Dual-Mode Bluetooth® CC2564 Module With Integrated Antenna Evaluation Board

User's Guide

Literature Number: SWRU427
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Contents

List of Figures

Dual-Mode Bluetooth® CC2564 Module With Integrated Antenna Evaluation Board (CC2564MODAEM)

1 Introduction

The CC2564MODAEM evaluation board contains the CC2564MODA *Bluetooth*® host controller interface (HCI) module with integrated antenna and is intended for evaluation and design purposes. For a complete evaluation solution, the CC2564MODAEM board plugs directly into the following hardware development kits (HDKs):

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

A certified and royalty-free TI dual-mode *Bluetooth* stack (TIBLUETOOTHSTACK-SDK) is available for the MSP430 and TM4C12x MCUs. The CC2564MODAEM hardware design files (schematics, layout, and bill of materials [BOM]) are provided as a reference to aid in the implementation of the CC2564MODA module.

The CC2564MODA module is a complete *Bluetooth* BR/EDR/LE HCI solution with integrated antenna based on TI's CC2564B dual-mode *Bluetooth* single-chip device, which reduces design effort and enables fast time to market. The CC2564MODA module includes TI's seventh-generation *Bluetooth* core, providing a product-proven solution that is *Bluetooth* 4.1 compliant. The devices provide one of the best *Bluetooth* RF performances with a transmit power and receive sensitivity that provides 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 all commonly used *Bluetooth* BR/EDR/LE modes of operation.

2 CC2564MODAEM Features

The CC2564MODAEM board includes the following features:

- CC2564MODA *Bluetooth* HCI module with integrated antenna (MOG package)
- Supports *Bluetooth* specification v4.1
- Supports dual-mode (*Bluetooth* and *Bluetooth* low energy)
- Offers class 1.5 transmit power (+10 dBm)
- Offers high sensitivity (-93 dBm typ)
- Offers 32.768-kHz oscillator
- Offers UART interface: control and data
- Offers PCM/I2S interface: voice and audio
- Offers layer PCB design
- Offers 1.8-V LDO (LP2985-18)
- Offers three voltage level translators (SN74AVC4T774)
- Offers EM connectors that plug directly into the following TI hardware development kits:
  - MSP-EXP430F5529
  - MSP-EXP430F5438
  - DK-TM4C123G
  - DK-TM4C129X
  - Other MCUs
- Offers COM connectors that plug directly into the TI HDKs
- Features certified and royalty-free TI dual-mode *Bluetooth* stack (TIBLUETOOTHSTACK-SDK):
  - MSP430™ (CC256XMSPBTBLESW)
  - TM4C (CC256XM4BTBLESW)
  - Other MCUs (CC256XSTBTBLESW)

3 CC2564MODAEM Board Applications

Examples of embedded wireless applications include the following:

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

4 Introduction to CC2564MODAEM Board

TI intends this user's guide to help you integrate TI's *Bluetooth* development platform, the CC2564MODAEM evaluation board, with TI's evaluation platforms and software development kits (SDKs). The guide describes the components and configurations of the board to use for various *Bluetooth* applications and includes specific information about the module to help apply the board specifics to your application. Module information and capabilities, including pin descriptions and available software and tools, are provided to enhance your out-of-box experience.

Figure 1 shows the CC2564MODAEM board.

Figure 1. CC2564MODAEM Board

5 Kit Contents

The CC2564MODAEM kit includes the following contents:

- One CC2564MODAEM board with the TI dual-mode *Bluetooth* CC2564 module with integrated antenna
- One block jumper for the MSP-EXP430F5438 board
- Four jumpers for the MSP-EXP430F5529 board

6 Requirements

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

Hardware

- One MSP430 experimenter board – sold separately:
  - MSP-EXP430F5529 board
  - MSP-EXP430F5438 board
- One 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)
- Integrated development environment (IDE) versions – platform dependent:
  - Code Composer Studio (CCS)
  - IAR 7.2/7.3 for ARM®
  - ARM Keil® µVision® 4.70.0.0

Figure 2 shows an example of the MSP430 hardware setup.

