User Guide

Sentrius™ RS1xx

Version 1.7

REVISION HISTORY

Version	Date	Notes	Contributor	Approver
1.0	05 Dec 2017	Initial version	Christopher Hofmeister	Jonathan Kaye
1.1	09 Apr 2018	Indicated that the Sentrius™ Sensor with an external sensor port (RJ45) *will be available* rather than *is* available.	Mark Cai	Jonathan Kaye
1.2	17 Oct 2018	Updated for firmware version 4.4. Added in Packet Format and Packet Type sections.	Colin Anderson	Jonathan Kaye
1.3	19 Dec 2018	Updated logos and URLs	Sue White	Jonathan Kaye
1.4	May 2019	Reset button, LIFO, and FIFO backlog retrieval. Updated rest of doc for clarity.	Colin Anderson	Jonathan Kaye
1.5	July 2019	Introduction of AS923 and AU915 regions.	Colin Anderson, Mark Monson, Daniel Cesarz	Jonathan Kaye
1.6	15 Aug 2019	Added AS923 Region Label Support within various sections and created Section 16	Robert Gosewehr	Jonathan Kaye
1.7	28 Aug 2019	Reflect new part numbers and modified ext. probe specification	Chris Boorman	Jonathan Kaye

CONTENTS

1 ABOUT THIS GUIDE

This document is the parent guide of the *RS1xx Configuration Guide*. It provides a comprehensive guide on how to configure the Sentrius™ RS186 and RS191 sensors to suit the intended application. It covers all Sentrius™ RS1xx functionality, including Bluetooth and LoRa configurations in detail, as well as setting up the sensor on a LoRa network server.

In order to comply with the LoRaWAN spec, Laird offers several different versions of the Sentrius Sensor. Regions covered include Europe (EU), North America (US) and Australia (AU915). Also covered is the Asia(AS) region but, in order to meet local regulatory requirements, this region is covered by individual firmware versions for each country.

Note: Step by step instructions, screen shots, and pictures are based on the Sentrius™ RS191, but the same are applicable for the Sentrius™ RS186 or other variants. Any differences are noted.

2 INTRODUCTION

2.1 Product Overview

The Sentrius™ RS1xx LoRa-Enabled Sensor from Laird is the ultimate in secure, scalable, robust LoRa solutions for end-to-end control of your private LoRaWAN network. Based on the Semtech SX1272 chipset, it offers a long range up to ten miles, perfect for highly scalable, flexible IoT networks. The Sentrius™RS1xx Sensor works with Laird's Sentrius™RG1xx Series Gateways for simple out-of-the-box integration and is compatible with third-party and LoRa network servers.

1. Temperature and humidity sensor
2. Bluetooth button
3. LEDs
4. Fixing holes

Figure 2: Back side of the Sentrius™ RS1xx sensor

Figure 1: Top of the Sentrius™ RS1xx sensor

Note: Laird has a comprehensive staff of design services engineers available to help customize the sensor. Please contact your local Laird sales representative for more details.

2.2 Specifications

See the RS1xx product brief for detailed specifications. It's available from the Documentation tab of the RS1xx Series product page: https://www.lairdconnect.com/wireless-modules/lorawan-solutions/sentrius-rs1xx-lora-enabled-sensors

2.3 Architecture Overview

The major pieces of a LoRa network can be seen in Figure 3. The RS1xx sensor is an *End Node* in the diagram below. The RS1xx requires the other components in the diagram below to operate.
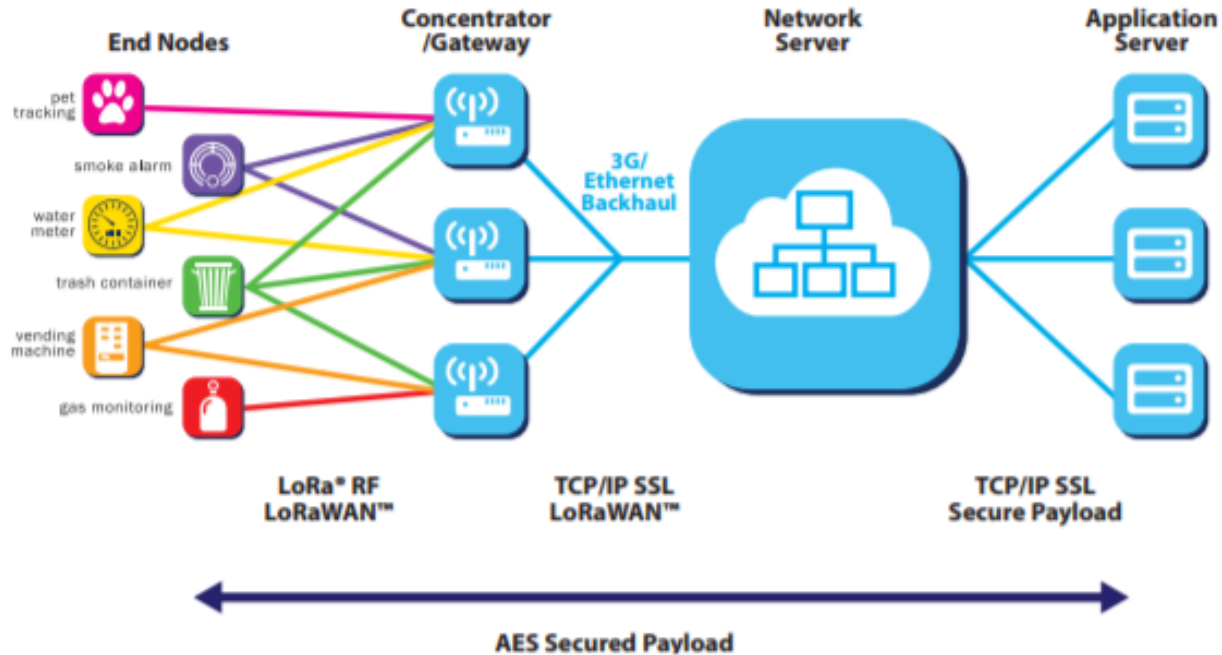

Figure 3: LoRa architecture

3 POWERING UP THE SENSOR

Note: The Sentrius™ Sensor has no power switch. Inserting the batteries powers up the device.

3.1 Battery Types

The Sentrius™ Sensor is designed for use with primary cell AA batteries, either lithium or alkaline 1.5V cells. Lithium batteries have more capacity but are costlier. Lithium batteries also have a lower temperature range of -40° C, as opposed to -20° C for alkaline. You must specify the type of battery being used because the algorithm that determines the percentage of remaining battery life must account for the battery type.

Default Battery Type for the Sentrius™ Sensor: Alkaline batteries

3.1.1 Changing Battery Type

The battery type can be changed via the Sentrius™ mobile application. Refer to the Configuration section for details.

