Dual-Mode Bluetooth® CC2564 Evaluation Board

User's Guide

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1 Introduction

The CC256XQFNEM evaluation board contains the CC2564B dual-mode Bluetooth controller and is intended for evaluation and design. For a complete evaluation solution, the CC256XQFNEM board plugs into the TI hardware development kits:

- MSP-EXP430F5529
- MSP-EXP430F5438
- DK-TM4C123G
- DK-TM4C129X
- Other MCUs

A certified and royalty-free TI Bluetooth® stack (TIBLUETOOTHSTACK-SDK) is available for the MSP430™ and TM4C12x MCUs. The CC256XQFNEM hardware design files (schematics, layout, and BOM) are provided as a reference to aid in the implementation of the CC2564 device.

The CC2564B is a complete Bluetooth BR/EDR/LE HCI solution that reduces design effort and enables fast time to market. The CC2564B device includes TI's seventh-generation Bluetooth core and provides a product-proven solution that is Bluetooth-4.1 compliant. The CC2564B device provide one of the best Bluetooth RF performances with a transmit power and receive sensitivity that provides range of 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.
1.1 Features

The CC256XQFNEM evaluation board contains the following:

- CC2564B device (QFN package)
- Bluetooth Specification v4.1
- Dual mode—Bluetooth + Bluetooth low energy
- Class 1.5 transmit power (12 dBm)
- High sensitivity (~93 dBm typical)
- 32.768-kHz oscillator
- UART interface—control and data
- PCM–I2S interface—voice and audio
- 4-layer PCB design
- 1.8 LDO (LP2985-18)
- 3 voltage-level translators (SN74AVC4T774)
- PCB-printed antenna
- RF connector (U.FL-R-SMT-1)
- EM connectors that plug directly into the TI hardware development kits:
  - MSP-EXP430F5529
  - MSP-EXP430F5438
  - DK-TM4C123G
  - DK-TM4C129X
  - Other MCUs
- COM connectors that plug directly into the TI hardware development kit TMDXEVM3358
- Certified and royalty-free TI dual-mode Bluetooth stack (TIBLUETOOTHSTACK-SDK):
  - MSP430 (CC256XMSPBTABLESW)
  - TM4C (CC256XM4BTABLESW)
  - Other MCU (CC256XSTBTABLESW)

CC256XQFNEM Board Applications

Example embedded wireless applications include the following:

- Cable replacement
- Printer adapters
- Personal digital assistants (PDAs)
- Printers and scanners
- Computers and peripherals
- Wireless sensors
- Industrial control applications
- Low-power medical
1.2 Introduction to CC256XQFNEM Board

This user's guide is intended for use with TI's Bluetooth development platform: the CC256XQFNEM board. This guide helps you quickly start using this board to integrate with TI's evaluation platforms and software SDKs. This document describes the components and configurations of this board for various Bluetooth applications. The device information and capabilities, including pin descriptions and available software and tools, will enhance your out-of-box experience. Figure 1 shows the CC256XQFNEM board.

Figure 1. CC256XQFNEM Board
Kit Content
- 1 CC256XQFNEM board with TI dual-mode Bluetooth CC2564 controller
- 1 block jumper for the MSP-EXP430F5438 board
- 4 jumpers for the MSP-EXP430F5529 board

Requirements
For a complete evaluation, the CC256XQFNEM board requires hardware and software tools selected from the following list:

Hardware
- 1 MSP430 experimenter board—sold separately
  - MSP-EXP430F5529 board
  - MSP-EXP430F5438 board
- 1 TM4C development kit—sold separately
  - DK-TM4C123G development kit
  - DK-TM4C129X development kit

Software
- TI dual-mode Bluetooth stack
  - On MSP430 MCUs: CC256XMSPBTBLESW
  - On TM4C MCUs: CC256XM4BTBLESW
- Other MCUs
  - On STM32F4 MCUs: CC256XSTBTBLESW

Tools
- TI dual-mode Bluetooth service pack for CC256x (optional)
- CC256x Bluetooth hardware evaluation tool (optional)
- IDE versions—platform dependent
  - Code Composer Studio™ (CCS)
  - IAR 7.2/7.3 for ARM®
  - ARM Keil® uVision 4.70.0.0
Figure 3. TM4C Hardware Setup Examples

Figure 4. Other MCU Hardware Setup Examples
1.3 Overview

The CC256XQFNEM board is the development environment for the CC2564B controller and plugs directly into TI MSP430 and TM4C experimenter boards with the added benefit of EM connectors that simplify prototype wiring and field trials.

