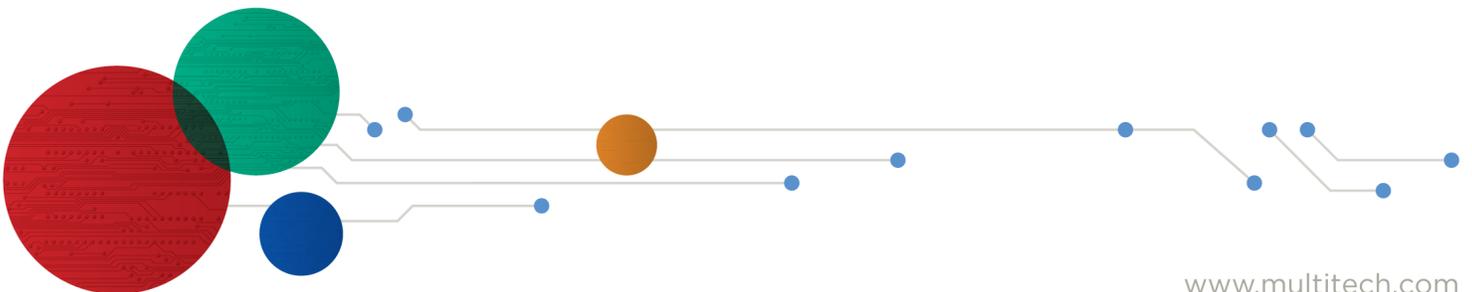# Reveal™ Wireless Vibration Sensor

User Guide

Reveal Wireless Vibration Sensor

Model: RBS301-VIB

Part Number: RB00017 rev. 1.0

Trademarks and Copyright

Copyright

Trademarks and Registered Trademarks

MultiTech, the MultiTech logo, DeviceHQ, xDot, and Conduit are registered trademarks and Reveal and mDot are trademarks of Multi-Tech Systems, Inc. All other products and technologies are the trademarks or registered trademarks of their respective holders.

Disclaimers

Information in this document is subject to change without notice and does not represent a commitment on the part of Multi-Tech Systems, Inc.. Multi-Tech Systems, Inc. provides this document "as is," without warranty of any kind, expressed or implied, including, but not limited to, the implied warranties of fitness or merchantability for a particular purpose. Multi-Tech Systems, Inc. may make improvements and/or changes in this manual or in the product(s) and/or the software described in this manual at any time.

Legal Notices

See the Legal Notices section of the website for up-to-date information on MultiTech warranty, returns policy, privacy statement, terms of sale, and terms of service.

Customer Support

MultiTech offers free technical support for Reveal sensors at:

https://support.radiobridge.com

MultiTech also offers technical support plans and service packages to help our customers get the most out of their MultiTech products.

World Headquarters

Multi-Tech Systems, Inc.

2205 Woodale Drive, Mounds View, MN 55112

Contents

Chapter 1 – Quick Start

Overview

The Reveal™ high-bandwidth vibration sensor measures vibration speed at low frequency ranges (10Hz – 1kHz), and peak g-force at high frequency ranges (1.5kHz – 10kHz). The sensor can support between one and four independent vibration inputs referred to as "channels" in this document. The vibration sensor can be used for simple motor on/off functionality, or vibration analysis utilizing ISO standards such as ISO 10816. The high frequencies are used for more advanced analysis not specified in ISO standards.

Part Numbers

Part Number	Rating	Wireless	Region
RBS306-VSHB-US	Outdoor/Industrial	LoRaWAN	North America, South America

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.	RB00017
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.
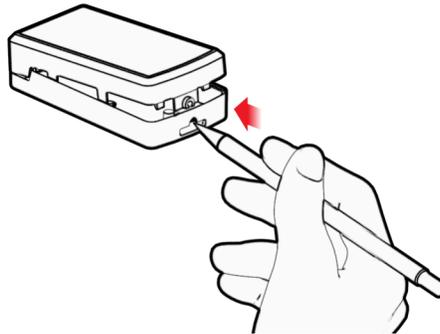
2. Remove the battery tab. You may need to remove the battery to remove the tab.
3. Re-insert the battery and close the case.

