MULTITECH®

MultiTech LoRaWAN® Wireless Sensors

User Guide

MultiTech LoRaWAN Wireless Sensors

Models:

- RBS3010NA01BN00 / RBS3010EU01BN00 / RBS3010AU01BN00 LoRaWAN Door/Window Sensor (US915 / EU868 / AU915)
- RBS3010NA03BN00 / RBS3010EU03BN00 / RBS3010AU03BN00 LoRaWAN Dry Contact Sensor (US915 / EU868 / AU915)
- RBS3010NA05BN00 / RBS3010EU05BN00 / RBS3010AU05BN00 LoRaWAN External Probe Temperature Sensor (US915 / EU868 / AU915)
- RBS3010NA08BN00 / RBS3010EU08BN00 / RBS3010AU08BN00 LoRaWAN Accelerometer-based Movement Sensor (US915 / EU868 / AU915)
- RBS3010NA09BN00 /RBS3010EU09BN00 / RBS3010AU09BN00 LoRaWAN Tilt Sensor (US915 / EU868 / AU915)
- RBS3010NA0ABN00 / RBS3010EU0ABN00 / RBS3010AU0ABN00 LoRaWAN Water Leak Sensor with Probe (US915 / EU868 / AU915)
- RBS3010NA0ABN08 / RBS3010EU0ABN08 / RBS3010AU0ABN08 LoRaWAN Water Leak Sensor with 1M Water Rope (US915 / EU868 / AU915)
- RBS3010NA0ABN0B / RBS3010EU0ABN0B / RBS3010AU0ABN0B LoRaWAN Water Leak Sensor with 5M Water Rope (US915 / EU868 / AU915)
- RBS3010NA0ABN09 / RBS3010EU0ABN09 / RBS3010AU0ABN09 LoRaWAN Water Leak Sensor with 10M Water Rope (US915 / EU868 / AU915)
- RBS3010NA0EBN00 / RBS3010EU0EBN00 / RBS3010AU0EBN00 LoRaWAN Integrated Temperature and Humidity Sensor (US915 / EU868 / AU915)
- RBS3010NA19BN00 / RBS3010EU19BN00 / RBS3010AU19BN00 LoRaWAN Internal Temperature Sensor (US915 / EU868 / AU915)
- RBS3010NA22BN00 / RBS3010EU22BN00 /RBS3010AU22BN00 LoRaWAN Temp, Humidity and Water Leak Probe Sensor (US915 / EU868 / AU915)
- RBS3010NA22BN08 / RBS3010EU22BN08 / RBS3010AU22BN08 LoRaWAN Temp, Humidity and 1M Water Rope Sensor (US915 / EU868 / AU915)
- RBS304-1-US LoRaWAN Push Button Sensor (US915)
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- RBS306-ABM-US LoRaWAN Armored Acceleration-based Movement Sensor (US915)
- RBS306-ATH-EXT-US LoRaWAN Armored External Probe Air Temperature/Humidity Sensor (US915)
- RBS306-CON-US LoRaWAN Armored Dry Contact Sensor (US915)
- RBS306-MBHR-US LoRaWAN Armored Maxbotix HR Series Ultrasonic Sensor Bridge (US915)
- RBS306-TEMP-EXT-US LoRaWAN Armored External-Probe Temperature Sensor (US915)
- RBS306-TEMP-TC-US LoRaWAN Armored Thermocouple Temperature Sensor (US915)
- RBS306-TILT-HP-US LoRaWAN Armored High Precision Tilt Sensor (US915)
- RBS306-US10M-US LoRaWAN Armored Ultrasonic Level Sensor 10 Meter (US915)
- RBS306-VM30-US LoRaWAN Armored Voltage Sensor (US915)
- RBS306-VSHB-11-US LoRaWAN Vibration Sensor, single axis single probe (US915)
- RBS306-WR1M-US LoRaWAN Armored Water Rope Sensor 1 Meter (US915)
- RBS306-WR10M-US LoRaWAN Armored Water Rope Sensor 10 Meter (US915)
- RBS3010NA27BN00 / RBS3010EU27BN00 / RBS3010AU27BN00 LoRaWAN Door/Window Sensor with Air Temperature and Humidity (US915 / EU868 / AU915)

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Contents

1 Overview

This section provides an overview of the LoRaWAN Wireless Sensors by category with part numbers, rating, and region information.

LoRaWAN Door/Window Sensor

The LoRaWAN Door/Window Sensor uses a Hall effect sensor to register open/close events for doors and windows by detecting the presence of a magnet. The device sends both Door Opened and Door Closed events.

Part Number	Sensor Name	Rating	Region
RBS3010NA01BN00	LoRaWAN Door/Window Sensor	Indoor	US915
RBS3010EU01BN00	LoRaWAN Door/Window Sensor	Indoor	EU868
RBS3010AU01BN00	LoRaWAN Door/Window Sensor	Indoor	AU915

LoRaWAN Dry Contact Sensor

The LoRaWAN Dry Contact Sensors detect a shorted connection between two wires. The device sends both Contact Open or Contact Shorted events.

Part Number	Sensor Name	Rating	Region
RBS3010NA03BN00	LoRaWAN Dry Contact Sensor	Indoor	US915
RBS3010EU03BN00	LoRaWAN Dry Contact Sensor	Indoor	EU868
RBS3010AU03BN00	LoRaWAN Dry Contact Sensor	Indoor	AU915
RBS306-CON-US	LoRaWAN Armored Dry Contact Sensor	Outdoor/Industrial	US915

LoRaWAN External Temperature Sensor

The LoRaWAN External Temperature Sensors measure temperature in degrees Celsius using an external thermistor probe with a precision of 1 degree. Available alerts include upper and lower threshold crossing, incremental change, and periodic interval.

Part Number	Sensor Name	Rating	Region
RBS3010NA05BN00	LoRaWAN External Probe Temperature Sensor	Indoor	US915
RBS3010EU05BN00	LoRaWAN External Probe Temperature Sensor	Indoor	EU868
RBS3010AU05BN00	LoRaWAN External Probe Temperature Sensor	Indoor	AU915
RBS306-TEMP-EXT-US	LoRaWAN Armored External-Probe Temperature Sensor	Outdoor/Industrial	US915

LoRaWAN Acceleration-based Movement Sensor

The LoRaWAN Acceleration-based Movement Sensors use an accelerometer to detect any movement of the device that exceeds a configurable threshold. Available alerts include both movement started and movement stopped.

Part Number	Sensor Name	Rating	Region
RBS3010NA08BN00	LoRaWAN Accelerometer-based Movement Sensor	Indoor	US915
RBS3010EU08BN00	LoRaWAN Accelerometer-based Movement Sensor	Indoor	EU868
RBS3010AU08BN00	LoRaWAN Acceleration-based Movement Sensor	Indoor	AU915
RBS306-ABM-US	LoRaWAN Armored Acceleration-based Movement Sensor	Outdoor/Industrial	US915

LoRaWAN Tilt Sensor

The LoRaWAN Tilt Sensor detects transitions between horizontal and vertical orientation and reports the angle of tilt with a precision of 1 degree. Available alerts include upper and lower angle threshold crossing or incremental change.

Part Number	Sensor Name	Rating	Region
RBS3010NA09BN00	LoRaWAN Tilt Sensor	Indoor	US915
RBS3010EU09BN00	LoRaWAN Tilt Sensor	Indoor	EU868
RBS3010AU09BN00	LoRaWAN Tilt Sensor (Low Precision)	Indoor	AU915

LoRaWAN Water Leak Sensor

The LoRaWAN Water Leak Sensors will detect the presence of water using either a point-of-leak water sensor or rope water sensor. Water detection ropes are available in various lengths. Available alerts include both water present and not present.

Part Number	Sensor Name	Rating	Region
RBS3010NA0ABN00	LoRaWAN Water Leak Sensor with Probe	Indoor	US915
RBS3010EU0ABN00	LoRaWAN Water Leak Sensor with Probe	Indoor	EU868
RBS3010AU0ABN00	LoRaWAN Water Leak Sensor with Probe	Indoor	AU915
RBS3010NA0ABN08	LoRaWAN Water Leak Sensor with 1M Water Rope	Indoor	US915

Part Number	Sensor Name	Rating	Region
RBS3010EU0ABN08	LoRaWAN Water Leak Sensor with 1M Water Rope	Indoor	EU868
RBS3010AU0ABN08	LoRaWAN Water Leak Sensor with 1M Water Rope	Indoor	AU915
RBS3010NA0ABN0B	LoRaWAN Water Leak Sensor with 5M Water Rope	Indoor	US915
RBS3010EU0ABN0B	LoRaWAN Water Leak Sensor with 5M Water Rope	Indoor	EU868
RBS3010AU0ABN0B	LoRaWAN Water Leak Sensor with 5M Water Rope	Indoor	AU915
RBS3010NA0ABN09	LoRaWAN Water Leak Sensor with 10M Water Rope	Indoor	US915
RBS3010EU0ABN09	LoRaWAN Water Leak Sensor with 10M Water Rope	Indoor	EU868
RBS3010AU0ABN09	LoRaWAN Water Leak Sensor with 10M Water Rope	Indoor	AU915
RBS306-WR1M-US	LoRaWAN Armored Water Rope Sensor 1 Meter	Outdoor/Industrial	US915
RBS306-WR10M-US	LoRaWAN Armored Water Rope Sensor 10 Meter	Outdoor/Industrial	US915

LoRaWAN Air Temperature & Humidity Sensor

The LoRaWAN Air Temperature & Humidity Sensors measure ambient temperature in degrees Celsius and humidity in percent relative humidity. Both external probe and integrated sensor models are offered. Available alerts include independent upper and lower threshold crossing for temperature and humidity, independent incremental change for temperature and humidity, and periodic interval for both.

Part Number	Sensor Name	Rating	Region
RBS3010NA0EBN00	LoRaWAN Integrated Temperature and Humidity Sensor	Indoor	US915
RBS3010EU0EBN00	LoRaWAN Integrated Temperature and Humidity Sensor	Indoor	EU868
RBS3010AU0EBN00	LoRaWAN Integrated Temperature and Humidity Sensor	Indoor	AU915
RBS306-ATH-EXT-US	LoRaWAN Armored External Probe Air Temperature/Humidity Sensor	Outdoor/Industrial	US915

LoRaWAN Internal Temperature Sensor

The LoRaWAN Internal Temperature Sensor measures ambient temperature in degrees Celsius using an integrated CMOS sensor with a precision of 0.1 degrees. Available alerts include upper and lower threshold crossing, incremental change, and periodic interval.

Part Number	Sensor Name	Rating	Region
RBS3010NA19BN00	LoRaWAN Internal Temperature Sensor	Indoor	US915
RBS3010EU19BN00	LoRaWAN Internal Temperature Sensor	Indoor	EU868
RBS3010AU19BN00	LoRaWAN Internal Temperature Sensor	Indoor	AU915

LoRaWAN Air Temperature, Humidity, and Water Leak Sensor

The LoRaWAN Air Temperature, Humidity, and Water Leak Sensor will detect the presence of water as well as report ambient temperature and humidity. Water is detected using either a point-of-leak water sensor or rope water sensor. Water detection ropes are available in various lengths. Available alerts include both water present and not present, as well as independent upper and lower threshold crossing for temperature and humidity, independent incremental change for temperature and humidity, and periodic interval for temperature and humidity.

Part Number	Sensor Name	Rating	Region
RBS3010NA22BN00	LoRaWAN Temp, Humidity and Water Leak Probe Sensor	Indoor	US915
RBS3010EU22BN00	LoRaWAN Temp, Humidity and Water Leak Probe Sensor	Indoor	EU868
RBS3010AU22BN00	LoRaWAN Temp, Humidity and Water Leak Probe Sensor	Indoor	AU915
RBS3010NA22BN08	LoRaWAN Temp, Humidity and 1M Water Rope Sensor	Indoor	US915
RBS3010EU22BN08	LoRaWAN Temp, Humidity and 1M Water Rope Sensor	Indoor	EU868
RBS3010AU22BN08	LoRaWAN Temp, Humidity and 1M Water Rope Sensor	Indoor	AU915

LoRaWAN Push Button Sensor

The LoRaWAN Push Button Sensor can be used as a panic button, remote control, or for other remote push button applications. The device can send press, release, and hold events.

Part Number	Sensor Name	Rating	Region
RBS304-1-US	LoRaWAN Push Button Sensor	Indoor	US915

LoRaWAN 4-20mA Current Loop Sensor

The LoRaWAN 4-20mA Current Loop Sensor measures amperage of a 4-20mA current loop with a precision of 10uA. Available alerts include upper and lower threshold crossing, incremental change, and periodic interval.

