Wireless Thermocouple Temp Sensor User Guide

VERSION 1.2
SEPTEMBER 2019

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1. QUICK START

To start using your sensor, simply go to:

https://console.radiobridge.com

From here you can register your device and immediately start receiving messages from the sensor.

The sensor configuration, message monitoring, and setting up alerts is usually self-explanatory through the user interface. For further explanations of any sensor features, you may refer to this user guide

2. OVERVIEW

2.1. Sensor Overview

The wireless sensors designed and manufactured by Radio Bridge provide full sensor to cloud solutions for Internet of Things (IoT) applications. The thermocouple temperature sensor measures temperature using an external K-type thermocouple. Other thermocouples may be used and can be configured via downlink messages. Temperature reporting can be based on thresholds, report-on-change, and periodic messaging.

Features include:

- Built-in radio that talks directly with LoRaWAN wireless networks
- Two types of tamper detection: enclosure tamper and wall mount tamper
    - Enclosure tamper detects if the packaging of the sensor itself is opened or broken Available on the RBSx01, RBSx05, and RBSx06 sensors.
    - Wall mount tamper detects if the sensor has been removed from the wall or mounting point. Available on the RBSx01 and RBSx05 sensors.
- 200,000+ transmissions on a single battery and a 5-10 year battery life depending on usage. See Battery section for more detail.
- Fully integrated internal antenna
- Over the air sensor configuration in the field
- Automatic low battery reporting and supervisory messages

2.2. Revision History

Table 1 Revision History

Revision	Date	Description
1.0	April 2019	Initial release of the document
1.1	May 2019	Precision and accuracy tables
1.2	September 2019	Updated common sections

2.3. Document Conventions

Table 2 Document Conventions

Font / Icon	Meaning
	Important notes
	Warnings and cautions

2.4. Part Numbers

Table 3 Part Numbers

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

3. TECHNICAL SPECIFICATIONS

3.1. Absolute Maximum Ratings

Table 4 Absolute Maximum Ratings

Parameter	Rating	Units
Operating ambient temperature (radio and plastic housing)	-40 to +70	°C

Storage ambient temperature (radio and plastic housing)	-40 to +100	°C
Thermocouple input	+/- 45	V
Thermocouple probe	-210 to +1800	°C

3.2. Operating Ranges

The Thermocouple Temperature Sensor comes with a K-type thermocouple by default, but will support other thermocouple types as defined in the following table.

Table 5 Operating Range Based on Thermocouple Type

Type	Temp Range	Nominal Sensitivity (uV/°C)
B	250°C to 1820°C	10.086 (+500°C to +1500°C)
E	-200°C to +1000°C	76.373 (0°C to +1000°C)
J	-210°C to +1200°C	57.953 (0°C to + 750°C)
K	-200°C to +1372°C	41.276 (0°C to + 1000°C)
N	-200°C to +1300°C	36.256 (0°C to +1000°C)
R	-50°C to +1768°C	10.506 (0°C to +1000°C)
S	-50°C to +1768°C	9.587 (0°C to +1000°C)
T	-200°C to +400°C	52.18 (0°C to +400°C)

Table 6 Thermocouple Precision and Accuracy

Parameter	Rating	Units
Precision	16	bits
Accuracy	0.06	°C

4. BATTERY LIFE

The sensor uses a lithium non-rechargeable battery and is capable of 200,000+ total messages depending on the wireless standard and usage. For an accurate estimate of battery life, please refer to the "Sensor Battery Estimator.xlsx" spreadsheet on the Radio Bridge website. This spreadsheet combines usage information such as average number of messages per day and estimates the battery life for a particular sensor.

Refer to the spreadsheet "Sensor Battery Estimator.xlsx" on the Radio Bridge website for specific battery life estimates.

The power required for a message transmission is much greater than the "sleep current" (the power consumed when the sensor is inactive) for high power radio technologies such as LoRaWAN. This means that the battery life for most sensors is primarily dependent on the number of transmissions per day.

Different battery types will deplete over time with different voltage profiles. For instance, a lithium battery will maintain a relatively high voltage for the life of the battery and then experience a rapid drop near the end, whereas an alkaline battery will experience a more gradual reduction in voltage over time. Radio Bridge sensors are shipped with lithium batteries, and these are recommended when the battery needs to be eventually replaced.

Temperature also plays a role in battery life. The battery life estimates in the online spreadsheet assume room temperature, but temperatures close to the maximum and minimum ratings will have a negative impact on battery life. For example, battery voltage tends to be lower in cold temperatures and the internal circuitry needs a certain minimum voltage to operate properly before it will shut down. Thus, battery life will tend to be shorter when running the sensor in cold environments.

Battery voltage will be lower in cold temperatures and thus battery life will be reduced in cold environments.

The battery voltage is reported by the supervisory messages as well as a low battery indicator. See the section on Message Protocol for more detail.

