CC2564C TI Dual-Mode Bluetooth® Stack on STM32F4 MCUs

The CC2564C dual-mode *Bluetooth*® stack on STM32F4 microcontrollers (MCU) software (CC2564CSTBTBLESW) for Bluetooth + Bluetooth low energy from TI enables the STM32® ARM® Cortex®-M4 processor and includes single-mode and dual-mode offerings implementing the Bluetooth 4.2 specification. The Bluetooth stack is fully qualified (QDID 85355 and QDID 69886) and provides simple command-line applications to help speed development, and has MFi capability upon request.

For a complete evaluation solution, the CC2564CSTBTBLESW software development kit (SDK) works directly with the STM3240G-EVAL hardware development kit. The stack for the STM32 MCU is certified and royalty free (CC2564CSTBTBLESW).

The software works with CC256xCQFN-EM board. It also provides complete Bluetooth BR, EDR, and low-energy HCI solution, reducing design effort and enabling a faster time to market. The CC256xCQFN-EM includes TI's dual-mode Bluetooth 4.2-compliant solution. The devices provide best-in-class RF performance with a transmit power and receive RX sensitivity that provide approximately two times the range of other BLE-only solutions. TI's power-management hardware and software algorithms help save a significant amount of power in common Bluetooth BR, EDR, and low-energy modes of operation.

1 Features

- Supports dual-mode Bluetooth 4.2 – Bluetooth certified and royalty free
- Offers a fully qualified Bluetooth Stack (QDID 85355 and QDID 69886)
- Offers thread-safe operation
- Supports both threaded (RTOS) and nonthreaded (No OS) environments (sample applications use FreeRTOS)
- Offers a fully documented API interface
- Works with any STM32F4 MCU
- Offers sample applications for the STM3240G-EVAL MCU Development Kit supported by CC256XEM-STADAPT
- Offers the capability to disable or enable protocols and profiles
- Supports Keil® and IAR Embedded Workbench® IDEs

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2 Bluetooth Profiles

Classic Profiles

- Advanced audio distribution profile (A2DP): Standard A2DP implementation and Assisted A2DP (A3DP) implementation with internal SBC encoding/decoding on the CC2564C device
- Audio and video remote control profile (AVRCP)
- Generic access profile (GAP)
- Generic audio and video distribution profile (GAVDP)
- Headset profile (HSP)
- Hands-Free Profile (HFP)
- Human-interface device (HID) profile
- Message access profile (MAP)
- Phonebook access profile (PBAP)
- Serial port profile (SPP)

Low-Energy Profiles

- Alert notification service (ANS)
- Alert notification profile (ANP)
- Battery service (BAS)
- Cycle speed and cadence service (CSCS)
- Device information service (DIS)
- Find me profile (FMP)
- Generic access profile service (GAPS)
- Generic attribute profile (GATT)
- Health thermometer service (HTS)
- Health thermometer profile (HTP)
- Heart rate service (HRS)
- Heart rate profile (HRP)
- Human-interface device service (HIDS)
- HID over GATT profile (HOGP)
- Immediate alert service (IAS)
- Link loss service (LLS)
- Phone alert state service (PASS)
- Phone alert state profile (PASP)
- Proximity profile (PXP)
- TX power service (TPS)

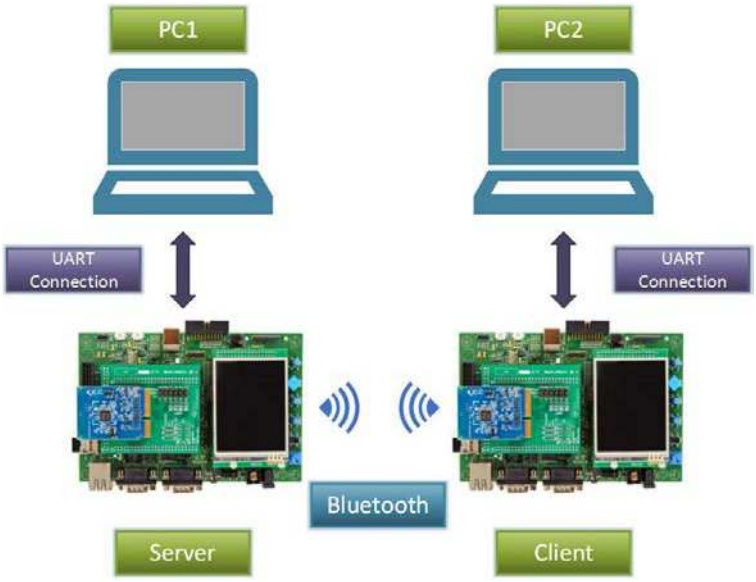
MFi Support

- iAP Protocol (iAP 1/iAP 2)
  - Provided as an add-on upon request

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3 Sample Application Overview

This demonstration lets you to evaluate TI's CC2564C Bluetooth device with the STM3240G-EVAL platform. The CC2564C STM3240G-EVAL Bluetooth applications offer a feature-rich and easy-to-use experience. These applications let you use a console to send Bluetooth commands, set up a Bluetooth device to accept connections, connect to a remote Bluetooth device, and communicate through Bluetooth. This demonstration includes one sample application for each profile with simple command-line sample applications to speed development.Figure 1 shows an overview of the demonstration.



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Figure 1. Overview of Demonstration

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4 CC2564CSTBTBLESW Hardware and Software Requirements

A complete evaluation requires the following hardware and software tools from the following list:

Hardware

- One dual-mode Bluetooth CC2564 evaluation board
  - CC256xCQFN-EM
- One CC256xEM Bluetooth adapter kit
  - CC256XEM-STADAPT
- One STM32 experimenter board
  - A STM3240G-EVAL board or STM32F4DISCOVERY board

NOTE: All the sample applications will work out of the box with the STM3240G-EVAL board. Sample applications must be ported to work with the STM32F4DISCOVERY board. The porting documentation can be found in the CC2564CSTBTBLESW installation directory.

