User Guide

Sentrius™ BT510

Version 2.0

REVISION HISTORY

Version	Date	Notes	Contributor	Approver
1.0	03 Feb 2020	Initial Release	Brent Mikkelsen Ian Tracy	Jonathan Kaye
1.1	04 Feb 2020	Added Japan and AS/NZS Regulatory statements. Added ordering information	Dave Neperud	Jonathan Kaye
1.2	03 Mar 2020	Updated Record Event Types table information for clarity	Brent Mikkelsen	Jonathan Kaye
1.3	20 Mar 2020	Updated mobile App section. Added more information to the Advertisement	Brent Mikkelsen	Jonathan Kaye
1.4	16 April 2020	Provided more detail on active mode. Changed default values for advertising duration. Added more reset information.	Brent Mikkelsen	Jonathan Kaye
1.5	21 May 2020	Added a line 13 (RESERVED) to Table 5	Brent Mikkelsen	Jonathan Kaye
2.0	11 Nov 2020	Reset is not required with version 4.0.0 or later. Update read log example with C-structure. Add link to Python examples. Updated all regulatory information	Andrew Hedin Maggie Teng Ryan Urness	Jonathan Kaye

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2

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CONTENTS

https://www.lairdconnect.com/iot-devices/iot-sensors/bt510-bluetooth-5-long-range-ip67-multi-sensor

3

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1   ABOUT THIS GUIDE

This document provides a comprehensive guide on how to configure the Sentrius™ BT510 Sensor functionality, including Bluetooth settings and temperature readings, motion, and contact detection.

2   INTRODUCTION

2.1   Product Overview

The Sentrius™ BT510 Sensor is a battery powered, Bluetooth v5 long-range integrated sensor platform enabling robust, reliable sensor data transfer in the harshest of environments. It contains a temperature sensor, also seamlessly integrating open/close contact and motion/impact detection and BLE beaconing capabilities. The BT510 is powered by Laird Connectivity's field proven BL654 BLE module that integrates Nordic Semiconductor's nRF52840 SoC silicon.

1. Fixing holes
2. LED
3. Hidden button to wake device
4. Magnetic switch

Figure 2: Back of the Sentrius™ BT510 sensor

Figure 1: Top of the Sentrius™ BT510 sensor

Note: Laird Connectivity 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 BT510 product brief for detailed specifications. It's available from the documentation tab of the BT510 series product page: https://www.lairdconnect.com/iot-devices/iot-sensors/bt510-bluetooth-5-long-range-ip67-multi-sensor

3   DEVICE OPERATION

3.1   Activating the Sensor

The Sentrius™ BT510 doesn't have a power switch. It is shipped with an installed battery and is in a low power state called shelf mode.

To wake the device, firmly press the button in the center of the round face for at least three seconds until the green LED turns on. This will put the device in active mode. Once in active mode the BT510 will be able report back the sensor readings for the magnet, accelerometer, and temperature.

When you release the button, the green LED blinks once a second.

The sensor is in sleep mode from the factory. Pressing the button for three seconds wakes the sensor and it starts to advertise. The sensor is now ready for normal operation configuration. This can be done using a phone or gateway. The LED blinks for 30 seconds or until a connection is made, the button is pressed again, or the sensor stops advertising. The default state of the sensor is to advertise for 30 minutes.

3.2   Battery Check

Quickly press the button to perform a battery good check. If the battery is good, the sensor briefly blinks the green LED and starts to advertise for 15 seconds. If the battery is below the recommend operating voltage, then the LED does not blink but the sensor tries to advertise. It is possible for the mobile application to connect to the BT510 within the 15 second advertisement duration, but if the BT510 has not been set to active mode the sensor will not take any sensor readings.

3.3   Factory Reset

If the button is held for more than 10 seconds and released, the sensor performs a factory reset. A factory reset erases all logs, pairing information, and reset the configuration to its default state. It will take the BT510 2 seconds after the reset before it is running again and a button press can be detected.

When the button as shown in Figure 1 is held for 10 seconds, the LED turns yellow or red. If the LED turns red, then factory reset is not allowed using the button. This is because the sensor is locked. The sensor can be locked by using one of the JSON properties. When locked, the factory reset can still be performed using Bluetooth. If the LED turns yellowish orange, then factory reset is allowed. The yellowish orange LED blinks when the button is released. Once the BT510 has been reset to factory settings the BT510 sensor will need to put back into active mode by holding the button for 3 seconds.

3.4   Replacing Batteries

The battery is a 3-volt lithium of CR2477 type.

Note: The battery door cover has a gasket inside to keep out liquids.

3.5   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.

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5
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4   SENSOR ARCHITECTURE

The Sentrius™ BT510 advertises events. An event can be a temperature measurement, an alarm, a battery measurement, a button press, a door opening/closing, or movement. The configuration of a sensor determines what kind of events it generates.

You can configure a sensor using a Bluetooth connection and the Laird virtual serial port(vSP) service. The protocol sent over the virtual serial port is JSON-RPC version 2. This allows you to add new commands and features without changing the Bluetooth interface. More details can be found at https://www.jsonrpc.org/specification.

4.1   Advertisements

Advertising each event once it becomes active is the default behavior of the sensor. This provides ample time for a gateway to detect an event, maximizes the lifetime of the battery, and allows the sensor to be a good RF citizen. Once a sensor is configured, it is possible that a gateway never needs to connect to a sensor. If multiple events occur at the same time, the sensor queues events and advertises each one for the configured advertising duration (default of indefinite).

If the sensor is configured to advertise indefinitely, then the advertisement queue is bypassed.

For each new event, the record number increments. You can use this value to filter out duplicate advertisements.

The TLV (type-length-value) fields are shown in the order that is broadcast by the sensor. However, this order is not guaranteed.

The sensor can be configured to transmit with an output power of +8 dBm. It can also be configured to use the LE coded PHY.

When using the coded PHY, the scan response isn't used.

