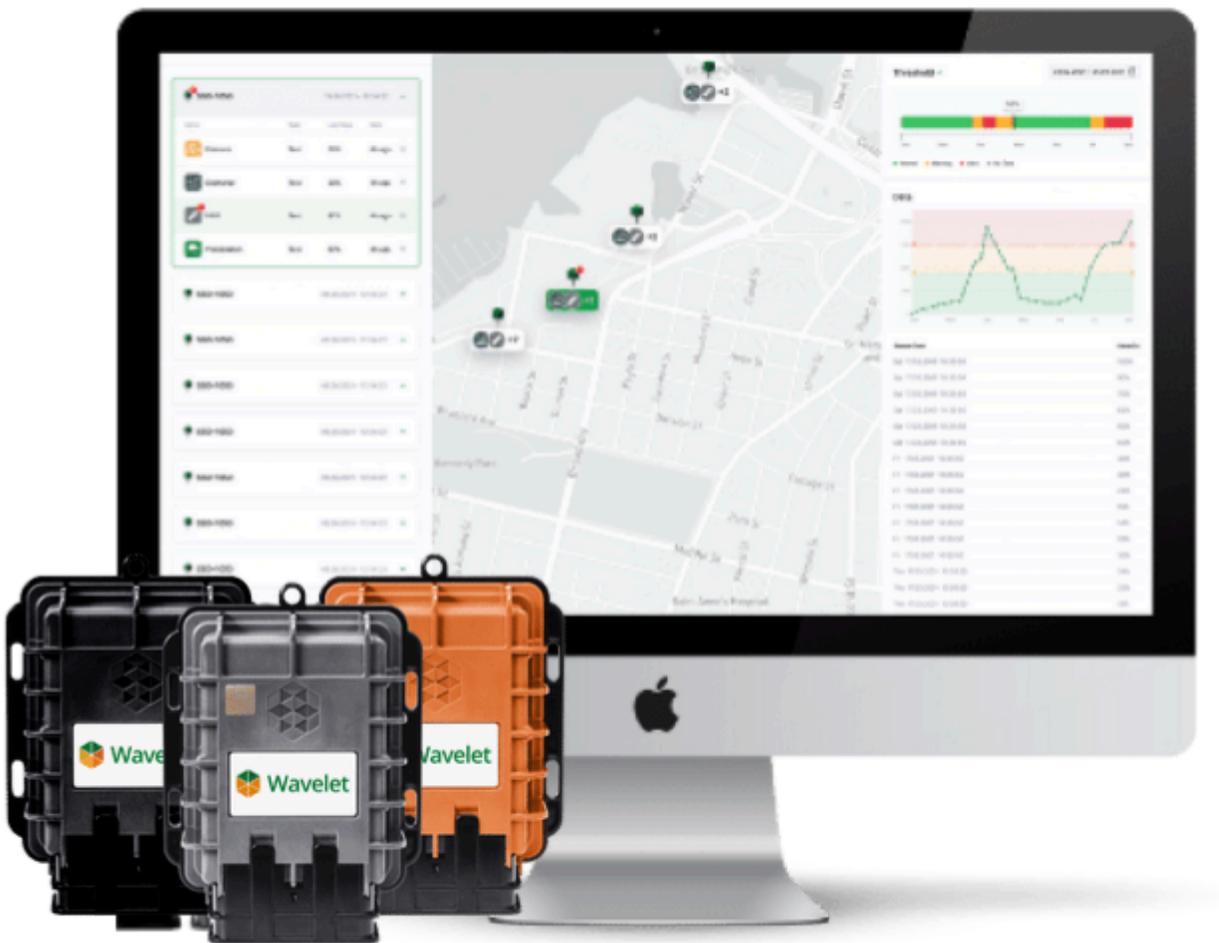


# geotech

## End-to-End Telemetry hardware and AI drive data management platform Installation and Operation Manual



DOCUMENTATION CONVENTIONS This document uses the following conventions to present information:



## **WARNING**

An exclamation point icon indicates a **WARNING** of a situation or condition that could lead to personal injury or death. You should not proceed until you read and thoroughly understand the **WARNING** message.



## **CAUTION**

A raised hand icon indicates **CAUTION** information that relates to a situation or condition that could lead to equipment malfunction or damage. You should not proceed until you read and thoroughly understand the **CAUTION** message.



## **NOTE**

A note icon indicates **NOTE** information. Notes provide additional or supplementary information about an activity or concept.

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# 1. Pre-Installation Checklist

Before the device is installed in the field, use this checklist to ensure a successful installation.

**Mandatory:** The device and sensors must be tested in the office **before installing in the field.**

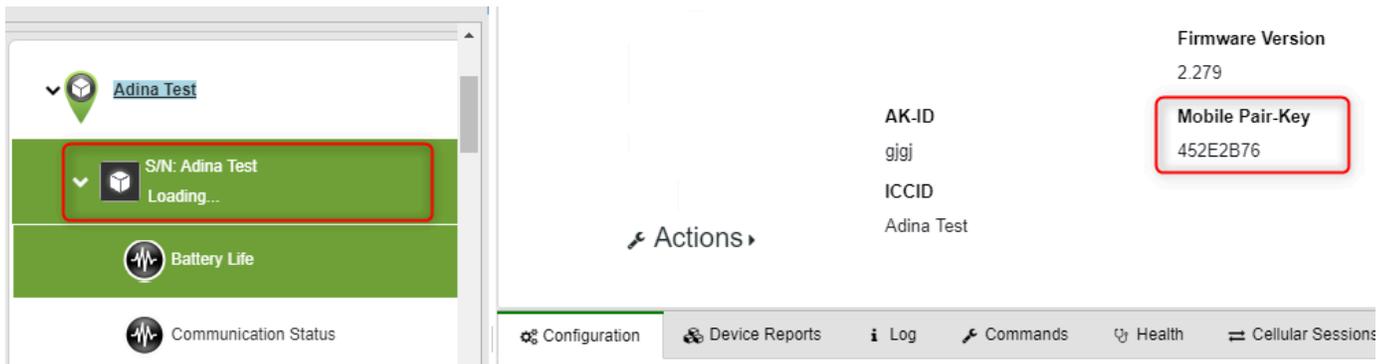
## 1.1. Hardware Pre-Reqs

1. Write down the S/N of the device (found on the back).
2. Tools for mounting the device and the antenna. Review where to [mount the antenna](#) before you go to the site.
3. If you are using an external power supply, review [how to connect it](#).
4. Test the sensors in the office before going out into the field.
5. Test the mounting brackets in the office before going out into the field.
6. Make sure you have all required components (check the BOM):
  - Wavelet device
  - External cellular antenna
  - Sensors that the user ordered
  - External power supply (optional)
  - Splitters (optional)

## 1.2. Software Pre-Reqs

1. Confirm that the user has a user account in the UI.
2. Give new customers access to the UI:
  - Give them credentials for the Cloud account
  - Give them the URL of the UI
  - Check that the user is able to log in to the new account from their laptop
3. You must have the AyyekaGo mobile app installed on your iPhone or Android. Be sure that your mobile device has the latest version.
4. Review the [Quick Start Guide](#)
5. Know what streams should be transmitting data so that you can check them when the device is active.
6. Confirm that the device is transmitting.
7. Check that the device is enabled to use the AyyekaGo mobile app with the Mobile Pair Key - shown in the UI, the mobile par key can be found on the UI as per Figure 1.1 below.

Figure 1.1 Mobile Pair-key



### 1.3. Connecting to the Device by Using AyyekaGo

AyyekaGo, the mobile app, communicates directly with the Wavelet via Bluetooth. You can leave the installation site with the confidence that your device is successfully integrated with sensors and is transmitting.

The mobile app allows you to leave the installation site with the confidence that your device is successfully integrated with sensors and is transmitting to the Ayyeka user interface.

With the AyyekaGo mobile app, you have a clear view of your data, and you can do some minimal transmission and sampling configuration. The AyyekaGo mobile app is not for collecting or analyzing data.

The mobile app communicates directly with the Wavelet via Bluetooth, so you must be in close physical proximity to the device, and the device must be activated (not in Hibernate mode).

If you haven't already done so, download the AyyekaGo mobile app for iOS or Android. Search the [App Store](#) or [Google Play](#) for "AyyekaGo" mobile app. Alternatively, use the following QR codes.



There are two ways to pair your phone with your Wavelet:

- Select Get Key Via Web. Enter your login credentials for the Ayyeka user interface.
- Select Enter Key Manually. The Mobile Pair Key is found in the Ayyeka user interface in the Devices tab (as per Figure 1.1 above).

Swipe the Activator key (magnet) over the embossed logo on the face of the device in order to initialize or restart the device. This will also initialize the Bluetooth radio receiver so that the mobile application can connect and communicate with the device. The device's Bluetooth radio will remain on for **10 minutes** for the mobile application to pair with it. When the mobile application connects with the device, the Bluetooth radio will remain on as long as the mobile application is active (navigating screens, executing commands, etc.). As soon as the mobile application disconnects from the device, times out, or fails to authenticate, the Bluetooth radio will turn off, requiring a new activation in order to be turned on again.

After you connect to your device, there are multiple display screens for different functionality. The first screen provides essential information, including, but not limited to:

- Signal strength
- Cellular carrier
- Confirmation of successful transmission and connection to the server.



**NOTE**

If you don't have an Activator key, the magnet on your magnetic mount antenna is a convenient alternative

## 1.4. Cellular Antenna Best Management Practices

How to use the proper cellular antenna, ensure it's well positioned, and get good signal quality. Nailing the details is essential for optimal wireless connectivity & battery life of the Wavelet datalogger.

Always use high-quality external antennae. Not all antennae are alike, and **external appearance has nothing to do with the actual RF performance of the antenna.**

### Overview

1. **Availability:** Cellular communication is only available in some places. It depends on the infrastructure deployed by the cellular provider in a specific area.
2. **Predictability:** Cellular signal strength is hard to predict. It is common to have a good signal in a specific spot and a bad one only a few feet away.
3. **Equipment dependency** - The antenna design and specific installation conditions dramatically affect the signal strength.
4. **Underground performance:** In most cases, if you have a fair or better above-ground signal, you can get an adequate signal underground. Cellular frequencies have a reasonably good ground penetration capability. Metallic objects (such as the manhole cover) or high water content in the ground will reduce the penetration.

## Here are some of them:

1. To start with, we equip the Wavelet with a multi-carrier SIM card. So we can work with more than one cellular provider and pick the best signal for every site.
2. We developed the antenna installation guidelines to instruct the install crews on how best to position and install the antenna (not as close as possible to the cover as most of them think!).
3. We extensively studied different antennas together with Radio-Frequency experts. We chose the best antennas for field asset monitoring.
4. In the rare cases that you cannot get a good signal underground in a specific site, we recommend that our customers install a different antenna (above ground). There will be a higher cost associated with such antennas.
5. We allow customers to bring their antennae as well. If they prefer to, some have particular preferences.

The Wavelet device uses cellular communication to communicate data from the field to the FAI platform. Depending on the specific Wavelet part number, the device uses 4G/3G/2G cellular network technologies. It is important to understand that a lack of cellular coverage will prevent the Wavelet from communicating data. A good antenna is critical to the optimal performance of the Wavelet.

Pay special attention to the antennae and the installed device's signal quality to achieve optimal results.



### NOTE

A good signal on your smartphone only sometimes guarantees a good signal with the Wavelet! Good signal strength will result in more reliable connectivity and longer battery life for devices in the field.

## 1.5. Antenna types

All Wavelet models require an external antenna. The Wavelet 4 V2 model has an additional internal antenna for use as a backup antenna. The internal antenna in the Wavelet 4 V2 model is used as a backup antenna only. Make sure always to install the devices with an appropriate external antenna. The external antenna has various shapes and mounting options (magnetic, dome, patch, and in-road). Make sure you use the proper antenna that fits the site conditions. Also, notice that some antennas require a ground plane for optimal performance, so they must be installed on a metallic plate, which comes with the antenna.

### 1.5.1. Using your own antenna

If you intend to use your own antenna, make sure that the antenna uses an SMA male connector and that the **connector is stainless steel**.



Your antenna should support all of the following frequencies (note the Model Number suffix of your Wavelet device, for example: -US):

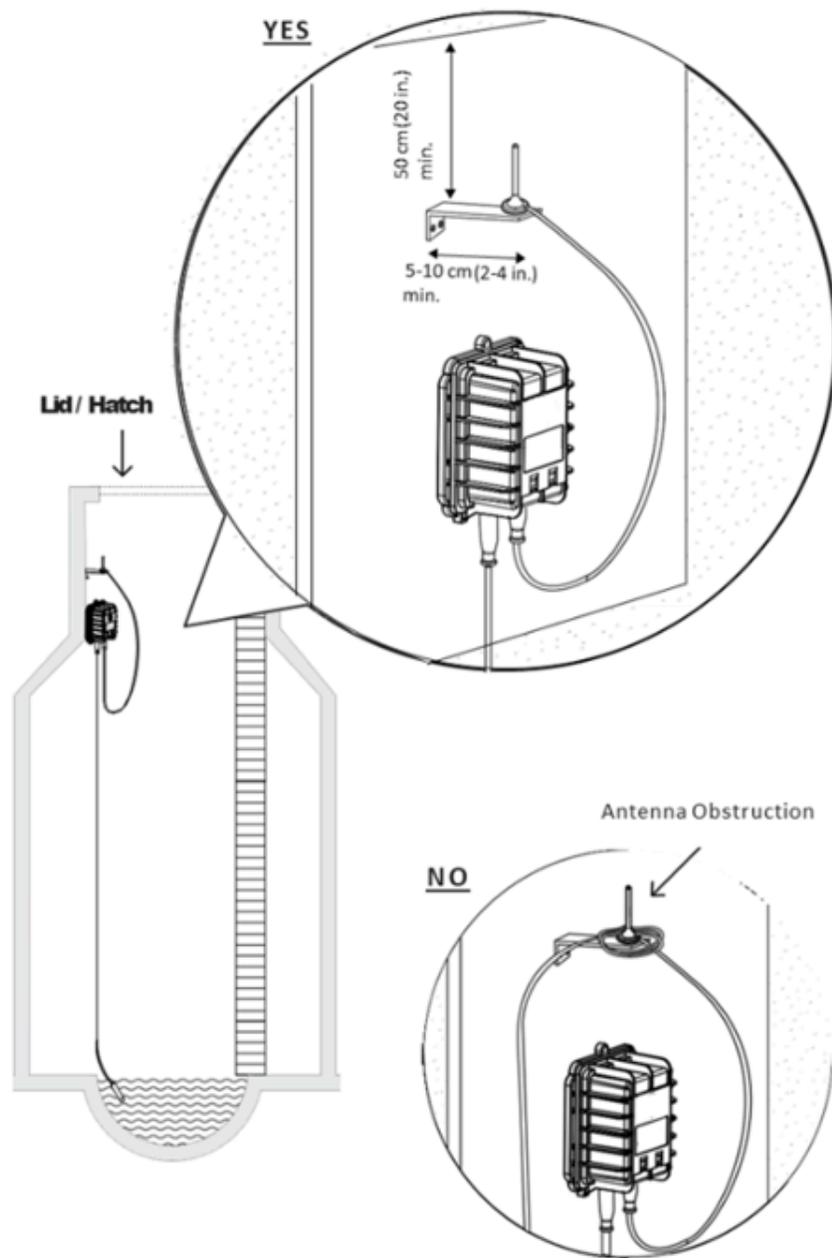
Technology	-US, -SA	-EU
2G	850, 900, 1800, 1900 MHz	900, 1800 MHz
3G	850, 1700, 1900 MHz	900, 1800, 2100 MHz
4G (LTE)	700, 850, 1700, 1900 MHz	800, 900, 1800, 2100, 2600 MHz

Cellular antennas supporting 2G and 3G bands will typically support all bands for these cellular technologies. However, if using a locally sourced antenna, always ensure that the antenna works for 4G bands at the installation location. 4G frequency bands are not universal globally, so selecting the suitable antenna is pivotal.

## 1.5.2. Installation guidelines

1. Ensure the antenna connector is secured tightly to the SMA female panel connector of the Wavelet.
2. The magnetic mount and dome antenna supplied by Geotech must be properly mounted to the metal L-bracket supplied with these products. This bracket provides a ground plane for the antennas to ensure optimal performance.
3. Wherever possible, the antenna should not be obstructed or enclosed by other metallic items, such as inside metal cabinets, underneath pipes, etc. The further and the higher away from obstructions the antennas can be placed, the better.
4. If the antenna is installed underground, mount it at least 50 cm (20 in) beneath the lid/hatch and the street surface.
5. The antenna must be mounted at least 5-10 cm (2-4 in) away from the wall.
6. The antenna must be mounted at least 5 cm (2 in) away from the Wavelet.
7. The cable length should be shorter than 3 m (9 ft) for typical installations. A long antenna cable results in gain loss, resulting in poorer signal quality. The shorter the cable, the better.
8. Always use a high-quality cable with limited attenuation if using an antenna cable extension.
9. The antenna cable must not be looped around the antenna.
10. Do not wrap cables, zip ties, or other items around the antenna.
11. If installed in a highly corrosive environment such as a sewer, apply technical grease to the antenna and sensor field attachable connectors after securing them to the panel connectors. Geotech recommends using Dow Corning Molykote 55 O-Ring Grease, although similar products can also be effective.
12. Graphic of antenna installation:

Figure 1.2 Best practice antenna installation



### 1.5.3. How to check the antenna and signal

Before leaving the site, make sure there's a good signal and successful data transmission. Use the AyyekaGo mobile app, and do the following steps:

1. Select the Wavelet whose signal quality you want to check.
2. Check that the CARRIER strength is 70% or higher. If the strength is less, re-position the antenna.
3. Click TRANSMIT NOW or use the magnetic Wavelet Activator on the device to initiate a transmission. There will be a few minutes of delay before the data transmission begins. Repeating either method will not expedite data transmission.
4. If the Wavelet does not transmit, try moving the antenna to a different position.
5. If the Wavelet still does not transmit after multiple attempts at re-positioning the antenna, consider changing the antenna location, including an in-road antenna.

### 1.6. Connecting to an External Power Source

In some circumstances, you might want to connect the Wavelet to an external power source rather than use the internal battery. Prerequisites:

- Use a Geotech -supplied power cable (speak with your sales representative)
- Use a cable with a round and even cross-section having the following specifications:
  - Cable wire cross-section surface area: 0.14-0.5 mm<sup>2</sup>
  - Wire gauge: AWG 26-20
  - Cable diameter Ø: 4-5.5 mm

Connect the external power supply cable to the 3-pin power outlet in the Wavelet.

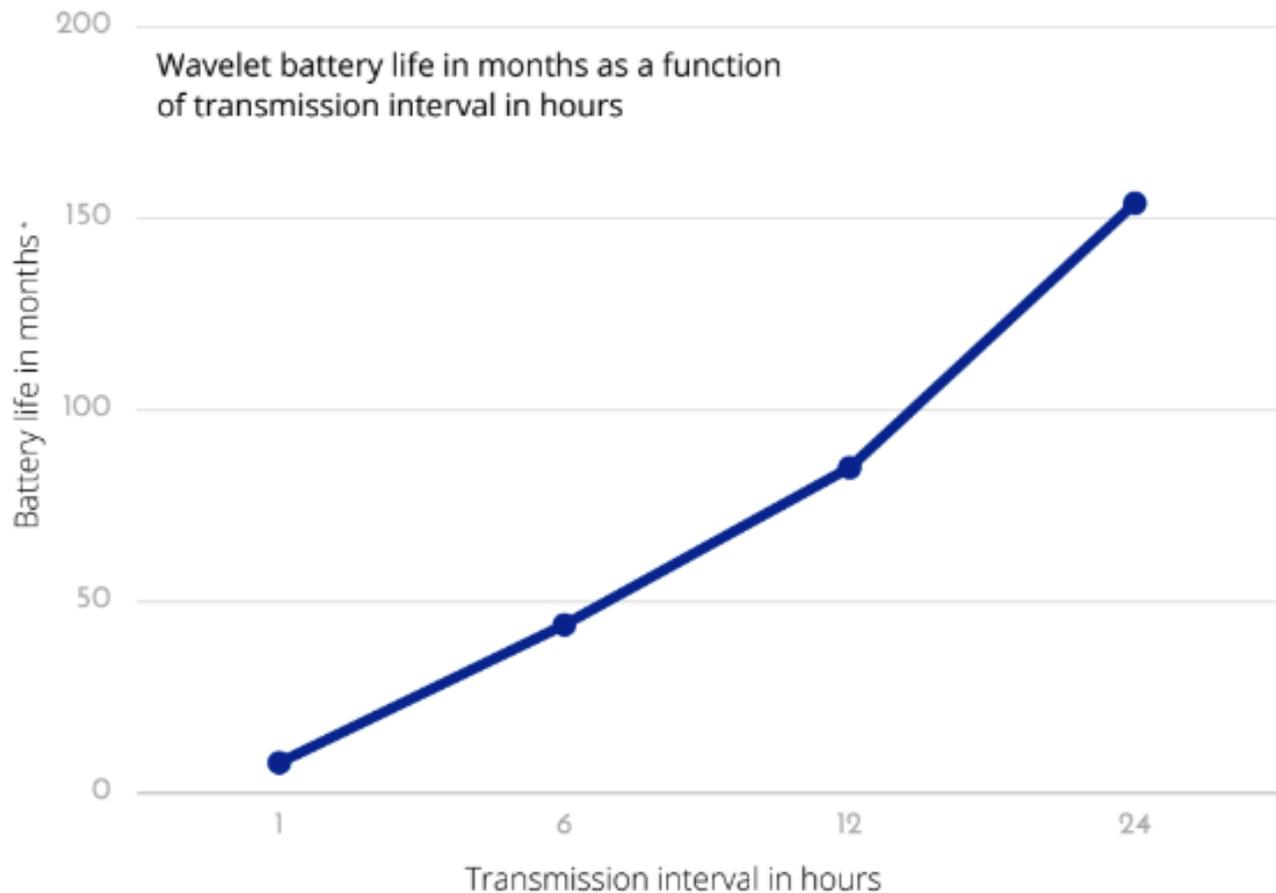


#### NOTE

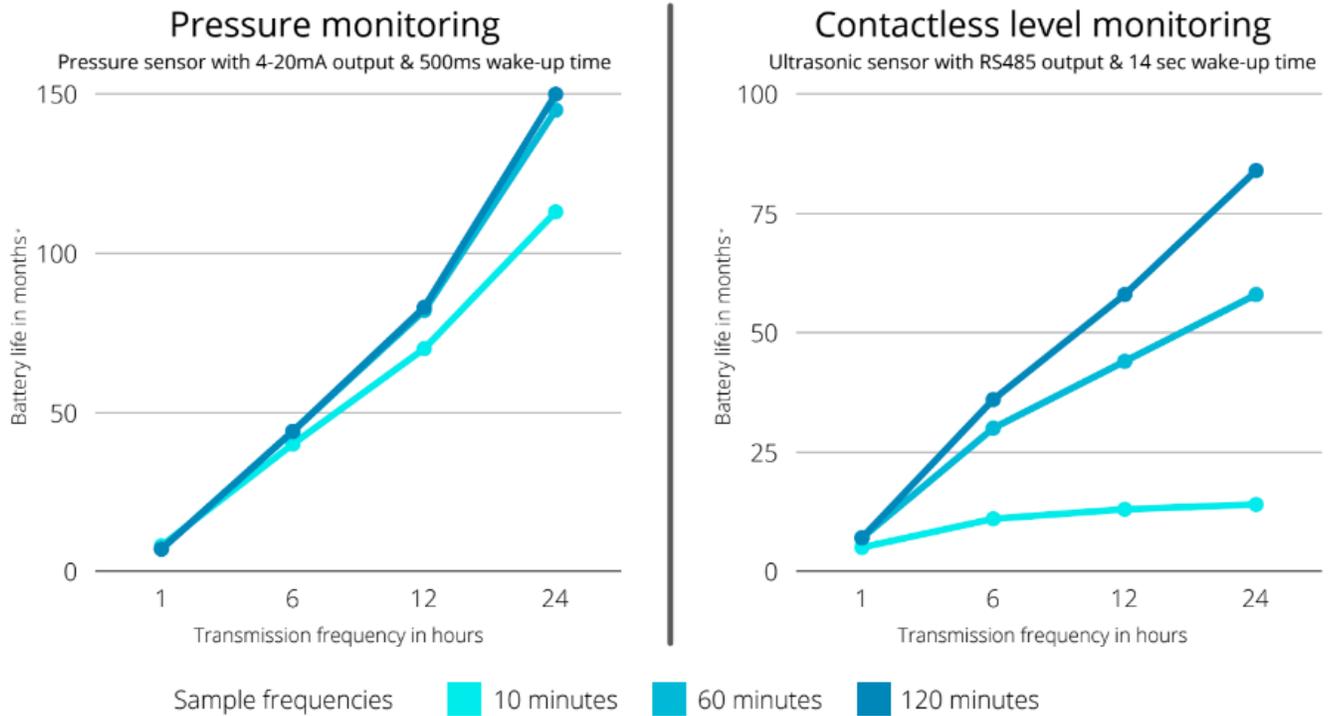
- Do not remove the internal battery because it is a backup power source if the external power supply is lost.
- The Wavelet can be configured with an SD card supporting up to 32 GB of data. Data is stored in the Wavelet device in non-volatile memory so that data is not lost in the event that the battery is spent and an external power source goes out.
- When the Wavelet is connected to the external power source, it no longer uses the internal battery. Nevertheless, sampling of the internal battery is still done, and the results are seen in the Samples tab of the Battery Lifestream.

