

TI 15.4-Stack CC13x0 SimpleLink™ Embedded Example Applications

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1 Introduction

This quick start guide provides instructions to quickly start using the TI 15.4-Stack Example Applications released as part of the CC13x0 SimpleLink SDK.

2 Required Hardware

To run the TI 15.4-Stack Example Application, the following hardware is required.

- [CC1310 LaunchPad™ \(2x\)](#)
or
- [CC1350 LaunchPad \(2x\)](#)
- Windows PC with Internet connection



3 Required Software

Install the following required software from the links provided.

- Install the [CC13x0 SimpleLink™ SDK](#) (simplelink_cc13x0_sdk_1_00_00_xx).
- Install [Code Composer Studio™ \(CCS\)](#) v 7.0.
 - When installing CCS, on the Processor Support menu expand the list of SimpleLink Wireless MCUs, and then select → SimpleLink CC13xx and CC26xx Wireless MCUs, as in [Figure 1](#).

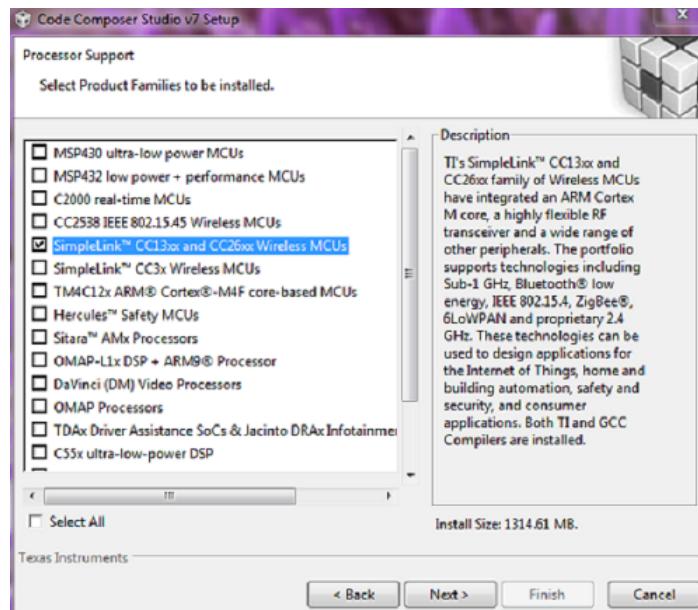


Figure 1. Processor Support Menu

- When CCS is installed, apply all available updates by selecting Help → Check of Updates.

NOTE: Note: This step may require restarting CCS when each update is applied.

- A hyperterminal for visualizing the UART data (for example Tera Term or PuTTY).

4 Background

TI 15.4-Stack Example Applications included in the CC13x0 SimpleLink SDK let users create ultra-low power, very-long range, star-network topology-network solutions. The two out-of-box example applications are described as follows.

The Collector Example Application demonstrates how to develop the PAN-Coordinator, or the central node in the network. This application starts the network, allows devices to join the network, and configures the joining devices on how often to report the sensor data. The application then sends periodic tracking request messages (to which it expects tracking response messages) to determine whether or not the sensor nodes are alive in the network.

The Sensor Example Application demonstrates how to develop the network device, which joined the network started by the Collector Example Application. The Sensor Example Application periodically sends sensor data reports at the report interval configured by the Collector Example Application, and responds to the tracking messages sent by the Collector Example Application.

5 Import Projects in the CCS Workspace

NOTE: In the following sections, the project names for CC1310 and CC1350 platforms are referred to as CC13x0. Replace x with either 1 or 5 depending on the wireless MCU being used.