4.1.1   1M PHY

Table 1: 1M PHY

Byte	Description	Value/Notes
0	0x02	Length (0x02)
1	GAP_ADTYPE_FLAGS	Type (0x01)
2	GAP_ADTYPE_FLAGS_BREDR_NOT_SUPPORTED	Data
3	0x1b (27)	Length (length is not included in overall length)
4	GAP_ADTYPE_MANUFACTURER_SPECIFIC	0xFF (Type)
5	Company ID 1	0x77 (Laird)
6	Company ID 2	0x00
7	Protocol ID LSB	0x01 (Identifies the advertisement format)
8	Protocol ID MSB	0x00
9	Network ID LSB	Assigned during configuration. Default is 0x000.
10	Network ID MSB	This can be used for filtering advertisements
11	Flags LSB	Indicate the current state of the system
12	Flags MSB	See: 4.1.6 Flags
13	BD_ADDR 0	Random static Bluetooth address (0 is LSB)
14	BD_ADDR 1	
15	BD_ADDR 2	
16	BD_ADDR 3	
17	BD_ADDR 4	
18	BD_ADDR 5	MSB
19	Record Type	See: 4.1.4 Record Event Types

Byte	Description	Value/Notes
20	Record Number LSB	This count matches the index in the NV log. It will rollover
21	Record Number MSB	
22	Epoch 0 LSB	This is a timestamp in seconds from Jan 1, 1970
23	Epoch 1	
24	Epoch 2	
25	Epoch 3 MSB	
26	Data byte 0 LSB	See: table 4 to match record type to data
27	Data byte 1	
28	Data byte 2	
29	Data byte 3 (MSB)	
30	Reset Count LSB	For testing purposes.

4.1.2 1M PHY Scan Response

Table 2: 1M PHY scan response

Byte	Description	Value/Notes
0	0x10 (16)	Length (length is not included in overall length)
1	GAP_ADTYPE_MANUFACTURER_SPECIFIC	0xFF (Type)
2	Company ID 1	0xE4 (Laird)
3	Company ID 2	0x00
4	Protocol ID LSB	0x03 (Identifies the advertisement format)
5	Protocol ID MSB	0x00
6	Product ID LSB	Identification of the device transmitting
7	Product ID MSB	
8	Firmware Version Major	Version of the main application installed
9	Firmware Version Minor	
10	Firmware Version Patch	
11	Firmware Type	Firmware type can be used to interleave versions for multiple devices
12	Configuration Version	Configuration version is updated when advertisement is built
13	Boot Loader Version Major	
14	Boot Loader Version Minor	
15	Boot Loader Version Patch	
16	Hardware Version	
17	Length (X)	(<=13)
18	DEVICE_NAME	0x08 or 0x09
19		Max Complete Name (0x09) is 12 characters

Byte	Description	Value/Notes
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

4.1.3 LE Coded PHY

Table 3: LE Coded PHY

Byte	Description	Value/Notes
0	0x02	Length (0x02)
1	GAP_ADTYPE_FLAGS	Type (0x01)
2	GAP_ADTYPE_FLAGS_BREDR_NOT_SUPPORTED	Data
3	0x26 (38)	Length (length is not included in overall length)
4	GAP_ADTYPE_MANUFACTURER_SPECIFIC	0xFF (Type)
5	Company ID 1	0x77 (Laird)
6	Company ID 2	0x00
7	Protocol ID LSB	0x02 (Identifies the advertisement format)
8	Protocol ID MSB	0x00
9	Network ID LSB	Assigned during configuration. Default is 0x000.
10	Network ID MSB	This can be used for filtering advertisements
11	Flags LSB	Indicate the current state of the system
12	Flags MSB	See: 4.1.6 Flags
13	BD_ADDR 0	Random static Bluetooth address (0 is LSB)
14	BD_ADDR 1	
15	BD_ADDR 2	
16	BD_ADDR 3	
17	BD_ADDR 4	
18	BD_ADDR 5	MSB
19	Record Type	See: 4.1.4 Record Event Types
20	Record Number LSB	This count matches the index in the NV log. It will rollover
21	Record Number MSB	

Byte	Description	Value/Notes
22	Epoch 0 LSB	This is a timestamp in seconds from Jan 1, 1970
23	Epoch 1	
24	Epoch 2	
25	Epoch 3 MSB	
26	Data 0 LSB	See: table 4 to match record type to data
27	Data 1	
28	Data 2	
29	Data 3 (MSB)	
30	Reset Count LSB	For testing purposes.
31	Product ID LSB	Identification of the device transmitting
32	Product ID MSB	
33	Firmware Version Major	Version of the main application installed
34	Firmware Version Minor	
35	Firmware Version Patch	
36	Firmware Type	Firmware type can be used to interleave versions for multiple devices
37	Configuration Version	Configuration version is updated when advertisement is built
38	Boot Loader Version Major	
39	Boot Loader Version Minor	
40	Boot Loader Version Patch	
41	Hardware Version	
42	Length (X)	(<=24)
43	DEVICE_NAME	0x09
44		
…		
66		

4.1.4 Record Event Types

Table 4: Record event types

ID	Event	Data	Format
0	RESERVED	-	
1	TEMPERATURE	TEMPERATURE	Hundredths of degree C (signed 16-bit number)
2	MAGNET (PROXIMITY)	MAGNET STATE	See: 4.1.5 Magnet States
3	MOVEMENT	-	-
4	ALARM HIGH TEMP 1	TEMPERATURE	Hundredths of degree C
5	ALARM HIGH TEMP 2	TEMPERATURE	Hundredths of degree C
6	ALARM HIGH TEMP CLEAR	TEMPERATURE	Hundredths of degree C

ID	Event	Data	Format
7	ALARM LOW TEMP 1	TEMPERATURE	Hundredths of degree C
8	ALARM LOW TEMP 2	TEMPERATURE	Hundredths of degree C
9	ALARM LOW TEMP CLEAR	TEMPERATURE	Hundredths of degree C
10	ALARM DELTA TEMP	TEMPERATURE	Hundredths of degree C
12	BATTERY GOOD	BATTERY VOLTAGE	Millivolts (unsigned 16-bit number)
13	ADVERTISE ON BUTTON	BATTERY VOLTAGE	Millivolts
14	RESERVED	-	-
15	RESERVED	-	-
16	BATTERY BAD	BATTERY VOLTAGE	Millivolts
17	RESET	RESET REASON	See: 4.1.7 Reset Reason

4.1.5 Magnet States

The magnet states are NEAR = 0 (door closed) and FAR = 1 (door open).

4.1.6 Flags

The flags are a bitmask of the current state of the sensor.

Table 5: Flags

Bit	Name
0	RTC was set (epoch)
1	Active Mode
2	Any flag was set
3	RESERVED
4	RESERVED
5	RESERVED
6	RESERVED
7	Low Battery Alarm
8	high temperature alarm bit 0
9	high temperature alarm bit 1
10	low temperature alarm bit 0
11	low temperature alarm bit 1
12	Delta Temperature Alarm
13	RESERVED
14	Movement Alarm
15	Magnet State

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10

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4.1.7 Reset Reason

The reset reasons come from the RESETREAS register in the Nordic nRF52840. Reserved values do not apply to the sensor.

