

RSTAR Affinity Data Logger Installation Guide



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TABLE OF CONTENTS

1	INTRODUCTION	1
1.1	RSTAR Affinity Connectivity Solution	1
1.2	Intended Audience	2
1.3	Icons Used In This Guide	2
1.4	RSTAR Affinity Data Logger.....	2
1.5	RSTAR Affinity Dashboard.....	2
1.6	RSTAR Affinity Field App	3
2	SYSTEM OVERVIEW.....	3
2.1	Enclosure.....	3
2.2	Internal Compartment	4
2.3	Service Port Compartment.....	4
2.4	Connectivity	5
2.4.1	Quick Connect	5
2.4.2	LoRaWAN External Antenna.....	5
3	INSTALLATION PROCEDURES.....	6
3.1	Installation Tools	6
3.2	Connect the Cable Gland	6
3.2.1	Configuration Identification Label	7
3.2.2	QR Identification Code	9
3.3	Install or Replace Batteries	9
3.4	Install External Antenna	10
3.5	Install the Data Logger	11
3.5.1	Pole Mount Option	11
3.5.2	Wall Mount Option	12
3.5.3	Magnet Mount Option	12
3.5.4	Mount to a Secondary Enclosure	13
3.6	Configure and Verify Installation	14

LIST OF FIGURES

Figure 1:	RSTAR Affinity Cloud and On-Premises Solution.....	1
Figure 2:	Enclosure and Components	3
Figure 3:	Service Port Compartment.....	4
Figure 4:	Cable Gland Connection	6
Figure 5:	Front Cover Tightening Sequence.....	7
Figure 6:	Configuration Identification Label	8
Figure 7:	Battery Compartment.....	9
Figure 8:	Antenna Connection.....	10
Figure 9:	Pole Mount Plate.....	11



Figure 10: Wall Mount Plate 12

Figure 11: Magnet Mounts 13

Figure 12: 4-20 mA Circuit Diagram 19

LIST OF TABLES

Table 1: IIM Pin Assignment5

Table 2: Recommended LoRaWAN Antenna5

Table 3: IIM Instrument Encoding Table.....8

Table 4: Instrument Type, Manufacturer Model Number, and Conductor Color21

1 INTRODUCTION

1.1 RSTAR AFFINITY CONNECTIVITY SOLUTION

The RSTAR Affinity Connectivity Solution comprises data loggers, gateways, secure communications for data telemetry, and mobile and desktop applications. RSTAR Affinity is a complete industrial internet of things (IIoT) solution for reliable, real-time data flow from your worksite to your desktop – all from a single vendor.

The RSTAR Affinity Connectivity Solution is a scalable and flexible system that can be customized to satisfy the complex and demanding requirements for data collection. The topology and communications options including cell and LoRaWAN radio protocol (for better signal and range), cover all on-site and remote monitoring scenarios.

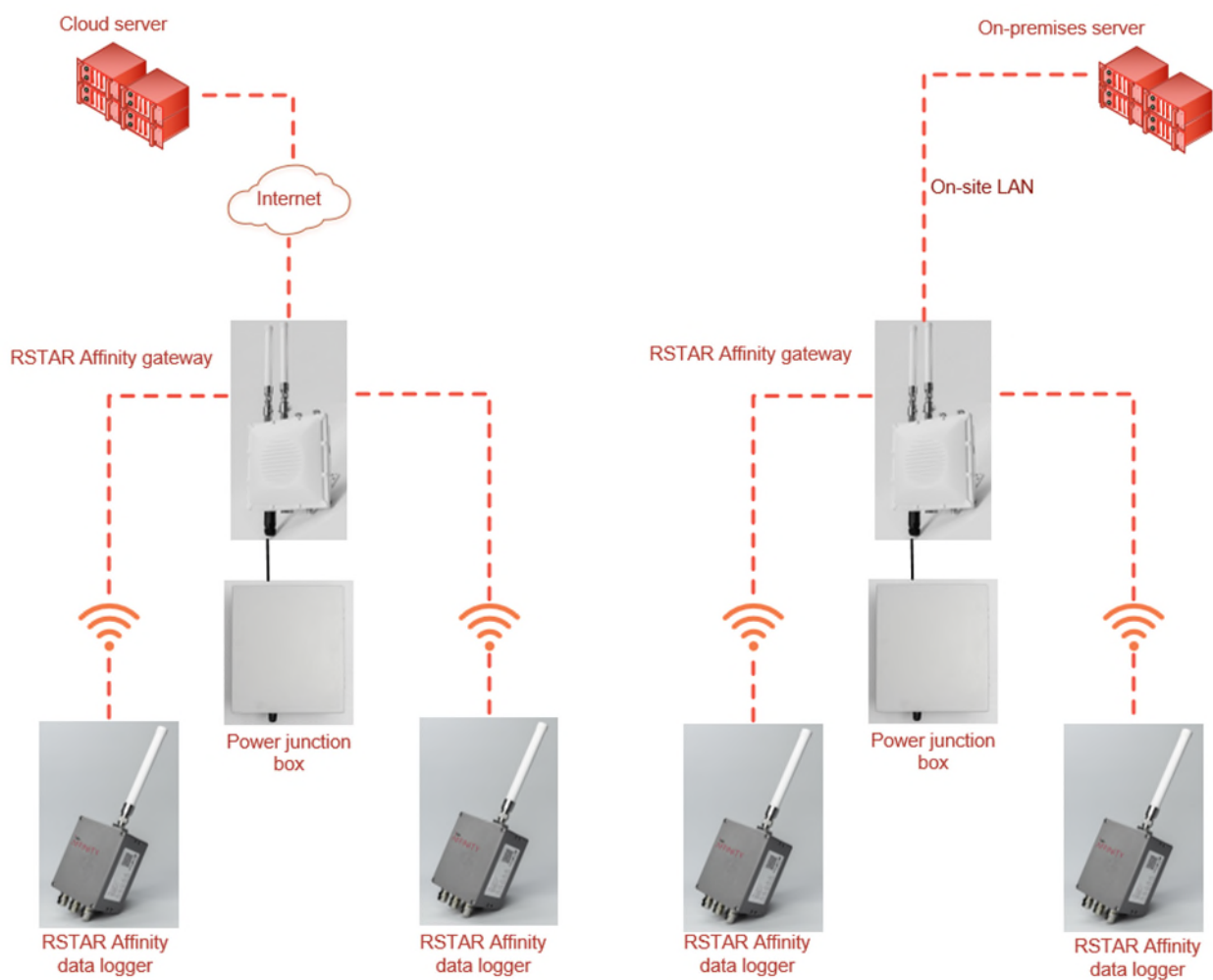


Figure 1: RSTAR Affinity Cloud and On-Premises Solution

1.2 INTENDED AUDIENCE

This guide is for the service personnel responsible for installing and commissioning an RSTAR Affinity data logger.