1. Open CCS and select the Project tab, then select the option Import CCS Projects... (see [Figure 2](#)).

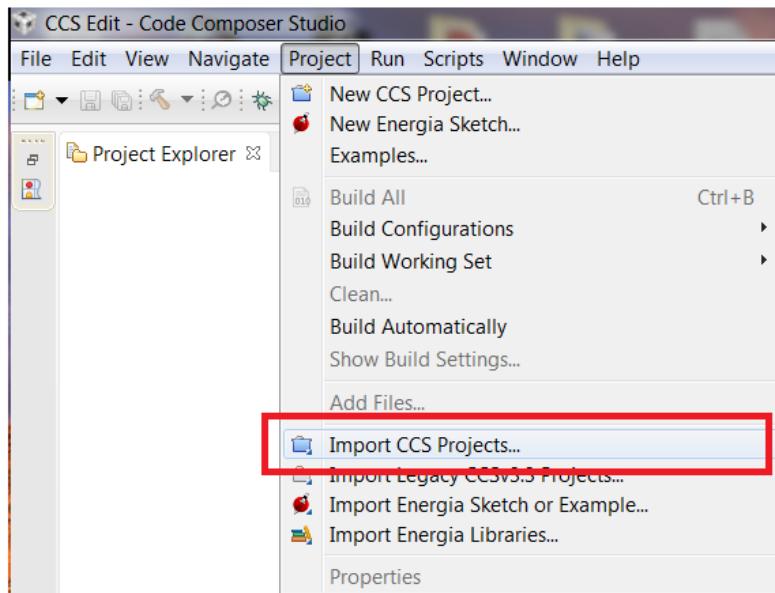


Figure 2. CSS Project Tab

2. Follow the instructions in [Figure 3](#) to import the required example applications. When using the CC1350 LaunchPad note that xx in [Figure 3](#) is the TI 15.4-Stack SDK build revision number at the release time.

