THE DATASHEET OF

CC2564MODNCMOET

CC2564MODx *Bluetooth*® Host Controller Interface (HCI) Module

1 Device Overview

1.1 Features

- Module Solution Based on TI's CC2564B Dual-Mode *Bluetooth*®, Available in Two Variants:
  - CC2564MODA With Integrated Antenna
  - CC2564MODN With External Antenna
- Fully Certified Module for FCC, IC, CE, and Bluetooth 4.1
  - FCC (Z64-2564N), IC (451I-2564N) Modular Grant (see Section 6.2.1.3, Section 7.1.1, and Section 7.1.2)
  - CE Certified as Summarized in the Declaration of Conformity (see Section 7.1.3)
  - Bluetooth 4.1 Controller Subsystem Qualified (CC2564MODN: QDID 55257; CC2564MODA: QDID 64631). Compliant up to the HCI Layer
- Highly Optimized for Design Into Small Form Factor Systems and Flexibility:
  - CC2564MODA
    - Integrated Chip Antenna
    - Module Footprint: 35 Terminals, 0.8-mm Pitch, 7 mm × 14 mm × 1.4 mm (Typical)
  - CC2564MODN
    - Single-Ended 50-Ω RF Interface
    - Module Footprint: 33 Terminals, 0.8-mm Pitch, 7 mm × 7 mm × 1.4 mm (Typical)
- BR and EDR Features Include:
  - Up to Seven Active Devices
  - Scatternet: Up to Three Piconets Simultaneously, One as Master and Two as Slaves
  - Up to Two Synchronous Connection Oriented (SCO) Links on the Same Piconet
  - Support for All Voice Air-Coding—Continuously Variable Slope Delta (CVSD), A-Law, µ-Law, and Transparent (Uncoded)
  - Assisted Mode for HFP 1.6 Wideband Speech (WBS) Profile or A2DP Profile to Reduce Host Processing and Power
  - Support of Multiple Bluetooth Profiles With Enhanced QoS
- Low Energy Features Include:
  - Support of up to 10 Simultaneous Connections
  - Multiple Sniff Instances Tightly Coupled to Achieve Minimum Power Consumption
  - Independent Buffering for Low Energy Allows Large Numbers of Multiple Connections Without Affecting BR or EDR Performance
  - Built-In Coexistence and Prioritization Handling for BR, EDR, and Low Energy
- Best-in-Class Bluetooth (RF) Performance (TX Power, RX Sensitivity, Blocking)
  - Class 1.5 TX Power up to +10 dBm
  - –93 dbm Typical RX Sensitivity
  - Internal Temperature Detection and Compensation to Ensure Minimal Variation in RF Performance Over Temperature, No External Calibration Required
  - Improved Adaptive Frequency Hopping (AFH) Algorithm With Minimum Adaptation Time
  - Provides Longer Range, Including Twice the Range of Other Low-Energy-Only Solutions
- Advanced Power Management for Extended Battery Life and Ease of Design
  - On-Chip Power Management, Including Direct Connection to Battery
  - Low Power Consumption for Active, Standby, and Scan Bluetooth Modes
  - Shutdown and Sleep Modes to Minimize Power Consumption
- Physical Interfaces:
  - UART Interface With Support for Maximum Bluetooth Data Rates
    - UART Transport Layer (H4) With Maximum Rate of 4 Mbps
    - Three-Wire UART Transport Layer (H5) With Maximum Rate of 4 Mbps
  - Fully Programmable Digital Pulse-Code Modulation (PCM)–I2S Codec Interface
- CC256x Bluetooth Hardware Evaluation Tool: PC-Based Application to Evaluate RF Performance of the Device and Configure Service Pack

1.2 Applications

- Mobile Accessories
- Sports and Fitness Applications
- Wireless Audio Solutions
- Set-Top Boxes and Remote Controls
- Toys
- Test and Measurement
- Industrial: Cable Replacement
- Wireless Sensors
- Automotive Aftermarket
- Wellness and Health

1.3 Description

The CC2564MODx module from Texas Instruments™ is a complete *Bluetooth*® BR/EDR, and low energy HCI solution that reduces design effort, cost, and time to market. The CC2564MODx module includes TI's seventh-generation core and provides a versatile, product-proven solution that is Bluetooth 4.1-compliant. The module is also certified for FCC, IC, and CE, requiring no prior RF experience to develop with this device; and the device includes a royalty-free software stack compatible with several host MCUs and MPUs. The CC2564MODx module provides best-in-class RF performance with transmit power and receive sensitivity that provides twice the range and higher throughput than other Bluetooth-low-energy-only solutions.

Furthermore, TI's power-management hardware and software algorithms provide significant power savings in all commonly used Bluetooth BR/EDR and low energy modes of operation.

