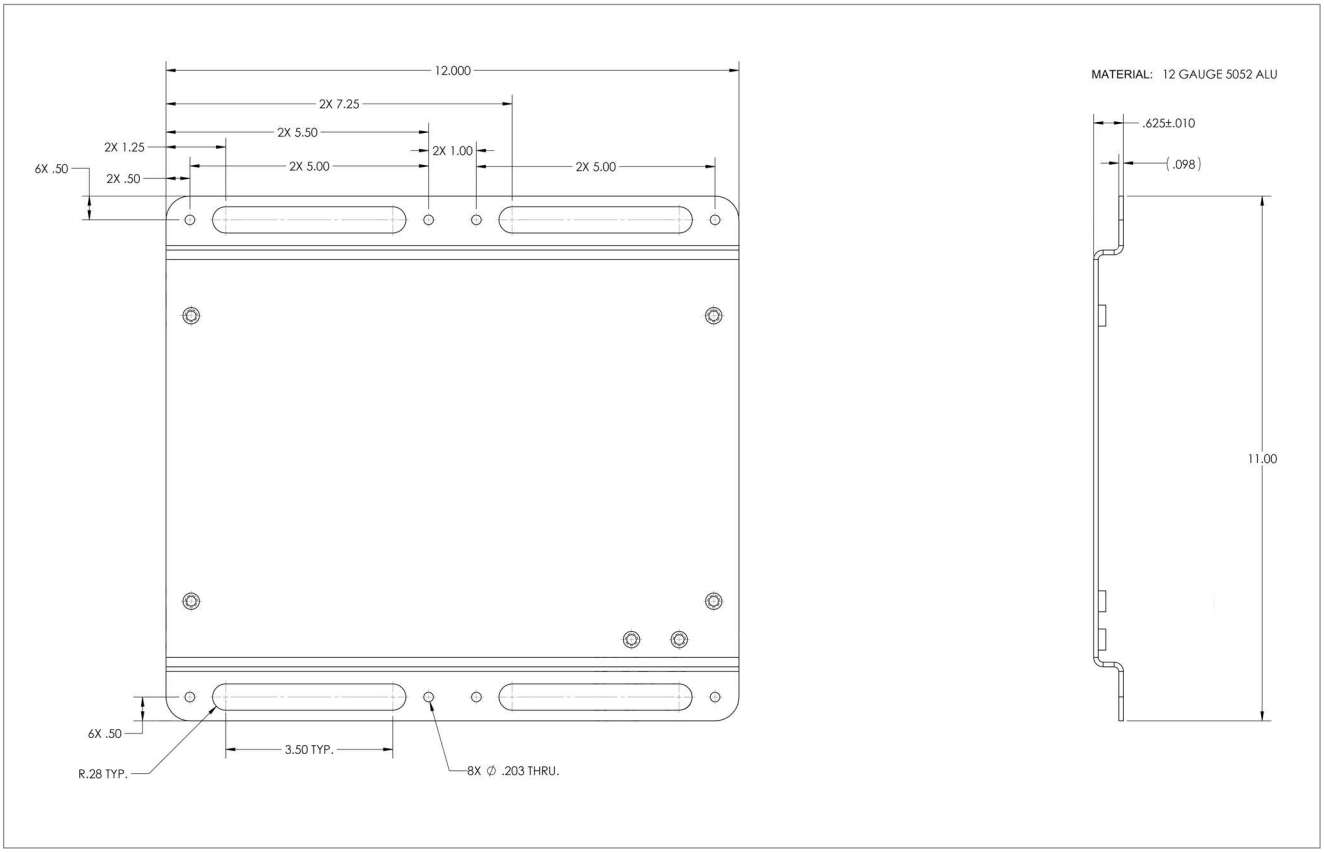


FIGURE 42: *Gateway (GTW), Eight-Channel (08C), Analog (ANA), Digital High Power (DHP), and Time Domain Reflectometry (TDR) Models*

