# Wireless Ultrasonic Level Sensor User Guide

VERSION 1.5
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 ultrasonic level sensor provides high accuracy ultrasonic proximity detection and ranging in air. If the measured distance rises above or falls below the configured thresholds, an alert is sent over the wireless network.

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 | February 2019 | Initial release of the document |
| 1.1 | March 2019 | Add International Part Numbers |
| 1.2 | May 2019 | Updated mechanical drawings |
| 1.3 | July 2019 | Replaced 5 meter product with 10 meter |
| 1.4 | August 2019 | Added hold time feature, mounting instructions, and updated mechanical drawings |
| 1.5 | 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-US10M-US | Outdoor/Industrial | LoRaWAN | North America, South America |
| RBS306-US10M-EU | Outdoor/Industrial | LoRaWAN | Europe |

# 3. TECHNICAL SPECIFICATIONS

## 3.1. Absolute Maximum Ratings

*Table 4 Absolute Maximum Ratings*

| Parameter | Rating | Units |
|---|---|---|
| Operating ambient temperature | -40 to +70 | °C |
| Storage ambient temperature | -40 to +100 | °C |

# 4. MOUNTING

The ultrasonic sensor can measure distances between 500mm to 10m and the sensor must be mounted such that the required distances are within that range. Distances outside of that range will result in incorrect measurements. This includes distances that are too close (less than 500mm) as well as too far (greater than 10m).

The sensor must also be mounted such that it is perpendicular to a flat surface. Mounting the sensor at an angle to the surface or using a surface that is not flat may result in incorrect measurements. Flat surfaces also include the surface of a liquid.

The ultrasonic sensor must be mounted perpendicular to a flat surface and at a distance between 500mm and 10m

# 5. 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.

# 6. 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.

# 7. 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.

## 7.1. 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.

## 7.2. 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 5 Uplink Message 0x10: Ultrasonic Level Detection Event*

| Byte | Description |
|---|---|
| 0 | Ultrasonic Level Event Payload (see Ultrasonic Level Event Payload Definitions) |
| 1 | Current distance in millimeters, upper byte (0-9999) |
| 2 | Current distance in millimeters, lower byte |

The distance can range between 0-9999 millimeters, so two bytes are needed to represent the distance. For example, if a distance is 642mm, it would be reported as 0x02 and 0x82 in bytes 1 and 2 respectively.

The ultrasonic level event is defined in the following table.

*Table 6 Ultrasonic Level Event Payload Definitions*

| Event Payload | Description |
|---|---|
| 0x00 | Periodic report |
| 0x01 | Distance has risen above upper threshold |
| 0x02 | Distance has fallen below lower threshold |
| 0x03 | Report on change increase |
| 0x04 | Report on change decrease |

The current distance field in the ultrasonic level event uplink message is the current distance measurement in millimeters with a range of 0-9999 (0-10 meters). The distance is automatically calibrated by the device.

## 7.3. 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 7 Downlink Configuration Message 0x10*

| 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.

### 7.3.1. 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.

| Byte | Description |
|---|---|
| 0 | 0x00 (Threshold mode) |
| 1 | Periodic reporting in 1 minute or 1 hour intervals. Default is 0 (disabled) |
| 2 | Hold time in 1 second or 1 minute intervals |
| 3 | Lower distance threshold in mm, upper byte. Default 100mm |
| 4 | Lower distance threshold in mm, lower byte |

| | |
|---|---|
| 5 | Upper distance threshold in mm, upper byte. Default 1,000mm |
| 6 | Upper distance threshold in mm, lower byte |

*Table 8 Downlink Configuration Message for Threshold Mode*

The upper and lower distance thresholds are *unsigned* values with units of one millimeter. Note that if the configuration settings exceed the maximum ratings on the sensor, the sensor may not report an event.

Periodic reporting and hold time are described in the sections below.

### 7.3.2. 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.

*Table 9 Downlink Configuration Message for Report on Change Mode*

| Byte | Description |
|---|---|
| 0 | 0x01 (Report on Change mode) |
| 1 | Periodic reporting in 1 minute or 1 hour intervals. Default is 0 (disabled) |
| 2 | Hold time in 1 second or 1 minute intervals |
| 3 | Distance increase in mm, upper byte |
| 4 | Distance increase, lower byte |
| 5 | Distance decrease in mm, upper byte |
| 6 | Distance decrease in mm, lower byte |

If the distance increase or decrease are non-zero, then the sensor will send an alert any time the distance changes by the specified amount. For example, if the distance increase and decrease are set to 5mm, then an alert is sent every time the distance

changes 5mm from the last report. The distance increase and decrease are unsigned values with units in millimeters.

Periodic reporting and hold time are described in the sections below.