1.3 ICONS USED IN THIS GUIDE

This guide uses the following icons to call attention to important information.



WARNING: This icon appears when an operating procedure or practice, if not correctly followed, could result in personal injury or loss of life.



CAUTION: This icon appears when an operating procedure or practice, if not strictly observed, could result in damage to or destruction of equipment.



CHECK: This icon appears to remind you of quality-related features.



NOTE: This icon appears to highlight specific non-safety related information.



RSTAR Affinity field app: This icon appears when you need to refer to an RSTAR Affinity field app documentation.

1.4 RSTAR AFFINITY DATA LOGGER

The RST Affinity data logger is part of the only turnkey solution on the geotechnical Industrial Internet of Things (IIoT) market that provides data collection, communications, site management, data insight, and remote monitoring together in one comprehensive product line. It collects data in a variety of applications with high accuracy. It passes this data securely to an RST Affinity gateway or a mobile device running the RSTAR Affinity field app through Bluetooth Low Energy (BLE) for monitoring and analysis away from the site.

The data logger is highly flexible and designed to interface with a wide range of measurement instruments. It is a wirelessly connected data collection device for measuring geotechnical instruments. It is battery-powered and provides reliable, unattended monitoring, and telemetry of mission critical instruments.

The data logger uniquely features five customizable ports capable of supporting your mission-specific instruments. This allows one data logger to interface with a variety of instruments, reducing overall equipment and installation costs.

1.5 RSTAR AFFINITY DASHBOARD

The RSTAR Affinity dashboard is the browser-based user interface that has an essential suite of mapping, graphing, data visualization, and reporting utilities developed specifically for the geotechnical space.

The dashboard also has automatic and transparent field calculations, alarm functionality, and a unique relative elevation mapping feature, along with user management. The open API supports integration with third-party data management and presentation software.

1.6 RSTAR AFFINITY FIELD APP

The RSTAR Affinity field app is a mobile application has account-based sign-in to ensure security and traceability through a built-in audit trail. Bluetooth connectivity and a QR code scanner make for quick, easy, and accurate instrument installation and commissioning, saving an average of four hours per sensor and eliminating human error during setup.

2 SYSTEM OVERVIEW

2.1 ENCLOSURE

The RSTAR Affinity data logger enclosure is designed with a detachable front cover to allow work on the wiring terminal blocks, batteries, and micro-USB diagnostic port. The antenna connector is on the top of the enclosure while the instrument interface module (IIM) ports are on the bottom.

→ **NOTE:** Use of the micro-USB is restricted to RST service personnel.

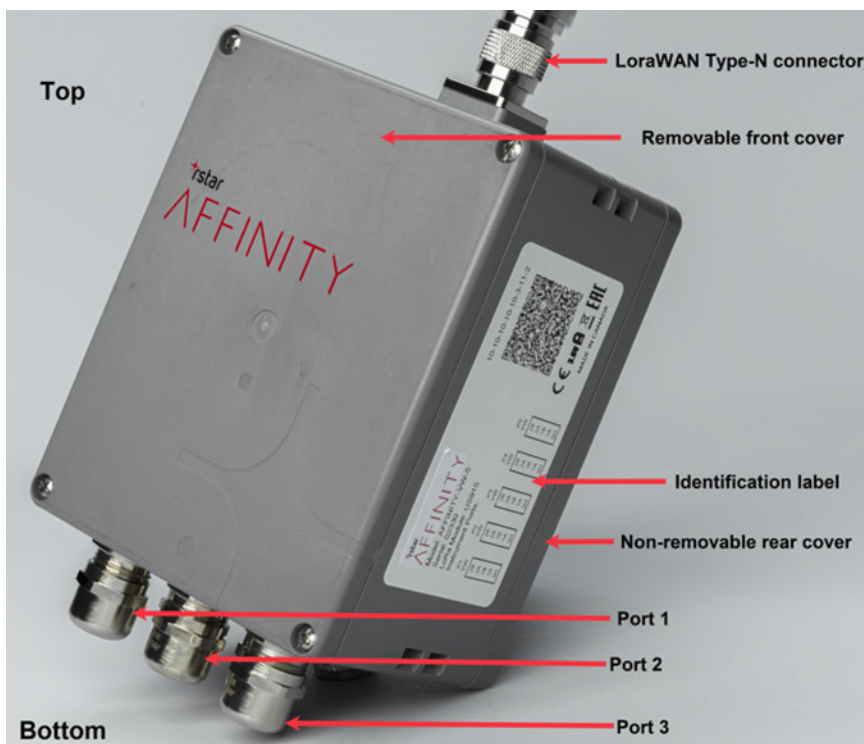


Figure 2: Enclosure and Components

2.2 INTERNAL COMPARTMENT

The internal compartment is in the back of the data logger. It contains the sensitive electronics and is not accessible by field personnel. This compartment has no serviceable components and uses anti-tamper screws to prevent inadvertent access.

2.3 SERVICE PORT COMPARTMENT

The data logger's service port compartment houses the batteries, micro-USB port, and instrument interface modules (IIM).

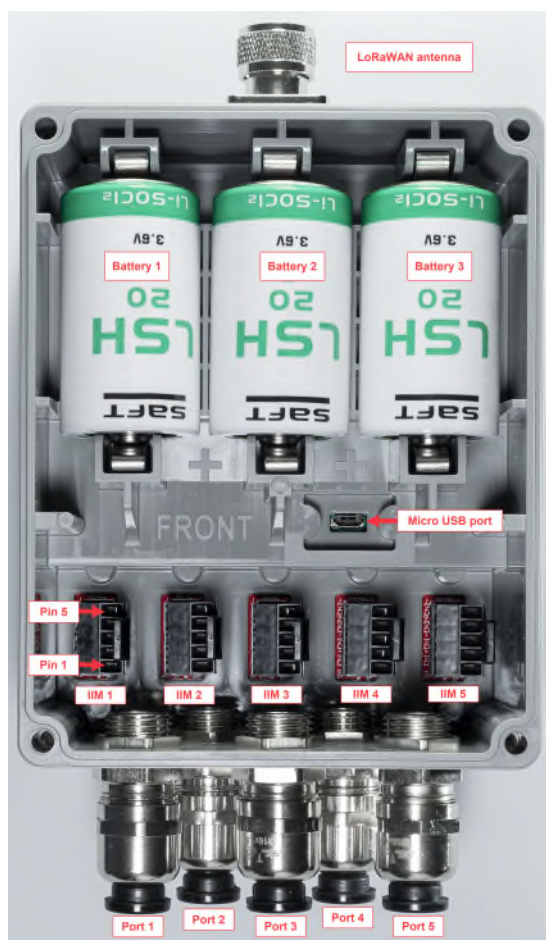


Figure 3: Service Port Compartment

The data logger accommodates up to five instrument interface modules (IIM). Each IIM is equipped with a five-wire terminal strip. The pins are arranged with pin 5 at the top and pin 1 at the bottom.