## 2. Internal Battery

Since the usage profile of Wavelet devices is flexible; it is not practical to indicate a single battery life figure that will accurately represent a typical use case. A much more coherent way of benchmarking the battery life of a Wavelet is to use the number of cellular transmission sessions per battery. In cases where the Wavelet does not supply power to sensors, **the internal battery typically supports 3,500 cellular data sessions**, and more than 5,000 sessions can be reached under ideal conditions. In cases where the Wavelet's internal battery is used to supply power to one or more sensors, the power consumption of the sensors should be factored into the expected battery life.



To support different scenarios, a battery consumption calculator can be provided by contacting Geotech Support. The calculator can be used to simulate different setups with different sensors. Two common use cases are presented as examples below. For each use case, different sample frequencies are charted, and the battery life vs. transmission frequency is presented.



## 2.1. Optimizing Battery Life

Battery life may be significantly affected by multiple factors. Optimizing for as many factors as feasible will help to increase battery life. It is not uncommon that similar setups in different installation sites result in different battery lifetimes. A comprehensive understanding of the different factors elaborated below will help field crews optimize the battery's operational lifetime.



### Reception

Poor cellular signal will cause the Wavelet to use more power due to the increased time required to connect to a network and finish the transmission. Always ensure the external antenna is connected properly to the Wavelet and properly mounted. Evaluate different positions for the antenna that provide the best possible signal strength.



### Thresholds

Set a proper number and range of thresholds. If immediate and more frequent transmissions are configured for thresholds, excessive threshold crossing will cause numerous alert events and drain the battery faster.



### Usage Profile

Carefully set the sample and transmission intervals to achieve optimal battery life. Whenever possible, use thresholds and alerts instead of frequent transmissions for situational awareness.



### Operating Conditions

Extreme temperatures and high humidity affect battery capacity and shorten battery life. If possible, avoid or mitigate the devices' exposure to extreme conditions.



### Workmanship

If sourcing sensors or cable assemblies independently, ensure proper sensors wiring to ensure optimum battery life and prevent power leakage in the wires.



### Powered Sensors

If the device powers the sensor with its internal battery, always look for a low-power sensor with a short wake-up (stabilization) time.

### 3. External power supply

Geotech offers an external Power Bank that helps to extend the life of your Ayyeka Wavelet internal battery. Designed to work in ambient light, the kit includes Solar Power Bank, built-in NiMH battery packs, cables, a combination pole, and a wall mount Mount. It comes pre-wired with a field connector directly connecting to your Wavelet device.

Figure 3.1 External power supply with Solar panel (PV)



- Solar PV: 5W
- Battery: two 7.2V 2000mAh NiMH Batteries (28.8Wh)



**NOTE**

This solar calculator is very helpful for assessing your energy needs and solar potential.

[https://re.jrc.ec.europa.eu/pvg\\_tools/en/#SA](https://re.jrc.ec.europa.eu/pvg_tools/en/#SA)

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## 4. LoRa Enabled Wavelet

### 4.1. Overview - What is LoRa?

Long Range WAN (LoRaWAN) is a low power Wireless Area Network for long-range bidirectional IoT (Internet of Things) connectivity. LoRa is an open-source, low-bitrate, wireless telecommunications system that utilizes unlicensed bands, transmitting a few bytes of data every few minutes over the LoRaWAN using low power. End-devices use LoRa to communicate with LoRa gateway(s), which are connected to the Internet and which act as transparent bridges to relay messages between these end-devices and a central network server.

Ayyeka supports LoRa-enhanced Wavelet devices. These devices include a hardware extension that provides LoRa connectivity in addition to existing cellular connectivity. Note that LoRa connectivity does not replace regular cellular connectivity: in a LoRa-enhanced Wavelet, all information is transmitted and received over the cellular network as in a regular Wavelet, in addition to LoRa transmissions.

Ayyeka supports LoRa-only Wavelet devices. These devices do not have cellular connectivity. As a result, Support cannot send commands or see any logs if troubleshooting is needed. AyyekaGo mobile app can configure only sampling interval and transmission interval.

**Note: Wavelet devices cannot act as a LoRa gateway.**

### 4.2. Sampling Information

How does LoRa know which sample to send? For example, if you have four channels that sample once every half-hour, which channel's sample does it send every fifteen minutes?

A special queue in the device is designated for LoRa data samples. The queue size is 1.

When a channel (not a group) samples, it tries to enter a sample to the queue, but, if there is already one sample of that channel in the queue, it will overwrite it in the same place in the queue. It will remove the older sample and put the newer sample in its place, but the sample will remain in the same place in the queue. Consequently, only one sample of every channel is in the queue at every single point in time, and it's the newest sample of that channel.

The queue cannot contain more than one sample (from analog, serial, and digital streams) from every channel at any point in time, and the one sample of each channel is the newest sample of that channel.

If there are no samples of that channel in the queue, it will enqueue the sample in FIFO order, but only if there is a free cell in the queue.

If there is no place in the queue, then:

- In a LoRa-only device, the samples are discarded.
- In a LoRa-enhanced device, all samples are stored on the SD card and transmitted by cellular at the next transmission. For example, if we have two channels, one sample of each can be in the queue. If we have 16 channels, only a subset of them can be in the queue.

The channels will transmit in something like a round robin order, as long as the number of channels is equal or less than the queue size.

If transmission is by LoRa every five minutes, will the device stop transmitting after a while because all permitted LoRa transmissions are used up?

- In EU - yes, it will stop transmitting after a while and for some time, until the next day, more or less.
- In US - no, because the limitations there are much less strict.

Note that it will stop transmitting LoRa samples, but data sampling continues.

#### 4.2.1. Health Counter Information

What health counter data is sent by LoRa?

No health counter data except Internal Battery Life% and External Power Voltage (if external power is used) is sent. Internal Battery Life% is sent every 12 hours.

#### 4.2.2. Samples After a Device Reboot

What happens to the sample data when the device is rebooted?

In a LoRa-only device, all LoRa samples are in RAM only. So, if the Wavelet is rebooted for any reason, they are deleted.

In a LoRa-enhanced Wavelet, samples are also stored on the SD card and will be transmitted via cellular as well.

Comparison of LoRa-only and LoRa-enhanced Devices

	LoRa-only Device	LoRa-enhanced Device
What communication is used?	LoRa only	LoRa + cellular network
What is the queue size?	1	1
Which samples are transmitted?	Serial, Analog, Digital From Health counters – only: <ul style="list-style-type: none"> <li>● Internal Battery Life%</li> <li>● External Power Voltage (if external power is used)</li> </ul>	Serial, Analog, Digital All Health counter data
Where are samples stored?	RAM only	RAM and SD card
If there is no free space in a queue, what happens?	Samples are discarded	Samples transmitted at the next cellular transmission
If the Wavelet is rebooted, what happens?	All samples in RAM are discarded	Samples stored in SD are sent with the next transmission

### 4.2.3. LoRa Transmission and Threshold Alerts

If you set an alert (threshold), will it be sent by GSM or by LoRa?

From the LoRa perspective, alerts are normal samples and there is nothing special about the threshold. The order of LoRa-transmitted samples is described in Sampling Information.

If you have a LoRa-enhanced device (GSM cellular network is enabled) and the threshold is reached to initiate a transmission, then the event sample will be transmitted over cellular network immediately.

If you have a LoRa-only (no GSM) device and a threshold is reached to initiate a transmission, nothing happens.

## 4.3. Parameters - What They Mean and Their Range of Values

The following list of parameters includes a brief explanation of each parameter the range of acceptable values.

Technical Streams

### 4.3.1. Health Tab

**BOOT COUNT:** The number of times that the device booted up since it was activated.

- If the number jumps, most likely the battery is dead
- If the number resets to 0, it could be due to a firmware upgrade or to a lost configuration

**BOOT REASON CODE and BOOT REASON:** The code number and the reason for the latest device reboot.

- Code: 12 | Brownout Detector Regulated Domain Reset Exter Pin Reset - dead battery
- Code: 1 | Power On Reset - the device was turned off either manually or by a command
- Code: 64 | System Reset - the device was rebooted either by a command or automatically (according to the value of the device's Watchdog > reset\_period parameter)

**GENERAL ERR: Not used**

**GSM POWERON:** The number of times that the GSM modem was turned on.

**GSM TX SUCCESS:** The number of times that transmission succeeded (relevant only to HTTP transmission)

**GSM ERR:** The number of times that transmission failed (for example, low battery, low signal).

- Bad signals (poor antenna placement or other antenna problem)
- Unable to communicate with the server

**GSM NO CREG:** The number of times that the device was unable to register on the cellular network.

**GSM MODEM DEAD:** Increased when modem fails to start.

- 0 = normal modem
- 1 = modem is dead

**GSM PDP FAIL:** The number of times that a ping test from the device to the server failed.

**GSM NO OPERATORS:** The number of times that the modem did not find any available cellular network provider.

**LOG REC DISCARDED:** The number of files that were discarded when storage was almost full.

**GPS FAIL FIX:** The number of times that the device was unable to get it's GPS position.

**TOUCH\_EVENT:** Not used. Disregard.

**MODBUS READ ERROR:** The number of errors on the serial modbus sensor.

If the number is in the hundreds or thousands:

- The sensor is not connected to the device
- The sensor is not configured properly (see [Overview of Modbus](#) in Serial Channel Advanced Configuration)

**TIMEKEEPER ACTSRC FAIL:** The number of times that the device failed to get the atomic time from the server during the HTTP transaction.

**SDCARD ERROR:** The number of times that SPI transactions with the SD card failed.

**LORA TX SUCCESS:** The number of times that LoRa transmission succeeded.

**LORA TX FAIL:** The number of times that LoRa transmission failed.

**LORA RECEIVED CMDS:** The device received data from LoRa. This information is useful in debugging to see if the device got the data we sent.

**LORA CONFIRMS FAIL:** LoRa sent the error code RN2483\_MAC\_ERR to indicate a communication problem.

**LORA POWER ON FAIL:** The LoRa module could not be powered up.

**LORA INIT FAIL:** The LoRa module powered up but failed during the setup process.

**TRACE CMDS:** The number of commands that the device receives when doing a device trace.

**SERVER CMDS:** The number of times that the device got a command from the server since the device was booted up. The commands are listed in the Commands tab for the device.

**BLE ERROR:** The number of times that the device had problems communicating with the mobile app. For example, the device was unable to send a message to the mobile app, or the device received a message from the mobile app that was not valid

**BLE CONNECTIONS:** The number of times when the mobile app was connected to the device.

**MQTT CONNECTION:** The number of times that the device connected successfully to the MQTT broker.

**MQTT PUBLISH:** The number of records that have been published to the MQTT broker since the last boot.

**MQTT PUBLISH ERROR:** The number of publication errors to the MQTT broker.

**MQTT CONNECTION ERROR:** The number of connection errors with the MQTT broker.

**DATA LOGGER ERROR:** Increased when saving samples to SD fails and instead, data is saved to FFS. The number of times that data samples could not be moved from RAM and saved to persistent memory (SD card or internal flash). Instead, the data samples were saved to FFS.

**DATA LOG CREATED:** The number of times that data samples were successfully saved to persistent memory (SD card or internal flash).

**POWERSUPPLY SWITCH:** The number of times that the power supply source was switched from external power to battery, or vice versa.

**LKGC LINK OPEN:** The number of times since reboot that the device reverted to the last known good configuration to establish communication.

## 4.4. LoRa Uplinks and Downlinks

A transmission from a LoRa-enhanced device to the server is called an Uplink, and transmission back from the sever to the LoRa-enhanced device is called a Downlink.

LoRa Uplink rate

Because LoRa utilizes unlicensed bands, its Uplink transmission rate is limited by local regulations. For example:

- In Europe – The minimum LoRa transmission interval is about 12.5 minutes (roughly five LoRa transmissions per hour)
- In the US – If you perform frequency hopping, there is no restriction. Since the LoRa-enhanced Wavelet enforces the frequency hopping limitation, you can set any LoRa transmission interval you wish for the Wavelet in the US.

### 4.4.1. LoRa Downlink rate

Local regulations also restrict the maximum number of LoRa downlinks. To comply with local regulations in almost all locales, Ayyeka limits LoRa downlinks to 10 downlinks per day per device.

Advantages and Limitations of LoRa-enhanced Wavelet

## LoRa technology advantages

LoRa technology offers the following advantages:

- Receipt of regular heartbeat messages from the Wavelet

Every LoRa transmission is a signal indicating the Wavelet is alive. This means you receive regular, frequent heartbeat messages from a LoRa-enhanced Wavelet.

- Receipt of near-real-time sample information

In each LoRa uplink, up to two recent samples (=sensor readings) can be sent with the LoRa signal.

- Ability to initiate near-real-time Wavelet configuration

Every LoRa uplink queries the Server for a downlink (response) from the server. The server utilizes this for Wavelet configuration, as follows: Every time a command (such as a threshold definition) is queued in the server for downloading to the Wavelet, the server also automatically creates a LoRa – Transmit Now command that will automatically be sent in response to the next Uplink received from the Wavelet. When the Wavelet receives a LoRa - Transmit Now response, the Wavelet initiates an unscheduled cellular connection, and a standard communication session is established with the server. In the session:

- The Wavelet sends all the information it had stored since the last transmission session (such as sample readings, events, health info, etc.)
- The server sends the Wavelet all the queued commands intended for the Wavelet, such as configuration settings, firmware upgrades, etc.

### 4.4.2. LoRa technology limitations

LoRa technology has the following limitations:

- The LoRa transmission interval should comply with local regulations. In Europe, for example, this limits the interval to no shorter than 12.5 minutes (=about five LoRa transmissions per hour).
- Ayyeka limits the number of LoRa downlinks to 10 per day per device.

- By the nature of LoRa technology, not every LoRa connection attempt succeeds.
- In each LoRa uplink, up to two samples (=sensor readings) can be sent with the LoRa signal. The LoRa transmission includes the two most recent samples that had not already been sent by LoRa, from two different streams. If the Wavelet is sampling only one stream, only one sample is sent. This means that if the sampling interval is longer than the LoRa transmission interval, there may not be any recent samples to send with some uplinks.

## 4.5. Viewing LoRa Activity and Information in the Management UI

Various LoRa information and activity can be viewed in the Management UI.

### 4.5.1. Viewing LoRa Information in Device View

To view device-related LoRa information, click Devices in the sidebar.

The screenshot displays the Management UI for a specific device. The top section shows the device's S/N (2118012241) and P/N (WA1111-EU-LR). Below this, there is a device image and a table of key information:

Site Name	Model Number	AK-ID
My_Site	WA1111-EU-LR	
Last Transmission	Hardware Revision	MEID
23-04-2019, 03:41:25	W4R2M_HG3LL1_SAND	
Firmware Version	ICCID	
2.220		

Additional information is shown in a red-bordered box on the right: LoRa DEVEUI (0004A30B00214FF1) and LoRa Service (A2A).

The left sidebar shows a list of device metrics, with several highlighted in red boxes:

- LoRa**: 23-04-2019, 03:41:25
- Battery Status**: 88 % | 26-03-2019, 01:11:25
- Demodulation Margin**
- Getways number**
- Received Signal Strength Indication**: -111.0 db | 23-04-2019, 03:41:23
- Signal Noise Ratio**
- Uplink Signal Noise Ratio**: 1.5 db | 23-04-2019, 03:41:23

The main content area is divided into two sections:

**TRANSMISSION INTERVAL**

Mode	Transmit Every
Normal	4h
Event	30min
Emergency	10min

**STREAM MANAGEMENT**

Sensor	Channel Type	Channel Number	Stream	Sample Group	Sample Interval
Undefined	ANALOG S32	0	Pressure	1	5 min.
Undefined	ANALOG S32	1			5 min.
Undefined	LORA SIGNAL	0	Signal Noise Ratio		N/A
Undefined	LORA SIGNAL	1	Getways number		N/A
Undefined	LORA SIGNAL	2	Demodulation Margin		N/A

You can view the following LoRa information:

## 4.5.2. Last transmission time

In the sites tree pane, below the device Serial Number, the TX field indicates when the last transmission occurred – regardless of whether it was a LoRa or a cellular transmission.

## 4.5.3. Stream information

In the sites tree pane, the following LoRa streams information is displayed. Some of the information originates from the device, and some from the LoRa network.

- The LoRa information originating from the device includes the following. Note that this information (except for Battery Status) is updated for every uplink:
  - Battery Status – Battery level notification. This is received in a LoRa uplink twice a day.
  - Demodulation Margin – Indicates how many dBm you can lose without losing your LoRa connection
  - Gateways number – Displays how many LoRa gateways (antennas) are receiving LoRa transmissions from this device
  - Signal Noise Ratio – An indication of LoRa signal quality compared to the background noise
- The LoRa information originating from the LoRa network includes the following. Note that this information is updated for every uplink:
  - Received Signal Strength Indication – The LoRa signal quality of the device, as measured by the LoRa network
  - Uplink Signal Noise Ratio – An indication of LoRa signal quality compared to the background noise, as measured by the LoRa network

## 4.5.4. Device information

In the top right pane, the following LoRa information is displayed:

- An icon indicating the device is a LoRa-enhanced device
- DEVEUI – The unique ID of the LoRa hardware extension
- LORA SERVICE – The name of the LoRa service provider.



## 4.5.5. Viewing LoRa Uplinks in Device Reports

To view information about LoRa uplink communication sessions:

1. Click Devices in the sidebar, and then click the device name.
2. In the right pane, click the Device Reports tab.

The icon in the left-most Comm Type column indicates whether the session was a cellular session  or a LoRa session .



Comm Type	Creation Date	Start Date	End Date	Hardware Version	Firmware V
LoRa	01-01-2019, 12:00:06	01-01-2019, 12:00:06	01-01-2019, 12:00:06		
LoRa	01-01-2019, 11:45:07	01-01-2019, 11:45:07	01-01-2019, 11:45:07		
LoRa	01-01-2019, 11:30:06	01-01-2019, 11:30:06	01-01-2019, 11:30:06		
LoRa	01-01-2019, 11:15:05	01-01-2019, 11:15:05	01-01-2019, 11:15:05		
LoRa	01-01-2019, 11:00:05	01-01-2019, 11:00:05	01-01-2019, 11:00:05		
LoRa	01-01-2019, 10:45:05	01-01-2019, 10:45:05	01-01-2019, 10:45:05		
	01-01-2019, 10:33:01	01-01-2019, 10:32:58	01-01-2019, 10:33:01	W4R2M_HG3LL1_SAN	2.22
	01-01-2019, 10:32:22	01-01-2019, 10:31:41	01-01-2019, 10:32:25	W4R2M_HG3LL1_SAN	2.22
LoRa	01-01-2019, 10:30:04	01-01-2019, 10:30:04	01-01-2019, 10:30:04		

## Viewing LoRa Command Status in Device Commands

In a LoRa-enhanced Wavelet, whenever a command (such as a firmware upgrade) is queued in the server for downloading to the Wavelet, the server also automatically creates a LoRa Transmit Now downlink LoRa command. This command is sent in response to the next Uplink received by the server from the Wavelet over LoRaWAN.

To view LoRa commands and their status:

1. Click Devices in the sidebar.
2. In the Sites Tree pane, click the device name.
3. In the right pane, click the Commands tab.

Comm Type	Creation Date	Command	Status	Prepare Date
 LoRa	19-11-2018, 20:23:13	LoRa - Transmit Now	<span style="background-color: green; color: white; padding: 2px;">100%</span>	19-11-2018, 20:23:13
	19-11-2018, 20:22:53	Reboot	<span style="background-color: green; color: white; padding: 2px;">100%</span>	19-11-2018, 20:23:10
 LoRa	18-11-2018, 21:04:14	LoRa - Transmit Now	<span style="background-color: green; color: white; padding: 2px;">100%</span>	18-11-2018, 21:04:14
	18-11-2018, 21:03:53	Reboot	<span style="background-color: gray; color: white; padding: 2px;">0%</span>	18-11-2018, 21:04:10

- The icon in the left-most Comm Type column indicates whether the command is a cellular command  or a LoRa command .
- The icon in the Status column indicates the status of the command.

By the nature of LoRa technology, not every LoRa connection attempt succeeds; uplink may have failed, or uplink may have succeeded but downlink failed. Therefore, the server's downlink LoRa – Transmit Now command is defined to be persistent. This means that if no cellular session is established in this LoRa interval, the command is re-sent at the next LoRa interval. After 3 failed send attempts – where failure means that no cellular connection was established in the LoRa interval – the command is marked as failed.

The Status of a LoRa command is a green 100%  when both of the following actions are done:

- The LoRa – Transmit Now command was sent to the Wavelet (a down link occurred)
- A cellular session was established between the Wavelet and the server.

#### 4.5.7. Viewing LoRa-transmitted Stream Samples

For each specific sensor, you can view the sensor samples sent in a LoRa transmission.

To view samples sent in a LoRa transmission:

1. Click Devices in the sidebar, and click the stream name in the Sites Tree pane.
2. In the right pane, select the Samples tab.

The icon in the left-most Comm Type column indicates whether the sample was sent via a cellular session  or

a LoRa session .

Expand All

2118012241 WA1111-EU-LR

S/N: 2118012241 WA1111-EU-LR  
 TX: 17 min ago

Battery Status  
 79 % | 3 hours ago

SYSTEM Communication Status  
 NORMAL | 52 min ago

Demodulation Margin  
 N/A

GPS  
 2.0 hdop | 5 hours ago

GSM  
 -103.0 db | 7 hours ago

Getways number  
 N/A

Humidity  
 103.0 % | 4 hours ago

Pressure  
 4.261 bar | 20 min ago

Received Signal Strength Indication  
 -109.0 db | 17 min ago

Pressure

Samples  
 Thresholds  
 Configuration

Samples
 



 Show Samples  
 Hide Samples

Comm Type	Sample Date	Raw Value	Final Value	Status
LoRa	01-01-2019, 11:57:05	10605	4.128	Visible
LoRa	01-01-2019, 11:42:05	10783	4.239	Visible
LoRa	01-01-2019, 11:27:05	10777	4.236	Visible
LoRa	01-01-2019, 11:12:05	10796	4.248	Visible
LoRa	01-01-2019, 10:57:05	10785	4.241	Visible
LoRa	01-01-2019, 10:42:05	10850	4.281	Visible
	01-01-2019, 10:27:05	10644	4.153	Visible
LoRa	01-01-2019, 10:27:05	10644	4.153	Visible
	01-01-2019, 10:22:05	10777	4.236	Visible
	01-01-2019, 10:17:05	10790	4.244	Visible
LoRa	01-01-2019, 10:12:05	10783	4.239	Visible
	01-01-2019, 10:12:05	10783	4.239	Visible
	01-01-2019, 10:07:05	10860	4.288	Visible

## 4.6. Setting LoRa Advanced Configuration Settings

Some advanced configuration tasks can only be done using the Device Advanced Configuration hierarchical tree, available through the UI. One of those tasks is the advanced configuration of LoRa settings in a LoRa-enabled device.

To set advanced LoRa configuration:

1. In the UI, click Devices in the left pane.
2. In the Sites Tree pane, select the device.
3. In the right pane, select the Configuration tab.
4. Scroll down past the Stream Management table, and click Advanced Device Configuration.
5. In the configuration tree that appears, expand the LPWAN node.
6. Define the LoRa settings in the parameter nodes nested under the LPWAN node. The available LoRa settings are described in Description of LoRa Advanced Configuration Settings below. To change the setting of a parameter, such as the Calibration Home Interval Seconds parameter:
  - a. Click the Calibration Home Interval Seconds node.
  - b. Click the current value, appearing in orange on the right.
  - c. Click Set Setting, and in the dialog box that appears, enter the desired LoRa interval in seconds.