The TI dual-mode Bluetooth stack software is certified and provided royalty free for TI's MSP430™ and MSP432™ ARM® Cortex®-M3 and ARM® Cortex®-M4 MCUs, and Linux® based MPUs. Other processors can be supported through TI's third party. The iPod® (MFi) protocol is supported by add-on software packages. Multiple profiles and sample applications, including the following, are supported:

- Serial port profile (SPP)
- Advanced audio distribution profile (A2DP)
- Audio/video remote control profile (AVRCP)
- Hands-free profile (HFP)
- Human interface device (HID)
- Generic attribute profile (GATT)
- Several Bluetooth low energy profiles and services

For more information, see TI Dual-Mode Bluetooth Stack.

In addition to software, the BOOST-CC2564MODA and CC2564MODxEM evaluation boards are available for each variant. For more information on TI's wireless platform solutions for Bluetooth, see TI's wireless-connectivity/dual-mode-bluetooth page.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE
CC2564MODNCMOET	MOE (33)	7.0 mm × 7.0 mm × 1.4 mm (Typical)
CC2564MODNCMOER	MOE (33)	7.0 mm × 7.0 mm × 1.4 mm (Typical)
CC2564MODACMOG	MOG (35)	7.0 mm × 14.0 mm × 1.4 mm (Typical)

(1) For more information on these devices, see Section 8.2.

1.4 Functional Block Diagram

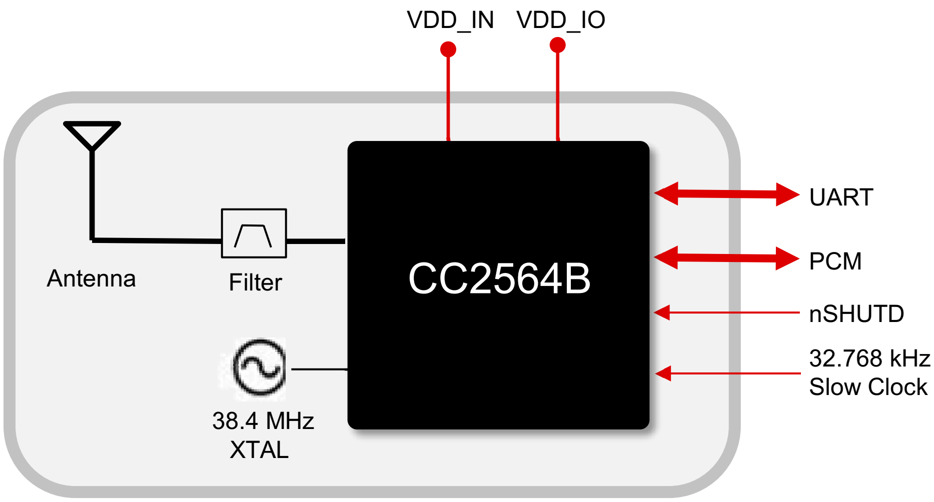


Figure 1-1. CC2564MODA Functional Block Diagram

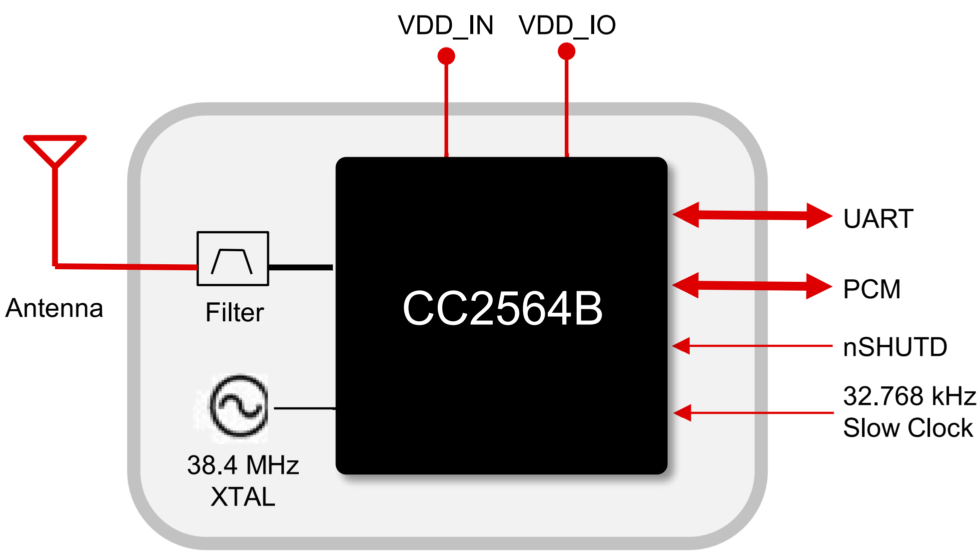


Figure 1-2. CC2564MODN Functional Block Diagram

Table of Contents

2 Revision History

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

Changes from December 28, 2015 to January 16, 2017	Page
• Changed Section 1.1	1
• Changed Section 1.3	2
• Added Table 3-2	7
• Changed Section 7	43
• Added Figure 7-1	46
• Changed Table 8-1	51