H.2 SINGLE-CHANNEL (01C) AND ADDRESSABLE (ADR) MODELS

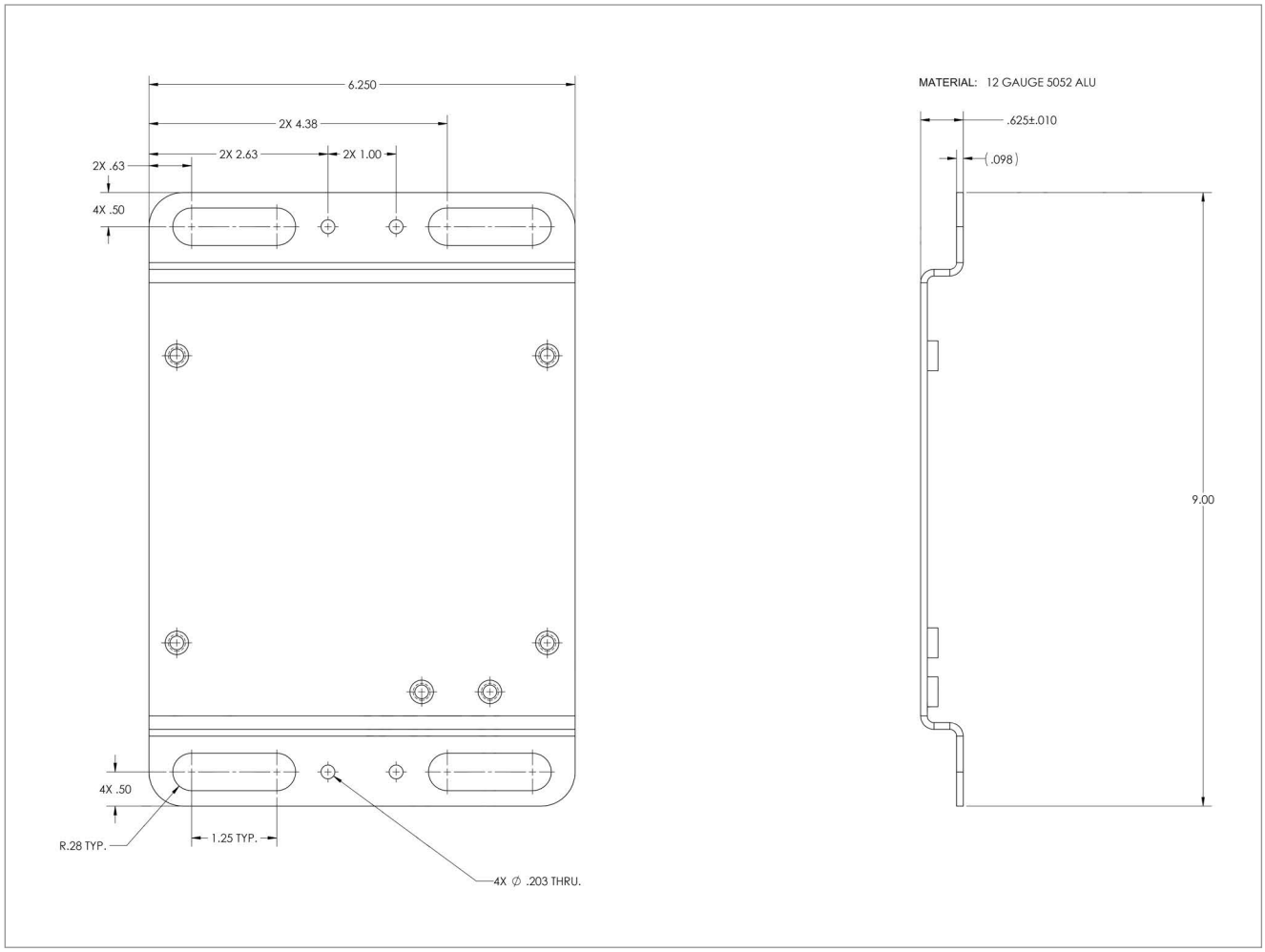


FIGURE 43: *Single-Channel (01C) and Addressable (ADR) Models*