Part Number	Sensor Name	Rating	Region
RBS306-420MA-US	LoRaWAN Armored 4-20mA Current Loop Sensor	Outdoor/Industrial	US915

LoRaWAN Ultrasonic Level Sensor

The LoRaWAN Ultrasonic Level Sensor (also MBHR Maxbotix Bridge) measures distance to a surface using an tethered Maxbotix ultrasonic probe with a precision of 1mm and a 10-meter range (MBHR supports multiple probe types with various resolutions and ranges). Available alerts include upper and lower distance threshold crossing, incremental change, and periodic interval.

Part Number	Sensor Name	Rating	Region
RBS306-MBHR-US	LoRaWAN Armored Maxbotix HR Series Ultrasonic Sensor Bridge	Outdoor/Industrial	US915
RBS306-US10M-US	LoRaWAN Armored Ultrasonic Level Sensor 10 Meter	Outdoor/Industrial	US915

LoRaWAN Thermocouple Temperature Sensor

The LoRaWAN Thermocouple Temperature Sensor measures temperature in degrees Celsius using a tethered thermocouple probe (Type K) with a precision of 0.01 degrees. Available alerts include upper and lower threshold crossing, incremental change, and periodic interval.

Part Number	Sensor Name	Rating	Region
RBS306-TEMP-TC-US	LoRaWAN Armored Thermocouple Temperature Sensor	Outdoor/Industrial	US915

LoRaWAN High-Precision Tilt Sensor

The LoRaWAN High-Precision Tilt Sensor detects transitions between horizontal and vertical orientation and reports the angle of tilt with precision of 0.1 degrees. Available alerts include upper and lower angle threshold crossing, incremental change, and periodic interval.

Part Number	Sensor Name	Rating	Region
RBS306-TILT-HP-US	LoRaWAN Armored High Precision Tilt Sensor	Outdoor/Industrial	US915

LoRaWAN Voltage Sensor

The LoRaWAN Voltage Sensor measures a voltage between 0-30V with a precision of 10mV. Available alerts include upper and lower distance threshold crossing, incremental change, and periodic interval.

Part Number	Sensor Name	Rating	Region
RBS306-VM30-US	LoRaWAN Armored Voltage Sensor	Outdoor/Industrial	US915

LoRaWAN Door/Window Sensor with Air Temperature and Humidity

The LoRaWAN Door/Window Sensor uses a reed switch sensor to register open/close events for doors and windows by detecting the presence of a magnet. The device sends both Door Opened and Door Closed events. The device also reports temperature and humidity readings.

Part Number	Sensor Name	Rating	Region
RBS3010NA27BN00	LoRaWAN Door/Window Sensor with Air Temperature and Humidity	Indoor	US915
RBS3010EU27BN00	LoRaWAN Door/Window Sensor with Air Temperature and Humidity	Indoor	EU868
RBS3010AU27BN00	LoRaWAN Door/Window Sensor with Air Temperature and Humidity	Indoor	AU915

2 Safety Instructions

Lithium Battery Safety

CAUTION: The battery used in this device may present a fire or chemical burn hazard if mistreated. Do not recharge, disassemble, heat above 100°C (212°F) or dispose of in fire. Replace battery with Panasonic CR123A. Use of another battery may present a risk of fire or explosion. Dispose of batteries according instructions.

ATTENTION: La batterie utilisée dans cet appareil peut présenter un risque d'incendie ou de brûlure chimique si elle est maltraitée. Remplacez la batterie par une Panasonic CR123A. Ne pas démonter, incinérer ou exposer à des températures supérieures à 100°C. Jeter les piles utilisé conformément aux instructions.

Lithium cells and batteries are subject to the Provisions for International Transportation. Multi-Tech Systems, Inc. confirms that the Lithium batteries used in the MultiTech product(s) referenced in this manual comply with Special Provision 188 of the UN Model Regulations, Special Provision A45 of the ICAO-TI/IATA[1]DGR (Air), Special Provision 310 of the IMDG Code, and Special Provision 188 of the ADR and RID (Road and Rail Europe).

User Responsibility

Keep the wireless sensor away from children.

Respect all local regulations for operating your wireless device. Use the security features to block unauthorized use and theft.

End user must operate product per country laws and rules.

3 Specifications

Absolute Maximum Ratings

Parameter	Rating
Operating ambient temperature (indoor version)	-20°C to +50°C*
Operating ambient temperature (outdoor version)	-40°C to +70°C
Storage ambient temperature	-40°C to +90°C

* Product with external probes should operate at a wider temperature range.

Battery Life

The sensor uses a lithium non-rechargeable battery, capable of an estimated 200,000+ messages.

Note: Refer to the Sensor Battery Estimator.xlsx spreadsheet on the on the sensor's product page for specific battery life estimates:

https://radiobridge.com/documents/Sensor%20Battery%20Estimator.xlsx

Battery life depends on the number of transmissions per day. Power required for a message transmission is greater than the “sleep current” for high power radio technologies (e.g, LoRaWAN).

Different battery chemical types deplete over time with different voltage profiles; a lithium battery maintains high voltage for the life of the battery with a rapid drop near the end of life, and an alkaline battery has gradual reduction in voltage over time. Sensors ship with a lithium battery, which is the recommended replacement type.

Recommended battery: Panasonic CR2 for RBS304 Push Button

Recommended battery: Panasonic CR123A for RBS301 and RBS306 devices

Battery life estimates in the online spreadsheet assume room temperature, meaning temperatures near the maximum and minimum ratings negatively impact battery life. Battery voltage lowers in cold temperatures, and internal circuitry needs a minimum voltage to operate properly.

See the Panasonic Energy Product Safety Data Sheet for more information on battery safety.

Note: Battery life will be reduced in cold environments leading to possible device shut down.

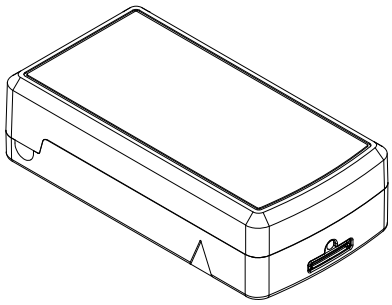
The battery voltage and a low battery indicator are reported by supervisory messages. Refer to the section on Message Protocol for details.

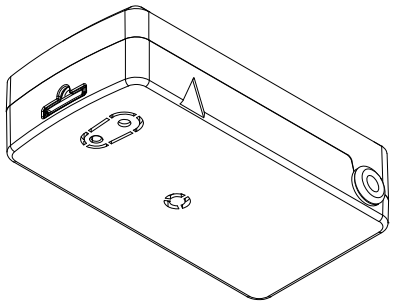
Mechanical Drawings

The mechanical drawings provided in this section are for the main body of the sensor. All dimensions use inches unless otherwise specified.

RBS301 Indoor Sensors

ISOMETRIC
TOP VIEW





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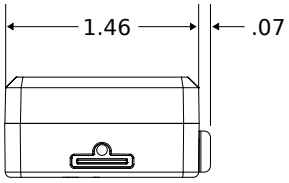

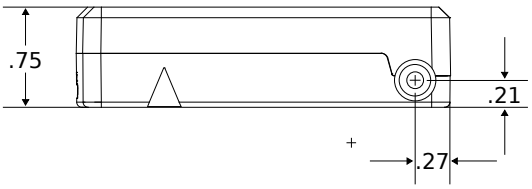

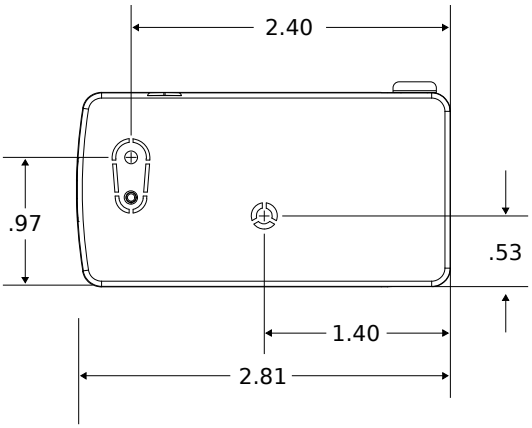

RBS304 Push Button Sensor

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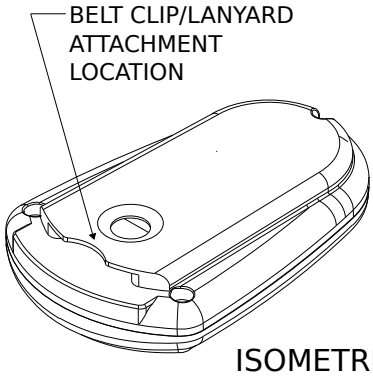
TOP VIEW



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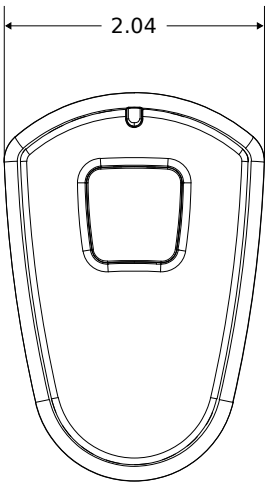
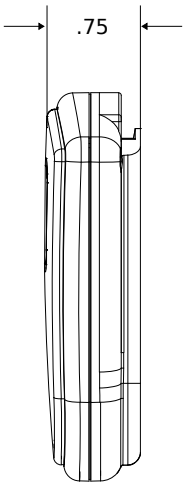
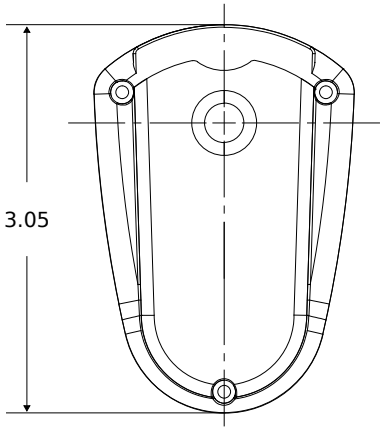
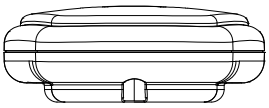
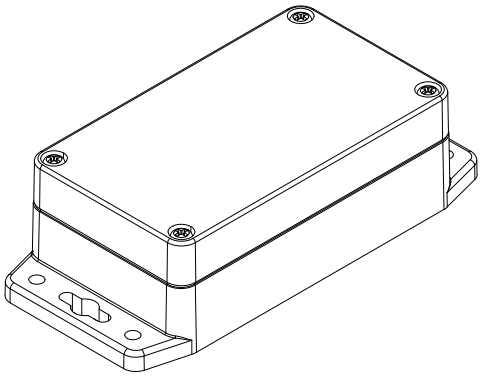








RBS306 Outdoor/Industrial Sensors



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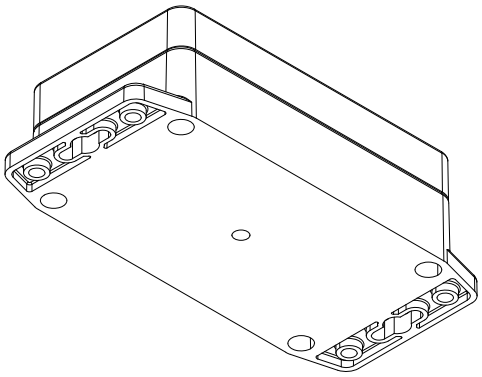

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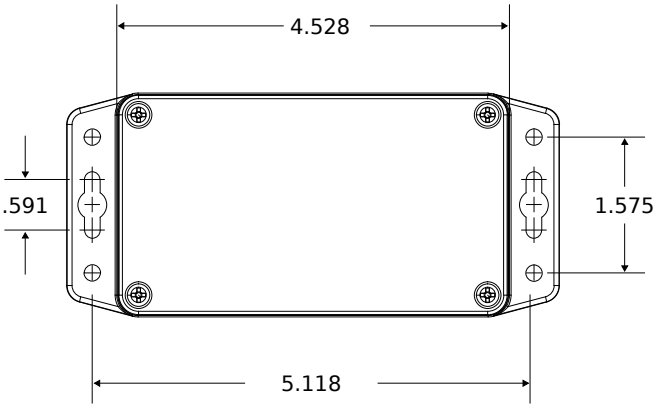
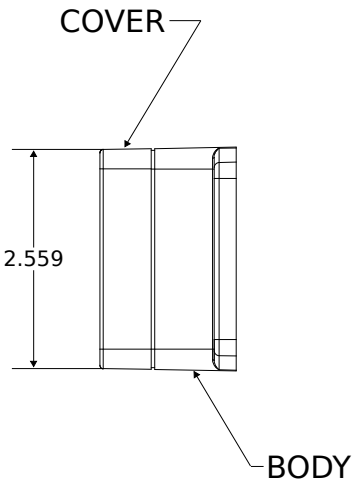
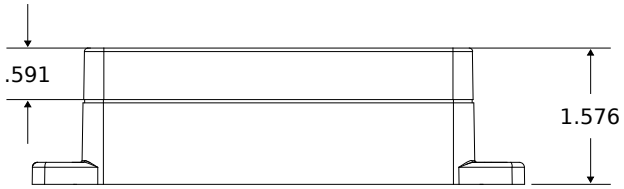
BOTTOM VIEW





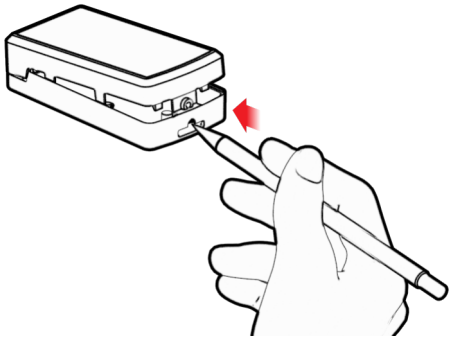


4 Before Installation

Prepare the Sensor

Sensors ship with batteries installed and a plastic tab over the battery, which needs to be removed before use. Pull the tab out of the sensor to connect the battery.

