Reveal™ Wireless Air Temperature Humidity Sensor

User Guide

Reveal Wireless Air Temperature Humidity Sensor

Model: RBS305-ATH

Part Number: RB0013 rev. 1.0

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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

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Chapter 1 – Quick Start

Overview

The Reveal™ wireless air temperature humidity sensor uses air flow to measure temperature and humidity levels. If the temperature and/or humidity rises above or falls below the configured thresholds, an alert is sent over the wireless network.

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.	RB00013
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.
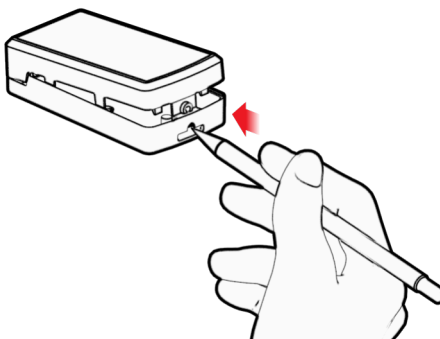
2. Remove the battery tab. You may need to remove the battery to remove the tab.
3. Re-insert the battery and close the case.

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 a lithium battery, which is 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
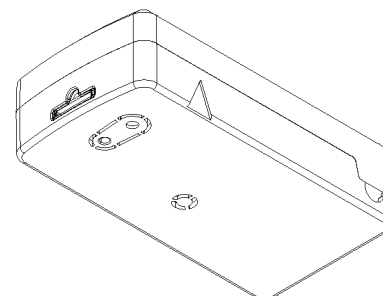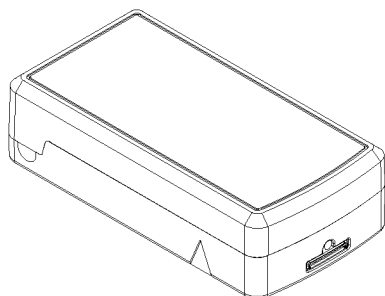
Armored Outdoor/Industrial RBSx06 Sensors

ISOMETRIC
TOP VIEW

ISOMETRIC
BOTTOM VIEW

4.528

.591

1.575

5.118

COVER

2.559

BODY

.591

1.576

Chapter 4 – Common Messages

Common Messages

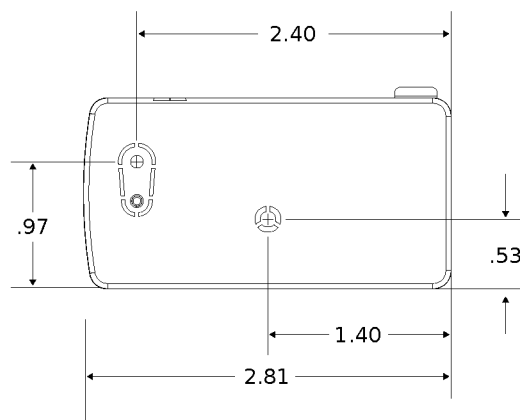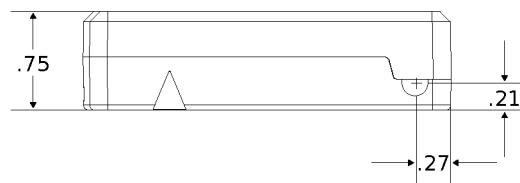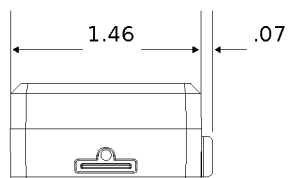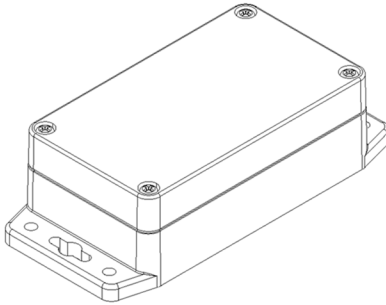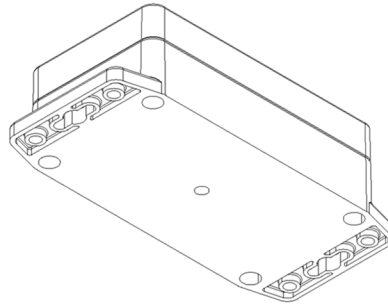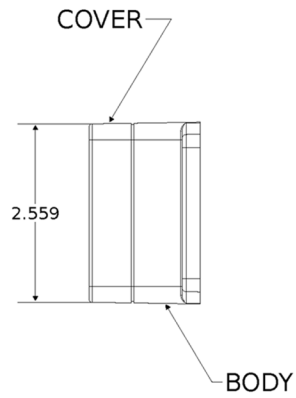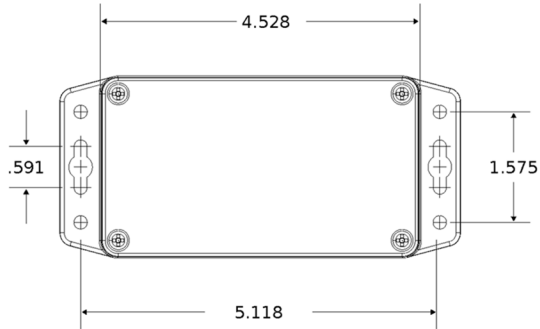This chapter defines the protocol and message definitions common to all Reveal wireless sensors. Common messages include basic error messages, tamper, supervisory, link quality, and downlink acknowledgments. Sensor specific messages are in the *Sensor Specific Messages* chapter.

