Wireless Acceleration Sensor

User Guide

Reveal Wireless Acceleration Based Movement Sensor

Model: RBS301-ABM

Part Number: RB00004 rev. 1.0

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MultiTech offers free technical support for Reveal sensors at:

https://support.radiobridge.com

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Chapter 1 – Quick Start

Sensor Overview

The Reveal™ acceleration-based movement sensor described in this document uses an internal accelerometer to detect movement events such as an asset being moved from a stationary position. When movement is detected that exceeds a certain threshold, an alert is sent over the wireless network.

> **Note:** This product should *not* be used for vibration detection. For vibration detection applications, such as detecting when a motor has turned on/off, see the Vibration Sensor products from Radio Bridge.

Quick Start

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

1. Create a Radio Bridge 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. Specify if you want to **Register Through Radio Bridge** or use an existing account with the network.
6. Make sure Console Only Device is NOT selected.
7. Enter the **Device Name**, **Device ID**, and **Device Key.**

   > **Note:** For easy Device ID and Key entry, scan the QR code on the device label. 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. Select the **Join EUI** and click **Continue**.
10. Review the summary and click **Confirmation**.

The console shows complete when the device is successfully added.

Part Numbers

Part Number	Rating	Wireless	Region
RBS301-ABM-US	Indoor	LoRaWAN	North America, South America
RBS301-ABM-EU	Indoor	LoRaWAN	Europe
RBS301-ABM-AU	Indoor	LoRaWAN	Australia, South America
RBS306-ABM-US	Outdoor / Industrial	LoRaWAN	North America, South America
RBS306-ABM-EU	Outdoor / Industrial	LoRaWAN	Europe

Documentation

The following documentation is available at https://www.multitech.com/products/sensors.

| Document	Description	Part Number
User Guide	This document provides overview, safety and regulatory information, design considerations, schematics, and general hardware information.	RB00004
Connection Guide	This document provides instructions and information on how to connect Reveal LoRaWAN sensors on gateways and networks.	RB00001

Chapter 2 – Preparing Sensor

Preparing an RBS301 Sensor

Sensors ship with batteries installed. There is a plastic tab over the battery, which needs to be removed.

■ Pull the tab out of the sensor to connect the battery. If the tab does not pull out easily, you may need to open the case to remove it.

To open the case:

1. Use a pen or similar object to press the button on the opposite side of the case.
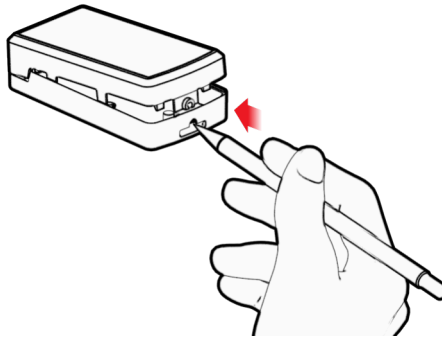
2. Remove the battery tab. You may need to remove the battery to remove the tab.
3. Re-insert the battery and close the case.

Preparing an RBS306 Sensor

Sensors ship with batteries installed. There is a plastic tab over the battery, which needs to be removed. To remove a tab that does not pull out easily:

■ Loosen screws to remove the battery tab. DO NOT REMOVE THE LID.

■ Hand-tighten the lid screws to seal the case against moisture. Do not overtighten the screws.

Replacing the Battery

Replacement battery type is listed in the Battery Life topic. To replace the battery:

1. Use a pen or similar object to press the button on the opposite side of the case.
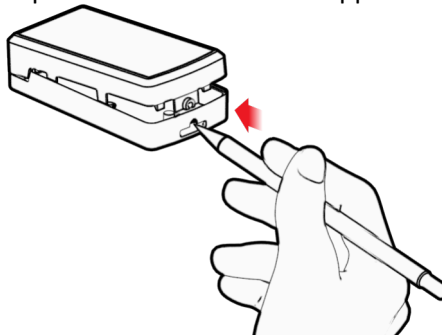
2. Remove the battery.

