SimpleLink™ Wi-Fi® SensorTag

The SimpleLink™ Wi-Fi® SensorTag from Texas Instruments™ (model CC3200SensorTag) provides a demo platform for showcasing the capabilities of the CC3200 device. With this easy-to-use platform, environmental sensing and other Internet of Things (IoT) applications can be done with ease.

The CC3200 device is part of the SimpleLink microcontroller (MCU) platform which consists of Wi-Fi®, *Bluetooth*® low energy, Sub-1 GHz and host MCUs. All share a common, easy-to-use development environment with a single core software development kit (SDK) and rich tool set. A one-time integration of the SimpleLink platform lets you add any combination of devices from the portfolio into your design. The ultimate goal of the SimpleLink platform is to achieve 100 percent code reuse when your design requirements change. For more information, visit www.ti.com/simplelink.

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1 Introduction

1.1 CC3200 SensorTag

The high-performance CC3200 device is the industry's first single-chip microcontroller (MCU) with built-in Wi-Fi connectivity for easy system application. Created for the Internet of Things (IoT), the SimpleLink™ Wi-Fi CC3200 device is a wireless MCU that integrates a high-performance ARM® Cortex®-M4 MCU that allows customers to develop an entire application with a single device. With on-chip Wi-Fi, internet, and robust security protocols, no prior Wi-Fi experience is needed for fast development.

The CC3200 SensorTag is a low-cost IoT demo platform for ARM® Cortex®-M4F-based microcontrollers. The SensorTag design highlights the CC3200 Internet-on-a chip™ solution and Wi-Fi capabilities. The CC3200 SensorTag features programmable user buttons, LEDs, reed relay, digital microphone, and a buzzer for user interaction. Onboard sensors, gyroscope, accelerometer, and compass allow for easy environmental sensing and IoT applications. Figure 1 shows the CC3200 SensorTag.

NOTE: All figures and references in this document apply to the Rev1.2. Most of the text in this document also applies to the Rev1.2, unless otherwise stated.

CAUTION

The kit contains electrostatic discharge (ESD) sensitive components.

Handle with care to prevent permanent damage.

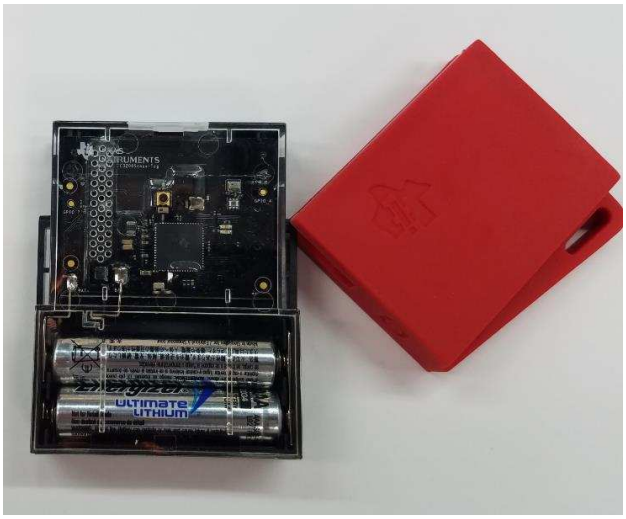

Figure 1. CC3200 SensorTag

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1.2 Key Features

The key features of the CC3200 SimpleLink Wi-Fi and IoT SensorTag are as follows:

- CC3200, SimpleLink Wi-Fi, Internet-on-a chip solution with integrated MCU
- Onboard inverted-F antenna with RF connector for conducted testing
- Two buttons, two LEDs, reed relay, digital microphone, and a buzzer for user interaction
- Sensors, gyroscope, accelerometer, and compass for easy integration in IoT application
- Debug and JTAG interface for flash programing

1.3 What is Included

The kit contents are as follows:

- One CC3200 Wi-Fi SensorTag
- One getting started guide
- Two AAA batteries

1.4 FCC/IC Regulatory Compliance

1.4.1 FCC

The CC3200 SimpleLink Wi-Fi and IoT solution with MCU LaunchPad™ hardware is FCC Part 15 compliant. Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could voice the authority of the user to operate the equipment.

1.4.1.1 Class B Operation

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 a particular 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 or more 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 the one the receiver is connected to.
- Consult the dealer or an experienced radio or TV technician for help.

1.4.1.2 RF Exposure Information (SAR)

This device complies with radio frequency (RF) exposure limits adopted by the FCC for an uncontrolled environment.

