

TI Dual-Mode *Bluetooth*[®] Stack on MSP432[™] MCUs

User's Guide



Literature Number: SWRU453A
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TI Dual-Mode Bluetooth® Stack on MSP432™ MCUs

1 Introduction

TI's dual-mode *Bluetooth*® stack on MSP432 MCUs (CC256XMS32BTBLESW) software for *Bluetooth* and *Bluetooth* low energy enables TI's MSP432™ microcontroller and is comprised of single-mode and dual-mode offerings implementing the *Bluetooth* 4.0 specification. The *Bluetooth* stack is fully qualified (QDID 69887 and QDID 69886), provides simple command line sample applications to speed development, and has MFI capability upon request.

For a complete evaluation solution, the CC256XMS32BTBLESW device works directly with the MSP-EXP432P401R LaunchPad™ development kit. The stack for the MSP432 MCU is certified and royalty-free (CC256XMS32BTBLESW).

The software works with the dual-mode *Bluetooth* CC2564 module with integrated antenna BoosterPack™ plug-in module (BOOST-CC2564MODA), which provide a complete *Bluetooth* BR/EDR/low energy HCI solution that reduces design effort and ensures a faster time to market. The dual-mode *Bluetooth* BoosterPack plug-in module includes TI's seventh-generation *Bluetooth* core and provides a product-proven solution that is *Bluetooth*-4.1 compliant. The device provides one of the best *Bluetooth* RF performances with a transmit power and receive sensitivity that provides a range of about 2× compared to other *Bluetooth* low energy-only solutions. TI's power-management hardware and software algorithms provide significant power savings in commonly used *Bluetooth* BR/EDR/low energy modes of operation.

2 Features

Features of the device include the following:

- Supports dual-mode *Bluetooth* 4.0—*Bluetooth* certified and royalty free
- Offers fully qualified *Bluetooth* stack (QDID 69887 and QDID 69886)
- Offers full-thread safety
- Supports nonthreaded (no OS) environment
- Offers fully documented API interface
- Works with any MSP432 MCU
- Includes available sample applications for the MSP-EXP432P401R LaunchPad development kit with the support of the BOOST-CC256XMODA
- Supports CCS, Keil®, and IAR IDEs

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Bluetooth is a registered trademark of Bluetooth SIG.
IAR Embedded Workbench is a registered trademark of IAR System AB.
Wi-Fi is a registered trademark of Wi-Fi Alliance.

2.1 **Classic Bluetooth Profiles Available**

- Advanced Audio Distribution Profile (A2DP 1.2): A3DP Implementation
- Audio and Video Transport Protocols (AVDTP 1.2)
- Audio and Video Remote Control Profile (AVRCP 1.3)
- Generic Access Profile (GAP)
- Headset Profile (HSP 1.2)
- Hands Free Profile (HFP 1.6)
- Human Interface Device Profile (HID 1.0)
- Message Access Profile (MAP 1.0)
- Phonebook Access Profile (PBAP 1.0)
- RFCOMM Protocol (RFCOMM)
- Service Discovery Profile (SDP)
- Serial Port Profile (SPP)

2.2 **Bluetooth low energy Profiles Available**

- Alert Notification Service (ANS 1.0)
- Battery Service (BAS 1.0)
- Device Information Service (DIS 1.0)
- Find Me Profile (FMP 1.0)
- Generic Access Profile Service (GAPS 1.0)
- Generic Attribute Profile (GATT 1.0)
- Health Thermometer Service (HTS 1.0)
- Heart Rate Service (HRS 1.0)
- Human Interface Device Service (HIDS 1.0)
- Immediate Alert Service (IAS 1.0)
- Link Loss Service (LLS 1.0)
- Phone Alert State Service (PASS 1.0)
- Proximity Profile (PXP 1.0)
- TX Power Service (TPS 1.0)

2.3 **MFi Support**

iAP Protocol (iAP 1/iAP 2)

3 Sample Application Overview

This demonstration lets users evaluate TI's CC256X *Bluetooth* device with the MSP-EXP432P401R LaunchPad development kit. The MSP-EXP432P401R *Bluetooth* sample applications are provided to enable a rich out-of-box experience for the user. These applications let the user use a console to send *Bluetooth* commands, set up a *Bluetooth* device to accept connections, connect to a remote *Bluetooth* device, and communicate over *Bluetooth*. One sample application for each profile is supported with simple command line sample applications to speed development. [Figure 1](#) shows an overview of the demonstration example.

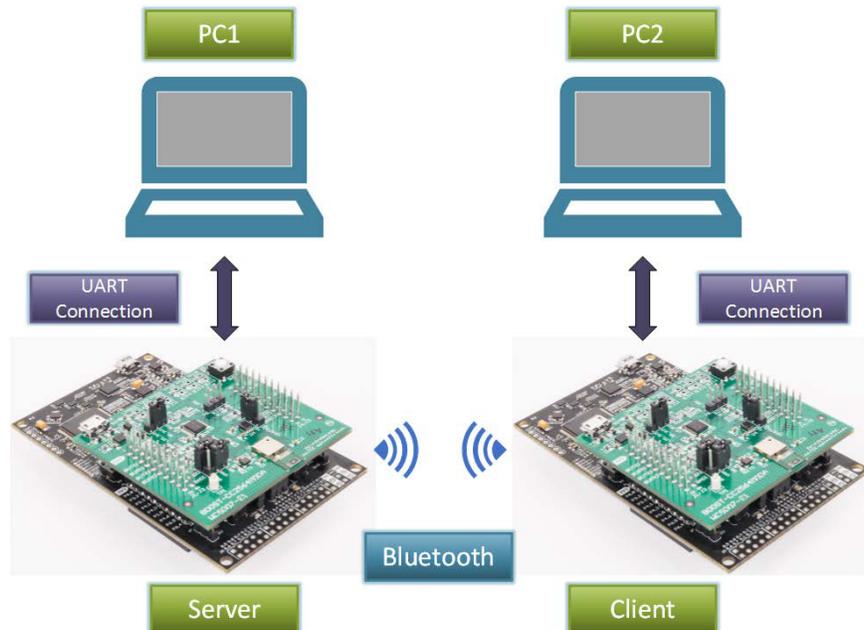


Figure 1. Demonstration Example Overview

4 Requirements

The following hardware and software tools are required for a complete evaluation:

Hardware

- 1 MSP432 LaunchPad Development Kit
 - [MSP-EXP432P401R](#)
- 1 Dual-Mode *Bluetooth* CC2564 Module With Integrated Antenna BoosterPack Plug-in Module
 - [BOOST-CC2564MODA](#)
- 1 SimpleLink Wi-Fi® CC3200 Audio BoosterPack (optional)—for audio and voice sample applications
 - [CC3200AUDBOOST](#)
- 1 Advanced Emulation BoosterPack for SimpleLink™ Wi-Fi CC3100 BoosterPack (optional)—for debugging
 - [CC31XXEMUBOOST](#)

Software

- TI Dual-Mode *Bluetooth* stack
 - On MSP432 MCUs: [CC256XMS32BTBLESW](#)
- Recommended IDE versions for testing
 - [Code Composer Studio™ integrated development environment \(CCS 6.1.1.00022\)](#)
 - [IAR Embedded Workbench® v7.3](#)
 - [ARM® Keil® µVision® IDE v5.17.0.0](#)

Figure 2 shows the hardware requirement combinations.