5. TEST MESSAGES

The sensor can be triggered to send test messages by placing a magnet next to the side of the sensor. The location of the magnet is indicated by the triangular notch on the side of RBSx01 and RBSx05 sensors. RBSx04 sensors do not have this capability. There is a small magnetic Hall effect sensor that will detect the presence of a magnet and send a message. This can be used for diagnostic purposes to ensure the sensor is within range and connected to the network.

6. MESSAGE PROTOCOL

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

Radio Bridge provides a web-based console at console.radiobridge.com to configure and monitor sensors. Usage of this console is highly recommended for most customers rather than implementing the protocols defined in this section.

If the standard Radio Bridge console (console.radiobridge.com) is not used, refer to this section to decode the sensor data and configure the sensor through downlink messages.

6.1. Common Messages

There are common messages across all wireless sensors that are defined in the document “Common Sensor Messages” which is available on the Radio Bridge website.

Refer to the document “Common Sensor Messages” for definitions of all common messages. Common messages are not defined in this document.

Common messages include basic error messages, tamper, supervisory, and downlink ack. It is important to refer to that document prior to decoding the messages defined in this section.

6.2. 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).

Table 7 Uplink Message 0x13: Temperature Event

Byte	Description
0	Temperature Event Payload (see Temperature Event Payload Definitions)
1-2	Current temperature in degrees Celsius (see decoding below)
3	Faults (see fault definitions)

6.2.1. Temperature Event Payload

The temperature event is defined in the following table.

Table 8 Temperature Event Payload Definitions

Event Payload	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
0x05	Fault

6.2.1. Temperature Decoding

The current temperature in bytes 1-2 is decoded by taking the 16-bit two's complement number and dividing by 16. Examples are shown in the following table.

Table 9 Temperature Decode

Temperature (Celsius)	Bytes 1-2
+1600.00	0110 0100 0000 0000
+1000.00	0011 1110 1000 0000
+100.9375	0000 0110 0100 1111
+25.00	0000 0001 1001 0000
+0.0625	0000 0000 0000 0001
0.00	0000 0000 0000 0000
-0.0625	1111 1111 1111 1111
-0.25	1111 1111 1111 1100
-1.00	1111 1111 1111 0000
-250.00	1111 0000 0110 0000

6.2.1. Faults

If something goes wrong with the thermocouple such as detection of a broken probe, a fault message will be generated and a code provided in byte 3 of the uplink based on the following table.

Table 10 Fault Definitions

Bit	Description
7	The cold-Junction temperature is outside of the normal operating range
6	The hot junction temperature is outside of the normal operating range
5	The cold-Junction temperature is at or lower than the cold-junction temperature high threshold
4	The Cold-Junction temperature is lower than the cold-junction temperature low threshold
3	The thermocouple temperature is too high
2	Thermocouple temperature is too low

1	The input voltage is negative or greater than VDD
0	An open circuit such as broken thermocouple wires has been detected

6.3. 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).

Table 11 Downlink Configuration Message 0x13

Byte	Bits	Description
0	7:5	Unused
	4:1	Thermocouple type (see type table)
	0	Mode: 0 for Threshold or 1 for Report on Change
1	7:0	Periodic reporting in 1 minute or 1 hour intervals. Default is 0 (disabled)
2-6		Defined by Mode (See Mode sections)

The mode byte selects one of two modes: threshold-based alerts or report-on-change alerts as described in the following sections.

6.3.1. Thermocouple Types

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 12 Thermocouple Type Setting

Byte 0, Bits 4:1	Description
0000	B Type
0001	E Type

0010	J Type
0011	K Type (default)
0100	N Type
0101	R Type
0110	S Type
0111	T Type
1000	Voltage Mode, Gain = 8. Code = 8 x 1.6 x 217 x VIN
1100	Voltage Mode, Gain = 32. Code = 32 x 1.6 x 217 x VIN

6.3.2. Threshold Mode

Bytes 2-6 for threshold mode are defined in the following table. Note that thresholds can only be set with precision defined by bytes 1 and 2 of the temperature decoding table.

Table 13 Downlink Configuration Message for Threshold Mode

Byte	Description
2	Restoral margin in degrees C. Default 5 degrees C.
3-4	Upper temperature threshold. Default 90 degrees C.
5-6	Lower temperature threshold. Default 10 degrees C.

The upper and lower temperature thresholds are defined by the temperature decode table used for the uplink messages. 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 1-255 degrees C). If a restoral margin is set to 0, it is disabled.

6.3.3. Report on Change Mode

Report on Change mode is set when byte 0 of the payload is set to 1. The remainder of the payload is defined in the following table.

Table 14 Downlink Configuration Message for Report on Change Mode

Byte	Description
2	Unused
3-4	Temperature increase
5-6	Temperature decrease

If the temperature increase or decrease are non-zero, then the sensor will send 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 defined by the temperature decode table used for the uplink messages except that the sign bit is ignored.