Table 1 shows the functional label for each of the IIM. Appendix C lists some of the instruments and sensors that can be connected to the corresponding IIM. Contact RST for information on instruments not listed.

IIM Type	Terminal Pin 1	Terminal Pin 2	Terminal Pin 3	Terminal Pin 4	Terminal Pin 5
VW*/TH*	Shield	VW 1	VW 1	Thermistor 1	Thermistor 1
VW/TH	Shield	VW 1	VW 1	VW 2	VW 2
VW/TH	Shield	Thermistor 1	Thermistor 1	Thermistor 2	Thermistor 2
TH/TH	Shield	Thermistor 1	Thermistor 1	Thermistor 2	Thermistor 2
RS-485	Shield	Ground	+12V Output	RS-485 - B	RS-485 - A
4-20mA		+12 Output 1	Shunt 1	+12V Output 2	Shunt 2

Table 1: IIM Pin Assignment

*VW stands for vibrating wire

**TH stands for thermistor

2.4 CONNECTIVITY

The data logger comes with options for different instrument interfaces. The connectors on the enclosure include up to five port cable glands and/or Quick Connect cables for sensors and instruments, and a LoRaWAN external antenna.

2.4.1 Quick Connect

The Quick Connect option on the data logger is IP67-rated and can be used in harsh environments. It simplifies field installation and is ideal where sensors are frequently replaced. The connectors are installed by RST for specific instruments. There are no modifications required for the Quick Connect option.

2.4.2 LoRaWAN External Antenna

The data logger can use either a factory installed LoRaWAN antenna (mounted inside the enclosure) or an optional external antenna (using the data logger's type-N connector). Refer to the data logger's configuration identification label (discussed in section 3.2.1) to see if your data logger comes with a built-in antenna.

The LoRaWAN network operates in three radio frequency bands. If you are using an optional external LoRaWAN antenna, refer to Table 2 for the recommended antennas to match the different bands.

Band	Antenna Recommendation	Gain	Dimensions
900-928 MHz	Taoglas Blade 868/ 915Mhz Omnidirectional	1 dBi	228 x 23 mm
863-870 MHz	Taoglas Blade 868/ 915Mhz Omnidirectional	1 dBi	228 x 23 mm
433 MHz	Taoglas OMB.433.B06F21	6dBi	1473 mm (max) x 24mm

Table 2: Recommended LoRaWAN Antenna

3 INSTALLATION PROCEDURES

This section details the installation of the RSTAR Affinity data logger's components.

3.1 INSTALLATION TOOLS

The following are the tools you need to install the data logger:

- number 2 Phillips head screwdriver
- 2 mm flat head screwdriver
- 20 mm open wrench or an optional gland wrench available from RST

3.2 CONNECT THE CABLE GLAND

→ **NOTE:** The cable gland seals the connection and protects the data logger from moisture and contamination. It accepts instruments with $\frac{1}{2}$ " (12.70 mm) diameter cables.

To connect the cable gland to the data logger, complete the following steps:

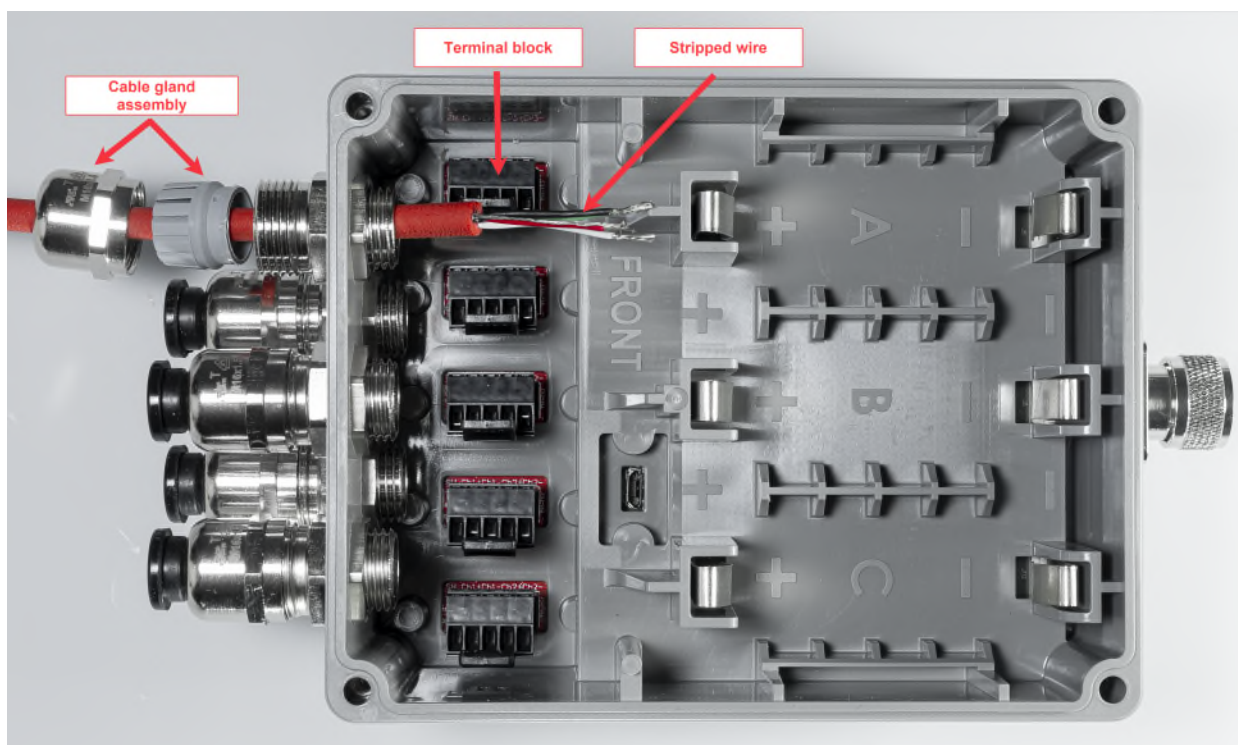


Figure 4: Cable Gland Connection

1. Unscrew the front cover of the data logger using a screwdriver to access the service port compartment.
2. Remove the cable gland assembly from the enclosure.