H.3 TILT (TLT) MODELS

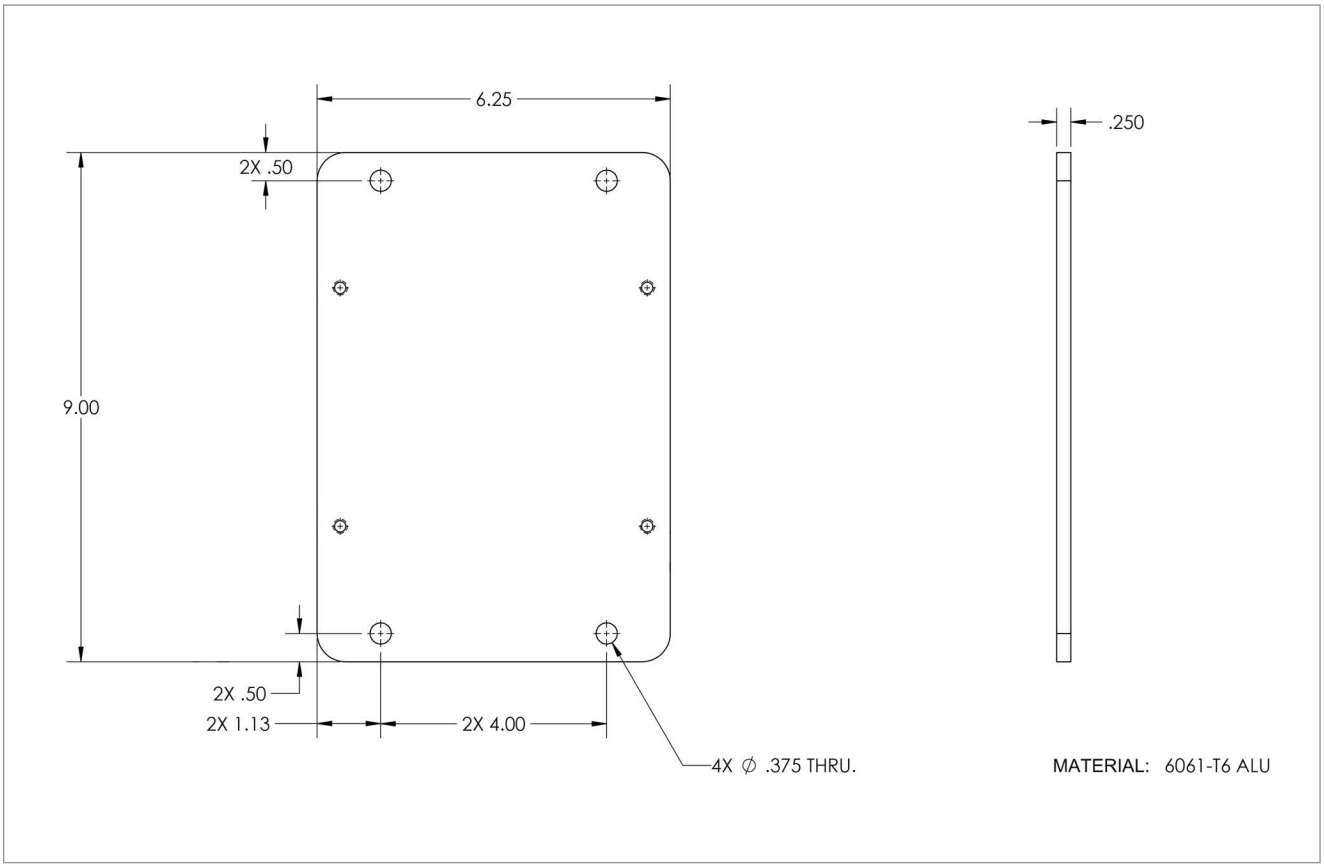


FIGURE 44: *Tilt (TLT) Models*

APPENDIX I. COMPONENTS (TYPICAL REPLACEMENT PARTS)