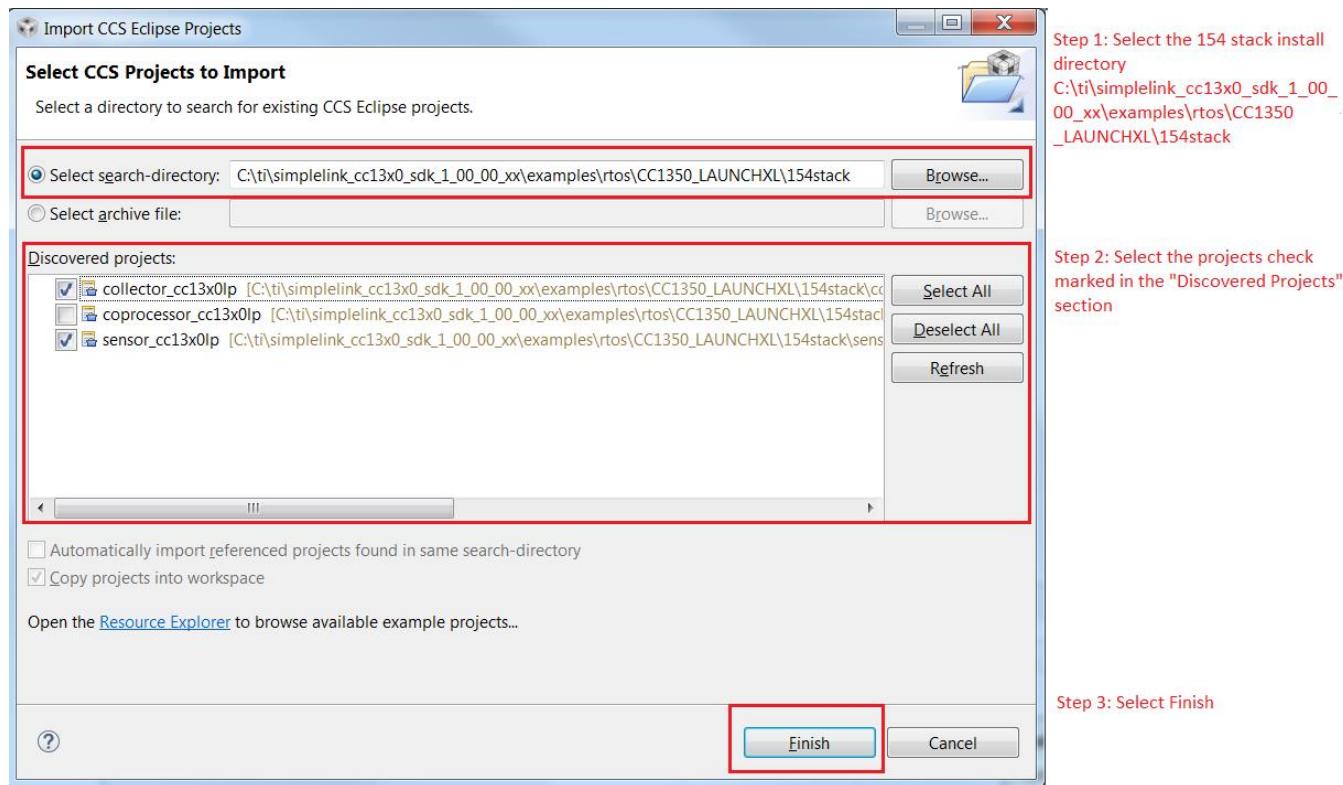


Figure 3. Import Required Example Applications

NOTE: If using the CC1310 LaunchPad, the install directory is
C:\ti\simplelink_cc13x0_sdk_1_00_00_xx\examples\rtos\CC1310_LAUNCHXL\ti154stack

6 Configuration Settings

After importing the projects, first configure the desired settings for the following parameters.

- PAN-ID
- PHY-ID
- Channel of operation

NOTE: Out-of-Box Collector and Sensor Example Applications are configured for a non-beacon mode of network operation. Refer to section 4.5 of the [Embedded Developer's Guide](#), on how to configure the desired network mode of operation.

In addition, the out-of-box example applications configure the TI 15.4-Stack with all features enabled for example, beacon mode support, non-beacon mode support, and frequency hopping support. Refer to section 4.5 of the [Embedded Developer's Guide](#) for more details on how to enable only the desired 15.4-Stack features and get flash and RAM savings for the application.

These settings must match on Sensor and Collector projects for the non-beacon mode out-of-box configuration that is used for the quick start guide.

To configure the settings on the Collector application project, follow these steps.

1. Select the collector_cc13x0lp project in the CCS Project Explorer window.
2. Find the config.h file, see [Figure 4](#) on how to locate this file.

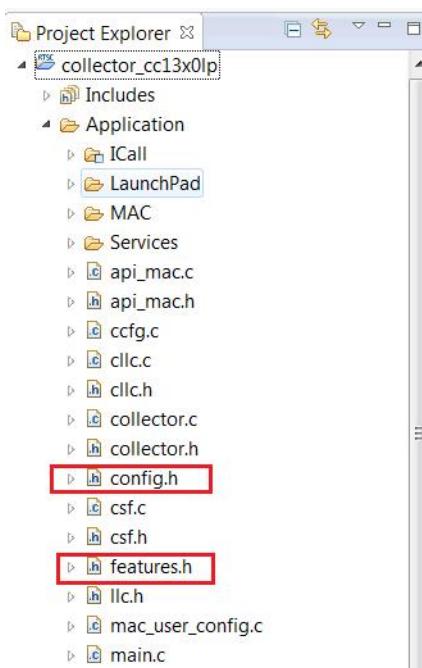


Figure 4. Locate config.h File

NOTE: After importing the projects, the files config.h and features.h are opened up. Out of the box, features.h needs no changes and is built to work in non beacon mode with security enabled.