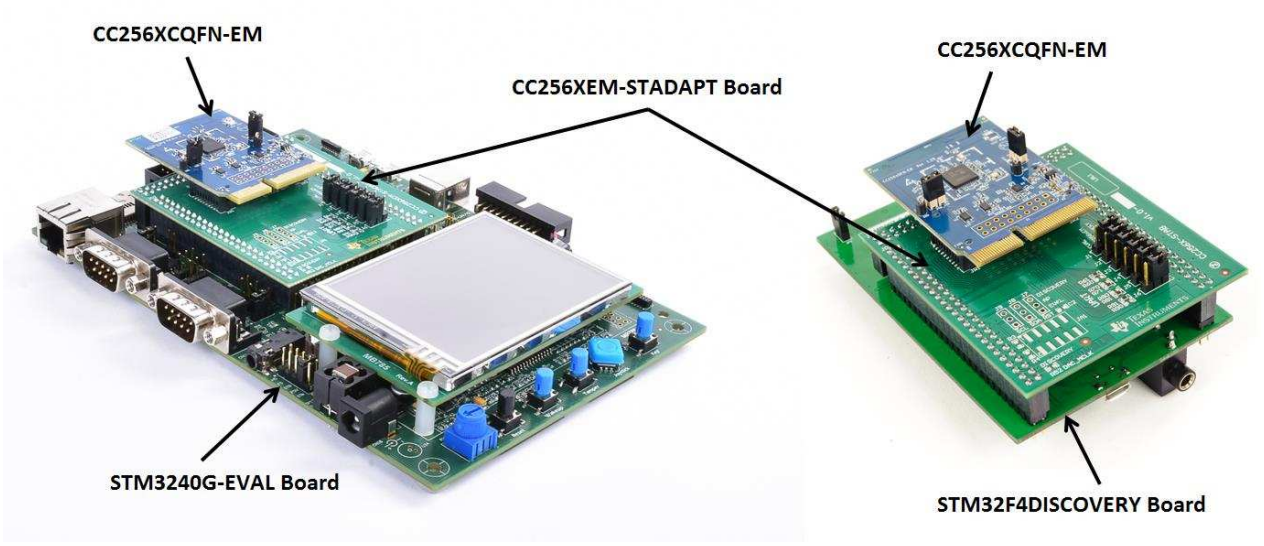
Because of hardware limitations on the STM32F4DISCOVERY board, the audio and voice applications cannot be ported to the STM32F4DISCOVERY board for complete evaluation. Use the STM3240G-EVAL for complete evaluation of the following audio and voice sample applications:

- A3DP Demo_SNK
- A3DP Demo_SRC
- AUD demo
- HFP demo
- HFPAG demo
- HSP demo

Software

- Dual-mode Bluetooth stack
  - On STM32F4 MCUs: CC2564CSTBTBLESW
- IDE versions
  - IAR 7.2 or 7.3 for ARM or Keil µVision® 4.70.0.0 or STSW-LINK004 (optional)

Figure 2 shows the hardware combination.



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Figure 2. Hardware Combination

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5 Setting Up the Hardware

Using TI's dual-mode Bluetooth CC2564C solution (CC256xCQFN-EM), the STM32 MCU evaluation board (STM3240G-EVAL or STM32F4DISCOVERY), with the support of the CC256xEM Bluetooth Adapter Kit (CC256XEM-STADAPT), developers can evaluate both classic and Bluetooth low energy capabilities with the TI Dual-Mode Bluetooth stack on STM32F4 MCUs.

To set up the hardware, perform the following steps:

1. Fit the jumpers onto the adapter board. (Ensure the jumpers are set to the correct position. For more information on the jumper positions and connections to the specific STM32 boards, see the *CC256xEM Bluetooth Adapter Kit User's Guide* and the *CC256xEM Bluetooth Adapter Kit Quick Start Guide*.
2. Fit the adapter board on top of the STM32 board. (See Figure 5 for an example using the STM3240G-EVAL board. See Figure 6 for an example using the STM32F4DISCOVERY board.)
3. Optional for Audio and Voice Sample Applications only:

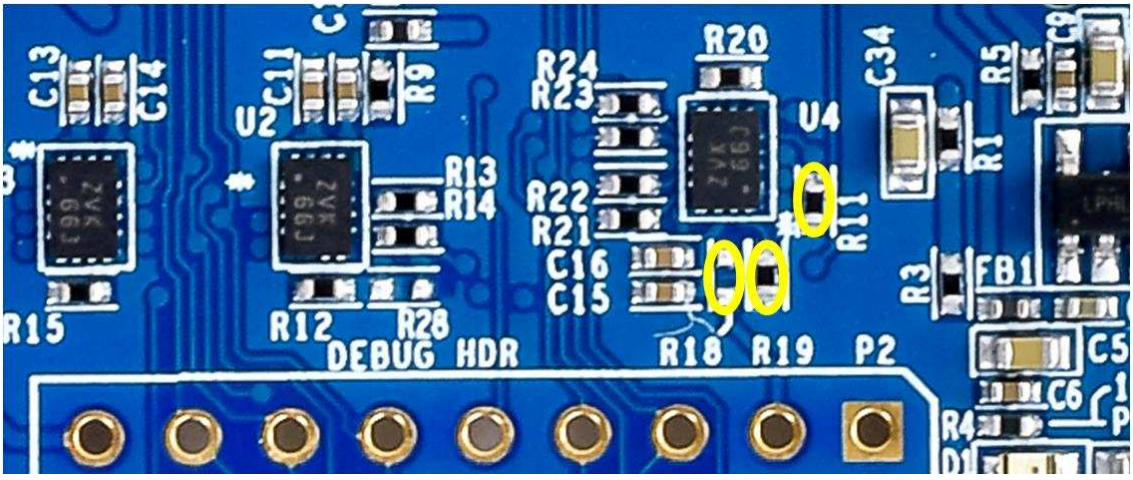
   Ensure that the directions of the PCM signals are properly set on the CC256XCQFN-EM to evaluate audio and voice sample applications. The directions of the PCM signals can be configured so that the PCM port on the CC2564C device is either PCM master or PCM slave, depending on the sample application. See Table 1 to ensure that the R18, R19, and R11 on the CC256XCQFN-EM are properly configured for complete evaluation of the audio and voice sample applications.

Table 1. CC256XCQFN-EM PCM Direction for Audio and Voice Sample Applications

Demo Name[1]	CC256XCQFN-EM PCM Role	R18[2]	R19[2]	R11[2]
A3DP Demo_SNK A3DP Demo_SRC HFP Demo_AG HFP Demo_HF HSP Demo	Slave	0 Ω	DNI	DNI
All other Sample Applications	Master (default)	DNI	10K Ω	0 Ω

(1) In addition to the changes listed below, ensure that the proper UART and I2S paths are configured on the CC256XEM-STADAPT board for each of the Demos. For details, see the *CC256xEM Bluetooth® Adapter Kit quick start guide*.
(2) DNI indicates *Do not install*.

Figure 3 shows the position of the R18, R19, and R11 resistors on the CC256XCQFN-EM board.