Changes from November 4, 2015 to December 28, 2015	Page
• Added CC2564MODA device variant	1
• Added applications in Section 1.2	2
• Changed VBAT to VDD_IN Figure 5-1 and Figure 5-2	3
• Changed storage temperature range in Section 4.1	8
• Changed restrictions on verification of parameters in Section 4.7.4.1	15
• Changed restrictions on verification of parameters in Section 4.7.4.2	18
• Changed values for Adjacent channel power |M-N| = 2 and Adjacent channel power |M-N| > 2 in Table 4-15	18
• Added "Includes a 128-bit hardware encryption accelerator as defined by the Bluetooth specifications" in Section 5.4	20
• Changed Figure 5-10	29
• Changed Figure 5-11	30
• Changed Section 6.2.2.1	41

3 Terminal Configuration and Functions

3.1 Pin Diagram

Figure 3-1 shows the top view of the terminal designations for the CC2564MODA device.

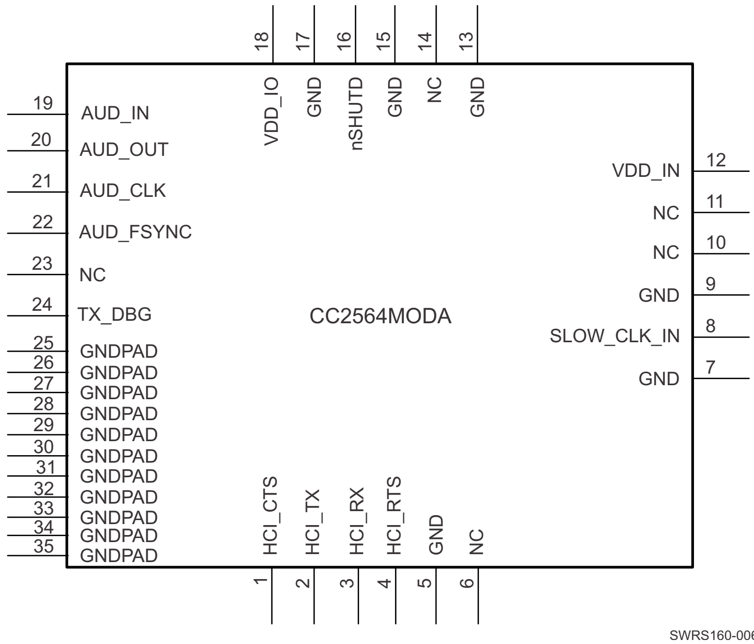


Figure 3-1. CC2564MODA Pin Diagram (Top View)

Figure 3-2 shows the top view of the terminal designations for the CC2564MODN device.

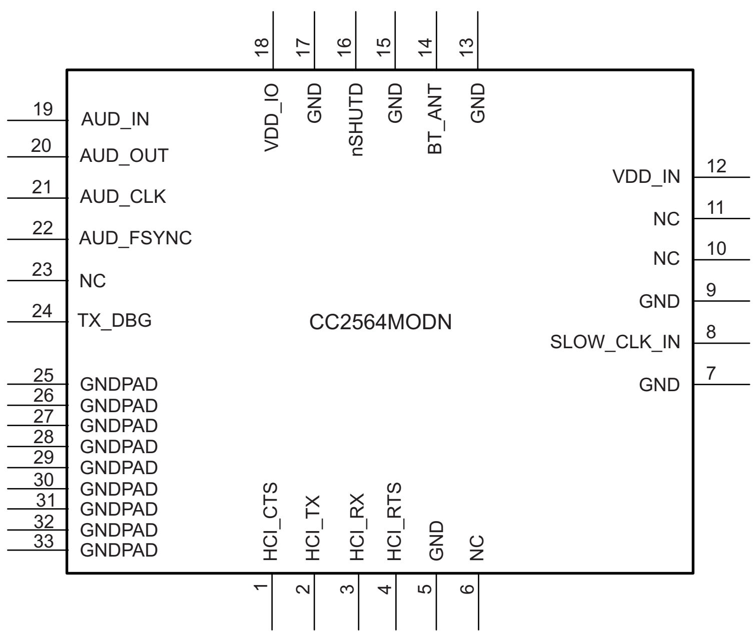


Figure 3-2. CC2564MODN Pin Diagram (Top View)

3.2 Pin Attributes

Table 3-1 describes the pin attributes.