3.2 Inserting Batteries

The batteries are inserted on the rear panel of the RS1xx sensor, as shown in Figure 2.

Note: The battery door cover has a gasket inside to keep out liquids. It is important that all screws on the back of the unit are properly inserted and tightened. Failure to do so could result in liquid ingress which would void the warranty on the device.

4 CONNECTING TO A LORA NETWORK SERVER

The exact steps needed to connect to a LoRa network server vary by network provider but in all cases, the following three described LoRa keys described must be known by the external LoRa network server.

4.1 AppEUI

The AppEUI is an 8-byte ID used to uniquely identify your application and/or installation. For example, imagine you are installing the Sentrius™ Sensor in a store chain. You could use a specific AppEUI to identify a specific store or perhaps the entire chain of stores.

4.1.1 Default AppEUI

The default AppEUI is 0xf9,0xc6,0x0e,0xce,0xa3,0xad,0xc6,0xbd, and it is set in the device by Laird at the time of manufacturing.

4.1.2 Reading or Changing the AppEUI

The AppEUI can be read or changed via the Sentrius™ mobile application. The number is generated by the end-user, so any number can be used.

4.2 DevEUI

The DevEUI is an 8-byte ID used to uniquely identify your device. It is assigned and set in the device by Laird at the time of manufacturing.

4.2.1 Reading the DevEUI Back Label

The DevEUI is printed on the back label of the sensor as highlighted in red in *Figure 4*.

In previous versions of the label, there is a large area of whitespace which can be used to apply a secondary label or write in information. The AS923 region supported label only has the green box area for this feature.

4.2.1.1 Barcode

The DevEUI is also accessible via the barcode on the back label where the last comma separated value is the DevEUI in the previous revision of the label. The AS923 region supported back label has a dedicated QR Code for the DevEUI.

Example Readout in previous label version: 450-0182,1,915 MHz Sentrius™ Sensor,0213117,0025CA0A010108D6
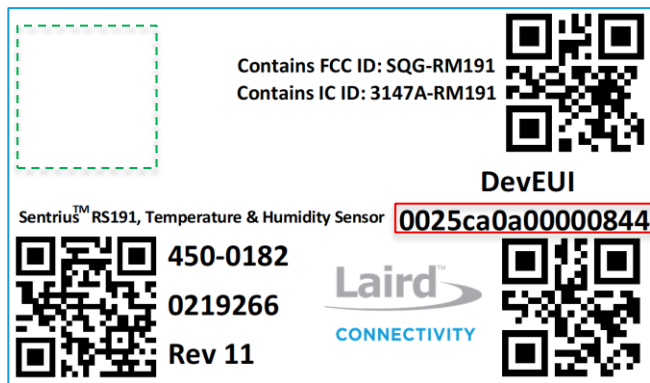
Figure 4: Back label – See Label Info for any possible label updates.

Note: The sensor labels may change at any time. Please reference *Label Info* for the latest label changes.

4.2.1.2 Reading or Changing the DevEUI via Mobile App

Normally there is no need to change the DevEUI. However, if necessary, it can be read or changed via the Sentrius™ mobile application. Because the IEEE governs the generation of the number, you must be familiar with these standards in order to change the DevEUI.

4.3   AppKey

The AppKey is a 16-byte security key assigned to the device. Laird assigns and sets it in the device at the time of manufacturing.

4.3.1 Reading the AppKey

4.3.1.1   Back Label

The AppKey is printed on a **removeable** label that is attached to the device when it is shipped (Figure 5).

Important!   It is the user's responsibility to keep track of the assigned AppKey and to keep it secure.

AppKey:

dd6be505df14903e7ddbf2da61a222d0

Figure 5: AppKey label

4.3.1.2   Barcode

The AppKey is also accessible via the barcode on the back label.

4.3.1.3   Reading or Changing the AppKey

Normally, there is no need to change the AppKey. However, it can be changed via the Sentrius™ mobile application if necessary.

Note: This key is write-only as there is a security risk in making it readable via the mobile application.

5   CONFIGURING THE PACKET FORMAT

From firmware version 4.0 onwards, the RS1xx offers two packet format options:

- Laird
- Cayenne

Prior to version 4.0, only the Laird option was available. If using the Laird packet format, the sensor must receive a network time packet (in Laird binary format) before data is stored in memory for future transmission. Data logging is not available with the Cayenne packet format, so network time is not required this packet format. Refer to the *Network Time* section for more information.

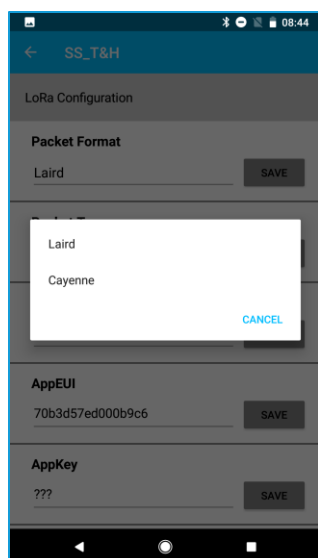The packet format can be configured on the Mobile App through the *LoRa Radio Settings and Info* option.

Figure 6: Packet format menu

A brief summary of the different formats is shown in Table 1.

Table 1: Comparison of packet formats

Format	Description
Laird	Time stamp, synchronised to the network time Temperature and humidity data Number of Alarms Number of Backlog packets stored Aggregated packets Backlogs Remaining battery capacity
Cayenne	Temperature and humidity data Remaining battery capacity Note – no timestamp is transmitted

The Cayenne packet format is described in greater detail in Appendix A - Cayenne packet format.

Refer to the Network Time section for more information.

Note: The battery capacity is reported as an integer value between 1 and 5. Each value represents a percentage range of 20% as follows

Table 2 : Battery percentage values

Value	Percentage Range
1	0 - 20
2	21 - 40
3	41 - 60
4	61 - 80
5	81- 100

6 CONFIGURING THE PACKET TYPE

With the Cayenne packet format selected, you have the option of configuring the RS1xx to transmit either confirmed or unconfirmed packets. You can configure this option through the *LoRa Radio Settings and Info* option in the Sentrius Mobile application. This option is **NOT** available with the Laird packet format, which only transmits confirmed packets.
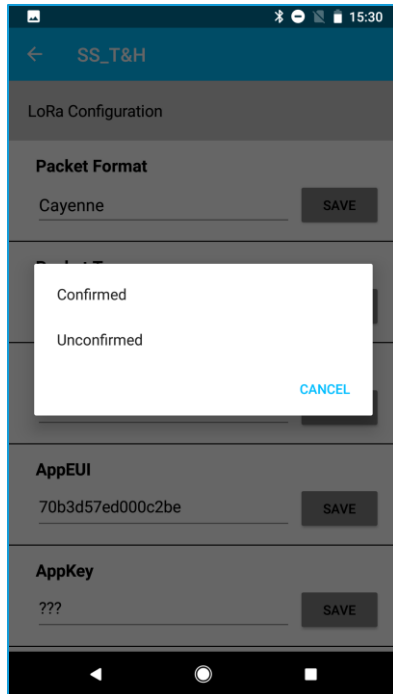

Figure 7: Packet type menu

With confirmed packets, there is a higher likelihood that an uplink data packet is successfully transmitted to the servers, as the RS1xx automatically resends a packet if an acknowledgement is not received (refer to the Ack/Retries section for more details on the Ack/Retry process). However, one downside is using up more bandwidth on the network as there is a downlink packet for each uplink.