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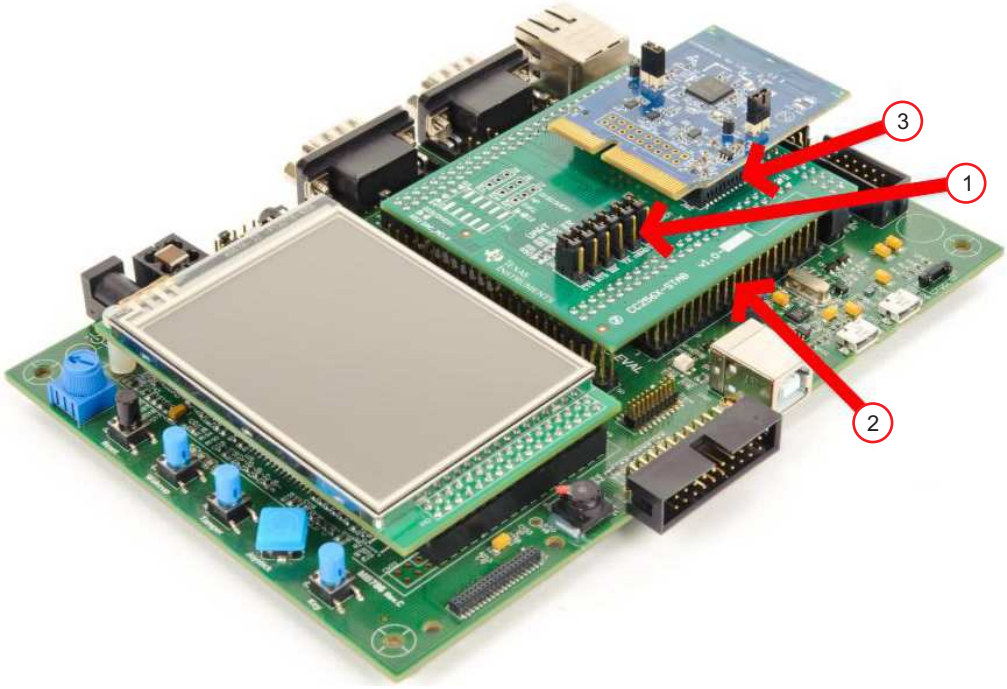
Figure 3. CC256XCQFN-EM PCM Role Selection for Audio and Voice Sample Applications

For more details regarding the PCM role selection on the CC256XCQFN-EM board, refer to *CC256xCQFN-EM User's Guide* and *Dual-Mode Bluetooth® CC2564CQFN-EM Evaluation Board*.

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4. Ensure that the proper USART port selection is configured on the CC256XEM-STADAPT board. For details, refer to the *CC256xEM Bluetooth® Adapter Kit* quick start guide.
5. Install the CC256xCQFN-EM board on the adapter board.

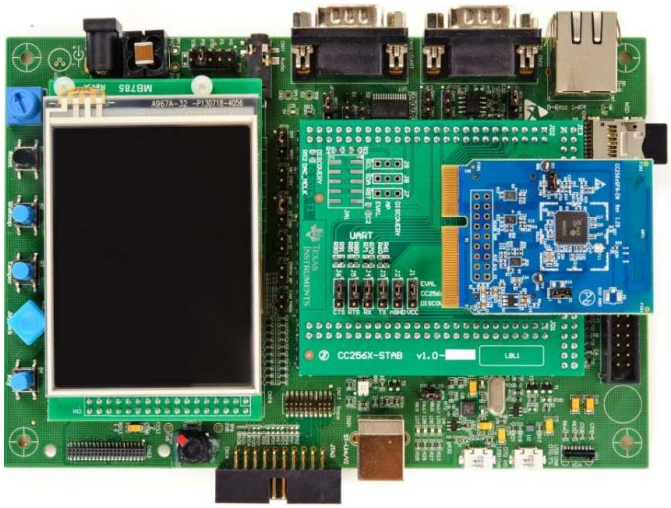
Figure 4 shows the setup for the STM32 board.



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Figure 4. STM32 General Setup

Figure 5 shows an example of the STM3240G-EVAL, the CC256X-STADAPT, and CC256xCQFN-EM boards combined.

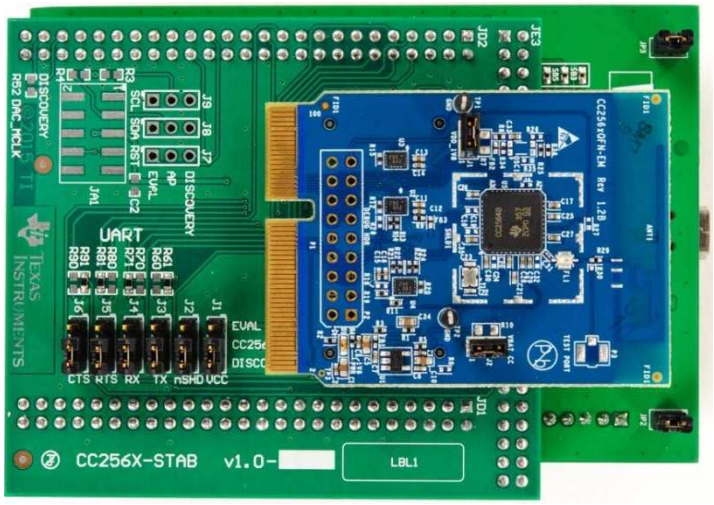


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Figure 5. STM3240G-EVAL, CC256X-STADAPT, and CC256xCQFN-EM Combination

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Figure 6 shows an example of the STM32F4DISCOVERY, the CC256X-STADAPT, and CC256xCQFN-EM boards combined.



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Figure 6. STM32F4DISCOVERY, CC256X-STADAPT, and CC256xCQFN-EM Combination

NOTE: Because of hardware limitations on the STM32F4DISCOVERY board, the audio and voice applications cannot be ported to the STM32F4DISCOVERY board for complete evaluation. Use the STM3240G-EVAL for complete evaluation of the audio and voice sample applications:

- A3DP Demo_SNK
- A3DP Demo_SRC
- AUD demo
- HFP demo
- HFPAG demo
- HSP demo

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6 Setting Up the Software

Do the following to set up the software for the demonstration:

1. Navigate to Bluetooth SDK.

NOTE: When you try to download the SDK, you will be prompted for a TI login. If you do not have a TI login, you must create one.

2. Create a TI login (if necessary).
3. Complete and submit the export approval form.

NOTE: Wait for TI to approve the request. After approving the request, TI provides you with a link to download the software.

4. Click *Download* to download the software.

NOTE: TI intends the Bluetooth SDK for use only with the STM3240G-EVAL board. Software modifications are required for the SDK to work with the STM32F4DISCOVERY board.