3. Insert the new battery and close the case.

Chapter 3 – Hardware Specifications and Information

Operating Temperatures

Parameter	Range (M)
Indoor Model	-30 to +70
Outdoor Model	-40 to +70
Storage (ambient temperature)	-40 to +100

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://www.multitech.com/products/sensors

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 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. Radio Bridge devices are shipped with lithium batteries, which are the recommended replacement type.

Recommended battery: Panasonic CR123/A

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.

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

The battery voltage is reported by the supervisory messages and a low battery indicator. See the section on Message Protocol for details.

Mechanical Drawings

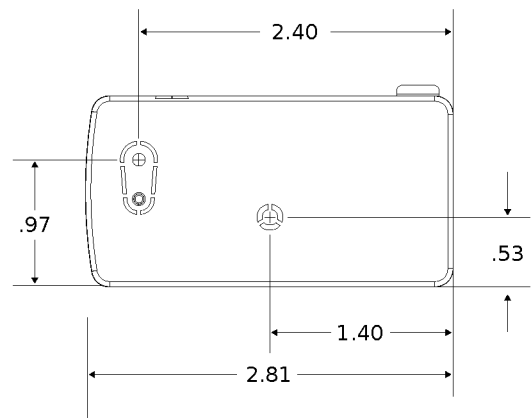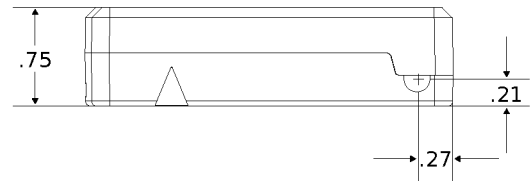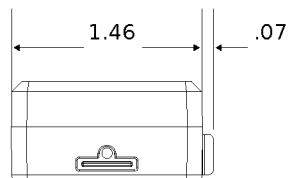The mechanical drawings provided in this section are for the main body of the sensor. All dimensions use inches unless specified.

Indoor RBSx01 Sensors

ISOMETRIC
TOP VIEW

ISOMETRIC
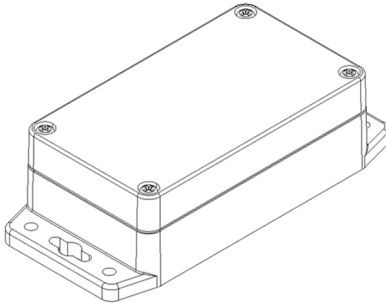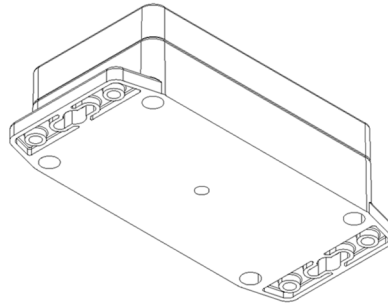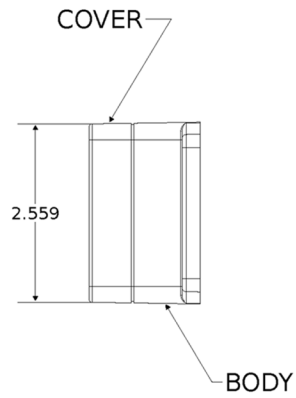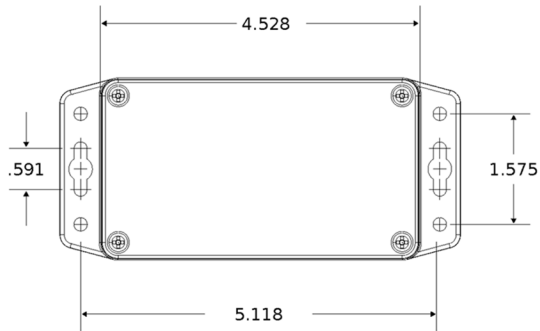BOTTOM VIEW