TI's CC2564B device uses a host controller interface (HCI), a cost-effective and flexible means to implement a Bluetooth network. The HCI reduces BOM cost by eliminating redundant processing capacity and giving designers the flexibility to choose a controller to work with because the Bluetooth stack resides and executes on the host processor of the application.

The CC256XQFNEM board has two connectors: EM and COM. The I/Os for the EM are at 3.3 V, the default assembly configuration. The I/Os for the COM are at 1.8 V and require hardware modification.

The CC256XQFNEM board is intended for evaluation purposes and works with TI's hardware development kit. See Section 3. To aid in the implementation of this reference design, schematic and layout files are available at the CC2564 product page. Figure 5 and Figure 6 show an overview of the front and back connectors, respectively, of the CC256XQFNEM board.

Figure 5. CC256XQFNEM Board Front Overview
Figure 6. CC2564MODNEM Board Back Connectors
2 Hardware Description

2.1 Overview

Figure 7 is the high-level block diagram of the CC256XQFNEM board. The CC2564 board integrates the antenna. The oscillator is the default clock with a frequency accuracy of 32.768 kHz ±250 ppm. The signals from the dual-mode Bluetooth CC2564 module include UART, PCM, nSHUTD, and slow clock. The CC256XQFNEM board has the following connectors:

- EM (default)
- COM

The connectors can supply power to the CC2564B device through either VBAT_EDGE or VBAT_MCU. For the EM connector, the signals are controlled through level shifters. The third connector (the debug header) can be used for testing. The I/Os of the EM connector are at 3.3 V. The I/Os of the COM connector are at 1.8 V and require hardware modification. The I/Os for the debug header connector are at 1.8 V and require hardware modification.

Figure 7. CC256XQFNEM Block Diagram
2.2 Connectors

2.2.1 EM Connector

The EM connectors can mount on a wide variety of TI MCU platforms such as the MSP430 (MSP-EXP430F5529 and MSP-EXP430F5438) and TM4C (DK-TM4C123G and DK-TM4C129X). The EM I/Os are at 3.3-V levels. For example, then MODULE_UART_RX refers to the receiving UART RX pin on the CC2564B controller that would connect to the UART TX pin on the MCU. Table 1 and Table 2 list the standard pinout and the pin assignments with respect to the CC2564B side.

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>EM Adapter Assignment</th>
<th>Pin Number</th>
<th>EM Adapter Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>2</td>
<td>N/C</td>
</tr>
<tr>
<td>3</td>
<td>MODULE_UART_CTS</td>
<td>4</td>
<td>N/C</td>
</tr>
<tr>
<td>5</td>
<td>SLOW_CLK</td>
<td>6</td>
<td>N/C</td>
</tr>
<tr>
<td>7</td>
<td>MODULE_UART_RX</td>
<td>8</td>
<td>N/C</td>
</tr>
<tr>
<td>9</td>
<td>MODULE_UART_TX</td>
<td>10</td>
<td>N/C</td>
</tr>
<tr>
<td>11</td>
<td>N/C</td>
<td>12</td>
<td>N/C</td>
</tr>
<tr>
<td>13</td>
<td>N/C</td>
<td>14</td>
<td>N/C</td>
</tr>
<tr>
<td>15</td>
<td>N/C</td>
<td>16</td>
<td>N/C</td>
</tr>
<tr>
<td>17</td>
<td>N/C</td>
<td>18</td>
<td>N/C</td>
</tr>
<tr>
<td>19</td>
<td>GND</td>
<td>20</td>
<td>N/C</td>
</tr>
</tbody>
</table>

Table 2. EM2 Connector

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>EM Adapter Assignment</th>
<th>Pin Number</th>
<th>EM Adapter Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N/C</td>
<td>2</td>
<td>GND</td>
</tr>
<tr>
<td>3</td>
<td>N/C</td>
<td>4</td>
<td>N/C</td>
</tr>
<tr>
<td>5</td>
<td>N/C</td>
<td>6</td>
<td>N/C</td>
</tr>
<tr>
<td>7</td>
<td>3.3 V</td>
<td>8</td>
<td>MODULE_AUDIO_DATA_OUT</td>
</tr>
<tr>
<td>9</td>
<td>3.3 V</td>
<td>10</td>
<td>MODULE_AUDIO_DATA_IN</td>
</tr>
<tr>
<td>11</td>
<td>MODULE_AUDIO_FSink</td>
<td>12</td>
<td>N/C</td>
</tr>
<tr>
<td>13</td>
<td>N/C</td>
<td>14</td>
<td>N/C</td>
</tr>
<tr>
<td>15</td>
<td>N/C</td>
<td>16</td>
<td>N/C</td>
</tr>
<tr>
<td>17</td>
<td>MODULE_AUDIO_CLK</td>
<td>18</td>
<td>MODULE_UART_RTS</td>
</tr>
<tr>
<td>19</td>
<td>nSHUTD</td>
<td>20</td>
<td>N/C</td>
</tr>
</tbody>
</table>
2.2.2 COM Connector

The COM connector interfaces with TI's MPU platforms, such as AM335x evaluation module (TMDXEVM3358). I/Os of the COM connector are at 1.8 V. Some components must not be installed (DNI) to use the COM connector. For further details, see Section 2.3. Table 3 lists the pinout for the COM connector.