Table 3-1. Pin Attributes

NO.	NAME	ESD[(1)] (V)	PULL AT RESET	DEF. DIR.[(2)]	I/O Type[(3)]	DESCRIPTION
1	HCI_CTS	750	PU	I	8 mA	HCI UART clear-to-send. The device can send data when HCI_CTS is low.
2	HCI_TX	750	PU	O	8 mA	HCI UART data transmit
3	HCI_RX	750	PU	I	8 mA	HCI UART data receive
4	HCI_RTS	750	PU	O	8 mA	HCI UART request-to-send. Host can send data when HCI_RTS is low.
5	GND	1000				Ground
7	GND	1000				Ground
8	SLOW_CLK_IN	1000		I		32.768-kHz clock in Fail-safe
9	GND	1000				Ground
12	VDD_IN			I		Main power supply for the module (2.2 to 4.8 V)
13	GND					Ground
14	BT_ANT	500		I/O		Bluetooth RF I/O (CC2564MODN only)
	NC					Not connected (CC2564MODA only)
15	GND					Ground
16	nSHUTD		PD	I		Shutdown input (active low)
17	GND					Ground
18	VDD_IO	1000		I		I/O power supply (1.8 V nominal)
19	AUD_IN	500	PD	I	4 mA	PCM data input Fail-safe
20	AUD_OUT	500	PD	O	4 mA	PCM data output Fail-safe
21	AUD_CLK	500	PD	I/O	HY, 4 mA	PCM clock Fail-safe
22	AUD_FSYNC	500	PD	I/O	4 mA	PCM frame sync Fail-safe
24	TX_DBG	1000	PU	O	2 mA	TI internal debug messages. TI recommends leaving a test point.
25	GNDPAD	1000				Ground
26	GNDPAD	1000				Ground
27	GNDPAD	1000				Ground
28	GNDPAD	1000				Ground
29	GNDPAD	1000				Ground
30	GNDPAD	1000				Ground
31	GNDPAD	1000				Ground
32	GNDPAD	1000				Ground
33	GNDPAD	1000				Ground
34	GNDPAD	1000				Ground (CC2564MODA only)
35	GNDPAD	1000				Ground (CC2564MODA only)

(1) ESD: Human Body Model (HBM). JEDEC 22-A114 2-wire method. CDM: All pins pass 500 V except BT_ANT, which passes 400 V.
(2) I = input; O = output; I/O = bidirectional
(3) I/O Type: Digital I/O cells. HY = input hysteresis, current = typical output current

3.3 Connections for Unused Signals

Table 3-2 lists the connections for unused signals.

Table 3-2. Connections for Unused Signals

PIN NUMBER	FUNCTION	ESD(1) (V)	PULL AT RESET	DEF. DIR.(2)	I/O Type(3)	DESCRIPTION
6	NC			I		Not connected
10	NC			O		Not connected
11	NC			O		Not connected
23	NC	500	PD	I/O	4 mA	Not connected

(1) ESD: Human Body Model (HBM). JEDEC 22-A114 2-wire method. CDM: All pins pass 500 V except BT_ANT, which passes 400 V.
(2) I = input; O = output; I/O = bidirectional
(3) I/O Type: Digital I/O cells. HY = input hysteresis, current = typical output current

4 Specifications

Unless otherwise indicated, all measurements are taken at the device pins of the TI test evaluation board (EVB). All specifications are over process, voltage, and temperature, unless otherwise indicated.

All values apply to the CC2564MODA and CC2564MODN devices, unless otherwise indicated.

4.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise indicated). All parameters are measured as follows: VDD_IN = 3.6 V and VDD_IO = 1.8 V (unless otherwise indicated).(1)

		MIN	MAX	UNIT
VDD_IN	Supply voltage	–0.5	4.8	V
VDD_IO		–0.5	2.145	V
	Input voltage to analog pins(2)	–0.5	2.1	V
	Input voltage to all other pins	–0.5	VDD_IO + 0.5	V
	Operating ambient temperature(3)	–30	85	°C
	Bluetooth RF inputs		10	dBm
T_{stg}	Storage temperature	–40	100	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) Analog pin: BT_ANT
(3) The module supports a temperature range of –30°C to +85°C because of the operating conditions of the crystal.

4.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±500	V
		Charged device model (CDM), per JEDEC specification JESD22-C101(2)	±500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

4.3 Power-On Hours(1)

DEVICE	CONDITIONS	POWER-ON HOURS
CC2564MODx	Duty cycle = 25% active and 75% sleep T_A = 70ºC	15,400 (7 years)

(1) This information is provided solely to give the customer an estimation of the POH under certain specified conditions, and is not intended to – and does not – extend the warranty for the device under TI's Standard Terms and Conditions.