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.

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.

Chapter 3 – Hardware Specifications and Information

Absolute Maximum Ratings

Parameter	Rating	Units
Operating ambient temperature (indoor version)	-30 to +70	°C
Operating ambient temperature (outdoor version)	-40 to +70	°C
Storage ambient temperature	-40 to +100	°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. Radio Bridge devices are shipped with lithium batteries, which are the recommended replacement type.

Recommended battery: Panasonic CR2

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

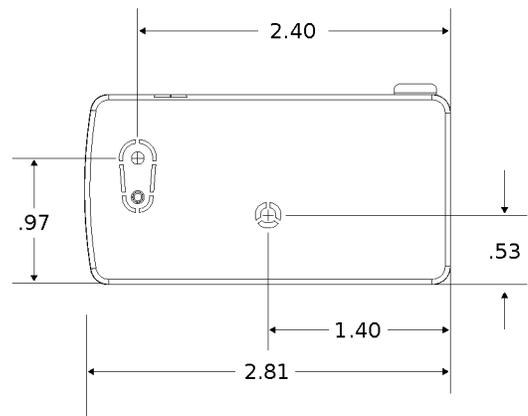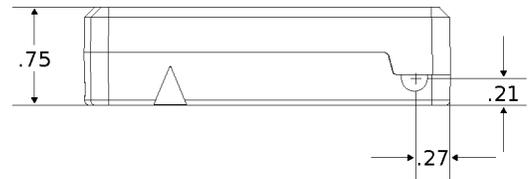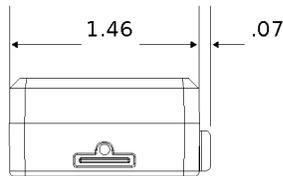The mechanical drawings provided in this section are for the main body of the sensor. All dimensions use inches unless specified.

Indoor RBSx01 Sensors
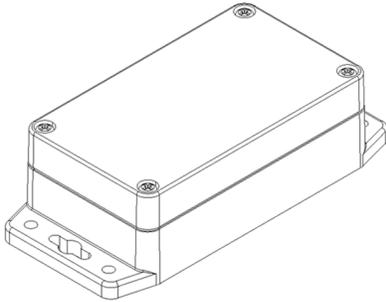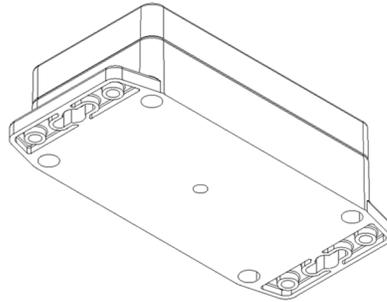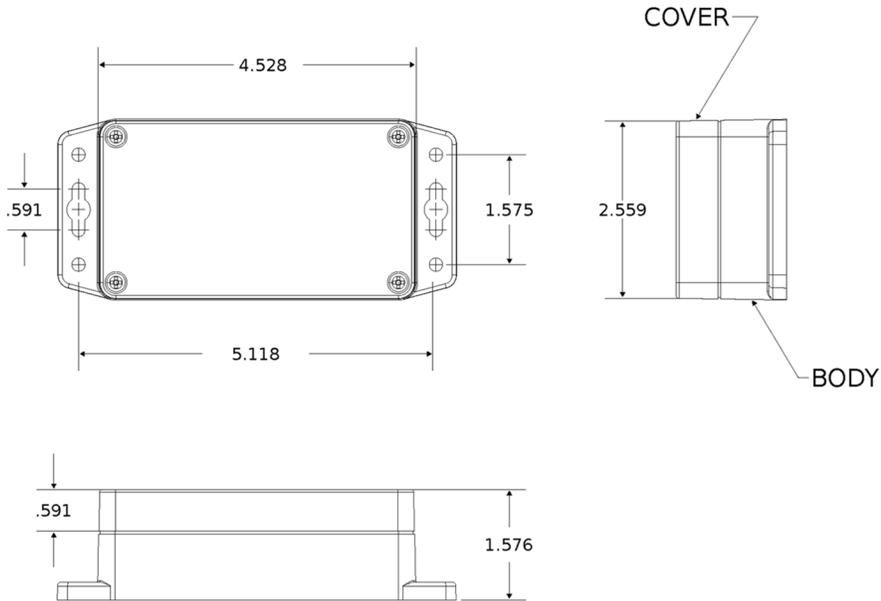
ISOMETRIC
TOP VIEW