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1.4.2 IC

This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions:

- This device may not cause interference, and
- 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:

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

1.4.2.1 RF Exposure Information (SAR)

This equipment complies with Innovation, Science and Economic Development Canada RF exposure limits set forth for an uncontrolled environment.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé.

1.4.3 EU

Texas Instruments Inc. declares that the radio equipment type CC3200SensorTag is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at www.ti.com/lit/pdf/sszq037.

1.4.3.1 RF Exposure Information (SAR)

This device meets the EU requirements and the International Commission on Non-Ionizing Radiation Protection (ICNIRP) on the limitation of exposure of the general public to electromagnetic fields by way of health protection.

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2 Hardware Description

2.1 Block Diagram

Figure 2 shows a block diagram of the CC3200 SensorTag.

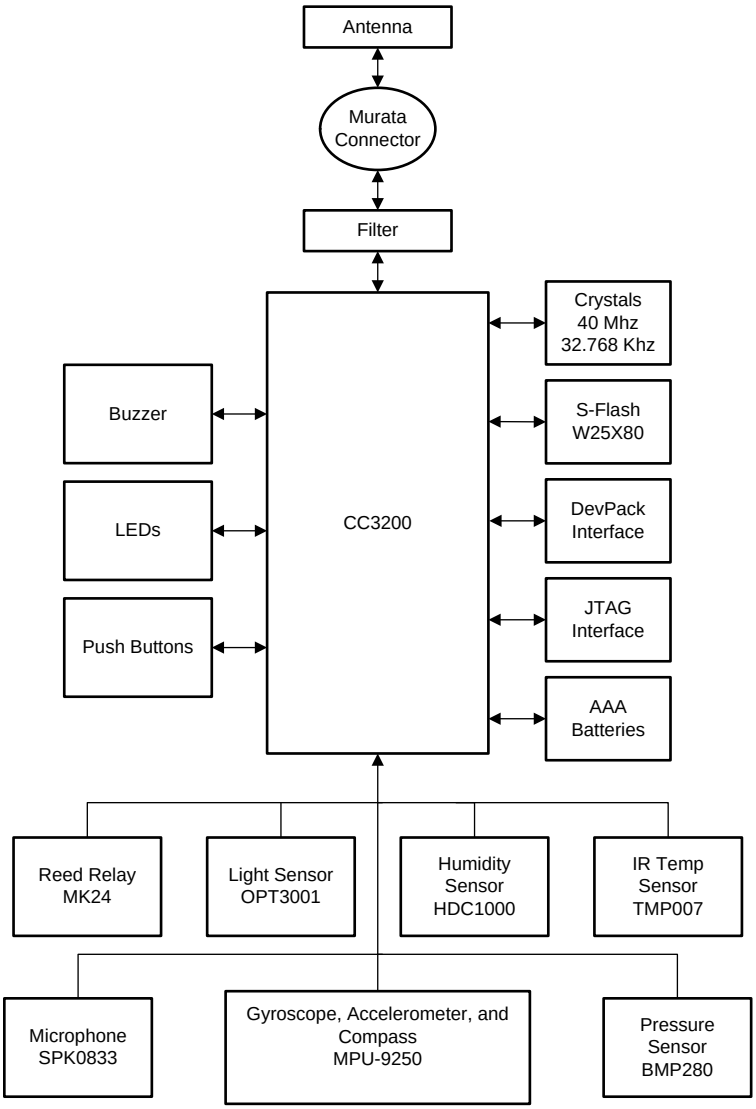

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Figure 2. CC3200 SensorTag Block Diagram

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2.2 Hardware Features

The hardware features of the CC3200 SensorTag are as follows:

- CC3200, SimpleLink Wi-Fi, internet-on-a chip solution with integrated MCU
- 20-pin DevPack SKIN connector and 10-pin JTAG connector
- Onboard inverted-F antenna with RF connector for conducted testing
- Two buttons, two LEDs, a reed relay, a digital microphone, and a buzzer for user interaction
- Gyroscope, accelerometer, and compass for easy integration in IoT application
- Debug and JTAG interface for flash programing
- AAA battery connector interface
- Infrared Thermopile Sensor, Pressure Sensor, Humidity Sensor, and Light Sensor
- Onboard 1-MB serial flash memory

2.3 RF Function and Frequency Range

The CC3200 SensorTag device is designed to operate in the WLAN 2.4-GHz band. The CC3200 SensorTag device also supports Channels 1 through 11 (2142 MHz to 2462 MHz). The SensorTag design uses the SimpleLink Wi-Fi CC3200 Internet-on-a chip device (see *CC3200 SimpleLink™ Wi-Fi® and IoT SensorTag Design Files*).