5. Run *CC256XSTMNoOSBTBLESW-v4.2.x.x-Setup.exe* after the download completes.
6. Accept the TI Bluetooth Stack Clickwrap License Agreement.

NOTE: After accepting the license agreement, the SDK installs to *C:\TI\Connectivity\CC256X BT\CC256xSTM32BluetopiaSDK\v4.2.x.x*\.

7. Access the SDK through *Start/Programs/TexasInstruments/CC256XBT/CC256xSTM32BluetopiaSDKv4.2.x.x*.

7 Building and Flashing the Bluetooth Code (STM3240G-EVAL)

Sample applications for FreeRTOS and NoOS are available for IAR and Keil.

Perform the following instructions to set up applications on each IDE version.

IAR

1. Navigate to *C:\TI\Connectivity\CC256XBT\CC256xSTM32BluetopiaSDK\v4.2.x.x* to open the workspace.
2. Select one of the following samples:
   - For NoOS, navigate to *\NoOS\STM3240G-EVAL\Samples* for a list of samples.
   - For FreeRTOS, navigate to *\FreeRTOS\STM3240G-EVAL\Samples* for a list of samples.
3. Select the demonstration to load onto the device. (This example uses SPPDemo.)
4. Navigate to NoOS.
5. Navigate to EWARM.
6. Select *SPPDemo.eww*.

NOTE: The IAR IDE opens.

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7. Select *Debug* (see Figure 7) or *Release Configuration* from the drop-down menu. (For this example, select *Debug*.)

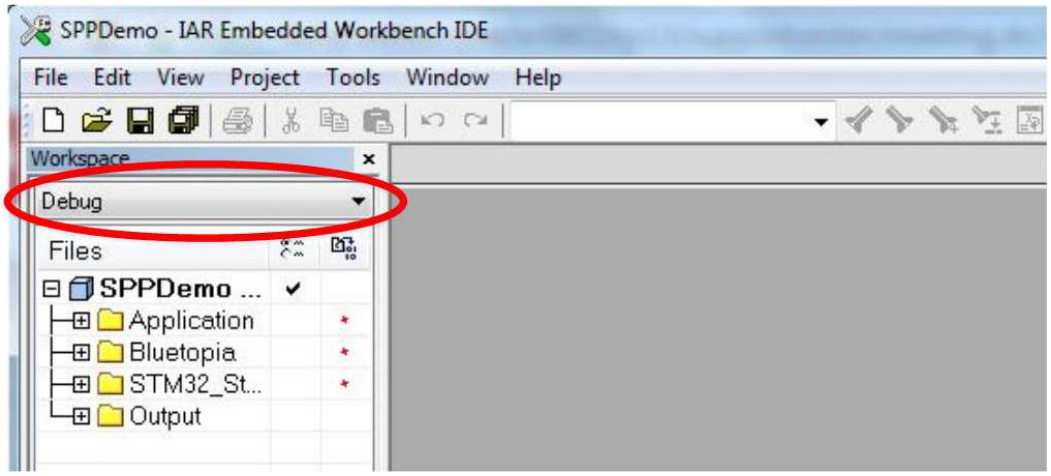


Figure 7. IAR Drop-Down Menu

8. Select *Download and Debug* from the *Project* drop-down menu or click the *Play* icon. (See Figure 8.)

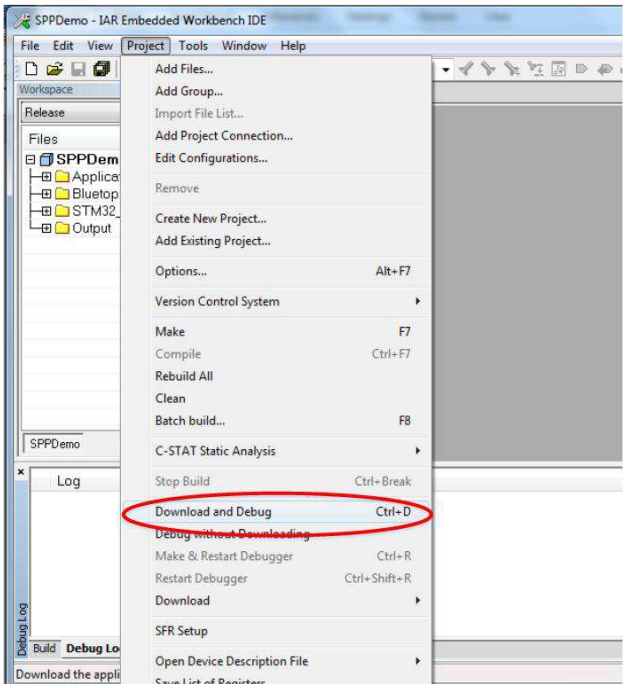


Figure 8. Download and Debug

NOTE: The IDE debugs and loads the software onto the device. This process may take 5 to 10 minutes.

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9. Click the red X icon in the IDE to stop debugging. (See Figure 9.)

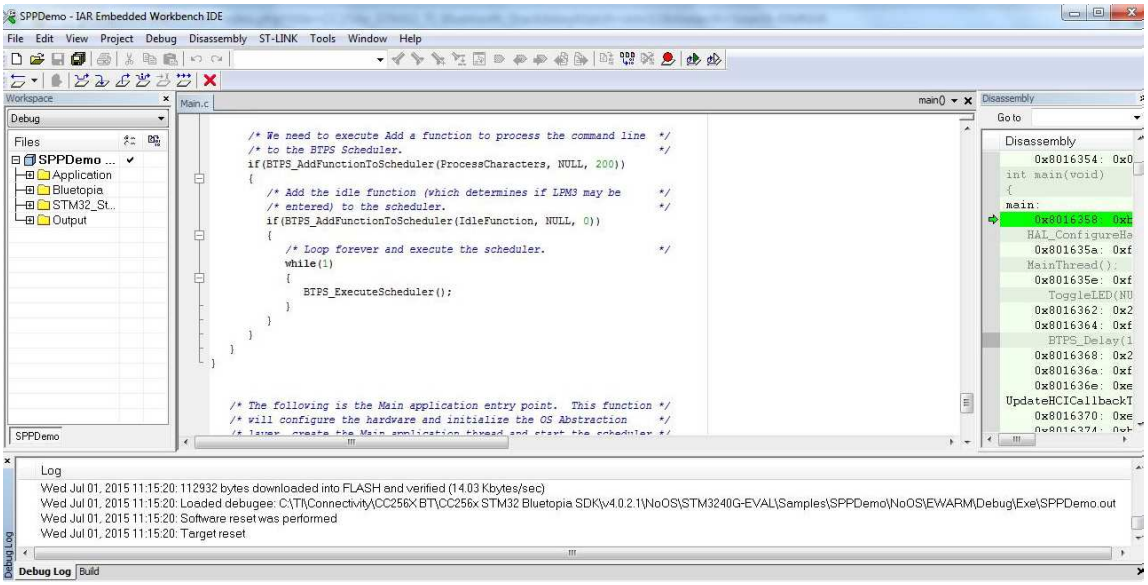


Figure 9. Debugging Screen

10. Disconnect the STM3240G-EVAL.
11. Reconnect the STM3240G-EVAL.
12. Press *Reset* on the STM3240G-EVAL device.
13. Click the *GO* button in the IAR (see Figure 10).