Table 6: Reset reasons

Value	Reason
0	Power Up
1	Reset Pin
2	Watchdog
3	Software Request
4	CPU Lock-up detected
5	Reserved
6	Low Power Comparator
7	Reserved
8	Reserved
9	Reserved
10	Unknown

4.2   Laird vSP (Virtual Serial Port)

Details can be found at https://www.lairdconnect.com/documentation/application-note-using-vsp-smartbasicpdf.

The sensor doesn't use the optional Modem In/Out characteristics.

4.3   JSON-RPC

The sensor supports version 2.0 of the specification. The sensor does not support batch commands.

More details can be found at https://www.jsonrpc.org/specification.

4.3.1 Methods

Table 7: JSON-RPC methods

Method (Command)	Parameters	Description
get	<properties>	The get command is used to get the value of an attribute.
set	<properties>	The set command is used to set attributes.
dump	None for all 0 for read-only 1 for read-write	Used to read all attributes. Configurable attributes are read-write.
reboot	None or 0 for normal Non-zero for enter bootloader	Restart the sensor immediately after sending acknowledgement.
factoryReset	NA	Reset the device to factory settings
prepareLog	integer, positional	0 = FIFO mode, 1 = LIFO mode
readLog	integer, positional	Number of events to read
ackLog	integer, positional	Number of events to invalidate
setEpoch	integer, positional	Seconds since client's reference point; used to timestamp data; tested with reference of January 1, 1970 midnight UTC.
getEpoch	none	Returns epoch in result

Method (Command)	Parameters	Description
ledTest	integer, duration of each step	Both LEDs off for X milliseconds Green LED on for X milliseconds Red LED on for X milliseconds Both LED on for X milliseconds. Processor remains running (doesn't enter low power mode) for duration of test. The minimum duration is 10 milliseconds. This command is primarily for production test.

4.4 Sensor Configuration

The sensor has multiple properties (attributes) that can be used to configure it for a particular use case.

The read only parameters reflect the current state of the sensor. Issuing a JSON-RPC command to get the temperature does not cause the sensor to take a temperature measurement. It returns the value of the last temperature measurement taken.

As indicated in the table, some parameters require the sensor to be reset before they take effect. For versions of firmware prior to 4.0.0, the software reset command will need to be sent before these changes to the parameter will work properly.

Note: The sensor contains more parameters than those that are listed in the table. They are used during production and reliability testing by Laird Connectivity. They may not exist in future software versions.

4.4.1 Example

In this example system, the device name is changed during configuration so that unconfigured devices are the only devices that advertise with the name *BT510*.

1. Start Scan for *BT510*.

```
Found Device E235431D1F8E with RSSI -47 and advertisement data
"0201061BFF77000100000000808E1F1D4335E20C030008B1D55DB80B00000210FFE4000300000001030A000000000008
06094254353130"
```

2. Stop Scan.

3. Connect to E235431D1F8E.

4. Set time in sensor.

```
>> {"jsonrpc": "2.0", "method": "setEpoch", "params": [1574285874], "id": 2}

<< {"jsonrpc": "2.0", "id": 2, "result": "ok"}
```

5. Configure sensor to take a temperature measurement every 15 minutes, a battery measurement every hour, and enable motion detection.

```
>> {"jsonrpc": "2.0", "method": "set", "params": {"sensorName": "Test-02", "location": "desk",
"advertisingDuration": 15000, "batterySenseInterval": 3600, "temperatureSenseInterval": 900,
"odr": 5}, "id": 3}

<< {"jsonrpc": "2.0", "id": 3, "result": "ok"}
```

6. Reset the sensor because name and advertising duration were changed.

```
>> {"jsonrpc": "2.0", "method": "reboot", "id": 4}
<< {"jsonrpc": "2.0", "id": 4, "result": "ok"}
```

7. Request Disconnect.

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12

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4.5   Event Log

All sensor events are recorded in a non-volatile log. The log can store seven days of measurements with a temperature sample rate of 15 minutes. Each event has a timestamp and a sample ID. These values are the same as those found in the advertisements.

The log can be read in FIFO mode or LIFO mode. In FIFO mode, the oldest event is retrieved first. In LIFO mode, the last event is retrieved first.

Many systems do not require the traceability that the event log provides. When the log is full, the oldest event is overwritten.

4.5.1   Event Structure

The JSON format used for sensor configuration has too much overhead for large amounts of data. Therefore, the event log data is transferred with a size in bytes and a Base64 encoded array of event structures.

Table 8: Event structure

Name	Size in Bytes	Description
timestamp	4	Seconds from Jan 1, 1970
event data	2	The type of data depends on the event type. Signed temperature in hundredths of degrees C, unsigned voltage in millivolts, or Magnet State.
type	1	See Record Event Types.
salt	1	A counter used by sensor to differentiate events with the same timestamp (simultaneous events).

This is a representation of a sensor event as a C-structure. Data is formatted least significant byte first.

```
struct
{
  uint32_t timestamp;
  uint16_t data;
  uint8_t type;
  uint8_t salt;

};
```

4.5.2   Example

1.   Connect to sensor.
2.   Tell the sensor to get ready to send logs in FIFO mode.

```
>> {"jsonrpc": "2.0", "method": "prepareLog", "params": [0], "id": 1}

<< {"jsonrpc": "2.0", "id": 1, "result": 9}
```

3.   Ask for 500 events. Sensor returns nine events (72/8). The sensor does not return more than 128 events per read.

```
>> {"jsonrpc": "2.0", "method": "readLog", "params": [500], "id": 2}

<< {"jsonrpc": "2.0", "id": 2, "result": [72,
"Ob/mXZIJAQA5v+ZdLgsMAXDA5l0BAAMAdsDmXXELDACRweZdLAkBAJHB5l1HCwwB0MLmXQEAAwDowuZdAQADAOjC5l0BAAMB
"]}
```

4.   Acknowledge events.

```
>> {"jsonrpc": "2.0", "method": "ackLog", "params": [9], "id": 3}

<< {"jsonrpc": "2.0", "id": 3, "result": 9}
```

Note: The sensor allows any number of events to be acknowledged even if they haven't been read. If more events are acknowledged than were read and another read is issued, then blank entries are returned.

