Dual-Mode *Bluetooth*® Stack on STM32F4 MCUs

User's Guide

Literature Number: SWRU428
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Dual-Mode Bluetooth® Stack on STM32F4 MCUs

TI's dual-mode *Bluetooth*® stack on STM32F4 MCUs (CC256XSTBTBLESW) software for *Bluetooth* + *Bluetooth* low energy enables the STM32 ARM® Cortex®-M4 processor and includes single mode and dual mode, while implementing the *Bluetooth* 4.0 specification. The *Bluetooth* stack is fully qualified (QDID 69887 and QDID 69886) and provides simple command-line applications to help speed development and can be MFI capable.

For a complete evaluation solution, the CC256XSTBTBLESW works directly with the STM3240G-EVAL hardware development kit. The stack for the STM32 MCU is certified and royalty-free (CC256XSTBTBLESW).

The software works with all CC256x EM boards (CC256XQFNEM, CC2564MODNEM, and CC2564MODAEM) to provide a complete *Bluetooth* BR/EDR/LE HCI solution, reducing design effort and enabling a faster time to market. The CC256x EM boards include TI's seventh-generation *Bluetooth* core and provide a product-proven, *Bluetooth* 4.1-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/LE modes of operation.

1 Trademarks

Cortex, KEIL, µVision are registered trademarks of ARM Limited.
ARM is a registered trademark of Arm Limited.
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2 Features

- Supports dual-mode *Bluetooth* 4.0 – *Bluetooth* certified and royalty free
- Offers a fully-qualified *Bluetooth* Stack (QDID 69887 and QDID 69886)
- Offers thread-safe operation
- Supports both threaded (RTOS) and non-threaded (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 IDEs

3 *Bluetooth* Profiles

Classic Profiles:

- Advanced Audio Distribution Profile (A2DP): A3DP implementation
- Audio/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 Profile (HID)
- 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)
- 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)

4 Sample Application Overview

This demonstration lets you to evaluate TI's CC256x *Bluetooth* device with the STM3240G-EVAL platform. The CC256x+ STM3240G-EVAL *Bluetooth* applications offer a rich out-of-box 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. See Figure 1 for an overview of the demonstration.

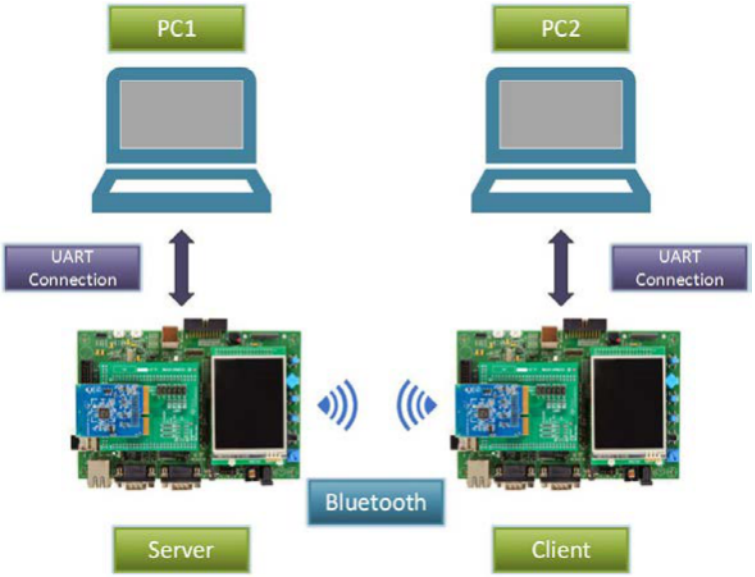

Figure 1. Overview of Demonstration

5 CC256XSTBTBLESW 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
  - CC256XQFNEM or CC2564MODNEM or CC2564MODAEM
- One CC256xEM *Bluetooth* adapter kit
  - CC256XEM-STADAPT
- One STM32 experimenter board
  - A STM3240G-EVAL board or STM32F4DISCOVERY board

Software

- Dual-mode *Bluetooth* stack
  - On STM32F4 MCUs: CC256XSTBTBLESW
- 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.