3. Thread the instrument or sensor cable through the cable gland and into the enclosure.
4. Pull the terminal tab to detach the terminal block from the data logger.
5. Use a 2 mm flat head screwdriver to tighten each of the stripped instrument wire to the assigned pins on the terminal block.
6. Tighten the cable gland to seal the connection and protect the data logger from moisture and dirt.
7. Screw the front cover back on the data logger following the tightening sequence shown in Figure 5. Make sure the rubber seal on the cover is free of debris and seated in its groove before tightening the screws.

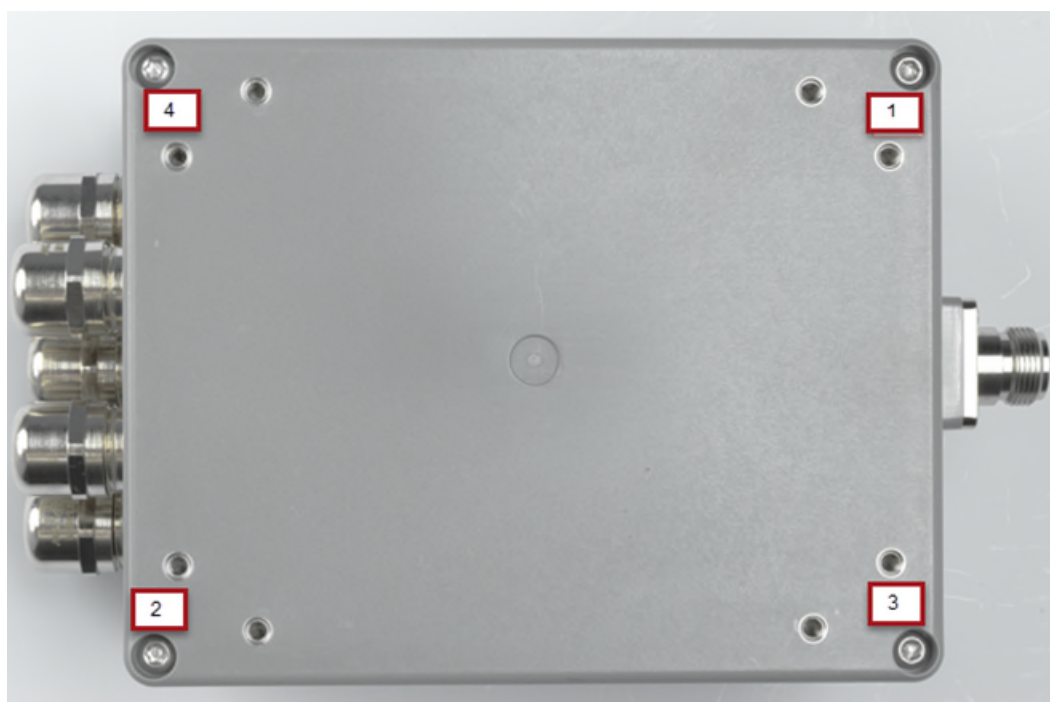


Figure 5: Front Cover Tightening Sequence

3.2.1 Configuration Identification Label

The data logger's flexible design supports a variety of instruments. Specific instrument interface modules (IIM) are installed at the factory. The label on the side of the enclosure shows the data logger's serial number and the configuration option shows as **aa-bb-cc-dd-ee-f-gg-h**, where:

- aa = instrument port 1 interface (sensor type and connection)*
- bb = instrument port 2 interface (sensor type and connection)*
- cc = instrument port 3 interface (sensor type and connection)*
- dd = instrument port 4 interface (sensor type and connection)*
- ee = instrument port 5 interface (sensor type and connection)*
- f = Number of batteries (1=one battery, 2=2 batteries, 3=3 batteries)

- gg = communication type and antenna (1=internal, 2=external antenna required)
- h = mounting type