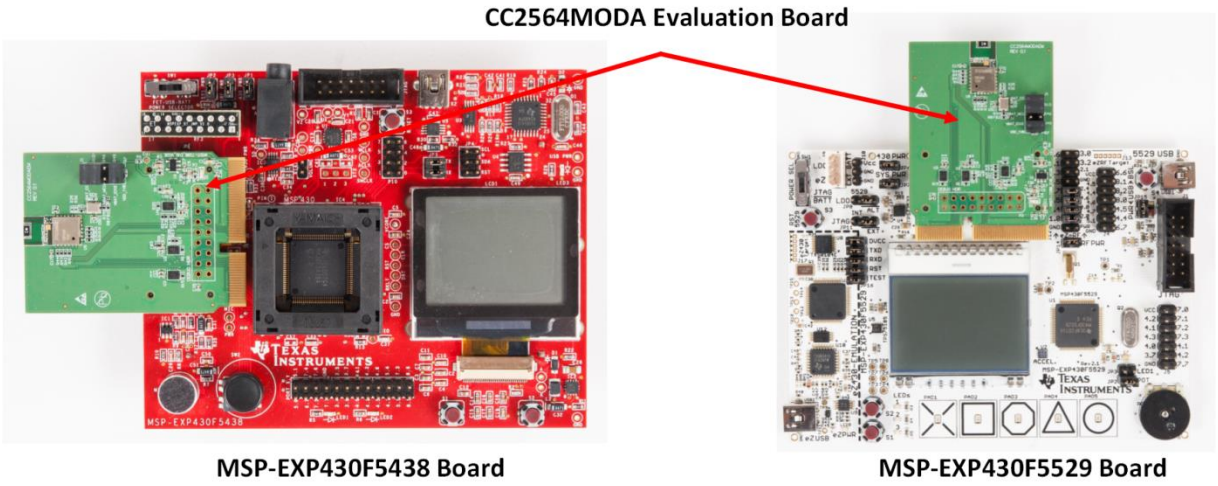

Figure 2. MSP430 Hardware Setup Example

Figure 3 shows an example of the TM4C hardware setup.

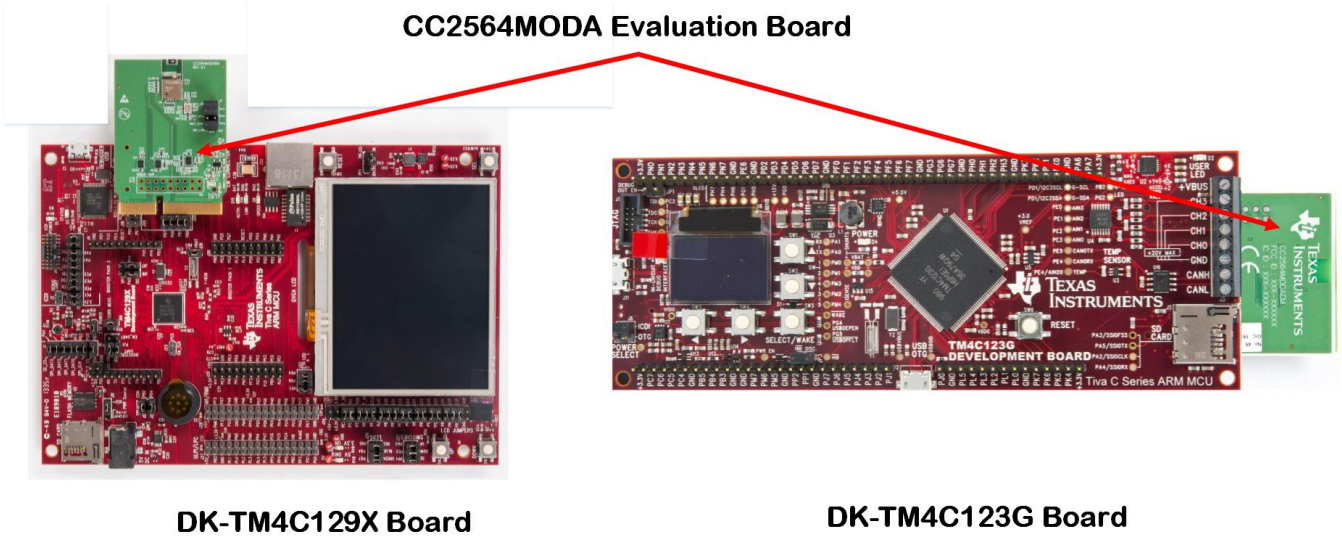

Figure 3. TM4C Hardware Setup Example

Figure 4 shows examples of other MCU hardware setups using the CC256xEM *Bluetooth* Adapter Kit (CC256x_STADAPT): the STM3240G-EVAL board and the STM32FDISCOVERY board.