Table 3. COM Connector

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Relevant COM Connector Pin Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SLOW_CLK_EDGE</td>
</tr>
<tr>
<td>8</td>
<td>1V8_IN</td>
</tr>
<tr>
<td>52</td>
<td>AUD_CLK_1V8</td>
</tr>
<tr>
<td>54</td>
<td>AUD_FSYNC_1V8</td>
</tr>
<tr>
<td>56</td>
<td>AUD_IN_1V8</td>
</tr>
<tr>
<td>58</td>
<td>AUD_OUT_1V8</td>
</tr>
<tr>
<td>66</td>
<td>HCI_TX_1V8</td>
</tr>
<tr>
<td>68</td>
<td>HCI_RX_1V8</td>
</tr>
<tr>
<td>70</td>
<td>HCI_CTS_1V8</td>
</tr>
<tr>
<td>72</td>
<td>HCI_RTS_1V8</td>
</tr>
<tr>
<td>76</td>
<td>TX_DEBUG_1V8</td>
</tr>
<tr>
<td>89</td>
<td>nSHUTDOWN_1V8</td>
</tr>
<tr>
<td>3, 9, 19, 37, 47, 63, 77, 83, 87, 95, 97</td>
<td>GND</td>
</tr>
<tr>
<td>2, 6, 18, 22, 42, 60, 64, 92</td>
<td>GND</td>
</tr>
</tbody>
</table>

2.2.3 Debug Header

The debug header enables signals in the design such as power, ground, debug, UART, and audio signals for testing and debugging. The I/Os are at 1.8 V. Table 4 lists the physical location of the pin numbers.

Table 4. Debug Header Pinout

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>EM Adapter Pin Assignment</th>
<th>Pin Number</th>
<th>EM Adapter Pin Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>2</td>
<td>VBAT</td>
</tr>
<tr>
<td>3</td>
<td>VIO_HOST</td>
<td>4</td>
<td>GND</td>
</tr>
<tr>
<td>5</td>
<td>AUD_FSYNC_1V8</td>
<td>6</td>
<td>AUD_CLK_1V8</td>
</tr>
<tr>
<td>7</td>
<td>AUD_OUT_1V8</td>
<td>8</td>
<td>AUD_IN_1V8</td>
</tr>
<tr>
<td>9</td>
<td>CLK_REQ_OUT_1V8</td>
<td>10</td>
<td>SLOW_CLK_EDGE</td>
</tr>
<tr>
<td>11</td>
<td>HCI_TX_1V8</td>
<td>12</td>
<td>HCI_RX_1V8</td>
</tr>
<tr>
<td>13</td>
<td>HCI_CTS_1V8</td>
<td>14</td>
<td>HCI_RTS_1V8</td>
</tr>
<tr>
<td>15</td>
<td>TX_DEBUG_1V8</td>
<td>16</td>
<td>nSHUTDOWN_1V8</td>
</tr>
<tr>
<td>17</td>
<td>VDD_1V8</td>
<td>18</td>
<td>GND</td>
</tr>
</tbody>
</table>
2.3 Board Configurations

2.3.1 Power Supplies Configuration
The CC2564 device requires the following two power sources:
- VDD_IN: main power supply for the module
- VDD_IO: power source for the 1.8-V I/O ring

The HCI module includes several on-chip voltage regulators for increased noise immunity and can connect directly to the battery.

2.3.1.1 Jumper Configuration
The CC256XQFNEM board has two jumpers that can be configured to control power on the CC2564B controller. Jumper VDD_1V8 (J1) is the power supply jumper to the CC2564B VDD_IO. Jumper VBAT_CC (J2) is the main VDD_IN power supply to the CC2564B. Ensure jumpers are placed for connecting power to the device. Table 5 lists the jumper configurations.