3. Set #define CONFIG_PAN_ID to the desired value.
 - Setting CONFIG_PAN_ID to 0xFFFF lets the device use any PAN.
4. Set the Phy ID according to the region of interest.
 - For US (or 915-MHz band operation) use the out-of-box CONFIG_PHY_ID settings as follows:

```
/*! Setting for Phy ID */
#define CONFIG_PHY_ID           (APIMAC_STD_US_915_PHY_1)

• For ETSI PHY for Europe (or 868-MHz band operation) configure the parameter CONFIG_PHY_ID
as follows:
```

```
/*! Setting for Phy ID */
#define CONFIG_PHY_ID           (APIMAC_STD_ETSI_863_PHY_3)
```

5. Set the preferred channel of operation in CONFIG_CHANNEL_MASK.

```
/*
Channel mask used when CONFIG_FH_ENABLE is false
Each bit indicates if the corresponding channel is to be
scanned First byte represents channel 0 to 7 and the last byte represents
channel 128 to 135
*/
#define CONFIG_CHANNEL_MASK      { 0x0F, 0x00, 0x00, 0x00, 0x00, 0x00, \
                                0x00, 0x00, 0x00, 0x00, 0x00, 0x00, \
                                0x00, 0x00, 0x00, 0x00 }
```

NOTE: The CONFIG_CHANNEL_MASK byte 1 most significant bit (MSB) represents channel 7, byte 2 MSB represents channel 15, and so on, therefore 0x0F means channels 0, 1, 2, and 3.

The channel numbers available in each band follow.

- 902–928 MHz (50 kbps): 0 to 128, for example:
when CONFIG_PHY_ID = APIMAC_STD_US_915_PHY_1
- 863–870 MHz (50 kbps): 0 to 33, for example:
when CONFIG_PHY_ID = APIMAC_STD_ETSI_863_PHY_3

Perform the same configuration setting for the config.h file of the sensor_cc13x0lp project.

NOTE: It is important to have the config.h file of both the Sensor and Collector application project configured as described in [Section 6](#) before moving ahead.

7 Program the Collector Example Application

1. Connect a LaunchPad to the PC, and name it collector-launchpad, because we will program the collector application on this.
2. Right-click on the collector_cc13x0lp project and select the Build option (see [Figure 5](#)). This action should build the collector application project.

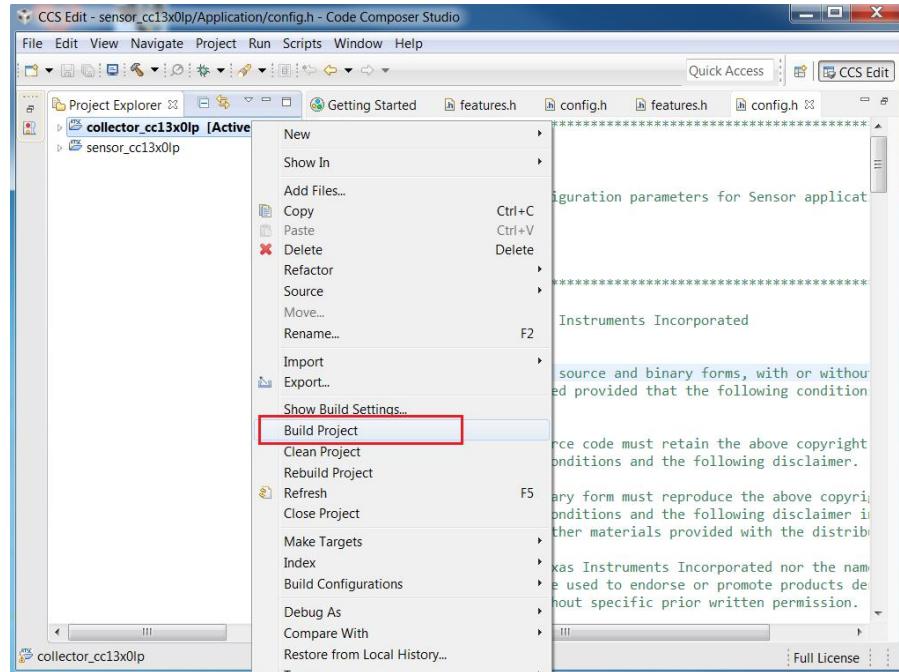


Figure 5. Collector Project

3. Download the project on the collector-launchpad. To download from the Run tab select the Debug option (see [Figure 6](#)).