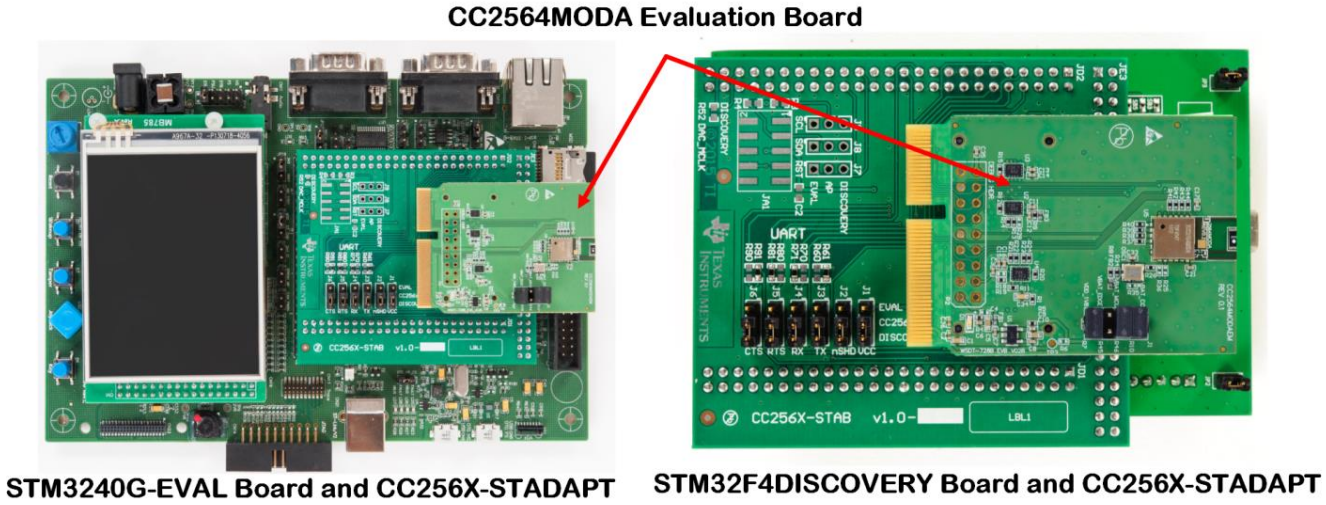

Figure 4. Other MCU Hardware Setup Examples

7 Overview

The CC2564MODAEM board is the development environment for the CC2564MODA module and plugs directly into TI's MSP430 and TM4C experimenter boards with EM connectors that simplify prototype wiring and field trials. This module is based on TI's CC2564B device, uses a host controller interface (HCI), and is a cost-effective and flexible way to implement a *Bluetooth* network. The HCI reduces the cost of the BOM, offering designers the flexibility to choose a controller and eliminate redundant processing capacity while the Bluetooth stack resides and executes on the host processor of the application.

The CC2564MODAEM board has two connectors: EM and COM. The I/Os for the EM are at 3.3 V, which is the default assembly configuration. The I/Os for the COM are at 1.8 V and require hardware modification.

TI intends the CC2564MODAEM board for evaluation purposes and to work with TI's Hardware Development Kit (for more information, see Section 9, *Software Tools*). To implement this reference design, schematic and layout files are available on the CC2564MODA product page.

Figure 5 shows the front overview of the CC2564MODAEM board.