### Description of LoRa Advanced Configuration Settings

This section describes the available LoRa advanced configuration settings.

Note: Except for the following three parameters, do not change any LoRa advanced parameter settings without consulting with support@ayyeka.com. Nonetheless, we also recommend that even when changing the following three parameters, you consult Support first:

- Active
- Home Interval Seconds
- Calibration Home Interval Seconds.

#### Active

Description:	Defines the LoRa enabled/disabled state of the device.
Options:	<ul style="list-style-type: none"> <li>• 0 – LoRa is disabled for the device</li> <li>• 1 – LoRa is enabled for the device. This is the default setting for LoRa-enhanced devices.</li> </ul>

#### Home Interval Seconds

Description:	Defines the LoRa transmission interval, in seconds, which is the time between LoRa transmissions. This value should comply with local regulations. For example, in Europe the minimum transmission interval is about 12.5 minutes. The default value is 900 seconds, which is 15 minutes.
Note:	In the US, if you perform frequency-hopping, you can transmit using LoRa as frequently as possible. Since the LoRa-enhanced Wavelet enforce the frequency-hopping limitation, you can set any LoRa transmission interval you wish for the Wavelet in the US.

### Calibration Home Interval Seconds

Description:	<p>Defines the LoRa transmission interval, in seconds, for times when the Wavelet is in calibration mode.</p> <p>Although the LoRa transmission interval should comply with local regulations, it can be set to a higher rate for a limited amount of time. A high LoRa transmission rate is necessary when the Wavelet is in Calibration mode. As soon as the Wavelet exits Calibration mode, the LoRa transmission frequency automatically reverts back to its Home Interval Seconds rate.</p> <p>The default value is 120 seconds, which is 2 minutes. Do not set the value to less than 2 minutes.</p>
--------------	--

### Link Protocol

Description:	<p>Defines the protocol to use for the payload, that is, how to encode the samples sent with the uplink.</p>
Options:	<ul style="list-style-type: none"> <li>● LP_NONE – Do not send any samples. This is the default setting.</li> <li>● LP_PROTOBUF – Use the Ayyeka proprietary <b>protobuf</b> payload protocol for sample encoding</li> <li>● LP_SIGFOX – deprecated</li> </ul>

### Require acknowledgement

Description:	<p>Defines whether every uplink requires an ack from the server.</p> <p>Although the ack response can also include a LoRa – Transmit Now instruction, requiring an ack severely limits the option of sending a LoRa – Transmit Now instruction. The reason is that the maximum number of downlinks that can be sent per day is 10. If you require acks, then the first 10 uplinks on a given day will trigger a downlink with an ack, after which you will not be able to send any more downlinks until the next day.</p> <p>For this reason, requiring acks should only be set when running diagnostics.</p>
Options:	<ul style="list-style-type: none"> <li>● 0 – Acknowledgement of every uplink is not required</li> <li>● 1 – Acknowledgement of every uplink is required</li> </ul>

### Retry TX count

Description:	Defines the number of time to re-send an uplink if an ack, although required, was not received. This is relevant only if Require acknowledgement is set to 1 (=ack required). When Retry Tx count is set to a whole number larger than 0, an uplink is re-sent every 30 seconds, until either an ack is received, or the defined number of retry times has been reached.
Options:	<ul style="list-style-type: none"> <li>● 0 – Do not re-send an unacknowledged uplink. This is the default setting.</li> <li>● A whole number greater than 0 – The maximum number of uplink resending attempts</li> </ul>

### Done one-time setup

Description:	Provides an indication of whether initial LoRa setup was performed.
Options:	<ul style="list-style-type: none"> <li>● 0 – LoRa initial setup has not been performed. It will automatically be performed by the system</li> <li>● 1 – LoRa initial setup has been performed</li> </ul>

### Enable Events

Description:	This parameter has been deprecated.
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### App\_key

Description:	Displays the encryption key for this specific DEVEUI (=LoRa hardware component ID) and App_EUI (=LoRa app ID). The App_key encrypts both the uplink and the downlink transmissions.
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### App\_EUI

Description:	Displays the application ID of this LoRa application, as registered by the current LoRa provider.
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### Link port

Description:	Defines the Wavelet port for all LoRa communications.
Options:	<ul style="list-style-type: none"> <li>● 1 – Wavelet port 1. This is the default setting.</li> <li>● 2 – Wavelet port 2</li> <li>● 3 – Wavelet port 3</li> <li>● 4 – Wavelet port 4</li> </ul>

### Link check interval

Description:	<p>Defines the time, in seconds, between consecutive checks of the LoRa link. The link check results are displayed in the management UI as the Demodulation Margin and Gateways number values.</p> <p>In actuality, a link check can be performed only when an uplink occurs. Therefore, if the link check interval is shorter than the LoRa transmission interval, a single link check will be performed upon every uplink.</p> <p>Note that specifying short link check intervals, with the result that every uplink will contain updated link check values, in no way affects the uplink payload. The reason is that certain bytes in the uplink are reserved for this information, whether the information is up-to-date or not.</p>
Options:	<ul style="list-style-type: none"> <li>● 0 – Do not check the LoRa link. This means that no Demodulation Margin and Gateways Number information will be displayed in the management UI.</li> <li>● A whole number greater than 0 – The LoRa link check interval. The default value is 1.</li> </ul>

### Power off

Description:	Defines the LoRa module state between LoRa transmissions.
Options:	<ul style="list-style-type: none"> <li>● 0 – Put the LoRa module in sleep mode between uplink transmissions. This is the default setting.</li> <li>● 1 – Power off the LoRa module between uplink transmissions</li> </ul>

### PLOCK enable

Description:	Defines whether the Wavelet's LoRa module should work in PLOCK mode as defined below.
Options:	<ul style="list-style-type: none"> <li>● 0 – Do not work in PLOCK mode. This is the default setting.</li> <li>● 1 – Work in PLOCK mode, while applying the PLOCK Timeout Seconds</li> </ul>
PLOCK mode	PLOCK is a mechanism for locking LoRa transmission when the Wavelet is sampling or transmitting over the cellular network.

### PLOCK Timeout Seconds

Description:	Defines the maximum time, in seconds, for a scheduled LoRa transmission to wait for the Wavelet to finish sampling/transmitting, before commencing with the LoRa transmission anyway. This parameter is only relevant if PLOCK enable is set to 1 (=LoRa works in PLOCK mode).
Options:	Specify a number. The default value is 120 seconds

### LPWAN log level

Description:	Defines the logging level for logging LoRa activities and events
Options:	<ul style="list-style-type: none"><li>● LOG_LEVEL_NONE - Do not log LoRa events</li><li>● LOG_LEVEL_LOG - Log only basic LoRa information in the log appearing in Device &gt; Log. This is the default setting.</li><li>● LOG_LEVEL_TRACE - Log all LoRa traces in the log appearing in Device &gt; Log. The level of detail is set in Trace module communication.</li></ul>

### Trace module communication

Description:	Defines the level of detail in the LoRa trace log. The selected level of detail will appear in the log displayed in Device > Log, if LPWAN log level is set to LOG_LEVEL_TRACE.
Options:	<ul style="list-style-type: none"><li>● 0 - Show only debug trace information in the trace log. This is the default setting.</li><li>● 1 - Show highly detailed information in the trace log</li></ul>

## 5. Set up Sensors

### 5.1. Connecting a 4-20mA Sensor to a Wavelet

You can connect a 4-20 mA sensor to the analog port of your device. You can define the formula used to convert the raw sampling data into engineering units if the formula being used is linear.

#### Preliminary Step: Determining the version of your device:

Step 1: Learning the analog port pinout

- Analog Connector Pinouts
- Analog Cable Splitter Pinouts

Step 2: Connecting the sensor

- Receives Power from the Wavelet
- Receives Power from an External Source

Step 3: Configuring sensor settings

Step 4: Verifying sensor installation

Step 5: Setting the engineering values

Terminology note: In this article, we use the following terms for the signals:

- Positive, which can be denoted by, among others: +, 4-20mA Input, Power Supply, Signal, Supply+
- Negative, which can be denoted by, among others: Supply-, Signal-, Common Ground, and may elsewhere be termed, among others, GND and COM.

Preliminary Step: Determining your Wavelet type

Some of the connection instructions may differ, depending on the type of the device - Wavelet 3™, Wavelet 4™, Wavelet Ex™, or a Wavelet V2™ . Therefore, the first step is to ascertain the type.

#### To find your Wavelet version:

1. In the left pane, click Devices.
2. In the Sites Tree pane, select the relevant site and the relevant device.
3. In the right pane, the HW field indicates the Wavelet type. The following screen captures show a Wavelet 3 and a Wavelet 4.



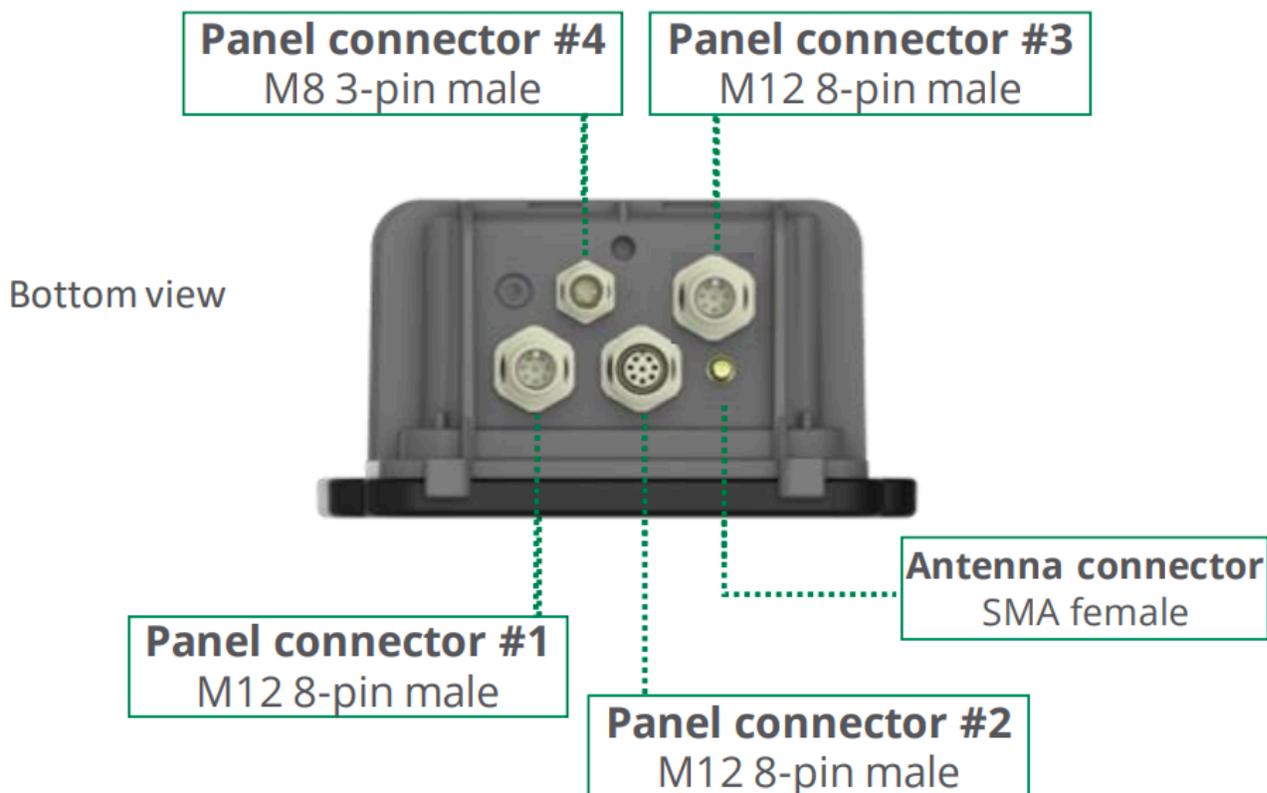
### 5.1.1. Step 1: Learning the analog port pinout

You can connect the sensor directly to the Wavelet 4 analog port, or connect to it via an Ayyeka analog cable splitter. The analog port is identical in both cases: an 8-pin male connector (the mating field attachable connector is an 8-pin female).

#### 5.1.1.1. Analog Connector Pinouts

The analog port is an 8-pin male connector (the mating field attachable connector is an 8-pin female).

Figure 4.1 View of connectors on the V2



#### 5.1.1.2. Analog Cable Splitter Pinouts

Each analog port on the analog cable splitter is an 8-pin male connector (the mating field attachable connector is an 8-pin female). However, the 2-port and 4-port analog cable splitters do not have a pin-to-pin connection to the panel connector on the Wavelet. Please note the pinout below for the cable splitters.

The signal is always wired to connector pin #1, while the signal corresponds to the sensor port number (P1, P2, P3, P4) shown on the cable splitter. For example, when using a 2-port analog cable splitter with two sensors, both sensors are wired for the 4-20mA signal to connector pin #1. Connector pin #1 on sensor port P1 corresponds to 4-20mA Input #1, while connector pin #1 on sensor port P2 corresponds to 4-20mA Input #2.

For details, see the 2-Port Analog Cable Splitter pinout sheet and the 4-Port Analog Cable Splitter pinout sheet.

### 5.1.1.3. Step 2: Connecting the sensor

A sensor can be connected to the Wavelet in one of two ways, depending on how the sensor receives power:

- The sensor receives power from the Wavelet
- The sensor receives power from an external source

### 5.1.1.4. Sensor Receives Power from the Wavelet

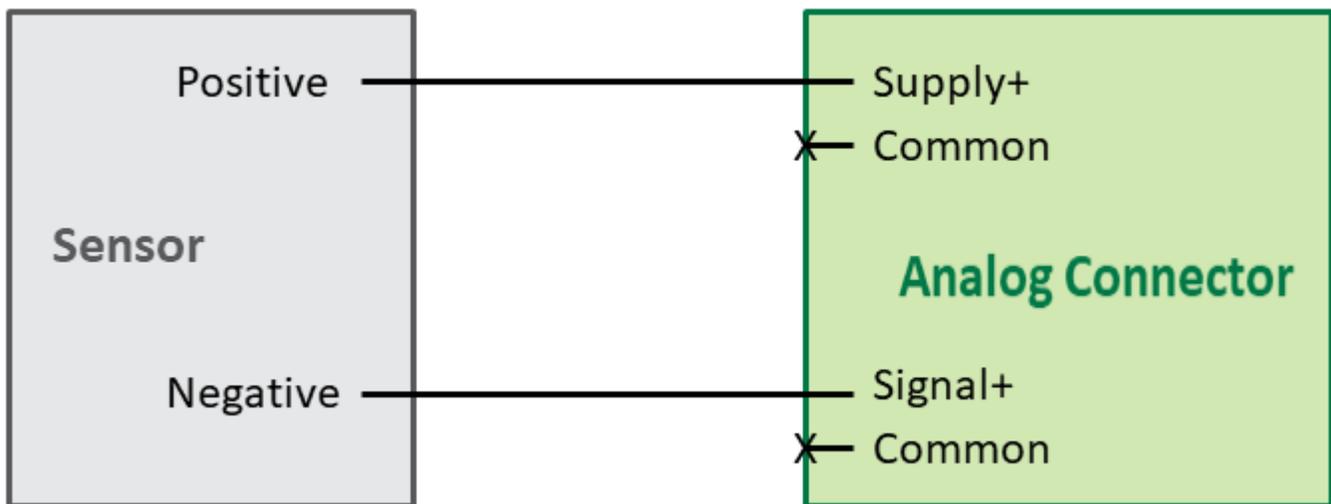
In this configuration; you need to:

- Connect the sensor's Positive pin to the Wavelet analog connector's Supply+ pin.
- Connect the sensor's Negative pin to the Wavelet analog connector's Signal+ pin.



Note that the Wavelet sensor power supply is 350mA, 12V.

**NOTE**



### 5.1.1.5. Sensor Receives Power from an External Source

In this configuration, you need to:

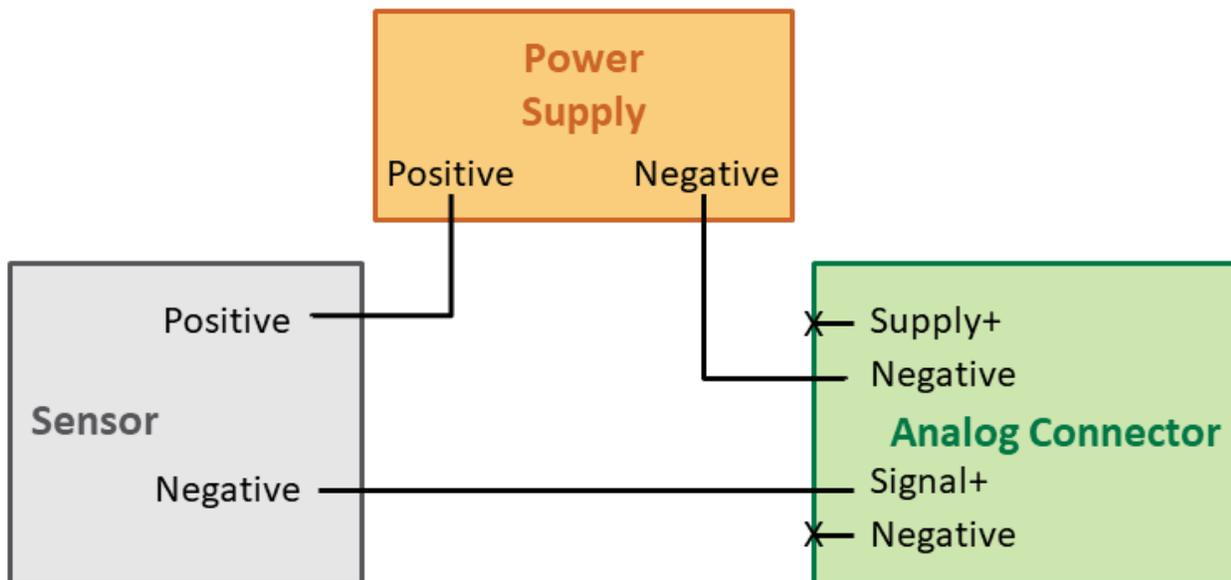
- Connect the power supply's Positive pin to the sensor's Positive pin.
- Connect the power supply's Negative pin to the Wavelet analog connector's Negative (-) pin.
- Connect the sensor's Negative pin to the Wavelet analog connector's Signal+ pin



Note that the Wavelet analog connector's Supply+ pin is not used in this configuration.

**NOTE**

Figure 4.2 Powering your sensor



### 5.1.2. Step 3: Configuring sensor settings

After properly wiring the sensor to the Wavelet, configure the sensor's settings in the management UI. Do the following steps:

1. In the left pane, click Devices.
2. In the Sites Tree pane, click the relevant device.
3. In the right pane, click the Configuration tab.
4. In the Configuration tab, scroll down and click Device Advanced Configuration.
5. In the configuration tree, click Analog > Channel > 0.
6. Click the node called active.
7. Right-click the existing value, and then click Set Setting.
8. In the New Value field, type in 1, and then click Submit.
9. In the configuration tree, click Analog > Channel > 0, and then do the following actions:
  - a. Click the node called channel\_type.
  - b. Right-click the existing value, and then click Set Setting.
  - c. In the New Value field, do the following actions, and then click Submit:
    - i. Select CT\_CURRENT\_1 if you connected the signal to pin 1 of the Wavelet analog port.
    - ii. Select CT\_CURRENT\_2 if you connected the signal to pin 7 of the Wavelet analog port.
    - iii. Select CT\_CURRENT\_3 if you connected the signal to pin 6 of the Wavelet analog port.
    - iv. Select CT\_CURRENT\_4 if you connected the signal to pin 5 of the Wavelet analog port.

Figure 4.3 Analog Connector Pinouts.



Note: The analog sensor port may be positioned elsewhere in a custom configuration.

In the configuration tree, click Analog > Channel > 0, and then do the following actions:

1. Click the node called sample\_power\_source.
2. Right-click the existing value, then click Set Setting.
3. In the New Value field, select the power source, and then click Submit:
  - a. Select PS\_INT if the sensor receives power directly from an external source.
  - b. Select PS\_EXT1\_BOOST if the sensor receives power from the Wavelet, and you connected to the Wavelet power supply through pin 4 of the Wavelet analog port.
  - c. Select PS\_EXT2\_BOOST if the sensor receives power from the Wavelet, and you connected to the Wavelet power supply through pin 3 of the Wavelet analog port.

For details, see Analog Connector Pinouts.

In the configuration tree, click Analog > Channel > 0, and then do the following actions:

- a. Click the node called wakeup\_time\_ms.
- b. Right-click the existing value, and click Set Setting.
- c. In the New Value field, type in the sensor's wakeup time in milliseconds. For example, if the sensor requires 2 seconds of wake-up time, enter 2000.
- d. Click Submit.

In the configuration tree, click Analog > Channel > 0, and then do the following actions:

- a. Click the node called sample interval.
- b. Right-click the existing value, and then click Set Setting.
- c. Specify the desired sampling interval in seconds. For more information, see [Setting the Stream Sampling Interval](#).
- d. Click Submit.

In the configuration tree, click Analog > Channel > 0, and then do the following actions:

- a. Click the node called group.

- b. Right-click the existing value, and then click Set Setting.
- c. Specify which group to associate the channel with. For more information, see [Setting the Stream Sampling Interval](#).
- d. Click Submit.

Save the configuration changes, and then validate that the device rebooted by doing the following steps:

- a. Click Devices in the left pane, and then select the device in the Sites Tree pane.
- b. In the right pane, click the Commands tab. You will see a Reboot command after a few seconds.
- c. If no Reboot command is displayed, click Actions > Reboot in the Device Information pane to reboot the device manually. Both the configuration changes and the reboot will take effect after the device contacts the server.

You can swipe the magnetic Activator key over the embossed logo on the face of the device to force a device reset, which can expedite the time for the Wavelet to connect to the server.

#### 5.1.3. Step 4: Verifying sensor installation

Following the configuration of sensor settings, use the management UI to verify that the sensor is correctly installed and communicating. Do the following steps:

- In the left pane, click Devices.
- In the Sites Tree pane, select the relevant site.
- Select the relevant device.
- Select the stream corresponding to the sensor.
- In the Samples tab, see the Raw Values, which are displayed in units of microamperes ( $\mu\text{A}$ ).
- Raw Values below 3,500 or above 20,500 indicate either improper sensor configuration in the UI (such as a configured sensor wake-up time that is too short) or hardware incompatibility with the Wavelet (such as a sensor that requires a higher voltage than the 12V provided by the Wavelet). See [Raw Values of a 4-20 Analog Sensor are Out of Range](#) in the Support section.
- Raw Values close to 4,000 indicate the sensor is connected but has no medium to sample (for example, the sensor is a hydrostatic water level sensor, but it is not submerged in water). Try to provide a medium (such as water).
- Raw Values between 4,000 – 20,000 indicate the sensor is connected correctly and is receiving data.
- Values close to 20,000 indicate the sensor is connected correctly and is receiving data but has reached its maximum output range.

### 5.1.4. Step 5: Setting the engineering values

You can define the formula used to convert the raw sampling data into engineering units if the formula being used is linear.

#### Example 1:

Let's say that you have the analog sensor SE00138 Pressure Sensor, 0-13.8 bar (0-200 psi). You need to convert the raw data (in the Raw Value column of the Sample tab) to engineering units corresponding to 0-200 psi range (in the Final Value column of the Sample tab).