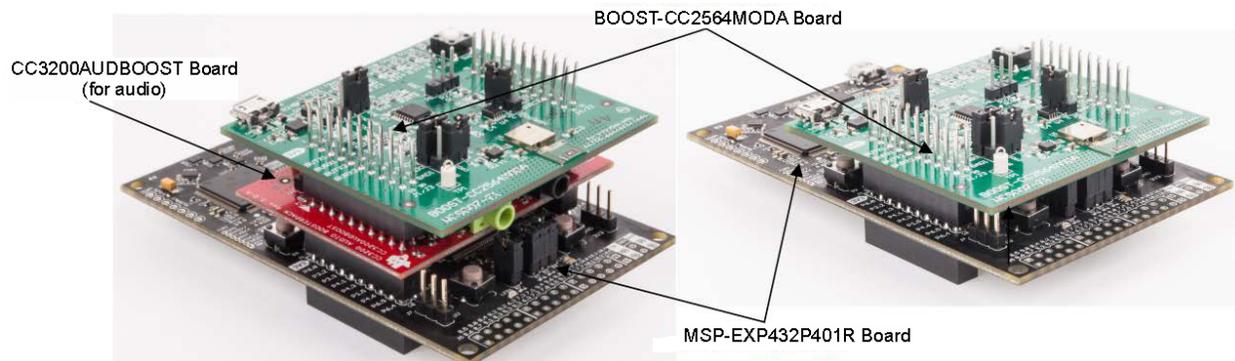


Figure 2. Hardware Requirement Combinations

5 Hardware Setup

Using TI's dual-mode *Bluetooth* CC2564 module with an integrated antenna BoosterPack plug-in module (BOOST-CC2564MODA), the MSP432 MCU LaunchPad development kit (MSP-EXP432P401R) can evaluate both classic and *Bluetooth* low energy capabilities with the TI dual-mode *Bluetooth* stack on MSP432 MCUs, with the optional support of the TI BoosterPack plug-in module for audio and voice (CC3200AUDBOOST) or debugging (CC31XXEMUBOOST) developers.

5.1 Setting Up the Hardware

To set up the hardware, do as follows:

1. Fit the dual-mode *Bluetooth* BoosterPack plug-in module (BOOST-CC2564MODA) onto the MSP432 LaunchPad development kit.

NOTE: The boards must be set to their default settings. For more information on the jumper positions and default setting for the BOOST-CC2564MODA, see the *Dual-Mode Bluetooth CC2564 Module With Integrated Antenna BoosterPack Plug-in Module User's Guide* ([SWRA444](#)) and the *Dual-Mode Bluetooth CC2564 Module With Integrated Antenna BoosterPack Plug-in Module Quick Start Guide* ([SWRU443](#)). For the jumper position and configurations for the MSP-EXP432P401R development kit, see the *MSP432 LaunchPad Development Kit User's Guide* ([SLAU597](#)).

Ensure the connectors are aligned ([Figure 3](#) shows the MSP-EXP432P401R and BOOST-CC2564MODA examples).

To use the CC3200AUDBOOST device for audio and voice applications (optional), do as follows:

2. Stack the BOOST-CC2564MODA onto the CC3200AUDBOOST.
3. Fit the CC3200AUDBOOST onto the MSP-EXP432P401R LaunchPad development kit (boards must be set to their default configuration, see [Table 1](#)).

Table 1. CC3200AUDBOOST Ports for Audio Sample Applications

Sample Applications	CC3200AUDBOOST
A3DP Demo_SRC	LINE_IN (J3)
A3DP Demo_SNK	Line_out (j4)
HFP Demo_AG	Mic (U6) LINE_OUT (J4)
HFP Demo_HF	Mic (U6) LINE_OUT (J4)
HSP Demo	Mic (U6) LINE_OUT (J4)

NOTE: For the default settings for the CC3200AUDBOOST device, see the *CC3200 SimpleLink Wi-Fi and IoT Solution, a SingleChip Wireless MCU – Audio BoosterPack User's Guide* ([SWRU383](#)). Ensure the connectors are aligned properly ([Figure 4](#) shows the MSP-EXP432P401R with BOOST-CC2564MODA and CC3200AUDBOOST examples).

For the CC31XXEMUBOOST BoosterPack plug-in module for debugging purposes (optional), do as follows:

4. Move nSHUTD to nS2 on the BOOST-CC2564MODA jumper J5.
5. Add a jumper to TX_DBG on J8.
6. Ensure that J22 and J4 are DNI.
7. Populate J1 and J2.
8. Stack the BOOST-CC2564MODA onto the CC31XXEMUBOOST.
9. Fit the CC31XXEMUBOOST onto the MSP-EXP432P401R LaunchPad development kit.

For the CC31XXEMUBOOST hardware configuration, see the *CC3100 SimpleLink Wi-Fi and IoT Solution BoosterPack Hardware User's Guide* ([SWRU371](#)). **Figure 5** shows the examples of the BOOST-CC2564MODA and CC31XXEMUBOOST.