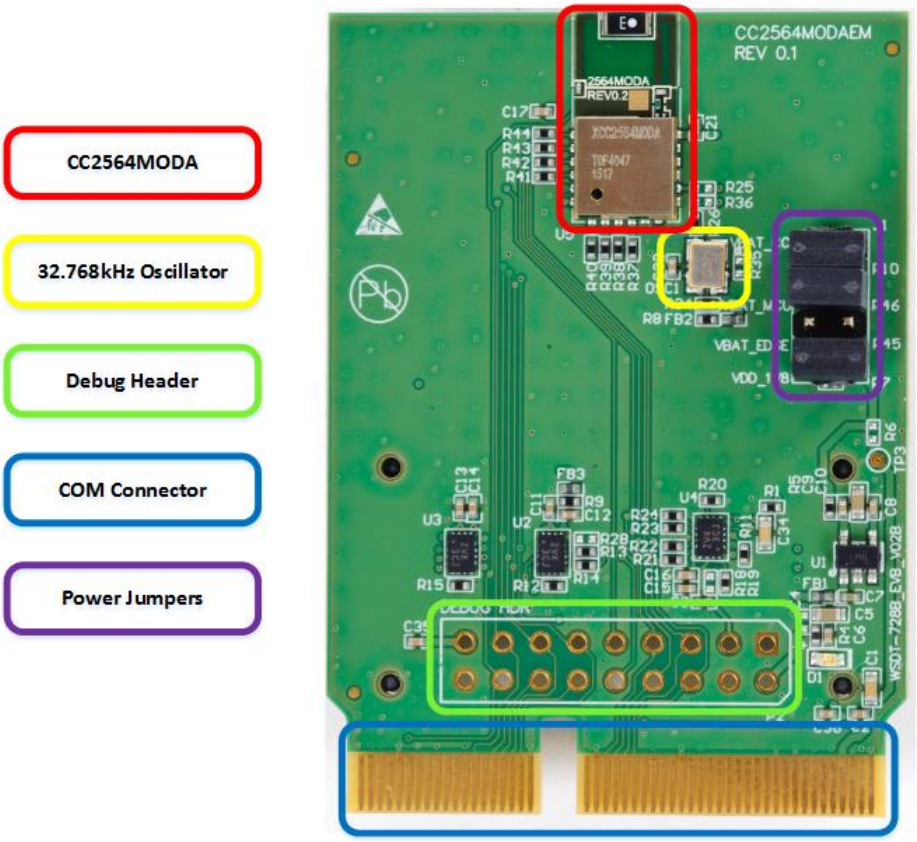

Figure 5. CC2564MODAEM Board Front Overview

Figure 6 shows the back of the CC2564MODAEM board.

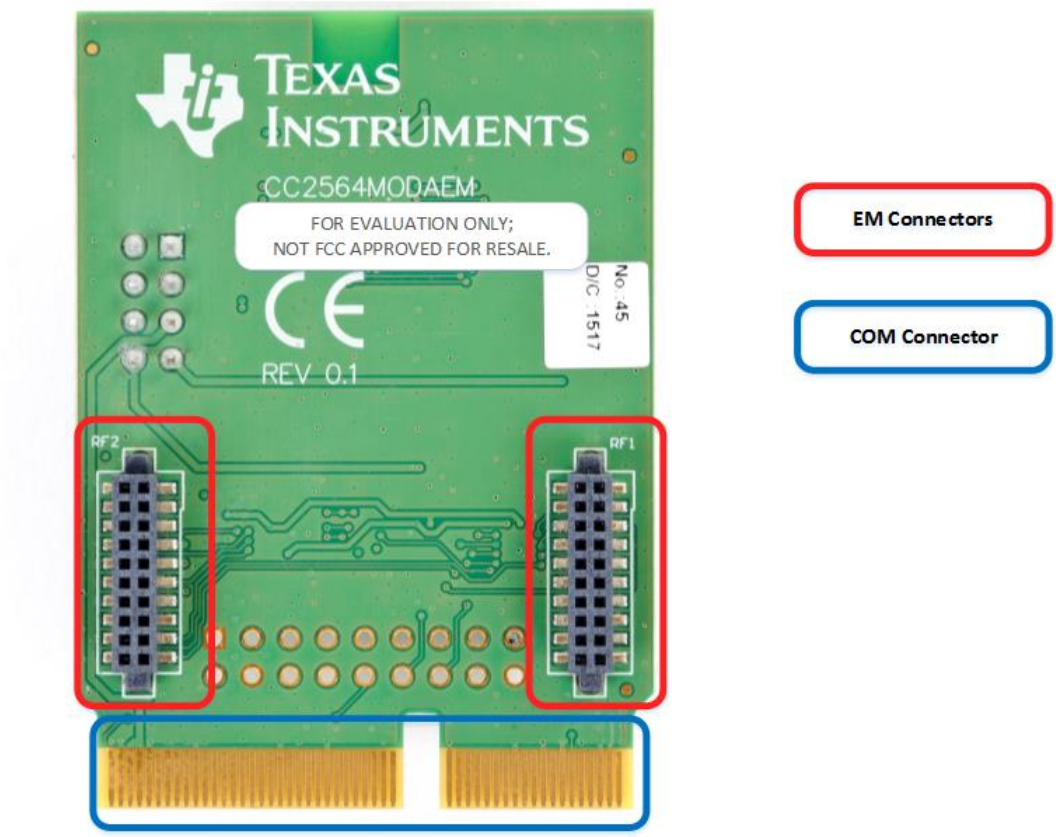

Figure 6. CC2564MODAEM Board Back Connectors

8 Hardware Description

Figure 7 shows the high-level block diagram of the CC2564MODAEM board. The CC2564MODA module includes an integrated 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 CC2564MODAEM board includes the following connectors:

- EM (default)
- COM

The connectors can supply power to the CC2564MODA module through VBAT_EDGE or VBAT_MCU. Signals for the EM connector are controlled using level shifters. The hardware can be configured and modified to use the slow clock from the connectors. A third connector, the debug header, is 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.