I.1 GATEWAY (GTW) MODELS

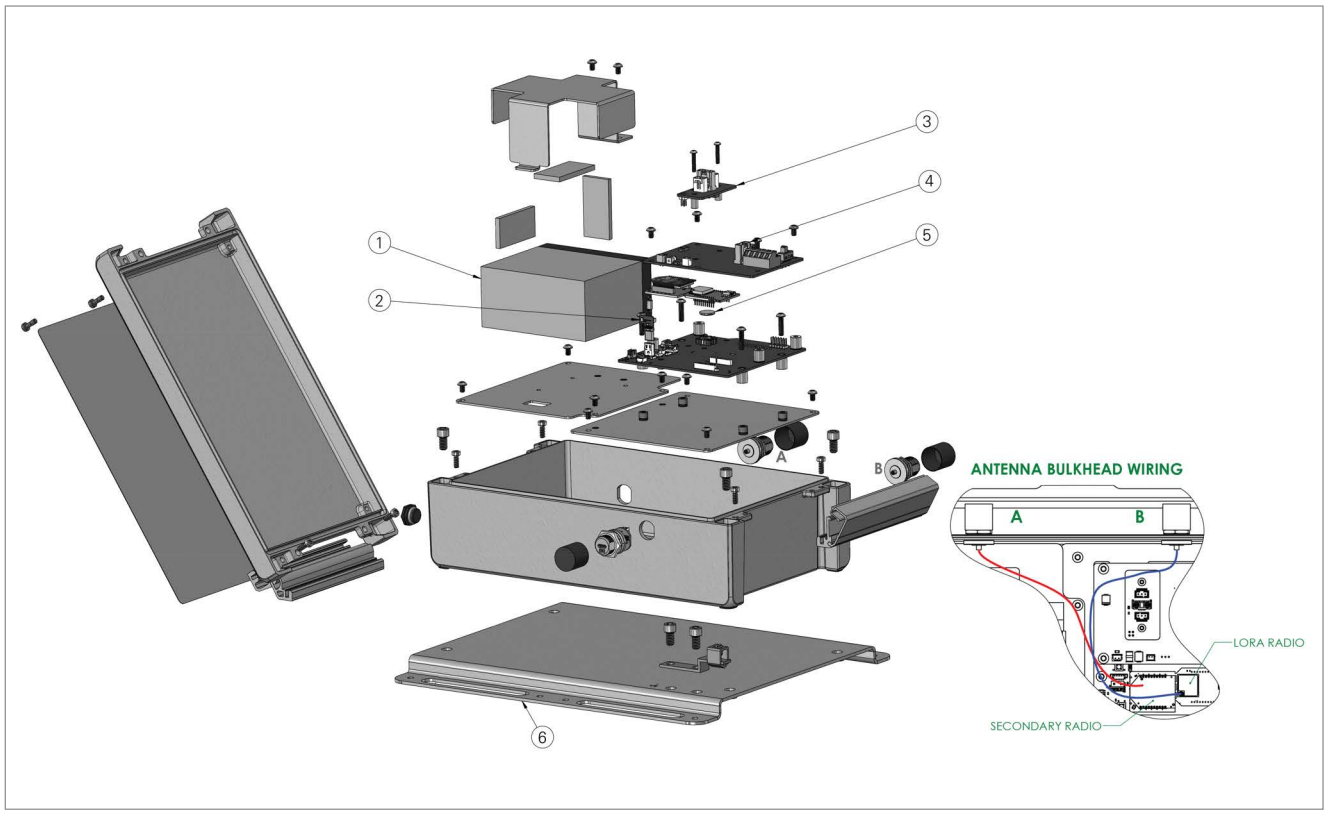


FIGURE 45: *Gateway (GTW) Models*

Item No.	Part Number	Description
1	BAT-209	Sealed Lead Acid Battery
2	S-8910-13	PicoBlade to USB-C Plug OVP
3	S-8910-3-1	LoRa SLA OVP
4	N/A	Fuse, contact GEOKON for more information.
5	BAT-122	Lithium Coin Cell Battery
6	BOX-501-BRACKET	Mounting Bracket
7 (Not pictured, for antenna locations **A** and **B**)	ELC-824	Antenna for both **A** and **B** locations