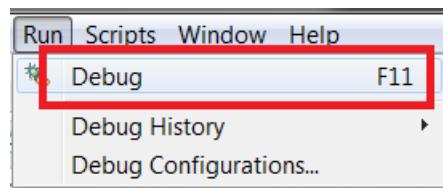


Figure 6. Debug Option

4. When the download is complete, the following screen appears. Select the terminate option to terminate the debug session (see [Figure 7](#)) and move on to the next step.

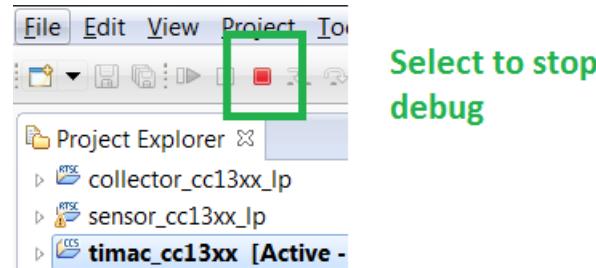


Figure 7. Terminate Debug

5. Power off this LaunchPad.

8 Program the Sensor Example Application

1. Power on the second CC1310 or CC1350 LaunchPad and call it the sensor-launchpad.
2. Right-click on the sensor_cc13x0lp project, and select the Build option. This action should build the sensor project.
3. Download the project on the second CC1310 or CC1350 LaunchPad.
4. Terminate the debug session when the download is complete.
5. Power off this LaunchPad.

9 Starting the TI 15.4-Stack-Based Network

Power on the first LaunchPad (collector-launchpad). Ensure that the network starts when the red LED turns on.

NOTE: At this time (after starting the network) the collector does not allow devices to join the network. The collector has closed the network for new device joins. To allow new devices to join the network press the Right button or BTN-2 on the collector-launchpad. Pressing BTN-2 again closes the network again, and new devices cannot join the network. Press button 2 again to allow new devices to join the network.

Figure 8 shows the UART output on the hyper terminal when the collector is powered up.

NOTE: The UART hyper-terminal must be configured with the following settings:

- Baud rate: 115200
 - Data: 8 bit
 - Parity: none
 - Stop: 1 bit
 - Flow control: none
-