5. Update the time (after all events have been read).

```
>> {"jsonrpc": "2.0", "method": "setEpoch", "params": [1575404269], "id": 4}

<< {"jsonrpc": "2.0", "id": 4, "result": "ok"}
```

Table 9: Decoded log

Index	Epoch	Salt	Local time	Data	Event Type
1	1575403321	0	03 Dec 19 14:02:01	24.5	TEMPERATURE
2	1575403321	1	03 Dec 19 14:02:01	28.62	BATTERY_GOOD
3	1575403632	0	03 Dec 19 14:07:12	-	MOVEMENT
4	1575403638	0	03 Dec 19 14:07:18	29.29	BATTERY_GOOD
5	1575403921	0	03 Dec 19 14:12:01	23.48	TEMPERATURE
6	1575403921	1	03 Dec 19 14:12:01	28.87	BATTERY_GOOD
7	1575404240	0	03 Dec 19 14:17:20	-	MOVEMENT
8	1575404264	0	03 Dec 19 14:17:44	-	MOVEMENT
9	1575404264	1	03 Dec 19 14:17:44	-	MOVEMENT

5 MOBILE APPLICATION

5.1 Overview

The Sentrius™ BT510 mobile application allows a user to configure a device, troubleshoot a device, see real-time sensor data, and update firmware.

5.2 Using the Sentrius™ BT510 Sensor Mobile App on Device

To use the Sentrius™ BT510 mobile application, follow these steps:

1. From the applicable app store (Apple or Android) search for and install the Sentrius™ BT510 Sensor mobile application on your device.
2. To connect to the Sentrius BT510 sensor, press and hold the button in the center of the Laird Connectivity logo for three seconds (#3 on Figure 3).

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14
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Figure 3: Front side of the Sentrius™ BT510 sensor

The sensor blinks the green LED, begins advertising, and becomes connectable.

3. Tap the search icon to discover the sensor(s) within range of the mobile device (Figure 4).
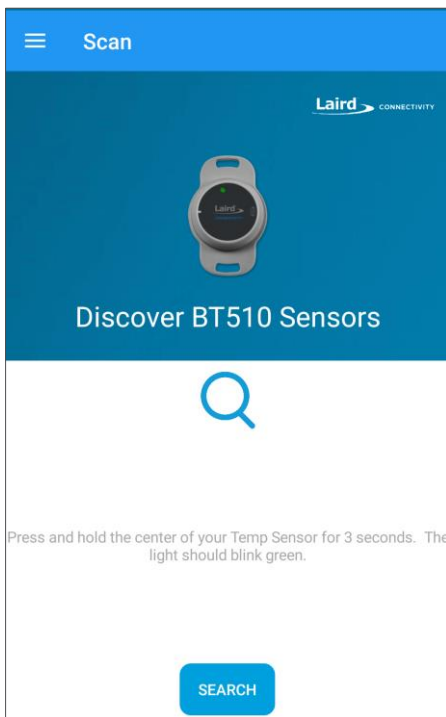

Figure 4: Scan for new sensors

4. Select the applicable device. The sensor name defaults to BT510 when searching for the sensor. The BLE ID is printed on the label located on the back of the sensor (Figure 5). The BLE ID matches the number of the applicable sensor located in the search results Discover screen (Figure 6).

Note: The number displayed in the search results is the same number as shown on the device label just in a different format. For example, from the following, the BLE ID **D936EE37716E** on the label matches **BT510 – D9-36-EE-37-71-6E** in the search results.

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15

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Figure 5: BLE ID location
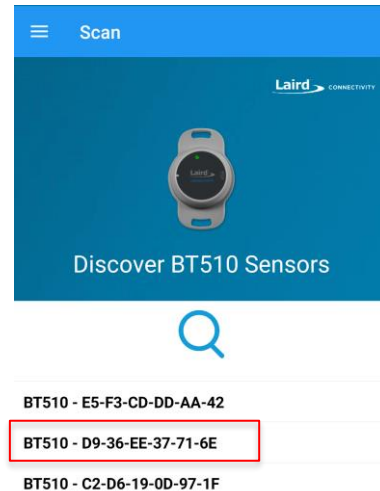
Figure 6: Device search results

Once you select the desired sensor and if this is the first time connecting to it, you need to pair the selected device.

5. When prompted *Pair with BT510?*, select **Pair**. If you select **Cancel**, the application disconnects from the sensor (Figure 7).
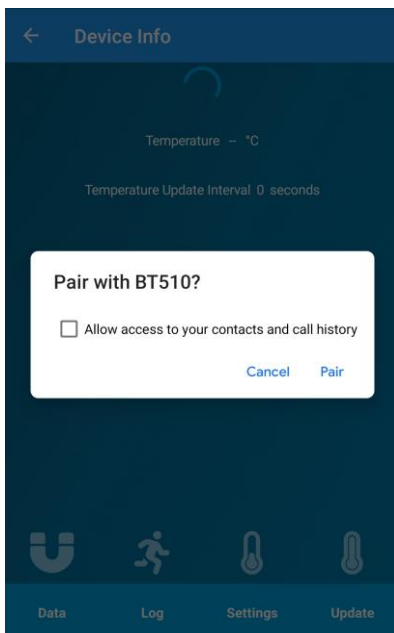
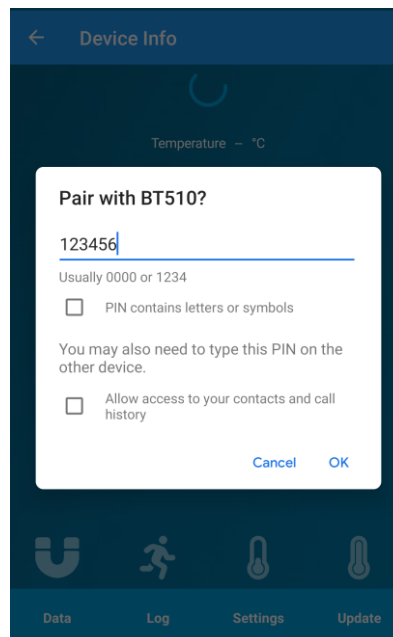The default pairing key is *123456* (Figure 8).

Figure 7: Pair window

Figure 8: Pair key

Once paired, the Main screen of the mobile application displays. This screen contains a graph of the temperature over time. It also indicates at what interval the temperature value is updated by the sensor (Figure 9).

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16
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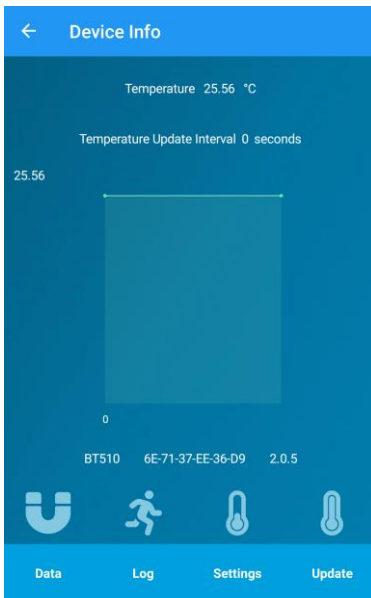
Figure 9: Main screen

	Lights up when there is change in the magnetic switch.
	Lights up when the configured *G Threshold* alarm value is reached.
	Lights up when the temperature of the sensor reaches one of the configured low temperature alarms.
	Lights up when the temperature of the sensor reaches one of the configured high temperature alarms.