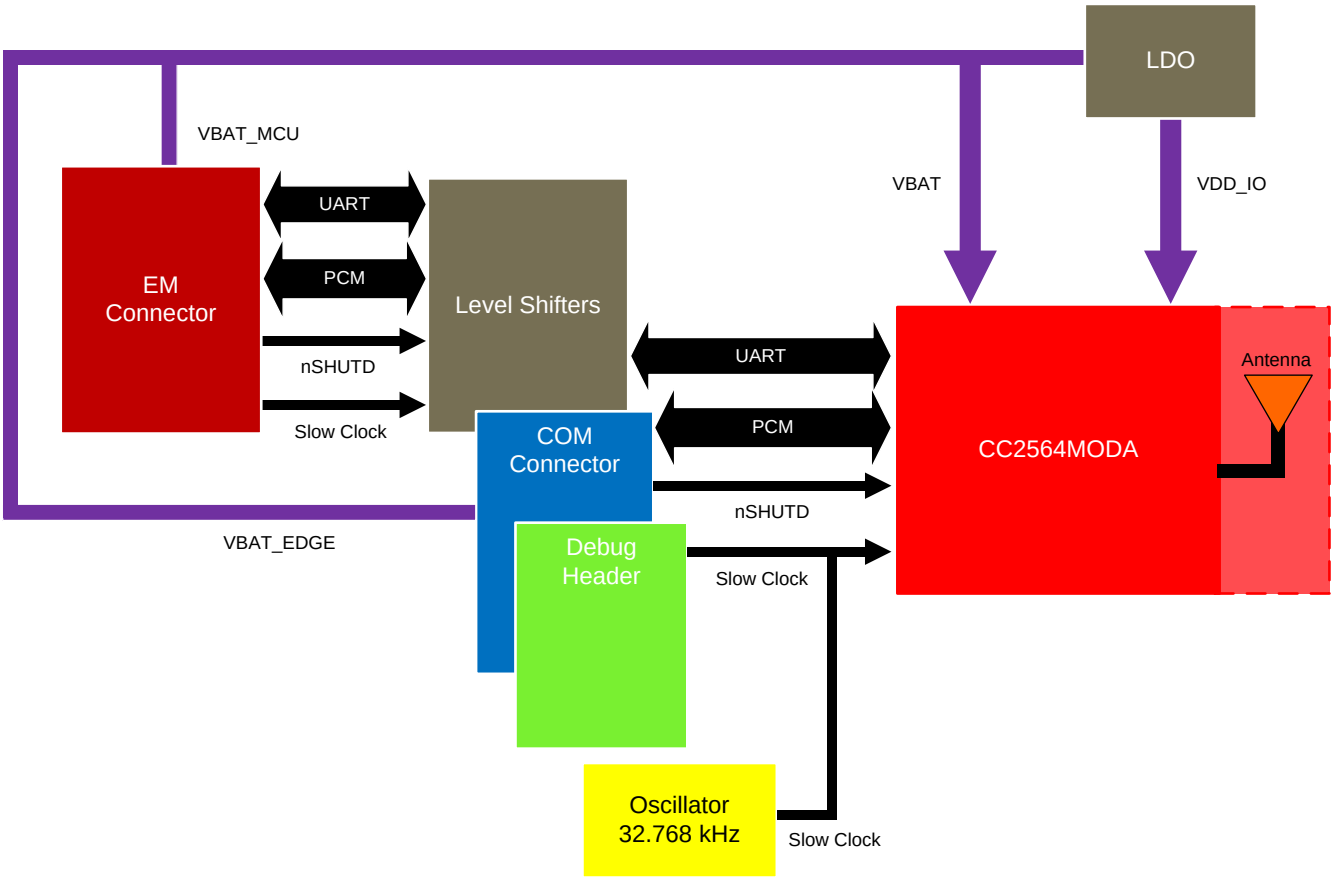

Figure 7. CC2564MODAEM Block Diagram

8.1 Connectors

This section describes the CC2564MODAEM EM, COM, and debug header connectors.

8.1.1 EM Connectors

The EM connectors mount on a variety of TI MCU platforms, such as the MSP430 (MSP-EXP430F5529 and MSP-EXP430F5438) and the TM4C (DK-TM4C123G and DK-TM4C129X) device. All EM I/Os are at 3.3-V levels. Pin assignments are described with respect to the CC2564MODA side. For example, MODULE_UART_RX refers to the receiving UART RX pin on the CC2564MODA module that connects to the UART TX pin on the MCU.

Table 1 describes the standard pinout for EM1.

Table 1. EM1 Connector Standard Pinout

Pin	EM Adaptor Assignment	Pin	EM Adaptor 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 describes the standard pinout for EM2.

Table 2. EM2 Connector Standard Pinout

Pin	EM Adaptor Assignment	Pin	EM Adaptor 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

8.1.2 COM Connector

The COM connector interfaces with TI's MPU platforms, such as the AM335x evaluation module (TMDXEVM3358). All COM I/Os are at 1.8 V. Some components must not be installed (DNI) to use the COM connector. Table 3 describes the COM pins (for more information, see Section 8.2, *Board Configurations*).

Table 3. COM Connector

Pin[(1)]	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

(1) All pins not listed are NC.

8.1.3 Debug Header

The debug header enables important 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 describes the debug header assignments.

