Dual-Mode *Bluetooth*® CC2564 Evaluation Board

User's Guide

Literature Number: SWRU450
March 2016

Dual-Mode Bluetooth® CC2564 Evaluation Board

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 (CC256XMSPBTBLESW)
  - TM4C (CC256XM4BTBLESW)
  - Other MCU (CC256XSTBTBLESW)

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

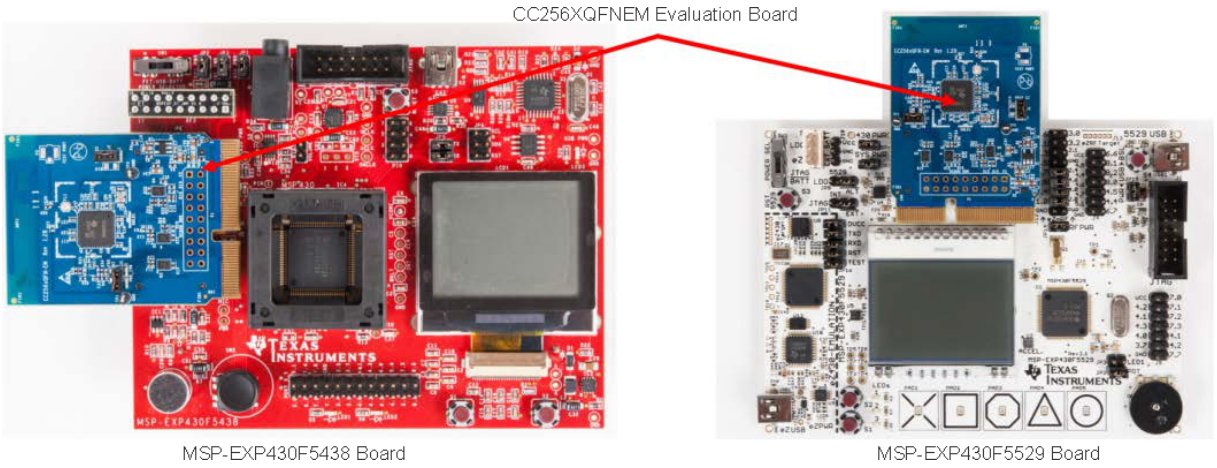

Figure 2. MSP430 Hardware Setup Examples

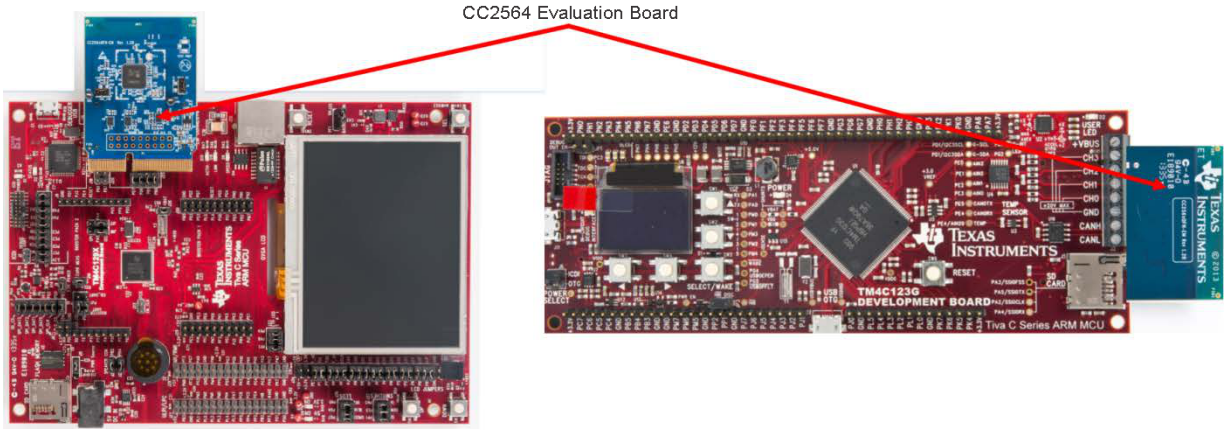

Figure 3. TM4C Hardware Setup Examples

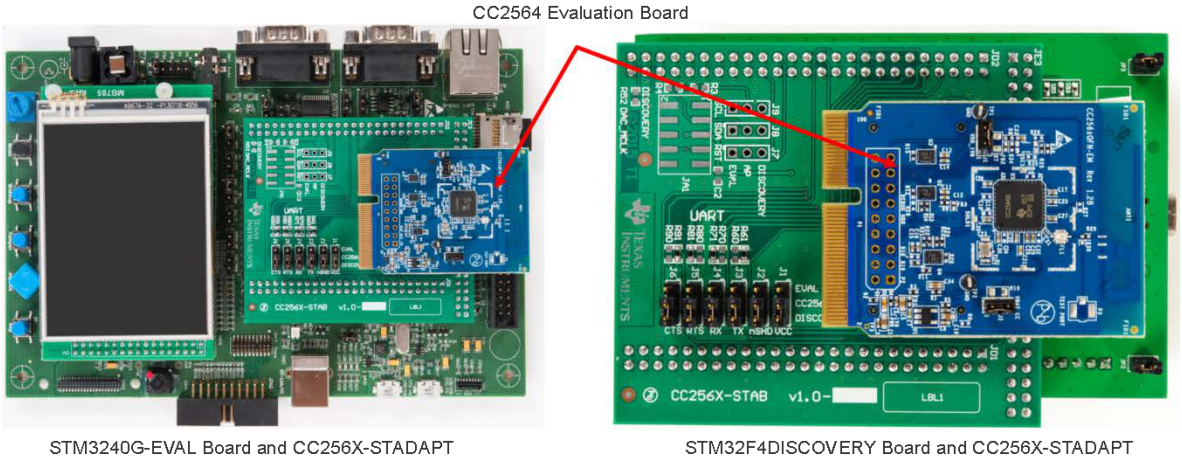

Figure 4. Other MCU Hardware Setup Examples

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.