With unconfirmed packets, the uplink packet is transmitted only once. If the packet is not received by the server, then the data is lost. It is not stored internally in the RS1xx for transmission at a later time.

With confirmed packets, if three successive uplinks are not acknowledged, the sensor tries to rejoin. Unconfirmed packets continue to be transmitted while the sensor is powered.

7 ADAPTIVE DATA RATE (ADR)

See the LoRaWAN Specification for a complete discussion of ADR. The LoRaWAN specification can be obtained from the LoRa Alliance.

7.1 Definitions

Knowledge of the following terms is important for this section:

- Uplink/Upstream – Transmissions originating from the sensor and received by the LoRa Network Server via the LoRa Gateway.
- Downlink/Downstream – Transmissions originating from the LoRa Network Server and received by the sensor via the LoRa Gateway.

7.2   Data Rate, Sensor Performance, and Tradeoffs

7.2.1 Range

As the data rate decreases, the RF range increases.

7.2.2 Battery Life

As the data rate decreases, each packet takes longer to transmit which decreases battery life.

7.2.3 Bandwidth

As the data rate decreases, it takes longer to transmit a packet, decreasing available bandwidth on the network and increasing the probability of RF collisions or interference.

7.2.4 EU Considerations

In the EU, many bands are highly restricted regarding how much air time a device can use. For example, some bands allow only a 0.1% duty cycle, although in most use cases the channels set in the sensor are in a 1% band. The duty cycle is the transmit time of the device relative to the non-transmit time. If a device transmits a packet that was one second long, it could not transmit for another 1000 seconds (1/1000 = 0.1%) (1000 seconds is over 15 minutes) in a 0.1% band.

Remember to take LoRa gateway duty cycle restrictions into consideration, regarding the number of sensors at certain data rates that a gateway can support, if confirmed packets are configured.

Plan carefully to ensure that a device does not exceed this duty cycle limitation, including possible retries. The LoRa stack running inside the sensor monitors the duty cycle of the device and does not allow a device to transmit if it exceeds the allowable duty cycle.

7.3   MAC Commands and the LoRa Standard

Configuration of the LoRa parameters are handled by the LoRa stack contained within the RS1xx firmware. Any changes to this configuration are handled automatically by the stack or via a downlink MAC command from the network server.

7.3.1 902-928 MHz US and Canada

On power up, the Sentrius™ Sensor starts transmitting Join requests alternately on a random 125-kHz channel at data rate 0 in the selected sub-band and then a random 500-kHz channel at data rate 6. It continues this sequence until the sensor joins the network.

7.3.2 863-870 MHz EU

On power up, the Sentrius™ Sensor starts transmitting Join Requests at data rate 5, reducing the data rate by one each attempt until it reaches data rate 0. If data rate 0 fails, the sequence repeats until the sensor joins the network.

7.3.3   915-928 MHz AS

On power up, the Sentrius™ Sensor starts transmitting Join Requests at data rate 5, reducing the data rate by one each attempt until it reaches data rate 2. If data rate 2 fails, the sequence repeats until the sensor joins the network.

7.3.4 915-928 MHz AU

On power up, the Sentrius™ Sensor starts transmitting Join requests alternately on a random 125-kHz channel at data rate 0 in the selected sub-band and then a random 500-kHz channel at data rate 6. It continues this sequence until the sensor joins the network.

7.3.5 Datarate control

The LoRa specification defines the commands necessary to manage the sensor data rate in response to changing RF conditions.

Information transferred between the LoRa stack contained within the RS1xx and the LoRa Network automatically adjust the system data rate to optimize communication reliability and power consumption.

8 DEVICE OPERATION

8.1 Care and Maintenance

The sensor can be cleaned with a mild, non-abrasive detergent. Because it is not waterproof, do not immerse it in water.

The sensor does not require any calibration.

8.2 Positioning of the Sensor

For optimum response to temperature, position the sensor in a way that air can flow though the sensor air channel.

Note: The white material is a Gortex cover that allows airflow through the channel, while preventing liquids from coming into contact with the sensor.

In addition, placing the sensor on a large thermal mass negatively impacts the temperature response.

Figure 8: Air flow through sensor

8.3 LoRa Messages

Note: The LoRa API is available in the RS1xx LoRa Protocol Guide which is available from the RS1xx product page.

8.4 Join Sequence

Before any temperature or humidity data can be transmitted to the application servers, the sensor must first join the network. On power-up, the sensor automatically attempts to join the network by transmitting a Join Request packet. If a join-accept message is received in return by the sensor, the sensor then transmits its current firmware version and the current uplink configuration parameters to the server.

The network time should be sent to the sensor as part of the first downlink message. If the network time fails to be received, the module continues to request it at each data uplink transmission. The module transmits logs to the server without being synchronized to the network time, but it does not store any unacknowledged logs to Flash, thus causing the data to be lost.

If a join-response message is not received by the sensor, it continues to attempt to join the network server periodically (approximately every minute), depending on band specific duty cycle and backoff restrictions. The sensor continues to operate in this mode until the join procedure has been successfully completed.
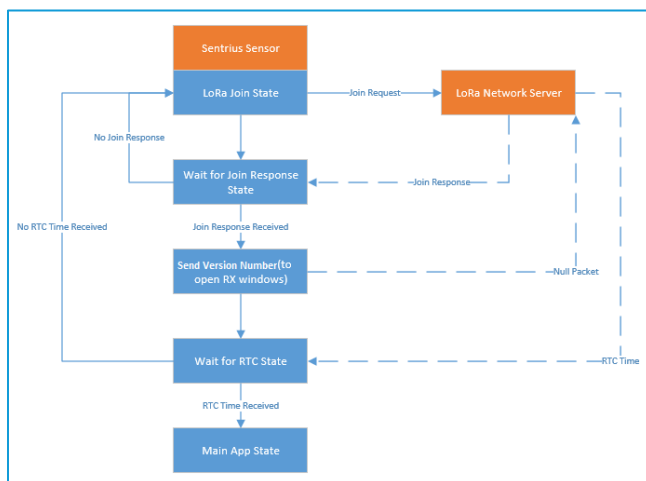

Figure 9: Join procedure

8.5   Ack/Retries

Sensor to LoRa network server RF messages can be configured to transmit confirmed packets, requiring an acknowledgement. Every RF message sent to the network server is expecting an acknowledgement message back from the network server telling the sensor, in effect, *I got your message.* The sensor retransmits the message a certain number of times depending on the current data rate if an acknowledgement is not received. Every two unsuccessful attempts at a data rate causes the sensor to lower its data rate by one. Refer to the following tables for how many attempts are made at each data rate.