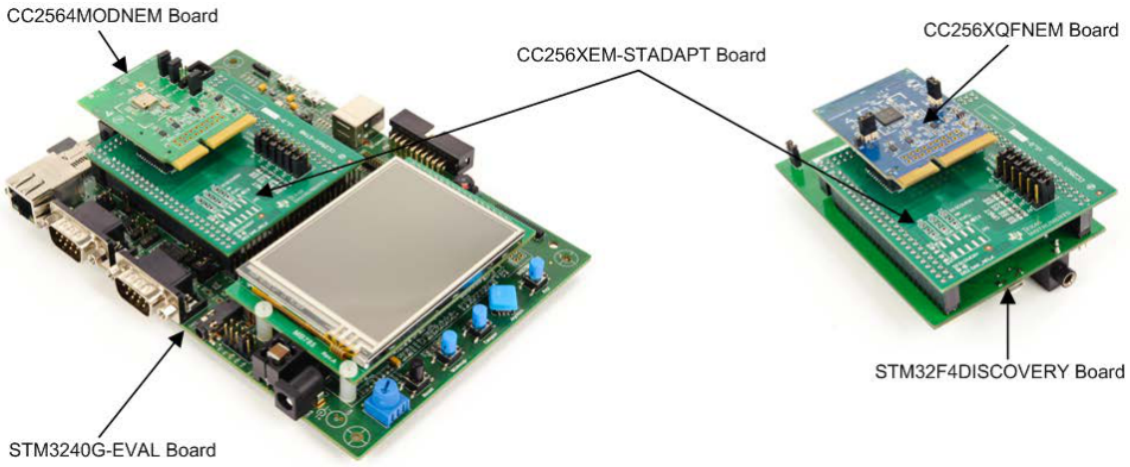

Figure 2. Hardware Combination

6 Setting Up the Hardware

Using TI's dual-mode *Bluetooth* CC256x solution (CC256XQFNEM or CC2564MODNEM), the STM32 MCU evaluation board (STM3240G-EVAL or STM32F4DISCOVERY), with the support of the CC256xEM *Bluetooth* adapter kit (CC256XEM-STADAPT), developers canevaluate 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 adaptor 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* [SWRU417] and the *CC256xEM Bluetooth Adapter Kit Quick Start Guide* [SWRU416].)
2. Fit the adaptor board on top of the STM32 board. (See Figure 4 for an example using the STM3240G-EVAL board. See Figure 5 for an example using the STM32F4DISCOVERY board.)
3. Install the CC256X module board on the adaptor board.

Figure 3 shows the setup for the STM32 board.