If you can't pull out the tab easily, refer to the solution that is relevant to your sensor in the following table.

Sensor Type	Solution
RBS301 Sensor	To remove the battery tab: 1. Use a pen, or a similar object, to press the button on the opposite side of the case.  2. Remove the battery tab. **Note:** You may need to remove the battery to remove the tab. Ensure the battery is re-inserted before continuing. 3. Close the case.
RBS304 Sensor	To remove the battery tab: 1. Loosen the screws and lift the back slightly. 2. Remove the battery tab. 3. Close the case and hand-tighten the screws. Do not overtighten.
RBS306 Sensor	**Important:** Do NOT remove the lid. To remove the battery tab: 1. Loosen the screws. 2. Without removing the lid, remove the battery tab. 3. Hand-tighten the lid screws to seal the case against moisture. 4. Torque the lid screws to 8.0 in/lbs.

Add the Sensor to a Network

Your sensor can be used through either a third-party network or the console.

- To use a third-party network, refer to the *Connecting LoRaWAN Sensors on Gateways and Networks* (RB00001), which is available through the sensor page at https://www.multitech.com/products/sensors.
- To use the console, use the following steps.

1. Create a console account at: https://console.radiobridge.com/.
2. Click on **Devices** on the left.
3. Click **Add Device**.
4. Select the network you want to use.
5. Make sure Console Only Device is NOT selected.
6. Specify if you want to **Register Through Radio Bridge** or use an existing account with the network.
7. Enter the **Device Name**, **Device ID**, and **Device Key.**

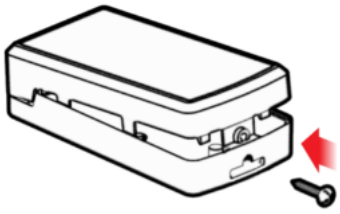
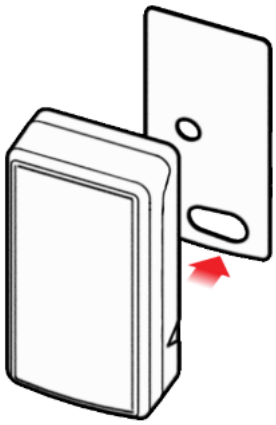
   Note: For easy Device ID and Key entry, scan the QR code on the yellow key card included with your device. Then copy and paste data into the console. With the QR code, the first line is the Device ID and the rest is the key.
8. Select the model from the **Device Type** drop down. Model is on the device label.
9. Set the **Join EUI**:
   - For RSB301 and RSB304: **7894E80000000000**
   - For RSB306: **0101010101010101**
10. Click **Continue**.
11. Review the summary and click **Confirmation**.

The console shows complete when the device is successfully added.

5 Installation

Mounting the Sensor

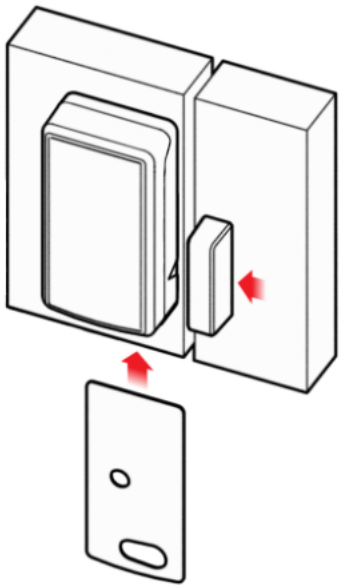
Sensors are shipped with double-sided tape for mounting the sensor. Refer to the following table for the mounting instruction that is relevant to your sensor.

Sensor Type	Solution
RBS301 Sensor	**Note:** For Door/Window Sensors, refer to Mounting a Door/Window Sensor. To mount the sensor: 1. (Optional) For increased security, use the included screw to fasten the case together.  2. Remove the plastic from the adhesive. 3. Stick the adhesive pad where you want to install the sensor. 
RBS304 Sensor	To mount the sensor: 1. Remove the plastic from the adhesive. 2. Stick the adhesive pad where you want to install the sensor.
RBS306 Sensor	To mount the sensor: 1. Remove the plastic from the adhesive. 2. Stick the adhesive pad where you want to install the sensor.

Mounting a Door/Window Sensor

The window/door sensor includes a sensor and a magnet that need to line up.

1. Use the included large adhesive pad to secure the sensor case on the door/window frame with the triangular notch facing the door/window as shown.

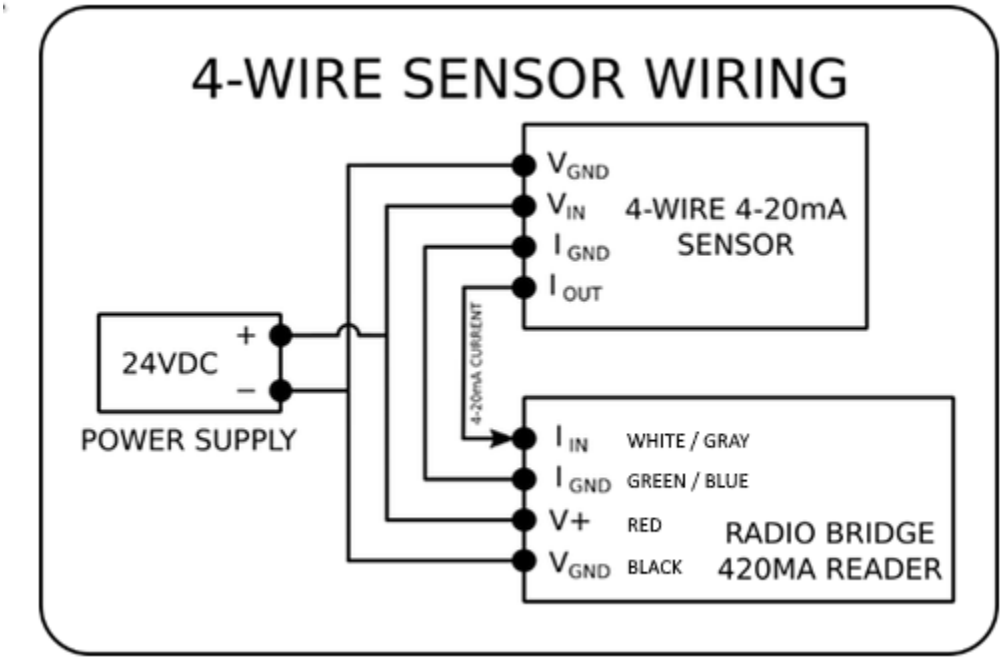


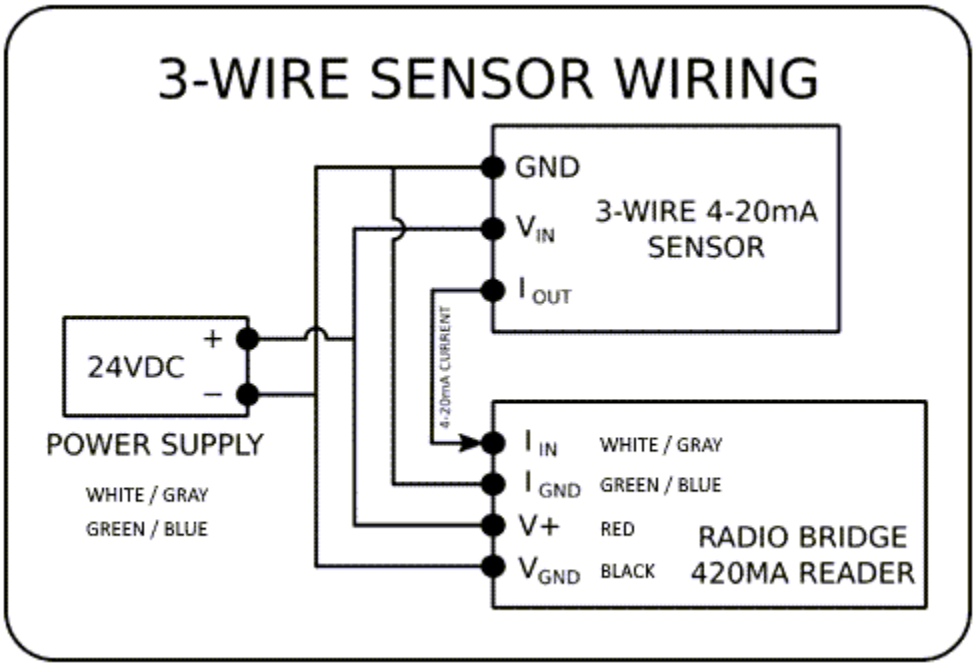
2. Attach the magnet piece to the door so it is aligned with the triangular notch on the sensor.

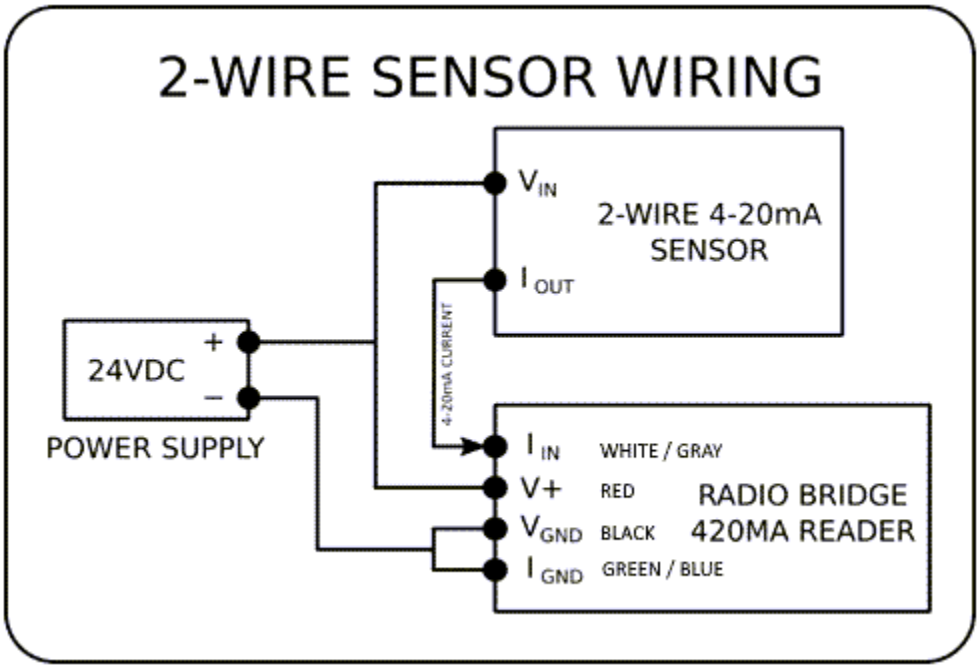
Wiring Diagrams for 4-20mA Current Loop Sensors

The following diagrams illustrate the wiring for 2, 3, and 4 wire systems.