US – RS191

Table 2: US retransmissions per data rate

Uplink Data Rate	Total number of retransmissions
DR4	8
DR3	8
DR2	6
DR1	4
DR0	2

EU – RS186

Table 3: EU retransmissions per data rate

Uplink Data Rate	Total number of retransmissions
DR7	8
DR6	8
DR5	8
DR4	8
DR3	8
DR2	6
DR1	4
DR0	2

For example, if in the US and at DR4, the maximum number of transmissions before a message is considered to have failed is eight. This means it transmits twice at DR4, twice at DR3, twice at DR2, and twice at DR1. If all transmissions are unsuccessful, the next time the device transmits, it is at DR0. If any of the data rates before that are successful, the unit remains at that data rate until the server deems its link is good enough to step up the data rate via ADR.

8.6   Disconnect

If the sensor detects three consecutive confirmed RF messages are lost, the sensor assumes the connection to the server is lost and stops sending data. It reverts to the join sequence described in the *Join Sequence* section of this guide.

8.7   Network Time

If configured for the Laird packet format, after the sensor joins a network, it can start sending data packets to the server. However, before the sensor can use the backlog feature it must first get the network time. This is sent in epoch time, number of seconds since January 1, 2015. Once the network time is received, the device can store failed packets in the Flash device.

On the successful reception of a Join Request, the server may automatically transmit the network time message to the sensor as part of the first downlink message. If the network server does not provide a Laird format time message, the sensor requests it. This is achieved by setting bit 0 of the options byte of a data uplink message to 1. More information on this can be seen in the RS1xx LoRa Protocol document available from the RS1xx product page.

Important!	When configured for the Laird packet format, the Sentrius™ Sensor is intended to work with a LoRa network server that provides network time in the custom Laird Format. See the *RS1xx LoRa Protocol* document which can be found at the link located in the Additional information section. This is required for the sensor to store un-transmitted data in the internal log flash. The sensor transmits data without the network time being available, but it won't backlog that data. This does not apply when configured for the Cayenne packet format.

8.8   Backlog Feature

If the Laird packet format is configured and the sensor fails to successfully transmit data to the network server, this data is logged to FLASH. Each backlog log or alarm includes the time that reading was taken. Separate areas in FLASH are maintained to store alarm and normal (non-alarm) data. During data retrieval, the alarm section is prioritized over the non-alarm data. Each section can store 4096 records.

The backlog data can be retrieved via the LoRa interface or the Bluetooth interface. Note that in some situations, such as the lowest data rate in the US or AS regions, it may not be practical to retrieve backlog data over LoRa due to bandwidth limitations.

There are separate commands for retrieving the backlogs in FIFO or LIFO mode. With FIFO, the oldest log is retrieved first. With LIFO the latest log is retrieved first. Both commands are identical as described in the sections below.

Once you start retrieving logs using a certain mode, you *must* clear ALL logs using that mode or reformat (erase all of the logs) the flash memory once you retrieve all the logs you require using that mode. Using the LIFO option means there can be gaps of already retrieved logs in flash. The LIFO option can handle this; FIFO cannot.

Note: The backlog feature only functions if the sensor has received a timestamp from the server. In situations where the timestamp is not available, any logs that are not successfully acknowledged by the server are lost.

8.8.1 Backoff Period

The backoff period is one of the LoRa messages that you can send to the sensor from the server (see the *RS1xx LoRa Protocol Guide* which is available from the RS1xx product page). Because retrieving the backlog may consume a large percentage of the bandwidth, it may be wise to make use of the backoff message. This message can be used to stop the sensor from sending data for a period of time, thus opening more bandwidth for the sensor. While a unit is in the backoff state, it continues to read the sensor, but it stores its data to FLASH. The backoff period could be assigned to the sensor from which the backlog is extracted, other sensors in the network, or both, depending on the application.

8.8.2 Operation at 902-928 US with DR0

Normally the sensor attempts to package up to six backlog readings into a single backlog uplink message. This keeps the total number of bytes in the packet less than 51 bytes, which is the limiting factor in the EU.
See 863-870 MHz EU for details. Only 11 payload bytes are available when operating at DR0 in the 902-928 (NA) band. At this data rate, the sensor only sends one backlog message at a time as this is all the data that can be fit into an 11-byte message.

8.9   Measuring Humidity

Measuring humidity accurately in certain circumstances can be difficult. Temperature swings, dew points, and other factors can lead to condensation on the sensor, leading to inaccurate humidity readings. To combat this, there is a heating element on the sensor itself which can be turned on to burn off this condensation and restore the sensor to proper operation. This is activated by means of a downlink command, with the heater being switched on as soon as the command is received. See the RS1xx LoRa Protocol document for more information on this command.

This allows the API server (see Figure 3) to implement an algorithm that is appropriate for the sensor environment while minimizing the power used in order to maximize battery life. Refer to the SiLABS si7021 datasheet for details on the Heater Control Register.

8.10 Setting up the Sensor

8.10.1   Sensor Read Period

The read period defines how often the sensor is read. For example, for a setting of 60, the sensor is read every 60 seconds.

8.10.2 Sensor Aggregate

The aggregate number is used to aggregate or bundle multiple sensor readings into a single RF packet. For example, with an aggregate number of two and a sensor read period of 60, a RF message is sent every (60 seconds x 2) 120 seconds. Obviously setting the aggregate count has a big effect on the battery life of the device; the less the device talks, the longer the batteries will last.

8.10.2.1 Operation at 902-928 NA with DR0

Only 11 payload bytes are available when operating at DR0 in the 902-928 band. This can create a conflict with an aggregate count greater than one, as the sensor cannot fit all the sensor data into the packet. In this case the sensor sends the last sensor reading to the LoRa server and logs the remaining data to FLASH. A flag is set in the uplink message notifying the server of the configuration error. It is the responsibility of the server to update the sensor configuration to use an aggregate count of one if it is desired not to backlog data in this case.

8.10.3 Alarm Levels

Minimum and maximum alarm levels may be set for both temperature and humidity. When an alarm is triggered, the sensor immediately sends the data to the server. Thereafter it resumes sending data at its normal frequency based on the sensor read period and aggregate count. If the alarm condition persists, the sensor again sends the alarm message in one hour, ensuring the server is aware of the condition.