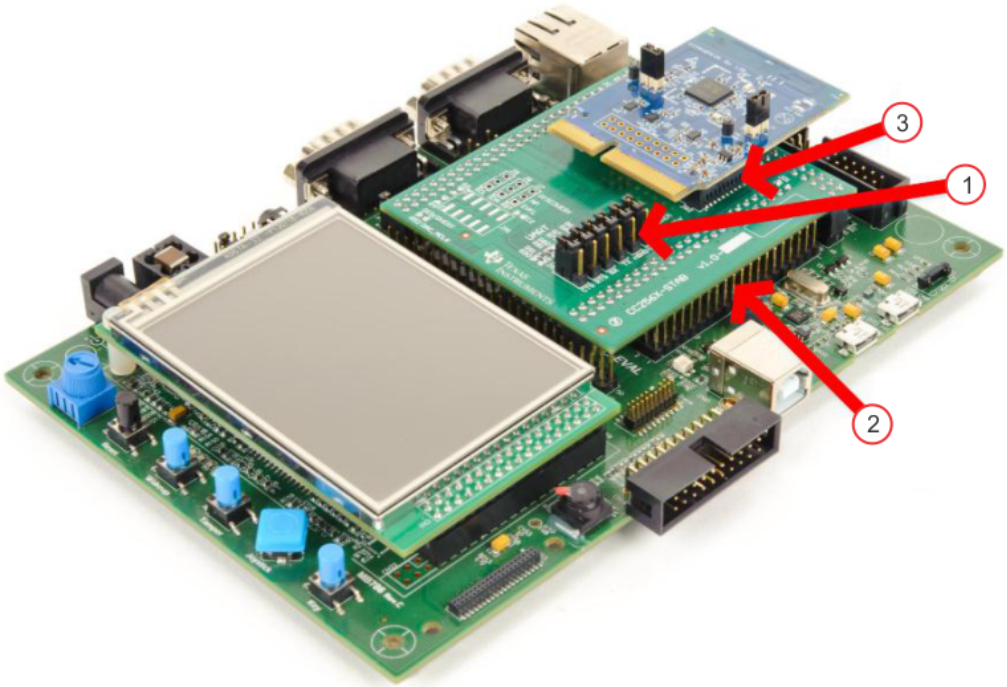

Figure 3. STM32 General Setup

Figure 4 shows an example of the STM3240G-EVAL, the CC256X-STADAPT, and QFNEM boards combined.

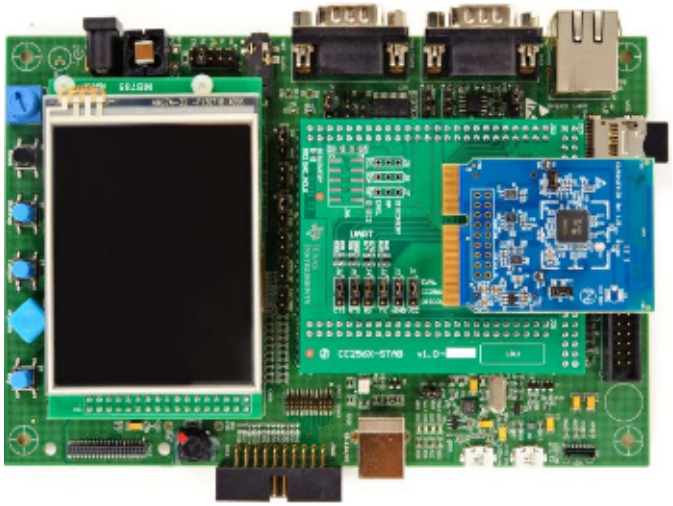

Figure 4. STM3240G-EVAL, CC256X-STADAPT, and QFNEM Combination

Figure 5 shows an example of the STM32F4DISCOVERY, the CC256X-STADAPT, and QFNEM boards combined.

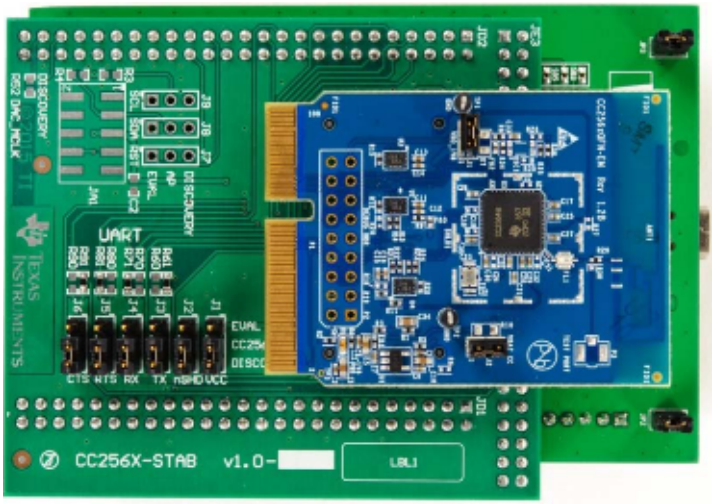

Figure 5. STM32F4DISCOVERY, CC256X-STADAPT, and QFNEM Combination

7 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-v4.0.2.1-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\v4.0.2.1*.

7. Access the SDK through *Start/Programs/TexasInstruments/CC256XBT/CC256xSTM32BluetopiaSDKv4.0.2.1*.

8 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\v4.0.2.1* 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.

7. Select *Debug*. (See Figure 6.) or *Release Configuration* from the drop-down menu. (For this example, select *Debug*.)