Figure 10. The GO Button

Keil

1. Navigate to *C:\TI\Connectivity\CC256XBT\CC256xSTM32BluetopiaSDK\v4.2.x.x* to open the workspace.
2. Select one of the following samples:
   - For NoOS, navigate to *\NoOS\STM3240G-EVAL\Samples* for a list of samples.
   - For FreeRTOS, navigate to *\FreeRTOS\STM3240G-EVAL\Samples* for a list of samples.
3. Select the demonstration to load onto the device. (This example uses SPPDemo.)
4. Navigate to *NoOS*.

NOTE: For RTOS, navigate to *FreeRTOS*.

5. Navigate to *RVMDK* in the list.
6. Click *SPPDemo.uvproj*.

NOTE: Keil µVision4 opens.

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7. Select *Debug* or *Release Configuration* from the drop-down menu. (For this example, select *Debug* [See Figure 11].)

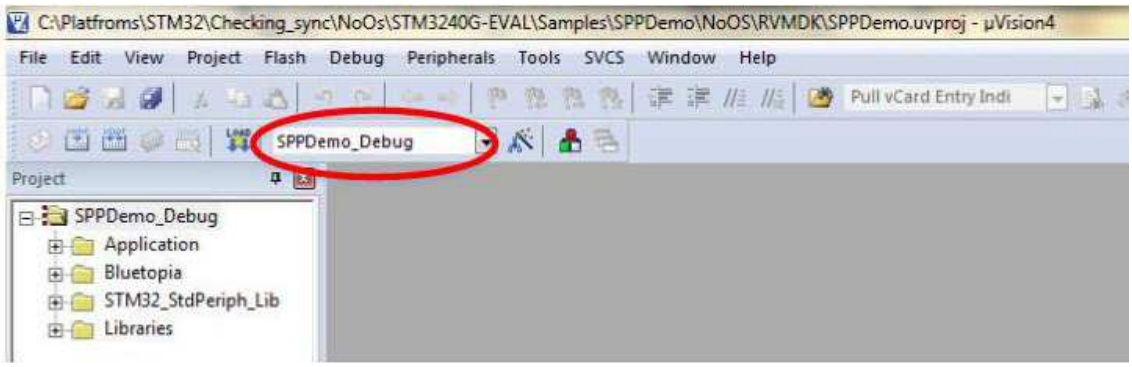


Figure 11. Debug Drop-Down Menu

8. Right-click *SPPDemo_Debug* in the project sidebar.
9. Select *Build target* to build the code. (See Figure 12.)

NOTE: Figure 13 shows the output when built correctly.

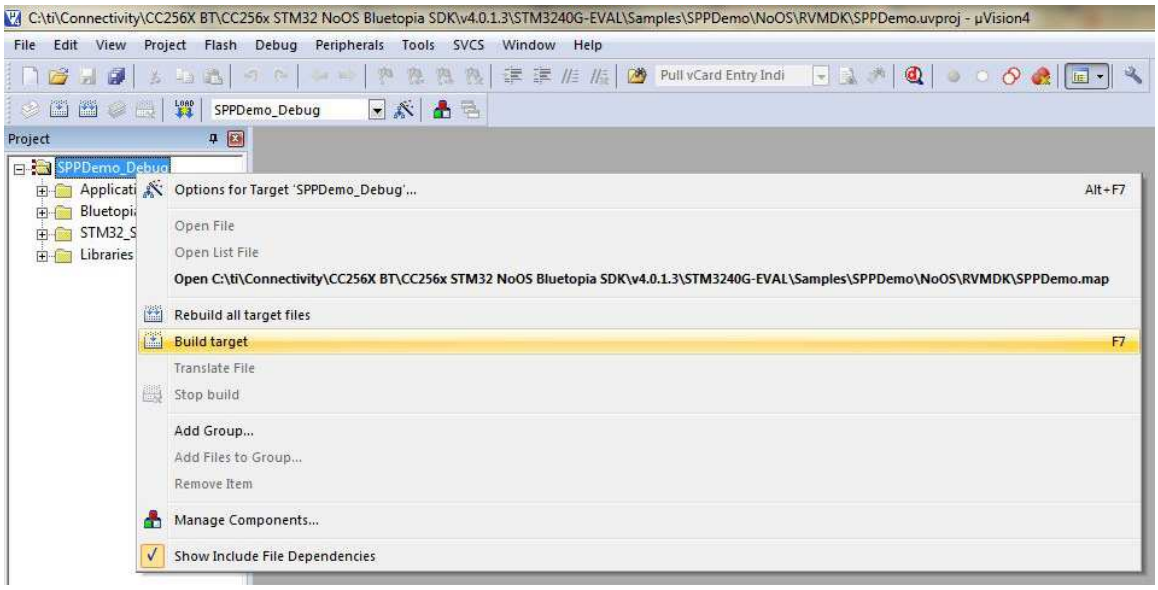


Figure 12. Building Target

NOTE: After a few minutes, the build process finishes and builds a .axf file. Each time you change the configuration, you must build a new .axf file.

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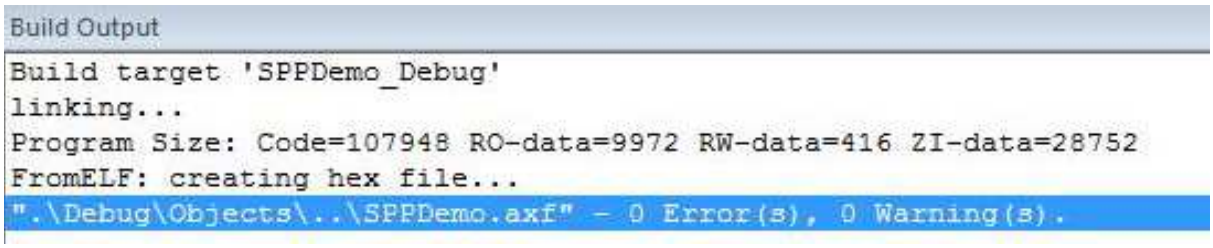


Figure 13. Build Output

10. Choose Debug mode or Release and Debug modes.
    - For Debug mode only:
      (a) Select *Start/Stop Debug Session* to start loading the profile on the STM32 device and to work in *Debug* mode. (See Figure 14.)