5.3   Device Configuration

The following section describes how to configure various aspects of the device. To access the configuration option, select **Settings** located near the bottom of the main screen (Figure 10).

Figure 10: Access Settings

5.3.1   Sensor Configuration

Device Name – Used to assign a user-friendly name to the sensor

Passkey – A unique number assigned to the device to help protect the configuration values from being changed without permission. This passkey is used when pairing a sensor to a new mobile device

Location - Can be a given a name to help identify the area where the sensor is being stored.

LE Coded PHY – When selected the device will switch to transmitting a Coded PHY extended advertisement. The mobile app may not be able to reconnect to the BT510.

NOTE: When selecting this option, the only way to return to 1M PHY (normal operation) is to perform a factory reset or send a JSON command.

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17

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Pressing the set button for any of these configurations except Location will cause the BT510 to reset with the new value. There is a 2 second delay before the BT510 reset. This might cause noticeable delay in response from the mobile app.

5.3.2 Interval Configuration

Temp Sense – The time in seconds when the sensor takes a temperature measurement.

Advertising Duration – Specifies how long the sensor should advertise each event. When sent to 0, it advertises indefinitely.

Advertising Interval – The time between advertising packets.

Connection Timeout – The time in seconds that the mobile device is connected to the sensor. When set to 0, there is no timeout.

Battery Sense – The time in seconds when the sensor takes battery measurement.

5.3.3 Alarm Configuration

G Threshold – Sets the acceleration threshold on the sensor. The lower the number, the lower amount acceleration acted on the device is required to trigger the alarm.

Temp Delta – The alarm is triggered when the temperature change between intervals is greater than value written here.

Temp High T1 – Alarm that triggers when the sensor temperature is higher than this value. It is also logged when triggered and has the high temp icon light up on the data screen.

Temp High T2 – Behaves the same as *Temp High T1*. This is just another alarm that can be triggered if the temperature is high than this value.

Temp Low T1 – Alarm that triggers when the sensor temperature is lower than this value. It is also logged when triggered and has low temp icon light up on the data screen.

Temp Low T2: This behaves the same as *Temp Low T1*. This is just another alarm that can be triggered if the temperature is lower than this value.

5.4 View Log

Select the Log icon located near the bottom of the screen (Figure 11). Figure 12 displays an example of log data over time.

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18

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Figure 11: Log icon

Figure 12: Log data

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19

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5.5 Update Firmware

Select the Update icon located near the bottom of the screen (Figure 13).

Figure 13: Update button

If the current firmware on the sensor is out of date, it is shown to have update package available as seen in Figure 14. Select the UPDATE button to begin the update process. It updates the bootloader first if it is out of date and then updates the firmware. Once the update is complete, a window appears that indicates success or failure (Figure 15).
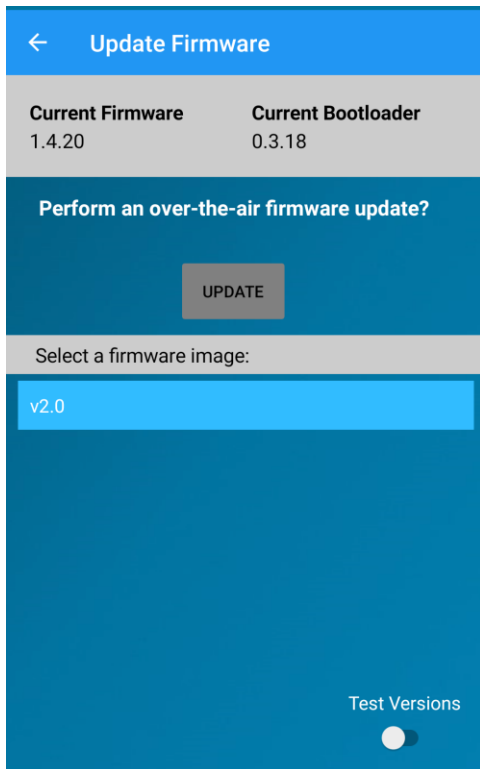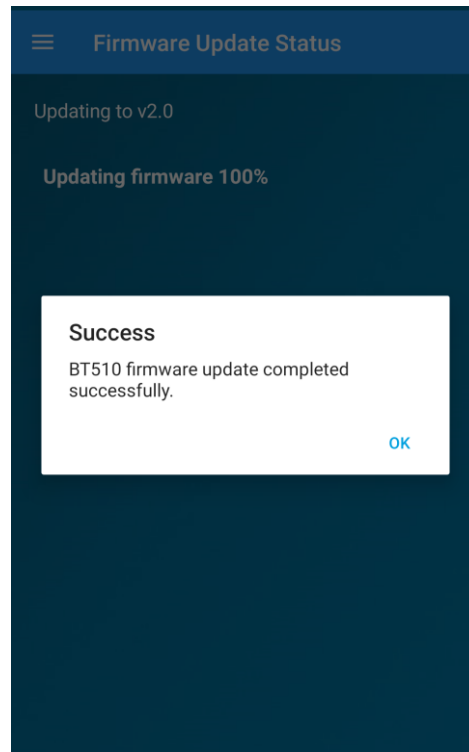

Figure 14: Available update

Figure 15: Update complete

6 BLUETOOTH SIG

The Sentrius™ Sensor is certified by the Bluetooth® SIG as a Bluetooth v5.0, End Product. The Declaration ID (DID) is D041400.

7 REGULATORY

7.1 Current Regulatory Certifications

The BT510 holds current certifications in the following countries (based upon being a host for the BL654):

Country/Region	Regulatory ID
USA (FCC)	SQGBL654
EU	N/A
Canada (ISED)	3147A-BL654
Australia	N/A
New Zealand	N/A

7.2 FCC Regulatory

This product contains the BL654 from Laird Connectivity.

Model	US/FCC
BL654	SQGBL654

7.2.1 FCC Documentation Requirements

Federal Communication Commission 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 try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into 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 Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

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.

FCC Radiation Exposure Statement

This product complies with the US portable RF exposure limit set forth for an uncontrolled environment and is safe for intended operation as described in this manual. Further RF exposure reduction can be achieved if the product is kept as far as possible from the user body or is set to a lower output power if such function is available.

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21
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This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.

This device is intended only for OEM integrators under the following condition:

1. The transmitter module may not be co-located with any other transmitter or antenna,

If the condition above is met, further transmitter testing is not required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this installed module.

IMPORTANT NOTE:
If this condition cannot be met (for example, certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID **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 authorization.