TABLE 27: *Gateway (GTW) Models Components Parts List*

I.2 SINGLE-CHANNEL (01C) AND ADDRESSABLE (ADR) MODELS

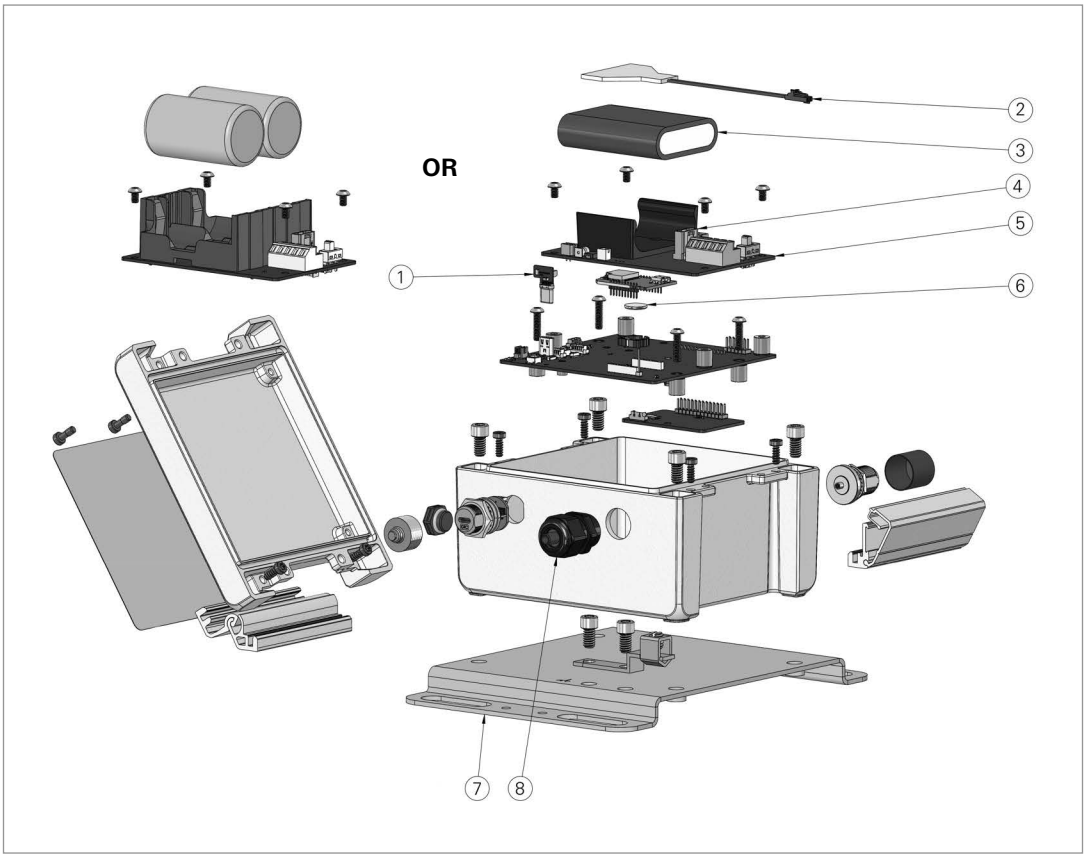


FIGURE 46: *Single-Channel (01C) and Addressable (ADR) Models*

Item No.	Part Number	Description
1 (Rechargeable units only)	S-8910-13	PicoBlade to USB-C Plug OVP
2 (Rechargeable units only)	ELC-1046	Thermistor Assembly
3	Non-Rechargeable: BAT-202 Rechargeable: BAT-207	Non-Rechargeable: Includes **one** Lithium D-Cell Battery (Two batteries are required for operation) Rechargeable: Battery Pack
4	N/A	Fuse, contact GEOKON for more information.
5	Non-Rechargeable: S-8910-4 Rechargeable: S-8910-3-LI	Battery Holder PCBA
6	BAT-122	Lithium Coin Cell Battery
7	BOX-500-BRACKET	Mounting Bracket
8	**CON-A443, including:** CON-A342 CON-A331 SEAL-09	**Assembled Cable Gland, including:** Dowel Pin Cable Fitting Seal Ring
9 (Not Pictured)	ELC-1051	Antenna

TABLE 28: *Single-Channel (01C) and Addressable (ADR) Models Components Parts List*

