MULTITECH

Radio Bridge
LoRaWAN® Wireless Sensor

External Probe Temperature Sensor User Guide

LoRaWan Wireless External Probe Temperature Sensor

Model: RBS301-TEMP-EXT, RBS306-TEMP-EXT

Part Number: RB00012 Rev. 1.2

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Chapter 1 – Quick Start

Sensor Overview

The LoRaWAN wireless external temperature sensor measures temperature using an external temperature probe and is for indoor use only. If the temperature rises above or falls below the configured thresholds, an alert is sent over the wireless network. Temperature is sampled every 15 seconds and averaged over 1 minute.

Part Number

Part Number	Rating	Wireless	Region
RBS301-TEMP-EXT-US	Indoor	LoRaWAN	NA
RBS306-TEMP-EXT-US	Outdoor/Industrial	LoRaWAN	NA

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.	RB00012
Connection Guide	This document provides instructions and information on how to connect 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.
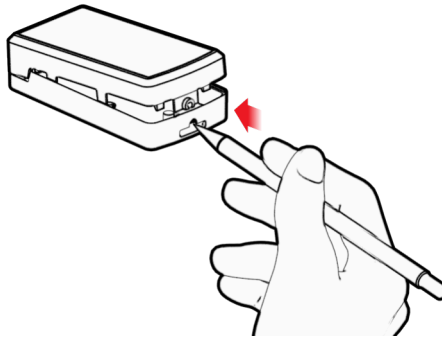
2. Remove the battery tab. You may need to remove the battery to remove the tab.
3. Re-insert the battery and close the case.

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.

Quick Start

Use your sensor through either the console or a third-party network. To use the console, use the following steps. 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

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** to **7894E80000000000** and click **Continue**.
10. Review the summary and click **Confirmation**.

The console shows complete when the device is successfully added.

Mounting the Sensor

To mount the sensor:
- Use the large adhesive pad included with a sensor to secure the case in position.

Mounting the Sensor with the Tamper Screw

For increased security, open the case, and fasten it to the wall using the included tamper screw as shown. Then reassemble the case. The tab will break away and send a tamper alert if the case is forcibly removed.

1. Open the case. To do this, use a pen or similar object to press the button on the opposite side of the case.
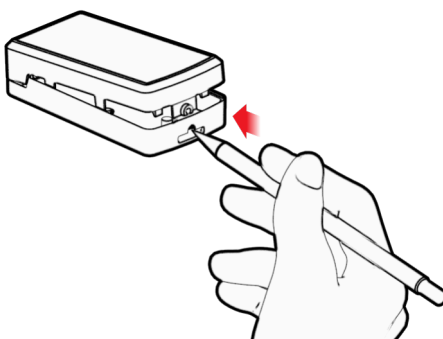
2. Stick the adhesive pad where you want to install the sensor.
3. Attach the case over the adhesive using the included tamper screw as shown.
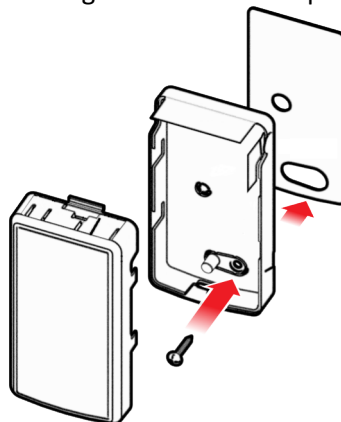
4. Reassemble the case.

The tab will break away if the case is forcibly removed. If you enabled the sensor's tamper option, the sensor sends a tamper alert. (Note: Tamper switches are disabled by default.)

Chapter 3 – Hardware Specifications and Information

Absolute Maximum Ratings

Parameter	Rating
Operating ambient temperature (indoor version)	-30°C to +70°C
Operating ambient temperature (outdoor version)	-40°C to +70°C
Storage ambient temperature	-40°C to +90°C

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. Sensors ship with a lithium battery, which is 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 and a low battery indicator are reported by supervisory messages. Refer to the section on Message Protocol for details.