Wire Color	Function
Red	5–24 VDC
Black	Ground
White/Gray	Current loop +
Green/Blue	Current loop –


4-WIRE SENSOR WIRING
VGND
VIN
IGND
IOUT
4-WIRE 4-20mA SENSOR
24VDC
+
–
POWER SUPPLY
4-20mA CURRENT
IIN
IGND
V+
VGND
WHITE / GRAY
GREEN / BLUE
RED
BLACK
RADIO BRIDGE 420MA READER


3-WIRE SENSOR WIRING
GND
VIN
IOUT
3-WIRE 4-20mA SENSOR
24VDC
+
–
POWER SUPPLY
WHITE / GRAY
GREEN / BLUE
4-20mA CURRENT
IIN
IGND
V+
VGND
WHITE / GRAY
GREEN / BLUE
RED
BLACK
RADIO BRIDGE 420MA READER



Installing Probe Water Sensors

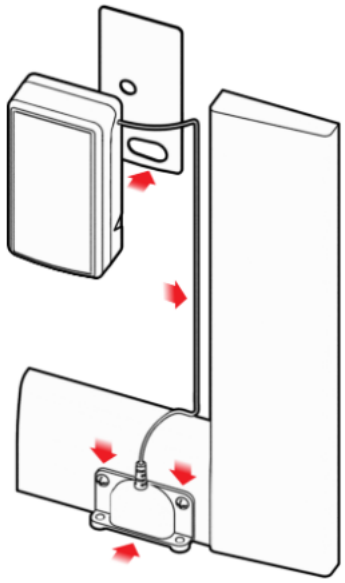
Install the water sensor so the probe reaches an area where water leaks may occur, such as water heaters, standing tanks, windows/doors, toilets, septic systems, condenser and refrigeration systems, floor drains, or water control valves. The probe may be placed inside containers to detect water.

Note: The probe is designed for water detection. It is not rated for use with harsh chemicals, solvents, oils, fuels, strong acids, or other caustic liquids.

1. Use the small adhesive pad attached to the probe to install it so the metal pins are flat on the floor. This allows the pins to make contact with a puddle from a nearby leak and send an alert. Place the probe where water from a leak would likely accumulate.
2. Use the included large adhesive pad to secure the case to the wall.
3. Coil any excess wire.

   Note: Do not coil the cable too tightly or it may cause damage.

   - If needed for better positioning, run the wire along pipes or around obstacles.
   - For best radio performance, avoid placing the sensor in another enclosure or in an area crowded with other equipment.
4. Secure the probe to the floor or wall using the small adhesive pad or with an appropriately sized screw in any of the probe's wall or floor mounting holes.



Installing Rope Water Sensors

Rope water sensors detect leaks along the length of the rope, it can be wrapped around a fixture or spread across a room, dropped ceiling, or anywhere you need leak detection. Install the sensor so the rope reaches the area you want to monitor for water leaks.

Note: When possible, install away from foot traffic and where heavy items will not be set on or rolled over the rope.

1. Spread the rope into the area you want to monitor for leaks.
2. Attach the sensor to a wall:
    - For a indoor sensor, use the included large adhesive pad to secure the case to a wall.
    - For an outdoor sensor, secure the sensor to a wall or floor with screws. Consult the mechanical drawing for hole dimensions.
    - For best radio performance, avoid placing the sensor in another enclosure or in an area crowded with other equipment.

6 Message Protocol

This chapter defines the protocol and message definitions for all sensor uplinks and downlinks. Common messages are utilized by all devices and include uplinks such as error messages, tamper alerts, battery voltage and signal quality, as well as general device configuration downlinks. Each sensor also includes its own specific uplink reports and downlink configurations depending on the type of sensor(s) it uses.

Note: MultiTech provides a web-based console at console.radiobridge.com which is useful for evaluating, demonstrating, configuring and troubleshooting devices. We recommend using this console to supplement understanding of the protocol specifications outlined here.

Uplink Messages

This section details the structure of uplink messages (sensor to web application).

Note: MultiTech offers a decoder library that you can use to decode the messages of all LoRaWAN uplinks and convert them into adjacent object. Please reference https://www.multitech.net/developer/software/sensors/.

Item	Length	Description
Protocol Version	4 bits	A constant 1, provides extensibility to the specific format of a message type.
Packet Counter	4 bits	Sequential Message Counter. Increments by one for each subsequent message. When it reaches 0xF (15 decimal), it wraps back to 0. This counter helps identify if a message is lost, out-of-order, or duplicated.
Message Type	1 byte	Payload format is 8 bytes. Refer to next table.
Message Payload	0-7 bytes	Each message type has between 0 and 8 bytes of payload data specific to the sensor. Refer to the following tables for payload information.

Common Message Types

This section defines the protocol and message definitions common to all wireless sensors. Common messages include basic error messages, tamper, supervisory, link quality, and downlink acknowledgements but do not include sensor specific data.

Message Type	Length	Description
0x00	6 bytes	Reset Message. Sent once on power up of device.
0x01	9 bytes	Supervisory Message. Sent at configurable time interval, typically once daily. Contains device status information including battery voltage.
0x02	1 byte	Tamper Event. Sent if the case is opened or closed.
0xFA	9 bytes	Device Info Message. Sends bytes of the current configuration.
0xFB	3 bytes	Link Quality Message. Contains RSSI and SNR signal statistics as received by the sensor.

Message Type	Length	Description
0xFF	1-9 bytes	Downlink Received Acknowledgement Message. Sent when a downlink is received successfully.

Sensor Specific Messages

This section enumerates the uplink message type that are specific to the sensor type used by the device. Sensor specific messages contain metrics as measured by the various sensor probes, along with various types of alerts indicating a change in reading, threshold crossing, or report on periodic interval.

Message Type	Length	Description
0x03	1 byte	Door/Window Sensor Event
0x06	2 bytes	Push Button Sensor Event
0x07	1 byte	Dry Contact Sensor Event
0x08	2 bytes	Water Leak Sensor Event
0x09	3 bytes	Thermistor Temperature Sensor Event
0x0A	2 bytes	Tilt Sensor Event
0x0D	5 bytes	Air Temperature and Humidity Sensor Event
0x0E	1 bytes	Accelerometer-based Movement Sensor Event
0x0F	4 bytes	High-precision Tilt Sensor Event
0x10	3 bytes	Ultrasonic Distance Sensor Event
0x11	3 bytes	4-20mA Current Loop Sensor Event
0x13	4 bytes	Thermocouple Temperature Sensor Event
0x14	3 bytes	Voltmeter Sensor Event
0x19	3 bytes	CMOS Temperature Sensor Event

Uplink Message Types

Reset Message (0x00)

The Reset Message is sent to the Cloud every time that the Sensor is Reset. The Reset Code has to do with the nature of the reset and is used by the factory for diagnostic purposes.

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Device Type Code. A Product Identifier Code identifying the specific hardware configuration of the device. Note these values do not always correlate to sensor event types since the specific device may include multiple sensor types. The below table shows currently registered Device Type Codes:
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x01</td><td>Door/Window Sensor Device</td></tr>
<tr><td>0x03</td><td>Dry Contact Sensor Device</td></tr>
<tr><td>0x05</td><td>External Probe Temperature Sensor Device</td></tr>
<tr><td>0x06</td><td>Push Button Sensor Device</td></tr>
<tr><td>0x08</td><td>Accelerometer-based Movement Sensor Device</td></tr>
<tr><td>0x09</td><td>Tilt Sensor Device</td></tr>
<tr><td>0x0A</td><td>Leak Detection Sensor Device</td></tr>
<tr><td>0x0E</td><td>Air Temp and Humidity Sensor Device</td></tr>
<tr><td>0x0F</td><td>High-precision Tilt Sensor Device</td></tr>
<tr><td>0x10</td><td>Ultrasonic Level Sensor Device</td></tr>
<tr><td>0x11</td><td>4-20mA Current Loop Sensor Device</td></tr>
<tr><td>0x12</td><td>External Probe Air Temp and Humidity Sensor Device</td></tr>
<tr><td>0x13</td><td>Thermocouple Temperature Sensor Device</td></tr>
<tr><td>0x14</td><td>Voltmeter Sensor Device</td></tr>
<tr><td>0x19</td><td>CMOS Temperature Sensor</td></tr>
</table>
</td></tr>
<tr><td>1</td><td>1 byte</td><td>Hardware Version. Human-readable byte containing two digit hardware version. Example: 0x27 would be hardware version 2.7</td></tr>
</table>

<table>
<tr><td>2-3</td><td>2 bytes</td><td>Human-readable in firmware versions prior to 2.0, where 0x0103 would represent version 1.3. From 2.0 onward, the firmware version is formatted as a three digit version number.
Format 0<table><tr><th>Bit Position</th><th>Description</th></tr><tr><td>15</td><td>Major Version Format. 0 = Prior Format, 1 = Current Format</td></tr><tr><td>14-8</td><td>Major Version Number</td></tr><tr><td>7-0</td><td>Minor Version Number</td></tr></table>Format 1<table><tr><th>Bit Position</th><th>Description</th></tr><tr><td>15</td><td>Major Version Format. 0 = Prior Format, 1 = Current Format</td></tr><tr><td>14-10</td><td>Major Version Number (5 bits)</td></tr><tr><td>9-5</td><td>Minor Version Number (5 bits)</td></tr><tr><td>4-0</td><td>Build Version Number (5 bits)</td></tr></table></td></tr>
<tr><td>4-5</td><td>2 bytes</td><td>Processor-dependent Reset Code. Used only for factory diagnostics.</td></tr>
</table>

Supervisory Message (0x01)

The wireless sensors will send a periodic supervisory message so that a backend system can verify that the device is still alive and to report error conditions. The supervisory message also contains a payload that contains the status (current) of the sensor.

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Device Error Codes. The Device Status Error Code byte is in the following format:<table><tr><th>Bit Position</th><th>Description</th></tr><tr><td>7-5</td><td>Not used</td></tr><tr><td>4</td><td>Tamper detected since last Reset</td></tr><tr><td>3</td><td>Current Tamper State</td></tr><tr><td>2</td><td>Error with last downlink</td></tr><tr><td>1</td><td>Battery Low; use this flag to signal battery replacement</td></tr><tr><td>0</td><td>Radio Communication Error or Radio Reset</td></tr></table></td></tr>
<tr><td>1</td><td>1 byte</td><td>Current Sensor State. Reflects the state of various single-byte sensor readings, however sensor type is not indicated here. For readings of full sensor state at even time intervals, use the periodic reporting feature of the Sensor Configuration.</td></tr>
<tr><td>2</td><td>1 byte</td><td>Battery Level. Human-readable byte containing two-digit battery voltage. Example: 0x29 would be 2.9 Volts. Since the lithium batteries do not discharge linearly, use the Battery Low bit from the Supervisory Error Code to signal battery replacement.</td></tr>
</table>

3	4 bytes	Current Sensor State. Reflects the state of various multi-byte sensor readings, however sensor type is not indicated here. For readings of full sensor state at even time intervals, use the periodic reporting feature of the Sensor Configuration.
7	2 bytes	Event Accumulation Count. The number of sensor events since last supervisory message. Use in combination with the "Disable All Sensor Messages" General Configuration Option to report sensor event totals rather than report events as they occur. Useful when only event frequency is desired. This feature also improves battery life and reduces communication traffic.

Tamper Event (0x02)

The sensor will send a message when the tamper switch has been either opened or closed through either an enclosure tamper or a wall mount tamper. The tamper message contains a 1-byte payload as shown in the following table.

Byte Position	Length	Description
0	1 byte	The tamper switch is a hardware option available at time of order. The device sends a message when device's enclosure has been opened or closed, or when the enclosure has been forcibly removed from its mounting position when secured with the included tamper screw.

Value	Description
0x00	Tamper Switch Opened
0x01	Tamper Switch Closed

Door/Window Event (0x03)

Byte Position	Length	Description
0	1 byte	Change in status of the magnet-activated hall-effect sensor. Reports closed when the included magnet is in proximity to the device.

Value	Description
0x00	Sensor is “closed” meaning that the magnet is present.
0x01	Sensor is “open” meaning that no magnet is present.

Push Button Event (0x06)

Byte Position	Length	Description
0	1 byte	Button Identifier of the button pressed Value: 0x03 — Description: Button ID 1
1	1 byte	The action performed on the button pressed. Value: 0x00 — Description: Button pressed Value: 0x01 — Description: Button released Value: 0x02 — Description: Button held

Dry Contact Event (0x07)

Byte Position	Length	Description
0	1 byte	Change in status of the connection between the contacts Value: 0x00 — Description: Contacts shorted (connected) Value: 0x01 — Description: Contacts opened (disconnected)

Water Event (0x08)

Byte Position	Length	Description
0	1 byte	Change in status of the conductance across the water probe or rope Value: 0x00 — Description: Water present Value: 0x01 — Description: Water not present
1	1 byte	Analog measurement of the conductance between probes (scale of 0-255). Used to verify conductance of the fluid being detected. Various fluids may not be identified using this measurement, although this number may help with event filtering by the application.

Thermistor Temp Event (0x09)

Byte Position	Length	Description
0	1 byte	Reporting event type Value: 0x00 — Periodic report 0x01 — Measurement has risen above upper threshold 0x02 — Measurement has fallen below lower threshold 0x03 — Report-on-change increase 0x04 — Report-on-change decrease
1	1 byte	Current temperature in degrees Celsius. When a temperature is out of range, the system reports it as 0x7F (highest positive signed number) on the high end and 0x80 on the low end.