NOTE: The maximum RF power transmitted in each WLAN 2.4-GHz band is 16.5 dBm (EIRP power).

2.4 Sensors and Peripherals

2.4.1 Reed Relay

The MK24-A reed relay is good for low-power operations (see [1]). The reed relay is suitable for IoT applications with a contact resistance of 350 MΩ, a maximum operating time of 0.25 ms, and a release time of 0.15 ms.

2.4.2 Digital Microphone

The SPH0641LU4H device is suitable for a varying range of applications; it provides a means for sensing sounds (see [2]). The SPH0641LU4H is a low-power microphone with high performance and good RF immunity. The microphone can be operated in the five modes that follow:

- Powered down mode, VDO = 0 V
- Sleep mode, VDO ranges from 3.6 V to 1.62 V
  $f_{CLOCK} \leq 250$ kHz
- Low-power mode, VDO ranges from 3.6 V to 1.62 V
  351 kHz ≤ f_{CLOCK} ≤ 815 kHz
- Ultrasonic mode, VDO ranges from 3.6 V to 1.62 V
  3.072 MHz ≤ f_{CLOCK} ≤ 4.8 MHz
- Standard performance mode, VDO ranges from 3.6 V to 1.62 V
  1.024 MHz ≤ f_{CLOCK} ≤ 2.475 MHz

2.4.3 Buzzer

The HCS0503B device can be used as an alarm (see [3]). Some of the specifications follow:

- Rated voltage of 3 V
- Output S.P.L ≥ 80 dB
- Coil resistance of 12 Ω ±3

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- Rated frequency of 4000 Hz

2.4.4 Gyroscope, Accelerometer, and Compass

The MPU-9250 device is a multichip module consisting of a 3-axis gyroscope, a 3-axis accelerometer, and a 3-axis magnetometer for position tracking (see [4]). The MPU-9250 features three 16-bit ADCs each for the gyroscope, accelerometer, and magnetometer. Some other features of the MPU-9250 are as follows:

- High-precision clock
- Precision tracking of fast and slow motions
- VDD operating range of 2.4 V to 3.6 V
- I2C and SPI serial communication interface

2.4.5 Infrared Thermopile Sensor

The TMP007 device is a fully-integrated microelectromechanical system (MEMS) thermopile sensor that measures the temperature of an object without direct contact (see [5]). The thermopile absorbs passive infrared energy from an object at wavelengths of 4 µm to 16 µm within the end-user defined field of view. Some other features are as follows:

- 14-bit local temperature sensor for cold junction reference
- Two-wire serial interface options
- Low power

2.4.6 Pressure Sensor

The BMP280 device is a digital pressure sensor for measuring barometric pressure conditions (see [6]). The BMP280 can also be used to determine altitude. Some other features of the sensor include the following:

- Wide pressure range of 300 hPa to 1100 hPa
- High accuracy
- Low current consumption of 2.7 µA @ 1 Hz sampling rate
- I2C and SPI serial communication interface

2.4.7 Humidity Sensor

The HDC1000 device is a digital humidity sensor with a relative humidity (RH) operating range of 0% to 100% that provides excellent measurement accuracy at very low power (see [7]). Some other features are:

- Relative humidity accuracy ±3%
- 14-bit measurement resolution
- Supply voltage range of 3 V to 5 V

2.4.8 Light Sensor

The OPT3001 device is a sensor that measures the intensity of visible light (see [8]). The device can sense a light spectrum similar to that of the human eye. Some other features follow:

- Measurements: 0.01 lux to 83k lux
- Wide power-supply range: 1.6 V to 3.6 V
- Low operating current: 1.8 µA
- Flexible interrupt system

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3 Operation Description

At start-up, the SensorTag enters access point mode for 2 minutes. When the SensorTag enters access point mode, the red LED blinks three times.

NOTE: After 5 minutes, the SensorTag emits a short beep and enters hibernate mode. To wake the SensorTag from hibernate mode into access point mode, press the power button.

TI recommends using the Watch DevPack (see [9]) with the Wi-Fi SensorTag. The display shows important status information and technical data that is useful for debugging network settings.

3.1 Downloading the SensorTag App

The SensorTag is available from the Apple® store and the Google Play™ store.