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD_1V8 (J1)</td>
<td>Supplies power to CC2564B I/Os</td>
</tr>
<tr>
<td>VBAT_CC (J2)</td>
<td>Main power supply for CC2564B</td>
</tr>
</tbody>
</table>

2.3.1.2 Measuring Current Consumption
These jumpers can measure the current consumption by placing current sense resistors on R10 for VBAT_CC (J2) and R7 for VDD_1V8 (J1). Both resistors are 0.10 $\Omega$, 1/4 W. J2 can measure the power consumed by the CC2564 controller, including the RF TX and RF RX, whereas the J1 can measure power consumed by the digital VDD_IO.

2.3.2 Radio Frequency (RF) Interface
The board can be configured to route the RF output from the CC2564B controller to the onboard copper antenna or the onboard U.FL connector. This configuration occurs by placing the resistor in either R29 or R30 position that has negligible resistance of 0 $\Omega$. R30 connects the RF to the U.FL, while R29 connects to the copper antenna. The U.FL connector is for conducted testing of the RF. The Bluetooth hardware evaluation tool (BHET) can be used to test basic RF functionality on this board. Figure 8 shows the CC2564 integrated antenna.
2.3.3 Slow Clock

2.3.3.1 Clock Inputs

The slow clock can come from an internal or external source. The CC2564B controller lets you place the slow clock on the board (the default setting) or source it from an external source and connects to the SLOW_CLK_IN and can be a digital signal in the range of 0 V to 1.8 V. The frequency accuracy of the slow clock must be 32.768 kHz ± 250 ppm for Bluetooth use (according to the Bluetooth specification). Figure 9 shows the clock input.

![Figure 9. Clock Input](image)

2.3.4 UART Configuration

The UART for the CC256XQFNEM board can be routed to the EM or COM connector. The signals are also available to the debug header to probe the signals. Figure 10 shows the EM connector as the default UART configuration, where the dashed line indicates that the COM connector is not connected. To configure the COM connector for UART, remove or depopulate the U3 level shifter as shown in Figure 11, where the level shifter is surrounded by a dashed line to indicate that it is not populated.

![Figure 10. UART Default Configuration](image)
2.3.5 PCM Configuration

For voice and assisted-audio features, the PCM signals from CC2564 controller (master) must connect to an external audio host (slave). The CC256XQFN board provides the PCM clock (BCLK) and FSYNC (WCLK) signals to the external codec. The PCM configuration is required for the following profiles:

- HFP
- HSP
- A3DP

Two configurations are available for the two connectors: EM and COM. Figure 12 shows the default configuration. The following sections describe how to set up each connector.
2.3.5.1 EM Configuration

The EM connector allows configuration of the CC2564 controller as either the master or slave. The default configuration is a master role for the module through the EM connector. By default, the EM board is configured for PCM master but not completely enabled. Resistor R11 must be removed. R11 is placed by default to avoid leakage current (I/O floating) when there is no audio usage. Figure 13 shows the R11 DNI to enable audio features.

To change the direction of the PCM to configure the module as the slave, do as follows:

2. Remove resistor R19 on the U4 level shifter (see Figure 14).

2.3.5.2 COM Configuration

To configure the COM connector, the resistors (R21, R22, R23, and R24) connected to U4 must be removed to disable the lines connecting to the level shifters. The signal in the COM connector can be configured to run in either direction without any changes to the board components.
3 Software Tools

3.1 TI Dual-Mode Bluetooth Stack

TI’s dual-mode Bluetooth stack enables Bluetooth + Bluetooth low energy and is comprised of single mode and dual-mode offerings implementing the Bluetooth 4.0 specification. The Bluetooth stack provides simple command line sample applications to speed development.

The stack works with the following:
- Any MSP430 MCU with flash equal to or greater to 128KB and RAM equal to or greater than 8KB (CC256XMSPBTBLESW)
- Any TM4C MCU with flash equal to or greater than 128KB (CC256XM4BTBLESW)
- Other MCUs (CC256XSTBTBLESW)

For detailed documentation, see the Bluetooth Demo APPS page.

3.2 TI Dual-Mode Bluetooth Service Pack for CC256x

The CC256x Bluetooth service packs (SPs) are mandatory initialization scripts that contain bug fixes and platform-specific configurations. The scripts must be loaded into the corresponding CC256x device after every power cycle. The CC256x SPs are delivered as a Bluetooth script (BTS) file. A BTS file is a scripted binary file that contains the embedded HCI commands and HCI events.

3.3 Bluetooth Hardware Evaluation Tool

The CC256x Bluetooth hardware evaluation tool can be downloaded as a complete package from TI. This program is an intuitive tool to test TI's Bluetooth chips, including this CC256xQFNEM board. This program is used to test RF performance and modify the service packs of TI's Bluetooth chips.
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