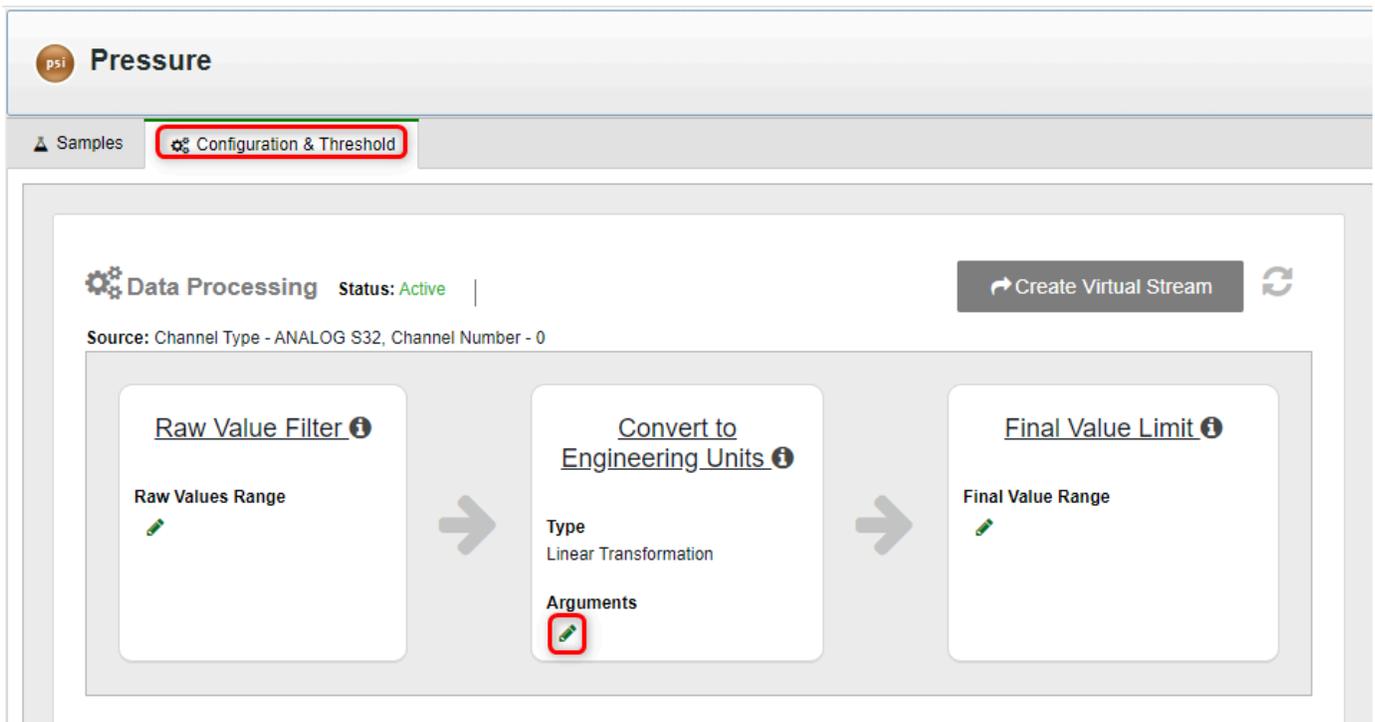
#### Example 2:

In this example, you have the analog sensor SE00197 Pressure Sensor - Absolute, 0-13.8 bar (0-200 psi). Instead of using the sensor's range of 0-200, you want to set the lower limit to be the ambient pressure in the pipe. The sensor will read the ambient pressure a few minutes after it is connected to the Wavelet. So, for the Final Value, you set the ambient pressure (in psi) to be the lower limit, and the upper limit will still be 200psi, as defined by the upper range of the sensor.

To change the formula for converting raw data to engineering units:

1. In the left pane, click Devices.
2. Click the stream name in the Sites Tree pane.
3. In the right pane, select the Configuration & Threshold tab.
4. In the Configuration & Threshold tab, click the pencil icon  in the Convert To Engineering Units area.

Figure 4.4 Threshold configuration



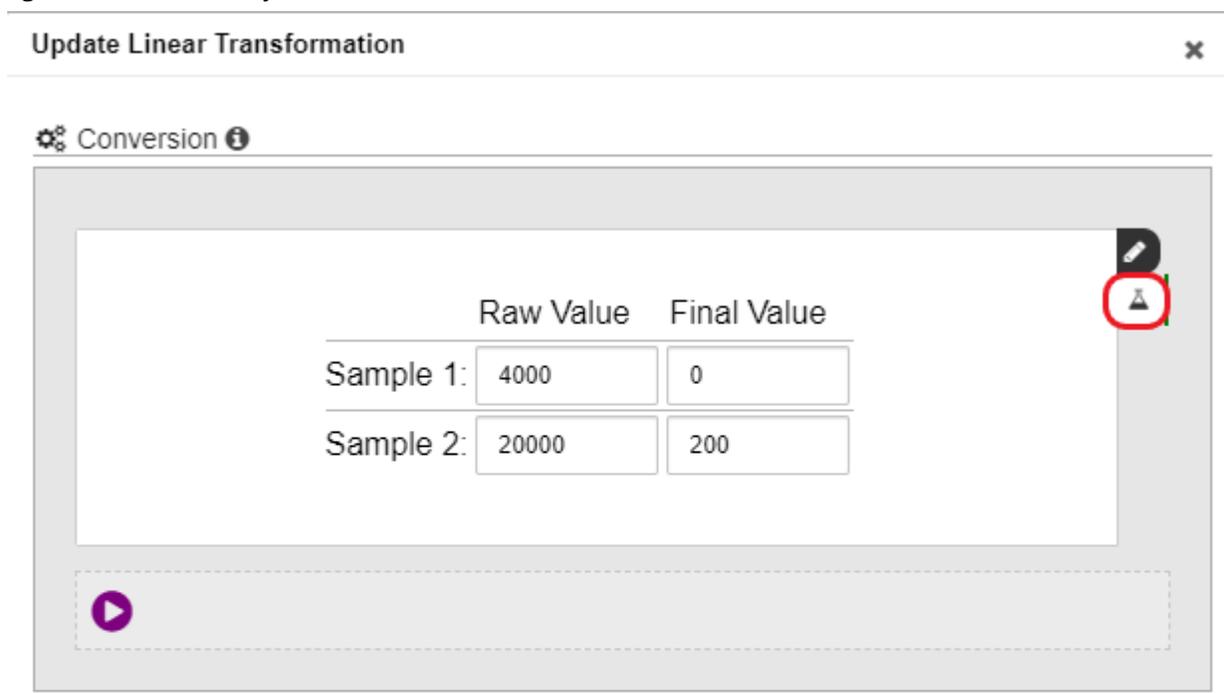
5. In the Update Linear Transformation window that appears, click the Beaker  icon.
6. Define a formula by entering two pairs of values. The system will compute the actual formula from the values you enter. Do the following actions:

**For Example 1:**

- In the Raw Value column, enter 4000 (4 mA) for Sample 1 and 20000 (20 mA) for Sample 2.
- In the Final Value column, enter appropriate stream minimum and maximum values for the sensor.

In our example, the pressure sensor range is 0-200 psi. You would enter 0 as the Final Value of Sample 1, and enter 200 as the Final Value of Sample 2. The Raw Value and Final values will be:

Figure 4.5 Linera transformation



	Raw Value	Final Value
Sample 1:	4000	0
Sample 2:	20000	200

**For Example 2:**

1. In the Raw Value column, enter 4000 (4 mA) for Sample 1 and 20000 (20 mA) for Sample 2.
2. In the Final Value column, enter the ambient pressure in the pipe for Sample 1 and 20000 (20mA) for Sample 2.
3. Optionally, you may Update old samples to retroactively update old samples according to the new conversion formula. You can update samples up to two weeks back.
4. Click Submit. The system will compute the conversion formula based on the values you entered.

5.2. Configuring SDI-12 Sensors

SDI-12 stands for Serial/Digital Interface at 1200 baud. It is a protocol that covers the communication and power supply aspects between a sensor and a datalogger, such as the Wavelet device.

SDI-12 protocol is an ASCII-based master-slave protocol. The device is the master and the sensor is the slave. One master can read multiple slaves.

**To configure the SDI-12 sensor:**

1. Click **Devices** in the left pane.
2. In the Sites Tree pane, select the device with the SDI-12 sensor.
3. Click the **Configuration** tab on the right pane.
4. Expand the ADVANCED DEVICE CONFIGURATION tree, and then select **Serial**.
5. Select the **Channel**, and then configure the following items:

Parameter	Required value	Details
sample_handler	SH_SDI12	
interface_type	IT_SDI12	
slave_addresses	The sensor's SDI-12 slave address	
read_addr	The zero-based index of the value to read	<p>Suppose that the sensor is responding with 9 values. To read the first value, specify 0. To read the second value, specify 1, etc.</p> <p>The fact that the SDI-12 handler might need to issue several Dn! commands do not affect the indexing of the values.</p> <p>The indexing is absolute with respect to the "aM!" command, regardless of the number of the Dn! commands issued. Consequently, the read_addr will start from 0 for each "aM!" or "aMn!" command issued. See the examples below.</p>
bus_baud, bus_parity, data bits, stop bits	N/A	These settings are ignored. The SDI-12 handler sets them automatically.
read_type, read_flag	N/A	These settings are ignored.

<p>extra_params</p>	<p>string format:</p> <pre>"&lt;use_crc&gt;, &lt;add_measurement_index&gt;,&lt;delay_ms&gt;"</pre>	<p>Use this configuration item to tweak the SDI-12 handler's default behavior. Be sure to include the quotation marks (") at the beginning and end of the string. Do not include the less than and greater than brackets ("&lt;" and "&gt;").</p> <p><b>&lt;use_crc&gt;</b> - By default, the SDI-12 handler uses CRC in all communication with the sensors. However, some sensors do not support CRC. By setting &lt;use_crc&gt; to '0', the handler won't use CRC. Setting &lt;use_crc&gt; to '1' will force the SDI-12 handler to use CRC. Specifying '*' will simply use the default value.</p> <p><b>&lt;add_measurement_index&gt;</b> - By default, the SDI-12 handler will issue the "aM!" command. To tell the SDI-12 to use the "aMn!" command and to specify the value of n, replace the value of &lt;add_measurement_index&gt; with this value. Valid values are 1 to 9. Specifying '0' or '*' or values larger than 9 will make the SDI-12 handler issue the regular "aM!" command instead.</p> <p><b>&lt;delay_ms&gt;</b> - By default, the SDI-12 handler will not use a delay (in milliseconds). Otherwise, this delay will occur before the device transmits the second query to the sensor. If this value did not exist, the device will simply use the default value (wait 0 millisecond).</p> <p><b>Examples:</b></p> <p><b>"" (empty string)</b> - use default values (use CRC + aM! command + no delay)</p> <p><b>"*,*"</b> - use default values (use CRC + aM! command + no delay)</p> <p><b>"*,1"</b> - use default value for &lt;use_crc&gt;, issue the "aM1!" command instead of "aM!" command, and have no delay.</p> <p><b>"0,*"</b> - do not use CRC and use aM! command and have no delay</p> <p><b>"0,1"</b> - do not use CRC and use aM1! command and have no delay</p> <p><b>"0,2"</b> - do not use CRC and use aM2! command and have no delay</p> <p><b>"*,*,100"</b> - use default values (use CRC + aM! command) and 100 milliseconds delay.</p>
---------------------	--	---

group	Set all channels of a specific sensor to the same group	
group_priority	Set the priority in a decreasing order across all channels of the same sensor	<p>This has an impact on the way the SDI-12 handler buffers the responses from the sensor.</p> <p><b>Important:</b> If the sensor has channels that use both "aM!" command and "aMn!" command, make sure the group_priority of the channels is ordered sequentially.</p> <p>For example, all channels that use "aM!" must have consecutive values in their group_priority item. Next, all channels that use "aM1!" must follow with consecutive values in their group_priority items as well. Then, all channels that use "aM2!", and so forth.</p>
All other settings:	use as usual	

Save the configuration changes, and then validate that the device rebooted by doing the following steps:

1. Click **Devices** in the left pane, and then select the device in the Sites Tree pane.
2. In the right pane, click the **Commands** tab. You will see a **Reboot** command after a few seconds.
3. If no Reboot command is displayed, click **Actions > Reboot** in the Device Information pane to reboot the device manually.

Both the configuration changes and the reboot will take effect after the device contacts the server.

You can swipe the magnetic Activator key over the embossed logo on the face of the device to force a device reset, which can expedite the time for the device to connect to the server.

### 5.2.1. SDI-12 Transaction without CRC

The following table shows a typical transaction with no CRC and just a few parameters:

Who	Command	Response	Comment
Master	1!		Check if slave #1 is there. This is SDI-12's "a!" command.
Slave		1	Slave confirms that it is available. Note: all of the slave's responses start with the slave's address in the first character.
Master	1M!		Master asks slave #1 to take a measurement on all parameters. This is SDI-12's "aM!" command.
Slave		10032	Slave responds by saying it needs 3 seconds ("003") to produce 2 ("2") measurements. <b>Note: the format of this response indicates that the slave can produce up to 9 measurements.</b>
Master	...waits for 3 seconds...		
Slave		1	The slave indicates that the data is ready. We can ignore this if we wait long enough.
Master	1D0!		Master asks for the first chunk of the results.
Slave		1+1.234+4.567	Slave responds with 2 values ("1.234" and "4.567").

All commands and responses are terminated with <CR><LF>.

<CR> means an ASCII value of 13 (which is 0D in hex).

<LF> means an ASCII value of 10 (which is 0A in hex). These two bytes are "new line".

## 5.2.2. SDI-12 Transaction with CRC

SDI-12 is designed to work even when the cable length between the logger and sensor is extremely long. When working on long cables, communication errors might happen. For example, bits might get flipped along the way. One way to detect this error is by adding a CRC code to the end of every response from the sensor. CRC stands for "cyclic redundancy check". It will not fix communication problems, but it will alert you that you have them. An SDI-12 master can instruct the slave to add a CRC code to every response. This is done by adding "C" to the "M" command.

### Example:

Who	Command	Response	Comment
Master	1!		Check if slave #1 is there. This is SDI-12's "a!" command.
Slave		1	Slave confirms that it is available. <b>Note:</b> All of the slave's responses start with the slave's address in the first character.
Master	1MC!		Master ask slave #1 to take a measurement on all parameters <b>and respond with a CRC code as well</b> . This is SDI-12's "aMC!" command.
Slave		10032	Slave responds saying it needs 3 seconds ("003") to produce 2 ("2") measurements. <b>Note: the format of this response indicates that the slave can produce up to 9 measurements.</b>
Master	...waits for 3 seconds...		
Slave		1	The slave indicates that the data is ready. We can ignore this if we wait long enough.
Master	1D0!		Master asks for the first chunk of the results.
Slave		1+1.234+4.567lpz	Slave responds with 2 values ("1.234" and "4.567") and a CRC code ("lpz"). The CRC code should match everything before it. If it doesn't, it means we have a problem. Note: This is just an example so it doesn't.

### 5.2.3. SDI-12 Transaction with Additional Measurements

The following table shows SDI-12 capabilities per firmware version:

Firmware Version	Supports CRC	Supports aM!	Supports aMn!	Supports aDn!
< 2.231	Yes	Yes	No	Yes, but only aD0!
2.231 and newer	Yes	Yes	Yes	Yes. Wavelet will issue aD0! and then aD1!...aDn! until all values are read

## 6. Maintenance

### 6.1. Device Maintenance - Monthly and On-going

Every device needs ongoing and monthly maintenance to preserve device health. The measures here are primarily preventive maintenance.

#### 6.1.1. On-going Maintenance

- It is recommended that every device has a technical alert set up for the humidity and battery technical streams. For acceptable ranges of these parameters, see the table of technical stream types.
- Protect your equipment from lightning strikes.
- It is recommended to keep the Firmware version in your devices current. Ayyeka will coordinate the date and time with you that is best to do FOTA (Firmware Over The Air) upgrades. The requirements for FOTA:
  - The devices must be connected to an external antenna.
  - The battery life (Battery Lifestream) should be at least 25%.

### 6.1.2. Monthly Maintenance

Check the following technical streams:

- Internal humidity stream - indicates how much moisture is in the device.
  - For all devices except the Wavelet Ex™, replace desiccants when internal humidity is 70% or higher.
  - The electronics in the Wavelet Ex™ are fully potted, so there are no desiccants to replace. The battery is potted and fills the full volume of the upper enclosure so that there is no room for a desiccant pack. You need to simply ensure the top enclosure doesn't have too much moisture building up. Use a dry cloth when swapping out the battery or performing routine maintenance at the site.
- Battery level stream - how much of the battery is left?
  - When the battery life is 30%, replace the battery (includes resetting the battery life). You might need to connect the device to external power to restore communication until the battery is replaced.
- GSM Signal strength or Cellular Signal Strength - indicates the strength of the modem signal.
  - If the signal strength is weak, reposition the antenna until the signal strength is stronger. Also, check that the antenna is properly connected.
- Check the following columns in the Health tab:
  - GSM errors
  - Reboots

For an explanation of these parameters, see [Parameters - What They Mean and Their Values](#).

### 6.2. Protecting Equipment from Lightning Strikes

Protecting your devices from lightning damage is critical if they are deployed in areas that are prone to lightning strikes. Even if the lightning does not directly strike the equipment, it can cause damage by traveling through the ground and into buried sensors or cables. Proper planning for such events can help reduce the risk of lost data or expensive equipment replacement and site downtime.

#### 6.2.1. How it Happens

Within a thundercloud, many small frozen raindrops collide with each other as they move in the air, and thus create an electric charge. The cloud fills up with electrical charges - positive charges at the top of the cloud and negative charges at the bottom.

Since opposites attract, a positive charge builds up on the ground below the cloud. The ground's electrical charge is focused on anything that sticks up, such as your mounted device, antenna, solar panel, camera, power source, and so forth. The charge coming up from these points eventually connects with a charge reaching down from the clouds and lightning strikes your equipment.

#### 6.2.2. What a Lightning Strike Costs You

In a lightning strike, the physical connectivity between the device and its components permits excess electrical flow. Consequently, high currents and high voltage will create physical damage to electrical equipment that might result in permanent damage. In such cases, the equipment needs to be repaired or replaced, and the equipment is offline for further data sampling. Thus, you incur a double loss: financial and data.

### 6.2.3. How You Can Protect Your Equipment

No system can be made completely resistant to all lightning strikes. Nevertheless, there are measures that can provide greater protection, thus maximizing the chance of equipment survival and minimizing the amount of lost data.

- Determine if you are in a lightning-prone area. Check the [lightning detection maps](#) for your country.
- Redirect the lightning away from the equipment to the ground. Lightning rods are good for this purpose.
- Protect the equipment as much as possible. Install any protective gear around the equipment. The Wavelet devices have internal protection mechanisms to block high-voltage surges. Nevertheless, a direct lightning strike might still damage the device.
- Reduce the length of exposed cable to a minimum.

### 6.3. Replacing the Battery

Shortly before your battery needs replacement, a configurable technical alert will send an SMS, email, or voice alert to the user group(s) designated to receive technical alerts, enabling them to prepare so your battery replacement will go smoothly.



#### **WARNING**

Replacing the battery of a Wavelet Ex™ must be done outside of the explosive, hazardous area!

In a Wavelet Ex™, you must use only a battery that is specifically for Wavelet Ex™!

### Battery Life and Battery Status Streams

Battery Life is a percentage of the battery that is still available for use based on empirical measurement of battery charge consumption and based on tracking battery usage, the screenshot below illustrates the battery life in the FAI platform.

#### **Prerequisite**

- You must have a torque screwdriver.
- The replacement battery must be new and not reused. Otherwise, when you [reset the battery status](#) in the UI or in the AyyekaGo mobile app, the Battery Status stream data might not be accurate.
- To reset the battery status in Fleet, you must have a Partner role.

To replace the battery:



1. Beware of static discharge, make sure to work in a clean environment, and ensure that your hands and the device are completely dry.  
Place the device face down on a dry, stable surface with the connectors pointing downward.

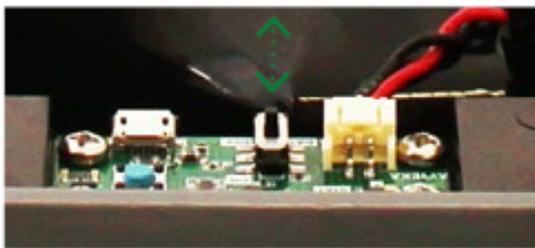


2. Partially unscrew the six (6) screws located on the back of the device enclosure, until you can lift off the back panel with the screws still affixed to their screw holes.



3. Remove the device's back panel and place it flat-side down adjacent to the device box.

Warning: Do not remove the rubber gasket that sits inside the rim of the back panel. The gasket is thin and not glued to the back panel.



4. On the interface board, move the ON/OFF switch to the OFF position.



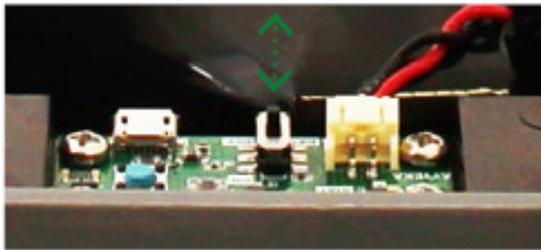
5. Carefully disconnect the male end of the battery connector cable from the female connector on the interface board. Using an indelible pen, mark the battery as "Used" and dispose of it properly.



6. Mark the new battery with the current date. Place the battery in the device enclosure and carefully connect the male end of the battery connector cable to the female connector on the interface board.

In the Wavelet 4R device, verify that the green LED light blinks one long blink followed by a short blink - 3 times.

In all other devices, verify that the green, red, and blue LED lights on the interface board blink briefly. This confirms that the battery has been successfully connected.



7. On the interface board, move the ON/OFF switch to the ON position. The device turns on and performs a 10-minute calibration process, after which it starts operating in normal mode.



8. Replace the device's back panel, ensuring that the battery cable is neatly arranged and not pinched within the device enclosure.

Important: Ensure that the rubber gasket is in place in the back panel. The gasket prevents water from entering the device.

If the gasket is missing, Geotech considers any subsequent water and/or dust damage to be the result of faulty use and/or maintenance. Those repairs will not be covered by the user's service contract.



9. Tighten the six back panel screws with a torque of 1 Nm. Do not over-tighten because it will strip the screw threads.



**CAUTION**

Failure to torque the back cover screws correctly could lead to water ingress and damage to the Wavelet.

**Reset the battery status by doing either step:**

- In the UI, do either action:
  - Click Devices in the left pane, and then select the device in the Sites Tree pane. In the right pane, below the picture of the device, click Actions, and then select Reset Battery Life.
  - Click Fleet in the left pane, and then select the device in the Devices pane. Click Set Action, and then select Reset Battery Life.

The device is now ready to resume monitoring and transmission.

- In the AyyekaGo mobile app, connect to the device, click More, and then click Reset Battery Life.

**6.4. Replacing the Desiccants**

Four desiccants (small white bags) are placed inside the device to remove moisture. If the Internal Humidity technical stream reaches a configurable value, a technical alert sends an alert to the designated user group(s).

The electronics in the Wavelet Ex™ are fully potted, so there are no desiccants to be replaced.

You must ensure that the top enclosure doesn't have too much moisture building up. During battery replacement or when using external power, dry out the upper enclosure with a soft cloth. It's also recommended to do this from time to time in particularly humid areas.

**Prerequisites**

- You must have a torque screwdriver.
- Beware of static discharge, make sure to work in a clean environment and ensure that your hands and the device are completely dry.

To replace the desiccants:



1. Place the device face down on a dry, stable surface with the connectors pointing downward.

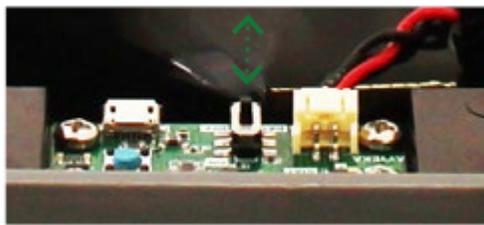


2. Partially unscrew the six (6) screws located on the back of the device enclosure, until you can lift off the back panel with the screws still affixed to their screw holes.

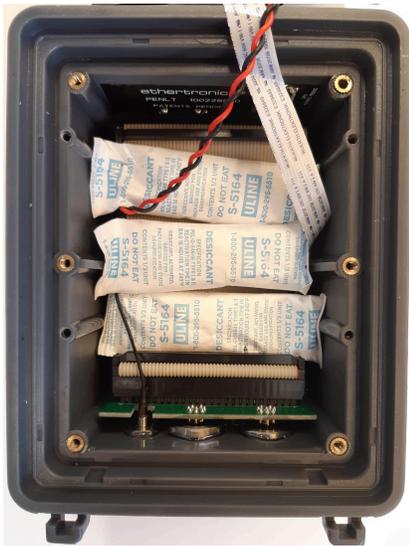


3. Remove the device's back panel and place it flat-side down adjacent to the device box.

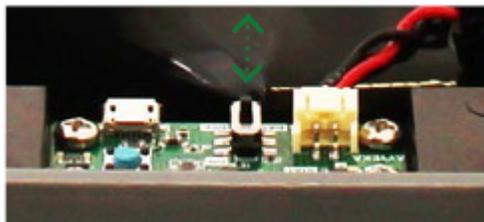
Warning: Do not remove the rubber gasket that sits inside the rim of the back panel. The gasket is thin and not glued to the back panel.



4. On the interface board, move the ON/OFF switch to the OFF position.



5. Carefully replace the existing desiccants with the new desiccants.



6. On the interface board, move the ON/OFF switch to the ON position. The device turns on and performs a 10-minute calibration process, after which it starts operating in normal mode.



7. Replace the device's back panel, ensuring that the battery cable is neatly arranged and not pinched within the device enclosure.