In addition, setting alarm levels puts sensor backlog data into a separate section of FLASH so that it may be prioritized during backlog retrieval.

8.10.4 LED Behavior

The first LED indicator is used for LoRa status (see Figure 1). The device can be configured to flash a LED based on the LoRa network status. A green LED flash indicates that the device is connected to the LoRa network server, an orange LED flash indicates that the device is not connected to the LoRa network server. See the Sensor Configuration section of this guide.

The second LED indicator is used for Bluetooth. The device can be configured to flash a blue LED when the device is connectable, or advertising. See the Sensor Configuration section of this guide.

8.11 Sensor Firmware Version

The LoRa network server can request the sensor firmware version from the sensor.

8.12 Resetting the Sensor

Reset the sensor by holding down the Bluetooth button for a minimum of five seconds.

9 CONFIGURATION

9.1 Label (Back Label Space)

The large open white space on the back label can be used to apply a secondary label by the end user. For example, it may be useful to write a friendly name on the device.

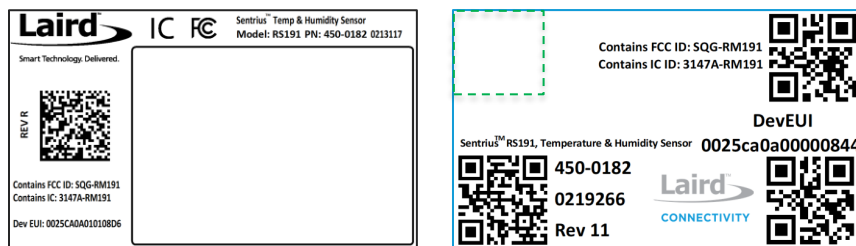**Note:** The AS923 region supported label has limited space for this feature.

Figure 10: Back label white space – See Label Info for any possible label changes.

9.2 Device Configuration

Table 4: Device configuration

Name	Description	Bluetooth	LoRa
Format App FLASH	Format the external FLASH on the device to clear out backlog data.		x
Set Battery Type	Set the battery type being used on the device.	x	x
Set BLE LED Behavior	Configure Blue LED to flash when advertising (connectable)	x	x
Set Humidity Alarm Thresholds	Set the min/max humidity values that will trigger an alarm condition.	x	x
Set LoRa AppEUI	Read/Write	x	
Set LoRa AppKey	Write Only	x	
Set LoRa DevEUI	Read/Write	x	
Set LoRa LED Behavior	Configure Green/Orange LED behavior based on LoRa status.	x	x
Set Temperature Alarm Thresholds	Set the min/max temperature values that will trigger an alarm condition.	x	x
Set Temp Humidity Sensor Read Options	Set parameters related to reading the sensor and sending data over LoRa.	x	x
Set Friendly Name	Set a user-friendly name on the device.	x	

10 MOBILE APPLICATION

10.1 Overview

The Sentrius™ mobile application allows a user to configure a device, troubleshoot a device, see real-time sensor data, and update firmware.

10.2 Install Sentrius™ Sensor Mobile App on Device

Search the appropriate app store (Apple or Android) for the Sentrius Sensor App and install on device.

10.3 Connect to Sentrius™ Sensor

Press the Bluetooth button (see #2 on Figure 11).

Figure 11: Top of the Sentrius

The Sentrius™ Sensor begins advertising and become connectable.

10.3.1 Select Device

The DevEUI printed on the pack of the label is sent as part of the Bluetooth advertisement. Look for that DevEUI in the Device List as shown in Figure 12.
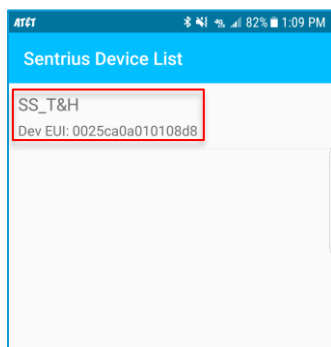

Figure 12: Select device to connect to

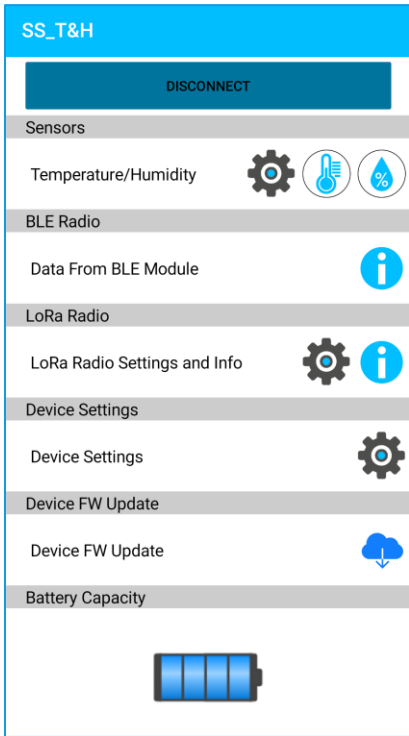## 10.4 Main Screen
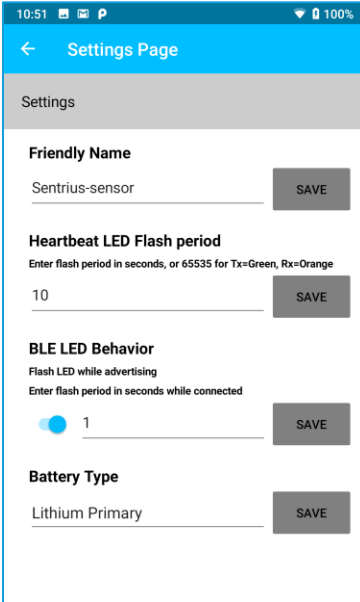
Figure 13 is the main screen of the mobile application.