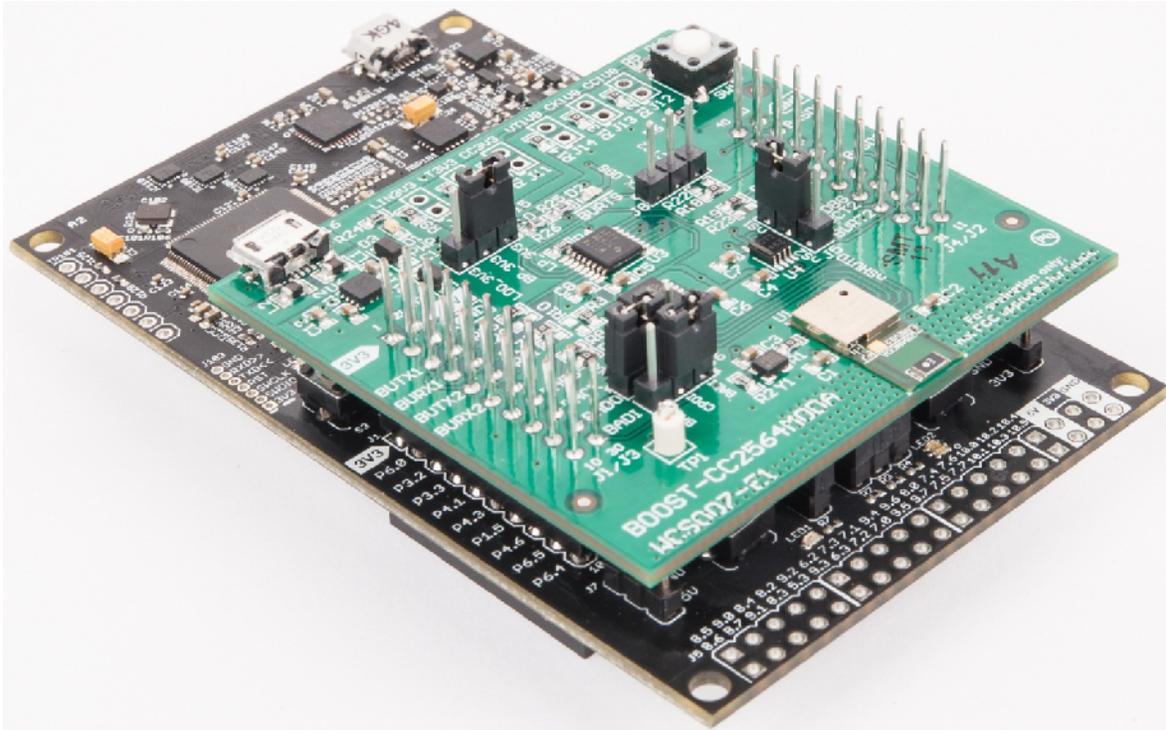


Figure 3. MSP-EXP432P401R and BOOST-CC2564MODA Combination

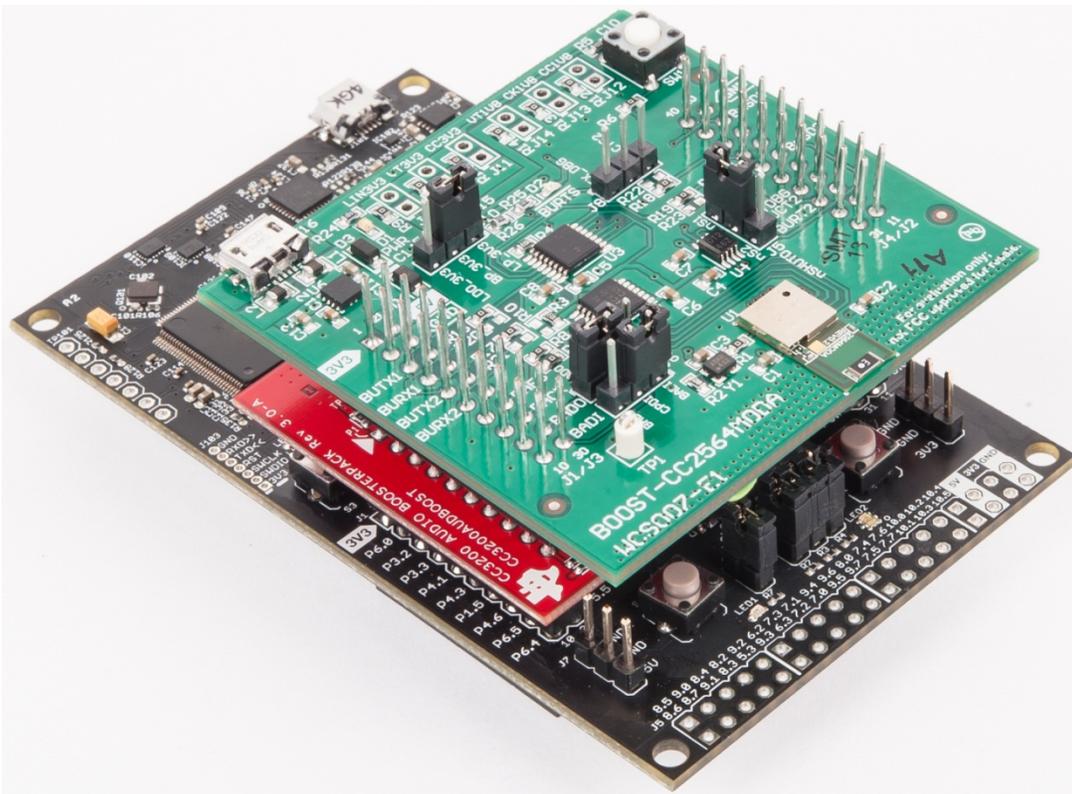


Figure 4. MSP-EXP432P401R, BOOST-CC2564MODA, and CC3200AUDBOOST Combination

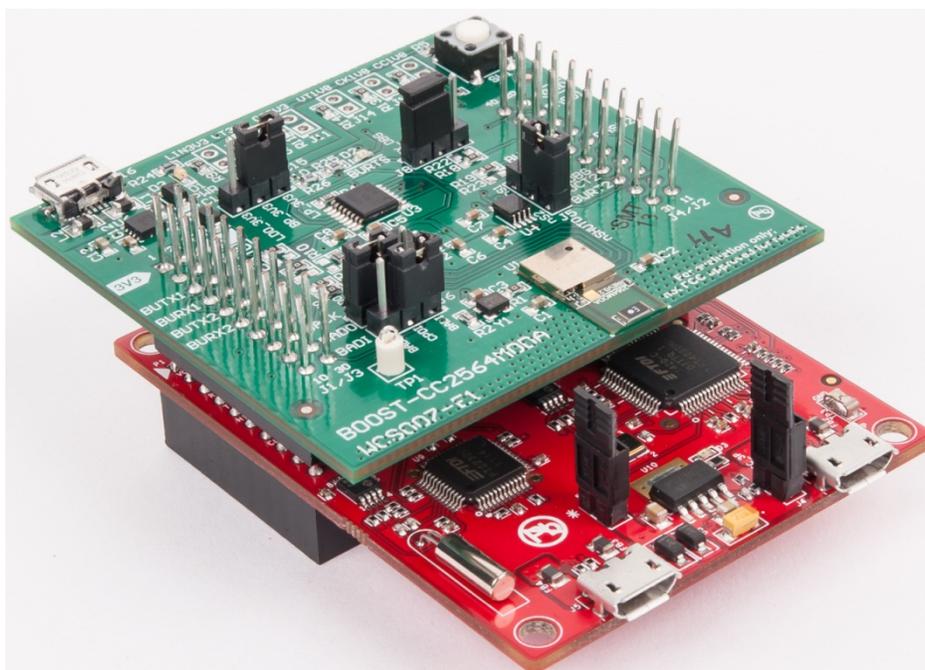


Figure 5. BOOST-CC2564MODA and CC31XXEMUBOOST Combination

6 Software Setup

6.1 Downloading and Installation

To download and install the [Bluetooth software development kit \(SDK\)](#), do as follows:

NOTE: To download the SDK, a TI login is required.

1. Create a TI login (if necessary).
2. Complete the export approval form.

NOTE: A request is submitted to TI for approval. When the request is approved, a confirmation appears on the next page with a link to download the software.

3. Click *Download* to start the download.
4. Run the setup file (for example, CC256XMS32BTBLESW-v4.0.3.0.1.0-Setup.exe).
5. Accept the TI *Bluetooth Stack Clickwrap License Agreement*.

NOTE: The SDK installs to *C:\TI\Connectivity\CC256X BT\CC256x MSP432 Bluetopia SDK*.

6. Navigate to the SDK through Start→ Programs→ Texas Instruments→ C256X BT→ CC256X MSP432 Bluetopia SDK v4.0.3.0.1.0 to access the file.

6.2 Building and Flashing the Bluetooth Code (MSP-EXP432P401R)

Sample applications are available for CCS, IAR, and Keil. To set up the sample applications on each IDE version, do as follows:

CCS

1. Navigate to the workspace through Project→ Import CCS Projects.
2. Open *C:\TI\Connectivity\CC256X BT\CC256x MSP432 Bluetopia SDK\4.0.3.0\Samples*.
3. Select the demonstration to load onto the device (for this example, the *SPPDemo*).