### 7.3.3. Hold Time

The purpose of the hold time is to add “debounce” or “hysteresis” to the sensor so that it does not send rapid events when the measurements are sitting close to the threshold. The measurements for the ultrasonic may jump between multiple values if it is not mounted properly, and thus if the measurement continuously jumps above and below a threshold, it will send a flood of threshold events without any hold time defined. For example, if the lower threshold for the ultrasonic is set to 1000 (1 meter) and the distance measurements are bouncing between say 900 and 1100 every 1 second, then there will be a lower threshold event every 2 seconds. If a hold time of 10 seconds is defined, no threshold events occur. The measurement must then drop below 1000 and stay below that threshold for 10 seconds before a lower threshold event message is created.

The hold time is defined in 1 minute increments when the most significant bit is 0, and it is defined in 1 second increments when the most significant bit is 1 as shown in the following table.

*Table 10 Period Bye (byte 2) from Downlink Configuration Message*

| Bit 7 | Bits 6:0 |
|---|---|
| 0 | Hold time defined in minutes (1-127 minutes) |
| 1 | Hold time defined in seconds (1-127 seconds) |

For example, to set a hold time of 4 minutes, byte 2 would be set to 0x04. To set the hold time to 15 seconds, byte 2 would be set to 0x8f.

It is highly recommended to use hold times in order to prevent spurious events and unnecessary messages.

### 7.3.4. Periodic Reports

The ultrasonic level 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 11 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) |

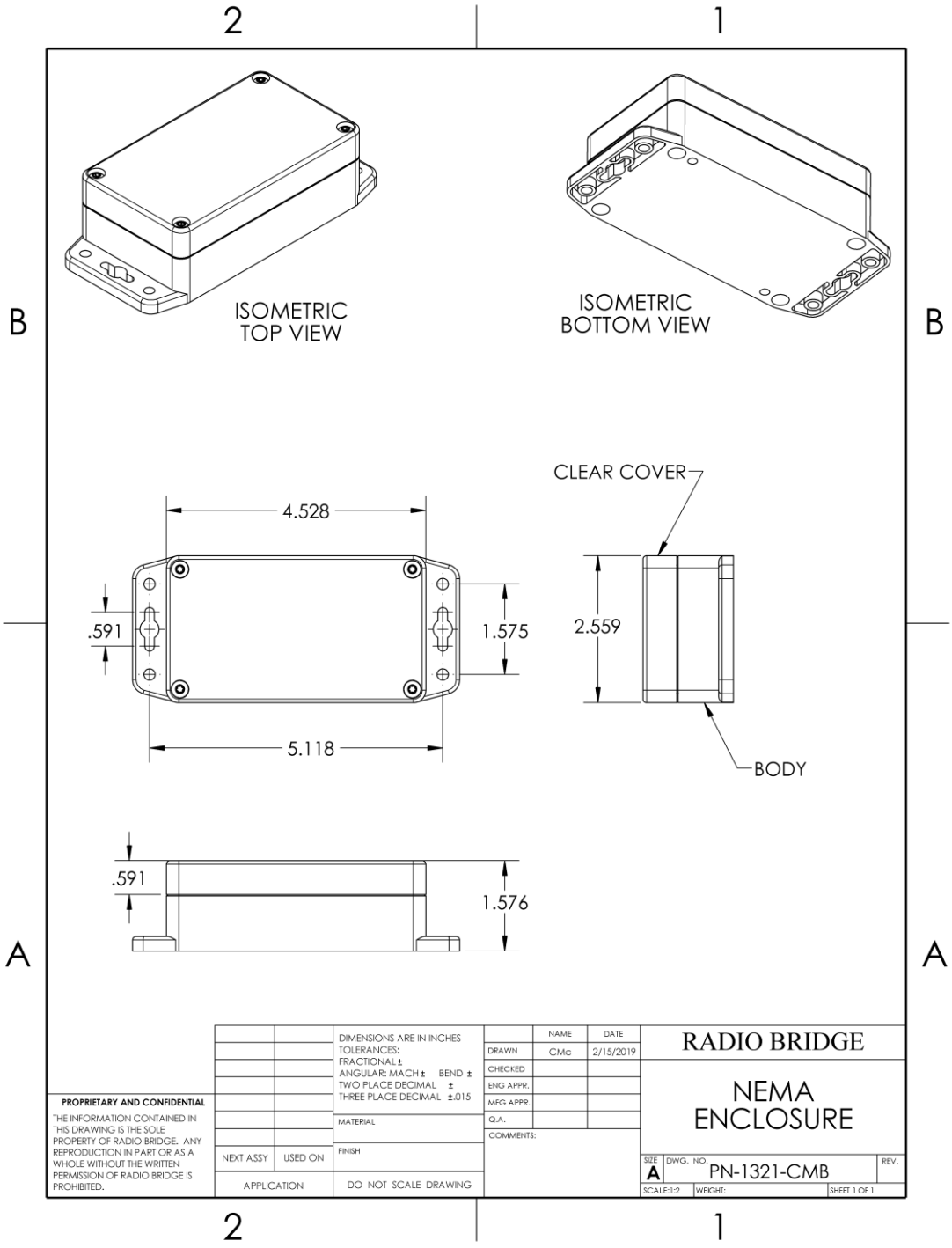
For example, to receive a report every 4 hours, byte 1 would be set to 0x04. To receive a periodic report every 15 minutes, byte 1 would be set to 0x8f.