Figure 13: Mobile application main screen
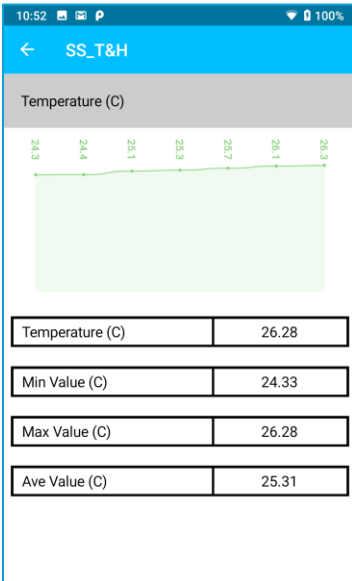
10.5 Configure Device

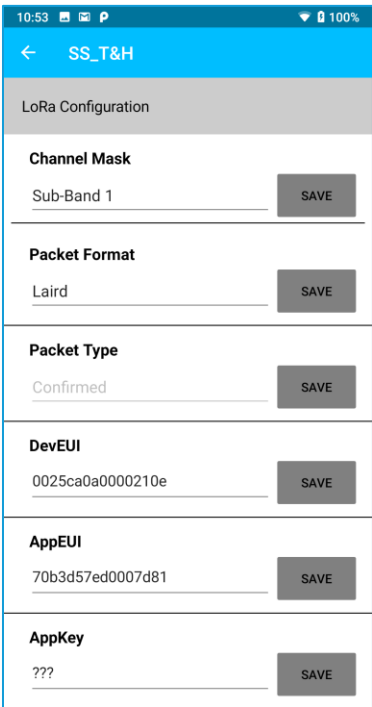### 10.5.1 Sensor Configuration

Navigation	Screen	Comments
		The read period, aggregate number, as well as temperature and relative humidity alarms can be configured. See Section 8.10 Setting up the Sensor for more information.

Navigation	Screen	Comments
Device Settings Device Settings	10:51 Settings Page **Settings** **Friendly Name** Sentrius-sensor — SAVE **Heartbeat LED Flash period** Enter flash period in seconds, or 65535 for Tx=Green, Rx=Orange 10 — SAVE **BLE LED Behavior** Flash LED while advertising Enter flash period in seconds while connected 1 — SAVE **Battery Type** Lithium Primary — SAVE	**Friendly Name –** Used to assign a user-friendly name to the device, such as its location. **LoRa LED Behavior** – Used to control the cadence of the heartbeat LED (time in seconds). For example, a setting of 10 flashes the appropriate LED every ten seconds. A setting of 0 turns off the LED. With a setting of 65535, the device flashes the green LED during LoRa transmit and the orange LED during LoRa receive. See the LED Behavior section of this guide for additional information. **Note:** The LED flash has an impact on battery life.
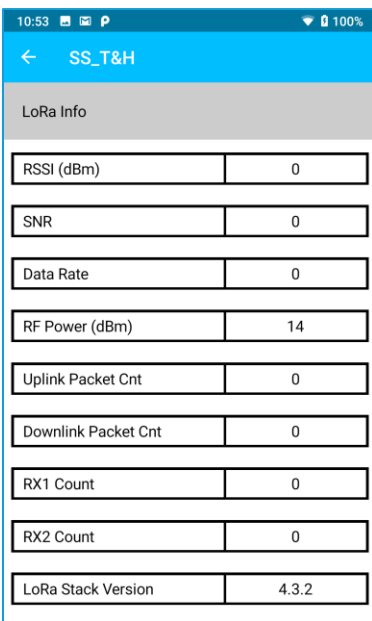
10.6 View Sensor Data

Navigation	Screen	Comments
Sensors Temperature/Humidity	10:52 SS_T&H Temperature (C) 24.3 24.4 25.1 25.3 25.7 26.1 26.3 Temperature (C) 26.28 Min Value (C) 24.33 Max Value (C) 26.28 Ave Value (C) 25.31	Humidity graph is similar, only the temperature graph is displayed in this example. Note that the graphs might not show contiguous data. A graph will only get updated when that page is selected, so no new values are added or deleted if the app is not showing that page. If a user switches from the graph to another page and then returns several minutes later the graph will start being updated from where it was previously. As there is no indication of time on the graph this can cause confusion.
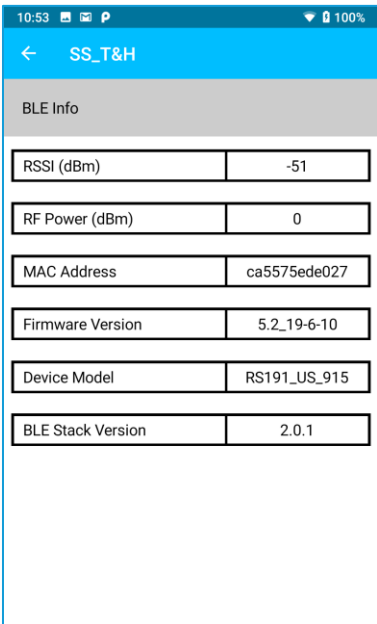
10.7 LoRa Configuration

Navigation	Screen	Comments
LoRa Radio — LoRa Radio Settings and Info ⚙ ℹ	**SS_T&H** — LoRa Configuration — **Channel Mask** Sub-Band 1 [SAVE] — **Packet Format** Laird [SAVE] — **Packet Type** Confirmed [SAVE] — **DevEUI** 0025ca0a0000210e [SAVE] — **AppEUI** 70b3d57ed0007d81 [SAVE] — **AppKey** ??? [SAVE]	Use to update LoRa Keys. **Note:** AppKey is write-only for security reasons.
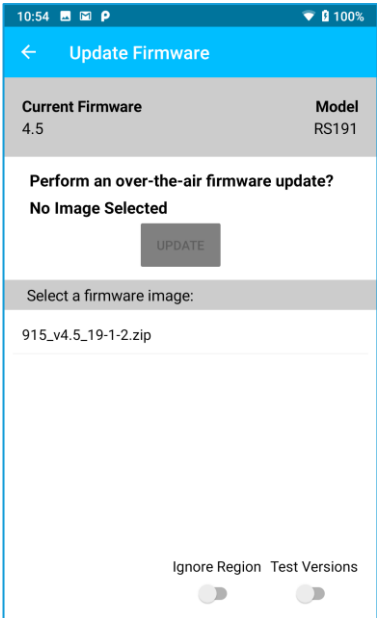
10.8 LoRa Network
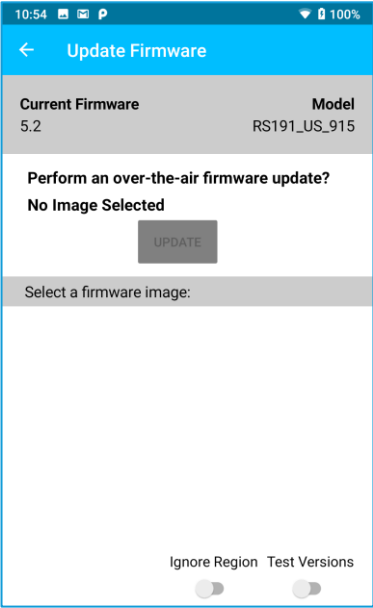
Navigation	Screen	Comments
LoRa Radio — LoRa Radio Settings and Info ⚙ ℹ	**SS_T&H** — LoRa Info — RSSI (dBm) 0 — SNR 0 — Data Rate 0 — RF Power (dBm) 14 — Uplink Packet Cnt 0 — Downlink Packet Cnt 0 — RX1 Count 0 — RX2 Count 0 — LoRa Stack Version 4.3.2	Use the LoRa Info page to view data on the LoRa Network.