- SimpleLink SensorTag, Google Play store
- TI SensorTag, Apple Store

3.2 Setting Up the SensorTag as an Access Point

Pull the plastic tab on the batteries to power the SensorTag.

NOTE: If the SensorTag has been connected to an access point before, you can reset the Wi-Fi settings by pressing both buttons on the side simultaneously for 6 seconds.

3.2.1 First-Time Configuration Only

On your mobile phone, go to the *Settings* menu and connect to the SensorTag-xx access point (see Figure 3). The -xx value is the two last digits of the SensorTag MAC address; this value is used to uniquely identify your SensorTag.

Connecting the phone to the access point may take up to 30 seconds the first time it connects.

NOTE: Only one device can be connected to the Wi-Fi SensorTag when it is configured as an access point. On some phone models, the 4G connection and 5-GHz Wi-Fi must be disabled to detect the SensorTag as access point.

Figure 3. Example of SensorTag Access Point

To launch the SensorTag app, you may have to pull down the menu in the SensorTag device list to refresh the device list. The app detects the new Wi-Fi SensorTag. If the SensorTag is programmed with firmware version 0.98, the app will prompt you to upgrade the SensorTag to the latest version (see Figure 4). Follow the steps to upgrade the SensorTag.

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If an upgrade has already taken place and a newer firmware version becomes available, users must first revert back to the factory default (firmware version 0.98). This can be done in one of 2 ways:

- In the mobile application, select Firmware Upgrade → Factory Default.

  or

- Depress the two SensorTag hardware buttons simultaneity for a few seconds until the beep sound is activated.

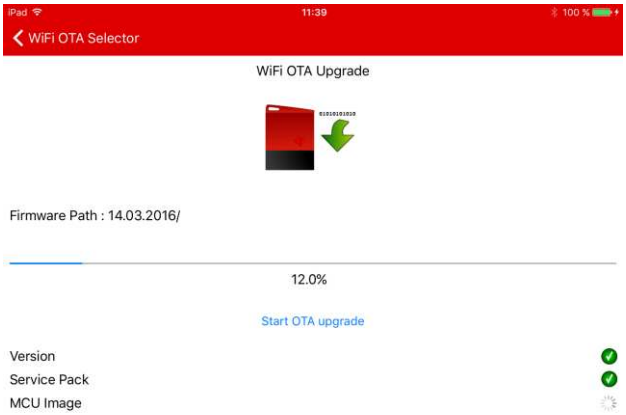

Figure 4. Wi-Fi® OTA Upgrade

From the firmware upgrade screen, go back to the SensorTag device list screen (see Figure 5 and Figure 6).

- For IOS® devices, go into Settings and manually reconnect to the SensorTag-xx access point.
- For Android devices, the phone will keep the connection to the SensorTag access point. On the Android device, select *Configure new Wi-Fi SensorTag*, and follow the on-screen instructions to configure the Wi-Fi settings.

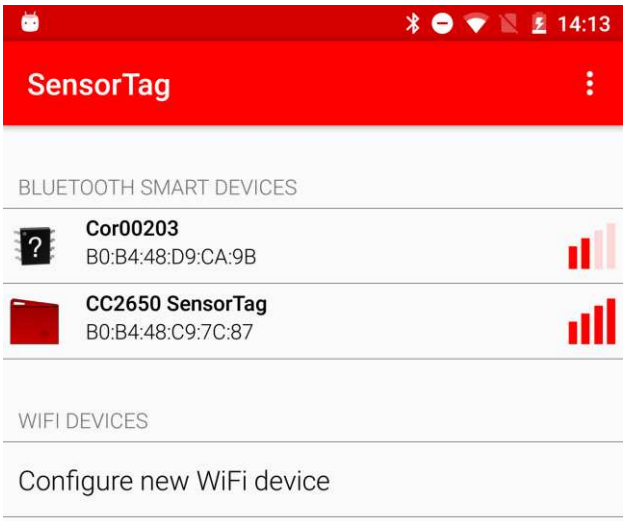

Figure 5. Available Device

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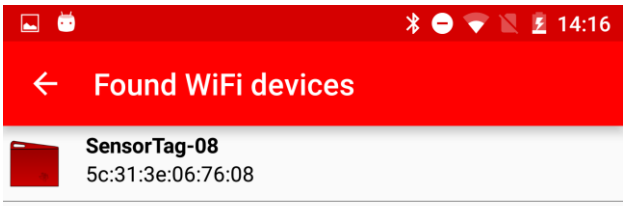

Figure 6. New Device Found

3.3 Connecting the SensorTag to Your Local Wi-Fi Network

On the *Sensor View* screen, the SensorTag data is displayed (see Figure 7). The default update interval for the sensor view is 1 second. After 90 seconds of inactivity, the SensorTag emits a short beep and enters hibernate mode to save power. Press any button to wake up the SensorTag.