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 0x01 for payload details.
0x02	1-byte event	A tamper event has occurred. Refer to Tamper Message 0x02 for details.
--	Sensor event	Sensor events are defined in the *Sensor Specific Messages* chapter.

COMMON MESSAGES

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.
1	Hardware version.
2-3	Firmware version.
4-5	Reset code. Used for factory diagnostics.

Firmware Version

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

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

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

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

Supervisory Message 0x01

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

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

The following table shows the supervisory message payload:

Bytes	Description
0	Supervisory error codes as follows: <table><tr><th>Bits</th><th>Description</th></tr><tr><td>7:5</td><td>Not used.</td></tr><tr><td>4</td><td>Tamper detected since last reset.</td></tr><tr><td>3</td><td>Current tamper state.</td></tr><tr><td>2</td><td>Error with last downlink.</td></tr><tr><td>1</td><td>Battery low (under 2.8v).</td></tr><tr><td>0</td><td>Radio communication error, communication with the integrated radio failed and the device was reset.</td></tr></table>
1	Current sensor state, 1-byte. This is device specific, refer Sensor Specific Messages chapter for details. For other devices, use the periodic reporting feature.
2	Battery level is a two-digit battery voltage. For example, if the battery voltage is 2.9V, byte 2 would be 0x29.
3-6	Extended sensor state, 4-bytes. Allows sensors with higher precision or multiple values to report during a supervisory event. For other devices, use the periodic reporting feature.
7-8	Event accumulation count is the number of sensor events since the last supervisory message. To improve battery life, can be used with the **Disable all sensor events** setting so only an event total is reported during a supervisory message, individual events are not reported as they occur. This feature is available in firmware v2.0 and beyond.

Tamper Message 0x02

A sensor sends a message when the tamper switch has been opened or closed through either an enclosure tamper or a wall mount tamper. The tamper message contains a 1-byte payload as shown in the following table.

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

Link Quality Message 0xfb

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

Bytes	Description
0	Current Sub-Band, sub-band currently joined and used for communication to the gateway and network server. Value ranges from 1-8 for US915. For other regions, value depends on available channels.
1	RSSI of last DOWNLINK received, signed integer format values in bytes 1 and 2 in two's complement format.
2	SNR of last DOWNLINK received, signed integer format values in bytes 1 and 2 in two's complement format.

Downlink Messages

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

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

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

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

General Configuration

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

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

Disable Sensor Events

The following table shows the disable sensor event bit definitions.

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

Radio Config

The following table shows the radio config byte definition.
    Note: Available in firmware version 1.4 or newer.

Bits	Description
7	Not used (reserved)
6	Enable duty cycle requirement. *LoRaWAN EU868 only*. To enforce the EU868 band duty cycle requirements, enable before production deployment. Default is disabled. Available in firmware 2.2.1 or later.
5:2	Uplink retries. *LoRaWAN only*. The range for uplink retries is 1-8 for confirmed messages (ACK required) and does not apply to unconfirmed messages. Default 0 (leave unchanged). Available in firmware v1.4 and above.
1	Use unconfirmed messages. *LoRaWAN only*. If set to use the unconfirmed messages bit, the sensor does not look for an ACK from the network server. Default is 1 (unconfirmed messages, no ACK required). EU sensors can't use confirmed messages, setting this bit to 0 on an EU device causes an error. Available in firmware v1.4 and above.
0	Disable Adaptive Data Rate (ADR). *LoRaWAN only*. To enable ADR, set to 0. To disable ADR, set to 1. Default is 0 (enabled). Available in firmware v1.3 and above.