Tilt Event (0x0A)

Byte Position	Length	Description
0	1 byte	Reporting event type Value: 0x00 — Sensor has transitioned to vertical orientation 0x01 — Sensor has transitioned to horizontal orientation 0x02 — Report-on-change toward vertical orientation 0x03 — Report-on-change toward horizontal orientation
1	1 byte	Angle of tilt from vertical axis in degrees (scale of 0-180)

Air Temp and Humidity Event (0x0D)

Byte Position	Length	Description
0	1 byte	Reporting event type Value / Description: 0x00 – Periodic report 0x01 – Temperature has risen above upper threshold 0x02 – Temperature has fallen below lower threshold 0x03 – Temperature report-on-change increase 0x04 – Temperature report-on-change decrease 0x05 – Humidity has risen above upper threshold 0x06 – Humidity has fallen below lower threshold 0x07 – Humidity report-on-change increase 0x08 – Humidity report-on-change decrease
1	1 byte	Integer portion of current temperature in degrees Celsius. The temperature value is a signed byte, where the first bit indicates the sign. For example, 0x10 means +16° C and 0x90 means -16° C.
2	1 byte	Decimal portion of current temperature in tenths of a degree Celsius. Note that only the upper four bits are used and range from 0x00 through 0x90. For example, if the value is 0x60 this represents 0.6 degrees.
3	1 byte	Integer portion of current percent relative humidity. This is always a positive integer. For example, if the value is 0x16, this represents 22%RH.
4	1 byte	Decimal portion of current tenths of a percent relative humidity. Note that only the upper four bits are used and range from 0x00 through 0x90. For example, if the value is 0x30 this represents 0.3%RH.

Accelerometer-based Movement (0x0E)

Byte Position	Length	Description
0	1 byte	The accelerometer has detected movement exceeding its sensitivity threshold. Value / Description: 0x00 – Movement started 0x01 – Movement stopped longer that the settling window duration

High-precision Tilt Event (0x0F)

Byte Position	Length	Description
0	1 byte	Reporting event type Value: 0x00 — Description: Periodic report Value: 0x01 — Description: Sensor has transitioned to vertical orientation Value: 0x02 — Description: Sensor has transitioned to horizontal orientation Value: 0x03 — Description: Report-on-change toward vertical orientation Value: 0x04 — Description: Report-on-change toward horizontal orientation
1	1 byte	Integer portion of the tilt angle in degrees. Note this is always a positive number ranging from 0-180. For example, if the value is 0x31, the angle is 49 degrees.
2	1 byte	Decimal portion of the tilt angle in tenths of a degree. Note that only the upper four bits are used and range from 0x00 through 0x90. For example, if the value is 0x40 this represents 0.4 degrees.
3	1 byte	Temperature in degrees Celsius. The temperature value is a signed byte, where the first bit indicates the sign. For example, 0x10 means +16° C and 0x90 means -16° C.

Ultrasonic Distance Event (0x10)

Byte Position	Length	Description
0	1 byte	Reporting event type Value: 0x00 — Description: Periodic report Value: 0x01 — Description: Distance has risen above upper threshold Value: 0x02 — Description: Distance has fallen below lower threshold Value: 0x03 — Description: Distance report-on-change increase Value: 0x04 — Description: Distance report-on-change decrease
1	2 bytes	Current distance in millimeters. This is a 16-bit positive integer. For example, if the value is 0x0282, the distance is 642mm. This full range of this value can vary with the type of ultrasonic probe being used.

4-20mA Current Loop Event (0x11)

Byte Position	Length	Description
0	1 byte	Reporting event type Value: 0x00 — Periodic report 0x01 — Current has risen above upper threshold 0x02 — Current has fallen below lower threshold 0x03 — Current report-on-change increase 0x04 — Current report-on-change decrease
1	2 bytes	Analog measurement of current loop in units of 10mA. This is a 16-bit positive integer ranging from 400-2000. For example, if the value is 0x0385, the current is 9.01mA.

Thermocouple Temperature Event (0x13)

Byte Position	Length	Description
0	1 byte	Reporting event type Value: 0x00 — Periodic report 0x01 — Temperature has risen above upper threshold 0x02 — Temperature has fallen below lower threshold 0x03 — Temperature report-on-change increase 0x04 — Temperature report-on-change decrease 0x05 — Fault Event occurred
1	2 bytes	Current Temperature in degrees Celsius. Decoded by taking the 16-bit two's complement number and multiplying by 1/16th. For example, if the value is 0x55C0 the temperature is 1372.00 degrees C. A value of 0xF060 would be -250.00 degrees.

<table>
<tr><td>2</td><td>1 byte</td><td>Fault code
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7</td><td>The cold-junction temperature is outside of the normal operating range.</td></tr>
<tr><td>6</td><td>The hot junction temperature is outside of the normal operating range.</td></tr>
<tr><td>5</td><td>The cold-junction temperature is at or above than the cold-junction temperature high threshold.</td></tr>
<tr><td>4</td><td>The cold-junction temperature is lower than the cold-junction temperature low threshold.</td></tr>
<tr><td>3</td><td>The thermocouple temperature is too high.</td></tr>
<tr><td>2</td><td>The thermocouple temperature is too low.</td></tr>
<tr><td>1</td><td>The input voltage is negative or greater than VDD.</td></tr>
<tr><td>0</td><td>An open circuit such as broken thermocouple wires has been detected.</td></tr>
</table></td></tr>
</table>

Voltage Event (0x14)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Reporting event type
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>Periodic report</td></tr>
<tr><td>0x01</td><td>Voltage has risen above upper threshold</td></tr>
<tr><td>0x02</td><td>Voltage has fallen below lower threshold</td></tr>
<tr><td>0x03</td><td>Voltage report-on-change increase</td></tr>
<tr><td>0x04</td><td>Voltage report-on-change decrease</td></tr>
</table></td></tr>
<tr><td>1</td><td>2 bytes</td><td>Voltage measurement in units of 10mV. This is a 16-bit positive integer ranging from 0-3000. For example, a value of 0x512 would be 12.98VDC.</td></tr>
</table>

CMOS Temperature Event (0x19)

Byte Position	Length	Description
0	1 byte	Reporting event type Value: 0x00 — Periodic report Value: 0x01 — Temperature has risen above upper threshold Value: 0x02 — Temperature has fallen below lower threshold Value: 0x03 — Temperature report-on-change increase Value: 0x04 — Temperature report-on-change decrease
1	1 byte	Integer portion of current temperature in degrees Celsius. The temperature value is a signed byte, where the first bit indicates the sign. For example, 0x10 means +16° C and 0x90 means -16° C.
2	1 byte	Decimal portion of current temperature in tenths of a degree Celsius. Note that only the upper four bits are used and range from 0x00 through 0x90. For example, if the value is 0x60 this represents 0.6 degrees.

Device Info Message (0xFA)

Byte Position	Length	Description
0	1 byte	Index of Device Configuration out of total number of Configuration Messages. Human-readable byte. 0x15 reads as message 1 of 5, 0x25 is message 2 of 5, and so on.
1	8 bytes	Bytes of the configuration (see Downlinks section). The bytes as positioned may be sent as-is in the form of a downlink to provide the same configuration to similar devices.

Link Quality Message (0xFB)

The link quality message provides a signal strength and signal to noise measurement at the device itself. The payload of the link quality message is shown in the following table.

Byte Position	Length	Description
0	1 byte	Current Sub-Band, sub-band currently joined and used for communication to the gateway and network server. Value ranges from 1-8 for US915. For other regions, value depends on available channels.
1	1 byte	RSSI of last DOWNLINK received, signed integer format values in bytes 1 and 2 in two's complement format.

Byte Position	Length	Description
2	1 byte	SNR of last DOWNLINK received, signed integer format values in bytes 1 and 2 in two's complement format.

Downlink ACK (0xFF)

Byte Position	Length	Description
0	1 byte	Acknowledgement and result of downlink received Value: 0x00 — Not used Value: 0x01 — Downlink invalid Value: 0x02 — Downlink valid Value: 0x03 — Downlink valid; subsequent bytes contain downlink received
1	8 bytes	Valid downlink bytes as received. Follows 0x03 in first byte only.

Downlink Messages

A downlink message is one that is sent to the sensor from the cloud and is used to configure the sensor itself. Messages cannot be initiated from the cloud since the sensor is typically sleeping and the radio is turned off, so the sensor itself must initiate a downlink message.

Item	Length	Description
Config Type	1 byte	The type of configuration corresponding to general sensor behavior, sensor specific behavior, or advanced features. See configuration types.
Config Payload	7 bytes	The bytes comprising the configuration. All downlinks sent to the device must define all byte positions -- partial configurations within a downlink message are not allowed. Each downlink sent must total 8 bytes in length including the config type and any remaining byte positions should be padded with zeros.

Common Configuration Types

Item	Length	Description
0x01	4 bytes	General Configuration
0xEC	0 bytes	Restore All Factory Defaults (Firmware 3.0 or newer)
0xED	1 byte	Device Info Request (Firmware 3.0 or newer)
0xEE	1 byte	Link Quality Configuration (Firmware 3.0 or newer)
0xEF	4 bytes	ADR Advanced Configuration (Firmware 3.0 or newer)
0xFC	3 bytes	Advanced Configuration

Sensor Configuration Types

Item	Length	Description
0x03	5 bytes	Door/Window Sensor Configuration
0x06	3 bytes	Push Button Sensor Configuration
0x07	5 bytes	Dry Contact Sensor Configuration
0x08	3 bytes	Water Sensor Configuration
0x09	7 bytes	Thermistor Temperature Sensor Configuration
0x0A	7 bytes	Tilt Sensor Configuration
0x0D	7 bytes	Air Temp and Humidity Sensor Configuration
0x0E	4 bytes	Accelerometer-based Motion Sensor Configuration
0x0F	7 bytes	High-precision Tilt Sensor Configuration
0x10	7 bytes	Ultrasonic Distance Sensor Configuration
0x11	7 bytes	4-20mA Current Loop Sensor Configuration
0x13	7 bytes	Thermocouple Temperature Sensor Configuration

Item	Length	Description
0x14	7 bytes	Voltmeter Sensor Configuration
0x20	4 bytes	Shake-to-send Configuration (Firmware 3.0 or newer)

Downlink Message Types

General Configuration (0x01)

The general configuration command is used for configuration parameters that apply to all sensor types. This command is defined in the following table.

Byte Position	Length	Description
0	1 byte	Disable all sensor events. When the sensor events are disabled supervisory and tamper-open will still send messages, but sensor events will not. Setting this bit to 1 will disable new event messages and setting to 0 will re-enable sensor event messages.
1	1 byte	Radio Configuration. The Radio config byte is defined in the following table.

Bit Position	Description
7	Not used.
6	Enable duty cycle requirement (LoRaWAN EU868 only). Set the enable duty cycle requirement to enforce the EU868 band duty cycle requirements. Default is clear / disabled. It is required to enable this prior to production deployment. Available in firmware 2.2.1 or later.
5-2	Number of uplink retries if ACK not received on confirmed uplink. The range for uplink retries is 1-8 for confirmed messages (ack required) and does not apply to unconfirmed messages. Default 0 (leave unchanged). Available in firmware v1.4 and above.
1	Use unconfirmed messages. If the use unconfirmed messages bit is set, the sensor will not look for an ack from the network server. Default is 1 (unconfirmed messages, no acks required). EU sensors cannot use confirmed messages, and thus setting this bit to 0 on an EU device will result in an error. Available in firmware v1.4 and above.
0	Disable Adaptive Data Rate. Set the disable adaptive data rate bit to disable ADR, clear to enable ADR. Default is 0 (enabled). Available in firmware v1.3 and above.