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.
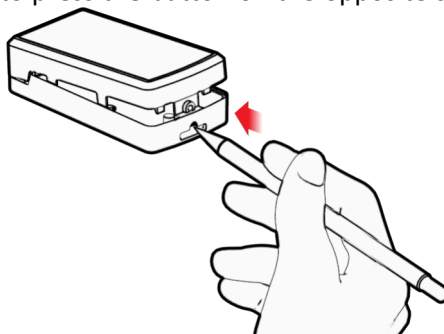
2. Remove the battery.
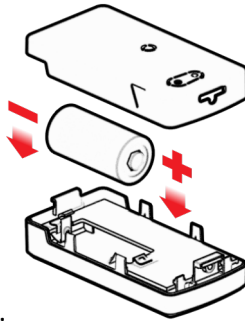
3. Insert the new battery as shown.
4. Close the case.

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
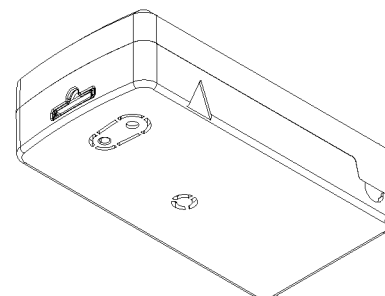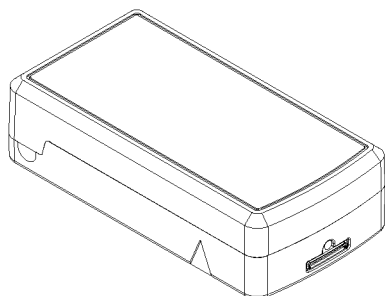
Armored Outdoor/Industrial RBSx06 Sensors

ISOMETRIC
TOP VIEW

ISOMETRIC
BOTTOM VIEW

4.528

.591

1.575

5.118

COVER

2.559

BODY

.591

1.576

Chapter 4 – Common Messages

Common Messages

This chapter defines the protocol and message definitions common to all MultiTech 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.

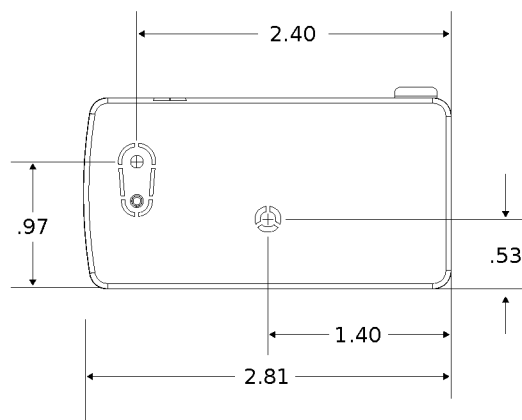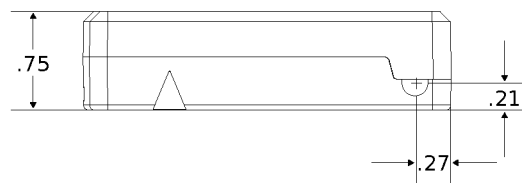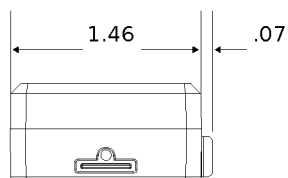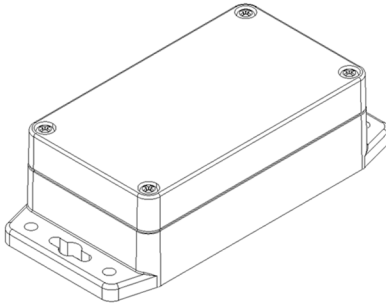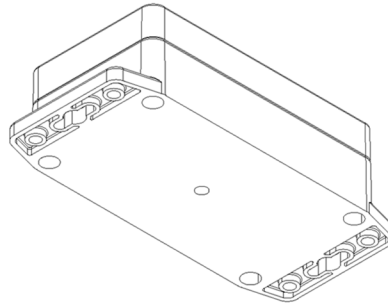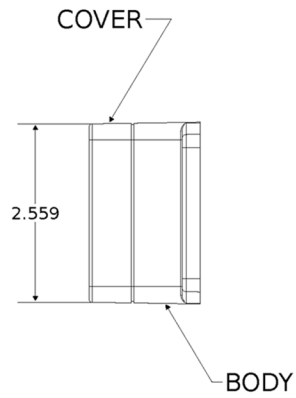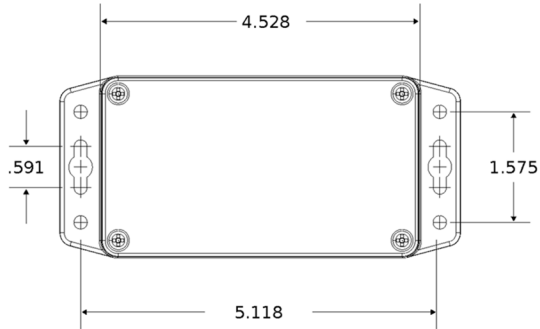> **Note:** MultiTech provides a web-based console at console.radiobridge.com for configuring and monitoring devices. We recommend using this console rather than the protocols defined in this section.