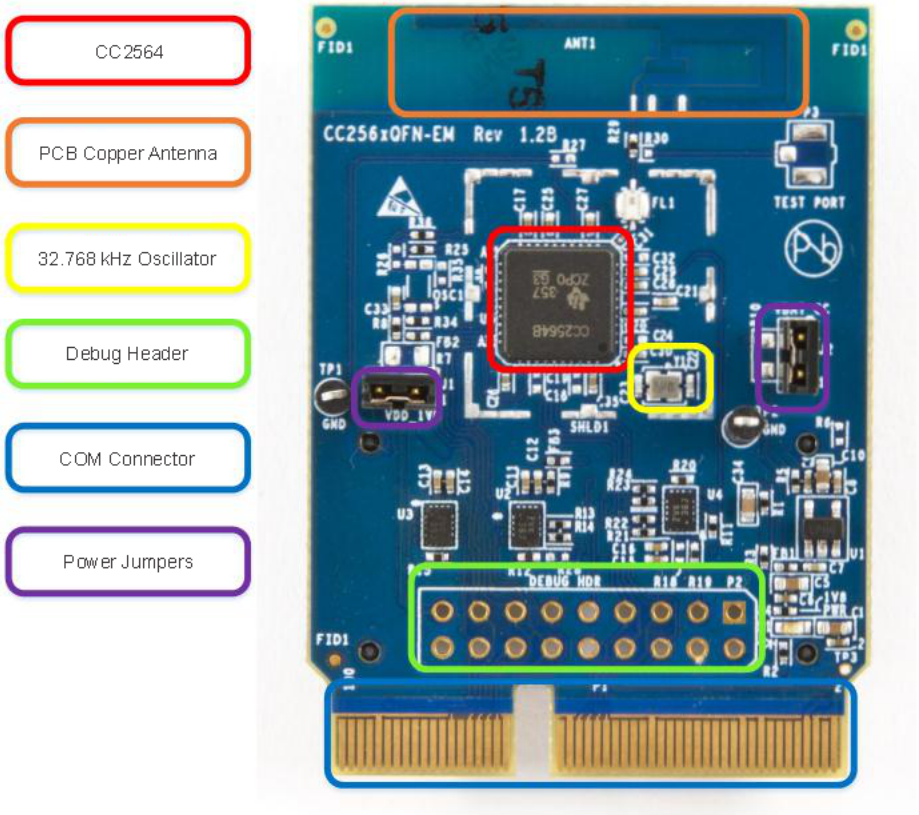

Figure 5. CC256XQFNEM Board Front Overview

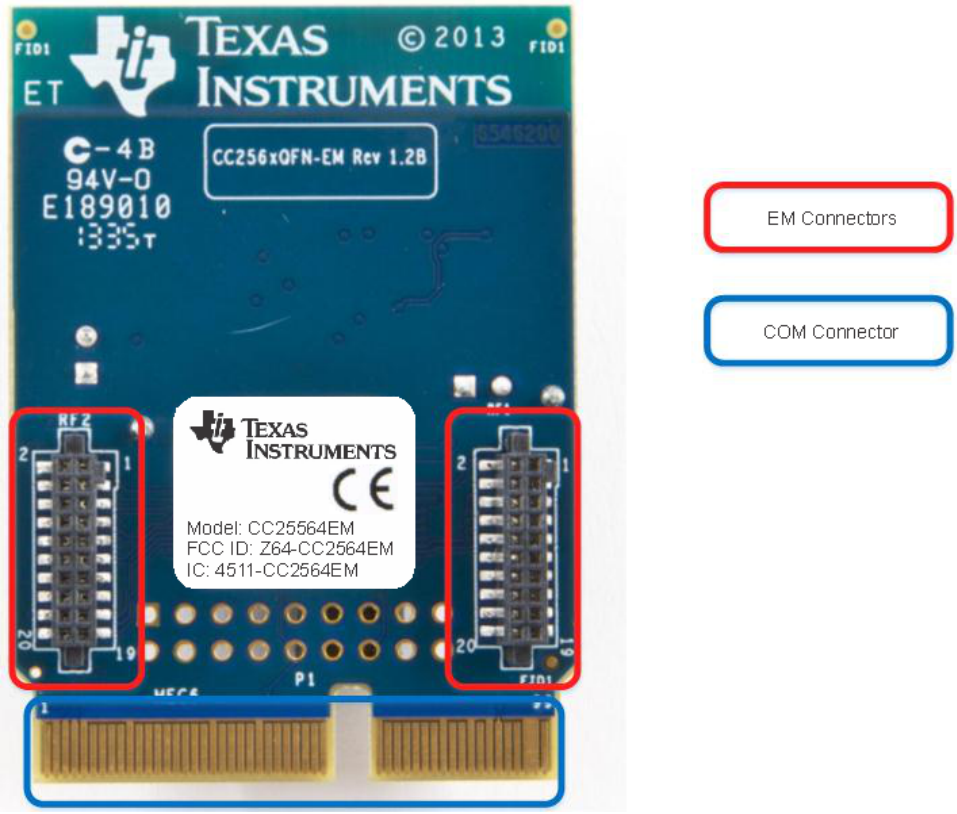

Figure 6. CC2564MODNEM Board Back Connectors

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.