4.4 Recommended Operating Conditions

			MIN	MAX	UNIT
VDD_IN	Power supply voltage		2.2	4.8	V
VDD_IO	I/O power supply voltage		1.62	1.92	V
V_{IH}	High-level input voltage	Condition: Default	0.65 × VDD_IO	VDD_IO	V
V_{IL}	Low-level input voltage	Condition: Default	0	0.35 × VDD_IO	V
t_r and t_f	I/O input rise and fall times,10% to 90% — asynchronous mode		1	10	ns
	I/O input rise and fall times, 10% to 90% — synchronous mode (PCM)		1	2.5	ns
	Voltage dips on VDD_IN ($V_{(BAT)}$) duration = 577 µs to 2.31 ms, period = 4.6 ms			400	mV
	Maximum ambient operating temperature (1)		–30	85	°C

(1) A crystal-based solution is limited by the temperature range required for the crystal to meet 20 ppm.

4.5 Power Consumption Summary

4.5.1 Static Current Consumption

OPERATIONAL MODE	MIN	TYP	MAX	UNIT
Shutdown mode(1)		1	7	µA
Deep sleep mode(2)		40	105	µA
Total I/O current consumption in active mode			1	mA
Continuous transmission—GFSK(3)			107	mA
Continuous transmission—EDR(4)(5)			112.5	mA

(1) $V_{(BAT)} + V_{IO} + V_{(SHUTDOWN)}$
(2) $V_{(BAT)} + V_{IO}$
(3) At maximum output power (10 dBm)
(4) At maximum output power (8 dBm)
(5) Both π / 4 DQPSK and 8DPSK

4.5.2 Dynamic Current Consumption

4.5.2.1 Current Consumption for Different Bluetooth BR and EDR Scenarios

Conditions: VDD_IN = 3.6 V, 25°C, nominal unit, 8-dBm output power

OPERATIONAL MODE	MASTER AND SLAVE	AVERAGE CURRENT	UNIT
Synchronous connection oriented (SCO) link HV3	Master and slave	13.7	mA
Extended SCO (eSCO) link EV3 64 kbps, no retransmission	Master and slave	13.2	mA
eSCO link 2-EV3 64 kbps, no retransmission	Master and slave	10	mA
GFSK full throughput: TX = DH1, RX = DH5	Master and slave	40.5	mA
EDR full throughput: TX = 2-DH1, RX = 2-DH5	Master and slave	41.2	mA
EDR full throughput: TX = 3-DH1, RX = 3-DH5	Master and slave	41.2	mA
Sniff, four attempts, 1.28 seconds	Master and slave	145	µA
Page or inquiry scan 1.28 seconds, 11.25 ms	Master and slave	320	µA
Page (1.28 seconds) and inquiry (2.56 seconds) scans, 11.25 ms	Master and slave	445	µA
A2DP source	Master	13.9	mA
A2DP sink	Master	15.2	mA
Assisted A2DP source	Master	16.9	mA
Assisted A2DP sink	Master	18.1	mA
Assisted WBS EV3; retransmit effort = 2; maximum latency = 8 ms	Master and slave	17.5 and 18.5	mA
Assisted WBS 2EV3; retransmit effort = 2; maximum latency = 12 ms	Master and slave	11.9 and 13	mA

4.5.2.2 Current Consumption for Different Low Energy Scenarios

Conditions: VDD_IN = 3.6 V, 25°C, nominal unit, 8-dBm output power

MODE	DESCRIPTION	AVERAGE CURRENT	UNIT
Advertising, nonconnectable	Advertising in all three channels 1.28-seconds advertising interval 15 bytes advertise data	114	µA
Advertising, discoverable	Advertising in all three channels 1.28-seconds advertising interval 15 bytes advertise data	138	µA
Scanning	Listening to a single frequency per window 1.28-seconds scan interval 11.25-ms scan window	324	µA
Connected (master role)	500-ms connection interval 0-ms slave connection latency Empty TX and RX LL packets	169 (master)	µA
Connected (slave role)		199 (slave)	

4.6 Electrical Characteristics

RATING			CONDITION	MIN	MAX	UNIT
High-level output voltage, V_{OH}			At 2, 4, 8 mA	0.8 × VDD_IO	VDD_IO	V
			At 0.1 mA	VDD_IO – 0.2	VDD_IO	
Low-level output voltage, V_{OL}			At 2, 4, 8 mA	0	0.2 × VDD_IO	V
			At 0.1 mA	0	0.2	
I/O input impedance			Resistance	1		MΩ
			Capacitance		5	pF
Output rise and fall times, 10% to 90% (digital pins)			C_L = 20 pF		10	ns
I/O pull currents	PCM-I2S bus, TX_DBG	PU	Typical = 6.5	3.5	9.7	µA
		PD	Typical = 27	9.5	55	
	All others	PU	Typical = 100	50	300	µA
		PD	Typical = 100	50	360	

4.7 Timing and Switching Characteristics

4.7.1 *Device Power Supply*

The power-management hardware and software algorithms of the TI Bluetooth HCI module provide significant power savings, which is a critical parameter in an MCU-based system.