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

Factory Reset (0xEC)

Restores all setting to factory defaults. Does not preserve any custom configuration.

- In US915, the device returned the device information message.
- In EU868, the device returns that downlink confirmation .

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. 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 table for payload information.
0x00	5-byte reset code	Device has reset. The reset cause is represented in the 5-byte reset code payload.
0x01	>9 bytes	Daily supervisory message (1-2 per day). The 9-byte payload contains current sensor status. Refer to Supervisory Message 0x01for payload details.

Message Type	Payload	Description
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.
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 powers up 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. (The following code is specific to your device). Temperature External Probe 0x05
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 (19 hours by default) 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. **Note:** For applications requiring periodic readings, using the periodic reporting feature is recommended. Refer to *Periodic Reports.* in Sensor Specific Downlink Messages.
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 receiving downlink messages upon transmitting, since the sensor is typically sleeping with the radio turned off.

All downlink messages must contain 8 bytes, padded with zeroes.

A downlink will be received after any uplink within the receive window.

The following command messages can be sent back to the sensor as downlink.

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. *EU868 only*. To enforce the EU868 band duty cycle requirements, enable before production deployment. Cannot be disabled. Available in firmware 2.2.1 or later.
5:2	Uplink retries. . 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 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 invalid downlink error (0xFF01). Available in firmware v1.4 and above.
0	Disable Adaptive Data Rate (ADR). 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 is always set for production deployments in the EU868 band. It cannot be changed.

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 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).

Device Info Request

The Device Info Request command is a downlink to inform the gateway to report its downlink configuration information.

Bit	Description
0x00	Downlink configuration type to request.
	0-254: Request device info for specific downlink type to report.
	255: Request device info for all downlink configurations.

Link Quality Configuration (0xEE)

The Link Quality configuration command configures the number of failed confirmed message attempts before re-entering the LoRaWAN join state.

Byte	Description
0x00	Number of failed confirmed message transmits before the device re-enters a LoRaWAN join state. The default value is 12.
	When the device transmits a confirmed message and exhausts uplink retries without receiving an acknowledgment, the device increments an internal failed counter by 1. This counter 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

The ADR configuration message overrides the LoRaWAN ADR_ACK_LIMIT and ADR_ACK_DELAY parameters.

Byte	Description
0x00	ADR_ACK_LIMIT value when running in Unconfirmed Mode. The default value is 64.
0x01	ADR_ACK_DELAY value when running in Unconfirmed Mode. The default value is 32.
0x02	ADR_ACK_LIMIT value when running in Confirmed Mode. The default value is 2.
0x03	ADR_ACK_DELAY value when running in "Confirmed Mode". The default value is 1.