Important: Ensure that the rubber gasket is in place in the back panel. The gasket prevents water from entering the device.

If the gasket is missing, Geotech considers any subsequent water and/or dust damage to be the result of faulty use and/or maintenance. Those repairs will not be covered by the user's service contract.



8. Tighten the six back panel screws with a torque of 1 Nm. Do not over-tighten because this will strip the screw threads.



**CAUTION**

Failure to torque the back cover screws correctly could lead to water ingress and damage to the Wavelet.

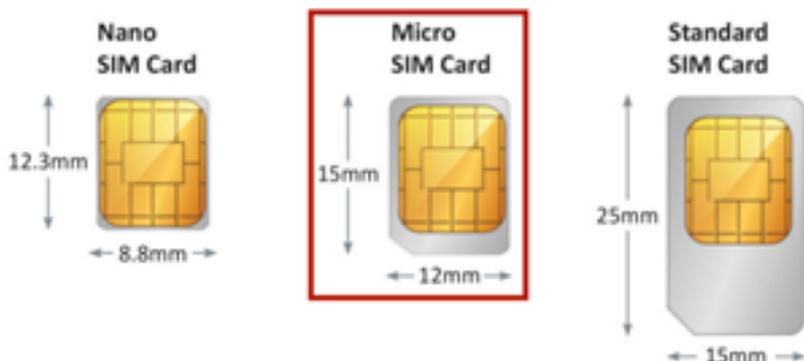
## 6.5. Replacing Wavelet SIM Card

You can replace the SIM card in your device (Wavelet V2™, Wavelet 4R™) when you need to change the data service provider or when the SIM card is defective.

Wavelet Ex™ is potted, so its SIM cannot be replaced. Wavelet 4R™ has one SIM card. Wavelet V2™ has two SIM cards. SIM1 is the main communication card. Typically, SIM2 is the backup card that is used if communication fails in SIM1. In this procedure, we will replace SIM1. The preferred method to configure the new SIM is through the UI. Alternatively, you can use AK commands.

### Prerequisites

- You must have a torque screwdriver.
- You must have a Micro-USB cable and a laptop.
- Ensure that the Micro-USB cable is functioning correctly by testing connectivity between another device (not a Wavelet) and your laptop.
- [Download PuTTY](#) terminal emulation software to the laptop. If the SIM replacement is unsuccessful, Support will need to access the device.
- The device uses a Micro-SIM card (3FF Sim Card). Ensure that you use an appropriately sized SIM card.



- Write down (or photograph) the new SIM's PIN and PUK numbers, the new SIM's APN address, and the device's serial device number.
- Initially, the device must be turned on. If the device is in hibernation mode, swipe the magnetic Activator key over the embossed logo on the face of the device until the LED lights flash.

### Replacement steps

**Tip:** Steps 1 and 3 below can be done in the AyyekaGo mobile app instead of the UI. The settings that need to be changed are on the Cellular Settings page.

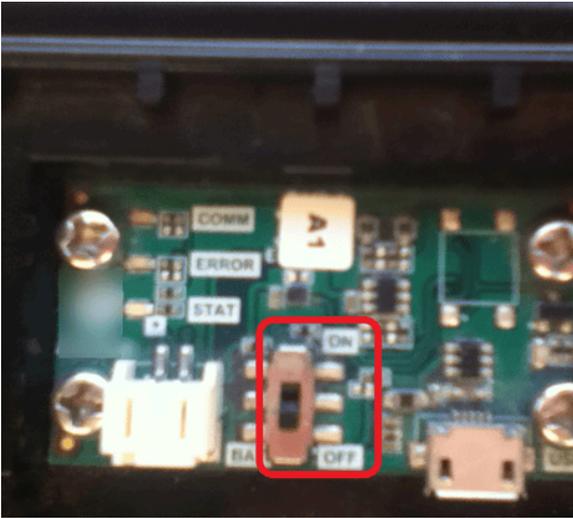
## Steps in the UI

### 1. Send a command to remotely change the SIM card's APN address. Do the following steps:

- Click Devices in the left pane.
- In the Sites Tree pane, select the device whose SIM you are replacing.
- Click the Configuration tab on the right pane.
- Expand the ADVANCED DEVICE CONFIGURATION tree, and then select GSM.
- Click the gsm\_apn parameter in the tree. (If you need to change SIM2, edit gsm\_apn\_sim2).
- Click Set Setting to change the value to the APN of the new SIM.
- As an example, suppose that the current APN is internetm2m.air.com. The new APN will be sim1.apn.com.
- A change-gsm-apn command will be generated, and the device will receive and execute the command at the next transmission.
- (Optional) Type in a username and password for the SIM card by editing the value of gsm\_apn\_user and gsm\_apn\_pass. (If you want to change SIM2, edit gsm\_apn\_sim2 and gsm\_apn\_pass\_sim2.)
- In the Configuration tab, click the green box in the TRANSMISSION INTERVAL pane to open the Select Transmission Interval window.
- Change the Transmission Interval to 10 minutes by moving the slider to 10 min, and then clicking Submit.
- Under the device picture at the top of the screen, click Actions, and then select Reboot.
- In the Commands tab, verify that the commands "Set Reporting Interval", "Set General Setting", and "Reboot" that were sent thus far have been received. Wait until all three commands' Status is 100% before proceeding.
- In the Configuration tab, check that the new APN was accepted. Repeat steps 1c and 1d. You should see the former APN and the new APN listed.

### 2. Steps in the Device

- Partially unscrew the six (6) screws located on the back of the device enclosure, until you can lift off the back panel with the screws still affixed to their screw holes.
- On the interface board, power off the device by moving the ON/OFF switch to the OFF position.



3. Disconnect the battery cable from the interface board.



**CAUTION**

Failure to do steps 2 and 3 might cause a short circuit in the device.

4. Remove the four internal screws, and then pull up the plastic casing.

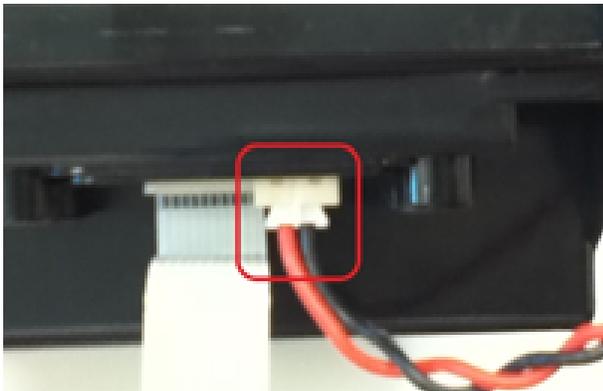


Warning: Do not remove the rubber gasket that sits inside the rim of the back panel. The gasket is thin and not glued to the back panel.

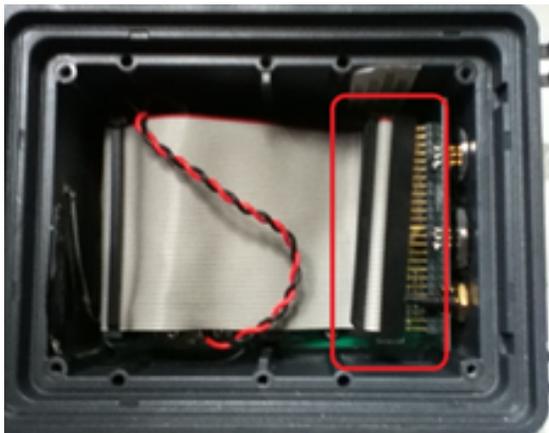
**CAUTION**



5. Unplug the red and black wires from the underside of the plastic casing to allow easier access to the SIM card. Set the casing to the side.



6. Unplug the flat cable.



7. The following picture shows the inside of a device after the flat cable is unplugged.



8. On the SIM1 card tray holder, note the Lock  and Unlock  icons. Slide the cover that is over the SIM1 card toward the Unlock direction. The cover will pop open.
9. Remove the original SIM1 card and put in the new one. Slide the tray holder cover toward the Lock direction to lock SIM1. The cover will snap closed.
10. Reconnect all wiring. Put the plastic casing back into place. Screw the four internal screws back in.

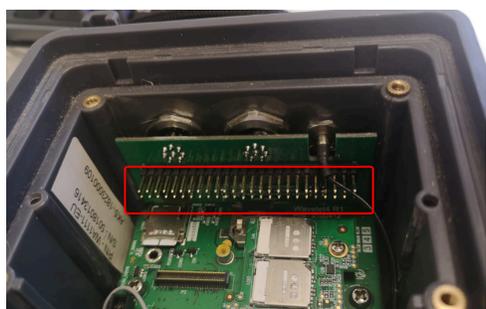
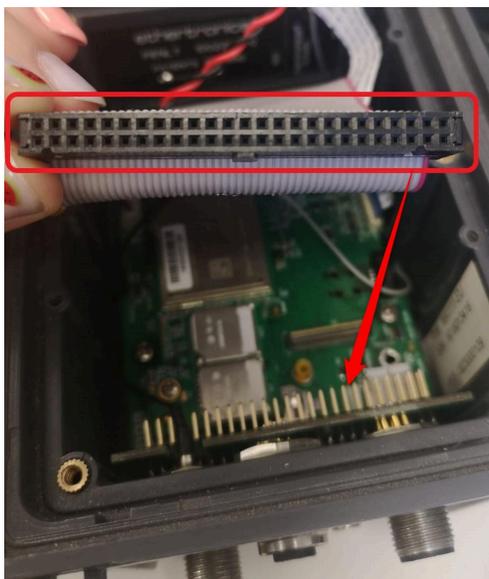


## CAUTION

Important: Ensure that the rubber gasket is in place in the back panel. The gasket prevents water from entering the device.

If the gasket is missing, Geotech considers any subsequent water and/or dust damage to be the result of faulty use and/or maintenance. Those repairs will not be covered by the user's service contract.

11. Reconnect the battery. The gray flat cable has two rows of pins. Be sure to connect the cable so that both rows connect securely to the pins. If only one row is inserted and the second row is not, it might cause a short circuit in the device when you power it on.



## NOTE

Do not turn the device on yet.

## Steps in the UI

1. In the Configuration tab on the right, expand the ADVANCED DEVICE CONFIGURATION tree, and select GSM
2. Click gsm\_done\_onetime\_setup parameter in the tree.
3. Click the value, and then select Set Setting. Change the value to 0.
4. Turn the device back on.
5. In the Commands tab, wait for the command Set General Setting to reach the Status of 100%.
6. Turn the device off.
7. In the Configuration tab, click the green box in the TRANSMISSION INTERVAL pane. Change the Transmission Interval back to 1 hour by moving the slider to 1h, and then clicking Submit.
8. Under the device pictured at the top of the screen, click Actions, and then select Hibernate.
9. Turn the device back on.
10. In the Commands tab, wait for both commands to reach the Status of 100%. The SIM card replacement process is complete.

### Post-replacement steps

1. Replace the back panel and tighten the six screws with a torque of 4.5 Nm. Do not over-tighten because this will strip the screw threads.
2. Wait 5-10 minutes for the device to perform a calibration process, and then to start transmitting to the cloud server.
3. In the UI, check whether the device is transmitting.
  - If the device is transmitting, the SIM was successfully replaced. No further action is needed.
  - If the device is not transmitting, contact Support. They will ask you to send a device trace or to use AK commands.
    - [Create a Device Trace.](#)
    - [Use AK commands.](#)



### NOTE

If you used the AyyekaGo mobile app instead of the UI, then go to the UI and select the device with the replaced SIM card. Click Actions, and then select Fetch Configuration.

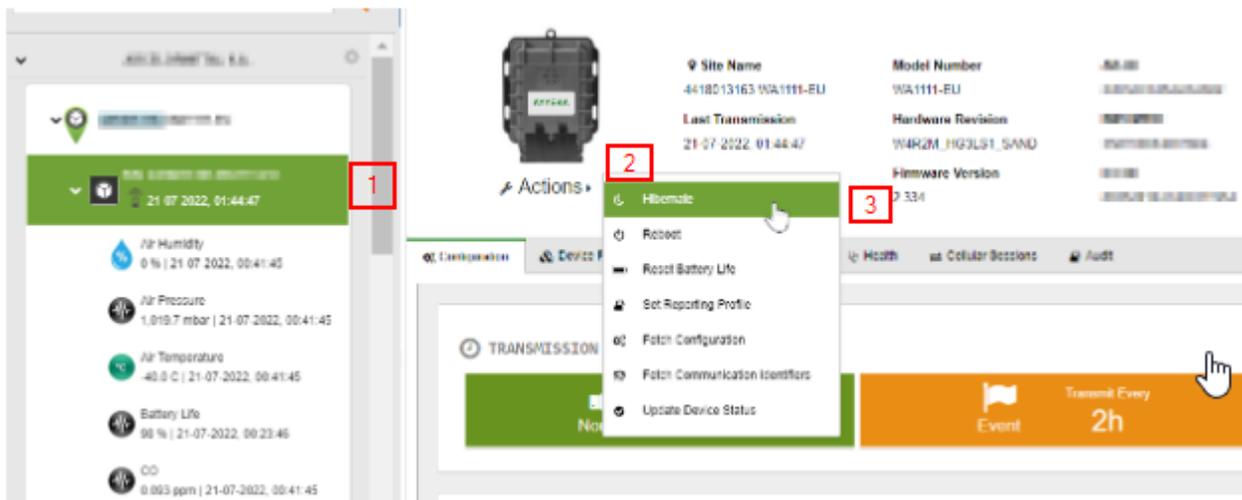
# 7. Troubleshooting

## 7.1. How to Put Your Wavelet Data Logger Into Hibernation Mode

Hibernation mode puts the device into an ultra-low power mode, conserving battery. During hibernation mode, the device will neither take samples nor transmit data. This mode is ideal when the devices are not in use, for example, when put in storage or being shipped.

### How to put the device into "Hibernation Mode" using FAI Pro

1. In the FAI Pro device management section, click on the selected device, then click on Actions → Hibernate:



2. At this point a command will be created and queued for processing by the device. Note that the command will only take effect on the next device transmission.

3. Wait until the hibernate command is completed. This can be seen in the "Commands" tab:

Comm Type	Creation Date	Command	Status	Prepare Date	HW-FW
		Get General Setting	100%		
		Reboot	100%		
		Set General Setting	100%		
		Reboot	100%		
		Set Configuration	100%		
		<b>Hibernate</b>	<b>100%</b>		
		Reboot	100%		
		Set General Setting	100%		
		Set General Setting	100%		

4. Allow up to 3 minutes for the device to process the command after it was received.

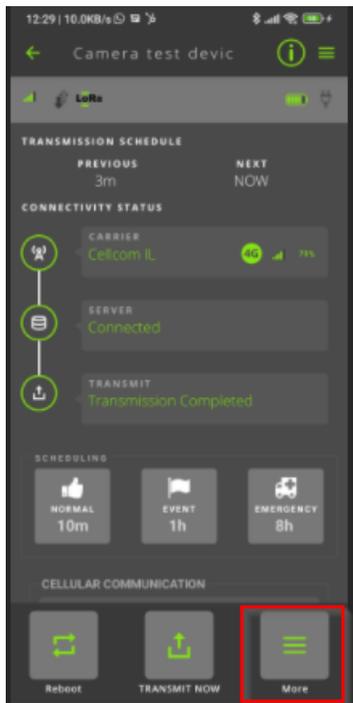
5. Visually confirm that the device entered hibernation mode:

Table 6.1 Model and associated LED sequence

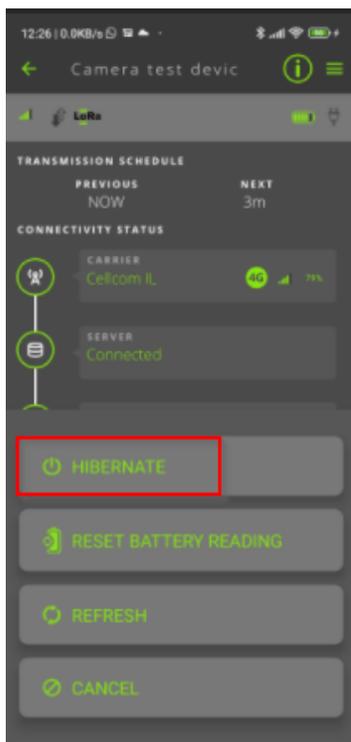
Model	Firmware version	LED Sequence
Wavelet V1 [WA1111-XX] Wavelet V2 [WA1111-XX-V2]	v2.463 and on	1 hour of { 2 * short blue blink 2 sec pause }
Wavelet 4R [WA4000]	v2.463 and on	1 hour of { 2 * short green blink 2 sec pause }

7.2. How to put the device into "Hibernation Mode" with the AyyekaGo Mobile App

1. Launch the AyyekaGo Mobile App and connect to the device.
2. Press on the three lines in the button right corner:



3. Press on the “HIBERNATE” button:



4. Allow up to 3 minutes for the device to process the command after it was received.
5. Visually confirm that the device entered hibernation mode:

Table 6.2 Model and associated LED sequence

Model	Firmware version	LED Sequence
Wavelet V1 [WA1111-XX] Wavelet V2 [WA1111-XX-V2]	v2.463 and on	3 * (blue & green blink) green blink
Wavelet 4R [WA4000]	v2.463 and on	6 green LED blink

### 7.3. How to get the Wavelet device out of Hibernation mode

1. Swipe the magnetic Activator key over the embossed logo on the face of the device until the LED lights flash.
2. Changed magnetic-reed behavior in hibernate: (starting fw ver 2.46x)The magnet needs to be in place for 3 seconds to exit hibernation.
3. To know if the magnet is in place, look at the device LED. The communication LED(Green) will turn on when the magnet is in place and off when it's out of position.

[See the video](#)

### 7.4. Device Problems

How to troubleshoot various problems that you might have with the device.

**Problem:** My LoRa-only device has no sample data

#### **Recommended Actions:**

**LoRa-only** devices do not have cellular connectivity. As a result, Support cannot send commands or see any logs if troubleshooting is needed.

The mobile app functionality is limited in LoRa-only devices, and it can configure only sampling intervals and transmission intervals.

Since there is no cellular connectivity, go to the device, and then do the following steps:

- Is data being sampled? If no, do the following steps:
  - a. Swap the sensor with a sensor that is known to be working.
  - b. If no data is sampled, RMA the sensor.
- Is data being transmitted? If no, do the following steps:
  - a. Use the mobile app to send a TRANSMIT NOW.
  - b. If no data is transmitted, check the antenna placement.
  - c. If there still is no data, RMA the device.

**Problem:** I made changes to the configuration, but the changes aren't taking effect

#### **Recommended Actions:**

Check the Transmission interval. All device configuration changes are relayed to the device as commands when the device next communicates with the server. The time of communication is determined by the defined Transmission interval.

In addition, some of the advanced settings available through **Configuration > Advanced Device Configuration** require a device reboot in order to take effect.

---

The reboot command, together with all other commands accumulated since the last transmission, will be relayed to the device when the device next communicates with the server

**Problem:** My device lost its configuration settings

**Recommended Actions:**

Devices with FW version 2.23x and older might suddenly lose their configuration. This is a known issue in earlier versions of the FW.

The solution is to update the FW to a newer version.

**Problem:** Updated GPS coordinates do not appear in the UI

**Recommended Actions:**

Typically, the issue is the time it takes for the GPS coordinates to be detected in the field. When the device reports new GPS coordinates to the server, the server takes several minutes to complete the processing.

The GPS coordinates are updated weekly after swiping the magnetic Activator key under a clear sky (not indoors).

If you are not near the device, send a reboot command (Click **Devices** in the left pane of the UI, and then select the device in the Sites Tree pane. In the right pane below the picture of the device, click **Actions**, and then select **Reboot**.)

**Important:** The internal GPS antenna is located at the top of the device, opposite the connector panel. That side of the device needs a clear view of a patch of sky for about 5-10 minutes in order to pick up a GPS signal. Trees, buildings, roofs, etc. interfere with the GPS signal.

**Problem:** My battery is draining faster than expected

**Recommended actions:**

There are a number of reasons why the battery drains faster than expected. Check the following items:

- Configuration (too many channels, long wake-up time)
- Transmitting too frequently
- Sampling too frequently
- "Hungry" sensor - requires a lot of power for a long wake-up time, or the sensor requires constant power. A camera sensor is an example of a "hungry" sensor.
- Thresholds are not set for optimum use, so the Event mode is frequently reached.

When a device is scheduled to transmit data, it transmits all the data it stored since its previous transmission. Thus, if you set the device to transmit at the Emergency rate for a certain threshold, then whenever the thresholds is reached and the device transmits at the Emergency rate, it will transmit data from all data streams, not only from the stream for which you defined the threshold.

- 2G SIM technology is used when transmitting (2G consumes more battery). This can be seen in the Log tab.
- Bad signal - see the Health tab parameters.
- A bad or incorrect sensor adapter. Check the sensor adapter for faulty or disconnected wiring.

## Problem:

The magnetic activator key does not turn the device on

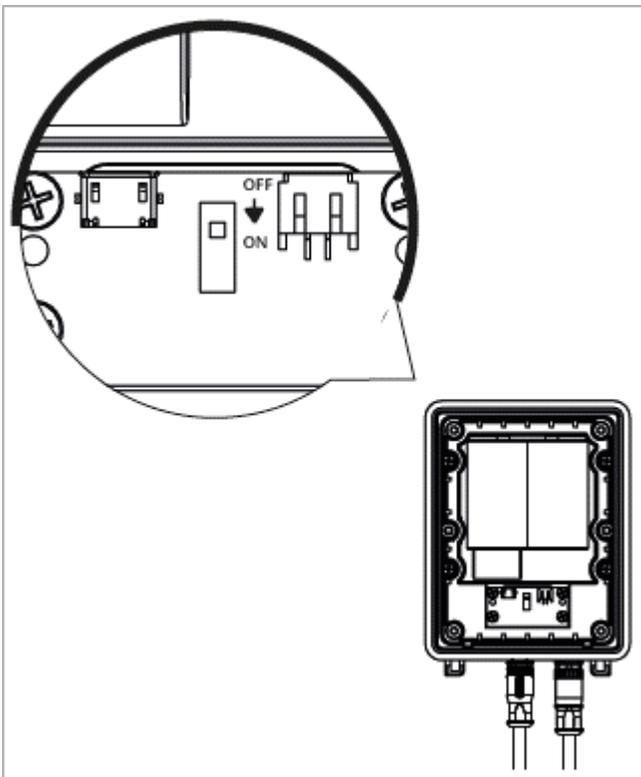
Sometimes, swiping the magnetic activator key does not cause the device to reset.

## Recommended Actions:

Hold the magnetic activator key over the embossed logo on the front of the device enclosure **for a full 30 seconds**. This action is like sending a reboot command to the device.

If the device still does not turn on, do the following steps:

- Partially unscrew the six (6) screws located on the back of the Wavelet enclosure, until you can lift off the back panel with the screws still affixed to their screw holes.
- Remove the Wavelet's back panel and place it flat-side down adjacent to the Wavelet box.
- On the interface board, move the ON/OFF switch to the ON position.



The Wavelet device turns on and performs a 10-minute calibration process, after which it starts operating in normal mode.

- Replace the Wavelet back panel, ensuring that the battery cable is neatly arranged and not pinched within the Wavelet enclosure.
- Tighten the six (6) back panel screws until the Wavelet is closed and sealed. Do not over-tighten as this will strip the screw threads.

## 7.5. Sensor Problems

How to troubleshoot various problems that you might have with the sensor.

The sensor is not sampling data

### Recommended actions

#### Get the following information:

- Is the sensor supported? See the [list of supported sensors](#).
  - If the sensor is not listed, then it is not supported. Ask Support for information about unsupported sensors.
  - If the sensor is supported, check its datasheet.
  - If the sensor is in a serial channel and uses Modbus communication, check the sensor's User Manual for Modbus configuration. Note especially what the offset and the endian type (big endian or little endian) are.
- Check the sensor's channel configuration (see Advanced Configuration for [Analog](#), [Digital](#), and [Serial](#) channels):
- In the STREAM MANAGEMENT table for the device, note which sample group the channel belongs to, and then go to **SampleGroup > GROUP > sample\_group\_#**.
  - The parameter group\_active must be set to AS\_ON or AS\_ON\_HOLD.
  - If the value of group\_active is AS\_ON\_HOLD, check that an actual Event triggered the group sample.
  - The parameter group\_sample\_interval\_sec must be greater than 0.
  - From FW 2.32.x and newer, every channel must be in a group. Any channel that is not in a group will not sample at all (with the exception of a digital sensor).
- wake\_time (or wakeup\_time)
- sensor\_power\_source (serial channel) or sample\_power\_source (analog channel)
- sample\_handler
- read\_addr
- slave\_addr
- Was the sensor giving good values, and then suddenly stopped? If so, check the following items:
  - Commands that were sent just prior to the loss of data
  - [Boot count](#) (was there a reset?)