- Navigate to SPPDemo→ CCS.

NOTE: The CCS SPPDemo project opens (see [Figure 6](#)).

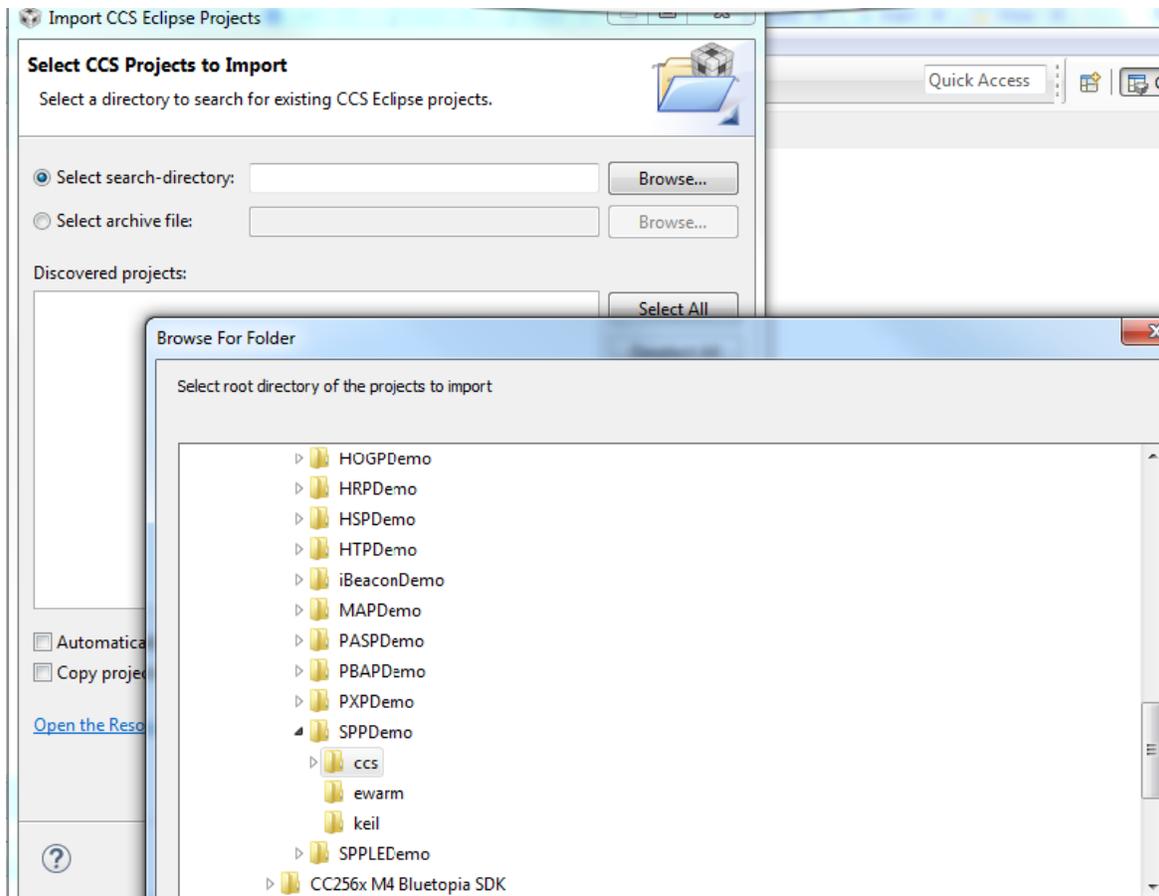


Figure 6. CCS Project Folder

- Open Project / Properties / General, and ensure that the “Manage the project’s target-configuration automatically” checkbox is set. See [Figure 7](#).