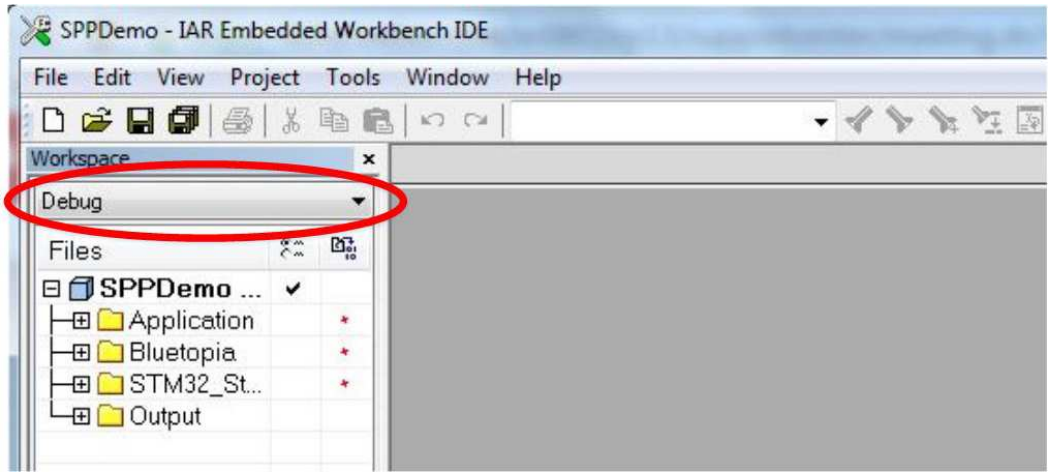

Figure 6. IAR Drop-down Menu

8. Select *Download and Debug* from the *Project* drop-down menu or click the *Play* icon. (See Figure 7.)

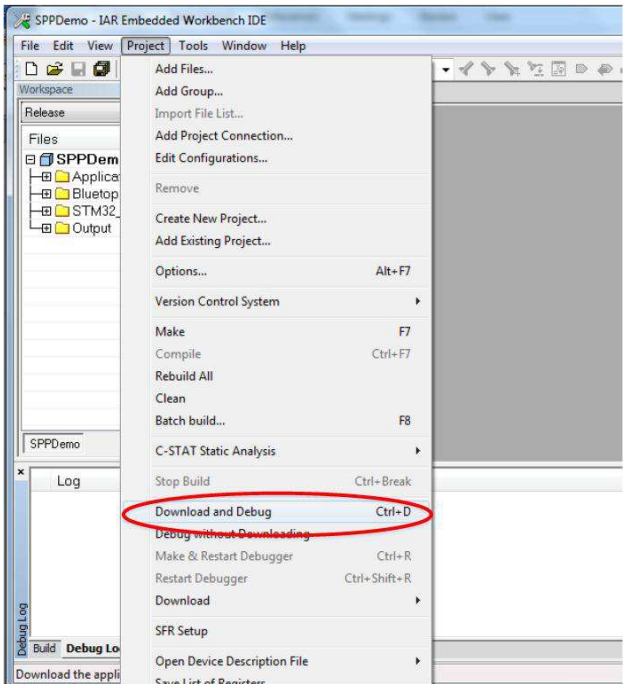

Figure 7. Download and Debug

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

9. Click the red X in the IDE to stop debugging. (See Figure 8.)

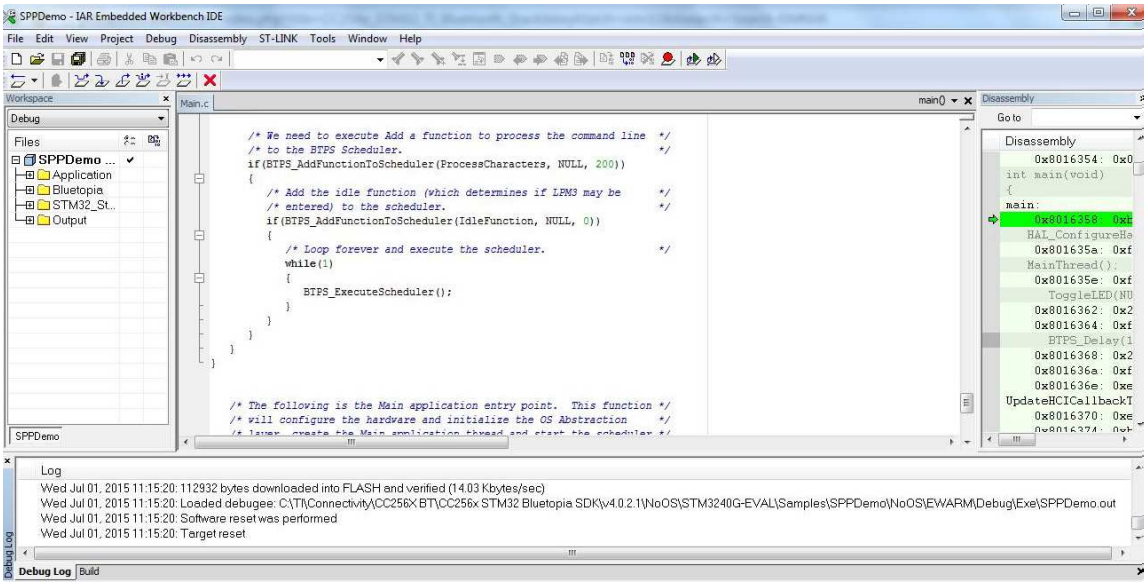

Figure 8. Debugging Screen

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

Figure 9. The GO Button