1.46   .07

.75   .21   .27

2.40   .97   .53   1.40   2.81
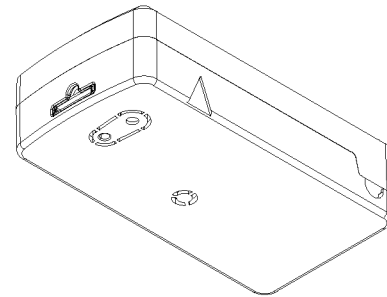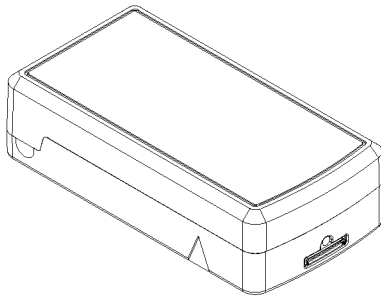
Armored Outdoor/Industrial RBSx06 Sensors

ISOMETRIC
TOP VIEW

ISOMETRIC
BOTTOM VIEW

COVER

4.528

.591

1.575

2.559

5.118

BODY

.591

1.576

Chapter 4 – Common Messages

Common Messages

This chapter defines the protocol and message definitions common to all Reveal wireless sensors. Common messages include basic error messages, tamper, supervisory, link quality, and downlink acknowledgments. Sensor specific messages are in the *Sensor Specific Messages* chapter.

Message Protocol

This section defines the protocol and message definitions for the device.

> **Note:** MultiTech provides a web-based console at console.radiobridge.com for configuring and monitoring devices. We recommend using this console rather than the protocols defined in this section.

If not using the console, use this topic to configure the device through downlink messages and decode the device data.

Uplink Messages

The uplink messages (sensor to web application) have the following structure.

Item	Size	Description
Protocol Version	4 bits	A constant 1, provides extensibility to the specific format of a message type.
Packet Count	4 bits	A sequential number starting at 0 for the first message sent from the sensor to the cloud. It increments by one for each subsequent message. When it reaches 0xF (15 decimal), it wraps back to 0. Packet count helps identify when a message is lost. For example, if the packet count goes 2,4 instead of 2,3,4, it indicates a message has been lost. It can also help identify out-of-order or duplicate messages.
Message Type	1 byte	Byte format is 8 bits, with 256 combinations possible.
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 table for payload information.

Message	Payload	Description
0x00	5-byte reset code	Device has reset. The reset cause is represented in the 5-byte reset code payload.
0x01	>3 (9)	Daily supervisory message (1-2 per day). The 3-byte payload contains current sensor status. Refer to Supervisory Message 0x01for payload details.
0x02	1-byte event	A tamper event has occurred. Refer to Tamper Message 0x02for details.
--	Sensor event	Sensor events are defined in the *Sensor Specific Messages* chapter.

Message	Payload	Description
0xfb	Link quality	Sent after each downlink configuration (refer to Link Quality Message) or to periodically ping the network server (refer to Link Quality Check Period).
0xfe	--	Reserved.
0xff	1-byte status	Downlink message ACK. Refer to Downlink ACK for more detail.

Reset Message 0x00

Every time a sensor resets it sends a reset message to the cloud.

The reset message payload is defined in the following table.

Bytes	Description
0	Sensor type code, a product identifier sent as part of the reset message. Acceleration-Based Movement 0x08
1	Hardware version.
2-3	Firmware version.
4-5	Reset code. Used for factory diagnostics.

Firmware Version

The 16-bit firmware version is constructed from reset payload Bytes 2-3, where Byte 2 is the most significant byte. Beginning with version 2.0, the format is as shown in the following table.

The original format is compatible by redefining the reserved most significant bit (Bit 15).