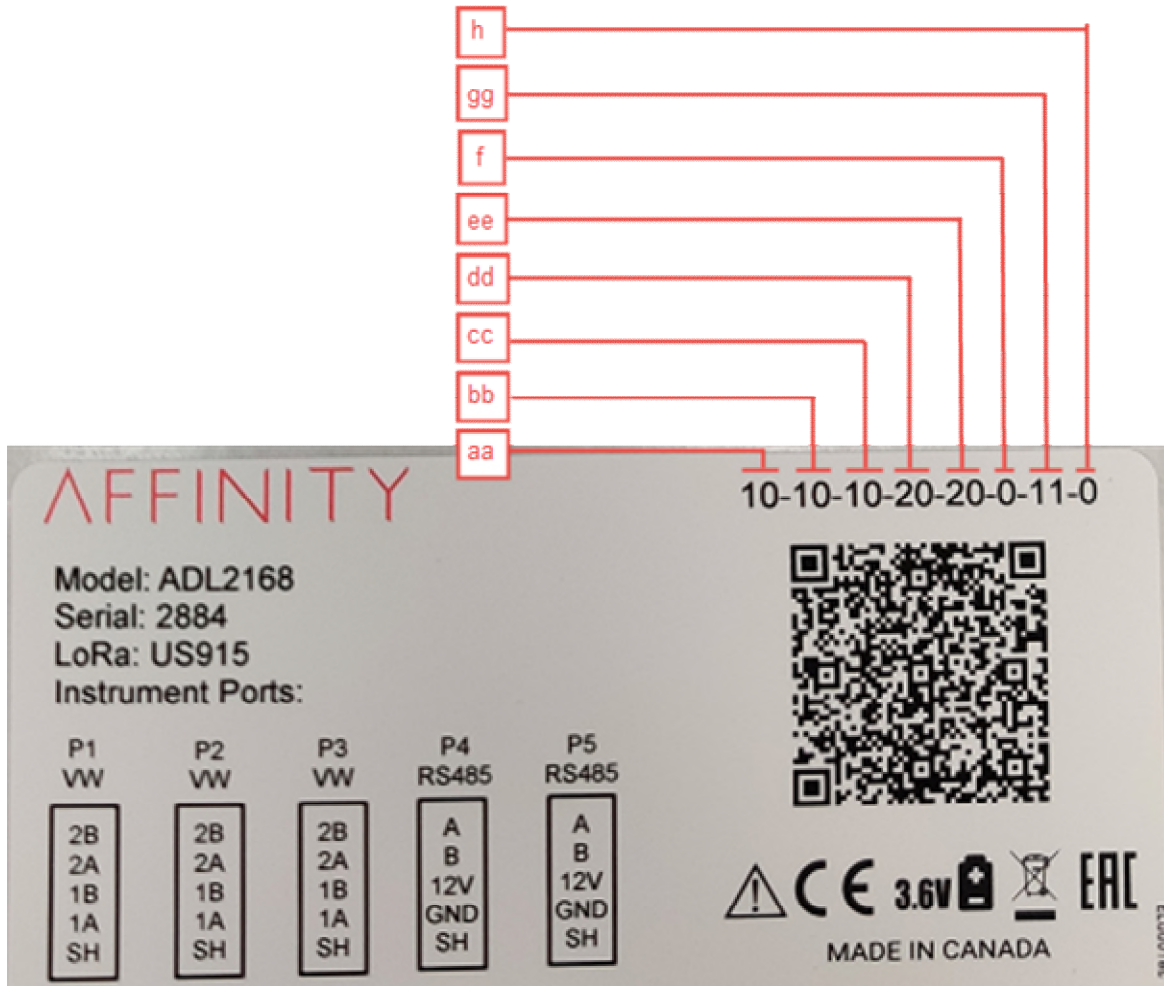


Figure 6: Configuration Identification Label

Items with an asterisk (*) mean IIM configuration is encoded as a two-digit number that identifies the IIM type and the connection option shown in Table 3.

Code	IIM Type	Number of Channels	Connector Type
10	Vibrating Wire and Thermistor IIM	2	Cable Gland
11	Vibrating Wire and Thermistor IIM	2	Quick Connect
20	RS-485 instrument IIM	1	Cable Gland
21	RS-485 instrument IIM	1	Quick Connect

Table 3: IIM Instrument Encoding Table

3.2.2 QR Identification Code

The QR code in the data logger contains the following configuration information:

- ID – data logger serial number
- P1 – port 1 IIM type and description
- P2 – port 2 IIM type and description
- P3 – port 3 IIM type and description
- P4 – port 4 IIM type and description
- P5 – port 5 IIM type and description
- Band – LoRaWAN frequency band
- Antenna – internal or external
- Battery – number of batteries installed

3.3 INSTALL OR REPLACE BATTERIES

Depending on the destination country, a data logger may or may not have factory-installed Li-SOCl₂ D cell batteries. If it has factory-installed batteries, you have to remove the insulating pull tabs which prevents the batteries from energizing during shipping and storage.

The data logger has three battery compartments labelled as A, B and C. The data logger detects batteries in the compartments and uses the first available battery in the sequence. The data logger continuously monitors battery consumption over time, disables the depleted battery and enables the next available battery in the sequence.

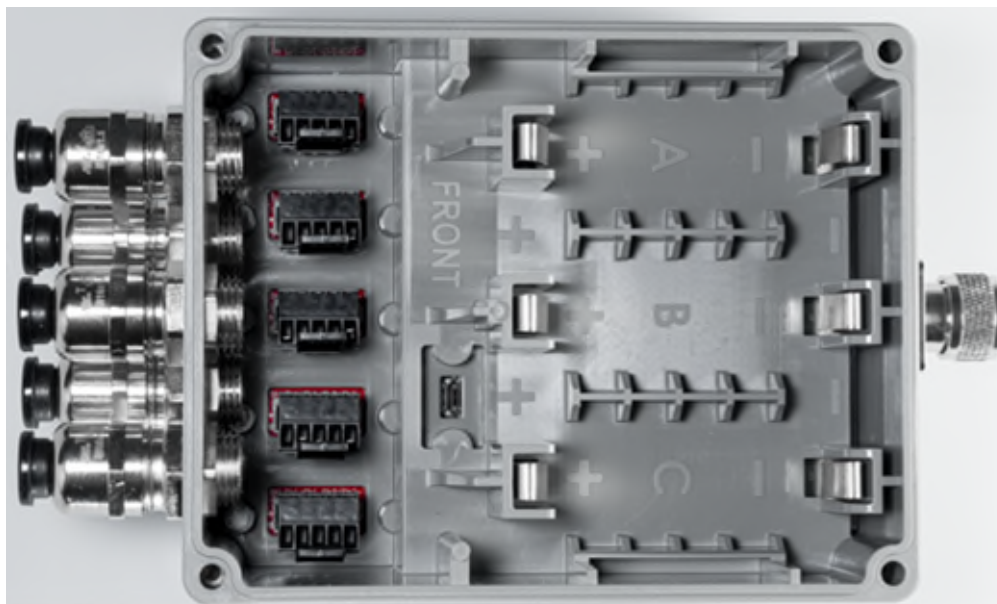


Figure 7: Battery Compartment

To install batteries on the data logger, complete the following steps:

1. Unscrew the data logger's front cover to access the service port compartment.

- If the data logger has factory-installed batteries, remove the insulating pull tabs.
- If replacing batteries, remove the installed batteries and go to step 2.

2. Insert the new batteries in the battery compartment.



NOTE: You may install up to three batteries. If you are installing only one battery, use battery compartment A. If you are installing two batteries, use compartments A and B.

3. Screw the front lid back on the data logger following the tightening sequence shown in Figure 5.

4. Reset the battery meter in the RSTAR Affinity field app.



Refer to the RSTAR Affinity Field App User Guide for information on resetting the battery meter.

3.4 INSTALL EXTERNAL ANTENNA

The data logger may be ordered with an internal antenna installed in the enclosure and an optional lightning arrestor. Refer to the data logger configuration code to identify if the data logger has a built-in antenna.

To install an external antenna on the data logger, complete the following steps:



Figure 8: Antenna Connection

1. Make sure the location for the data logger has a line of sight to the RSTAR Affinity gateway.
 - If line of sight is blocked, consider elevating the antenna on an antenna mast.
2. Connect the coax cable to the antenna.
 - If using an optional lightning arrestor, connect it between the data logger and the coax cable.

3.5 INSTALL THE DATA LOGGER

Keep in mind when installing the data logger that although it is designed to withstand harsh environmental conditions and its IP67-rated enclosure is dust-tight and weather-resistant, it can be exposed to elements such as rain and splashes of water but cannot be submerged in liquid.