End-Product Labeling

The end product must be labeled in a visible area with the following: **Contains FCC ID: BL654**

Manual Information to the End User

The OEM integrator must be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

7.3 ISED (Canada) Regulatory

Model	CANADA/IC
BL654	3147A-BL654

7.3.1 ISED (Canada) Statements

The end user manual shall include all required regulatory information/warning as shown in this manual.

This device complies with Industry Canada's license-exempt RSSs. 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.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. *l'appareil ne doit pas produire de brouillage;*
2. *l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.*

Radiation Exposure Statement

The product complies with the Canada portable RF exposure limit set forth for an uncontrolled environment and are safe for intended operation as described in this manual. The minimum separation distance for portable use is limited to 15mm assuming use of antenna with 2 dBi of gain. The further RF exposure reduction can be achieved if the product can be kept as far as possible from the user body or set the device to lower output power if such function is available.

Déclaration d'exposition aux radiations:

Le produit est conforme aux limites d'exposition pour les appareils portables RF pour les Etats-Unis et le Canada établies pour un environnement non contrôlé. La distance de séparation minimale pour l'utilisation portative est limitée à 15mm en supposant l'utilisation de l'antenne avec 2 dBi de gain. Le produit est sûr pour un fonctionnement tel que décrit dans ce manuel. La réduction aux expositions RF peut être augmentée si l'appareil peut être conservé aussi loin que possible du corps de l'utilisateur ou que le dispositif est réglé sur la puissance de sortie la plus faible si une telle fonction est disponible.

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22
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This device is intended only for OEM integrators under the following conditions:

1. The transmitter module may not be co-located with any other transmitter or antenna.

If the condition above is met, further transmitter testing is not required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes:

1. Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 1 condition ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

If this condition cannot be met (for example, certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID **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 Canada authorization.

NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End-Product Labeling

The final end product must be labeled in a visible area with the following: **Contains IC: 3147A-BL654**

Plaque signalétique du produit final

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: **Contient des IC: 3147A-BL654**

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.
Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

7.4   Australia and New Zealand Regulatory

RCM: Pending Compliant to standards EN 300 328 V1.9.1, AS/NZS 4268: 2012-A1:2013, and EN 55022:2010/AC:2011
If this device is used in a product, the OEM has responsibility to verify compliance of the final end product to the Australia/New Zealand (RCM) Standards. All end-products require their own certification (SDoc). You will not be able to leverage the module certification and ship product into the country.

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23
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7.5 CE Regulatory

The BT510 has been tested for compliance with relevant standards for the EU market. The BL654 module has been tested with the Printed PCB antenna.

Reference the Declarations of Conformity listed below for a full list of the standards that the BT510 were tested to. Test reports are available upon request.

7.5.1 User's Guide Requirements

The integrator must include specific information in the user's guide for the device into which the BT85x is integrated. In addition to the required FCC and IC statements outlined above, the following Radio Equipment Directive (RED) statements must be added in their entirety and without modification into a prominent place in the user's guide for the device into which the BT510 is integrated:

This device complies with the essential requirements of the 2014/53/EU – Radio Equipment Directive (RED). The following test methods have been applied in order to prove presumption of conformity with the essential requirements of the 2014/53/EU – Radio Equipment Directive (RED):

- **EN 62368-1:2014/A11:2017**

  Safety requirements for audio/video, information, and technology equipment

- **EN 300 328 v2.2.2 (2019-07)**

  Electromagnetic compatibility and Radio Spectrum Matters (ERM); Wideband Transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using spread spectrum modulation techniques; Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive

- **EN 62311:2008 | EN 50665:2017 | EN 50385:2017**

  RF exposure

- **EN 301 489-1 v2.2.0 (2017-03)**

  Electromagnetic compatibility and Radio Spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements

- **EN 301 489-17 V3.2.0 (2017-03)**

  Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific conditions for 2,4 GHz wideband transmission systems and 5 GHz high performance RLAN equipment

- **EU 2015/863 (RoHS 3)**

  Declaration of Compliance – EU Directive 2015/863; Reduction of Hazardous Substances (RoHS)

This device is a 2.4 GHz wideband transmission system (transceiver), intended for use in all EU member states and EFTA countries, except in France and Italy where restrictive use applies.

In Italy the end-user should apply for a license at the national spectrum authorities in order to obtain authorization to use the device for setting up outdoor radio links and/or for supplying public access to telecommunications and/or network services.

This device may not be used for setting up outdoor radio links in France and in some areas the RF output power may be limited to 10 mW EIRP in the frequency range of 2454 – 2483.5 MHz. For detailed information the end-user should contact the national spectrum authority in France.

български [Bulgarian]	С настоящото *[име на производителя]* декларира, че това устройство *[вид оборудване]* е в съответствие със съществените изисквания и други приложими разпоредби на Директиви 2014/53/EC
Hrvatski [Croatian]	*[naziv proizvođača]* ovim putem izjavljuje da je ovaj uređaj *[vrsta opreme]* sukladan osnovnim zahtjevima i ostalim bitnim odredbama Direktiva 2014/53/EU
Česky [Czech]	*[Jméno výrobce]* tímto prohlašuje, že tento *[typ zařízení]* je ve shodě se základními požadavky a dalšími příslušnými ustanoveními směrnice 2014/53/EU.
Dansk [Danish]	Undertegnede *[fabrikantens navn]* erklærer herved, at følgende udstyr *[udstyrets typebetegnelse]* overholder de væsentlige krav og øvrige relevante krav i direktiv 2014/53/EU.