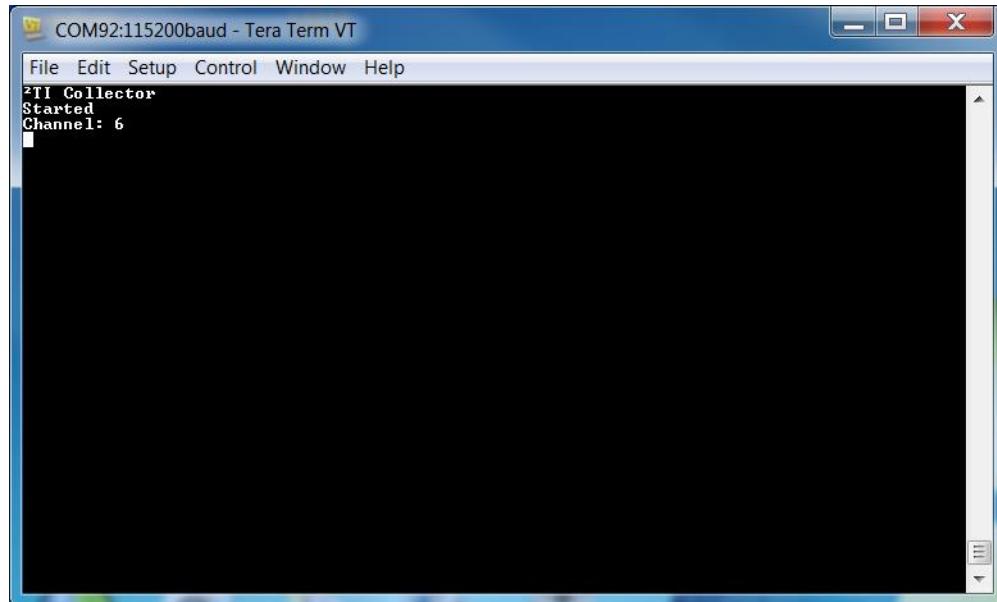


Figure 8. Screenshot of Hyperterminal When Collector is Powered Up

10 Joining the Sensor Device to the Network

1. To allow new devices to join the network, press the Right button or BTN-2 on the collector-launchpad. Pressing BTN-2 again closes the network again and new devices cannot join the network. Pressing BTN-2 toggles the ability to join new devices to the network as allowed or not allowed. When the network is open to new devices the red LED blinks, and when it is not the red LED stays on solid, which indicates that the network is closed to new devices.
2. Power on the second LaunchPad (sensor-launchpad). Now the device tries to join the network (ensure that the collector is allowing new devices to join the network). [Figure 9](#) shows the hyper terminal display.

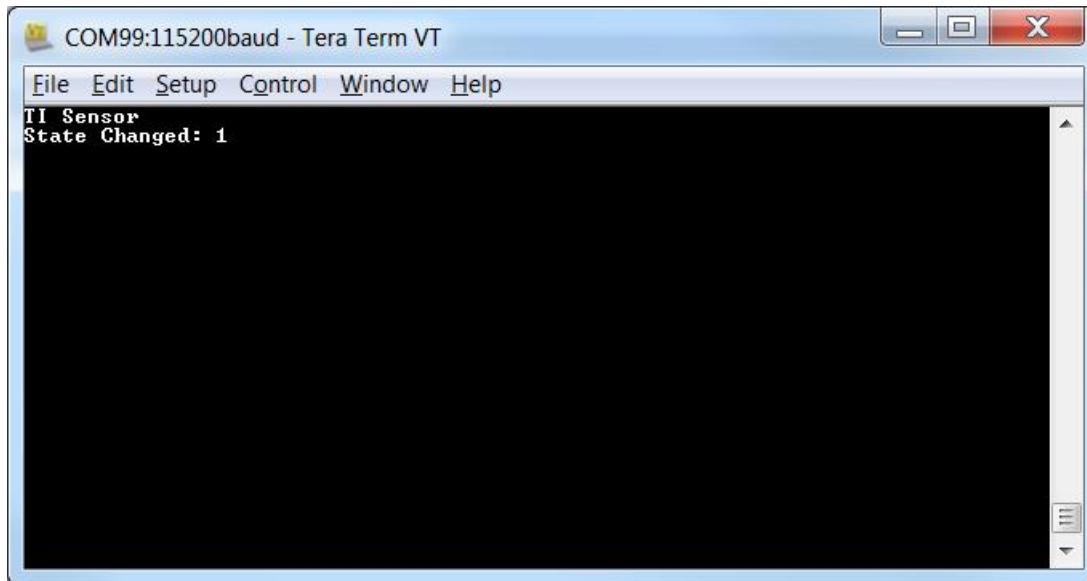
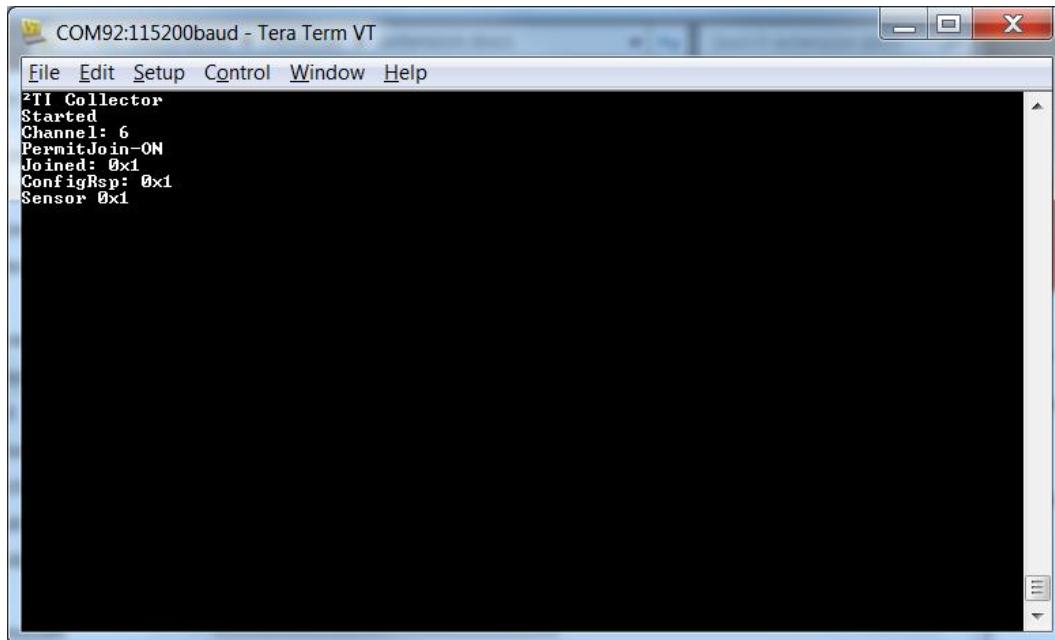