6.3.4. 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.

Table 15 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.

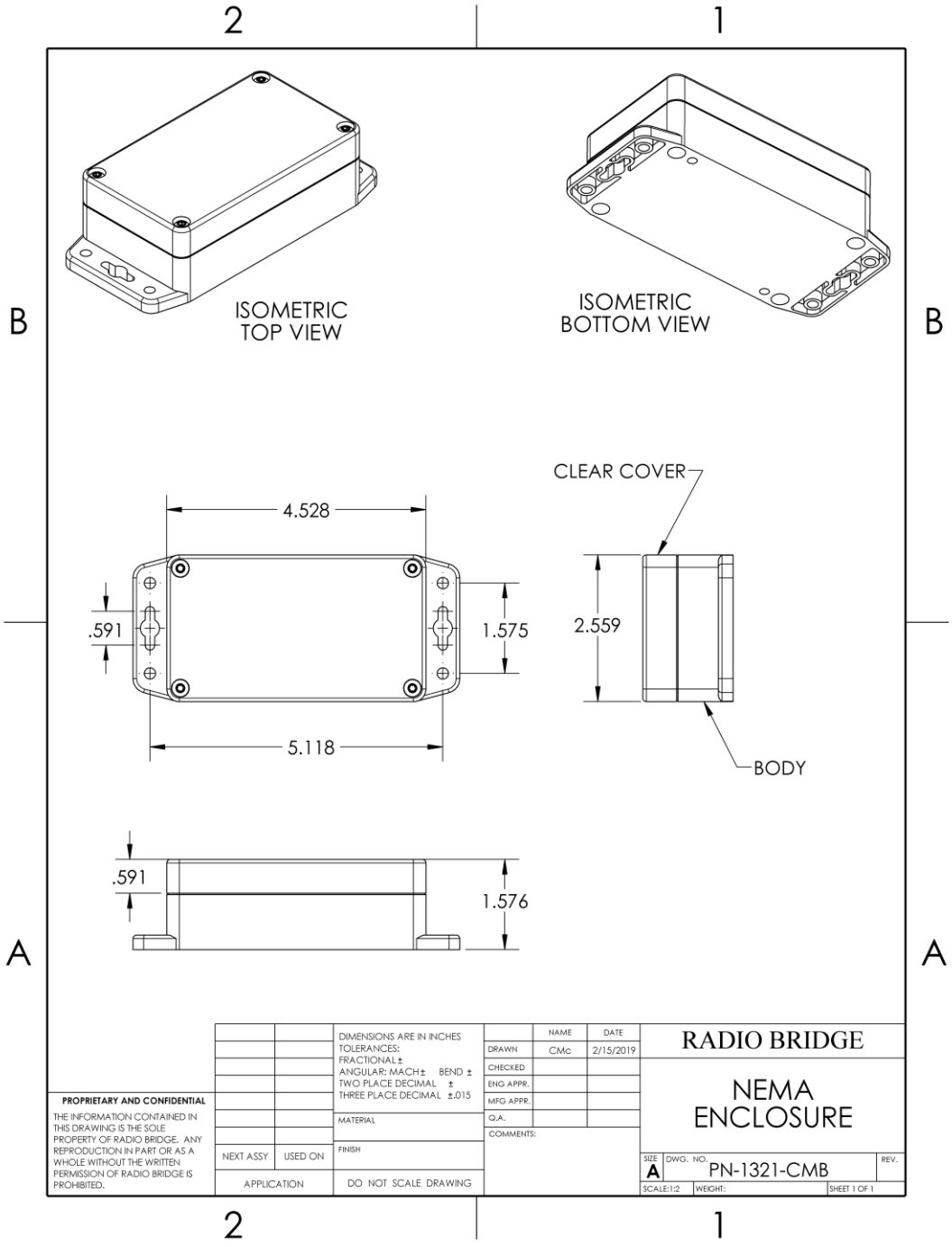
Note that **prior to firmware version 1.3, only hourly reporting is available**. The firmware version can be found in the reset message and is logged on the Radio Bridge console.

Periodic reporting is not recommended as it will increase data service fees and significantly reduce battery life. Wherever possible, use thresholds or report-on-change only.

7. MECHANICAL DRAWINGS

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

7.1. ARMORED OUTDOOR/INDUSTRIAL RBSX06 SENSORS



8. REGULATORY AND COMPLIANCE

8.1. 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 Radio Bridge could void authority to operate the devices.

Sigfox RBS101, RBS104, and RBS105 sensors FCC ID: 2APNUSFM10R2

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

8.2. 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

8.3. 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

9. CUSTOMER SUPPORT

Radio Bridge offers free technical support at:

https://support.radiobridge.com

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

10. DISCLAIMERS

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