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24

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Deutsch [German]	Hiermit erklärt *[Name des Herstellers]*, dass sich das Gerät *[Gerätetyp]* in Übereinstimmung mit den grundlegenden Anforderungen und den übrigen einschlägigen Bestimmungen der Richtlinie 2014/53/EU befindet.
Eesti [Estonian]	Käesolevaga kinnitab *[tootja nimi]* seadme *[seadme tüüp]* vastavust direktiivi 2014/53/EL põhinõuetele ja nimetatud direktiivist tulenevatele teistele asjakohastele sätetele.
English	Hereby, *[name of manufacturer]*, declares that this *[type of equipment]* is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU.
Español [Spanish]	Por medio de la presente *[nombre del fabricante]* declara que el *[clase de equipo]* cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 2014/53/UE.
Ελληνική [Greek]	ΜΕ ΤΗΝ ΠΑΡΟΥΣΑ *[όνομα του κατασκευαστή]* ΔΗΛΩΝΕΙ ΟΤΙ *[εξοπλισμού]* ΣΥΜΜΟΡΦΩΝΕΤΑΙ ΠΡΟΣ ΤΙΣ ΟΥΣΙΩΔΕΙΣ ΑΠΑΙΤΗΣΕΙΣ ΚΑΙ ΤΙΣ ΛΟΙΠΕΣ ΣΧΕΤΙΚΕΣ ΔΙΑΤΑΞΕΙΣ ΤΗΣ ΟΔΗΓΙΑΣ 2014/53/ΕΕ.
Français [French]	Par la présente *[nom du fabricant]* déclare que l'appareil *[type d'appareil]* est conforme aux exigences essentielles et aux autres dispositions pertinentes de la directive 2014/53/UE.
Íslenska [Icelandic]	Hér, *[Nafn framleiðanda]*, því yfir að þetta *[gerð búnaðar]* tæki er í samræmi við grunnkröfur og önnur viðeigandi ákvæði tilskipana 2014/53/ ESB
Italiano [Italian]	Con la presente *[nome del costruttore]* dichiara che questo *[tipo di apparecchio]* è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 2014/53/UE.
Latviešu valoda [Latvian]	Aršo*[izgatavotājanosaukums]* deklarē, ka *[iekārtas tips]* atbilstDirektīvas 2014/53/ES būtiskajāmprasībām un citiemar to saistītajiemnoteikumiem.
Lietuvių kalba [Lithuanian]	Šiuo *[gamintojo pavadinimas]* deklaruoja, kad šis *[įrangos tipas]* atitinka esminius reikalavimus ir kitas 2014/53/ES Direktyvos nuostatas.
Nederlands [Dutch]	Hierbij verklaart *[naam van de fabrikant]* dat het toestel *[type van toestel]* in overeenstemming is met de essentiële eisen en de andere relevante bepalingen van richtlijn 2014/53/EU.
Malti [Maltese]	Hawnhekk, *[isem tal-manifattur]*, jiddikjara li dan *[il-mudel tal-prodott]* jikkonforma mal-ħtiġijiet essenzjali u ma provvedimenti oħrajn relevanti li hemm fid-Dirrettiva 2014/53/UE.
Magyar [Hungarian]	Alulírott, *[gyártó neve]* nyilatkozom, hogy a *[... típus]*megfelel a vonatkozó alapvetõ követelményeknek és az 2014/53/EU irányelv egyéb elõírásainak.
Norsk [Norwegian]	Herved *[navnet på produsenten]*, erklærer at denne *[type utstyr]* enheten, er i samsvar med de grunnleggende kravene og andre relevante bestemmelser i direktivene 2014/53/EU
Polski [Polish]	Niniejszym *[nazwa producenta]* oświadcza, że *[nazwa wyrobu]* jest zgodny z zasadniczymi wymogami oraz pozostałymi stosownymi postanowieniami Dyrektywy 2014/53/UE.
Português [Portuguese]	*[Nome do fabricante]* declara que este *[tipo de equipamento]* está conforme com os requisitos essenciais e outras disposições da Directiva 2014/53/UE.
Română [Romanian]	Prin prezenta, *[numele producătorului]* declară că acest dispozitiv *[tipul de echipament]* este în conformitate cu cerințele esențiale și alte prevederi relevante ale Directivelor 2014/53/UE
Slovenščina [Slovenian]	*[Ime proizvajalca]* izjavlja, da je ta *[tip opreme]* v skladu z bistvenimi zahtevami in ostalimi relevantnimi določili direktive 2014/53/EU.
Slovenčina [Slovak]	*[Menovýrobcu]* týmtovyhlasuje, že *[typzariadenia]* spĺňazákladnépožiadavky a všetkypríslušnéustanovenia Smernice 2014/53/EU.
Suomi [Finnish]	*[Valmistaja]* vakuuttaa täten että *[laitteen tyyppimerkintä]* tyyppinen laite on direktiivin 2014/53/EU oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen.
Svenska [Swedish]	Härmed intygar *[företag]* att denna *[utrustningstyp]* står I överensstämmelse med de väsentliga egenskapskrav och övriga relevanta bestämmelser som framgår av direktiv 2014/53/UE.

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25

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7.5.2 EU Declarations of Conformity

Manufacturer	Laird Connectivity
Products	Sentrius™ BT510 Sensor
Product Description	Bluetooth v5 IP67 Multi Sensor
EU Directives	2014/53/EU – Radio Equipment Directive (RED)

Reference standards used for presumption of conformity:

Article Number	Requirement	Reference standard(s)
3.1a	Low voltage equipment safety	EN 62368-1: 2014
	RF Exposure	EN 62311:2008 EN 50665:2017 EN 50385:2017
3.1b	Protection requirements – Electromagnetic compatibility	EN 301 489-1 v2.2.3 (2019-11) (Draft) EN 301 489-17 v3.1.1 (2017-02)
3.2	Means of the efficient use of the radio frequency spectrum (ERM)	EN 300 328 v2.1.1 Wide-band transmission systems

Declaration:

We, Laird Connectivity, 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.

The minimum distance between the user and/or any bystander and the radiating structure of the transmitter is 20 cm.

Place of Issue:	Laird Connectivity W66N220 Commerce Court, Cedarburg, WI 53012 USA tel: +1-262-375-4400 fax: +1-262-364-2649
Date of Issue:	11 Dec 2019
Name of Authorized Person:	Ryan Urness
Signature of Authorized Person:	

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26
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8 ORDERING INFORMATION

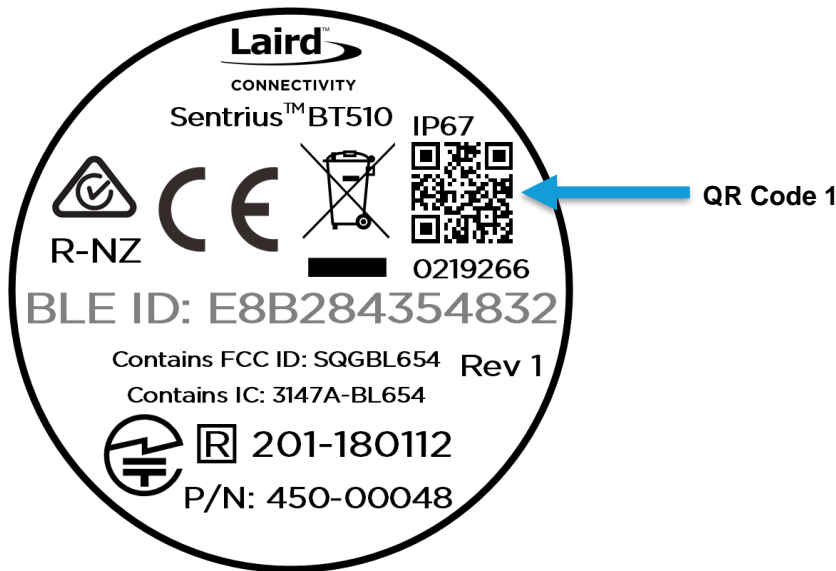| Part Number	Description	Packaging
455-00083	Sentrius™ BT510 Sensor, Single	Single (1)
450-00048B	Sentrius™ BT510 Sensor, Bulk Packaged	Bulk (100)
455-00058	Magnet Kit (Open/Close) for Sentrius™ BT510, Single	Single (1)

9 LABEL INFO

Figure 16: BT510 back sensor label

The QR Code contains the part number, hardware revision, date code, and BLE ID (All CAPS).