10.9 BLE Info

Navigation	Screen	Comments
BLE Radio / Data From BLE Module	SS_T&H — BLE Info / RSSI (dBm) -51 / RF Power (dBm) 0 / MAC Address ca5575ede027 / Firmware Version 5.2_19-6-10 / Device Model RS191_US_915 / BLE Stack Version 2.0.1	Use the BLE Info page to view information on the BLE connection.

10.10 Update Firmware

Navigation	Screen	Comments
Device FW Update / Device FW Update	Update Firmware — Current Firmware 4.5 / Model RS191 / Perform an over-the-air firmware update? / No Image Selected / UPDATE / Select a firmware image: / 915_v4.5_19-1-2.zip / Ignore Region Test Versions	Click the **Update FW** link. Select **Update** on the page that is displayed. The released firmware builds from Laird are stored in the cloud. The Sentrius App will look in this location and display available versions of the firmware. Select the appropriate file to start the update process. The **Test Versions** and **Ignore Region** button are for internal Laird use only. They are password protected so as to avoid incorrect use. **Note:** The sensor does not allow downgrading the firmware. Firmware versions that are lower than the version the device is running are not displayed.

Navigation	Screen	Comments

10.11   Integrating Sentrius™ Sensor into a Third-Party Application

The GATT tables used on the Sentrius™ Sensor are documented in the Bluetooth Developer Studio, a PC tool available from the Bluetooth SIG. These files are bundled together with the Mobile Application Source code which can be downloaded from the Software Download section of the RS1xx Product Page.

Note: The mobile application is written in Xamarin (C#), a product by Microsoft designed for cross-platform (Android + iOS) development. The source code for the project is available from Laird as mentioned above.

11 BLUETOOTH SIG

The Sentrius™ Sensor is certified by the Bluetooth® SIG as a Bluetooth v4.2, End Product. The Qualified Design ID (QDID) is 100178.

12 FCC AND ISED CANADA REGULATORY STATEMENTS

This product contains the RM191 from Laird.

Model	US/FCC	CANADA/IC
RS191	SQG-RM191	3147A-RM191

12.1 Power Exposure Information

To comply with FCC RF exposure limits for general population/uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and operating in conjunction with any other antenna or transmitter.

IMPORTANT NOTE: If these conditions cannot be met (for certain configurations or co-location with another transmitter), then the FCC and Industry Canada authorizations are no longer considered valid and the FCC ID and IC Certification Number cannot be used on the final product. In these circumstances, the OEM integrator is responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC and Industry Canada authorization.

12.2 OEM Responsibilities

To comply with FCC and Industry Canada RF exposure limits for general population/uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures.

WARNING: Changes or modifications not expressly approved by Laird could void the user's authority to operate the equipment.

FCC Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in an installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Warning

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.

Industry Canada (IC) Warning

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

French equivalent is:

Le présent appareil est conforme aux CNR d'Industrie Canada applicable aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

ISED Radiation Exposure Statement

To comply with ISED Canada RF exposure limits for general population / uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be operating in conjunction with any other antenna or transmitter.

French equivalent is:

Déclaration IC d'exposition aux radiations
Pour se conformer à Industrie Canada RF limites d'exposition pour la population générale / exposition non contrôlée, l'antenne utilisée pour ce transmetteur doit être installée pour fournir une distance d'au moins 20 cm de toutes les personnes et ne doit pas fonctionner en conjonction avec toute autre antenne ou transmetteur.

13 CE REGULATORY

The RS186 has been tested for compliance with relevant standards for the EU market. The RM186 module has been tested with custom internal slot antenna.

Reference the Declaration of Conformities listed below for a full list of the standards that the modules were tested to. Test reports are available upon request.

13.1 EU Declarations of Conformity

Manufacturer	Laird
Products	Sentrius™ RS186 Sensor
Product Description	IP65 Integrated Temperature/Humidity Sensor with LoRa and BLE connectivity
EU Directives	2014/53/EU – Radio Equipment Directive (RED)

Reference standards used for presumption of conformity:

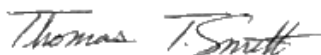| Article Number	Requirement	Reference standard(s)
3.1a	Health	EN62311:2008
	Safety	EN60950-1:2006+A11+A1:2010+A12:2011+ A2:2013
3.1b	Protection requirements – Electromagnetic compatibility	EN 301 489-1 v2.2.0 (2017-03) EN 301 489-3 v2.1.1 (2017-03) EN 301 489-17 v3.2.0 (2017-03)
3.2	Means of the efficient use of the radio frequency spectrum (ERM)	EN 300 220-1 v3.1.1 (2017-02) EN 300 220-2 v3.1.1 (2017-02) EN 300 328 v2.1.1 (2017-03)

Declaration:

We, Laird, declare under our sole responsibility that the essential radio test suites have been carried out and that the above product to which this declaration relates is in conformity with all the applicable essential requirements of Article 3 of the EU Radio Equipment Directive 2014/53/EU, when used for its intended purpose.

|	
Place of Issue:	Laird W66N220 Commerce Court, Cedarburg, WI 53012 USA tel: +1-262-375-4400 fax: +1-262-364-2649
Date of Issue:	30 November 2017
Name of Authorized Person:	Thomas T Smith, Director of EMC Compliance
Signature of Authorized Person:	

14   ORDERING INFORMATION

Part Number	Description
455-0001	Sentrius™ RS1xx Sensor - 915MHz Temp / Humidity including LoRa and BLE – North America
455-0002	Sentrius™ RS1xx Sensor - 868MHz Temp / Humidity including LoRa and BLE – Europe
455-00059	Sentrius™ RS1xx Sensor - 923MHz Temp / Humidity including LoRa and BLE – Taiwan
455-00060	Sentrius™ RS1xx Sensor - 923MHz Temp / Humidity including LoRa and BLE – New Zealand
455-00061	Sentrius™ RS1xx Sensor - 923MHz Temp / Humidity including LoRa and BLE – Hong Kong
455-00062	Sentrius™ RS1xx Sensor - 915MHz Temp / Humidity including LoRa and BLE – Australia (AU915)
455-00063	Sentrius™ RS1xx Sensor - 923MHz Temp / Humidity including LoRa and BLE – Australia (AS923)