ISOMETRIC
BOTTOM VIEW

1.46   .07

.75

.21

.27

2.40

.97

.53

1.40

2.81
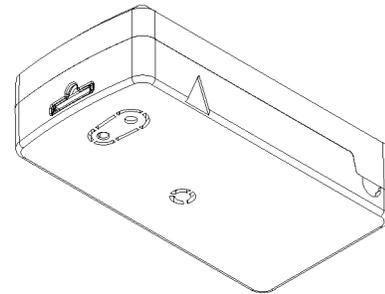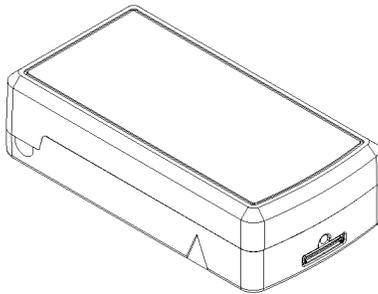
Armored Outdoor/Industrial RBSx06 Sensors

ISOMETRIC
TOP VIEW

ISOMETRIC
BOTTOM VIEW

4.528

.591

1.575

2.559

COVER

BODY

5.118

.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.
	Door/Window 0x01
	Door/Window High Security 0x02
	Contact 0x03
	Temperature No-Probe 0x04
	Temperature External Probe 0x05
	Single Push Button 0x06
	Dual Push Button 0x07
	Acceleration-Based Movement 0x08
	Tilt 0x09
	Water 0x0a
	Tank Level Float 0x0b
	Glass Break 0x0c
	Ambient Light 0x0d
	Air Temperature and Humidity 0x0e
	High-Precision Tilt 0x0f
	Ultrasonic Level 0x10
	4-20mA Loop 0x11
	Air Temp and Humidity – External Probe 0x12
	Thermocouple 0x13
	Voltmeter 0x14
	Custom (for customized sensors) 0x15
	GPS 0x16
	Honeywell 5800 Bridge 0x17
	Magnetometer 0x18
	Internal Temp Sensor 0x19
	Compass Sensor 0x1A
	Weather Station Bridge 0x1B
	Vibration Sensor High Bandwidth 0x1C-0x20
1	Hardware version.

Bytes	Description
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).

Vibration Event

The table below describes the vibration event uplink messages for each channel, all containing the low-frequency vibration and the high-frequency vibration data. Note that each channel is divided into its own message where ID of 0x1C is Channel 1, ID 0x1D is Channel 2, ID 0x1E is Channel 3, and ID 0x1F is Channel 4.

Byte	Description
0	Vibration Event Payload (see Vibration Event Payload Definitions)
1	Low-frequency vibration peak velocity in inches/sec in the given channel
2	High-frequency vibration peak g-force in the given channel
3	Temperature of accelerometer probe (signed two's complement)
4	Bias voltage of sensor

The vibration event is defined in the following table.

Event Payload	Description
0x00	Periodic report
0x01	High frequency vibration has risen above upper threshold
0x02	High frequency vibration has fallen below lower threshold
0x03	Low frequency velocity has risen above upper threshold
0x04	Low frequency velocity has fallen below lower threshold
0x05	Accelerometer exceeded g-force range (see Scaling Factor in downlink section)

All velocity values for the low-frequency vibration sensor are in units of inches/sec and represent peak value derived from the root-mean-squared calculation: peak velocity = RMS * 1.414.