Table 4. Debug Header Pinout

Pin	EM Adapter Pin Assignment	Pin	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

8.2 Board Configurations

8.2.1 Power Supplies Configuration

The CC2564MODA module requires 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 be connected directly to the battery.

8.2.1.1 Jumper Configurations

The CC2564MODAEM board has four jumpers that can be configured to control power on the board. The power supply can be enabled through either the COM or EM connector through the VBAT_MCU or VBAT_EDGE jumper. VBAT_EDGE and VBAT_MCU supply power to the entire board. VDD_1V8 is the power supply jumper to the pins going in and out of the module. The VBAT_CC jumper is the main default power supply to the CC2564 device.

NOTE: For correct operation, ensure that jumpers are configured to connect power to the device.

Table 5 describes the jumper configurations and has the configuration for the board.

Table 5. Jumper Configurations

Jumper	Description
VDD_1V8 (J1)	Supplies power to CC2564 I/Os
VBAT_CC (J2)	Main power supply for CC2564
VBAT_EDGE (J3)	Enables power supply through COM connector
VBAT_MCU (J4)	Enables power supply through EM connectors

Figure 8 shows the default settings for the jumpers on the CC2564MODAEM board.

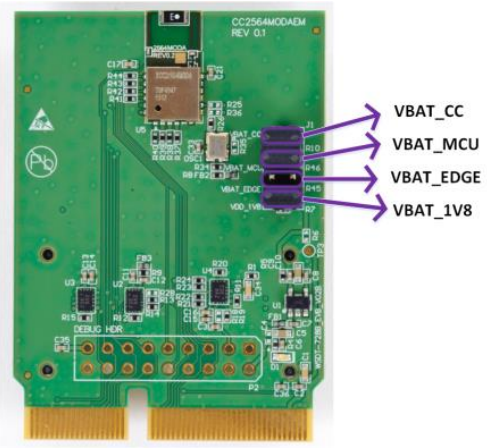

Figure 8. Jumper Configurations

8.2.1.2 Measuring Current Consumption

These jumpers measure current consumption by placing current sense resistors on R10 for VBAT_CC and R7 for VDD_1V8. Both resistors are 0.10 Ω, 1/4 W. The VBAT_CC jumper (J2) measures the power consumed by the CC2564 device, including the RF TX and RF RX. The VDD_1V8 jumper (J1) measures power consumed by the digital VDD_IO.

8.2.2 Slow Clock

8.2.2.1 Clock Inputs

The slow clock can be placed on the board (the default setting) or sourced from an external source. The CC2564MODA connects to SLOW_CLK_IN and can be a digital signal in the range of 0 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 inputs.

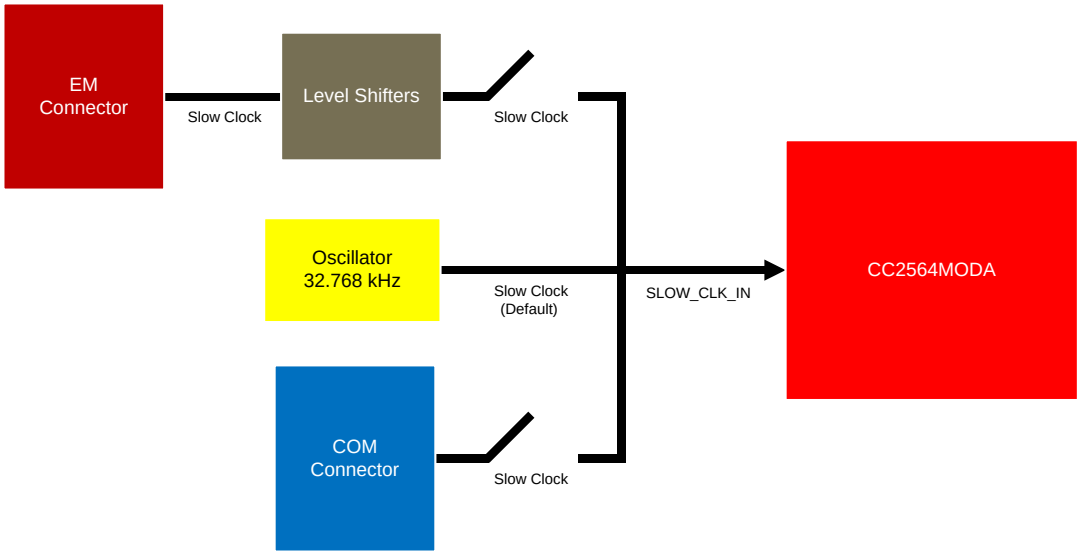

Figure 9. Clock Input

8.2.3 UART Configuration

The UART for the CC2564MODAEM 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. The dotted line shows 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 10, where the level shifter is dotted to represent the unpopulated level shifter