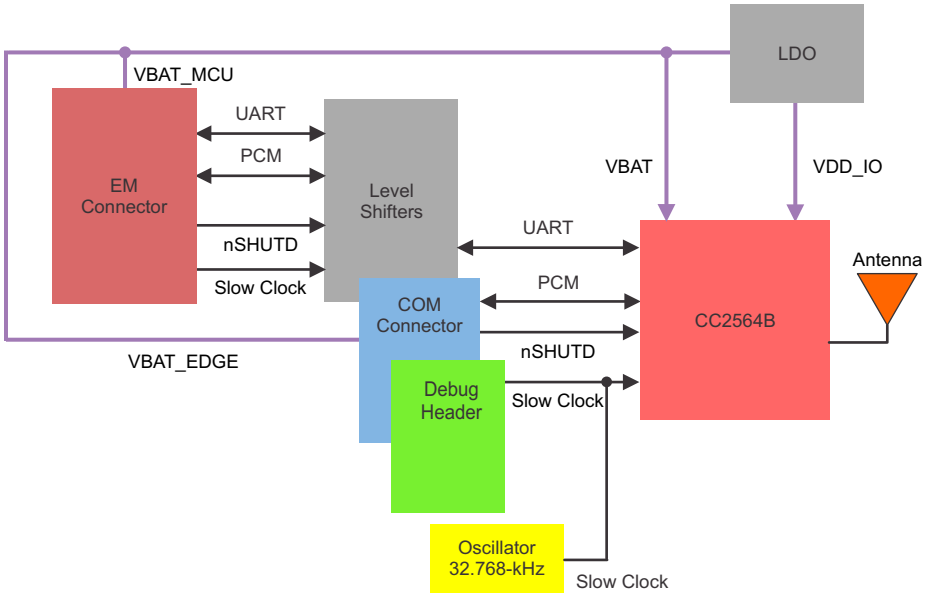

Figure 7. CC256XQFNEM Block Diagram

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 1. EM1 Connector

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

Table 2. EM2 Connector

Pin Number	EM Adapter Assignment	Pin Number	EM Adapter Assignment
1	N/C	2	GND
3	N/C	4	N/C
5	N/C	6	N/C
7	3.3 V	8	MODULE_AUDIO_DATA_OUT
9	3.3 V	10	MODULE_AUDIO_DATA_IN
11	MODULE_AUDIO_FSINK	12	N/C
13	N/C	14	N/C
15	N/C	16	N/C
17	MODULE_AUDIO_CLK	18	MODULE_UART_RTS
19	nSHUTD	20	N/C

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

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

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

Pin Number	EM Adapter Pin Assignment	Pin Number	EM Adapter Pin Assignment
1	GND	2	VBAT
3	VIO_HOST	4	GND
5	AUD_FSYNC_1V8	6	AUD_CLK_1V8
7	AUD_OUT_1V8	8	AUD_IN_1V8
9	CLK_REQ_OUT_1V8	10	SLOW_CLK_EDGE
11	HCI_TX_1V8	12	HCI_RX_1V8
13	HCI_CTS_1V8	14	HCI_RTS_1V8
15	TX_DEBUG_1V8	16	nSHUTDOWN_1V8
17	VDD_1V8	18	GND

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 5. Jumper Configurations

Jumper	Description
VDD_1V8 (J1)	Supplies power to CC2564**B** I/Os
VBAT_CC (J2)	Main power supply for CC2564**B**

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 Ω, 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 Ω. 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.

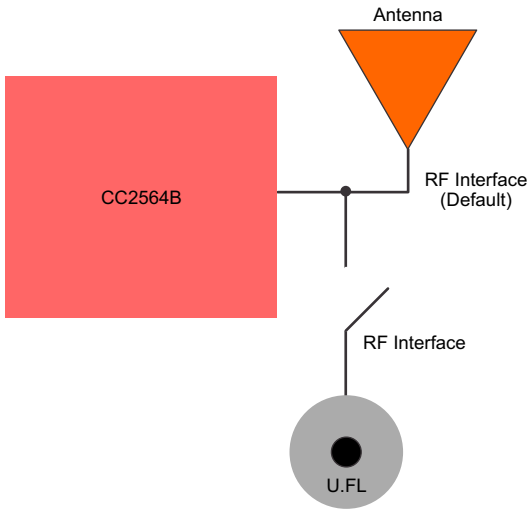

Figure 8. CC2564 Integrated Antenna

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.