- Battery and external power (if used), did all streams stop or just one particular one? (check in the Visualization window).
  - Check all channels connected to that sensor (in the STREAM MANAGEMENT table). Is one channel of the sensor not showing values or are all channels not showing values?
  - Was there any physical maintenance on site such as site maintenance, swap sensors, disconnecting the sensor, replacing desiccants in the device, replace the battery
  - Restore configuration (click **Actions > Restore Configuration**) to send all settings in UI to the device.
- If the sensor never worked, request pictures of wiring and installation (if relevant).

## Data samples from the serial sensor show Modbus errors

The serial channel is working because the sensor is attempting to sample data. There are values, but the values are all Modbus errors (-2147483648).

Samples		Configuration & Threshold		
Comm Type	Sample Date	Raw Value	Final Value	Status
	06/25/2020, 12:01:20 PM	-2147483648	-84,546,431.222	Visible
	06/25/2020, 11:56:20 AM	-2147483648	-84,546,431.222	Visible
	06/25/2020, 11:51:20 AM	-2147483648	-84,546,431.222	Visible
	06/25/2020, 11:46:20 AM	-2147483648	-84,546,431.222	Visible
	06/25/2020, 11:41:20 AM	-2147483648	-84,546,431.222	Visible
	06/25/2020, 11:36:20 AM	-2147483648	-84,546,431.222	Visible

### Recommended action:

Check the configuration of the sensor. Check the power source of the sensor:

- If the sensor has its own power source, check the state of (sensor\_power\_source).
- If the sensor is getting power from the device and the battery is low, sampling might stop.

Was the sensor giving good values and then suddenly stop? If so, check the following items:

- Commands that were sent just prior to the loss of data
- Boot count (was there a reset?)
- Battery and external power (if used), did all streams stop or just one particular one? (check in the Visualization window).
- Check the Internal Humidity technical stream for moisture in the housing.

- Check all channels connected to that sensor (in the STREAM MANAGEMENT table). Is one channel of the sensor not showing values or are all channels not showing values?
- Was there any physical maintenance on site, such as site maintenance, swapping sensors, disconnecting the sensor, replacing desiccants in the device, and replacing the battery?

Check the wiring of the serial sensor. If the user isn't sure about the wiring, take a photo of the sensor wiring and send it to Support.

Ultrasonic sensor displays outlying values from normal measurement

Every ultrasonic sensor is sensitive to interference from mist, foam, turbulence, and so forth. Consequently, outlying values should be expected from time to time.

To hide these outlying values from your graph reports and APIs. The data will still be displayed in the Samples tab as a Hidden value.

Alternatively, if you're seeing outlying values often re-evaluate the type of ultrasonic sensor that you're using. Check that it is suitable for your specific environment. If needed, contact Support.

Raw Values of a 4-20 Analog Sensor are Out of Range

to Perform the following checks if the raw values received from the sensor are below 3,500  $\mu$ A or above 20,500  $\mu$ A.

### 7.5.1. Measuring voltage at the analog port

When the device is on, connect a voltmeter to the analog port pins, as follows:

- If this is an installation where the sensor receives power from the device, connect the voltmeter to the **Supply+** and **Negative (-)**
- If this is an installation where the sensor receives power directly from an external source, connect the voltmeter to the **Signal+** and **Negative (-)**.
- 



#### NOTE

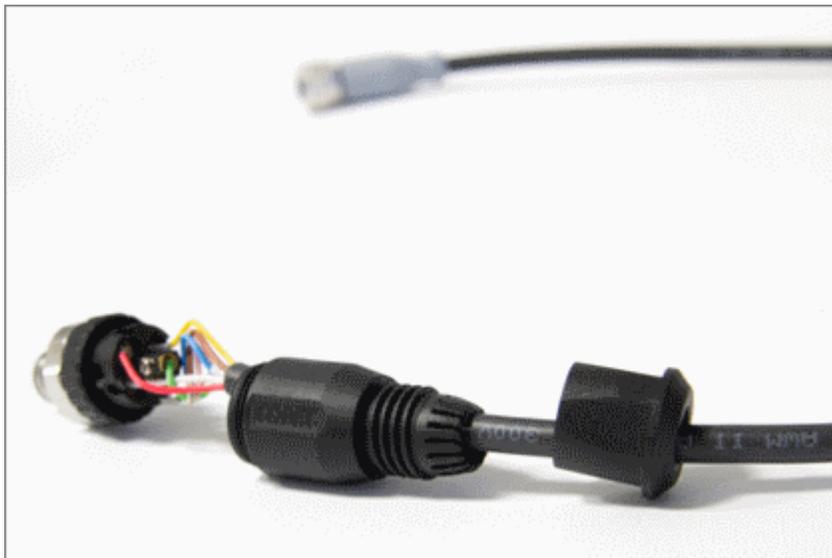
Note that power is not supplied continuously, but only for short bursts of time, depending on the configured sampling interval and duration. Typically, the sampling interval is between 1-5 minutes, and the sampling duration is between 100 ms – 2 sec.

#### Note the voltage:

- If the voltage is 12V, then proceed to measure the voltage on the analog cable.
- If the voltage is not 12V, the device may be damaged, off, or configured incorrectly. Contact Geotech for technical support.

### 7.5.2. Measuring voltage on the analog cable

Carefully open the housing of the field attachable connector on the cable of the sensor connecting to the device, to expose the wires (conductors). Be sure not to forcefully twist the wires while opening the connector housing.



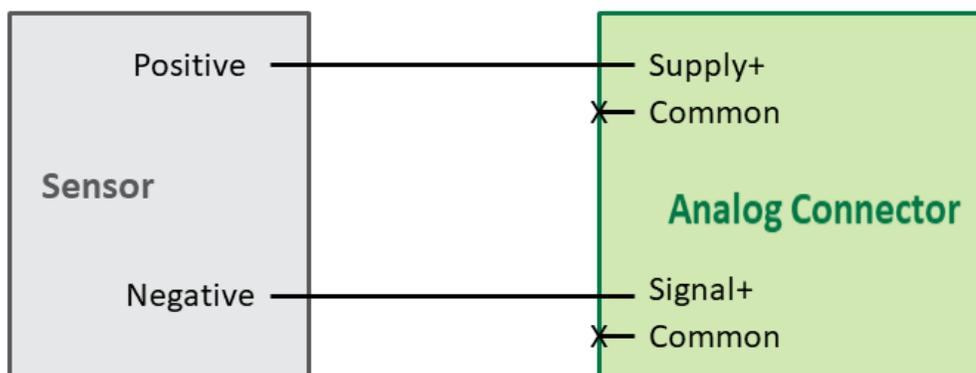
Connect a voltmeter to the exposed **Signal+** and **Negative (-)**.

Note the voltage:

- If the voltage is between 0.4 – 2.1V (which corresponds to 4,000 – 20,000  $\mu$ A), then proceed to Measure the current between the sensor and the device.
- If the voltage is not between 0.4 – 2.1V, then the sensor connections to the Wavelet are incorrect, loose, or damaged. If you need assistance, contact Geotech for technical support.

### 7.5.3. Measuring current between the sensor and the device

1. Use an Ampere meter to measure the current between the Wavelet and the sensor cable, by connecting the **Signal+** pin on the Wavelet analog connector with the **Negative (-)** pin on the sensor cable connector.



**Note the current:**

- If the value is not between 4 – 20mA, then either the sensor is damaged, or the sensor connections to the device are incorrect, loose, or damaged.
- If the value is between 4 – 20mA, then either the device is damaged or it is configured incorrectly. Contact Support for additional support.

## 7.6. Communication Problems

How to troubleshoot various problems that you might have with device communication.

**Problem:**

Sample data is being collected, but there is no communication with FAI Pro or with FAI Local server.

**Background:**

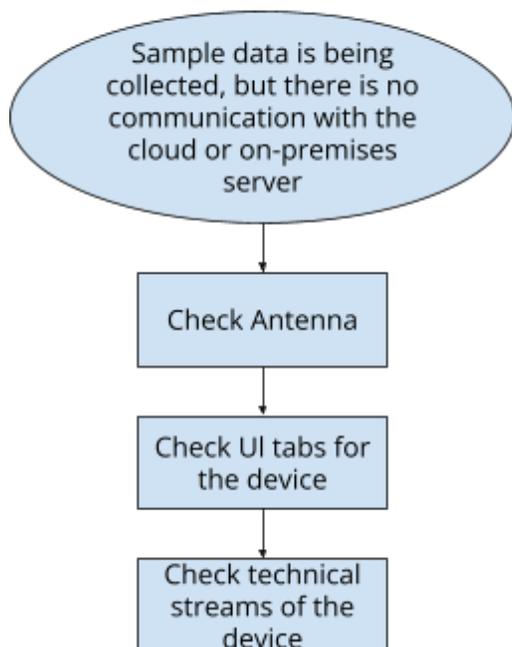
Communication can use MQTT or HTTP protocols. HTTP is the default and this protocol can transmit all stream types (data, technical, virtual, external, and event). MQTT can only transmit data streams.

All devices transmit HTTP. Devices with firmware version 2.388 and newer can transmit both HTTP and MQTT, if configured to do so. Otherwise, they can be configured to work with only HTTP. The Wavelet 4R™ device with FW version 2.388 and newer supports MQTT.

If the device is configured to work with both technologies, the device transmits commands, logs, health statuses, and so forth with HTTP, but sensor data is transmitted with MQTT. Consequently, HTTP and MQTT transmissions alternate - one HTTP transmission (or more) and one MQTT transmission, then again HTTP, MQTT, HTTP, MQTT, and so on. Both HTTP and MQTT protocols are used on each scheduled transmission.

The following decision tree gives you a bird's eye view of troubleshooting particular problems.

Communication Problem



**Recommended actions:**

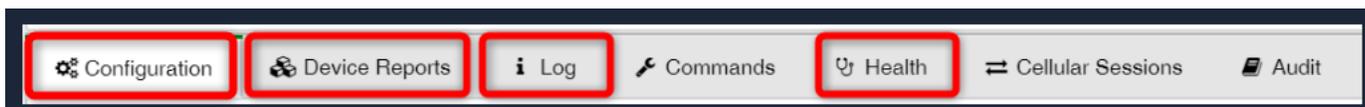
Communication problems may occur if there are disruptions with the external antenna, low battery, misconfigured streams, or inability to reach the cellular network provider.

- Confirm that an external antenna is connected. An external antenna is required.
- See External Cellular Antenna - Overview, Recommended Practices, Installation.
- If no antenna is attached to the device, attach an antenna and check the transmission.

Geotech considers a device improperly installed if it does not use an external antenna.

If the device and antenna are in problematic areas, for example, in hilly regions or in manholes, get a photo of both the device and antenna.

In the UI, check the following tabs for the device:



**Configuration tab** - what is the retry frequency to reconnect to the cellular network?

- If the device fails to connect to a cellular network (both HTTP and MQTT), the device will retry to connect according to the value of the parameter  
 GSM>HOME\_INTERVAL\_RETRY\_ARRAY>home\_interval\_retry\_minutes. This parameter will affect connection retries in the Normal, Event, and Emergency transmission intervals. In the meantime, the device will continue to collect and store data. The transmission frequency is automatically reduced to

conserve power until communications can be successfully re-established, at which point the device returns to its normal transmission frequency.

In the Advanced Device Configuration area, check **GSM > HOME\_INTERVAL\_RETRY\_ARRAY**. Each number, 0-5, represents the number of connection retries:

- 0 - 1st delay after a connection failure. Has not yet retried to connect.
- 1 - The 1st connection retry. The 2nd (consecutive) connection failure delay.
- 2 - The 2nd connection retry. The 3rd (consecutive) connection failure delay.
- 3 - The 3rd connection retry. The 4th (consecutive) connection failure delay.
- 4 - The 4th connection retry. The 5th (consecutive) connection failure delay.
- 5 - The 5th connection retry. The 6th (consecutive) connection failure delay.

For each connection retry, check the value of **home\_interval\_retry\_minutes**.

**Commands tab** - what commands were sent to the device just before the problem started? Click the command to see what specific command was sent before the problem occurred. The following are commands that might cause issues:

- The Server Address is incorrect. In the Advanced Device Configuration area, check HTTP > Server Address
- The external antenna is not selected. In the Advanced Device Configuration area, check GSM > Antenna Selection
- SIM and APN are not configured correctly. In the Advanced Device Configuration area, check GSM > gsm\_apn\*, GSM > gsm\_sim\*, and GSM > lkgc\_gsm\*

Log tab - any communication errors listed in the Message column? Look for strings such as BATTERY\_LOW, FAILED, and SIM. Look for which network carrier is used.

- CREG +0,1 = Connected to a network, with a designated SIM card (VERIZON) Not Roaming
- CREG 0,2 = Looking for a network
- CREG 0,3 = SIM not activated
- CREG 0,4 =
- CREG 0,5 = Connected to a network, Roaming

Device Reports tab - Check the [Device Reporting Profile](#).

[Health tab](#) - Check for a number of boot counts and errors.

In the UI, check the following technical streams for the device:

- Battery Life (or Status) - how much of the battery is left? If the battery is low, connect the device to external power. External power will restore communication until the battery is replaced.
- GSM (or Cellular Signal Strength or Signal Strength) - indicates the strength of the modem signal. If the signal strength is weak, reposition the antenna until the signal strength is stronger. Also, check that the antenna is properly connected.
- Internal Humidity - indicates how much moisture is in the device. Replace desiccants when internal humidity is 70% or higher.

### **What happens to the data when communication is lost?**

You cannot retrieve data samples manually via the USB port until communication is restored.

If communication was down for less than three days, data samples will be transmitted as soon as the communication is restored.

If communication is down for a longer period, the data samples will be transmitted as soon as the communication is restored, but **the samples have the date 1970-01-01**.

## 7.7. Transmission Problems

How to troubleshoot various problems you might have with the device transmission.

**Problem:** The Wavelet is on, and data samples are being taken, but the device is not transmitting data samples.

### Before You Begin:

1. Check that the device is turned on and is not in Hibernation mode.
2. If the device is not transmitting at all, do the following actions:
  - a. Check communication and battery.
  - b. The device will reboot itself after a set number of days (the value of the device's Watchdog > reset\_period parameter). If you do not want to wait several days, swipe the magnetic Activation Key over the embossed logo on the face of the device.
3. If the device is LoRa-enabled or LoRa-only, note the following points:
  - a. LoRa communication only transmits data but not commands.
  - b. LoRa has its own transmission schedule, and there is a limited number of transmissions per hour. If you exceed the limit, data is lost. Consequently, alert data might also be lost.
  - c. For details, see Understanding LoRa Transmission.

### IS the device on an On-Premises Server?

If the device was moved to an on-premises server, check that the MQTT server is communicating with the on-premises server and not with the cloud server. Also, check that MQTT is enabled and configured.

1. Check the MQTT settings for the device in **Device > Advanced Device Configuration > GSM:**
  - a. MQTT Server Address should be changed from mqtt.Ayyeka.com to the IP address of the on-premises server.
  - b. MQTT Server Port should be 8883.

## Transmitting Technical Stream Data Only?

1. If the device is transmitting technical stream data but not data stream samples, do the following checks:
  - a. Check the Sample tab of the data stream:
    - i. Are there any sample values?
    - ii. Are there sample values but that are out-of-range (as determined in the Configuration & Threshold tab)?
  - b. If there are no sample values whatsoever, check the MQTT settings for the device in **Device > Advanced Device Configuration > GSM:**
    - i. MQTT Server Address
    - ii. MQTT Server Port
    - iii. LKGC MQTT Server Address
    - iv. LKGC MQTT Server Port

## Is the User Near the Device?

- **No, the user is not near the device**

If the user is not in proximity to the device, check the following items in the UI:

- Check the Battery Life (or Battery Status in older FW) and GSM Signal Strength technical streams.
- Check information in the following tabs for the device:



## Health

Check the counters in the following columns:

- Boot Count - The number of times the device booted up since it was activated. Is the count increasing?
- Boot Reason - The reason for the latest device reboot. Is there any Watchdog reset or brownout (indicates low battery)? If there are several Watchdog resets, contact Geotech Support.
- GSM No Creg - The number of times that the device was unable to register on the cellular network. Indicates communication problems.
- GSM Error - The number of times that transmission failed. Indicates battery or signal problems.
- GSM Modem Dead - Any value other than 0 indicates a problem with the modem itself. Contact Geotech support for RMA.
- GSM No Operator (in FW versions 2.320 and later) - Any value other than 0 indicates that the device is struggling to find a cellular network operator.

## Device Reports

- Check the Files Received column to see if it is stuck on 199 and has not completed. This issue might be from an antenna problem.
- Check the Files Sent column for the number of files sent from the server to the device. These files are typically commands, such as 'get config', 'set config', or 'reboot'.
- Check the method of communication (MQTT, HTTP).

## Log

Check the Message column for any mention of the following problems:

- Battery Low - Connect external power or [replace the battery](#).
- Failed reading from SD card - Contact Geotech Support.
- Failed opening link - the device is struggling to communicate. Check antenna and signal strength.
- Operator + Technology - Check if there is frequent switching between operators or between technologies. Frequent switching indicates that the device is spending time with network cellular providers.
- Wait three days for a Watchdog Reset (in the Log tab) to occur. Alternatively, go out to the field and physically examine the device.

## Yes, the user is near the device

If the user is in proximity to the device:

1. If the FW version is 2.279 or later, use the AyyekaGo mobile app to do the following steps:
2. Select the Wavelet that does not transmit.
3. Check that the CARRIER strength is 70% or higher.
4. Check that you meet the antenna [placement guidelines](#). If needed, move the antenna to a different position.
5. Force a transmission by either of the following methods:
  - a. In the mobile app, click Transmit Now.
  - b. Ask the user to swipe a magnetic Wavelet Activator over the face of the device.

**Important:** There will be a few minutes of delay between a successful transmission and the use of either the Transmit Now command or the Wavelet Activator for initiating data transmission. Repeating either method will not expedite data transmission.

Check the [LED lights](#) on the device to find the device status as it transmits.

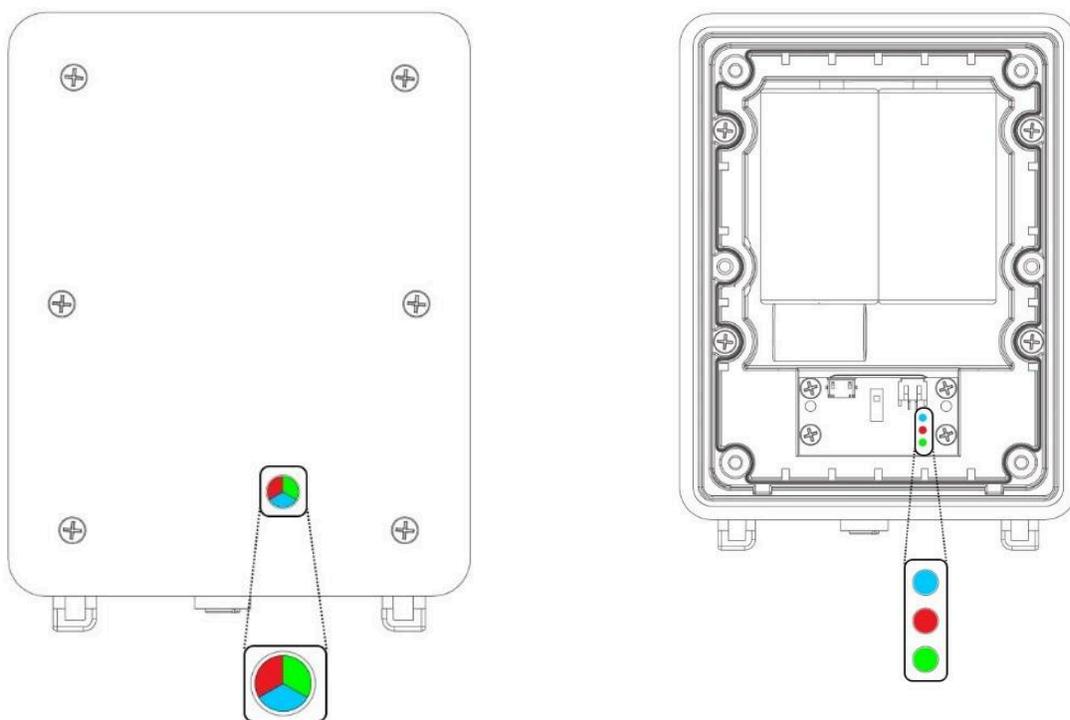
## 7.8. LED Light Status Indicators and Calibration Mode

The three LED lights (green, red, and blue) on the interface board of a Wavelet V2™ and Wavelet Ex™ provide indications of the device's status. The Wavelet 4R™ has one LED light (green).

### 7.8.1. Viewing the Indicator LEDs

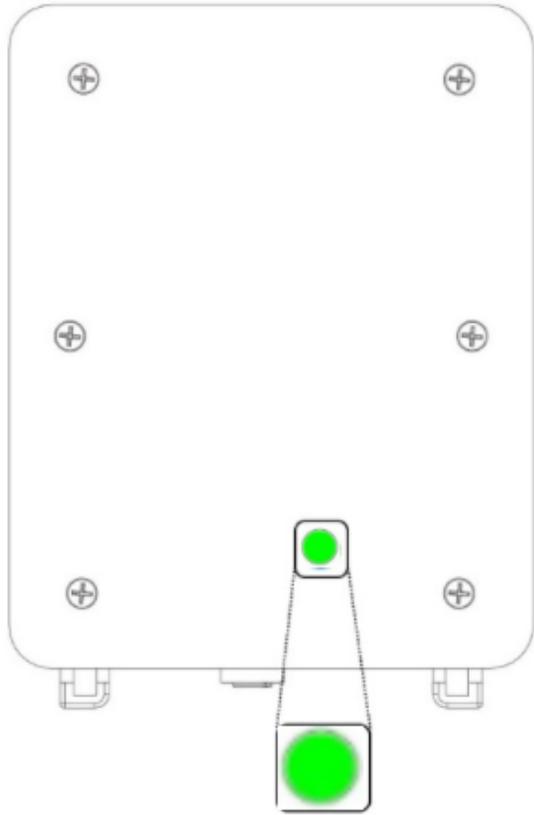
In the device, a round window on the back enables you to see the three indicator LEDs (green, red, and blue). View the LED status through that window.

Note that opening the enclosure can affect the humidity levels in the enclosure. If this is the first time you are opening the enclosure, contact Geotech.

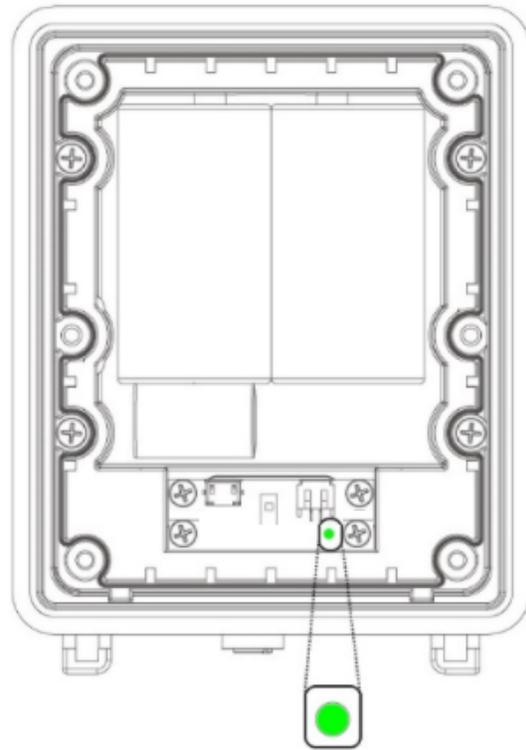


Location of the round window - Wavelet sealed

Location of LEDs - Wavelet opened



**Location of the round window - Wavelet 4R sealed**



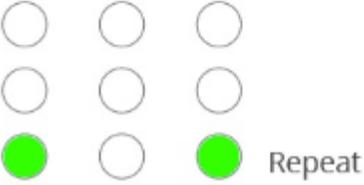
**Location of LEDs - Wavelet 4R opened**

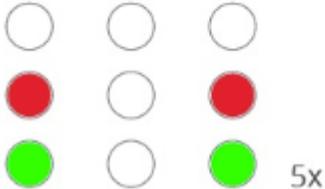
### 7.8.2. LED Status Indications for Wavelet 4R

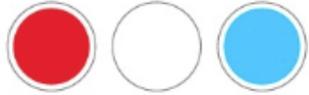
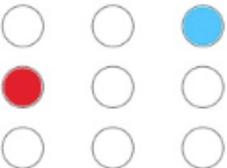
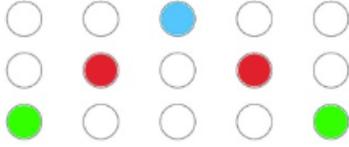
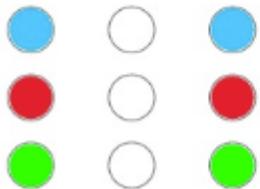
The following table lists the LED light status for devices

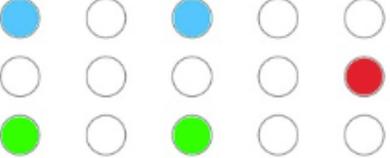
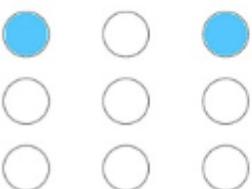
Green LED Status	Interpretation
The LED is off	<p>Not connected to the network. The LED light does not blink when the device is sampling.</p> <p><b>Note:</b> The device might be powered down (the power switch is in the OFF position), in Hibernate mode, or have insufficient battery power. Hibernate mode puts the device into an ultra-low power mode. The device will neither take samples nor transmit data.</p>
The LED blinks a long blink followed by a short blink - 3 times	The device is powering up.
The LED blinks 4 short blinks - 3 times	Communication error. The device failed to transmit.
The LED blinks 3 short blinks - 3 times	The device was just activated by swiping the Magnetic Activator key over the embossed logo on the face of the device. Next, the calibration activity starts, in which the device samples and transmits frequently.
The LED has 1 long blink - once	Communication is successful.