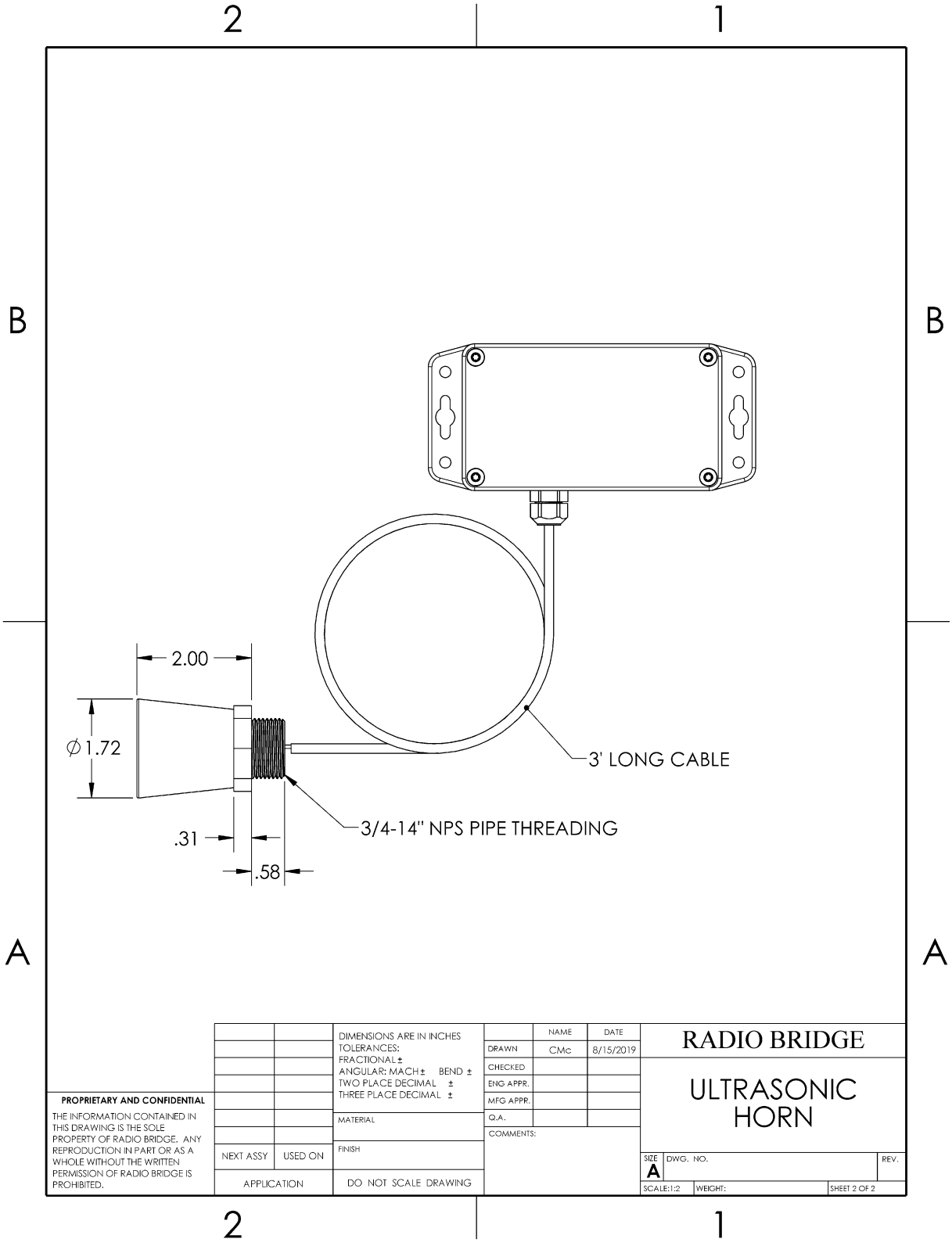
Periodic reporting is not recommended as it will increase data service fees and significantly reduce battery life. Wherever possible, use thresholds or report-on-change only.

# 8. MECHANICAL DRAWINGS

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

## 8.1. ARMORED OUTDOOR/INDUSTRIAL RBSX06 SENSORS




2
1
B
B
A
A
2.00
⌀1.72
.31
.58
3' LONG CABLE
3/4-14" NPS PIPE THREADING
PROPRIETARY AND CONFIDENTIAL
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NEXT ASSY
USED ON
APPLICATION
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
MATERIAL
FINISH
DO NOT SCALE DRAWING
NAME
DATE
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8/15/2019
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
RADIO BRIDGE
ULTRASONIC HORN
SIZE A
DWG. NO.
REV.
SCALE:1:2
WEIGHT:
SHEET 2 OF 2

# 9. REGULATORY AND COMPLIANCE

## 9.1. 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

## 9.2. 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

## 9.3. 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

# 10. 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.

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