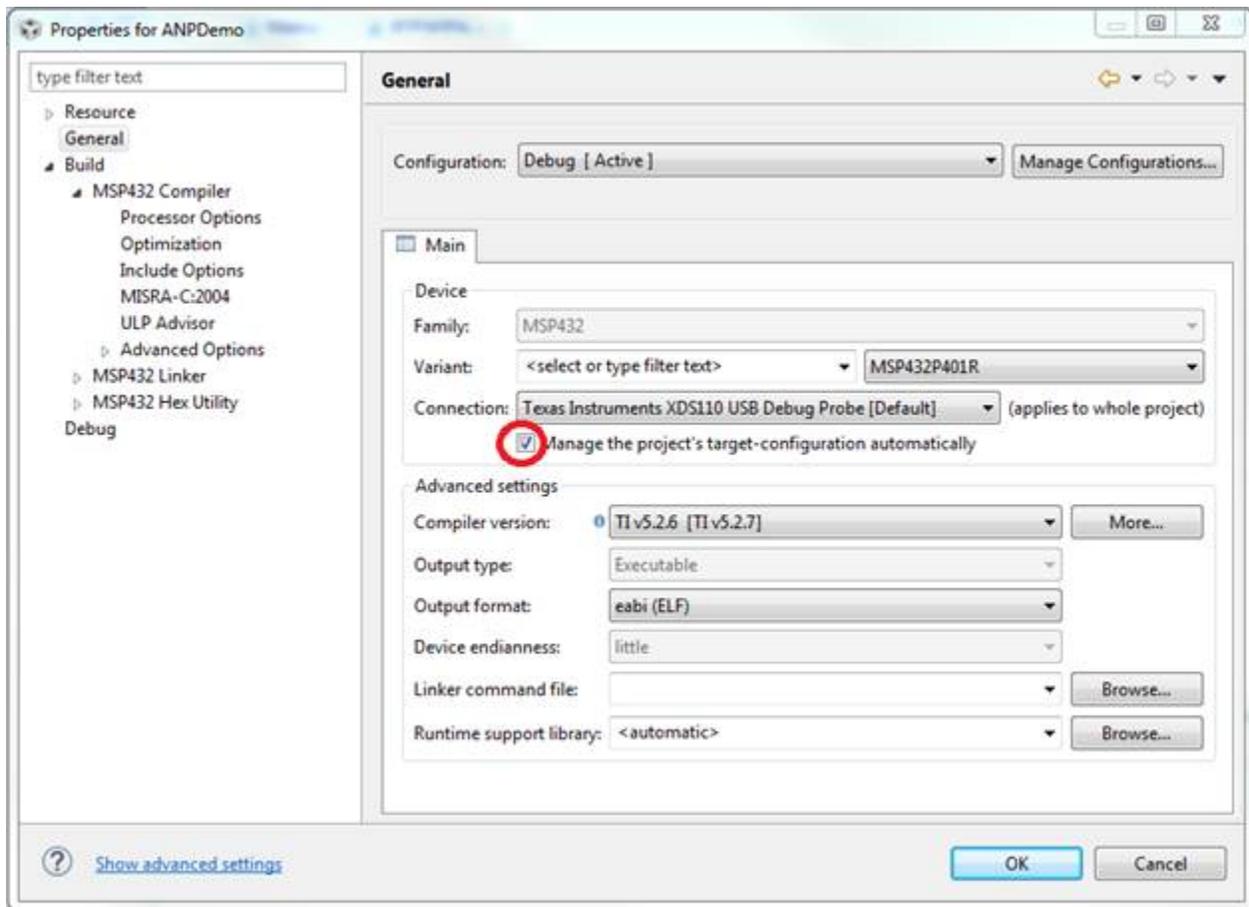


Figure 7. Project Properties / General

6. Ensure the MSP432 device is connected.
7. Select the Debug button from the toolbar (see [Figure 8](#)).

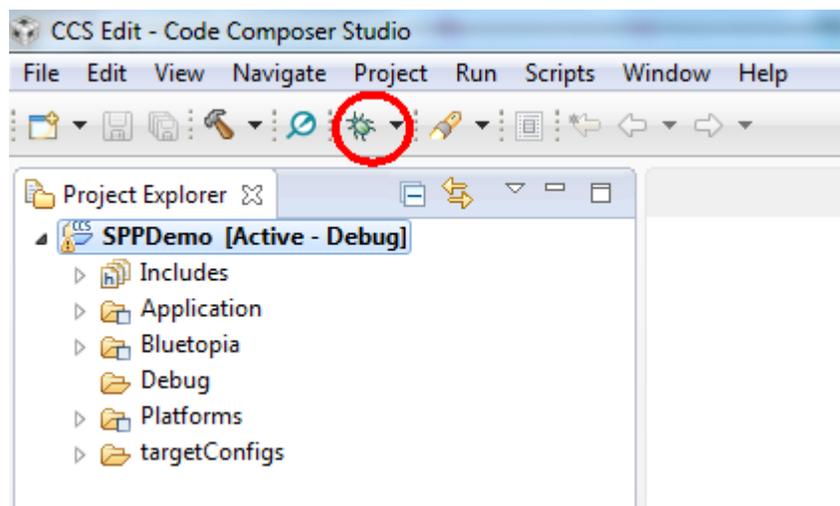


Figure 8. Debug

NOTE: Let the IDE debug and load the software onto the device. This process may take 5 to 10 minutes. After the IDE loads the software, the it is ready to use.

To begin using the profile, do as follows:

1. Press the play and resume button on the CCS toolbar (see [Figure 9](#)).

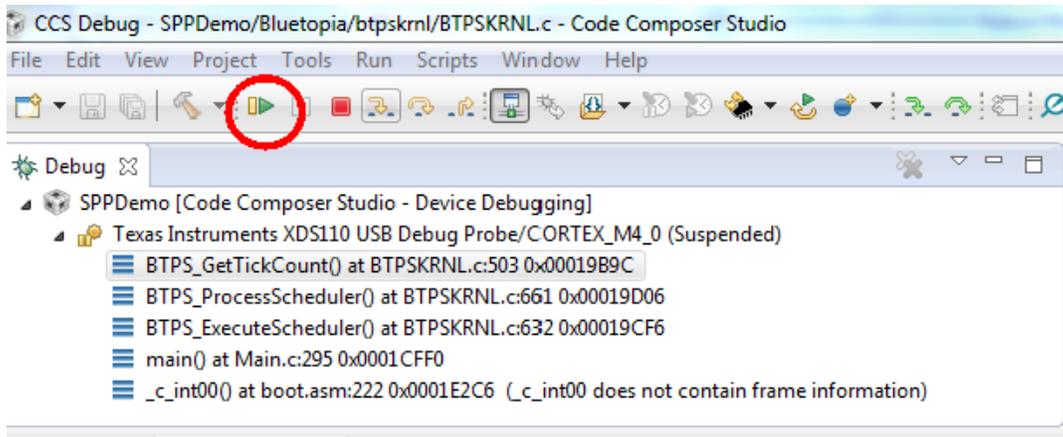


Figure 9. Play and Resume Button

IAR

To open the workspace, do as follows:

1. Navigate to *C:\TI\Connectivity\CC256X BT\CC256x MSP432 Bluetopia SDK\4.0.3.0\Samples*.
2. Select the demonstration to load onto the device (for this example, the *SPPDemo*).
3. Navigate to *SPPDemo*→ *EWARM*.
4. Select *SPPDemo.eww*.

NOTE: The IAR IDE opens.

5. Select either the *Debug* or *Release* configuration from the drop-down menu (in this example, select *Debug*, see [Figure 10](#)).