Byte	Description
15	Format (bit == 0)
14:8	Major number (7 bits)
7:0	Minor number (8 bits)
15	Format (bit == 1)
14:10	Major number (5 bits)
9:5	Minor number (5 bits)
4:0	Build number (5 bits)

16-Bit Firmware Version Examples
- 0x0103 is decoded as Firmware Version 1.3
- 0x8823 is decoded as Firmware Version 2.1.3

Supervisory Message 0x01

Wireless sensors periodically send a supervisory message so the backend system can verify the device is still alive and report error conditions. The supervisory message payload include current sensor status.

You can also trigger a supervisory message. To do this:
- Place a magnet near the triangular notch on the side of the sensor.

The following table shows the supervisory message payload:

Bytes	Description
0	Supervisory error codes as follows: <table><tr><th>Bits</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 (under 2.8v).</td></tr><tr><td>0</td><td>Radio communication error, communication with the integrated radio failed and the device was reset.</td></tr></table>
1	Current sensor state, 1-byte. This is device specific, refer Sensor Specific Messages chapter for details. For other devices, use the periodic reporting feature.
2	Battery level is a two-digit battery voltage. For example, if the battery voltage is 2.9V, byte 2 would be 0x29.
3-6	Extended sensor state, 4-bytes. Allows sensors with higher precision or multiple values to report during a supervisory event. For other devices, use the periodic reporting feature.
7-8	Event accumulation count is the number of sensor events since the last supervisory message. To improve battery life, can be used with the **Disable all sensor events** setting so only an event total is reported during a supervisory message, individual events are not reported as they occur. This feature is available in firmware v2.0 and beyond.

Tamper Message 0x02

A sensor sends a message when the tamper switch has been 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.

Payload	Description
0x00	Tamper switch opened.
0x01	Tamper switch closed.

Link Quality Message 0xfb

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

Bytes	Description
0	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	RSSI of last DOWNLINK received, signed integer format values in bytes 1 and 2 in two's complement format.
2	SNR of last DOWNLINK received, signed integer format values in bytes 1 and 2 in two's complement format.

Downlink Messages

Downlink messages are from the cloud to the sensor and are used to configure the sensor. The sensor initiates downlink messages, since the sensor is typically sleeping with the radio turned off.

For LoRaWAN devices, a downlink can be received after any uplink within the receive window.

The following messages can be sent back to the sensor upon a downlink request.

Command	Payload	Description
0x00	Not used	Not used
0x01	4 bytes	General configuration
--	0-7 bytes	Sensor configuration, refer to the *Sensor Specific Messages* chapter
0xfc	3 bytes	Advanced configuration

General Configuration

Use the general configuration command to configure parameters that apply to all sensor types.

Byte	Description
0x00	Disable sensor events
0x01	Radio config
0x02	Supervisory period. Default 19 hours.
0x03	Sampling rate

Disable Sensor Events

The following table shows the disable sensor event bit definitions.

Bit	Description
7:1	Not used
0	Disable all sensor events

Radio Config

The following table shows the radio config byte definition.

Note: Available in firmware version 1.4 or newer.

Bits	Description
7	Not used (reserved)
6	Enable duty cycle requirement. *LoRaWAN EU868 only*. To enforce the EU868 band duty cycle requirements, enable before production deployment. Default is disabled. Available in firmware 2.2.1 or later.
5:2	Uplink retries. *LoRaWAN only*. 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. *LoRaWAN only*. If set to use the unconfirmed messages bit, the sensor does not look for an ACK from the network server. Default is 1 (unconfirmed messages, no ACK required). EU sensors can't use confirmed messages, setting this bit to 0 on an EU device causes an error. Available in firmware v1.4 and above.
0	Disable Adaptive Data Rate (ADR). *LoRaWAN only*. To enable ADR, set to 0. To disable ADR, set to 1. Default is 0 (enabled). Available in firmware v1.3 and above.

Important: The duty cycle bit must be set for production deployments in the EU868 band.

Supervisory Period

The general configuration command's supervisory period controls the time between supervisory messages as defined in the following table.