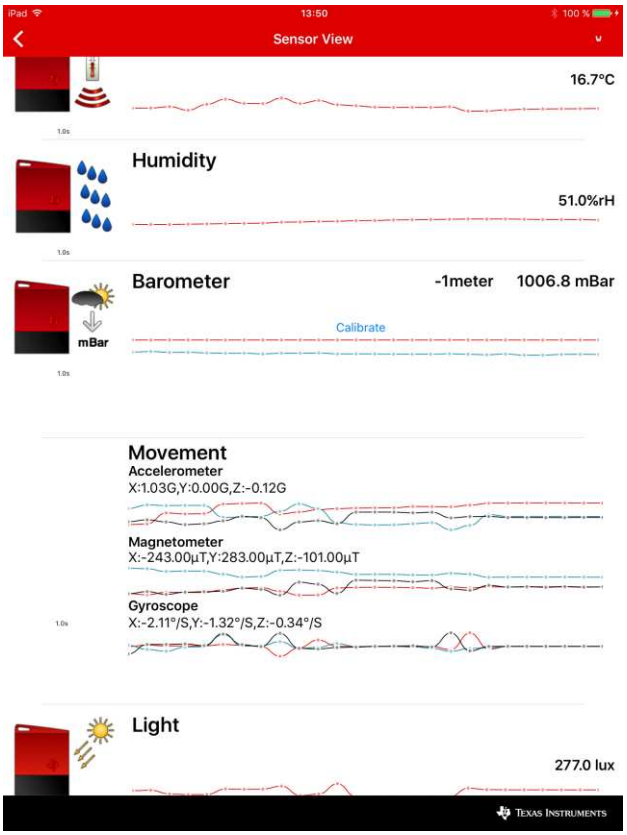

Figure 7. SensorTag Sensor Data

To view the sensor data directly in the Cloud, follow the Cloud URL. The SensorTag will now send data directly to the IBM® quickstart cloud using MQTT.

NOTE: These data are sent directly without any security or encryption enabled.

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To view the SensorTag on another PC or web browser, use the *Share* button and share by email (see Figure 8).

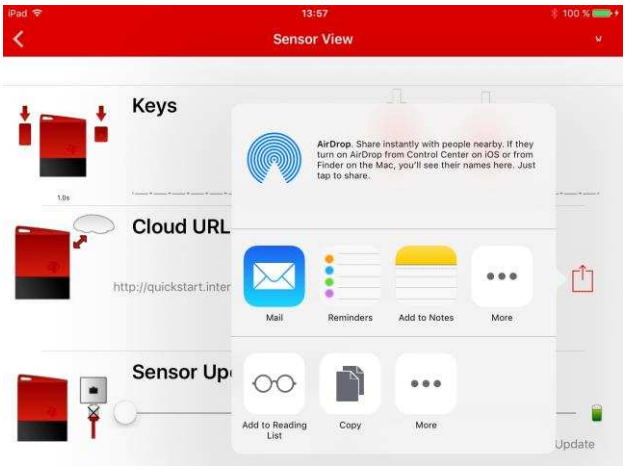

Figure 8. Sharing SensorTag View

3.4 Switching Between Modes

If you would like to repeat the provisioning method, press and hold the user button for 6 seconds to toggle between station mode (connected to your AP) and AP mode (direct connection to your phone). When in AP mode, the provisioning process can be repeated.

3.5 Troubleshooting

If you have problems connecting the SensorTag to your access point, use the advanced setup.

Take note of the IP address of the SensorTag (see Figure 9).

Figure 9. Example of SensorTag IP Address

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The IP address can be used to configure the Wi-Fi setup for advanced settings through a web browser. Alternatively, the Wi-Fi SensorTag can be accessed by typing *sensortag.net* in the browser. Advanced Wi-Fi settings can be configured in the profiles tab. (see Figure 10).