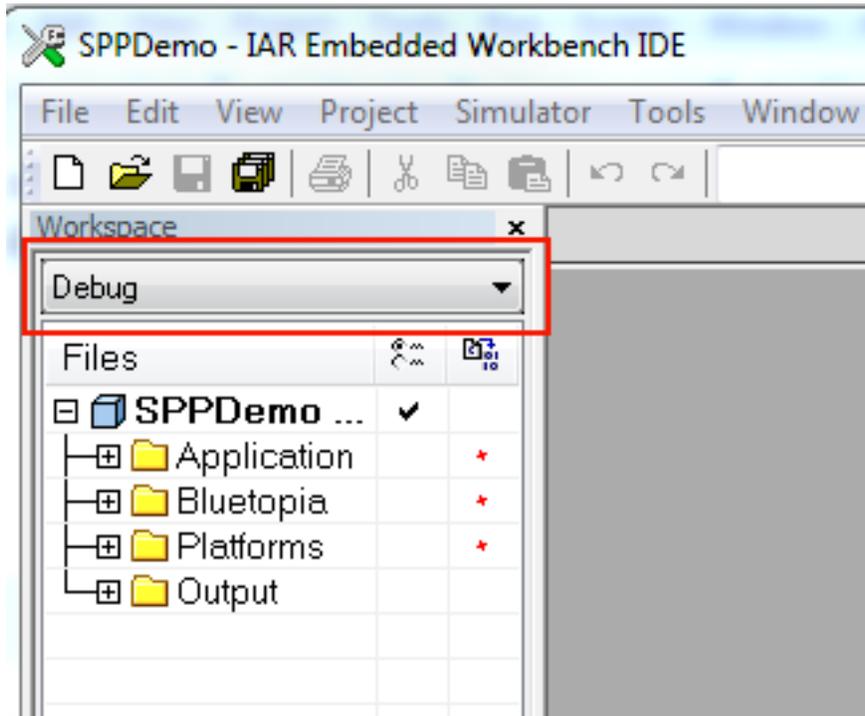


Figure 10. Debug Workspace

6. Ensure that the MSP-EXP432P401R LaunchPad development kit is connected.

7. Select *Download and Debug* from the *Project* tab or the play icon (see Figure 11).

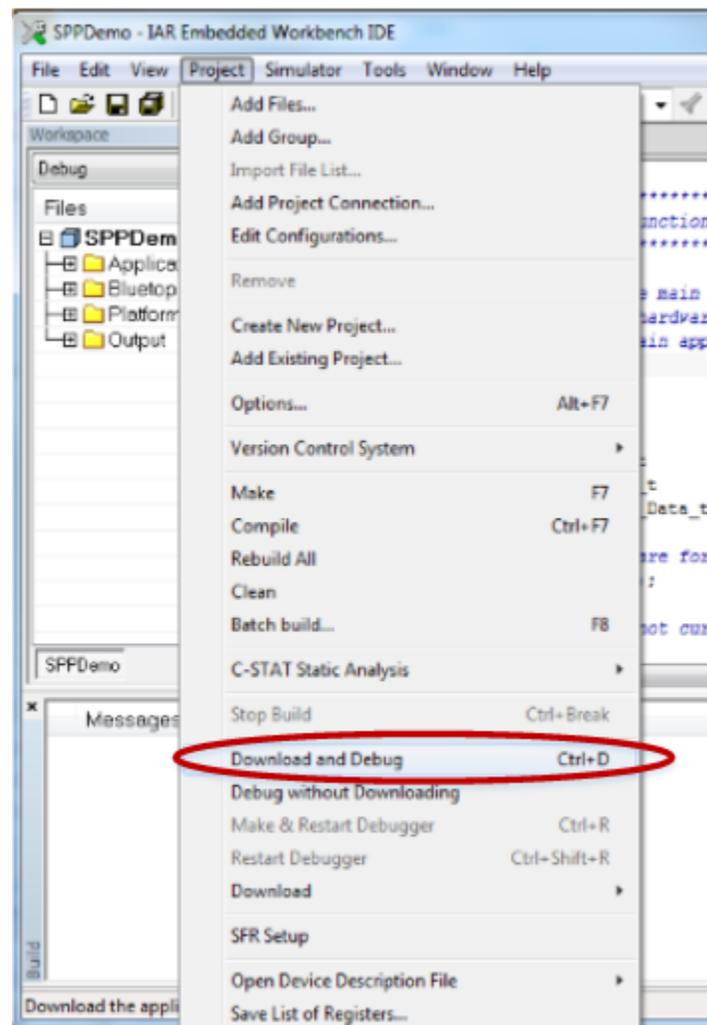


Figure 11. Download and Debug

NOTE: Let the IDE debug and load the software onto the device. This process may take 5 to 10 minutes.

8. Click the red X in the IAR toolbar to stop debugging (see Figure 12).

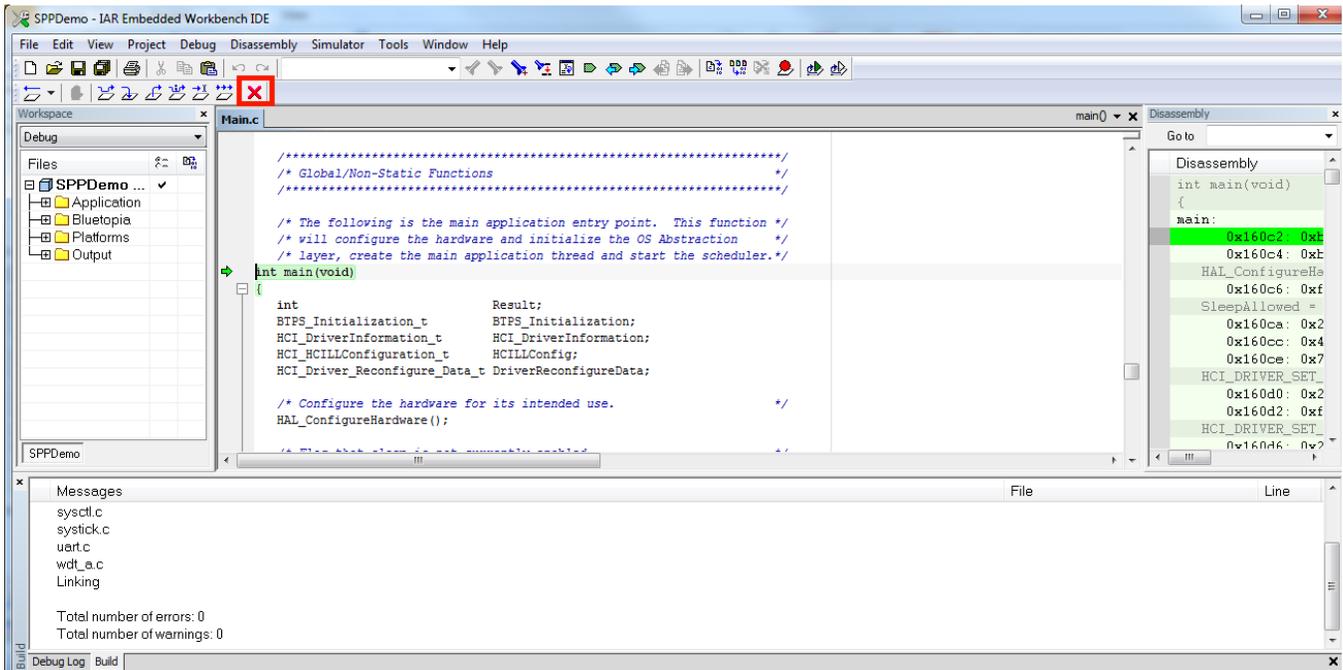


Figure 12. Red X

To begin using the profile, do as follows:

1. Press the Go button in IAR (see [Figure 13](#)).

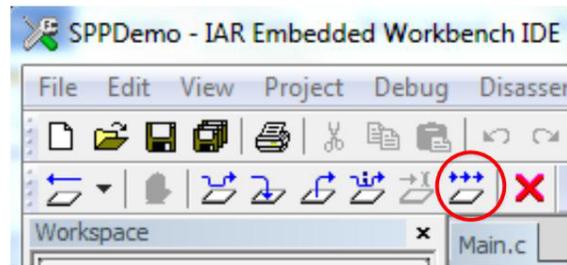


Figure 13. The Go Button

Keil

To open the workspace, do as follows:

1. Navigate to *C:\TI\Connectivity\CC256X BT\CC256x MSP432 Bluetopia SDK\4.0.3.0\Samples*.
2. Select the demonstration to load on the device (for this example, use *SPPDemo*).
3. Navigate to *SPPDemo*→ *keil* in the samples list.
4. Select *SPPDemo.uvprojx*.

NOTE: Keil uVision5 opens.

5. Select either the *Debug* or *Release* configuration from the drop-down menu (in this example, select *Debug*, see [Figure 14](#)).

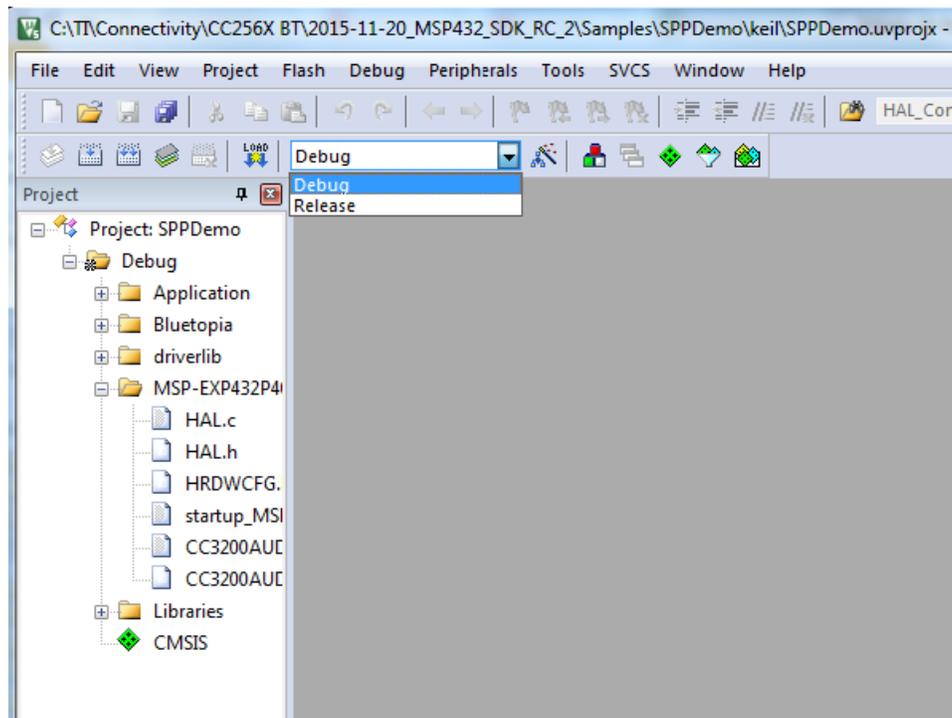


Figure 14. Configurations

To build the code, do as follows:

1. Navigate to Project→ Build Target in the program menu (see [Figure 15](#)).

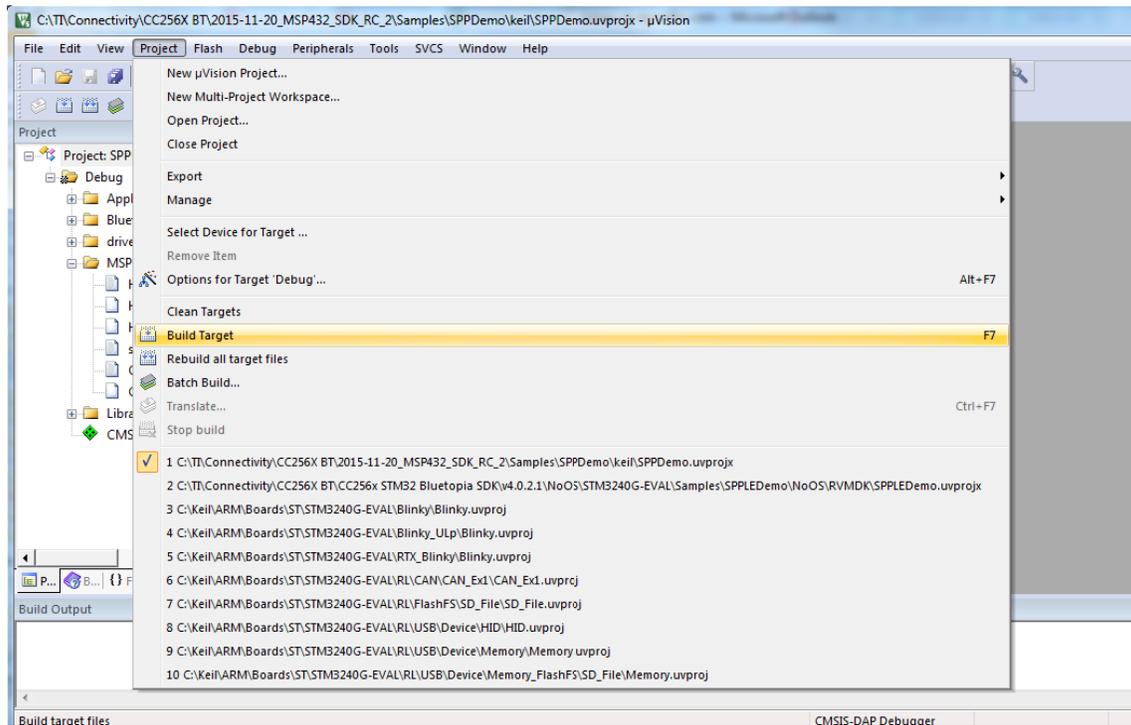


Figure 15. Build Project→ Target

NOTE: After a few minutes, the build process finishes and should build a .axf file. Each time the configuration is changed, a new .axf file must be built.

2. Choose from the following two options.
 - For Debug Mode Only, do as follows:
 - (a) Select *Start/Stop Debug Session* to start loading the profile on the MSP432 device (see [Figure 16](#)).

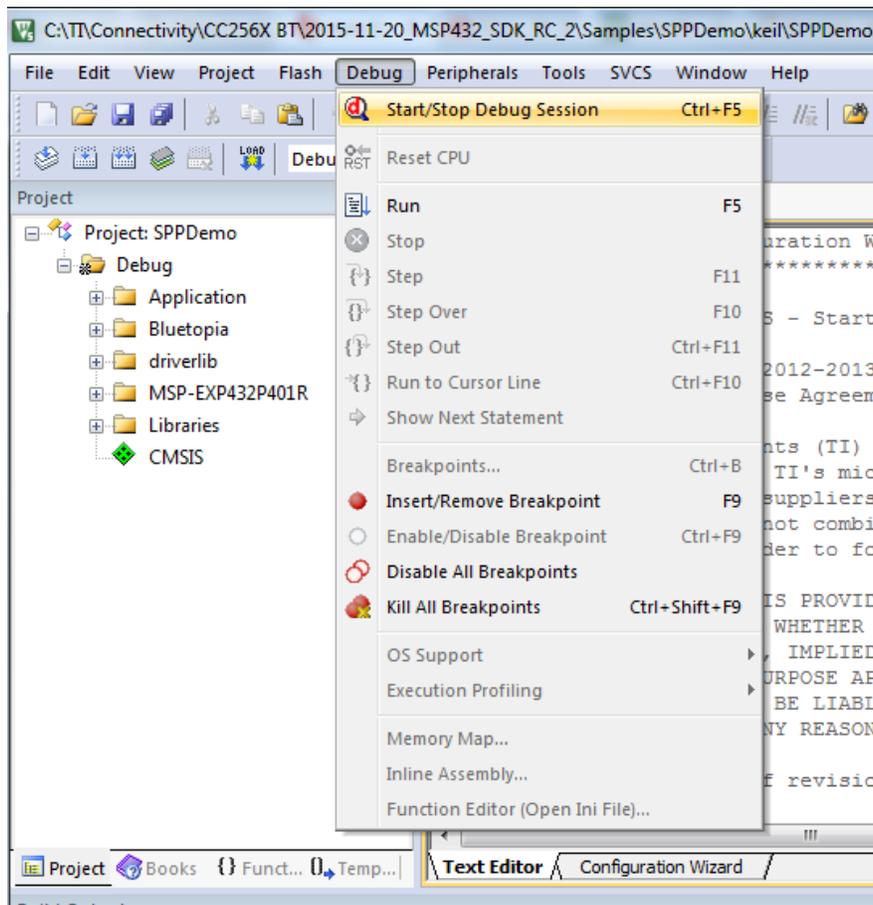


Figure 16. Start/Stop Debug Session

NOTE: The debug session finishes in a few minutes.

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

NOTE: The profile loads on the MSP-EXP432P401R LaunchPad development kit.

- (c) Unplug the device.
- (d) Plug in the device.
- For Release and Debug Modes:
 - (a) Press the LOAD button to start loading the profile on the MSP432 device (see [Figure 17](#)).