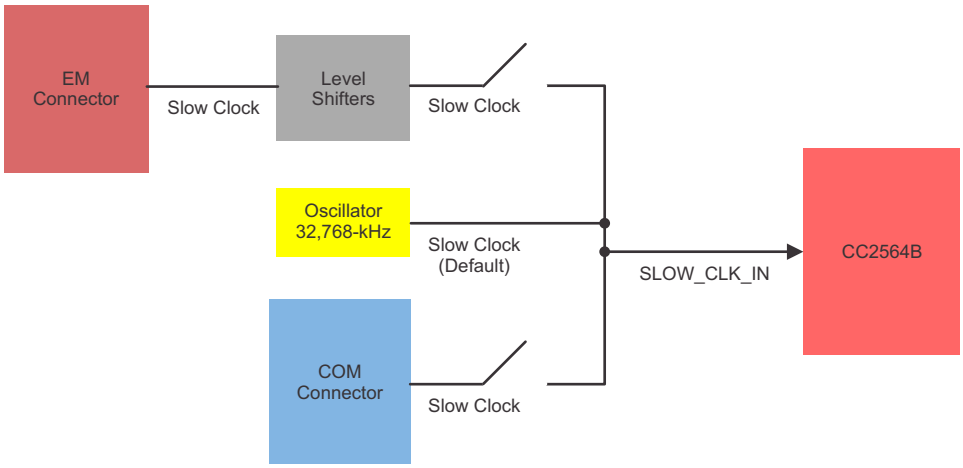

Figure 9. Clock Input

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.

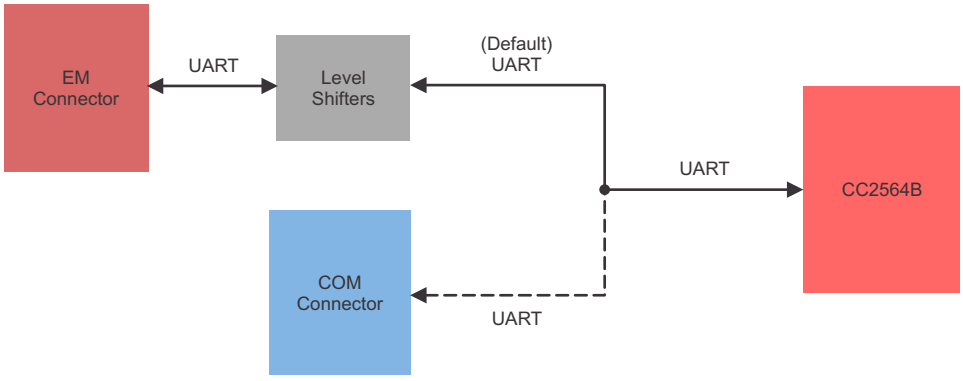

Figure 10. UART Default Configuration

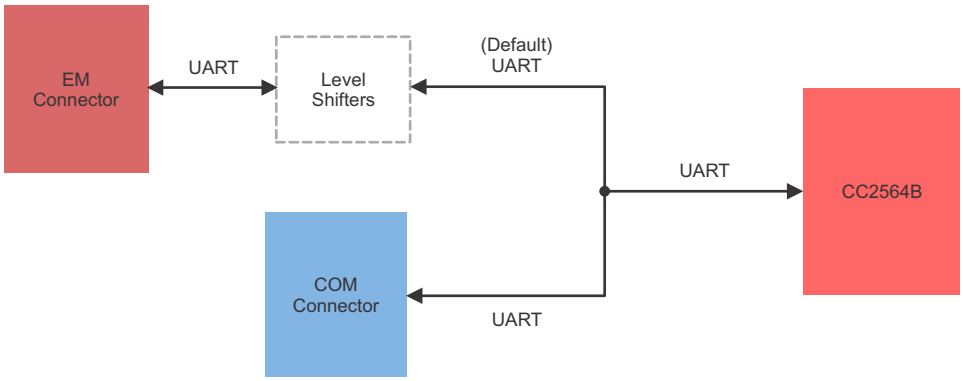

Figure 11. UART COM Connector Configuration

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.