KEIL

1. Navigate to *C:\TI\Connectivity\CC256XBT\CC256xSTM32BluetopiaSDK\v4.0.2.1* 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.

7. Select *Debug* or *Release Configuration* from the drop-down menu. (For this example, select *Debug* [See Figure 10].)

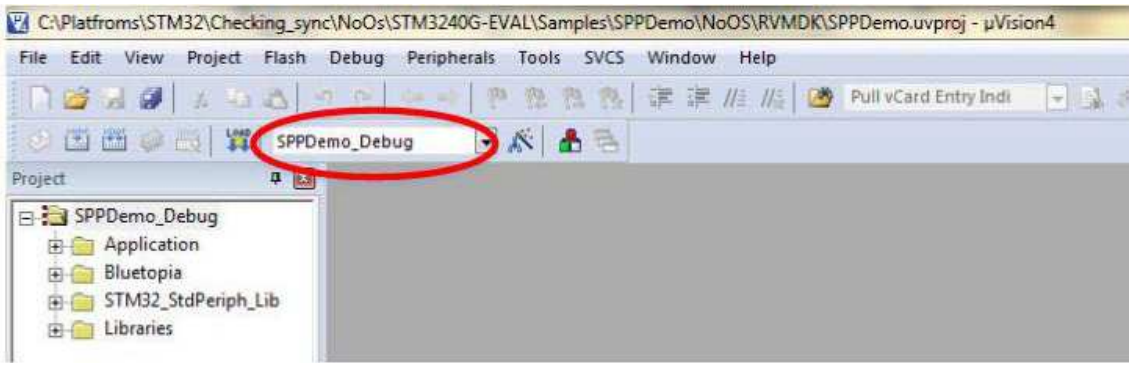

Figure 10. Debug Dropdown Menu

8. Right-click *SPPDemo_Debug* in the project sidebar.
9. Select *Build target* to build the code. (See Figure 11.)

NOTE: Figure 12 shows the output when built correctly.