<table>
<tr><td>2</td><td>1 byte</td><td>Supervisory period. Default 19 hours. The supervisory period from the general configuration command controls the time between supervisory messages as defined in the following table.
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7</td><td>Supervisory period interval unit of measurement.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Period value is in hours.</td></tr>
<tr><td>1</td><td>Period value is in minutes.</td></tr>
</table></td></tr>
<tr><td>6-0</td><td>Value from 1-127. 0 is not valid.</td></tr>
</table></td></tr>
<tr><td>3</td><td>1 byte</td><td>Sampling Rate. Controls the rate at which the device wakes up out of low power sleep mode to check the state of the sensor. Note, this is not the same as the rate at which the device reports a reading over radio. By increasing the time between samples, the battery life can be greatly increased. Note that the sampling period only applies to sensors that take scaled measurements like temperature and tilt. It does not apply to sensors with binary inputs such as door/window sensors or push buttons. A value of 0 in this field leaves the sampling rate at the current value and for any non- zero value the sampling rate can be determined by the following table:
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7-6</td><td>Sampling period interval unit of measurement.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>Period value is in increments of 250ms (0.25 - 15 seconds).</td></tr>
<tr><td>0x01</td><td>Period value is in increments of 1 second (1 - 63 seconds).</td></tr>
<tr><td>0x10</td><td>Period value is in increments of 1 minute (1 - 63 minutes).</td></tr>
<tr><td>0x11</td><td>Period value is in increments of 1 hour (1 - 63 hours).</td></tr>
</table></td></tr>
<tr><td>5-0</td><td>Value from 1-127.</td></tr>
</table></td></tr>
</table>

Door/Window Sensor Configuration (0x03)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Disable events (see the table Disable Events Bit Definitions).
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7-2</td><td>Not used.</td></tr>
<tr><td>1</td><td>Disable close events. Set to disable, clear to enable.</td></tr>
<tr><td>0</td><td>Disable open events. Set to disable, clear to enable.</td></tr>
</table></td></tr>
<tr><td>1-2</td><td>2 bytes</td><td>Open hold time. The hold times are 16-bit values that represent the amount of time the sensor must be held in a particular position (open or closed) before a message is sent. The hold time values range from 1-65535 and are represented in 250ms increments. This gives the hold times a range of 250 milliseconds – 4.5 hours. If the hold time is 0, the feature is disabled and an alert will be sent any time the state changes.</td></tr>
<tr><td>3-4</td><td>2 bytes</td><td>Close hold time.</td></tr>
</table>

Push Button Configuration (0x06)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Disable events (see the table Disable Events Bit Definitions).
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7-3</td><td>Unused.</td></tr>
<tr><td>2</td><td>Disable button hold event. Set to disable, clear to enable.</td></tr>
<tr><td>1</td><td>Disable button released event. Set to disable, clear to enable.</td></tr>
<tr><td>0</td><td>Disable button pressed event. Set to disable, clear to enable.</td></tr>
</table></td></tr>
<tr><td>1</td><td>1 byte</td><td>Hold Delay. The hold delay defines the amount of time the button must be held before a button held event is sent. The field can range from 0-20 in 250ms increments (0-5 seconds). If set to 0 then the hold delay will not send an event message.</td></tr>
</table>

<table>
<tr><td>2</td><td>1 byte</td><td>LED Configuration. For the blink after send, note that if a message is confirmed (acknowledgements) then the blink occurs after the message is sent and an ack is received. If the message is unconfirmed (no acknowledgements) then the blink occurs after the message is sent. The behavior of the LED can be controlled through the LED configuration byte defined in the following table.
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7-3</td><td>Unused.</td></tr>
<tr><td>2</td><td>Rapidly blinks the LED after a confirmed message's ACK received. A value of 0 enables a rapid blinking of the LED after a message ack is received, a value of 1 disables LED on ACK. Does not apply to unconfirmed messages.</td></tr>
<tr><td>1</td><td>Slowly blinks LED after a message send. A value of 0 enabled a slow blinking of the LED after a message is sent, a value of 1 disables LED on send.</td></tr>
<tr><td>0</td><td>Solidly illuminates LED during button press. A value of 0 enables solid illumination of the LED during button press, a value of 1 disabled LED on press.</td></tr>
</table>
</td></tr>
</table>

Dry Contact Sensor Configuration (0x07)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Disable events (see the table Disable Events Bit Definitions).
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7-2</td><td>Not used.</td></tr>
<tr><td>1</td><td>Disable contact open events. Set to disable, clear to enable.</td></tr>
<tr><td>0</td><td>Disable contact closed events. Set to disable, clear to enable.</td></tr>
</table>
</td></tr>
<tr><td>1-2</td><td>2 bytes</td><td>Contacts shorted hold time. The hold times are 16-bit values that represent the amount of time the sensor must be held in a particular position (open or closed) before a message is sent. The hold time values range from 1-65535 and are represented in 250ms increments. This gives the hold times a range of 250 milliseconds – 4.5 hours. If the hold time is 0, the feature is disabled and an alert will be sent any time the state changes.</td></tr>
<tr><td>3-4</td><td>2 bytes</td><td>Contacts opened hold time.</td></tr>
</table>

Water Leak Sensor Configuration (0x08)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Disable events (see the table Disable Events Bit Definitions).
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7-2</td><td>Not used.</td></tr>
<tr><td>1</td><td>Disable water not present events. Set to disable, clear to enable.</td></tr>
<tr><td>0</td><td>Disable water present events. Set to disable, clear to enable.</td></tr>
</table>
</td></tr>
<tr><td>1</td><td>1 byte</td><td>Threshold of relative resistance of the water probe/rope. The range of the measurement is 0-255, default is 80. It is not recommended to change this setting. Water detection will generally far exceed this threshold when wet, and fall far below when dry. This value can not be used to determine the fluid being detected and is not a means to adjust sensitivity. False alerts or undesired detections should be addressed by fine tuning the installation positioning and avoiding contact of the probe with conductive materials.</td></tr>
<tr><td>2</td><td>1 byte</td><td>Restoral margin. An alert is sent when the relative measurement increases above the defined threshold. The restoral margin requires that the measurement reduces by a certain amount below the threshold before another alert is triggered. Both the threshold and restoral margin are in units of relative resistance measurements on a scale of 0-255. The default is 0. It is not recommended to alter this setting.</td></tr>
</table>

Thermistor Temp Configuration (0X09)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Reporting Mode.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>Threshold Mode. The upper and lower temperature thresholds are signed values with units of one degree Celsius (range is -40 to 100 degrees C). Note that if the configuration settings exceed the maximum ratings on the sensor, the sensor may not report an event.</td></tr>
<tr><td>0x01</td><td>Report on Change Mode. If the temperature increase or decrease are non-zero, then the sensor sends an alert any time the temperature changes by the specified amount. For example, if the temperature increase and decrease are set to 5 degrees, then an alert is sent every time the temperature changes 5 degrees from the last report. The temperature increase and decrease are unsigned values with units in degrees C.</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td>1</td><td>1 byte</td><td>Periodic Reporting Time Interval (0 = disable periodic reporting).
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7</td><td>Periodic Report interval unit of measurement. The sensor can also send periodic updates in either Threshold or Report on Change Mode. A setting of 0 will disable periodic reporting.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Period value is in hours.</td></tr>
<tr><td>1</td><td>Period value is in minutes.</td></tr>
</table></td></tr>
<tr><td>6-0</td><td>Value from 1-127.</td></tr>
</table></td></tr>
<tr><td>2</td><td>1 byte</td><td>Restoral Margin (Threshold Mode only). The Restoral Margin is used for the upper and lower thresholds and requires the temperature value to cross back over the threshold by this amount before a new event is reported. This prevents excessive event messages if the temperature is at or near the threshold. For example, consider an upper temp threshold set at 30 degrees Celsius and the restoral margin set at 5 degrees. If the temperature initially exceeds 30 degrees then an event is generated and a message is sent to the network. The temperature must now drop to 25 degrees and then exceed 30 degrees before another event is reported. The restoral margins are unsigned values with units of 1 degree Celsius (range is 1-15 degrees C). If a restoral margin is set to 0, it is disabled.</td></tr>
<tr><td>3</td><td>1 byte</td><td>Absolute Temperature for Lower Threshold (Threshold Mode) or Relative Temperature Increase (Report on Change Mode).</td></tr>
<tr><td>4</td><td>1 byte</td><td>Absolute Temperature for Upper Threshold (Threshold Mode) or Relative Temperature Decrease (Report on Change Mode).</td></tr>
</table>

Tilt Sensor Configuration (0X0A)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Disable events (see table Disable Event Bit Definitions).
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7-4</td><td>Not used.</td></tr>
<tr><td>3</td><td>Disable report-on-change toward vertical. Default disabled.</td></tr>
<tr><td>2</td><td>Disable report-on-change toward horizontal. Default disabled.</td></tr>
<tr><td>1</td><td>Disable transitions to vertical orientation only. Default enabled.</td></tr>
<tr><td>0</td><td>Disable transitions to horizontal orientation only. Default enabled.</td></tr>
</table></td></tr>
</table>

1	1 byte	Angle for transition to horizontal state in degrees. Default 55 degrees. The angle in bytes 1 and 2 define the angle in degrees off of the vertical axis that the sensor needs to be tilted to generate an alert. For example, if the sensor is used to detect garage open/close events, the vertical threshold might be set at 35 degrees and the horizontal threshold may be set at 55 degrees. It is not recommended to set both to the same values (both at 45 degrees for instance) since this may generate multiple alerts when it is oriented near the threshold. The range for each threshold is 0-90 degrees where 0 is completely vertical and 90 is completely horizontal.
2	1 byte	Angle for transition to vertical state in degrees. Default 35 degrees.
3	1 byte	Vertical hold time. The hold times are 8-bit values that represent the amount of time the tilt sensor must be held in a particular orientation before a message is sent. The hold time values range from 1-255 and are represented in 250ms increments. This gives the hold times a range of 250 milliseconds – 1 minute. If the hold time is 0, the feature is disabled and an alert will be sent any time the orientation changes.
4	1 byte	Horizontal hold time.
5	1 byte	Report-on-change toward vertical (0-90 degrees). The report-on-change feature will create an alert when the angle of the tilt increases or decreases by a specified amount. This allows for detecting a tilt when the initial orientation is not completely vertical. For example, one could place the sensor on a telephone pole and set a report-on-change event for 10 degrees. This configuration will send an alert if the pole leans another 10 degrees from its current position. The minimum value for the report-on-change angle is 5 degrees. A setting less than this will disable the feature.
6	1 byte	Report-on-change toward horizontal (0-90 degrees).

Air Temp and Humidity Configuration (0X0D)

Byte Position	Length	Description
0	1 byte	Reporting Mode.

Value	Description
0x00	Threshold Mode. The upper and lower temperature thresholds are signed values with units of one degree Celsius (range is -40 to 100 degrees C). Note that if the configuration settings exceed the maximum ratings on the sensor, the sensor may not report an event.
0x01	Report on Change Mode. If the temperature increase or decrease are non-zero, then the sensor sends an alert any time the temperature changes by the specified amount. For example, if the temperature increase and decrease are set to 5 degrees, then an alert is sent every time the temperature changes 5 degrees from the last report. The temperature increase and decrease are unsigned values with units in degrees C.

<table>
<tr><td>1</td><td>1 byte</td><td>Periodic Reporting Time Interval (0 = disable periodic reporting).
<table><tr><th>Bit Position</th><th>Description</th></tr><tr><td>7</td><td>Periodic Report interval unit of measurement. The sensor can also send periodic updates in either Threshold or Report on Change Mode. A setting of 0 will disable periodic reporting.
<table><tr><th>Value</th><th>Description</th></tr><tr><td>0</td><td>Period value is in hours.</td></tr><tr><td>1</td><td>Period value is in minutes.</td></tr></table></td></tr><tr><td>6-0</td><td>Value from 1-127.</td></tr></table></td></tr>
<tr><td>2</td><td>1 byte</td><td>Restoral Margin (Threshold Mode only). The Restoral Margin is used for the upper and lower thresholds and requires the temperature or humidity values to cross back over the threshold a certain amount before a new event is reported. This prevents excessive event messages if the measurement is at or near the threshold. For example, consider an upper temp threshold set at 30 degrees Celsius and the restoral margin set at 5 degrees. If the temperature initially exceeds 30 degrees then an event is generated and a message is sent to the network. The temperature must now drop to 25 degrees and then exceed 30 degrees before another event is reported. The restoral margins are unsigned values with units of 1 degree Celsius (range is 1-15 degrees C) and 1% relative humidity (range is 1%-15%). If a restoral margin is set to 0, it is disabled.</td></tr>
<tr><td>3</td><td>1 byte</td><td>Absolute Temperature for Lower Threshold (Threshold Mode) or Relative Temperature Increase (Report on Change Mode). Default Threshold 10 degrees C.</td></tr>
<tr><td>4</td><td>1 byte</td><td>Absolute Temperature for Upper Threshold (Threshold Mode) or Relative Temperature Decrease (Report on Change Mode). Default Threshold 40 degrees C.</td></tr>
<tr><td>5</td><td>1 byte</td><td>Absolute Humidity for Lower Threshold (Threshold Mode) or Relative Humidity Increase (Report on Change Mode). Default Threshold 40% relative humidity.</td></tr>
<tr><td>6</td><td>1 byte</td><td>Absolute Humidity for Upper Threshold (Threshold Mode) or Relative Humidity Decrease (Report on Change Mode). Default Threshold 60% relative humidity.</td></tr>
</table>