Example Readout: 450-00048,1,0919452,CB09AE5B8D7F

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27

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10   JSON Properties

Category	Name	Type	Min	Max	Default	Units	Reset Req.	Description/ Notes
rw	sensorName	s	0	23	BT510	NA	1	The sensor name is part of the advertisement.
rw	location	s	0	32	""	NA	0	User configurable string that is unused by sensor.
rw	advertisingInterval	u	20	10000	1000	ms	1	The interval between advertising packets.
rw	advertisingDuration	u	0	0	0	ms	1	0 = indefinite This specifies how long the sensor should advertise each event. 15000 is often used for normal operation.
rw	connectionTimeout	u	0	10000	60	s	0	0 = none
rw	passkey	s	6	6	123456	NA	1	6 digits 0 to 9
rw	lock	u	0	1	0	NA	0	Reserved for future use.
rw	batterySenseInterval	u	0	86400	0	s	0	
rw	temperatureAggregationCount	u	1	32	1	samples	0	When greater than 1, the temperature samples are averaged.
rw	temperatureSenseInterval	u	0	86400	0	seconds	0	
rw	highTemperatureAlarmThreshold1	i	-128	127	127	°C	0	Range is larger than actual operating range.
rw	highTemperatureAlarmThreshold2	i	-128	127	127	°C	0	threhold2 > threshold 1, threshold 1 checked first
rw	lowTemperatureAlarmThreshold1	i	-128	127	-127	°C	0	
rw	lowTemperatureAlarmThreshold2	i	-128	127	-127	°C	0	threshold 2 < threshold 1
rw	deltaTemperatureAlarmTheshold	u	0	255	255	°C	0	
rw	odr	u	0	9	5	NA	0	LIS2DH12_ODR_POWERDOWN 0 LIS2DH12_ODR_1HZ 1 LIS2DH12_ODR_10HZ 2 LIS2DH12_ODR_25HZ 3 LIS2DH12_ODR_50HZ 4 LIS2DH12_ODR_100HZ 5 (default/tested value) LIS2DH12_ODR_200HZ 6 LIS2DH12_ODR_400HZ 7 LIS2DH12_ODR_1620HZ 8 LIS2DH12_ODR_1344_5376HZ 9
rw	scale	u	0	3	2	NA	0	LIS2DH12_SCALE_2G 0 LIS2DH12_SCALE_4G 1 LIS2DH12_SCALE_8G 2 LIS2DH12_SCALE_16G 3
rw	activationThreshold	u	0	255	8	NA	0	With odr 5 and scale 2
rw	returnToSleepDuration	u	0	255	6	NA	0	
ro	tempCc	i	-128000	127000	NA	Hundredths of a °C	0	
ro	batteryVoltageMv	u	0	0	NA	Milli-volts	0	

Category	Name	Type	Min	Max	Default	Units	Reset Req.	Description/ Notes
ro	hwVersion	s	1	1	NA	NA	0	*major*
ro	firmwareVersion	s	0	11	NA	NA	0	*major.minor.revision*
ro	resetReason	s	0	8	NA	NA	0	For development
rw	scratchpad1	u	0	0	NA	NA	0	For development. This can be used to test read/write operation without affecting sensor operation.
rw	scratchpad2	u	0	0	NA	NA	0	For development
rw	scratchpad3	u	0	0	NA	NA	0	For development
ro	bluetoothAddress	s	12	12	NA	NA	0	
ro	mtu	u	20	244	20	bytes	0	For development. Maximum Transmission Unit for Bluetooth Notifications and Write without response
ro	accelerometerSelfTestStatus	u	0	4	NA	NA	0	0 Reserved / 1 Unable to communicate with sensor (possible I2C issue) / 2 Self-test pass / 3 Self-test fail
ro	flags	u	0	0	NA	NA	0	Bitmask is the same as what is found in the advertisement.
ro	resetCount	u	0	0	NA	NA	0	
rw	useCodedPhy	u	0	1	NA	NA	1	When 1 the coded PHY is used as the primary and secondary PHY to send connectable but non-scannable extended advertisements.
rw	txPower	i	-40	8	0	dBm	0	-40 dBm, -20 dBm, -16 dBm, -12 dBm, -8 dBm, -4 dBm, 0 dBm, +2 dBm, +3 dBm, +4 dBm, +5 dBm, +6 dBm, +7 dBm, +8 dBm
rw	networkId	u	0	65535	0	NA	0	The Network ID is part of the advertisement. It can be used to put sensors in a group that is then filtered by Network ID on a gateway.
rw	configVersion	u	0	255	0	NA	0	The version can be used to help synchronize changes made by a phone application and a gateway. This value is unused by the sensor.
ro	bootloaderVersion	s	0	11	NA	NA	0	*major.minor.revision*

11   FREQUENTLY ASKED QUESTIONS

https://www.lairdconnect.com/support/faqs

What is the command to enter the bootloader (Nordic Secure DFU)?

```
{"jsonrpc": "2.0", "method": "reboot", "params": [1], "id": 1}
```

Where can I find more examples?

There are Python examples that use the BL654 USB dongle that can be found at https://github.com/LairdCP/BT510-Python.

https://www.lairdconnect.com/iot-devices/iot-sensors/bt510-bluetooth-5-long-range-ip67-multi-sensor

29

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Laird ™ **CONNECTIVITY**

12 ADDITIONAL ASSISTANCE

Please contact your local sales representative or our support team for further assistance:

Laird Connectivity
Support Centre: https://www.lairdconnect.com/resources/support

Email: wireless.support@lairdconnect.com

Phone: Americas: +1-800-492-2320
Europe: +44-1628-858-940
Hong Kong: +852 2923 0610

Web: https://www.lairdconnect.com/iot-devices/iot-sensors/bt510-bluetooth-5-long-range-ip67-multi-sensor

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Note: This is a first production release version of this BT510 user guide.
Information contained in this document is subject to change.

https://www.lairdconnect.com/iot-devices/iot-sensors/bt510-bluetooth-5-long-range-ip67-multi-sensor

31
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