Figure 9. Screenshot Showing Sensor at Start-up

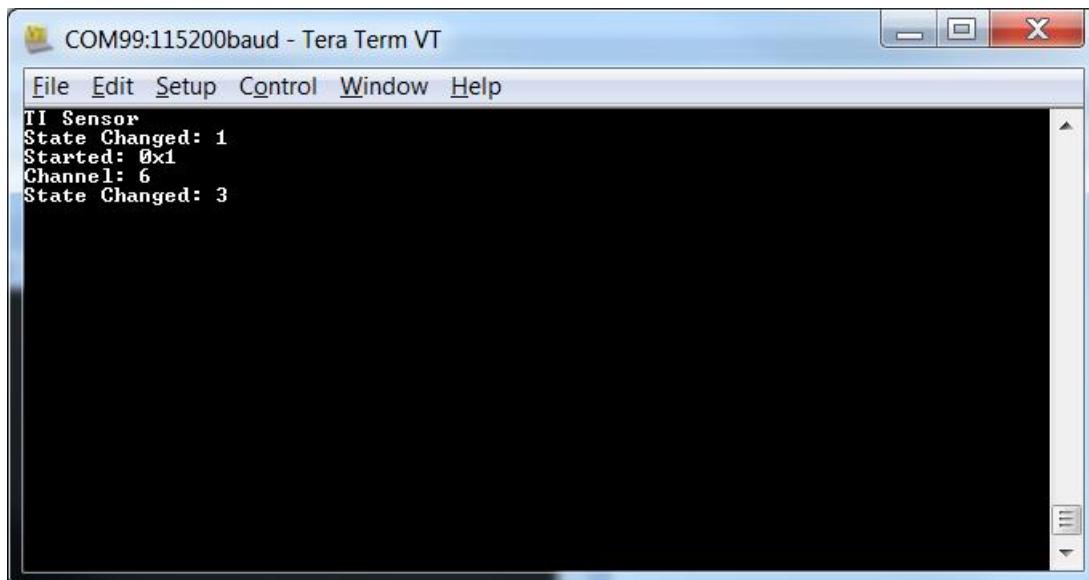
3. When the sensor device has joined the network, LED1 is set to solid, and the display on the hyperterminal appears as in [Figure 10](#) for the collector-launchpad and [Figure 11](#) for the sensor-launchpad.