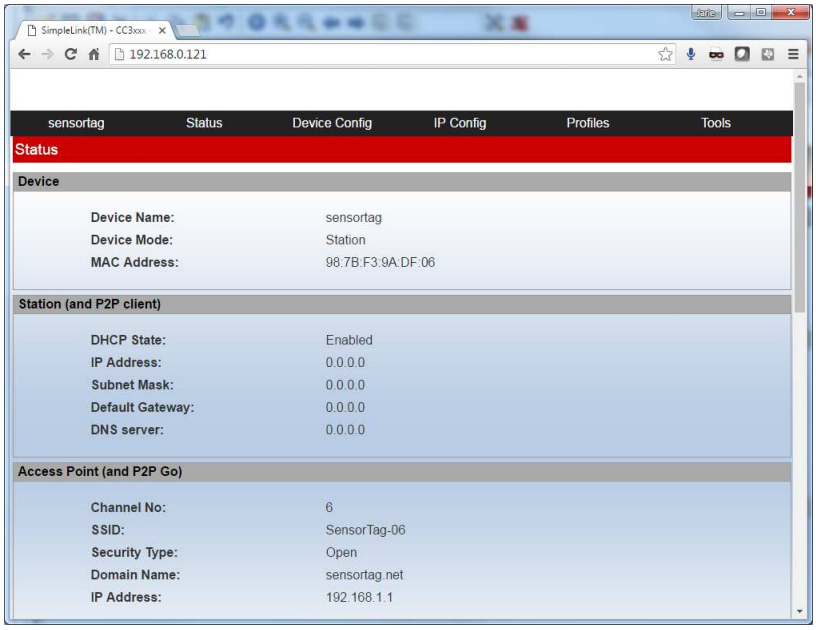

Figure 10. Sensortag.net Snippet

Pressing both buttons simultaneously for 6 seconds resets the SensorTag and deletes all the Wi-Fi settings. The SensorTag can now be configured as a new device.

3.6 Replacing the Batteries

To replace the battery, follow these steps:

1. Remove the red rubber casing and plastic casing as shown in Figure 11.
2. Remove and replace batteries.

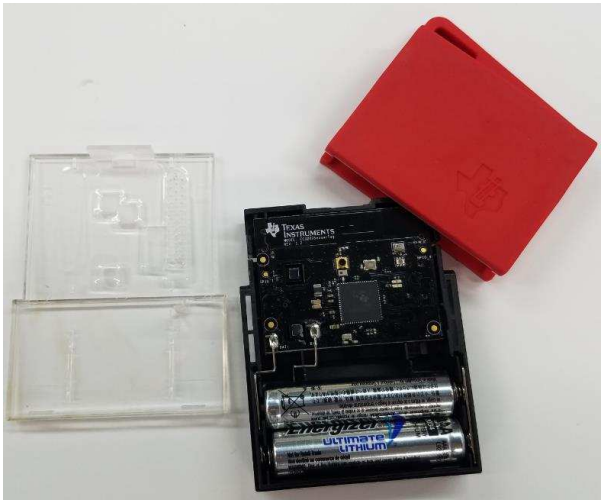

Figure 11. Replacing the Batteries

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WARNING

There is a risk of explosion if the batteries are replaced by an incorrect type. To minimize the risk of explosion, ensure the replacement batteries are the correct type. Dispose of used batteries according to the instructions.

Waste Electrical and Electronic Equipment (WEEE)

This symbol means that according to local laws and regulations your product and/or its battery shall be disposed of separately from household waste. When this product reaches its end of life, take it to a collection point designated by local authorities. Proper recycling of your product will protect human health and the environment.

4 Design Files

4.1 Hardware

All design files include schematics, layout, bill of materials (BOM), Gerber files, and documentation. All documentation materials are available for download from SimpleLink Wi-Fi CC3200 LaunchPad Reference Design.

5 PCB Revision

PCB Revision	Description
Rev 1.2	Baseline

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6 References

1. *MK24 Series Reed Sensor*
2. Knowles SPH0641LU4H Digital Microphone
3. *HCS0503B Buzzer*
4. *MPU-9250 Nine-Axis (Gyro + Accelerometer + Compass) MEMS MotionTracking™ Device*
5. *TMP007 Infrared Thermopile Sensor with Integrated Math Engine Data Sheet*
6. *BMP280 Barometric Pressure Sensor*
7. *HDC1000 Low Power, High Accuracy Digital Humidity Sensor with Temperature Sensor Data Sheet*
8. *OPT3001 Ambient Light Sensor (ALS) Data Sheet*
9. Watch DevPack
10. SimpleLink Wi-Fi CC3200 LaunchPad Reference Design
11. *CC3200 SimpleLink™ Wi-Fi® and IoT SensorTag Design Files*

Revision History

Date	Revision	Notes
February 2017	SWRU509*	Initial release

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