The power-management module is optimized for drawing extremely low currents.

4.7.1.1 Power Sources

The TI Bluetooth HCI 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.

4.7.1.2 Power Supply Sequencing

The device includes the following power-up requirements (see Figure 4-1):

- nSHUTD must be low. VDD_IN and VDD_IO are don't-care when nSHUTD is low. However, signals are not allowed on the I/O pins if I/O power is not supplied, because the I/Os are not fail-safe. Exceptions are SLOW_CLK_IN and AUD_xxx, which are fail-safe and can tolerate external voltages with no VDD_IO and VDD_IN.
- VDD_IO and VDD_IN must be stable before releasing nSHUTD.
- The slow clock must be stable within 2 ms of nSHUTD going high.

The device indicates that the power-up sequence is complete by asserting RTS low, which occurs up to 100 ms after nSHUTD goes high. If RTS does not go low, the device is not powered up. In this case, ensure that the sequence and requirements are met.

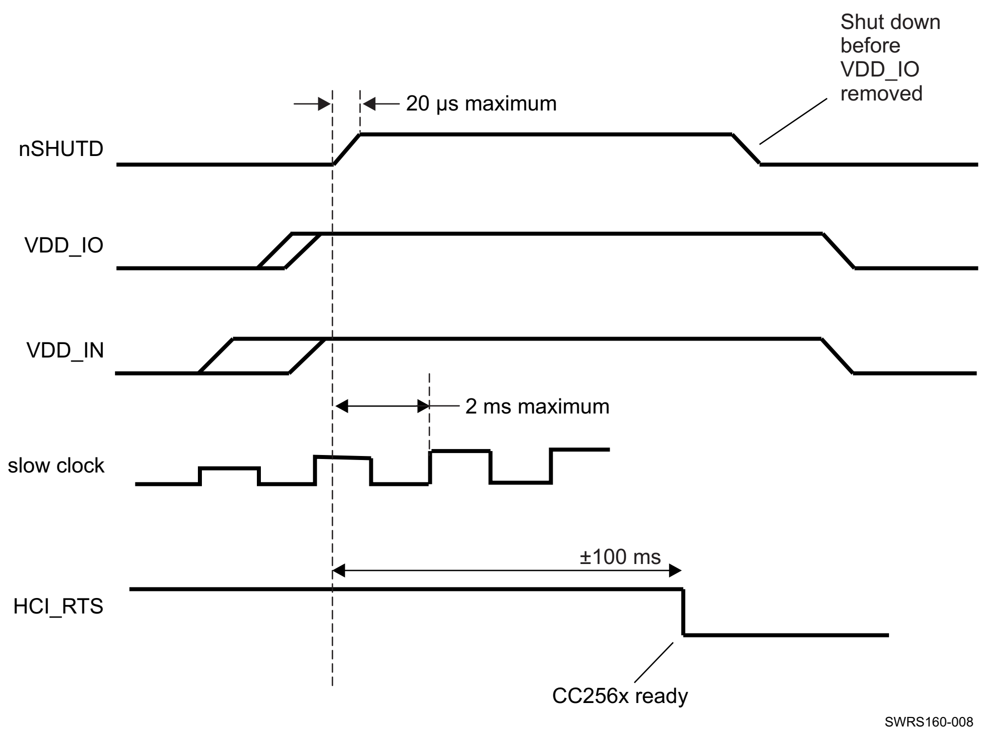


Figure 4-1. Power-Up and Power-Down Sequence

4.7.1.3 Power Supplies and Shutdown – Static States

The nSHUTD signal puts the device in ultra-low power mode and performs an internal reset to the device. The rise time for nSHUTD must not exceed 20 µs; nSHUTD must be low for a minimum of 5 ms.

To prevent conflicts with external signals, all I/O pins are set to the high-impedance (Hi-Z) state during shutdown and power up of the device. The internal pull resistors are enabled on each I/O pin, as described in Section 3.2. Table 4-1 describes the static operation states.

Table 4-1. Power Modes

	VDD_IN (1)	VDD_IO (1)	nSHUTD (1)	PM_MODE	COMMENTS
1	None	None	Asserted	Shutdown	I/O state is undefined. I/O voltages are not allowed on nonfail-safe pins.
2	None	None	Deasserted	Not allowed	I/O state is undefined. I/O voltages are not allowed on nonfail-safe pins.
3	None	Present	Asserted	Shutdown	I/Os are defined as tri-state with internal pullup or pulldown enabled.
4	None	Present	Deasserted	Not allowed	I/O state is undefined. I/O voltages are not allowed on nonfail-safe pins.
5	Present	None	Asserted	Shutdown	I/O state is undefined.
6	Present	None	Deasserted	Not allowed	I/O state is undefined. I/O voltages are not allowed on nonfail-safe pins.
7	Present	Present	Asserted	Shutdown	I/Os are defined as tri-state with internal pullup or pulldown enabled.
8	Present	Present	Deasserted	Active	See Section 4.7.1.4

(1) The terms *None* or *Asserted* can imply any of the following conditions: directly pulled to ground or driven low, pulled to ground through a pulldown resistor, or left NC or floating (high-impedance output stage).