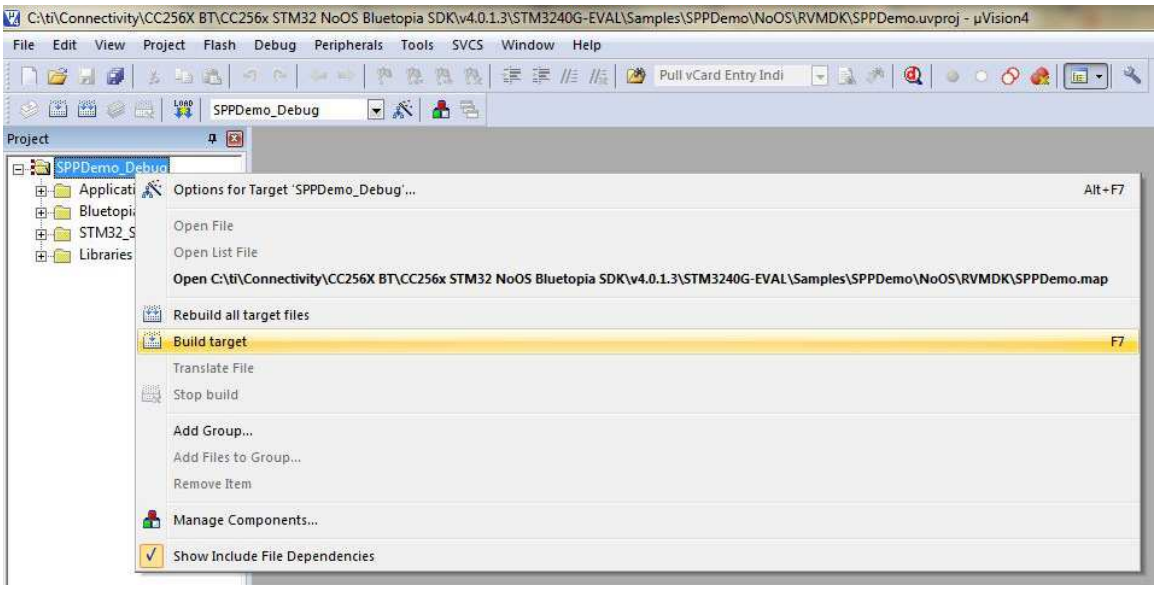

Figure 11. Building Target

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

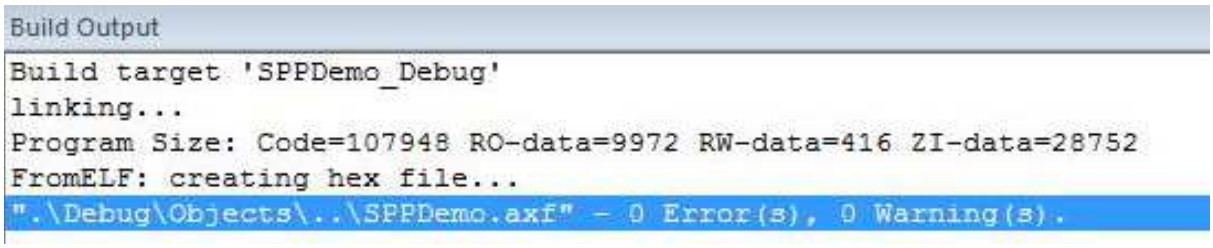

Figure 12. Build Output

10. Choose Debug mode or Release and Debug modes.
    - For Debug mode only:
      1. Select *Start/Stop Debug Session* to start loading the profile on the STM32 device and to work in *Debug* mode. (See Figure 13.)