Bit 7	Bits 6:0
0	Period defined in hours (1-127 hours). Available in firmware v1.3 and above.
1	Period defined in minutes (1-127 minutes) Available in firmware v1.3 and above.

For example, to receive a report every 4 hours, set Byte 1 to 0x04. To receive a periodic report every 15 minutes, set Byte 1 to 0x8f.

Sampling Rate

Sampling rate controls the frequency at which devices wake from low power sleep mode to check the sensor state. Some sensors require very little power to check the state and need to react quickly. Other sensors can be sampled at a lower rate, such 30-second or 30-minute intervals. Increasing the time between samples increases battery life.

Refer to the Battery Estimator on the Radio Bridge site for battery life estimates relative to sampling rate: https://radiobridge.com/documents/Sensor%20Battery%20Estimator.xlsx

A value of 0 in this field leaves the sampling rate at the current value. Use the following table to determine the sampling rate if the value is not zero.

Note: Sampling period only applies to sensors that take measurements like temperature and tilt, it does not apply to sensors with binary inputs such as door/window sensors or push buttons.

This feature is available in firmware v2.0 and above.

Bit 7:6	Bits 5:0
00	Sampling period defined in increments of 250ms (0.25-15 seconds).
01	Sampling period defined in increments of seconds (1-63 seconds).
10	Sampling period defined in increments of minutes (1-63 minutes).
11	Sampling period defined in increments of hours (1-63 hours).

Advanced Configuration

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

Byte	Description
0x01	Port number (LoRaWAN only)
0x02	Link quality check period (LoRaWAN only)

Port Number

For LoRAWAN devices only. Byte 0x01 of the advanced configuration command 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.

Link Quality Check Period

For LoRaWAN devices only. Setting this register causes the device to ping the network server periodically with a requested ack. Typically used with unconfirmed messages, this feature creates a periodic confirmed message and looks for the ack to ensure the device is still connected.

The following table shows this byte's encoded bit definitions.

Available in firmware v2.0 and above.

Bit 7	Bits 6:0
0	Period defined in hours (1-127 hours).
1	Period defined in minutes (60-127 minutes)

Downlink ACK

The cloud app uses this downlink ACK message to verify the that sensor received the downlink message received and it was considered valid.

The sensor replies to the downlink data with a 0xFF message (downlink ACK) with the payload shown in the following table.

Command	Payload
0x00	Not used
0x01	Message was invalid or undefined
0x02	Message was valid

Chapter 5 – Sensor-Specific Messages

Uplink Messages

The uplink message (sensor to web application) specific to the sensor is defined in following table. The common uplink messages are not included in this section (see common messages document)..

Byte	Description
0	Movement event

The movement event byte is defined in the following table

Event	Description
0x00	Movement started
0x01	Movement has stopped (see Setting Window)

Downlink Messages

The downlink message (web application to sensor) specific to the sensor configuration is defined in following table. The common downlink messages are not included in this section (see common messages document).

Byte	Description
3	Disable reporting (see Disable Reporting table below)
2	Scaling (See Scaling table below)
1	Settling window time (see section Settling Window)
0	Acceleration change threshold for any axis (X, Y, or Z). Bits 6:0 only

The table below describes the bit definitions for the Disable Reporting byte from the downlink command. In each case setting the bit will disable the reporting and clearing the bit will enable reporting.

Bit	Description
7:2	Not used
1	Disable reporting for movement stop
0	Disable reporting for movement start

The table below defines the scaling parameter in the downlink command.

Setting	Description	Units for Threshold
0x00	+/-2g	0.016g
0x01	+/-4g	0.032g
0x02	+/-8g	0.062g
0x03	+/-16g	0.186

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.

Chapter 6 – Regulatory Information

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, RBS304, and RBS305 sensors FCC ID: 2APNUCMABZ

LoRaWAN RBS306 sensors: This device contains FCC IAU792U13A16858

This device contains equipment certified under IC: 125A-0055

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: 8531.90.9001

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

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