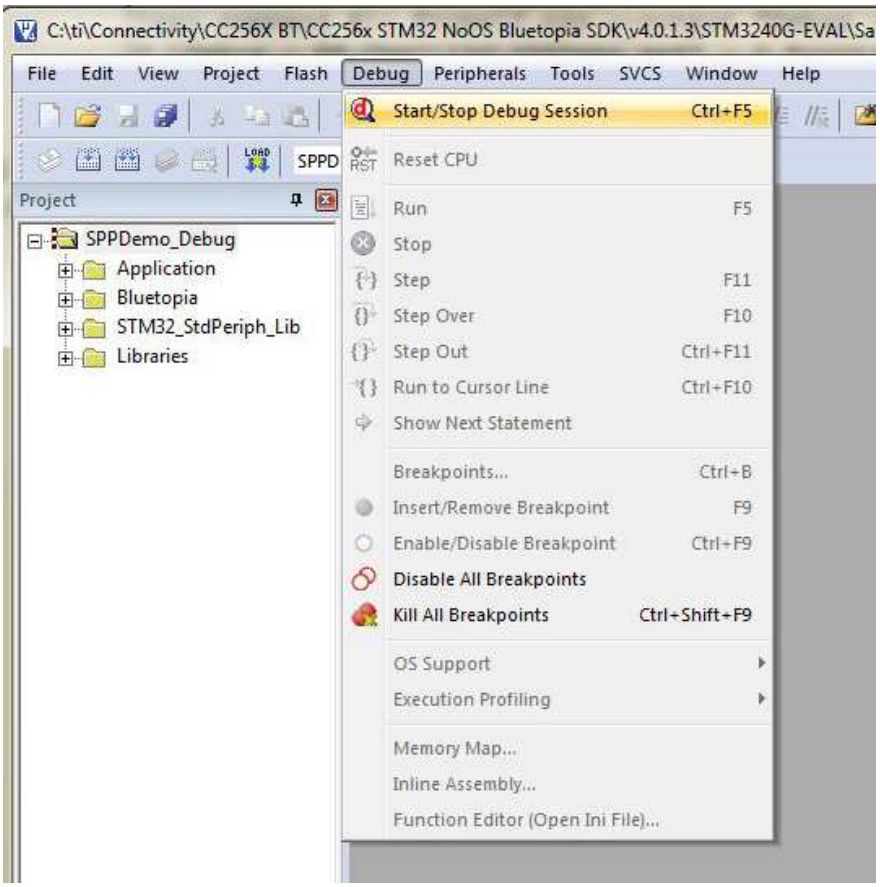


Figure 14. Debug Mode

NOTE: The loading process completes in a few minutes.

      (b) Stop the debugging session from the *Debug* drop-down menu.

NOTE: The profile loads on the STM3240G-EVAL board.

      (c) Unplug the device.
      (d) Plug the device in again to start working with it.

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- For Release and Debug modes:
  (a) Click *LOAD* to start loading the profile on the STM32 device. (See Figure 15.)

NOTE: The loading process completes in a few minutes.

The profile loads on the STM3240G-EVAL board.

  (b) Unplug the device.
  (c) Plug the device in again to start working with it.



Figure 15. Release and Debug Mode

7.1 Flashing the Bluetooth Code

STSW-LINK004

You can use the STSW-LINK004 utility to flash the software when you have created the binary file through IAR or Keil.

To flash the software, do the following:

1. Open the file from the *File* drop-down menu.
2. Select the demonstration to load on the device. (This example uses SPPDemo.)
   - For NoOS, navigate to *C:\TI\Connectivity\CC256XBT\CC256xSTM32BluetopiaSDK\v4.2.x.x\NoOS\STM3240G-EVAL\Samples\SPPDemo\NoOS\EWARM\Debug\Exe*.
   - For FreeRTOS, navigate to *C:\TI\Connectivity\CC256XBT\CC256xSTM32BluetopiaSDK\v4.2.x.x\FreeRTOS\STM3240G-EVAL\Samples\SPPDemo\FreeRTOS\EWARM\Debug\Exe.*
3. Select a bin file. (This example uses SPPDemo.bin.)

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4. Click *Program & Verify...* from the *Target* drop-down menu. (See Figure 16.)