4.7.1.4 I/O States in Various Power Modes

CAUTION

Some device I/Os are not fail-safe (see Section 3.2). Fail-safe means that the pins do not draw current from an external voltage applied to the pin when I/O power is not supplied to the device. External voltages are not allowed on these I/O pins when the I/O supply voltage is not supplied because of possible damage to the device.

Table 4-2 lists the I/O states in various power modes.

Table 4-2. I/O States in Various Power Modes

I/O NAME	SHUT DOWN (1)		DEFAULT ACTIVE (1)		DEEP SLEEP (1)	
	I/O State	Pull	I/O State	Pull	I/O State	Pull
HCI_RX	Z	PU	I	PU	I	PU
HCI_TX	Z	PU	O-H		O	
HCI_RTS	Z	PU	O-H		O	
HCI_CTS	Z	PU	I	PU	I	PU
AUD_CLK	Z	PD	I	PD	I	PD
AUD_FSYNC	Z	PD	I	PD	I	PD
AUD_IN	Z	PD	I	PD	I	PD
AUD_OUT	Z	PD	Z	PD	Z	PD
TX_DBG	Z	PU	O			

(1) I = input, O = output, Z = Hi-Z, — = no pull, PU = pullup, PD = pulldown, H = high, L = low

4.7.1.5 nSHUTD Requirements

Table 4-3. nSHUTD Requirements

PARAMETER		MIN	MAX	UNIT
V_{IH}	Operation mode level [(1)]	1.42	1.98	V
V_{IL}	Shutdown mode level [(1)]	0	0.4	V
	Minimum time for nSHUT_DOWN low to reset the device	5		ms
t_r and t_f	Rise and fall times		20	µs

(1) An internal 300-kΩ pulldown retains shut-down mode when no external signal is applied to this pin.

4.7.2 Clock Specifications

Table 4-4. Slow Clock Requirements

CHARACTERISTICS		CONDITION	MIN	TYP	MAX	UNIT
	Input slow clock frequency			32768		Hz
	Input slow clock accuracy (Initial + temp + aging)	Bluetooth			±250	ppm
		ANT			±50	ppm
t_r and t_f	Input transition time t_r and t_f (10% to 90%)				200	ns
	Frequency input duty cycle		15%	50%	85%	
V_{IH}	Slow clock input voltage limits	Square wave, DC-coupled	0.65 × VDD_IO		VDD_IO	V peak
V_{IL}	Slow clock input voltage limits	Square wave, DC-coupled	0		0.35 × VDD_IO	V peak
	Input impedance		1			MΩ
	Input capacitance				5	pF

4.7.3 Peripherals

4.7.3.1 UART

Figure 4-2 shows the UART timing diagram.

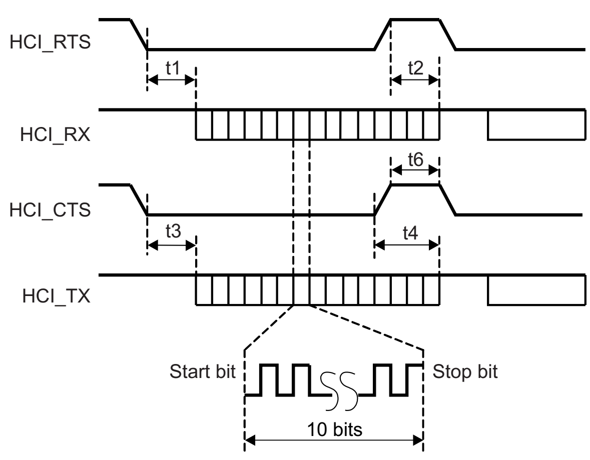


Figure 4-2. UART Timing

Table 4-5 lists the UART timing characteristics.

Table 4-5. UART Timing Characteristics

SYMBOL	CHARACTERISTICS	CONDITION	MIN	TYP	MAX	UNIT
	Baud rate		37.5		4000	kbps
	Baud rate accuracy per byte	Receive and transmit	–2.5		1.5%	
	Baud rate accuracy per bit	Receive and transmit	–12.5		12.5%	
t3	CTS low to TX_DATA on		0	2		µs
t4	CTS high to TX_DATA off	Hardware flow control			1	byte
t6	CTS-high pulse width		1			bit
t1	RTS low to RX_DATA on		0	2		µs
t2	RTS high to RX_DATA off	Interrupt set to 1/4 FIFO			16	byte

Figure 4-3 shows the UART data frame.