Options for installing or mounting the data logger include the following:

- Pole mount – for use on a pole with diameter between from and 120 mm (5") and 254 mm (10")
- Wall mount – for use on a flat wall or panel
- Magnet mount – for use on a magnetic wall or panel
- Secondary enclosure mount – for use within a secondary enclosure

3.5.1 Pole Mount Option

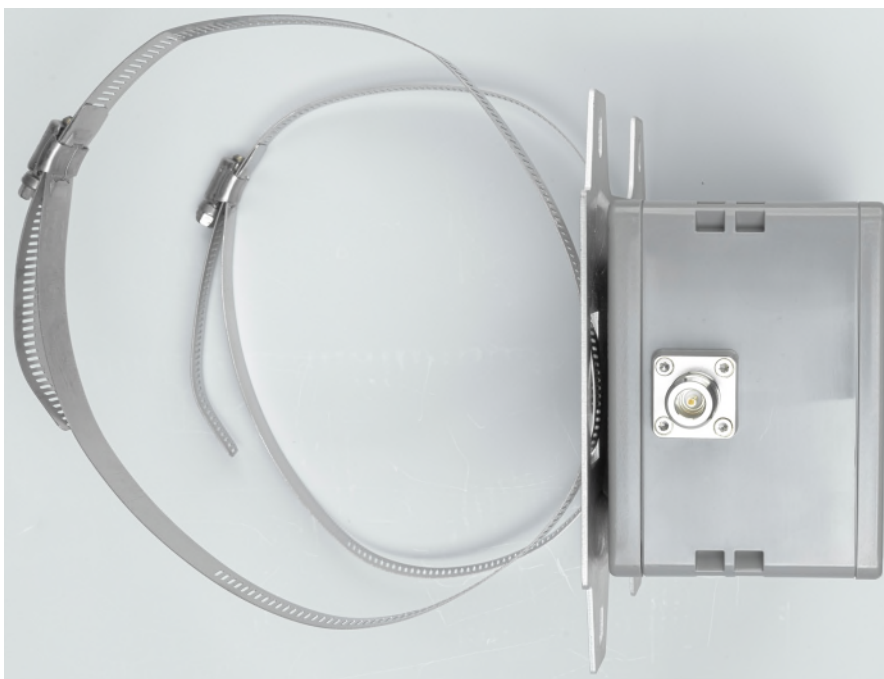


Figure 9: Pole Mount Plate

To mount the data logger on a pole, complete the following steps:

1. Remove the four screws from the back of the data logger.
2. Install the back plate using the same four screws. Tighten the screws.
3. Thread the hose clamps through the top and bottom slots on the back plate.
4. Wrap the hose clamps around the pole and tighten the screws.

3.5.2 Wall Mount Option

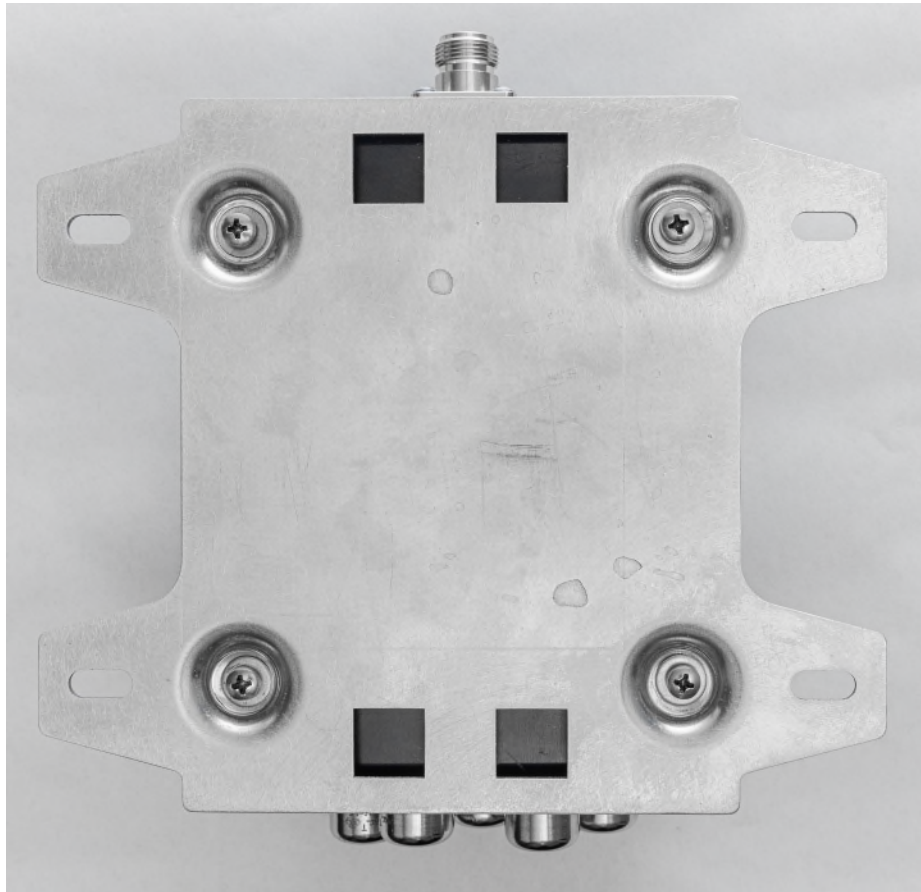


Figure 10: Wall Mount Plate

→ **NOTE:** You will need to supply your own screws to mount the data logger to a wall.

To mount the data logger to a wall, complete the following steps:

1. Remove the four screws from the back of the data logger.
2. Install the back plate using the same four screws. Tighten the screws.
3. Install the wall mount plates using the provided screws. Tighten the screws.
4. Mount the data logger to a wall.

3.5.3 Magnet Mount Option

The magnetic mount option uses four ring magnets with an attraction force of 10 pounds screwed to the rear panel of the data logger.