COM92:115200baud - Tera Term VT

```
File Edit Setup Control Window Help
^TI Collector
Started
Channel: 6
PermitJoin=ON
Joined: 0x1
ConfigRsp: 0x1
Sensor 0x1
```

Figure 10. Screenshot From Collector Application After First Sensor is Connected to Network



COM99:115200baud - Tera Term VT

```
File Edit Setup Control Window Help
^TI Sensor
State Changed: 1
Started: 0x1
Channel: 6
State Changed: 3
```

Figure 11. Screenshot After Sensor Application is Connected to Network

NOTE: Network Reset:

It is possible to restart the network from scratch without the need to re-flash the devices, by clearing out the NV used to store network information. This task is done by holding down BTN-2 and pressing the reset button.

11 Data Communication

The collector application configures the sensor device to send data periodically at the interval configured through the define CONFIG_REPORTING_INTERVAL (see the collector.c file in the collector_cc13x0lp project). The messages being sent by observing the LED2 (green LED) toggle follow:

- On the sensor LaunchPad each time a sensor data report message is sent out
- On the collector LaunchPad each time a sensor data report is received

The collector can toggle LED1 (red LED) of the first sensor to join the network. This toggling is done by pressing BTN-1 on the collector. A slight delay (a few seconds) in toggle operation may occur on the sensor node. This delay is because the sensor nodes are in sleep mode, and only wake up periodically to receive the command buffered on the collector.

12 Additional Information

For additional information, developers should refer to the TI 15.4-Stack Developer's Guide and other documents included with the TI 15.4-Stack SDK installation.

Other useful links:

- Find answers to your questions and common issues, post your questions, and answer questions from other developers at the TI e2e forums:
http://e2e.ti.com/support/wireless_connectivity/proprietary_sub_1_ghz_simplici/.
- [TI 15.4-Stack Wiki Page](#)

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (June 2016) to A Revision	Page
• Changed 0c0F to 0x0f in Section 6 note.	6

Changes from A Revision (September 2016) to B Revision	Page
• Changed text from CC1310 to CC13x0 throughout	2
• Changed launchpad website from http://www.ti.com/tool/430boost-sharp96 to http://www.ti.com/tool/launchxl-cc1350...	2
• Changed text from TI 15.4-Stack SDK to CC13x0 SimpleLink SDK throughout	2
• Changed http://www.ti.com/tool/TI-15.4-STACK to http://www.ti.com/tool/cc13xx-sw	2
• Changed CCS version from 6.1.2 to 7.0	2
• Added step 3 to Required Software (Section 3).....	3
• Updated Import Required Example Applications image (Figure 3)	4
• Added note to Import Projects in the CCS Workspace (Section 5).....	4
• Added note to Configuration Settings (Section 6).....	5
• Reordered steps in Program the Collector Example Application (Section 7)	7
• Changed collector_cc1310_lp to collector_cc13x0lp throughout	7
• Updated Collector Project image (Figure 5)	7
• Changed text from CC1310 to CC1310 or CC1350 throughout	8
• Changed text from sensor_cc1310_lp to sensor_cc13x0lp throughout	8
• Reordered steps in Program the Sensor Example Application (Section 8).....	8
• Changed Section 8 text from first CC1310 LaunchPad to second CC1310 LaunchPad	8
• Added note to Starting the TI 15.4-Stack-Based Network (Section 9).	8
• Updated Hyperterminal When Collector is Powered Up image (Figure 8)	8
• Updated Showing Sensor at Start-up image (Figure 9).	9
• Updated Collector Application After First Sensor is Connected to Network image (Figure 10).....	10
• Updated Sensor Application is Connected to Network image (Figure 11).	10
• Added note to Joining the Sensor Device to the Network (Section 10).	10
• Added toggle LED instructions in Data Communication (Section 11)	11
• Added wiki page website to Additional Information (Section 12).	11

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