The low frequency velocity values must be divided by 100 to obtain the value in inches/sec. For example, if the low-frequency peak velocity byte is 0x6E or 110 decimal, the velocity is 1.1 in/sec.

The high frequency g-force values must be divided by 4 to obtain the value in g-force. For example, if the high-frequency byte is 0x0A or 10 decimal, the peak g-force is 2.5g.

The range for the temp sensor is 0C to 100C.

The bias voltage should sit at the midpoint of the voltage reference to the accelerometer. For example, if the accelerometer is powered at 3.3V, the bias should be 1.65V. If the bias voltage is not at this midpoint, it could indicate a cabling issue, a broken accelerometer, or some other problem in the system. The bias voltage byte in the uplink message must be divided by 100 to obtain the actual value. For example, if the bias voltage byte is 0xA5 or 165 decimal, the bias voltage is 1.65V.

Condensed FFT

FFTs are important for identifying specific conditions in vibration analysis, but sending a full FFT over a LoRaWAN network is not feasible with respect to payload sizes, power consumption, on-air time, and other considerations. Thus, the vibration sensor sends a "Condensed FFT" which provides both total energy and peak energy from specific frequency bands in the FFT. The following table defines the eight bands that are reported:

Band	Frequencies
0	10-20Hz
1	21-40Hz
2	41-55Hz
3	56-70Hz
4	71-110Hz
5	111-130Hz
6	131-230Hz
7	231Hz+

The frequency ranges in the above table represent important bands required for diagnosing common failure conditions. For all of the eight bands, a total energy value is reported which is the sum of all bins in the FFT between those two frequencies, and a peak energy value which is just the peak value from a single bin between the two frequencies.

The uplink messages for the condensed FFT are shown in the table below

Byte	Description
0	Payload definition byte Bits 7:4 Payload type (see Condensed FFT Payload Definitions) Bits 3:0 Channel (0x00, 0x01, 0x02, or 0x03)
1-2	Value for frequency band 0 or 4
3-4	Value for frequency band 1 or 5
5-6	Value for frequency band 2 or 6
7-8	Value for frequency band 3 or 7

Payload Type	Description
0x0	Total energy values, bands 0-3 in bytes 1-8 (16 bit values)
0x1	Total energy values, bands 4-7 in bytes 1-8 (16 bit values)
0x2	Peak energy values, bands 0-3 in bytes 1-8 (16 bit values)
0x3	Peak energy values, bands 4-7 in bytes 1-8 (16 bit values)

In the condensed FFT message, bytes 1-8 contain four 16-bit values. For example, if the sensor is reporting a peak energy value of 300 in frequency band 5 of channel 1, the payload definition byte would be 0x31 and bytes 3-4 would be 0x012C (300 decimal).

Downlink Messages

The downlink message (web application to sensor) specific to the vibration sensors are defined in this section. The common downlink messages are not included in this section (see common messages document).

The low-frequency and high-frequency sensors are divided into two downlink messages, as some products may contain one or the other, or both.

The table below describes the configuration used for each channel.

Byte	Description
0	Control byte (see Control Byte below)
1	Periodic reporting (see Periodic Reports below)
2	Low frequency upper threshold in inches/second
3	Low frequency lower threshold in inches/second
4	High frequency upper threshold in g-force
5	High frequency lower threshold in g-force
6	Sampling duration (see Sampling Duration section below)

The configuration defined above is the same for each channel. Using ID 0x1C configures Channel 1, ID of 0x1D configures Channel 2, ID 0x1E configures Channel 3, and ID 0x1F configures Channel 4.

All velocity values in the low-frequency sensor are in units of inches/sec and represent peak value derived from the root-mean-squared calculation: peak velocity = RMS * 1.414.