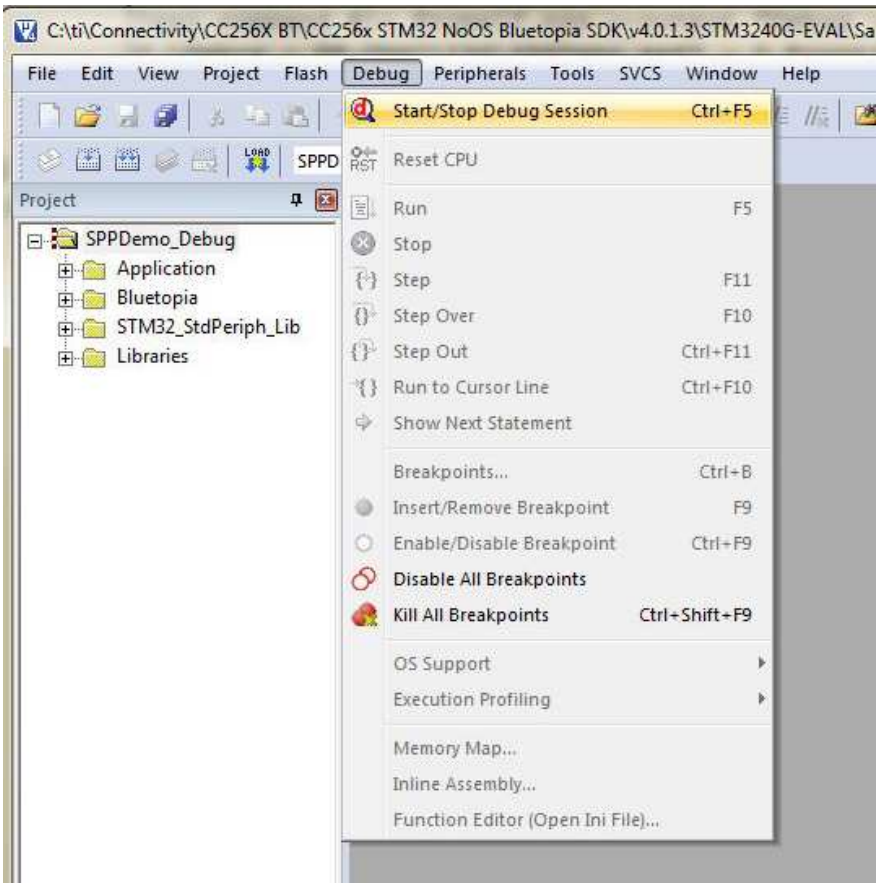

Figure 13. Debug Mode

NOTE: The loading process completes in a few minutes.

      2. Stop the debugging session from the *Debug* drop-down menu.

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

      3. Unplug the device.
      4. Plug the device in again to start working with it.

- For Release and Debug modes:
  1. Click *LOAD* to start loading the profile on the STM32 device. (See Figure 14.)

NOTE: It should complete in a few minutes.

The profile loads on the STM3240G-EVAL board.

  2. Unplug the device.
  3. Plug the device in again to start working with it.

Figure 14. Release and Debug Mode

8.1 *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\v4.0.2.1\NoOS\STM3240G-EVAL\Samples\SPPDemo\NoOS\EWARM\Debug\Exe*.
   - For FreeRTOS, navigate to *C:\TI\Connectivity\CC256XBT\CC256xSTM32BluetopiaSDK\v4.0.2.1\FreeRTOS\STM3240G-EVAL\Samples\SPPDemo\FreeRTOS\EWARM\Debug\Exe.*
3. Select a bin file. (This example uses SPPDemo.bin.)