Accelerometer-based Motion Configuration (0X0E)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Disable events (see table Disable Event Bit Definitions).
<table><tr><th>Bit Position</th><th>Description</th></tr><tr><td>7-2</td><td>Not sed.</td></tr><tr><td>1</td><td>Disable reporting for Movement Stopped.</td></tr><tr><td>0</td><td>Disable reporting for Movement Started.</td></tr></table></td></tr>
</table>

<table>
<tr><td>1</td><td>1 byte</td><td>Acceleration Scaling Factor. The scaling parameter defines the G-force (1g is the force of gravity) range that the internal accelerometer operates with, and the lower settings will be more sensitive than higher settings. The threshold setting will have units based on the scaling factor as shown in the table above. For example, if the scaling is set to +/- 2g (2x the force of gravity), then the threshold setting can be multiplied by 0.016g to calculate the total G-force threshold. The accelerometer is measured every 250ms and if the difference between two consecutive measurements exceeds the threshold, then a message is sent. The minimum setting for the acceleration change threshold is 5. If a lower number is programmed, the sensor will not generate an event. Note: For best practice, use the largest scaling factor that the system will allow and the smallest threshold. For example, use a threshold of 5 with scaling factor 4g instead of threshold of 10 with 2g.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>+/- 2g (Units for Threshold = 0.016g).</td></tr>
<tr><td>0x01</td><td>+/- 4g (Units for Threshold = 0.032g).</td></tr>
<tr><td>0x02</td><td>+/- 8g (Units for Threshold = 0.062g).</td></tr>
<tr><td>0x03</td><td>+/- 16g (Units for Threshold = 0.186g).</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>1 byte</td><td>Settling Time. In order to prevent continuous reporting of movement events, a “settling window” is used to ensure movement has stopped before the sensor reports a new event. In other words, the settling window defines the amount of time where the acceleration of all axis must stop changing before the sensor will report another event. The settling window time sets has units of 250ms increments (range of 250ms to 63 seconds). The default settling window is 5 seconds.</td></tr>
<tr><td>3</td><td>1 byte</td><td>Acceleration Change Threshold for any/all axes. This will relate to the Units for Threshold values determined by the Scaling Factor. Range 0 - 127.</td></tr>
</table>

High-precision Tilt Sensor Configuration (0X0F)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Reporting Mode.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>Threshold Mode. The angles in bytes 3-6 define the angle in degrees relative to the vertical axis that the sensor must be tilted to generate an alert. For example, if the sensor is used to detect garage open/close events, the toward-vertical threshold might be set at 35 degrees and the away-from-vertical threshold may be set at 55 degrees. It is not recommended to set both to the same values (both at 45 degrees for instance) since this may generate multiple alerts when it is oriented near the threshold. The range for each threshold is 0-180 degrees where 0 is completely vertical, 90 is horizontal, and 180 is inverted. Since the high-precision tilt sensor has precision to 0.1 degrees, the angles are defined by both an integer value and a fractional value. For example, to define an angle of 16.8 degrees, the values would be 0x10 and 0x08 respectively.</td></tr>
<tr><td>0x01</td><td>Report on Change Mode. The report-on-change feature will create an alert when the angle of the tilt increases or decreases by a specified amount. This allows for detecting a tilt when the initial orientation is not completely vertical. For example, one could place the sensor on a telephone pole and set a report-on-change event for 10 degrees. This configuration will send an alert if the pole leans another 10 degrees from its current position. Since the high-precision tilt sensor has precision to 0.1 degrees, the angles are defined by both an integer value and a fractional value. For example, to define an angle of 16.8 degrees, the values would be 0x10 and 0x08 respectively.</td></tr>
</table></td></tr>
<tr><td>1</td><td>1 byte</td><td>Periodic Reporting Time Interval (0 = disable periodic reporting).
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7</td><td>Periodic Report interval unit of measurement. The sensor can also send periodic updates in either Threshold or Report on Change Mode. A setting of 0 will disable periodic reporting.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Period value is in hours.</td></tr>
<tr><td>1</td><td>Period value is in minutes.</td></tr>
</table></td></tr>
<tr><td>6-0</td><td>Value from 1-127.</td></tr>
</table></td></tr>
</table>

2	1 byte	Hold Time. The hold time is an 8-bit value that represent the amount of time the tilt sensor must be held in a particular orientation (or exceeding a particular threshold) before a message is sent. This is a way to add extra "debounce" to the sensor so that it does not send excessive messages oscillating around a threshold. The hold time values range from 1-255 and are represented in 250ms increments. This gives the hold times a range of 250 milliseconds – 1 minute. If the hold time is 0, the feature is disabled and an alert will be sent any time the orientation changes.
3	1 byte	Angle for transition away from the 0-degree vertical state, whole integer value, default = 55 degrees (Threshold Mode). Angle for report-on-change mode away from 0-degree vertical position (toward the 180 degree inverted position), whole integer value (Report on Change Mode).
4	1 byte	Angle for transition away from the 0-degree vertical state, fractional value (Threshold Mode). Angle for report-on-change mode away from 0-degree vertical position, fractional value (Report on Change Mode).
5	1 byte	Angle for transition toward the 0-degree vertical state, whole integer value, default 35 degrees (Threshold Mode). Angle for report-on-change mode toward the 0-degree vertical position, whole integer value (Report on Change Mode).
6	1 byte	Angle for transition toward the 0-degree vertical state, fractional value (Threshold Mode). Angle for report-on-change mode toward the 0-degree vertical position, fractional value (Report on Change Mode).

Ultrasonic Distance Configuration (0X10)

Byte Position	Length	Description
0	1 byte	Reporting Mode.

Value	Description
0x00	Threshold Mode. The upper and lower distance thresholds are unsigned values with units of one millimeter. Note that if the configuration settings exceed the maximum ratings on the sensor, the sensor may not report an event.
0x01	Report on Change Mode. If the distance increase or decrease are non-zero, then the sensor will send an alert any time the distance changes by the specified amount. For example, if the distance increase and decrease are set to 5mm, then an alert is sent every time the distance changes 5mm from the last report. The distance increase and decrease are unsigned values with units in millimeters.

<table>
<tr><td>1</td><td>1 byte</td><td>Periodic Reporting Time Interval (0 = disable periodic reporting).
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7</td><td>Periodic Report interval unit of measurement. The sensor can also send periodic updates in either Threshold or Report on Change Mode. A setting of 0 will disable periodic reporting.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Period value is in hours.</td></tr>
<tr><td>1</td><td>Period value is in minutes.</td></tr>
</table></td></tr>
<tr><td>6-0</td><td>Value from 1-127.</td></tr>
</table></td></tr>
<tr><td>2</td><td>1 byte</td><td>Hold Time. The purpose of the hold time is to add “debounce” or “hysteresis” to the sensor so that it does not send rapid events when the measurements are sitting close to the threshold. The measurements for the ultrasonic may jump between multiple values if it is not mounted properly, and thus if the measurement continuously jumps above and below a threshold, it will send a flood of threshold events without any hold time defined. For example, if the lower threshold for the ultrasonic is set to 1000 (1 meter) and the distance measurements are bouncing between say 900 and 1100 every 1 second, then there will be a lower threshold event every 2 seconds. If a hold time of 10 seconds is defined, no threshold events occur. The measurement must then drop below 1000 and stay below that threshold for 10 seconds before a lower threshold event message is created.
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7</td><td>The hold time is defined in 1 minute increments when the most significant bit is 0, and it is defined in 1 second increments when the most significant bit is 1 as shown in the following table.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Period value is in minutes.</td></tr>
<tr><td>1</td><td>Period value is in seconds.</td></tr>
</table></td></tr>
<tr><td>6-0</td><td>Value from 1-127.</td></tr>
</table></td></tr>
<tr><td>3</td><td>1 byte</td><td>Lower distance threshold in mm, upper byte. Default 100mm (Threshold Mode). Distance increase in mm, upper byte (Report on Change Mode).</td></tr>
<tr><td>4</td><td>1 byte</td><td>Lower distance threshold in mm, upper byte. Default 100mm (Threshold Mode). Distance increase, lower byte (Report on Change Mode).</td></tr>
<tr><td>5</td><td>1 byte</td><td>Upper distance threshold in mm, upper byte. Default 1000mm (Threshold Mode). Distance decrease in mm, upper byte (Report on Change Mode).</td></tr>
<tr><td>6</td><td>1 byte</td><td>Upper distance threshold in mm, lower byte (Threshold Mode). Distance decrease in mm, lower byte (Report on Change Mode).</td></tr>
</table>

4-20mA Current Loop Configuration (0x11)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Reporting Mode.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>Threshold Mode. The upper and lower thresholds are unsigned values with units of 10uA. Note that if the configuration settings exceed the maximum ratings on the sensor, the sensor may not report an event.</td></tr>
<tr><td>0x01</td><td>If the increase or decrease values are non-zero, then the sensor will send an alert any time the analog measurement changes by the specified amount. For example, if the measurement increase and decrease are set to 5mA, then an alert is sent every time the measurement changes 5mA from the last report. The increase and decrease are unsigned values with units of 10uA.</td></tr>
</table></td></tr>
<tr><td>1</td><td>1 byte</td><td>Periodic Reporting Time Interval (0 = disable periodic reporting).
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7</td><td>Periodic Report interval unit of measurement. The sensor can also send periodic updates in either Threshold or Report on Change Mode. A setting of 0 will disable periodic reporting.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Period value is in hours.</td></tr>
<tr><td>1</td><td>Period value is in minutes.</td></tr>
</table></td></tr>
<tr><td>6-0</td><td>Value from 1-127.</td></tr>
</table></td></tr>
<tr><td>2</td><td>1 byte</td><td>Restoral Margin (Threshold Mode only). The Restoral Margin is used for the upper and lower thresholds and requires the measurement value to cross back over the threshold a certain amount before a new event is reported. This prevents excessive event messages if the measurement is at or near the threshold. For example, consider an upper threshold set at 15mA and the restoral margin set at 1mA. If the measurement initially exceeds 15mA then an event is generated and a message is sent to the network. The measurement must now drop to 14mA and then exceed 15mA before another event is reported. The restoral margins are unsigned values with units of 10uA (range is 10uA-2.55mA). If a restoral margin is set to 0, it is disabled.</td></tr>
<tr><td>3-4</td><td>2 bytes</td><td>Lower analog measurement threshold. Default 8mA (Threshold Mode). Analog measurement increase (Report on Change Mode).</td></tr>
<tr><td>5-6</td><td>2 bytes</td><td>Upper analog measurement threshold. Default 16mA (Threshold Mode). Analog measurement decrease (Report on Change Mode).</td></tr>
</table>

Thermocouple Temperature Configuration (0x13)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Reporting Mode and Thermocouple Probe Type. Although the sensor comes with a K-type thermocouple by default, there are several common thermocouple types are supported. Bits 4:1 in byte 0 define the type as shown in the table below.
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7-5</td><td>Unused</td></tr>
<tr><td>4-1</td><td>Thermocouple Type.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x0000</td><td>B Type</td></tr>
<tr><td>0x0001</td><td>E Type</td></tr>
<tr><td>0x0010</td><td>J Type</td></tr>
<tr><td>0x0011</td><td>K Type (default)</td></tr>
<tr><td>0x0100</td><td>N Type</td></tr>
<tr><td>0x0101</td><td>R Type</td></tr>
<tr><td>0x0110</td><td>S Type</td></tr>
<tr><td>0x0111</td><td>T Type</td></tr>
<tr><td>0x1000</td><td>Voltage Mode, Gain=8. Code=8×1.6×217×VIN</td></tr>
<tr><td>0x1100</td><td>Voltage Mode, Gain=32. Code=32× 1.6×217×VIN</td></tr>
</table></td></tr>
<tr><td>0</td><td>Reporting Mode.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x0</td><td>Threshold Mode. The upper and lower temperature thresholds are defined by the temperature decode table used for the uplink messages. If the configuration settings exceed the maximum sensor ratings, the sensor may not report an event.</td></tr>
<tr><td>0x1</td><td>Report on Change Mode. If the temperature increase or decrease are non-zero, the sensor sends an alert when the temperature changes by the specified amount. Example: if the temperature increase and decrease are set to 5 degrees, an alert is sent every time the temperature changes 5 degrees from the last report. The temperature increase and decrease are defined by the temperature decode table used for the uplink messages except that the sign bit is ignored.</td></tr>
</table></td></tr>
</table></td></tr>
</table>