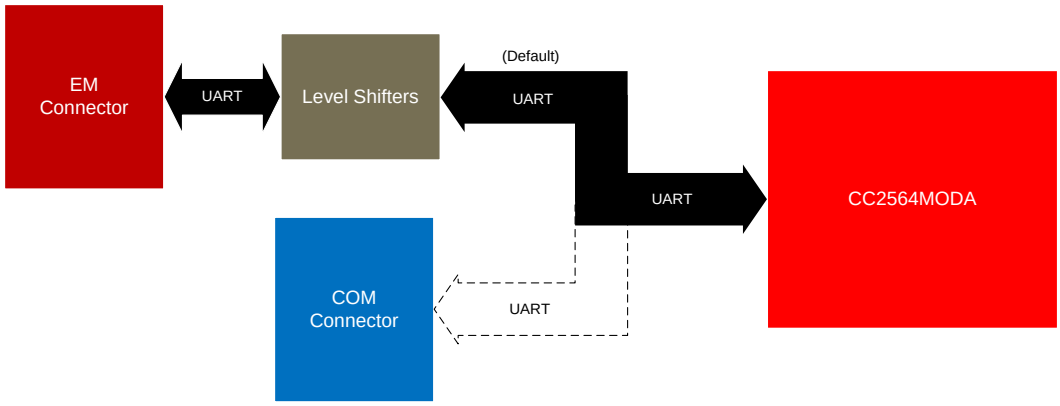

Figure 10. UART Default Configuration

Figure 11 shows the UART COM connector configuration.

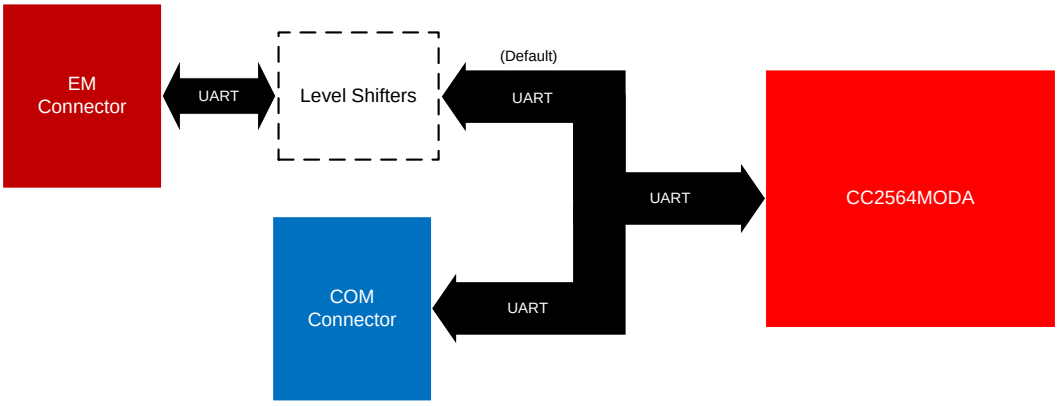

Figure 11. UART COM Connector Configuration

8.2.4 PCM Configuration

For voice and assisted audio features, the PCM signals from the CC2564MODA (master) module must be connected to an external audio host (slave). This relationship signifies that the CC2564MODA module provides the FSYNC and slow clock signals to the 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 and the following sections show how to set up each connector.

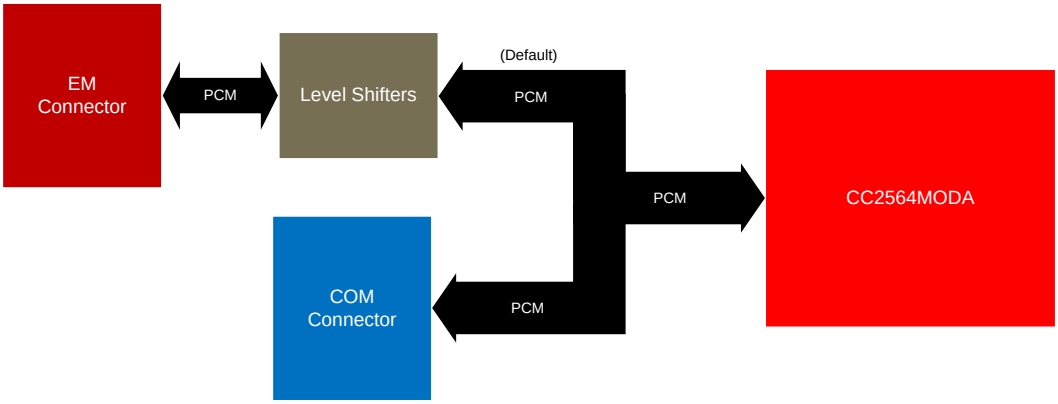

Figure 12. PCM Connector Configuration

8.2.4.1 EM Configuration

The EM connectors allow configuration of the CC2564MODA as the master or as the slave. The default configuration is a master role for the module through the EM connectors. To change the direction of the PCM so that the module is configured as the slave, perform the following steps:

1. Connect resistor R18.
2. Remove resistor R19 on the U4 level shifter (for the positions of the resistors, see Figure 13).