I.3 EIGHT-CHANNEL (08C) AND ANALOG (ANA) MODELS

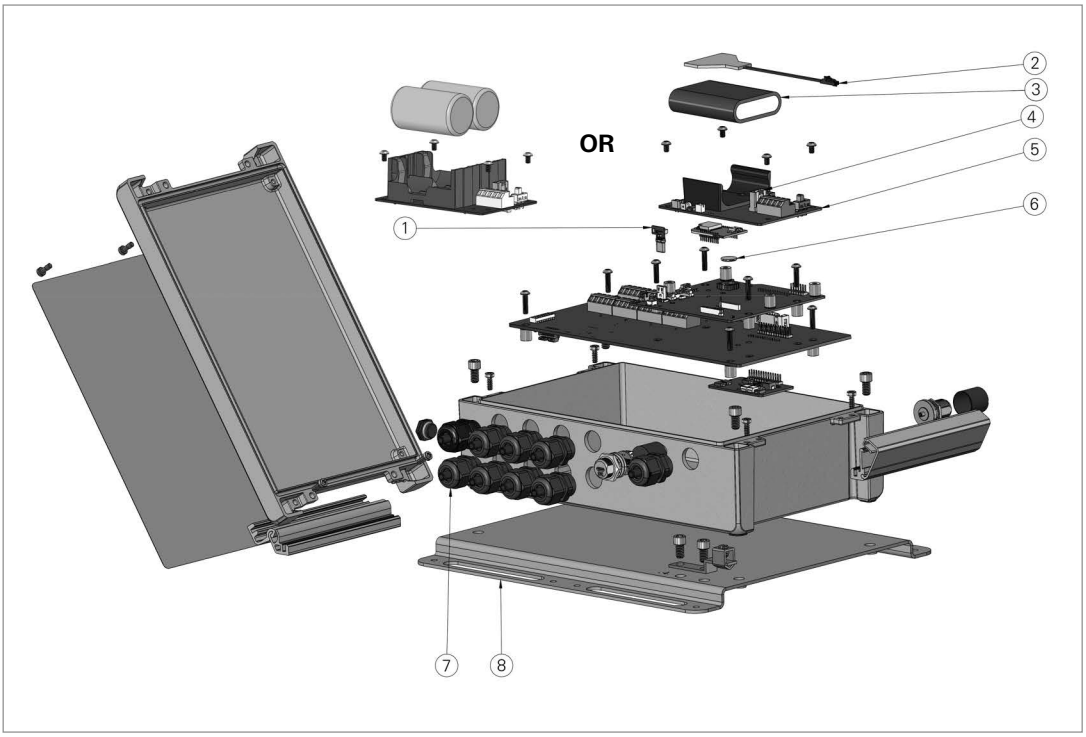


FIGURE 47: *Eight-Channel (08C) and Analog (ANA) Models*

Item No.	Part Number	Description
1 (Rechargeable units only)	S-8910-13	PicoBlade to USB-C Plug OVP
2 (Rechargeable units only)	ELC-1046	Thermistor Assembly
3	Non-Rechargeable: BAT-202 Rechargeable: BAT-207	Non-Rechargeable: Includes **one** Lithium D-Cell Battery (Two batteries are required for operation) Rechargeable: Battery Pack
4	N/A	Fuse, contact GEOKON for more information.
5	Non-Rechargeable: S-8910-4 Rechargeable: S-8910-3-LI	Battery Holder PCBA
6	BAT-122	Lithium Coin Cell Battery
7	**CON-A443, including:** CON-A342 CON-A331 SEAL-09	**Assembled Cable Gland, including:** Dowel Pin Cable Fitting Seal Ring
8	BOX-501-BRACKET	Mounting Bracket
9 (Not Pictured)	ELC-1051	Antenna