14.1   Evaluation Kit Details (applies to 455-0001, 455-0002, and other regional variants)
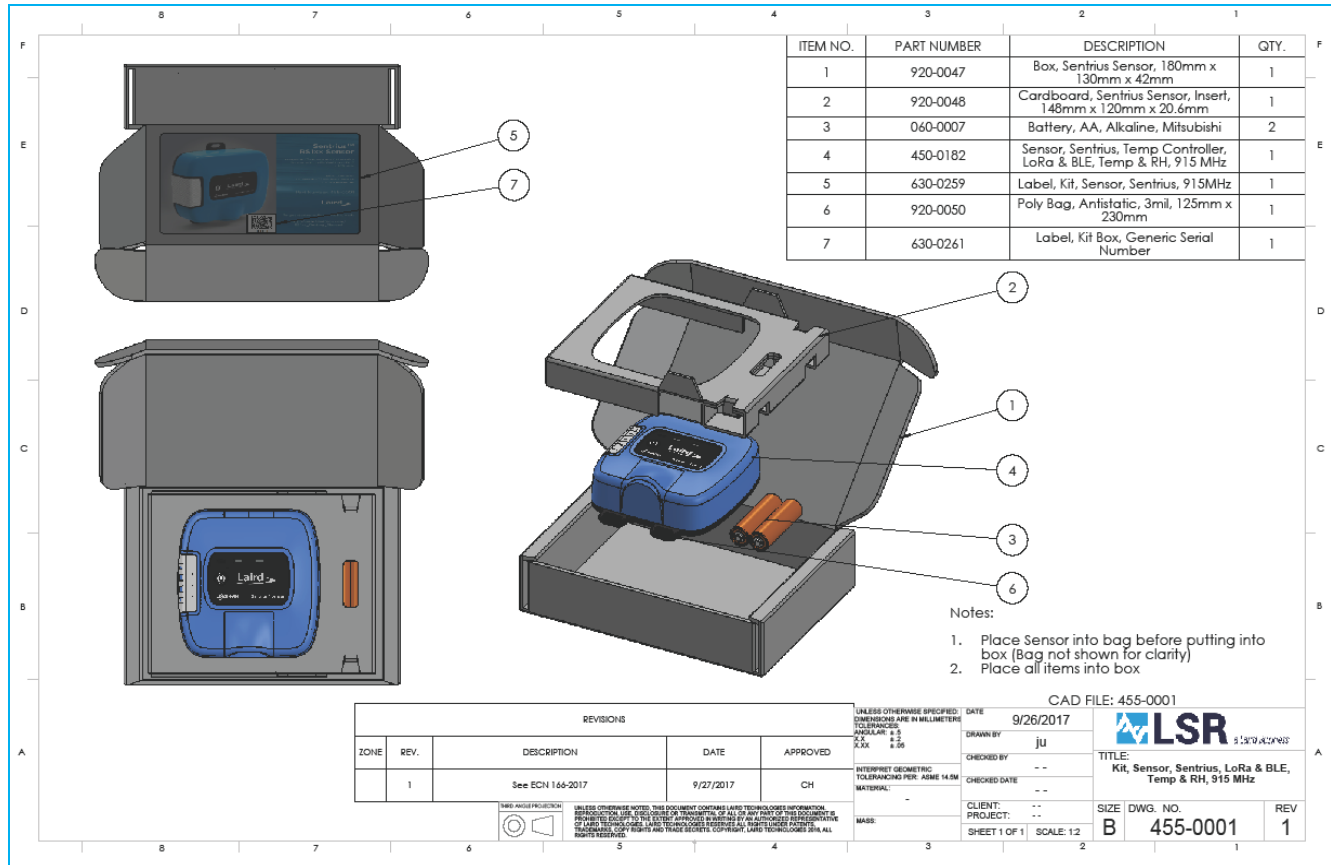
15   OTHER VARIANTS

15.1   External Sensor Port

The Sentrius™ Sensor is available with an external sensor port (RJ45) (Figure 14). It allows users to connect an external 1-wire temperature probe to make remote temperature measurements.
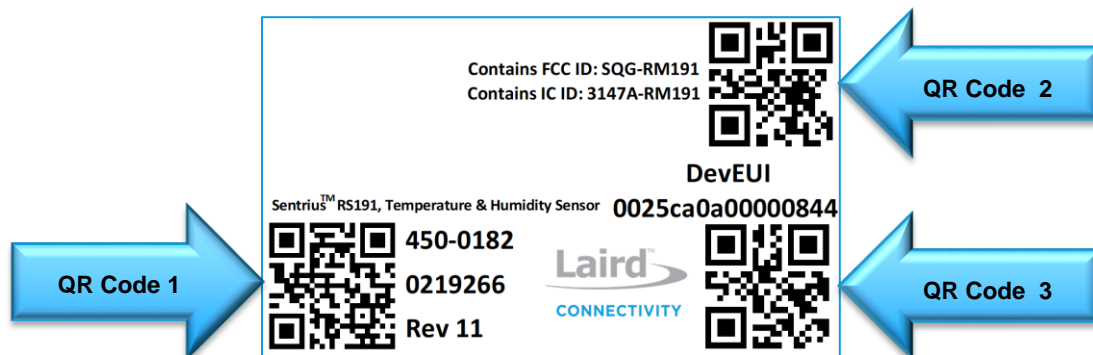
Figure 14: External sensor port and probe

For the latest product brief and user guide for the external temperature probe please see the Documentation tab on the RS1xx product page.

16   LABEL INFO

16.1   AS923 Supported Sensor Back Label

16.2 QR Code 1 Info

The QR Code contains the Part Number, Hardware Revision, Date Code, and DevEUI.

Example Readout: 450-0182,11,0213117,0025ca0a00000844

16.3 QR Code 2 Info

The QR Code contains the unique Firmware part number associated with the region the sensor will be installed in and certified for. For example, a sensor certified and installed in Europe would have a firmware part number 480-0114.

Example Readout: 480-0111

16.4 QR Code 3 Info

The QR Code contains the DevEUI. All constants are lowercase.

Example Readout: 0025ca0a00000844

17 ADDITIONAL INFORMATION

For the latest version of this manual, quick start guide, regulatory information and firmware updates, please see the Documentation tab the RS1xx page: https://www.lairdconnect.com/wireless-modules/lorawan-solutions/sentrius-rs1xx-lora-enabled-sensors

18 APPENDIX A - CAYENNE PACKET FORMAT

A full description of the Cayenne system can be found at https://github.com/myDevicesIoT/cayenne-docs/blob/master/docs/LORA.md and the packet format details can be found under the Reference Implementation section.

An example of a Cayenne formatted packet transmitted from an RS1xx is shown in Table 5 below.

Table 5: Cayenne Packet Format

Index	Value	Description
0	0x01	Data Channel
1	0x67	Temperature Data Header
2	0xXX	Temperature Data MSB
3	0xXX	Temperature Data LSB
4	0x02	Data Channel
5	0x68	Humidity Data Header
6	0xXX	Humidity Data
7	0x03	Data Channel Header
8	0x01	Digital Output Header (remaining battery life)
9	0xXX	Battery Life