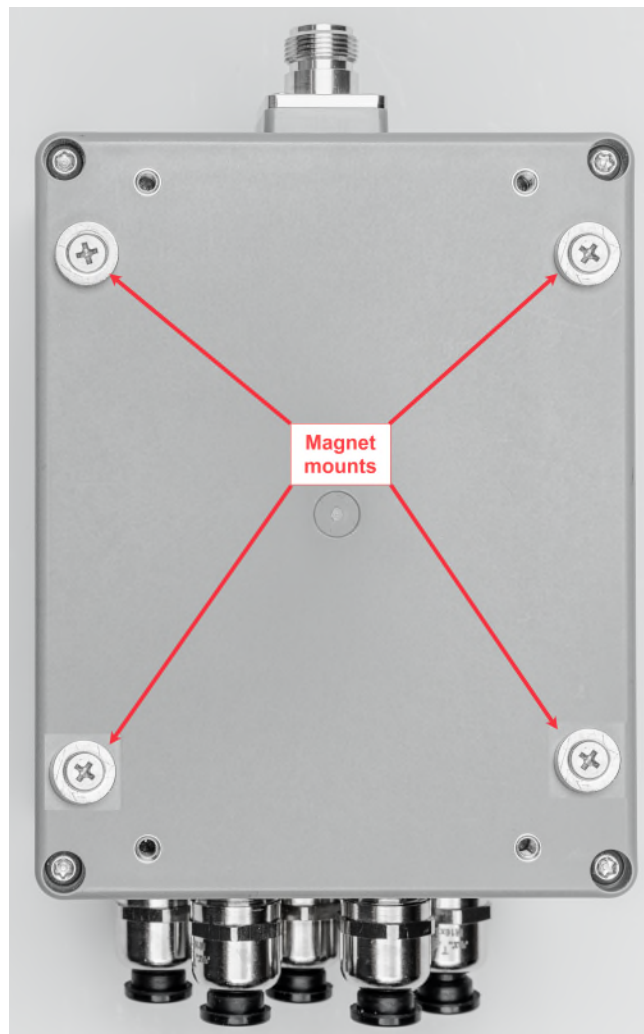


Figure 11: Magnet Mounts

To install the data logger using the magnet, complete the following steps:

1. Remove any screw from the back of the data logger used on previous installations.
2. Screw the magnets as shown in the picture. Tighten the screws.
3. Mount the data logger on a magnetic surface.

3.5.4 Mount to a Secondary Enclosure

Radio signals are affected by electrically conductive material that may absorb or reflect radio signals. If you're using a secondary enclosure that is electrically conductive, you can extend the external antenna and mount it outside the enclosure to allow for better signal.

3.6 CONFIGURE AND VERIFY INSTALLATION

To configure and verify the data logger's installation, use the RSTAR Affinity field app. It incorporates all the tools required to:

- configure each sensor installed in the data logger
- monitor the data collected from the sensor
- reset the battery lifecycle accumulator whenever a new battery is installed
- measure the radio signal strength from the data logger to the RSTAR Affinity Gateway
- retrieve the data logger's operational statuses and information, historical collect data log files, error, and event logs for troubleshooting purposes
- download new firmware to the data logger



Refer to the RSTAR Affinity Field App User Guide for details.

Appendix A: RSTAR AFFINITY DATA LOGGER SPECIFICATION

ENVIRONMENTAL	
Operating Temperature	-40 to +60 Celsius
Storage Temperature	-40 to +80 Celsius
Ingress Protection	Meets IP66 standards
PHYSICAL	
Dimensions	110mm (L) x 105mm (W) x 70mm (H)
Weight	550 g
Enclosure Material	Polybutylene terephthalate (PBT)
Mounting options	Wall, pole, magnetic and secondary enclosure
ELECTRICAL	
Battery Type	D cell 3.67V Li-SOCl ₂ – 19000 mA-hr
Battery Capacity	Three
Nominal Current	10 uA dormant, 20 mA active (placeholder)
Battery Life	See Appendix A for battery life expectancy
COMPUTING SPECIFICATIONS	
Processor	STM-32 L4, Arm Cortex-M4
On-board flash storage	64 MB SPI Flash
Expandable storage	16 GB micro-SD memory card
Bluetooth	BT 5.0 Class 2, 10-meter range
Wireless telemetry option	RAK 4200 LoRa module
GENERAL INSTRUMENT INTERFACES	
Number of instrument ports	Maximum five ports
Connector Type	Cable gland or factory-configured threaded connector
Instrument isolation	Optical isolation between instrument and logger
Vibrating Wire and Thermistor IIM	
Number of Channels	Dual sensors vibrating wire and/or resistive thermistor
Vibrating Wire Resonant Frequency	1,200- TO 3,500Hz
Thermistor Type	*NTC (3K, 5K, 10K, 2.252K or custom)
Thermistor Range	50 to 200,000 ohms
Thermistor and Thermistor IIM	



Number of Channels	Dual-resistive thermistors
Thermistor Type	NTC (3K, 5K, 10K, 2.252K, or custom)
Thermistor Range	50 to 200,000 ohms
RS-485 IIM	
Number of Channels	Single RS-485 instrument
Data Rate	1,200 to 11,5200 Baud, half duplex
Power Output	12 V DC (voltage direct current), 2 A continuous
Dual Channel 4-20mA IIM	
Number of Channels	Dual 4-20 mA two-wire current loop
Power Output	12 V DC, 2 A continuous
Single Channel 4-20mA IIM	
Number of Channels	Single 4-20 mA three or four-wire configurations

*NTC stands for Negative Temperature Coefficient

Appendix B: ESTIMATED BATTERY LIFE

→ **NOTE:** This section only provides estimates of battery life.

Battery life varies depending on various factors including:

- Number of sensors or instruments connected to each logger. The higher the number of instruments, additional power is consumed to retrieve, process, store and upload the collected data.
- Type of sensors or instruments. Sensor and instruments consume different power due to their inherit design. Typically, active instruments that require the data logger to provide power to the instrument shortens battery life than passive sensors.
- Frequency of data collection. For each data collection, the data logger consumes power to wake up from dormant mode, perform data collection and re-enter dormant mode.
- Temperature. Environmental temperatures below 10° C may affect the charge retention capacity of Li SOCl₂ batteries.

RST Instruments will provide the estimated battery life as information becomes available.

Appendix C: INSTRUMENT INTERFACE MODULE

VIBRATING WIRE AND THERMISTOR IIM

The Vibrating Wire and Thermistor IIM (VW/TH) may be configured to support up to two sensors which may be a combination of:

- two vibrating wire sensors
- two thermistor sensors
- one vibrating wire and one thermistor sensor

This IIM module is designed for a vibrating wire piezometer with a resonant frequency between 2,000 and 3,500 Hz. This IIM module converts the thermistor's resistance in the range of 20 ohms to 200,000 ohms with accuracy of 0.1%.

The pin assignments are:

- Pin 1 – shield
- Pin 2, 3 – thermistor or vibrating wire piezometer
- Pin 4, 5 – thermistor or vibrating wire piezometer

THERMISTOR AND THERMISTOR IIM

The Thermistor and Thermistor IIM (TH/TH) supports up to two thermistor sensors. This IIM module converts thermistor's resistance in the range of 20 ohms to 200,000 ohms with accuracy of 0.1%.