4. Click *Program & Verify...* from the *Target* drop-down menu. (See Figure 15.)

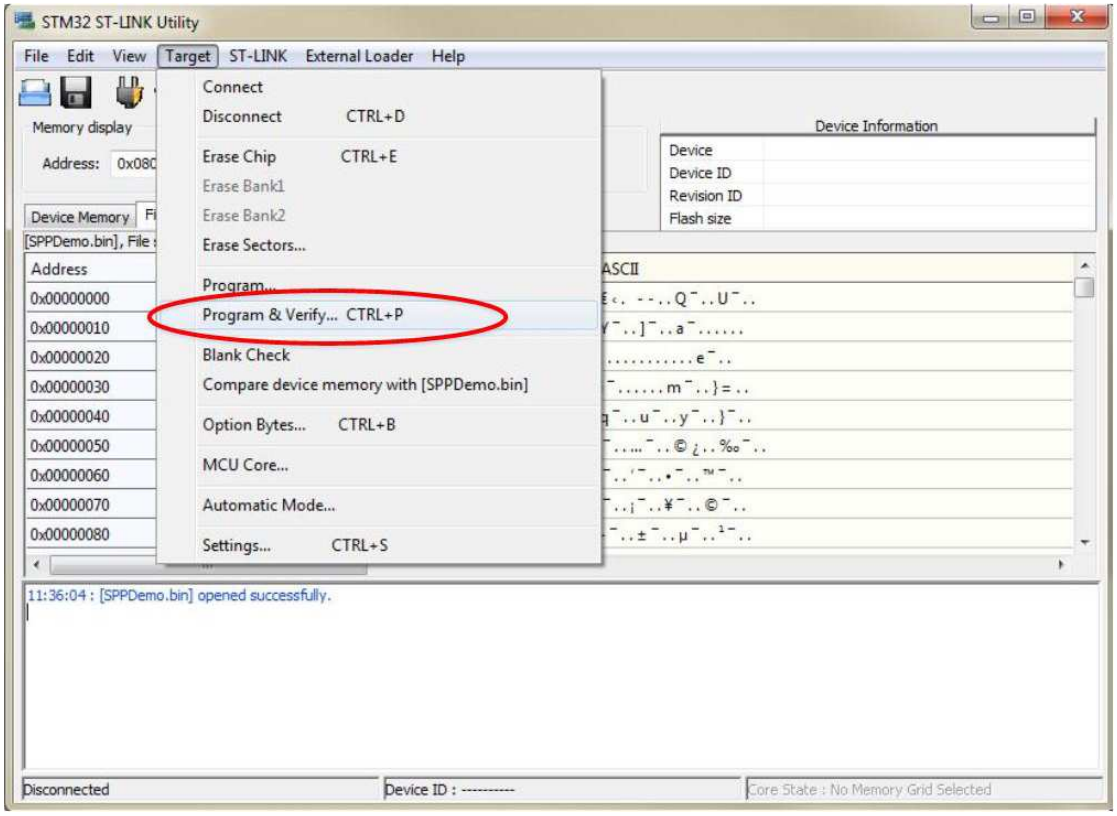

Figure 15. Program and Verify

NOTE: The information for your device shows.

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

6. Press *Start*. (See Figure 16.)

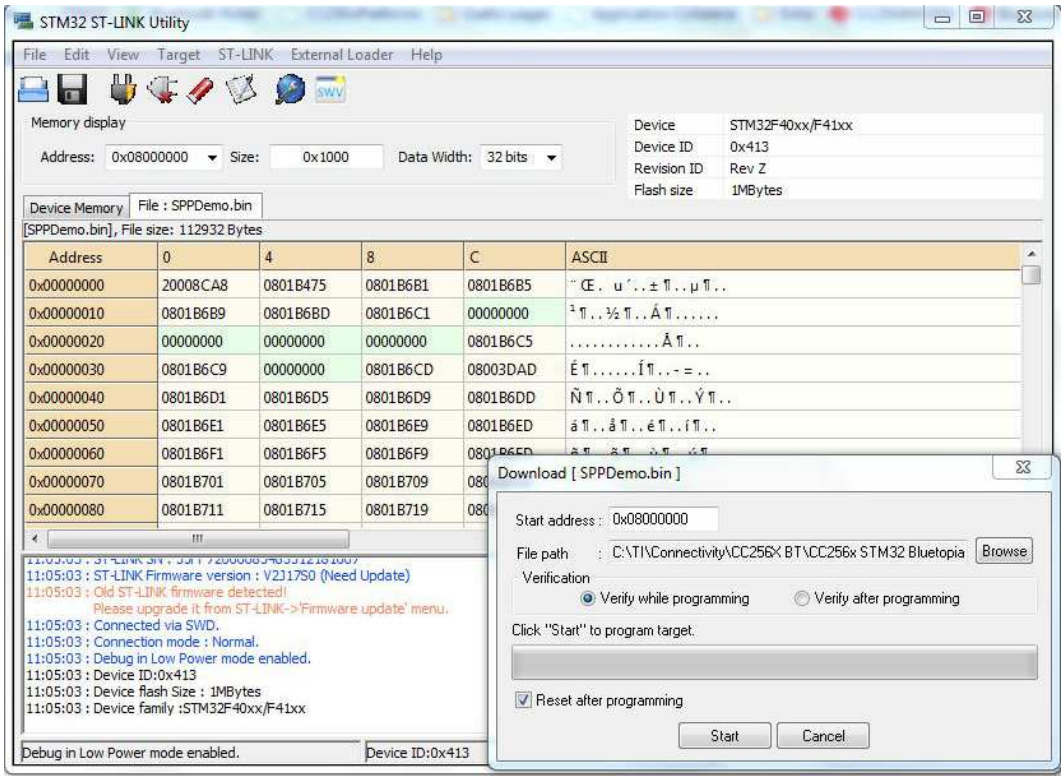

Figure 16. Start Download

NOTE: The command window displays *Verification...OK*. (See Figure 17.)

Figure 17. Verification...OK

9 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 1 lists the available profiles for *Bluetooth* SDK.

Table 1. 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
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
SPPLE demo	Server Client	IAR KEIL	IAR KEIL	STM3240G-EVAL

10 Classic *Bluetooth* Sample Applications

AUD Demo

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

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.

11 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 a 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.

12 *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.
- Allows the user to 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.

Revision History

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