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

Supervisory Period

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

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

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

Sampling Rate

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

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

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

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

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

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

Advanced Configuration

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

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

Port Number

For LoRAWAN devices only. Byte 0x01 of the advanced configuration command changes the uplink port per the LoRaWAN protocol. The default port is 2, and a value of 0 in this field means to leave it at the default.

This feature is available in firmware v1.4 and above.

Link Quality Check Period

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

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

Available in firmware v2.0 and above.

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

Downlink ACK

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

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

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

Chapter 5 – Sensor-Specific Messages

Uplink Messages

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

Uplink Message 0x1B: Weather Station Event

Bytes	Description
0	Event Identifier
1-8	Event Payload

Byte 0 defines the remainder of the payload. The event identifiers are summarized in the following table.

Event Identifiers

Byte 0	Description	
0x00	Error	
0x01	Wind direction	
0x02	Wind speed	
0x03	Pressure, Temperature, and Humidity	
0x04	Rain	
0x05	Hail	
0x06	Weather station status	

Each event is described in the tables below.

Event 0x00 Error

Bytes	Description
1	Error event (see following table for bit definitions)

Error Bit Definitions

Bit	Description
0	Timeout waiting for response from weather station
1	CRC error
2	Some data is marked as invalid

When any of the bits defined above are set, the error has occurred. The bit is cleared when no error is present.

Event 0x01 Wind Direction

Bytes	Description
1-2	Wind Direction minimum
3-4	Wind Direction average
5-6	Wind direction maximum
7-8	Unused

Wind direction is expressed in degrees of angle relative to North: North = 0°, East = 90°, South = 180°, and West = 270°.

Event 0x01 Wind Direction

Bytes	Description
1-2	Wind speed minimum
3-4	Wind speed average
5-6	Wind speed maximum
7-8	Unused

Wind speed is expressed in units of 0.1 meters/second. For example, a speed value of 0x0001 = 0.1 m/s.

Event 0x03 Pressure, Temperature, and Humidity

Bytes	Description
1-2	Temperature
3-4	Pressure
5-6	Humidity
7-8	Unused

The temperature is expressed in units of 0.1 degrees Celsius, meaning you must divide the value in this field by 10 to obtain the correct value. Temperature is a signed value in two's complement format.

The pressure is expressed in units of 10 Pascals, meaning you must multiply this field by 10 to obtain the correct value.

The humidity is expressed in units of 0.1%, meaning you must divide this field by 10 to obtain the correct value.

Event 0x04 Rain

Bytes	Description
1-2	Rain duration
3-4	Rain accumulation
5-6	Rain intensity
7-8	Unused

The rain duration is expressed in units of seconds.

The rain accumulation is expressed in units of .01 mm, meaning you must divide this field by 100 to obtain the correct value.

The rain intensity is expressed in units of 0.1 mm/h, meaning you must divide this field by 10 to obtain the correct value.

Event 0x04 Hail

Bytes	Description
1-2	Hail duration
3-4	Hail accumulation
5-6	Hail intensity
7-8	Unused

The hail duration is expressed in units of seconds.

The hail accumulation is expressed in units of 0.1 mm, meaning you must divide this field by 10 to obtain the correct value.

The hail intensity is expressed in units of 0.1 mm/h, meaning you must divide this field by 10 to obtain the correct value.

Event 0x04 Weather Station Status

Bytes	Description
1-2	Heating temperature
3-4	Heating voltage
5-6	Supply voltage
7-8	Reference voltage

The heating temperature is expressed in units of 0.1 degrees Celsius, meaning you must divide this field by 10 to obtain the correct value.

The heating voltage and supply voltage are expressed in units of 0.1 V, meaning you must divide these fields by 10 to obtain the correct value.

The reference voltage is expressed in units of 0.001 V, meaning you must divide this field by 1,000 to obtain the correct value.

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).

Weather Station Bridge Downlink Configuration Message 0x1B

The following table describes the configuration for the weather station bridge.

Byte	Description
0	Control Byte (defined in the following table)
1	Periodic reporting (see Periodic Reports)

Control Byte of Downlink Message Byte 0

The following table describes the control byte for the weather station bridge.

Bits	Description
0	Reset rain and hail accumulation and duration parameters
1	Reset rain and hail intensity parameters
2	Reset all ongoing measurements except rain

Periodic Reports

The weather station bridge sends all data on a periodic basis. This period is defined in byte 1 of the downlink message. The period is expressed in 1 hour increments when the most significant bit is 0, and in 1 minute increments when the most significant bit is 1 as shown in the following table.

Period Bye 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.

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