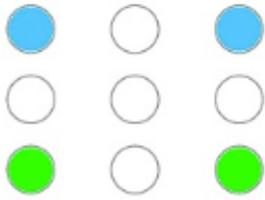
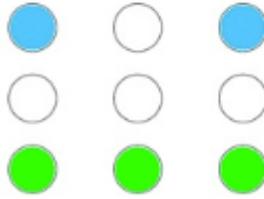
7.8.3. LED Status Indications for All Other Devices

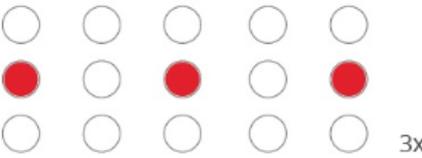
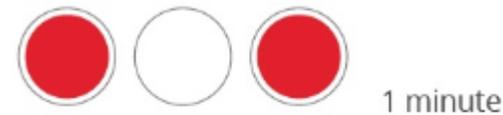
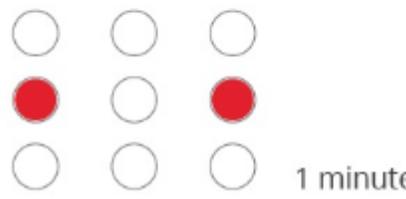
LEDs Status	Interpretation	Relevant for Wavelet version	Visual Indication
All LED are off	<p>Not connected to the network. The LED lights do not blink when the device is sampling.</p> <p><b>Note:</b> Wavelet may be powered down (the power switch is in the OFF position), in Hibernate mode, or have insufficient battery power. Hibernate mode puts the device into an ultra-low power mode. The device will neither take samples nor transmit data.</p>	All versions	<p>Lights when device is sealed:</p>  <p>Lights when device is open:</p> 
Green LED is blinking	Attempting to connect to the network.	All versions	<p>Lights when device is sealed:</p>  <p>Lights when device is open:</p> 

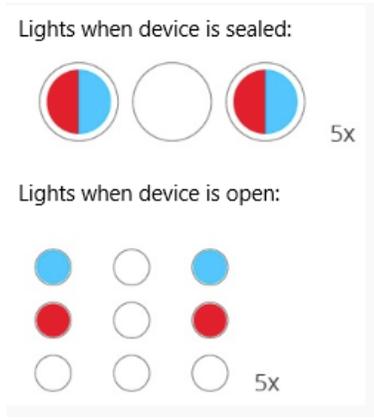
<p>Green LED remains on</p>	<p>Transmission of data is in progress; the LED will turn off when the transmission is complete.</p>	<p>All versions</p>	<p>Lights when device is sealed:</p>  <p>Lights when device is opened:</p> 
<p>Green and Red LEDs blink five times</p>	<p>Communication error. The device failed to transmit.</p>	<p>All versions</p>	<p>Lights when device is sealed:</p>  <p>Lights when device is open:</p> 

<p>Red and Blue LEDs blink sequentially for an hour</p>	<p>Wavelet has entered Hibernate mode. The red and blue LEDs blink sequentially during the first hour in Hibernate mode. Hibernate mode puts the device into an ultra-low power mode. The device will neither take samples nor transmit data.</p>	<p>All versions</p>	<p>Lights when device is sealed:</p>  <p>60 minutes</p> <p>Lights when device is open:</p>  <p>60 minutes</p>
<p>Green-Red-Blue-Red-Green LEDs blink sequentially five times</p>	<p>Wavelet is activated by swiping the Magnetic Activator key over the embossed logo on the face of the device. Next, the Wavelet calibration activity starts, in which the Wavelet samples and transmits frequently.</p>	<p>All versions</p>	<p>Lights when device is sealed:</p>  <p>5x</p> <p>Lights when device is open:</p>  <p>5x</p>
<p>Green, Red, Blue LEDs blink five times</p>	<p>The bootloader starts up when the device powers up. Power-up is typically followed by a firmware boot sequence.</p>	<p>All versions</p>	<p>Lights when device is sealed:</p>  <p>5x</p> <p>Lights when device is open:</p>  <p>5x</p>

<p>Green and Blue LEDs blink twice, then Red</p>	<p>Firmware is booting.</p>	<p>All versions</p>	<p>Lights when device is sealed:</p>  <p>Lights when device is open:</p> 
<p>Blue LED is blinking</p>	<p>Bootloader is active, not connected to the network.</p>	<p>All versions</p>	<p>Lights when device is sealed:</p>  <p>Repeat</p>
	<p>If the Wavelet has an additional LPWAN board, the blinking blue LED indicates the Wavelet is attempting to connect to the LoRa network.</p>	<p>LoRa-enhanced Wavelet</p>	<p>Lights when device is open:</p>  <p>Repeat</p>

<p>Blue and Green LEDs are blinking</p>	<p>Bootloader is active, trying to connect to network.</p>	<p>All versions</p>	<p>Lights when device is sealed:</p>  <p>Repeat</p> <p>Lights when device is open:</p>  <p>Repeat</p>
<p>Blue LED is blinking, Green LED is constantly ON</p>	<p>Bootloader is active, upgrading firmware.</p>	<p>All versions</p>	<p>Lights when device is sealed:</p>  <p>Repeat</p> <p>Lights when device is open:</p>  <p>Repeat</p>

<p>Red LED blinks three sequences of three short blinks each</p>	<p>Battery charge was just measured and is low (battery charge is measured after each transmission and each sensor sampling). Replace the battery pack.</p>	<p>Wavelet, Firmware version 2.239 and newer</p>	<p>Lights when device is sealed:   3x</p> <p>Lights when device is open:   3x</p>
<p>Red LED blinks for one minute</p>	<p>Battery voltage is too low to perform data transmission. If the battery is not empty, and the transmission/sampling frequency is not too high, the voltage will eventually rise and data will be transmitted.</p>	<p>Wavelet 4, version 2.239 and newer</p>	<p>Lights when device is sealed:   1 minute</p> <p>Lights when device is open:   1 minute</p>
<p>Blue LED remains on</p>	<p>Transmission of data over LoRa is in progress; the LED will turn off when transmission is complete.</p>	<p>LoRa-enhanced Wavelet</p>	<p>Lights when device is sealed:  </p> <p>Lights when device is open:  </p>

<p>Blue and Red LEDs blink five times</p>	<p>LoRa communication error. The device failed to transmit.</p>	<p>LoRa-enhanced Wavelet</p>	
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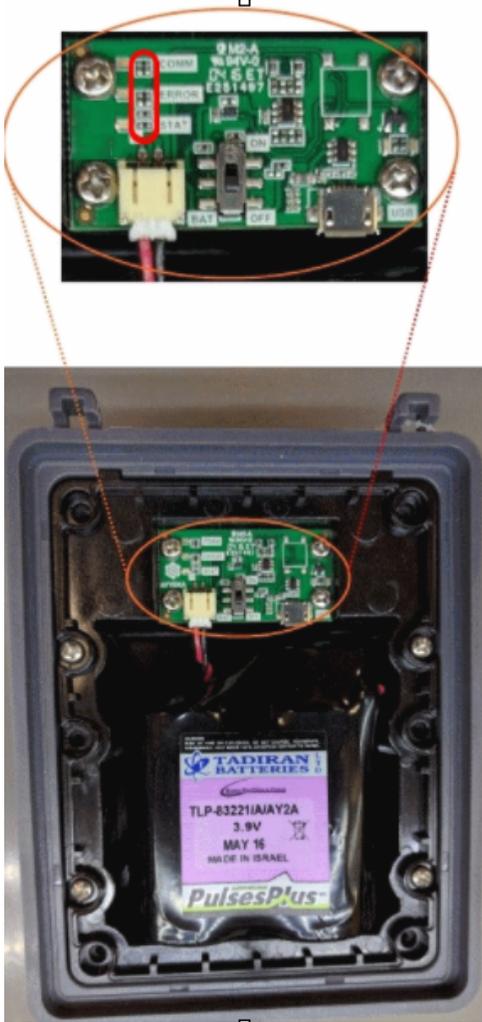
#### 7.8.4. Accessing the Interface Board LEDs

##### To access the Wavelet's interface board LEDs:

Partially unscrew the six (6) screws located on the back of the Wavelet enclosure, until you can lift off the back panel.

**Note:** The Wavelet 4R device has only a green LED.

The other devices have three LEDs (**COMM**, **ERROR**, and **STAT**) that are on the interface board, as shown in the figure below. The **COMM** LED is green, the **ERROR** LED is red, and the **STAT** LED is blue.



## 7.8.5. Calibration Mode

Calibration mode is the state of the device during its boot up. While in Calibration mode, no changes are made to the device's configuration.

A device goes into Calibration mode when you do any of the following actions:

- The Reboot command is generated by the FAI Pro/FAI Local platform when some commands are sent. Additionally, a "Reboot" command can be sent from the AyyekaGo mobile app.

For example, this command is sent automatically when a device's configuration is changed.

- You swipe the magnet over the embossed logo on the front of the device.

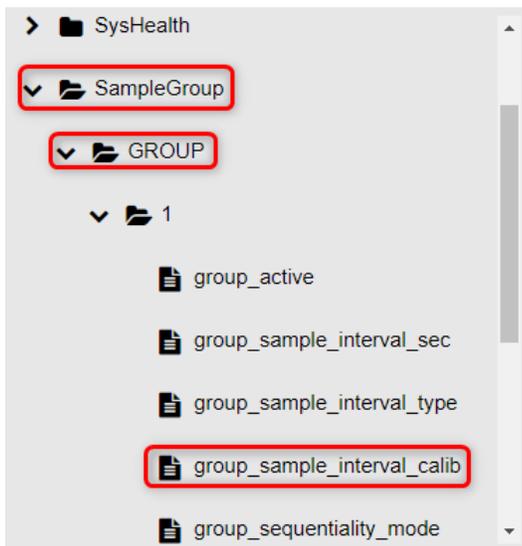
For example, you swipe the magnet if you want to force an immediate transmission of sample data rather than wait for the next scheduled transmission.

- You perform a manual reboot by turning the ON/OFF switch found on the top PCB board of the device to the OFF position, and then later turning it to the ON position.

For example, you turn the ON/OFF switch when changing the device's desiccants or battery.

Calibration mode affects the following device functions:

- Transmission – During calibration, the device does not transmit at its regular transmission rate. Instead, the device transmits more frequently (every 1-3 minutes) for the next 10-15 minutes.
- Data Sampling – During calibration, the device does not sample at its regular sampling interval rate (as defined in ADVANCED DEVICE CONFIGURATION > SampleGroup > GROUP > # > group\_sample\_interval\_calib).



- Bluetooth® - By default, Bluetooth is not enabled in order to conserve the battery. In Calibration mode, Bluetooth is enabled as long as the device is in Calibration mode (10-15 minutes) or as long as the device is connected to the mobile app.

## **8. General**

### 8.1. Device Quick Start Guides

You can download the Quick Start Guide in PDF format for your device.

#### **8.1.1. Wavelet V2™**

#### **8.1.2. Wavelet 4R™**

#### **8.1.3. Wavelet Ex V2™**

### 8.2. Supported Accessories

The Ayyeka Wavelet range is compatible with most typical industrial sensors available on the market using the following Interface types:

- MODBUS RTU
- SDI-12
- 4-20mA
- 0 - 24V
- Pulse

Cellular Antenna Patch Taoglas GSA.8827.A.101111

Cellular Antenna Dome Laird TRA6927M3PWN-001

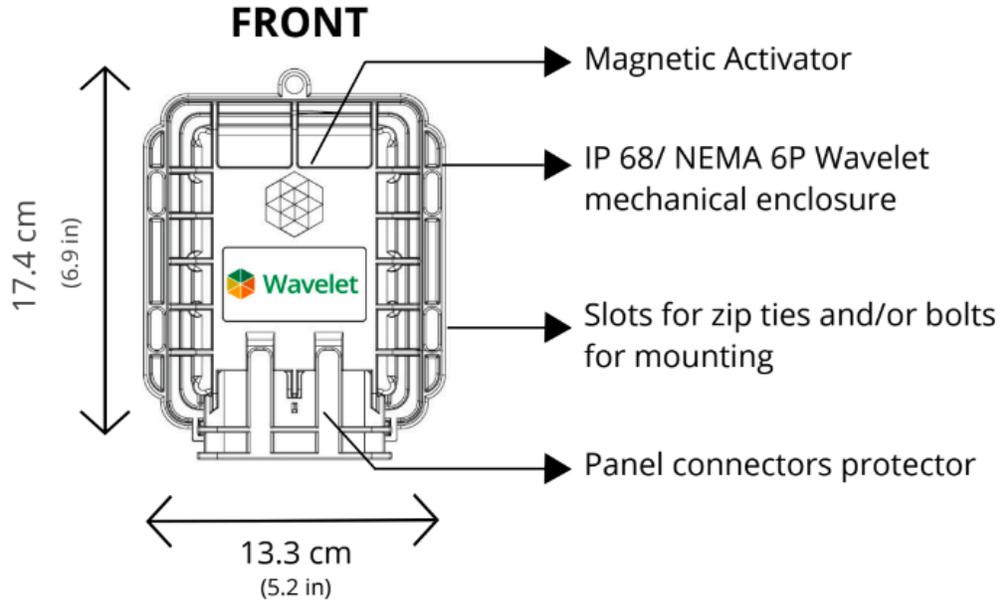
Cellular Antenna - Magnetic Mount APAMSLJ-164

WA00222\_External In-Road Antenna\_Installation Guidelines

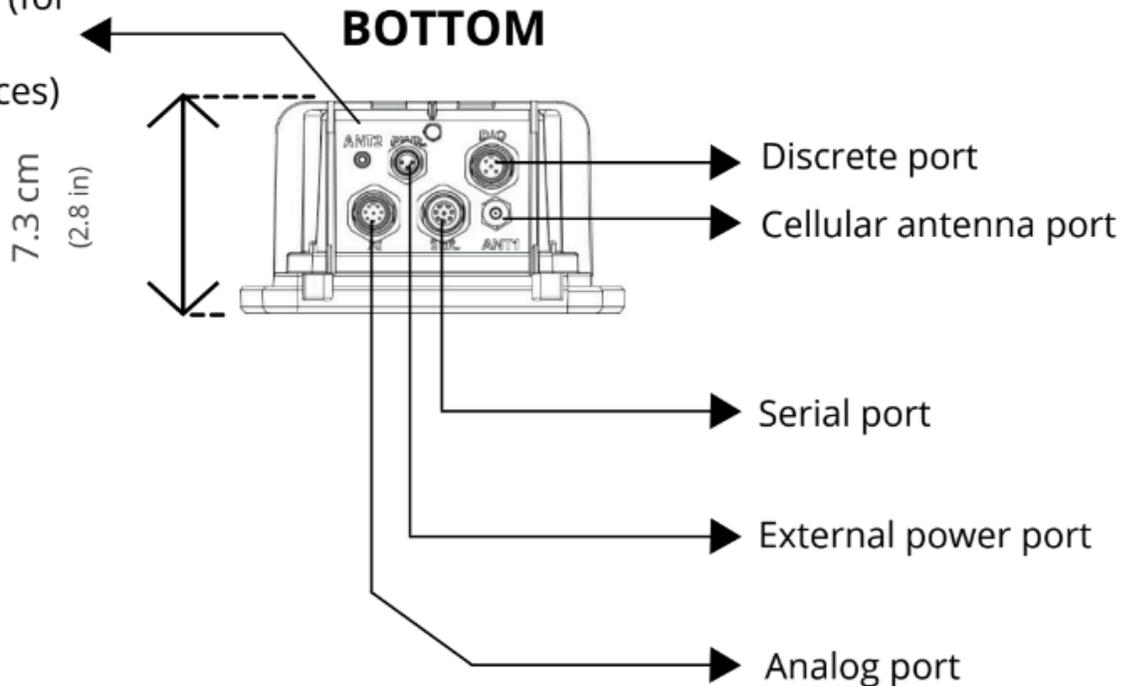
Indoor Power Supply, US Wall Plug Triad WSU120-2000-R

8.4. Device Mechanical Drawings

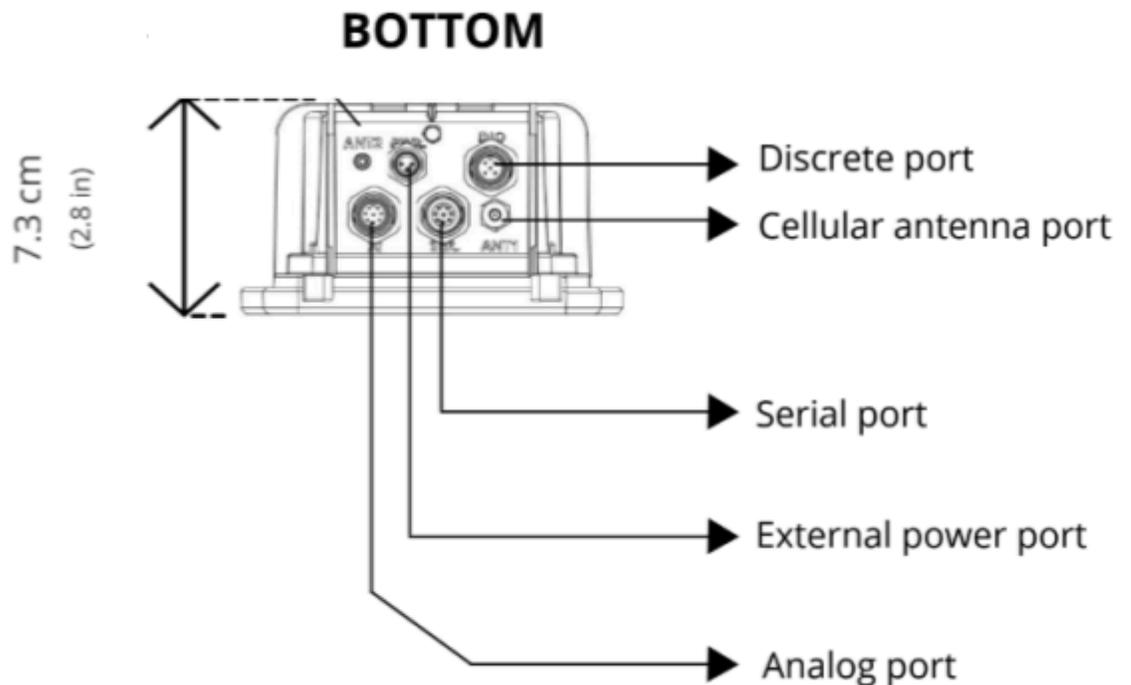
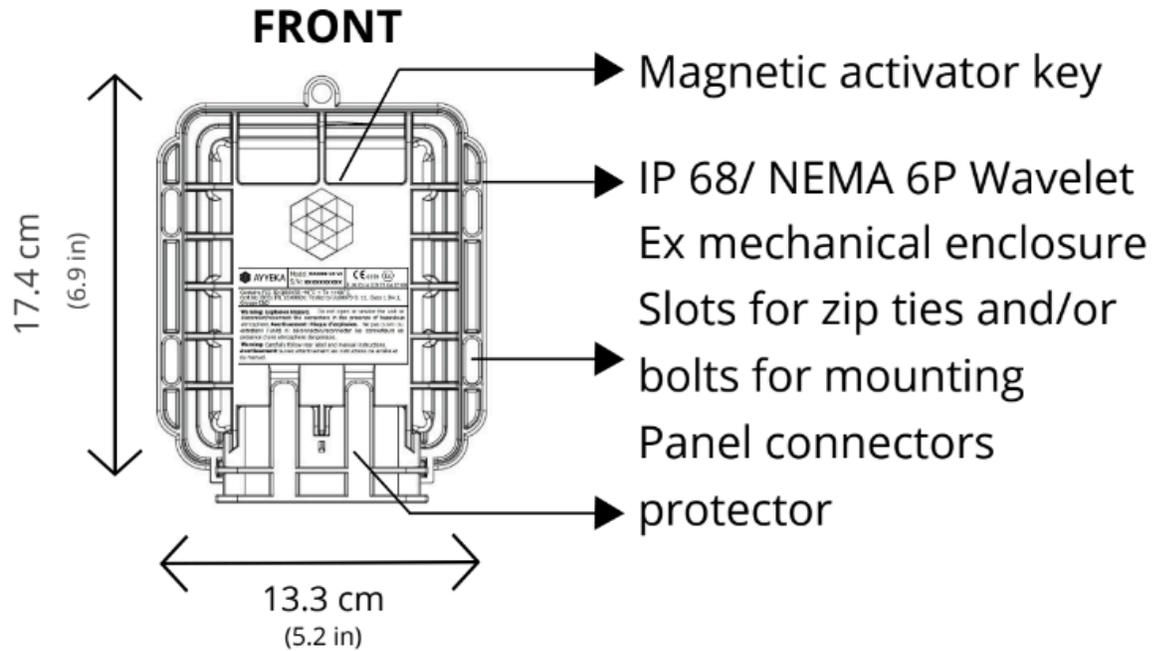
8.4.1. Wavelet V2 device.