For additional details with usage to ADR_ACK_LIMIT and ADR_ACK_DELAY, refer to *LoRaWAN Link Layer Specification v1.0.4 - Section 4.3.1.1: Adaptive data-rate control in frame header.*

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
0x02	Link quality check period

Port Number

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

. 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 bridge is defined in following table. The common uplink messages are not included in this section (see Common Messages section).

Uplink Message 0x09: Temperature Station Event

Bytes	Description
0	Temperature Event Payload (see Temperature Event Payload Definitions
1	Current temperature in degrees Celsius
2	Relative temperature measurement

The temperature event is defined in the following table.

Temperature Event Payload Definitions

Byte 0	Description	
0x00	Periodic report	
0x01	Temperature has risen above upper threshold	
0x02	Temperature has fallen below lower threshold	
0x03	Report on change increase	
0x04	Report on change decrease	

The current temperature field in the temperature event uplink message is the current temperature in degrees Celsius. The temperature has been calibrated with controlled temperature chambers.

The relative temperature measurement is the raw (analog to digital) measurement and ranges on a scale from 0-255. This value can be used with different calibration tables defined by the user.

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.

Downlink Messages

The downlink messages (web application to sensor) specific to the weather station bridge are defined in this section. The common downlink messages are not included in this section (see Common Messages section).

External Probe Temperature Sensor Downlink Configuration Message 0x09

Byte	Description
0	Mode: 0x00 for Threshold, or 0x01 for Report on Change
1-6	Defined by Mode (See Mode sections)

The mode byte selects one of two modes: threshold based alerts or report-on-change alerts. The remainder of the payload (bytes 1-6) are determined by the mode selected and defined in the next two sections.

Threshold Mode

Threshold mode is set when byte 0 of the payload is set to 0x00. The remainder of the payload is defined in the following table.

Bits	Description
0	0x00 (Threshold mode)
1	minute or 1 hour intervals. Default is 0 (disabled)
2	Restoral margin (bits 3:0 only). Default 5 degrees C.
3	Lower temperature threshold. Default 10 degrees C.
4	Upper temperature threshold. Default 90 degrees C.

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.

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 1-15 degrees C). If a restoral margin is set to 0, it is disabled.

Report on Change Mode

Report on Change mode is set when byte 0 of the payload is set to 0x01. The remainder of the payload is defined in the following table.

Bits	Description
0	0x01 (Report on Change mode)
1	Periodic reporting in 1 minute or 1 hour intervals. Default is 0 (disabled)
2	Not used
3	Temperature increase
4	Temperature decrease

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.

Periodic Reports

The temperature sensor can also send periodic updates, and this is defined in byte 1 of both modes. A setting of 0 will disable periodic reporting. The period is defined in 1 hour increments when the most significant bit is 0, and it is defined in 1 minute increments when the most significant bit is 1 as shown in the following table.

Period Bye (byte 1) from Downlink Configuration Message

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

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

Note that prior to firmware version 1.3, only hourly reporting is available. The firmware version can be found in the reset message and is logged on the console.

Periodic reporting is not recommended as regular practice as its use increases data service fees and significantly reduces battery life. Wherever possible, use thresholds or report-on-change only.

Chapter 6 – Safety

Lithium Battery Safety

A lithium battery (3V, CR123A) provides power to the device. This battery has an estimated life expectancy of up to ten years. The battery is user replaceable. If the battery fails, The battery must be replaced by the same type.

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).

CAUTION: Risk of explosion if this battery is replaced by an incorrect type. Dispose of batteries according to instructions.

Attention: Risque d'explosion si vous remplacez la batterie par un modèle incompatible. Jetez les piles usagées selon les instructions.

User Responsibility

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

Chapter 7 – 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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