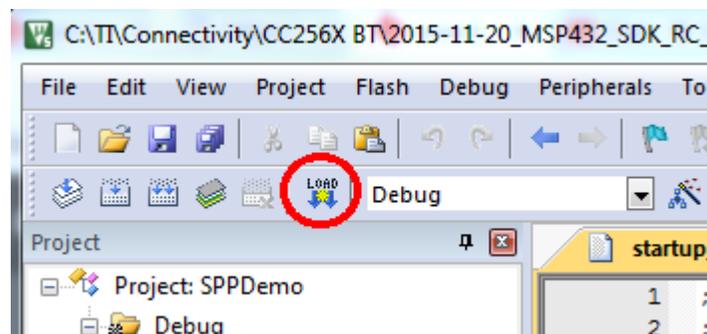


Figure 17. LOAD Button

NOTE: The profile finishes in a few minutes. The profile loads on the MSP-EXP432P401R LaunchPad development kit.

- (b) Unplug the device.
- (c) Plug in the device.

7 Sample Applications

TI dual-mode *Bluetooth* stack on MSP432 MCUs includes sample applications directory available with source code which demonstrates the use of the TI's *Bluetooth* stack. These sample applications are a simple, command line applications that display a list of available commands. [Table 1](#) lists the specific audio connectors for the audio sample applications. The parameters for this port are as follows:

- Baud: 115,200
- Data Bits: 8
- Parity: None
- Stop Bits: 1
- Flow Control: None

[Table 2](#) lists available profiles for *Bluetooth* SDK.

Table 2. Available Profiles for *Bluetooth* SDK

Profile	Role	NoOS	Platforms
A3DP Demo_SNK	Sink Controller	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA CC3200AUBOOST
A3DP Demo_SRC	Source Target	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA CC3200AUBOOST
ANP Demo	Server Client	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA
FMP Demo	Target Locator	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA
HFP Demo_AG	Audio Gateway	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA CC3200AUBOOST
HFP Demo_HF	Audio Gateway Hands-Free Unit	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA CC3200AUBOOST
HID Demo	Host Device	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA
HOGP Demo	Host Device	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA
HRP Demo	Collector Sensor	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA
HSP Demo	Audio Gateway Headset	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA CC3200AUBOOST
HTP Demo	Collector Thermometer	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA
iBeacon Demo	Server Client	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA
MAP Demo	Server Client	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA
PASP Demo	Server Client	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA

Table 2. Available Profiles for *Bluetooth* SDK (continued)

Profile	Role	NoOS	Platforms
PBAP Demo	Server Client	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA
PXP Demo	Monitor Reporter	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA
SPP Demo	Device A Device B	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA
SPPLE Demo	Server Client	CCS IAR Keil	MSP-EXP432P401R BOOST-CC2564MODA

7.1 Classic Bluetooth Sample Applications

A3DP Sink Demo

- The assisted advanced audio distribution profile (A3DP) shows how to send stereo audio over *Bluetooth*.
- For a step-by-step demonstration of how to run this application for the sink role, visit the [A3DP demo sink wiki](#).

A3DP Source Demo

- The assisted advanced audio distribution profile shows how to send stereo audio over *Bluetooth*.
- For a step-by-step demonstration of how to run this audio gateway application for the source role, visit the [A3DP demo source wiki](#).

HFP Demo

- The hands-free profile (HFP) lets the user demonstrate the use of hands-free profile on embedded device. The HFP is used to connect a headset or speaker phone with a mobile device to provide remote control and voice connections.
- The HFP supports two roles: hands free and audio gateway.
- For a step-by-step demonstration of how to run the audio gateway application, visit the [HFP AG demo application wiki](#).
- For a step-by-step demonstration of how to run the hands-free application, visit the [HFP HG Demo application wiki](#).

HID Demo

- The human interface device (HID) enables a host to connect and control a HID device.
- For a step-by-step demonstration of how to run this application, visit the [HID demo wiki](#).

HSP Demo

- The headset profile (HSP) lets the user demonstrate the use of HSP on embedded device. The HSP is used to connect a headset or speaker phone with a mobile device or to connect an audio gateway with a headset device to provide basic control and voice connections.
- For a step-by-step demonstration of how to run this application, visit the [HSP demo wiki](#).

MAP Demo

- The MAP demo lets the user exchange message objects over *Bluetooth*.
- For a step-by-step demonstration of how to run this application, visit the [MAP demo application wiki](#).

PBAP Demo

- The PBAP demo lets the user exchange phonebook objects over *Bluetooth*.
- For a step-by-step demonstration of how to run this application, visit the [PBAP demo application wiki](#).

SPP Demo

- This application shows how to use the SPP module and how to handle the different callback events. The application can be used to interface with a remote SPP client or server.
- For a step-by-step demonstration of how to run this application, visit the [SPP demo application wiki](#).

7.2 *Classic Bluetooth + Bluetooth low energy Sample Applications*

SPP + SPPLE Demo

- This application shows how to use low energy (LE) and the GATT profile. This sample emulates using SPP over LE using the GATT profile. This sample acts as an LE master and an LE slave.
- 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 the [SPP + SPPLE demo wiki](#).

7.3 *Bluetooth low energy Sample Applications*

ANP Demo

- This application shows how to use LE and the GATT profile. This sample implements the alert notification profile (ANP) using the GATT profile. This sample acts as an LE master and an LE slave.
- For a step-by-step demonstration of how to run this application, visit the [ANP demo wiki](#).

iBeacon Demo

- The iBeacon profile is used to provide a different type of location-based information and services. There are two roles defined in this profile: a server and a client. The server transmits a user-defined message, which is received by any client that is in range. The received iBeacon message can trigger different behaviors.
- This application lets the user advertise specific *Bluetooth* low energy data that can be read by an iBeacon scanner (client).
- For a step-by-step demonstration of how to run this application, visit the [iBeacon demo wiki](#).

HRP Demonstration

- This application shows how to use LE and the GATT profile. This sample implements the heart rate monitoring profile (HRP) using the GATT profile. This sample acts as an LE master and an LE slave.
- For a step-by-step demonstration of how to run this application, visit the [HRP demo wiki](#).

HTP Demonstration

- This application shows how to use LE and the GATT profile. This sample implements the health thermometer profile (HTP) using the GATT profile. This sample acts as an LE master and an LE slave.
- For a step-by-step demonstration of how to run this application, visit the [HTP demo wiki](#).

PASP Demonstration

- This application shows how to use LE and the GATT profile. This sample implements the phone alert status profile (PASP) using the GATT profile. This sample acts as an LE master and an LE slave.
- For a step-by-step demonstration of how to run this application, visit the [PASP demo wiki](#).

HOGP Demonstration

- This application shows how to use LE and the GATT profile. This sample implements the HID using the GATT profile.
- For a step-by-step demonstration of how to run this application, visit the [HOGP demo wiki](#).

PXP Demonstration

- This application shows how to use LE and the GATT profile. This sample implements the proximity profile (PXP) using the GATT profile. This sample acts as an LE master and an LE slave.
- For a step-by-step demonstration of how to run this application, visit the [PXP demo wiki](#).

FMP Demonstration

- This application shows how to use LE and the GATT profile. This sample implements the find me profile (FMP) using the GATT profile. This sample acts as an LE master and an LE slave.
- For a step-by-step demonstration of how to run this application, visit the [FMP demo wiki](#).

Revision History

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

Changes from Original (March 2016) to A Revision	Page
• Updated Samples link.....	9
• Added Step 5 to Building and Flashing the <i>Bluetooth</i> Code (MSP-EXP432P401R).....	10
• Updated Samples link.	12
• Updated Samples link.	17

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