TABLE 29: *Eight-Channel (08C) and Analog (ANA) Models Components Parts List*

I.4 DIGITAL HIGH POWER (DHP) AND TIME DOMAIN REFLECTOMETRY (TDR) MODELS

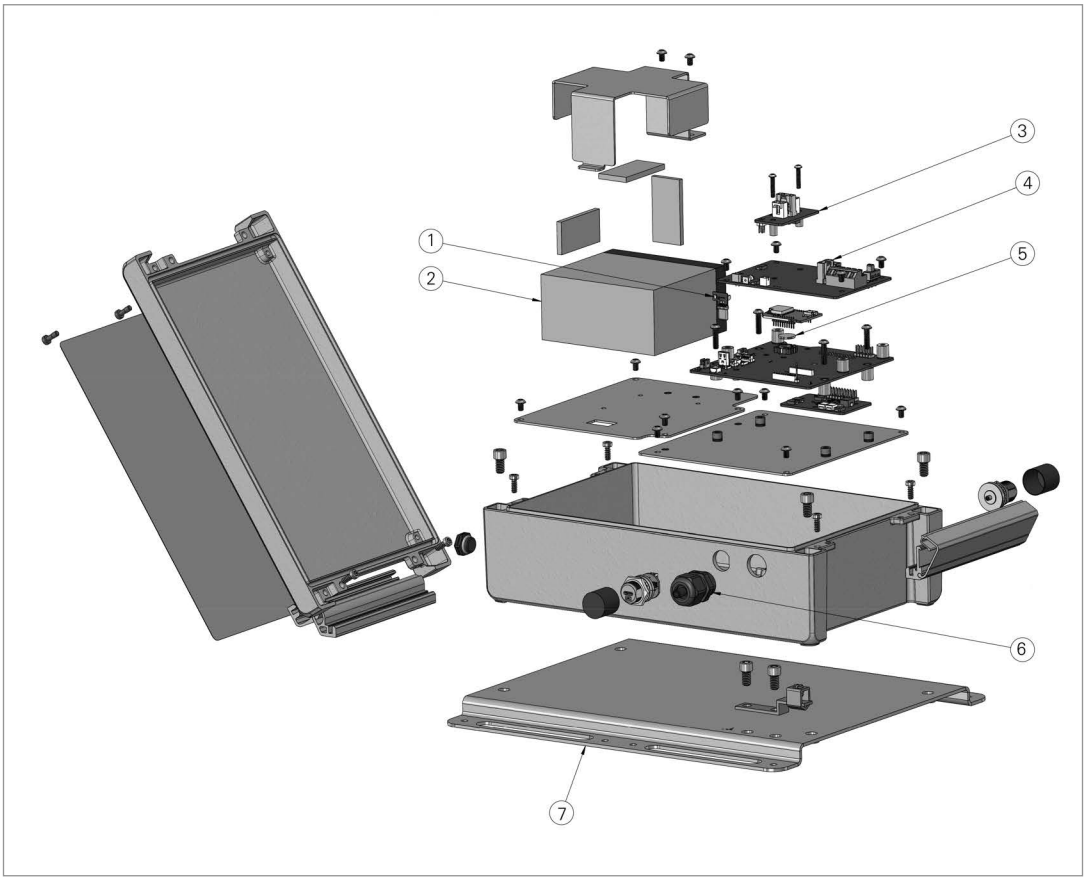


FIGURE 48: *Digital High Power (DHP) and Time Domain Reflectometry (TDR) Models (Antenna Not Pictured)*

Item No.	Part Number	Description
1	S-8910-13	PicoBlade to USB-C Plug OVP
2	BAT-209	Sealed Lead Acid Battery
3	S-8910-3-1	LoRa SLA OVP
4	N/A	Fuse, contact GEOKON for more information.
5	BAT-122	Lithium Coin Cell Battery
6	**CON-A443, including:** CON-A342 CON-A331 SEAL-09	**Assembled Cable Gland, including:** Dowel Pin Cable Fitting Seal Ring
7	BOX-501-BRACKET	Mounting Bracket
8 (Not Pictured)	ELC-1051	Antenna

TABLE 30: *Digital High Power (DHP) and Time Domain Reflectometry (TDR) Models Components Parts List*