<table>
<tr><td>1</td><td>1 byte</td><td>Periodic Reporting Time Interval (0 = disable periodic reporting).
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7</td><td>Periodic Report interval unit of measurement. The sensor can also send periodic updates in either Threshold or Report on Change Mode. A setting of 0 will disable periodic reporting.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Period value is in hours.</td></tr>
<tr><td>1</td><td>Period value is in minutes.</td></tr>
</table></td></tr>
<tr><td>6-0</td><td>Value from 1-127.</td></tr>
</table></td></tr>
<tr><td>2</td><td>1 byte</td><td>Restoral Margin (Threshold Mode only). The Restoral Margin is used for the upper and lower thresholds and requires the temperature value to cross back over the threshold a certain amount before a new event is reported. This prevents excessive event messages if the temperature is at or near the threshold. For example, consider an upper temp threshold set at 30 degrees Celsius and the restoral margin set at 5 degrees. If the temperature initially exceeds 30 degrees then an event is generated and a message is sent to the network. The temperature must now drop to 25 degrees and then exceed 30 degrees before another event is reported. The restoral margins are unsigned values with units of 1 degree Celsius (range is 1-255 degrees C). If a restoral margin is set to 0, it is disabled.</td></tr>
<tr><td>3-4</td><td>2 bytes</td><td>Upper temperature threshold. Default 90 degrees C (Threshold Mode). Temperature increase (Report on Change Mode).</td></tr>
<tr><td>5-6</td><td>2 bytes</td><td>Lower temperature threshold. Default 10 degrees C (Threshold Mode). Temperature decrease (Report on Change Mode).</td></tr>
</table>

Voltmeter Configuration (0x14)

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>0</td><td>1 byte</td><td>Reporting Mode.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0x00</td><td>Threshold Mode. The upper and lower thresholds are unsigned values with units of 10mV. Note that if the configuration settings exceed the maximum ratings on the sensor, the sensor may not report an event.</td></tr>
<tr><td>0x01</td><td>Report on Change Mode. If the increase or decrease values are non-zero, then the sensor will send an alert any time the analog measurement changes by the specified amount. For example, if the measurement increase and decrease are set to 5V, then an alert is sent every time the measurement changes 5V from the last report. The increase and decrease are unsigned values with units of 10mV.</td></tr>
</table></td></tr>
<tr><td>1</td><td>1 byte</td><td>Periodic Reporting Time Interval (0 = disable periodic reporting).
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7</td><td>Periodic Report interval unit of measurement. The sensor can also send periodic updates in either Threshold or Report on Change Mode. A setting of 0 will disable periodic reporting.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Period value is in hours.</td></tr>
<tr><td>1</td><td>Period value is in minutes.</td></tr>
</table></td></tr>
<tr><td>6-0</td><td>Value from 1-127.</td></tr>
</table></td></tr>
<tr><td>2</td><td>1 byte</td><td>Restoral Margin. The Restoral Margin is used for the upper and lower thresholds and requires the measurement value to cross back over the threshold a certain amount before a new event is reported. This prevents excessive event messages if the measurement is at or near the threshold. For example, consider an upper threshold set at 15V and the restoral margin set at 1V. If the measurement initially exceeds 15V then an event is generated and a message is sent to the network. The measurement must now drop to 14V and then exceed 15V before another event is reported. The restoral margins are unsigned values with units of 10mV (range is 2.55V). If a restoral margin is set to 0, it is disabled.</td></tr>
<tr><td>3-4</td><td>2 bytes</td><td>Lower analog measurement threshold. Default 10V (Threshold Mode). Analog measurement increase (Report on Change Mode).</td></tr>
<tr><td>5-6</td><td>2 bytes</td><td>Upper analog measurement threshold. Default 12V (Threshold Mode). Analog measurement decrease (Report on Change Mode).</td></tr>
</table>

Shake-to-Send Configuration (0x20)

Byte Position	Length	Description
0	1 byte	Enable / disable Shake-to-Send events. **Value** / **Description** 0x00 / Disable Shake-to-Send Events. 0x01 / Enable Shake-to-Send Events (default).
1	1 byte	Scaling Factor. A higher scale may reduce sensitivity, precision and accuracy. Threshold units are based on the scale value. **Value** / **Description** 0x00 / 2g scale 0x01 / 4g scale 0x02 / 8g scale 0x03 / 16g scale (default)
2	1 byte	Motion Threshold. Defines acceleration threshold upon which a Shake-to-Send message is sent. Default = 20. Increase to require stronger shake (range 0-127).
3	1 byte	Settling Time. Defines how long the device's motion is below the shake threshold before exiting the shaking state. Time is in increments of 250ms, range 0-255, default = 5 seconds.

Factory Reset (0xEC)

No Payload
Restores all setting to factory defaults. Does not preserve any custom configuration.

Device Info Request (0xED)

Byte Position	Length	Description
0	1 byte	Report current sensor configurations. Uplink will be sent containing the sensors current configuration bytes. The configuration payload may also be used literally as a downlink for future use.

Link Quality Configuration (0xEE)

Byte Position	Length	Description
0	1 byte	Number of failed confirmed message transmits before the device re-enters a LoRaWAN join state. When the device transmits a confirmed message and exhausts uplink retries without receiving an acknowledgment, the device increments an internal failed counter by 1. The counter does not increment if the message being transmitted is not a confirmed message. If this counter does not exceed the threshold specified in this byte, the device attempts a retransmit. The default value is 12.

ADR Advanced Configuration (0xEF)

Byte Position	Length	Description
0	1 byte	ADR_ACK_LIMIT value when running in Unconfirmed Mode. The default value is 64.
1	1 byte	ADR_ACK_DELAY value when running in Unconfirmed Mode. The default value is 32.
2	1 byte	ADR_ACK_LIMIT value when running in Confirmed Mode. The default value is 2.
3	1 byte	ADR_ACK_DELAY value when running in Confirmed Mode. The default value is 1.

Advanced Configuration (0xFC)

The advanced configuration command is used for advanced configuration parameters that apply to all sensor types. This command is defined in the following table.

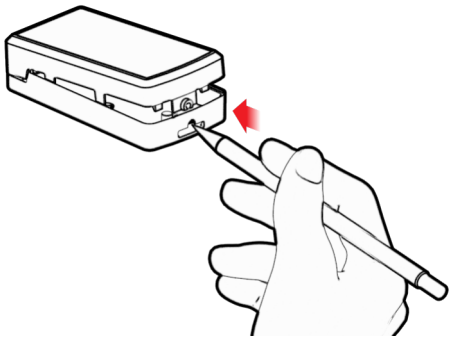
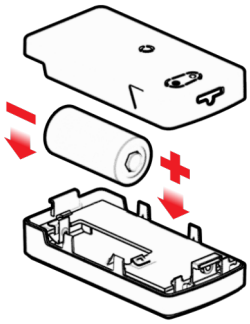
Byte Position	Length	Description
1	1 byte	Port Number. Changes the uplink port per the LoRaWAN protocol. The default port is 2, and a value of 0 in this field means to leave it at the default. This feature is available in firmware v1.4 and above. The maximum port number is 223 (0xDF).

<table>
<tr><th>Byte Position</th><th>Length</th><th>Description</th></tr>
<tr><td>2</td><td>1 byte</td><td>Link Quality Check Period. Setting this register causes the device to “ping” the network server on a periodic basis with a requested ack to ensure the device is still connected. This is implemented as a confirmed message containing connectivity info, and is typically used in conjunction with unconfirmed messages. In other words, while running with unconfirmed messages, this feature will create a periodic confirmed message and look for the ack to ensure connectivity. A value of 0x00 means disable the connectivity period feature. Available in firmware v2.0 and above. The Link Quality period in byte 2 is defined in the following table.
<table>
<tr><th>Bit Position</th><th>Description</th></tr>
<tr><td>7</td><td>Link Quality Check period interval unit of measurement.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Period value is in hours.</td></tr>
<tr><td>1</td><td>Period value is in minutes.</td></tr>
</table></td></tr>
<tr><td>6-0</td><td>Value from 1-127.</td></tr>
</table></td></tr>
</table>

7 Maintenance

Replacing the Battery

For replacement battery types, refer to Battery Life. To replace the battery, refer to the solution that is relevant to your sensor in the following table.:

Sensor Type	Solution
RBS301 Sensor	To replace the battery: 1. Use a pen, or a similar object, to press the button on the opposite side of the case.  2. Replace the battery.  3. Close the case.
RBS304 Sensor	To replace the battery: 1. Loosen the screws and remove the lid. 2. Replace the battery. 3. Set the lid back in place and hand-tighten the screws. Do not overtighten.

Sensor Type	Solution
RBS306 Sensor	To replace the battery: 1. Loosen the screws and remove the lid. 2. Replace the battery. 3. Set the lid back in place and hand-tighten the lid screws to seal the case against moisture. 4. Torque the lid screws to 8.0 in/lbs.

8 Disposal

Instructions for Disposal of WEEE by Users in the European Union

The symbol shown below is on the product or on its packaging, which indicates that this product must not be disposed of with other waste. Instead, it is the user's responsibility to dispose of their waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about where you can drop off your waste equipment for recycling, contact your local city office, your household waste disposal service or where you purchased the product.

July, 2005

9 Regulatory Information

FCC 47 CFR Part 15 Regulation Class B Devices

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Warning: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Federal Communications Commission (FCC)

Per FCC 15.19(a)(3) and (a)(4) This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Per FCC 15.21, Changes or modifications not expressly approved by MultiTech could void authority to operate the devices.

LoRaWAN RBS301 Wireless Sensor:

- FCC ID: AU792U22A05869
- IC: 125A-0066

LoRaWAN RBS304 Wireless Sensor:

- FCC ID: AU792U22F10870
- IC: 125A-0067

LoRaWAN RBS306 Wireless Sensor:

- FCC ID: AU792U13A16858
- IC: 125A-0055

Industry Canada Class B Notice

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

This device complies with Industry Canada license-exempt RSS standard(s). The operation is permitted for the following two conditions:

1. The device may not cause interference, and
2. This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil numérique de la classe B respecte toutes les exigences du Reglement Canadien sur le matériel brouilleur.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage, et
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

EU EMC, Safety, and R&TTE Directive (RED) Compliance

CE The CE mark is affixed to this product to confirm compliance with the following European Community Directives:

- Council Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment; and
- Council Directive 2014/53/EU on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.
- Council Directive 2014/35/EU on the harmonization of the laws of Member States relating to Electrical Equipment designed for use within certain voltage limits.

MultiTech declares that this device is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU. The declaration of conformity may be downloaded at https://multitech.com/product-support/.

Standards

Directive	Description	Applicable Standards
2014/35/EU Art. 3,1 2011/65/EU	LVD	EN 62368-1:2014 + A11:2017
2014/53/EU	MPE /RF Exposure	EN 62311:2008
	ROHS	EN IEC 63000:2018

Directive	Description	Applicable Standards	
2014/53/EU	RED	Art 3.1b EN 301 489-1 V2.1.1 (General) EN 301 489-3 V2.1.2 (SRD devices) EN61326 (Lab Equip)	Art. 3.2 EN 300 220-2 V3.1.1 and v3.2.1(SRD devices)

Harmonized Commodity Description (HS Code)

The Harmonized Commodity Description and Coding System generally referred to as "Harmonized System" or simply "HS" is a multipurpose international product nomenclature developed by the World Customs Organization (WCO).

HS Code: 8517.62.0090

Export Control Classification Number (ECCN)

ECCNs are five character alpha-numeric designations used on the Commerce Control List (CCL) to identify dual-use items for export control purposes. An ECCN categorizes items based on the nature of the product, i.e. type of commodity, software, or technology and its respective technical parameters.

ECCN: 5a992.c

Environmental Notices

EU REACH-SVHC Statement

Multi-Tech Systems, Inc. confirms that none of its products or packaging contain any of the Substances of Very High Concern (SVHC) on the REACH Candidate List, in a concentration above the 0.1% by weight allowable limit.

For the current REACH-SVHC statement and additional regulatory documents, go to https://multitech.com/approvals-and-certifications/.

EU WEEE Directive

Note: This statement may be used in documentation for your final product applications.

The Waste from Electrical and Electronic Equipment (WEEE) Directive places an obligation on EU-based manufacturers, distributors, retailers, and importers to take back electronics products at the end of their useful life. A sister directive, ROHS (Restriction of Hazardous Substances) complements the WEEE Directive by banning the presence of specific hazardous substances in the products at the design phase. The WEEE Directive covers all MultiTech products imported into the EU as of August 13, 2005. EU-based manufacturers, distributors, retailers and importers are obliged to finance the costs of recovery from municipal collection points, reuse, and recycling of specified percentages per the WEEE requirements.

EU RoHS 3 Directive

MultiTech confirms that all products comply with the chemical concentration limitations set forth in the Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS 3) regulations for CE and UKCA, following the standard EN IEC 63000:2018.

For the current Certificate of Compliance for Hazardous Substances and additional regulatory documents, go to https://multitech.com/approvals-and-certifications/.

Warranty

To read the warranty statement for your product, go to https://www.multitech.com/warranty.

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