The pin assignments are:

- Pin 1 – shield
- Pin 2, 3 – first thermistor
- Pin 4, 5 – second thermistor

RS-485 IIM

The RS-485 IIM connects to an RS-485 instrument that adheres to the RS-485 electrical standard. This IIM may be configured to process data communication rate between 1,200 and 115,200 Baud in half duplex operation. This IIM also has an optional +12V DC output.

The pin assignments are:

- Pin 1 – shield
- Pin 2 – ground
- Pin 3 - +12V DC power output
- Pin 4 – RS-485 B (inverting pin)
- Pin 5 – RS-485 A (non-inverting pin)

DUAL 4-20 MA IIM

The Dual 4-20mA IIM may be configured to support up to two separate 4-20 mA sensors that supports a 4-20mA device. An 82-ohm series shunt resistance converts the current sense to a voltage.

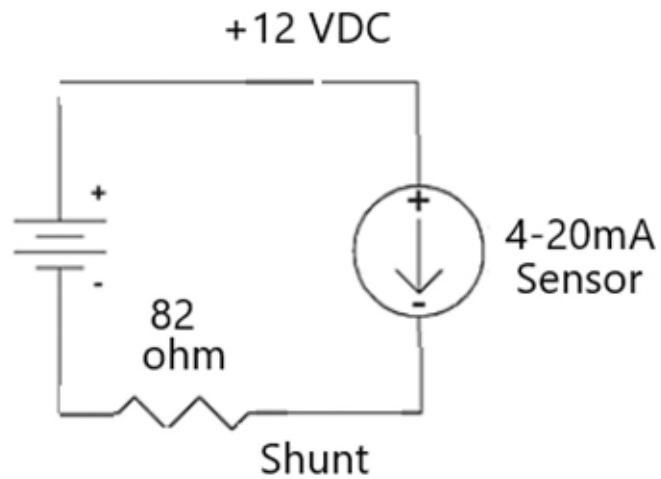


Figure 12: 4-20 mA Circuit Diagram

The pin assignments are:

- Pin 1 – shield
- Pin 2 – sensor 1 +12V DC output source
- Pin 3 – sensor 1 shunt input
- Pin 4 – sensor 2 + 12 VDC output source
- Pin 5 – sensor 2 shunt

Appendix D: INSTRUMENT WIRING DIAGRAM FOR CABLE GLAND INSTALLATION

Table 4 lists the instrument type, manufacturer model number, and conductor color. Custom means the interface wiring is dependent on the vendor's cables. Check with the vendor for the appropriate color-coded pin assignment.

Instrument Type	Model Numbers Prefix	IIM Type	IIM Pin 1	IIM Pin 2	IIM Pin 3	IIM Pin 4	IIM Pin 5
Generic Vibrating Wire	Generic	VW/TH	Shield	Custom	Custom	Custom	Custom
Generic Thermistor	Generic	VW/TH	Shield	Custom	Custom	Custom	Custom
Generic Vibrating Wire and Thermistor	Generic	VW/TH	Bare	Custom	Custom	Custom	Custom
VW Piezometer	VW2100 VW2090 VW2191	VW/TH	Bare	Black	Red	White	Green
VW Pressure Transducer	VW2190	VW/TH	Bare	Black	Red	White	Green
VW Push-in Pressure Cell	VWPC2100	VW/TH	Bare	Black	Red	White	Green
VW Total Earth Pressure Cell	LPTPC06 LPTPC09 LPTPC12	VW/TH	Bare	Black	Red	White	Green
VW NATM Stress Cell	VW3291	VW/TH	Bare	Black	Red	White	Green
VW Liquid Settlement	SSVW105	VW/TH	Bare	Black	Red	White	Green
VW In-Line Extensometer	EXINLINE	VW/TH	Bare	Black	Red	White	Green
VW Multi-Point Borehole Extensometer	VW2100 VW2090 VW2191	VW/TH	Bare	Black	Red	White	Green
VW Crack Meter	VWCM	VW/TH	Bare	Black	Red	White	Green
VW Soil Extensometer	EXSR	VW/TH	Bare	Black	Red	White	Green
VW Joint Meter	VWJM	VW/TH	Bare	Black	Red	White	Green
VW Arc Weld Strain Gauge	VWSG-A	VW/TH	Bare	Black	Red	White	Green
VW Embedment Strain Gauge	VWSG-E	VW/TH	Bare	Black	Red	White	Green
VW Spot Weld Strain Gauge	VWSG-S	VW/TH	Bare	Black	Red	White	Green
VW Sister/Rebar Strain Gauge	VW5000	VW/TH	Bare	Black	Red	White	Green
VW Load Cell	VWS VWA	VW/TH	Bare	Black	Red	White	Green
Generic Modbus	Generic	RS485	Shield	Custom	Custom	Custom	Custom
ShapeArray™	SAAV SAAX SAAV Extend	RS485	Bare	Black	Red	Blue	White
Digital Tilt Meter	IC6556 IC6656	RS485	Bare	Black	Red	White	Green
Digital Submersible Tilt Meter	IC6750 IC6756	RS485	Bare	Black	Red	White	Green



Instrument Type	Model Numbers Prefix	IIM Type	IIM Pin 1	IIM Pin 2	IIM Pin 3	IIM Pin 4	IIM Pin 5
Vertical Tilt Beam	IC6017 IC6018	RS485	Bare	Black	Red	White	Green
Horizontal Tilt Beam	IC6082 IC6083	RS485	Bare	Black	Red	White	Green
Tunnel Profile Monitor System	ICTCCST	RS485	Bare	Black	Red	White	Green
Track Monitoring Settlement System	IC9000 IC9003 IC9050 IC9053 IC9100	RS485	Bare	Black	Red	White	Green
Vertical In Place Inclinator – Legacy	IC7565B IC7575B IC7570B IC7525B IC7555B IC7520B IC7550B	RS485	Bare	White	Brown	Black	Blue
Horizontal In Place Inclinator – Legacy	IC32003H IC32005H IC32075H IC3200H IC32015H IC32205H	RS485	Bare	White	Brown	Black	Blue
Vertical In Place Inclinator	IPI27050-U	RS485	Bare	Black	Red	White	Green
Horizontal In Place Inclinator	IPI27050-D	RS485	Bare	Black	Red	White	Green
Precision Liquid Settlement Array	SS5010 SS5020 SS5030	RS485	Bare	Black	Red	White	Green
Digital Bus Strain Gauge Piezometer	ELSGP510S ELSGP511S	RS485	Bare	Black	Red	White	Green

Table 4: Instrument Type, Manufacturer Model Number, and Conductor Color