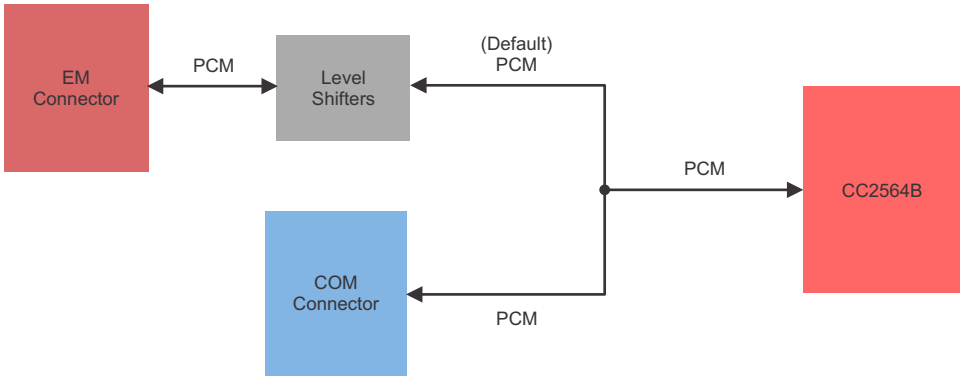

Figure 12. PCM Connector Configuration

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.

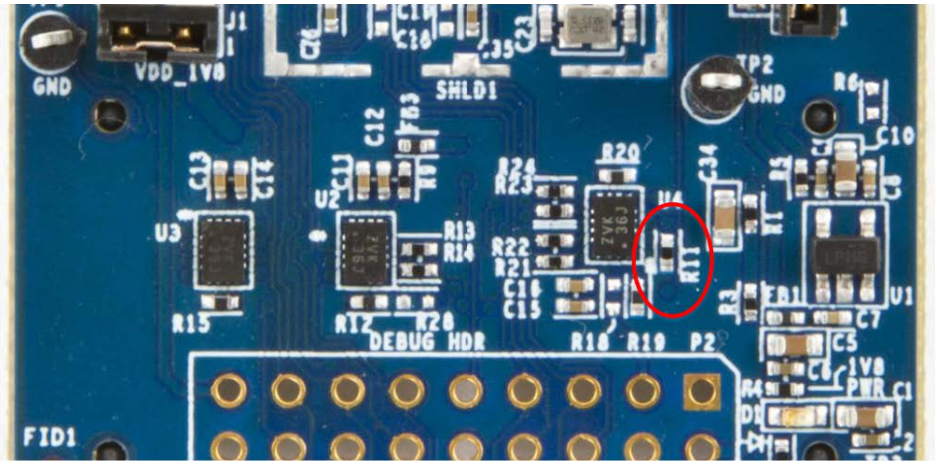

Figure 13. R11 DNI to Enable Audio Features

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

1. Connect resistor R18.
2. Remove resistor R19 on the U4 level shifter (see Figure 14).

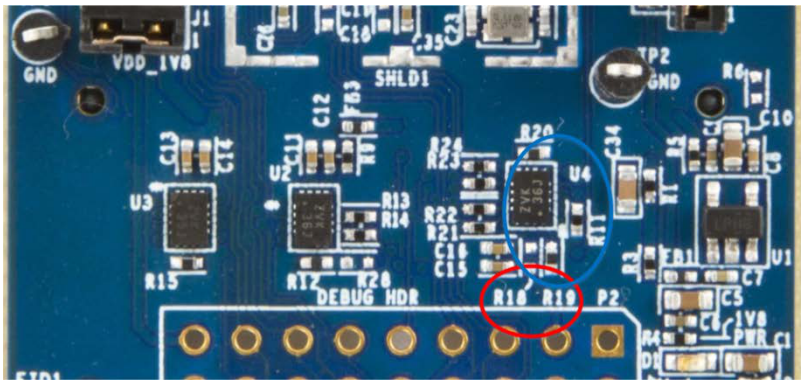

Figure 14. Resistors to Change the Direction of PCM

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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