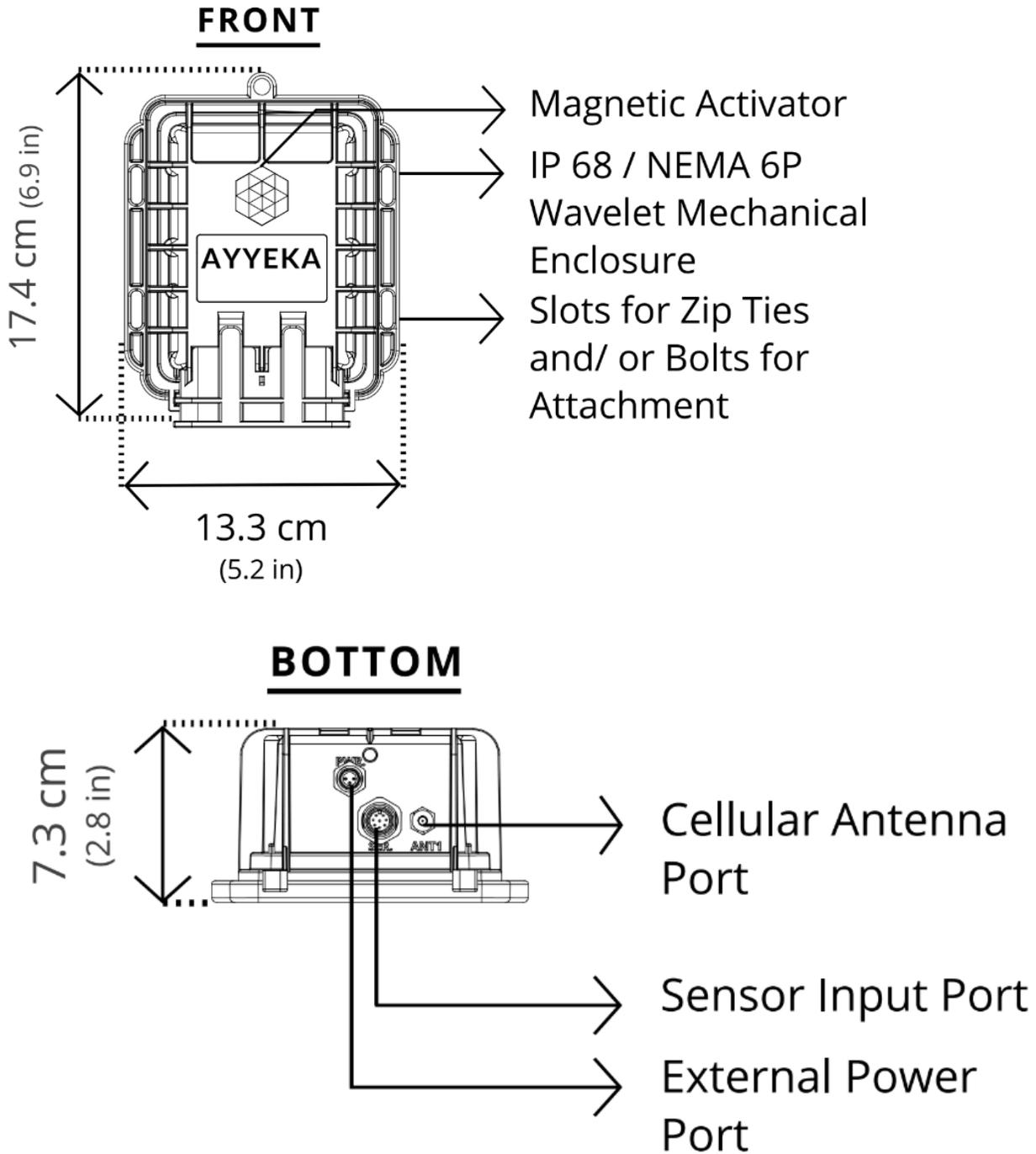
LoRaWAN antenna port (for LoRaWAN-enabled devices)



8.4.2. Wavelet Ex V2



8.5. Wavelet 4R



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## 9. Device Pinouts

This article has links to download the pinout sheet of devices. **Every Wavelet model has a different pinout (pin-out) for each connector port.** If you are unsure which model you are wiring a sensor to, contact support. Be sure to have the device's serial number handy.

### 9.1. Wavelet 4R

For Wavelet 4R models, p\n WA4000 See pinout [here](#)

### 9.2. Wavelet Ex

For Wavelet Ex models, p\n WA3888-xx-V2, See pinout [here](#)

### 9.3. Cable Splitter Pinouts

Important: Cable splitters must not be used with Wavelet Ex™ (WA3888).

- [WA00146 2-Port Discrete Cable Splitter](#)
- [WA00155 4-Port Serial Cable Splitter](#)
- [WA00156 2-Port Serial Cable Splitter](#)
- [WA00157 4-Port Analog Cable Splitter](#)
- [WA00158 2-Port Analog Cable Splitter](#)
- [WA00277 2-Port Splitter for Wavelet 4R™](#)
- [WA00278 4-Port Splitter for Wavelet 4R™](#)
- [WA00287 5-Port Splitter for Wavelet 4R™](#)

### 9.4. Cable Assembly Pinouts

This article has links to download the pinout (pin-out) sheet of cable assemblies.

- [WA00138 Analog Cable Assembly:](#)
- [WA00140 Serial Cable Assembly:](#)
- [WA00141 Digital Cable Assembly:](#)
- [WA00148 Power Cable Assembly - all devices:](#)
- [WA00234 Intrinsically Safe Cable Assembly:](#)

## 9.5. Setting up scheduled data transmissions

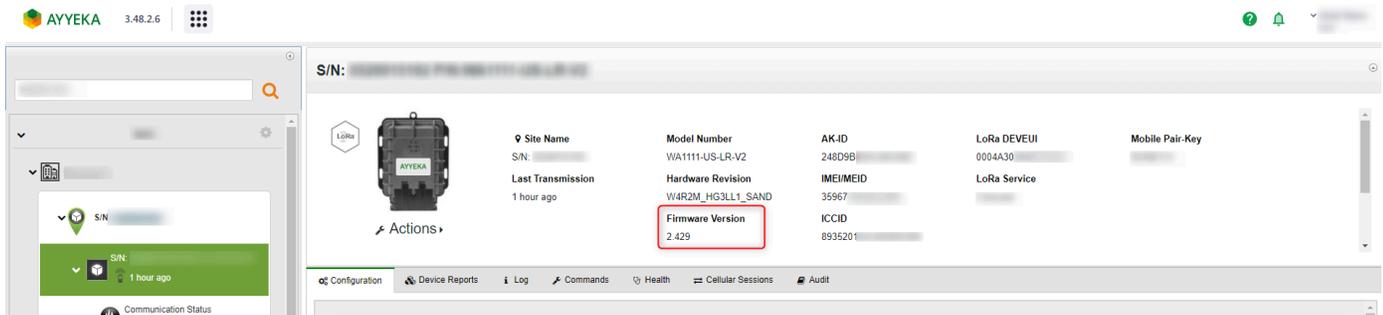
You can set up the Wavelet to schedule its data transmissions to the time of the day you prefer.

In some cases, there is a need to schedule the data transmission of the Wavelet to a specific time of the day (and not based on particular intervals). Wavelet devices only support this feature with firmware (FW) version 2.429 and above, and you can set it up in the advanced configuration of the Wavelet.

This article explains the setup for the scheduled transmission feature in a Wavelet.

### Step 1 - Confirm the Wavelet FW version supports the scheduled transmission feature

Use the FAI or the AyyekaGo mobile app to verify that the Wavelet has FW 2.429 or higher.



### Step 2 - Configure the feature in the advanced configuration

Use the advanced configuration to set up the scheduled transmission.

The feature allows scheduling events on the device on specified hours/dates. The schedules are encoded in Cron syntax.

Cron syntax

[Cron](#) is a job scheduler utility common in Linux systems. we adapted the Cron syntax to specify job schedules

a schedule string is made of 5 fields separated by spaces:

```

1 # _____ minute (0 - 59)
2 # | _____ hour (0 - 23)
3 # | | _____ day of the month (1 - 31)
4 # | | | _____ month (1 - 12) or JAN-DEC
5 # | | | | _____ day of the week (0 - 6) or SUN-SAT
6 # | | | | |
7 # | | | | |
8 # | | | | |
9 # * * * * *
```

A schedule transmission command (Cron job) will be executed if all the fields of the Cron expression match the current date/time.

The values of the fields can be either:

- wildcard: \* matches all
- simple values: e.g., 0 0 1 1 \* will match at 1/1 00:00 on any day of the week
- ranges: 0-3: e.g 0 12-17 \* \* \* will match on every round hour from 12:00 to 17:00
- intervals: \*/n matches on every nth division e.g \*/5 \* \* \* \* will match every 5 minutes

In addition, multiple values can be grouped into a field using commas:

e.g: \*/5 7-9,19-21 \* 1,5 \* will match on every 5 min between 7-9 am and 19-21 pm on January and May

## Examples

every Sunday at 13:00	0 13 * * 0
every 5 minutes between 7:00 and 14:00	*/5 7-14 * * *
every 1st of the month at 12:00 and 00:00	0 0,12 1 * *

You can create your Cron syntax online here - [link](#)

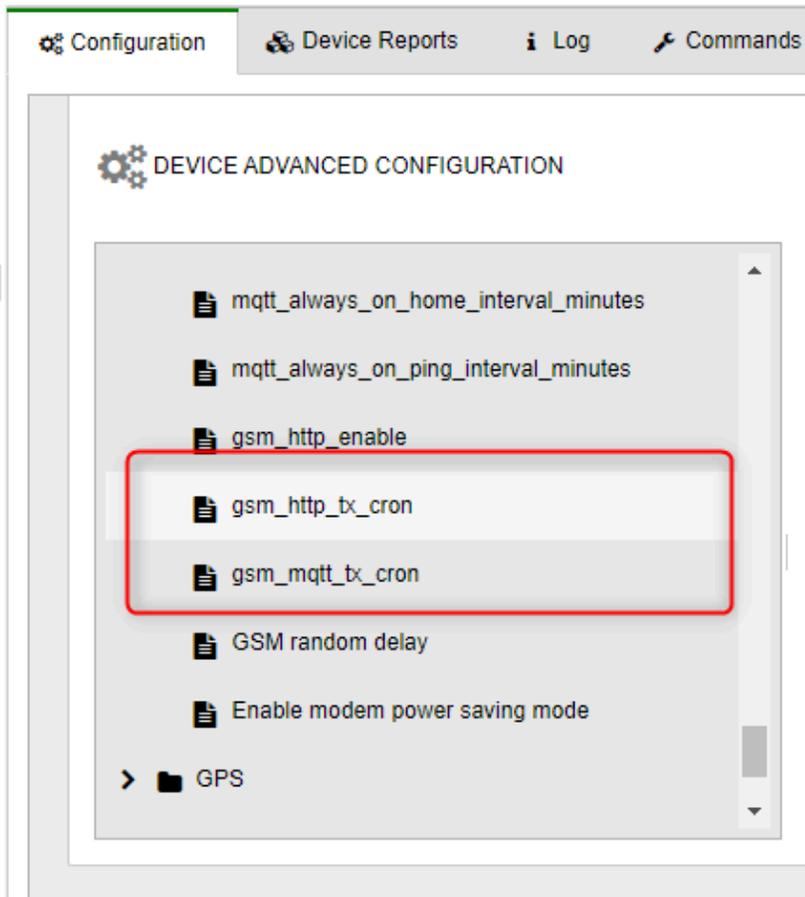
## Scheduled events in Wavelet

The Wavelet will execute Cron jobs when a cron expression matches the current datetime (in UTC)

Currently, we implemented two scheduled jobs: HTTP and MQTT transmissions.

HTTP transmission schedule can be set by writing a valid Cron expression to the `gsm->http_tx_cron` setting

MQTT transmission schedule can be set by writing a valid Cron expression to the `gsm->mqtt_tx_cron` setting the Cron transmission schedule is used in addition to the regular tx intervals (configured by `gsm_settings.http_tx_interval/mqtt_tx_interval`), so the Wavelet will transmit if either the cron expression is matched or an amount of time  $\geq$  tx\_interval has passed since last communication with the server.



### Known issues and recommendations:

- Try to keep scheduled events separated by at least 5 minutes or so
- It is recommended to set a long tx\_interval if the Cron schedule is to be used
- It's better to avoid expressions that have non-wildcard values at both the weekday and day-of-month fields, e.g., "0 \* \* 1 1" which means "every round hour on the 1st of the month and on Mondays": both weekday and month-day conditions need to be satisfied for the condition to match so this will only match when the 1st of the month falls on a Monday.

## **10. Appendix**

### 10.1. Ayyeka wavelet V2 VS. Wavelet 4R

The Wavelet V2 and the Wavelet 4R plug-and-play edge devices excel in any remote environment. Each model is uniquely designed to focus on different objectives. To best meet the needs of a specific deployment, the following differences should be considered:



**Wavelet V2** - Designed for ultimate versatility, the Wavelet V2 supports up to 12 separate sensors simultaneously on one device. The Wavelet V2 offers the most extensive sensor connection ports and cellular network connectivity in the market and is an ideal solution for any robust deployment.



**Wavelet 4R** - Designed for ultimate scalability, the Wavelet 4R is a cost-effective solution for sizable deployments. The Wavelet 4R offers the most popular Wavelet features and is best used for deployments at multiple sites with an identical application.

Both the Wavelet V2 and Wavelet 4R offer comprehensive cybersecurity protection, total compatibility with Ayyeka's Field Assets Intelligence™ (FAI) software platform, and the rugged IP68 design of the Wavelet product line. Both Wavelets are compatible with the AyyekaGo mobile app as well as the full set of safety and radio certifications.

The primary differences between the Wavelet V2 and Wavelet 4R are:

	Wavelet V2	Wavelet 4R
# Analog inputs	4	2
# Digital inputs	5	2
Serial inputs	RS485, RS232, and SDI-12	RS485 and RS232
Internal Antenna & GPS	Yes	No
Internal memory size	~500 million data points	~1 million data points
Internal humidity sensor	Yes	No
SIM cards	2 SIM slots (3FF form factor)	1 SIM slot (4FF form factor)
Serial, digital, & analog ports	3 separate ports	All-in-one

10.2. Pinout Wavelet V2

Model#: WA1111-xx-V2

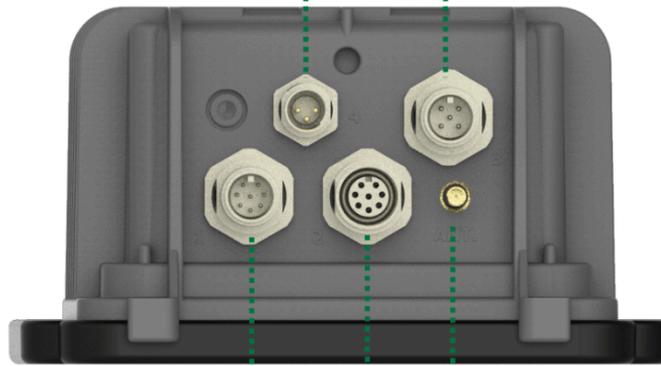
Front view



**Panel connector #4**  
M8 3-pin male

**Panel connector #3**  
M12 5-pin male

Bottom view



**Panel connector #1**  
M12 8-pin male

**Antenna connector**  
SMA female

**Panel connector #2**  
M12 8-pin female

## Pinout: Wavelet V2

Model#: WA1111-xx-V2

### PANEL CONNECTOR #1 – M12 8-PIN MALE

Connector Pin #	Signal	Cable Connector Pin Assignment	
		Front	Back
1	4-20mA or 0-27.5V Input #1		
2	IO_4 – periodic or output Dry contact, open drain, 0V or 2.8V (max)		
3	Wavelet 12V Power Supply #2 (+)		
4	Wavelet 12V Power Supply #1 (+)		
5	4-20mA or 0-27.5V Input #4		
6	4-20mA or 0-27.5V Input #3		
7	4-20mA or 0-27.5V Input #2		
8	GND		

### PANEL CONNECTOR #2 – M12 8-PIN FEMALE

Connector Pin #	Signal	Cable Connector Pin Assignment	
		Front	Back
1	RS232 TX		
2	Wavelet 12V Power Supply #4 (+)		
3	Wavelet 12V Power Supply #3 (+)		
4	SDI-12		
5	RS485 B		
6	RS485 A		
7	RS232 RX		
8	GND		

### PANEL CONNECTOR #3 – M12 5-PIN MALE

Connector Pin #	Signal	Cable Connector Pin Assignment	
		Front	Back
1	PCNT_0 – pulse counting, edge, periodic, output Dry contact, open drain, 0V or 2.8V (max)		
2	IO_3 – periodic or output Dry contact, open drain, 0V or 2.8V (max)		
3	PCNT_1 – pulse counting, edge, periodic, output Dry contact, open drain, 0V or 2.8V (max)		
4	GND		
5	IO_2 – edge, periodic, output Dry contact, open drain, 0V or 2.8V (max)		

### EXTERNAL POWER – PANEL CONNECTOR #4 – M8 3-PIN MALE

Connector Pin #	Signal	Cable Connector Pin Assignment	
		Front	Back
1	6-24VDC		
3	No Connection		
4	Negative (-)		

## Pinout: Wavelet V2

---

Model#: WA111-xx-V2



### **IMPORTANT NOTES:**

Only one RS232 device can be connected simultaneously.

The RS232 TX signal line of a sensor should be connected to the pin for RS232 RX signal of the Wavelet, and the RS232 RX signal line should be connected to the pin for the RS232 TX signal line of the Wavelet.

The RS485 A signal line of a sensor should be connected to the pin for RS485 A signal of the Wavelet, and the RS485 B signal line should be connected to the pin for the RS485 B signal line of the Wavelet.

10.3. Pinout: Wavelet 4R

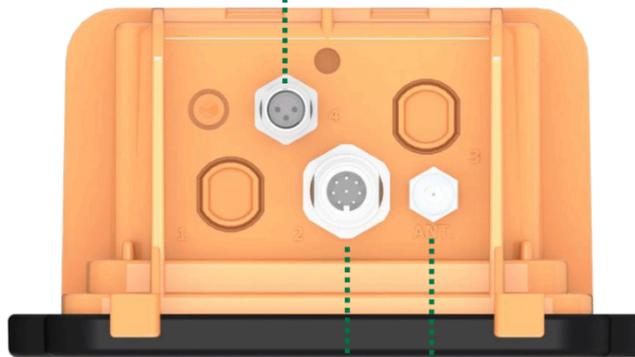
Model#: WA4000-xx

Front view



**Panel connector #4**  
M8 3-pin male

Bottom view



**Antenna connector**  
SMA female

**Panel connector #2**  
M12 8-pin male

## Pinout: Wavelet 4R

Model#: WA4000-xx

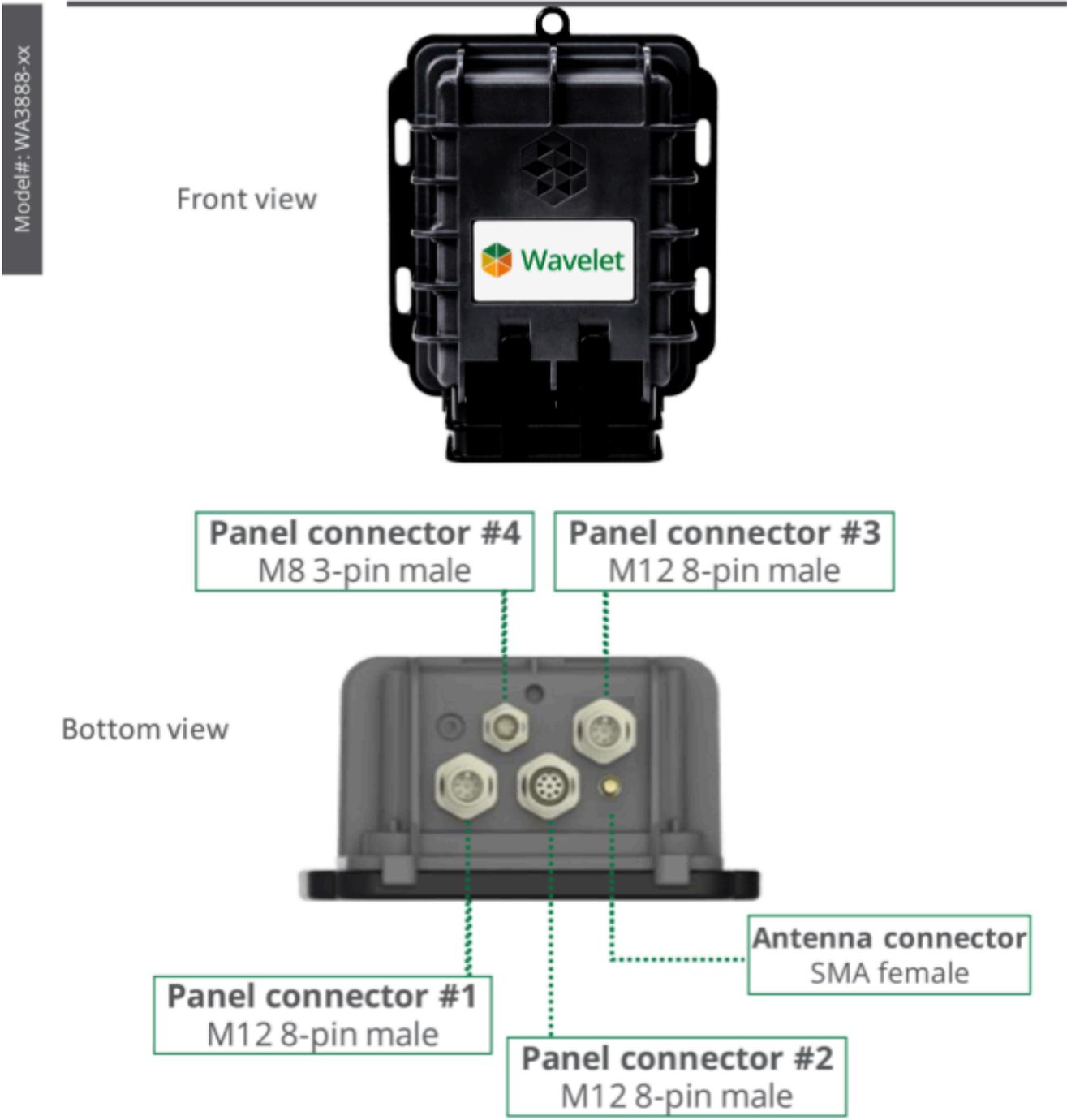
### PANEL CONNECTOR #2 – M12 8-PIN MALE

Connector Pin #	Signal	Cable Connector Pin Assignment	
		Front	Back
1	4-20mA or 0-24V Input #1		
2	PCNT_0 – pulse counting, edge, periodic, output Dry contact, open drain, 0V or 2.8V (max)		
3	RS485 A and RS232 RX		
4	Wavelet 12V Power Supply #1 (+)		
5	RS485 B and RS232 TX		
6	PCNT_1 – pulse counting, edge, periodic, output Dry contact, open drain, 0V or 2.8V (max)		
7	4-20mA or 0-24V Input #2		
8	GND		

### EXTERNAL POWER – PANEL CONNECTOR #4 – M8 3-PIN MALE

Connector Pin #	Signal	Cable Connector Pin Assignment	
		Front	Back
1	6-24VDC		
3	No Connection		
4	Negative (-)		

10.4. Pinout: Wavelet Ex V2



Model#: WA3888-xx-V2

## Pinout: Wavelet Ex V2

### PANEL CONNECTOR #1 – M12 8-PIN MALE

Connector Pin #	Signal	Cable Connector Pin Assignment	
		Front	Back
1	4-20mA or 0-24V Input #1		
2	PCNT_0 – pulse counting, edge, periodic, output Dry contact, open drain, 0V or 2.8V (max)		
3	RS485 A		
4	Wavelet 12V Power Supply #1 (+)		
5	RS485 B		
6	RS232 RX		
7	RS232 TX		
8	GND		

### PANEL CONNECTOR #2 – M12 8-PIN MALE

Connector Pin #	Signal	Cable Connector Pin Assignment	
		Front	Back
1	4-20mA or 0-24V Input #2		
2	PCNT_1 – pulse counting, edge, periodic, output Dry contact, open drain, 0V or 2.8V (max)		
3	RS485 A		
4	Wavelet 12V Power Supply #2 (+)		
5	RS485 B		
6	SDI-12		
7	IO_3 – periodic or output Dry contact, open drain, 0V or 2.8V (max)		
8	GND		

### PANEL CONNECTOR #3 – M12 8-PIN MALE

Connector Pin #	Signal	Cable Connector Pin Assignment	
		Front	Back
1	4-20mA or 0-24V Input #3		
2	IO_2 – edge, periodic, output Dry contact, open drain, 0V or 2.8V (max)		
3	RS485 A		
4	Wavelet 12V Power Supply #3 (+)		
5	RS485 B		
6	SDI-12		
7	IO_4 – edge, periodic, output Dry contact, open drain, 0V or 2.8V (max)		
8	GND		

### EXTERNAL POWER – PANEL CONNECTOR #4 – M8 3-PIN MALE

Connector Pin #	Signal	Cable Connector Pin Assignment	
		Front	Back
1	6-12VDC		
3	No Connection		
4	Negative (-)		

## Pinout: Wavelet Ex V2

Model#: WA3888-xx-V2

 **IMPORTANT NOTES:** Only one RS232 device can be connected simultaneously.

The RS232 TX signal line of a sensor should be connected to the pin for RS232 RX signal of the Wavelet, and the RS232 RX signal line should be connected to the pin for the RS232 TX signal line of the Wavelet.

The RS485 A signal line of a sensor should be connected to the pin for RS485 A signal of the Wavelet, and the RS485 B signal line should be connected to the pin for the RS485 B signal line of the Wavelet.

## **11. Warranty applicable to Ayyeka Wavelet products (the "Products").**

1. **Limited Warranty.** For a period of one year (unless specified otherwise in the manual) from date of first sale, product is warranted to be free from defects in materials and workmanship. Geotech agrees to repair or replace, at Geotech's option, the portion proving defective, or at our option to refund the purchase price thereof. Geotech will have no warranty obligation if the product is subjected to abnormal operating conditions, accident, abuse, misuse, unauthorized modification, alteration, repair, or replacement of wear parts. User assumes all other risk, if any, including the risk of injury, loss, or damage, direct or consequential, arising out of the use, misuse, or inability to use this product. User agrees to use, maintain and install product in accordance with recommendations and instructions. User is responsible for transportation charges connected to the repair or replacement of product under this warranty.