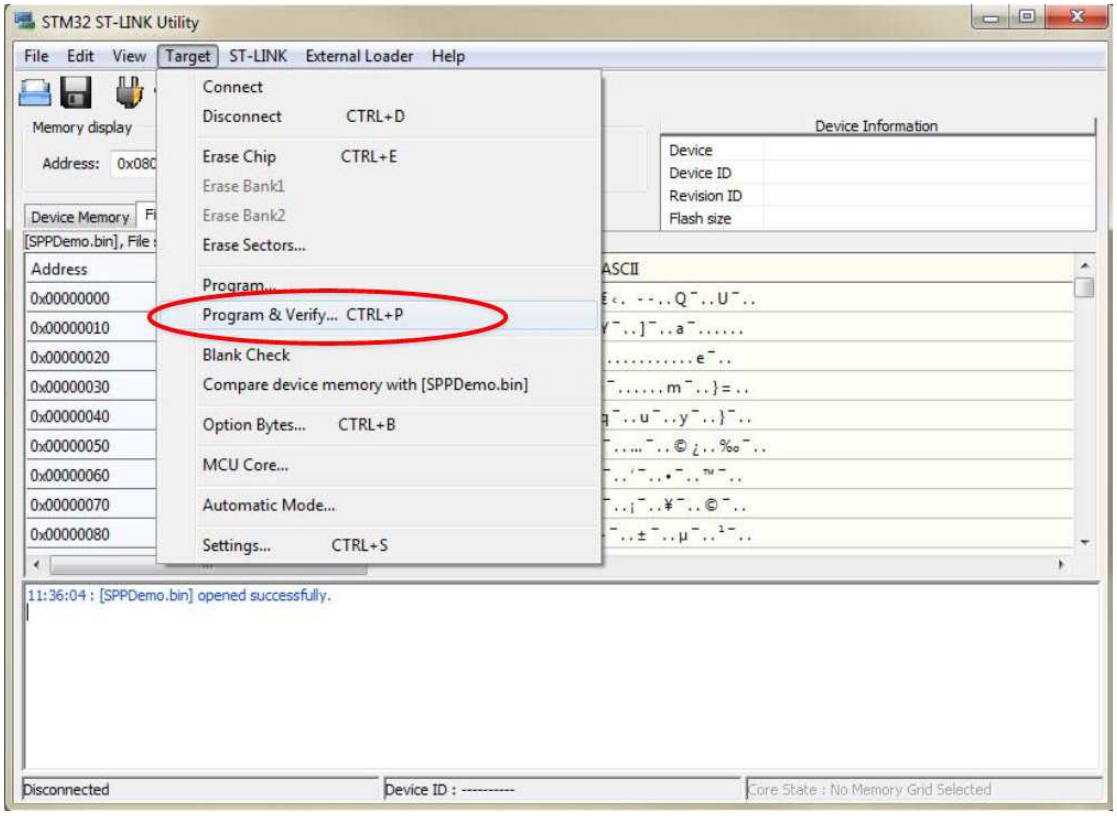


Figure 16. Program and Verify

NOTE: The information for your device shows.

5. Ensure the values in Device Information changed to your device information.

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6. Press *Start*. (See Figure 17.)

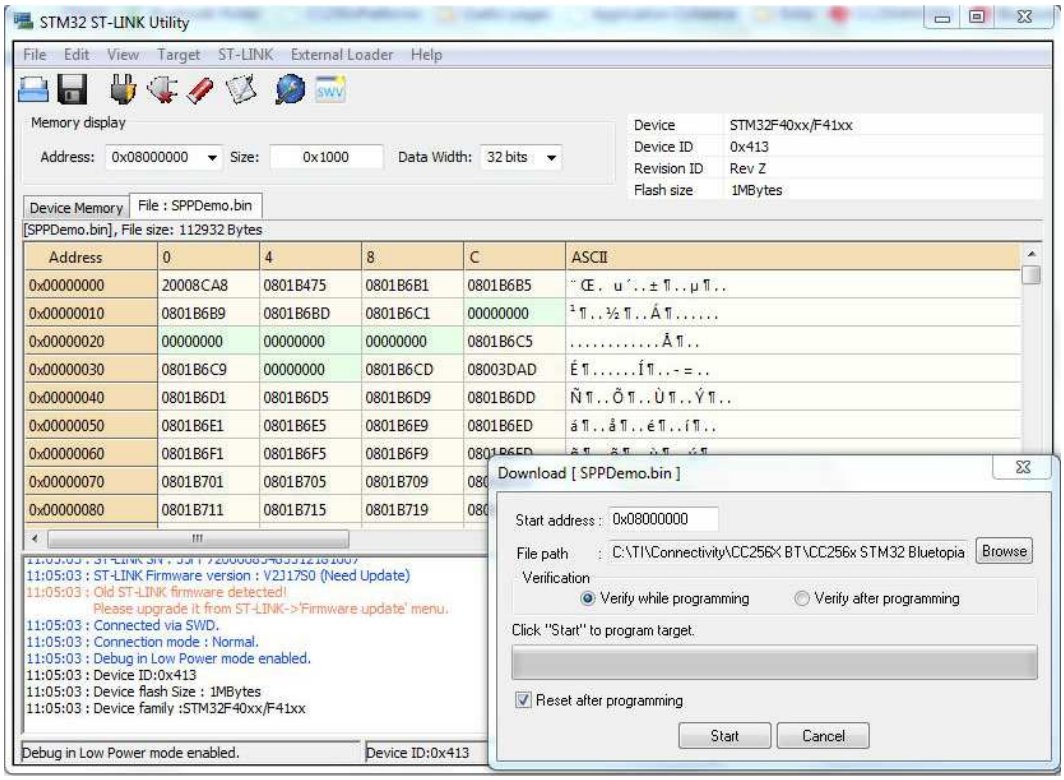


Figure 17. Start Download

NOTE: The command window displays *Verification...OK*. (See Figure 18.)



Figure 18. Verification...OK

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8 Applications

The dual-mode Bluetooth stack on STM32F4 MCUs includes a sample application directory for NoOS and FreeRTOS with source code that demonstrates TI's dual-mode Bluetooth stack. These simple, command-line sample applications display a list of available commands. Table 2 lists the available profiles for Bluetooth SDK.

Table 2. Table of Available Profiles for Bluetooth SDK

Profile	Role	FreeRTOS	NoOS	EM Platform
A3DP Demo_SNK	Sink Controller	IAR Keil	IAR Keil	STM3240G-EVAL
A3DP Demo_SRC	Source Target	IAR Keil	IAR Keil	STM3240G-EVAL
ANP demo	Server Client	IAR Keil	IAR Keil	STM3240G-EVAL
AUD demo	Source Sink	IAR Keil	IAR Keil	STM3240G-EVAL
FMP demo	Target Locator	IAR Keil	IAR Keil	STM3240G-EVAL
CSCP demo	Server Client	IAR Keil	IAR Keil	STM3240G-EVAL
HFP demo	Audio gateway Hands-free unit	IAR Keil	IAR Keil	STM3240G-EVAL
HFPAG demo	Audio gateway Hands-free unit	IAR Keil	IAR Keil	STM3240G-EVAL
HID demo	Host Device	IAR Keil	IAR Keil	STM3240G-EVAL
HOGP demo	Host Device	IAR Keil	IAR Keil	STM3240G-EVAL
HRP demo	Collector Sensor	IAR Keil	IAR Keil	STM3240G-EVAL
HSP demo	Audio gateway Headset	IAR Keil	IAR Keil	STM3240G-EVAL
HTP demo	Collector Thermometer	IAR Keil	IAR Keil	STM3240G-EVAL
iBEACON demo	Server Client	IAR Keil	IAR Keil	STM3240G-EVAL
MAP demo	Server Client	IAR Keil	IAR Keil	STM3240G-EVAL
PASP demo	Server Client	IAR Keil	IAR Keil	STM3240G-EVAL
PBAP demo	Server Client	IAR Keil	IAR Keil	STM3240G-EVAL
PXP demo	Monitor Reporter	IAR Keil	IAR Keil	STM3240G-EVAL
SPP demo	Device A Device B	IAR Keil	IAR Keil	STM3240G-EVAL
SPPDMMulti demo	Server Client	IAR Keil	IAR Keil	STM3240G-EVAL
SPPLE demo	Server Client	IAR Keil	IAR Keil	STM3240G-EVAL

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9 Classic Bluetooth Sample Applications

AUD Demo

- Lets you use the advanced audio distribution profile (A2DP) to stream high-quality audio over Bluetooth.