The desired low frequency velocity threshold values must be multiplied by 100 for the configuration value. For example, if the desired low-frequency threshold is 1.1 in/sec, then the threshold value would be 110 or 0x6E. Thus, the resolution of the velocity values is 0.01 in/sec with a max value of 2.55 in/sec.

The desired high frequency g-force threshold values must be multiplied by 4 for the configuration value. For example, if the desired high-frequency threshold is 2.5g, then the threshold value would be 10 or 0x0A. Thus, the resolution of the g-force values is 0.25g with a max value of 63.75g.

A value of zero in any of the above threshold values disables the reporting of that event.

Control Byte

The control byte for both downlink messages is defined in the following table.

Bit	Description
0-3	Unused
4-6	Scaling factor (see Scaling factor section)
7	Auto-scaling (see Auto Scaling section). Set to 1 if auto-scaling is on, 0 if it is disabled.

Periodic Reports

The vibration sensor can also send periodic updates, and this is defined in byte 1 of both sensor downlinks. 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.

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.

Scaling Factor

The scaling factor sets the full range of the accelerometer probe. By default, the accelerometer has a full dynamic range of +/- 40g which is much higher than most applications required. For best results, set the scaling factor as high as possible for a particular application. For example, if the max g-force expected is +/- 15g, then use the 2x scaling factor which reduces the overall range to +/- 20g and will provide results on a scale that has better resolution. If a scaling factor is too high and hits the limit of the accelerometer, an uplink message will be sent indicating that the accelerometer is out of range and you must increase the scaling factor.

The scaling factor is part of the Control Byte defined above, and the two bits are defined in the following tables for the low frequency products.

Bits 6:4	Scaling Factor
000	x1 (default)
001	x2
010	x4
011	x5
100	x8
101	x10
110	x16
111	x32

The scaling factor how much to amplify the accelerometer signal. This is useful for low levels of vibration that need to be scaled up to improve the dynamic range. For example, a scaling factor of x2 (bits = 001) means that the signal is amplified by a factor of 2. If the signal is amplified too much and hits the limit of the accelerometer, a message indicating that the signal has been clipped will be sent (see uplink messages above), and if the auto-scaling is enabled the scaling factor will be automatically reduced. The Auto-Scaling feature defined in the next section.

Auto Scaling

The scaling factor defined in the previous section sets the full range of the accelerometer, and the auto-scaling feature defined in this section allows the vibration sensor to automatically increase the scaling based on the current levels of vibration.

When enabled, the auto-scaling feature will increase the scaling if the maximum g-forces on the current sample exceed 90% of the current range.

If a condition occurs where the g-force has exceeded the maximum range of the accelerometer, a message will be sent to the user (see uplink messages), the scaling factor will decrease, and the measurement will be run again with the updated scaling factor.

Note that auto-scaling will only move the scale down, not up. To adjust the scaling factor up to increase resolution, see the previous section to send the corresponding downlink.

To enable auto-scaling, set the corresponding bit in the control byte to 1, and set to 0 to disable. The auto-scaling is on by default.

Sampling Duration

The sampling duration byte specifies how many samples to capture before reporting a value, checking a threshold, etc. The byte is defined in the table below.

Bits	Description
7:4	Low Frequency samples to average
3:0	High Frequency

As shown in the above table, the sample duration can be set independently for the high frequency and low frequency measurements. In the low frequency measurements, the additional samples are used for spectral averaging in the frequency domain to reduce the noise floor.

For high frequency measurements, the additional samples essentially widens the window for identifying the maximum value. Generally speaking, adding additional samples will increase the maximum value because we are looking for a max value across a longer period of time.

The additional samples defined in this byte all happen at the same time, ie back-to-back. For example, if the system-wide sampling rate (see the Common Messages document) is set to one hour and the low frequency sampling duration is set to four, then every hour the sensor will take four samples and report the average value.

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