I.5 TILT (TLT) MODELS

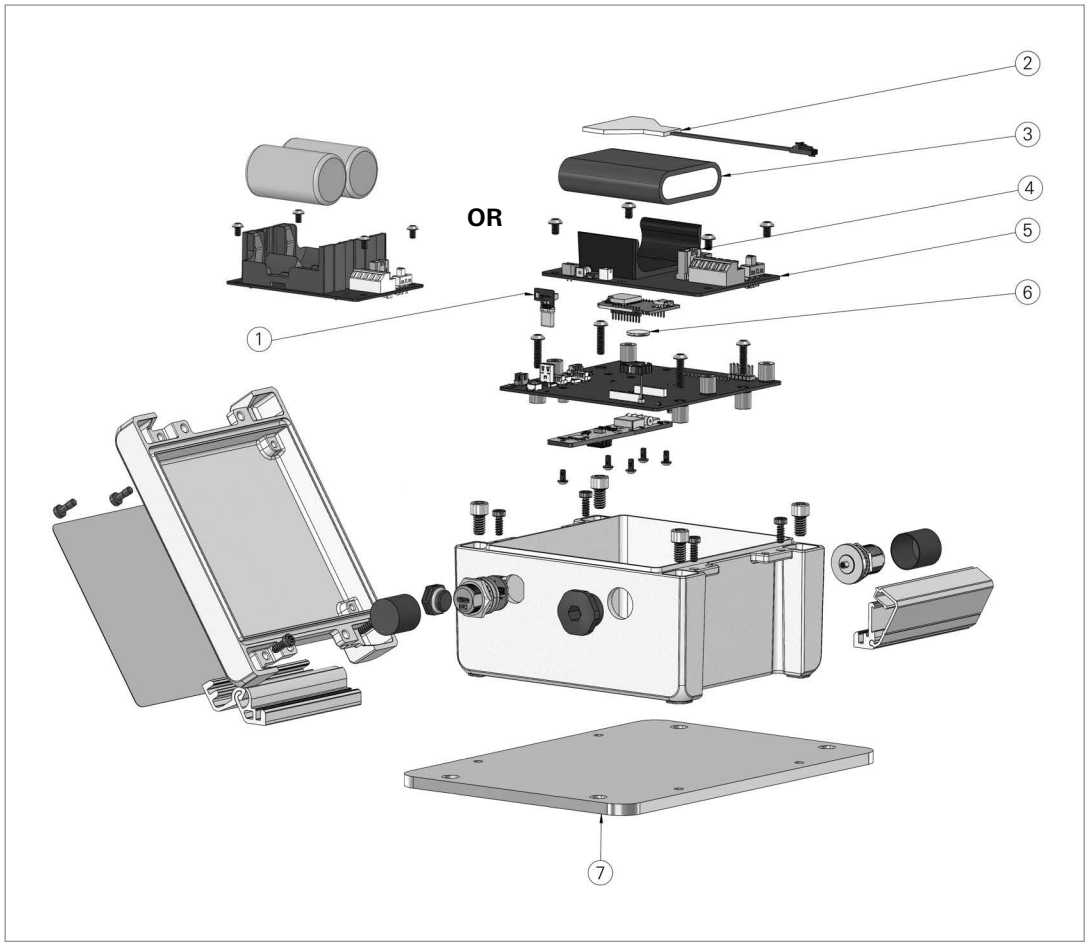


FIGURE 49: *Tilt (TLT) Models*

Item No.	Part Number	Description
1 (Rechargeable units only)	S-8910-13	PicoBlade to USB-C Plug OVP
2 (Rechargeable units only)	ELC-1046	Thermistor Assembly
3	Non-Rechargeable: BAT-202 Rechargeable: BAT-207	Non-Rechargeable: Includes **one** Lithium D-Cell Battery (Two batteries are required for operation) Rechargeable: Battery Pack
4	N/A	Fuse, contact GEOKON for more information.
5	Non-Rechargeable: S-8910-4 Rechargeable: S-8910-3-LI	Battery Holder PCBA
6	BAT-122	Lithium Coin Cell Battery
7	BOX-500-TILTBRACKET	Mounting Bracket
8 (Not pictured)	ELC-1051	Antenna

TABLE 31: *Tilt (TLT) Models Components Parts List*

GEOKON®

GEOKON
48 Spencer Street
Lebanon, New Hampshire
03766, USA

Phone: +1 (603) 448-1562
Email: teamsales@geokon.com
Website: www.geokon.com

GEOKON
is an **ISO 9001:2015**
registered company