NOTE: The AUD Demo uses the AUD module of the ti dual-mode Bluetooth stack. AUD implements the non-assisted A2DP profile and the Audio/Video Remote Control Profile (AVRCP).

- Supports the sink role only.
- Visit the AUD demonstration application wiki for instructions for this demonstration.

A3DP Sink Demo

- Lets you use the assisted advanced audio distribution profile (A3DP) to send stereo audio over Bluetooth.
- Visit the A3DP demonstration sink wiki for instructions for this demonstration for the sink role.

A3DP Source Demo

- Lets you use the assisted advanced audio distribution profile (A3DP) to send stereo audio over Bluetooth.
- Visit the A3DP demonstration source wiki for a instructions for this demonstration for the source role.

HFP Demo

- Lets you use hands-free profile (HFP) to provide remote control and voice connections over Bluetooth to a mobile device.
- Supports the hands-free role.
- Visit the HFP demonstration wiki for instructions for this demonstration.

HFPAG Demo

- Lets you use the hands-free profile on an embedded device.
- Connects a headset or speaker phone with a mobile device to provide remote control and voice connections.
- Supports the hands-free and audio-gateway roles.
- Provides two applications that demonstrate the audio-gateway and hands-free roles of the profile, respectively.
- Offers audio routing to the STM3240G-EVAL board DAC for the hands-free application and audio-gateway role application.
- Visit the HFPAG demonstration application wiki for instructions for this demonstration.

HID Demo

- Offers a demonstration of the human-interface device (HID) profile that enables a host to connect and control a HID device.
- Visit the HID demonstration wiki for instructions for this demonstration.

HSP Demo

- Lets you demonstrate the headset profile (HSP) on an embedded device.
- Connects a headset or speaker phone with a mobile device.
- Connects an audio gateway with a headset device to provide basic control and voice connections.
- Visit the HSP demonstration wiki for instructions for this demonstration.

MAP Demo

- Lets you exchange message objects over Bluetooth.
- Visit the MAP demonstration application wiki for instructions for this demonstration.

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PBAP Demo

- Lets you exchange phone book objects over Bluetooth.
- Visit the PBAP demonstration application wiki.

SPP Demo

- Shows how to use the serial port profile (SPP) module.
- Shows how to handle the different callback events.
- Lets you interface with a remote SPP client or server.
- Visit the SPP demonstration application wiki for instructions for this demonstration.

10 Classic Bluetooth + Bluetooth low energy Applications

SPP + SPPLE Demo

- Shows how to use Low Energy (LE) and the GATT profile.
- Emulates using SPP over LE using the GATT profile.
- Acts as a LE master and LE slave.
- Shows how to use the SPP module.
- Shows how to handle the different SPP callback events.
- Acts as either an SPP server or SPP client
- Uses the same command for SPP as the SPP demonstration.
- Visit the SPP + SPPLE demonstration wiki for instructions for this demonstration.

SPPDMMulti Demo

- This application is based on the SPP + SPPLE Demo application and demonstrates how to use the chosen features from Bluetooth specification 4.1 and Bluetooth specification 4.2:
  - LE Dual Mode Topology: Connect in classic Bluetooth and Bluetooth low energy to the same device.
  - LE Link Layer Topology: Support multiple simultaneous roles; that is, Peripheral and Central.
  - L2CAP LE Connection Oriented: Support LE Credit Based Flow Control Mode.
  - LE Ping: Used to verify presence of the remote Link Layer. In addition, can be used to verify message integrity in the LE ACL by forcing the remote device to send an LE ACL packet that contains a valid MIC.
  - LE Low Duty Cycle Advertising: Designed for cases where reconnecting with a specific device is required, but time is not of the essence or it is not known if the central device is in range or not.
  - 32-bit UUID: Register services with aliases that are represented as 32-bit values instead of 128-bit UUIDs.
  - LE Secure Connections: Enhance the LE Security Manager with public key Elliptic Curve Diffie-Hellman (ECDH) key generation.
- The application lets the user establish connection between multiple BLE devices using the SPPLE custom service, send Bluetooth commands, and exchange data over BLE. This application also shows how to use the SPP module and how to handle the different SPP callback events. The application acts as either an SPP server or an SPP client and exposes the same command set for SPP as the SPPDemo.
- For a step-by-step demonstration of how to run this application, visit SPPDMMulti demo wiki.

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11 Bluetooth low energy Applications

ANP Demo

- Shows how to use low energy (LE) and the GATT profile.
- Implements the alert notification profile (ANP) using the GATT profile.
- Acts as an LE master and LE slave.
- Visit the ANP demonstration wiki for instructions for this demonstration.

iBEACON Demo

- Provides location-based information and services for iOS devices.
- Has server and client roles.
- Lets the user use a console to use Bluetooth low energy (BLE) to advertise specific data that can be read by the client.

HRP Demo

- Shows how to use low energy (LE) and the GATT profile.
- Implements the heart rate profile (HRP) using the GATT profile.
- Acts as an LE master and LE slave.
- Visit the HRP demonstration wiki for instructions for this demonstration.

HTP Demo

- Shows how to use low energy (LE) and the GATT profile.
- Implements the health thermometer profile (HTP) using the GATT profile.
- Acts as an LE master and LE slave.
- Visit the HTP demonstration wiki for instructions for this demonstration.

PASP Demo

- Shows how to use low energy (LE) and the GATT profile.
- Implements the phone alert status profile (PASP) using the GATT profile.
- Acts as an LE master and LE slave.
- Visit the PASP demonstration wiki for instructions for this demonstration.

HOGP Demo

- Shows how to use low energy (LE) and the GATT profile.
- Implements the human-interface device (HID) using the GATT profile.
- Visit the HOGP demonstration wiki for instructions for this demonstration.

PXP Demo

- Shows how to use low energy (LE) and the GATT profile.
- Implements the proximity profile (PXP) using the GATT profile.
- Visit the PXP demonstration wiki for instructions for this demonstration.

FMP Demo

- Shows how to use low energy (LE) and the GATT profile.
- Implements the find me profile (FMP) using the GATT profile.
- Acts as an LE master and slave.
- Visit the FMP demonstration wiki for instructions for this demonstration.

CSCP Demo

- This application shows how to use LE and the GATT profile establish connection between two BLE devices with the cycling speed and cadence service (CSCS), notify measurements and change the sensor location and cumulative wheel value in the Speed Cadence (SC) Control Point.
- For a step-by-step demonstration of how to run this application, visit the CSCP demo wiki.

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Revision History

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

Changes from November 14, 2016 to February 28, 2017	Page
• Changed Table 1	5

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