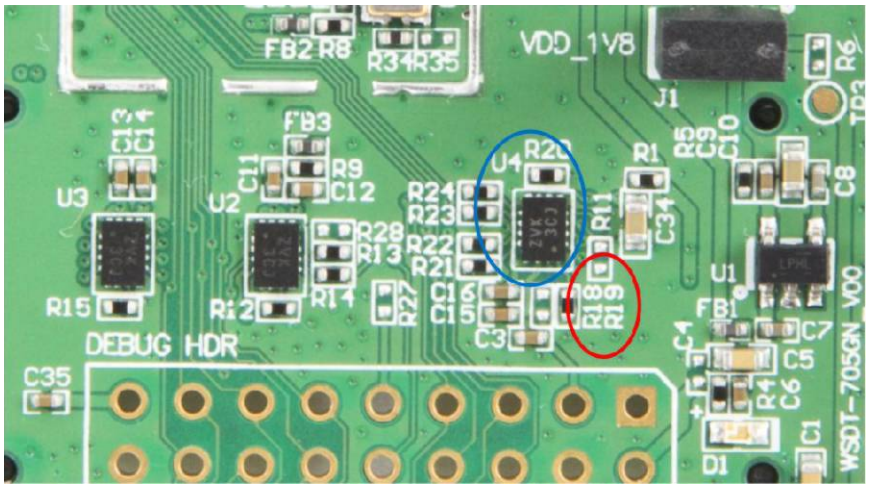

Figure 13. Resistors to Change the Direction of the PCM

The board can also be set up to use audio features. To use audio features, disconnect (DNI) the R11 resistor on the U4 level shifter (for the positions of the resistors, see Figure 14).

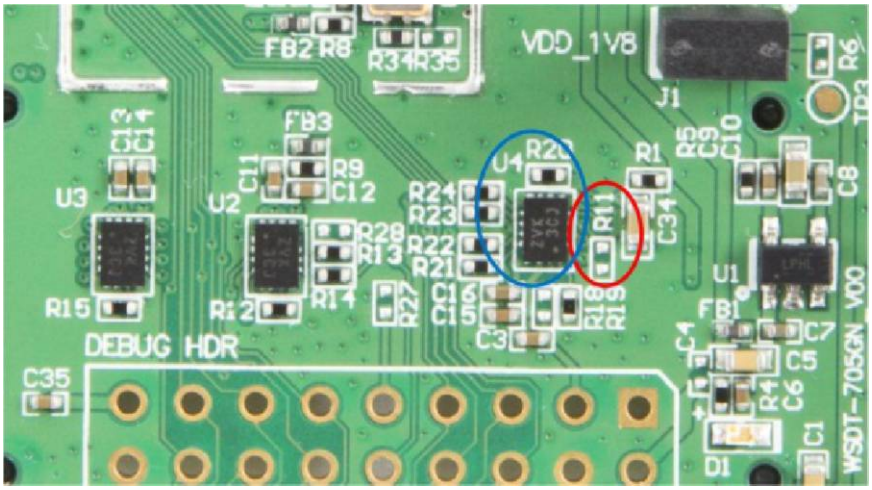

Figure 14. R11 DNI to Enable Audio Features

8.2.4.2 COM Configuration

To configure the COM connector, the resistors connected to U4 must be pulled high, switching the direction of the level shifter. The signal in the COM connector can be configured to run in either direction without requiring any changes to the board components.

9 Software Tools

9.1 TI Dual-Mode *Bluetooth* Stack

TI's dual-mode *Bluetooth* stack enables *Bluetooth* + *Bluetooth* low energy technology and is comprised of single-mode and dual-mode offerings implementing the specification for *Bluetooth* 4.0 wireless technology. 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 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 Stack Demo APPS wiki page.

9.2 TI Dual-Mode Bluetooth Service Packs for the CC256x Device

The CC256x *Bluetooth* Service Packs 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.

9.3 Bluetooth Hardware Evaluation Tool

The CC256x Bluetooth Hardware Evaluation Tool is a program that can be downloaded as a complete package from TI. The tool is an intuitive user-friendly tool used to test TI's *Bluetooth* chips, including this CC256xQFNEM board. More specifically, the tool tests RF performance and modifies the service packs of our *Bluetooth* chips.

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