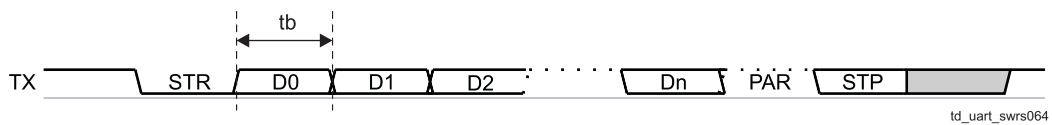


Figure 4-3. Data Frame

Table 4-6 describes the symbols used in Figure 4-3.

Table 4-6. Data Frame Key

SYMBOL	DESCRIPTION
STR	Start bit
D0...Dn	Data bits (LSB first)
PAR	Parity bit (optional)
STP	Stop bit

4.7.3.2 PCM

Figure 4-4 shows the interface timing for the PCM.

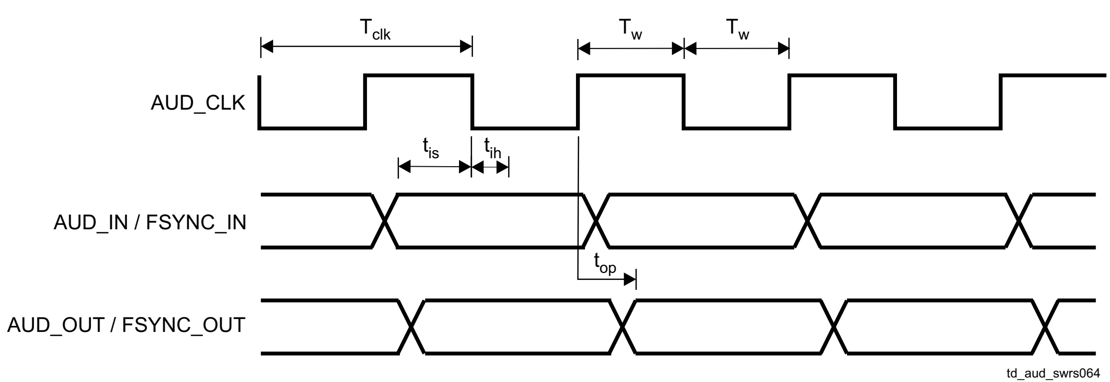


Figure 4-4. PCM Interface Timing

Table 4-7 lists the associated PCM master parameters.

Table 4-7. PCM Master

SYMBOL	PARAMETER	CONDITION	MIN	MAX	UNIT
T_{clk}	Cycle time		244.14 (4.096 MHz)	15625 (64 kHz)	ns
T_w	High or low pulse width		50% of T_{clk} min		ns
t_{is}	AUD_IN setup time		25		ns
t_{ih}	AUD_IN hold time		0		ns
t_{op}	AUD_OUT propagation time	40-pF load	0	10	ns
t_{op}	FSYNC_OUT propagation time	40-pF load	0	10	ns

Table 4-8 lists the associated PCM slave parameters.

Table 4-8. PCM Slave

SYMBOL	PARAMETER	CONDITION	MIN	MAX	UNIT
T_{clk}	Cycle time		66.67 (15 MHz)		ns
T_w	High or low pulse width		40% of T_{clk}		ns
T_{is}	AUD_IN setup time		8		ns
T_{ih}	AUD_IN hold time		0		ns
t_{is}	AUD_FSYNC setup time		8		ns
t_{ih}	AUD_FSYNC hold time		0		ns
t_{op}	AUD_OUT propagation time	40-pF load	0	21	ns

4.7.4 RF Performance

4.7.4.1 Bluetooth BR and EDR RF Performance

All parameters in this section are verified using a 38.4-MHz XTAL and an RF load of 50 Ω at the BT_ANT port. These parameters are verified in a conducted mode and do not include antenna performance.

Table 4-9. Bluetooth Receiver—In-Band Signals

CHARACTERISTICS	CONDITION	MIN	TYP	MAX	BLUETOOTH SPECIFICATION	UNIT
Operation frequency range		2402		2480		MHz
Channel spacing			1			MHz
Input impedance			50			Ω
Sensitivity, dirty TX on(1)	GFSK, BER = 0.1%		–93		–70	dBm
	π /4-DQPSK, BER = 0.01%		–92.5		–70	
	8DPSK, BER = 0.01%		–85.5		–70	
BER error floor at sensitivity + 10 dB, dirty TX off	π / 4-DQPSK		1E–7		1E–5	
	8DPSK				1E–5	
Maximum usable input power	GFSK, BER = 0.1%	–5			–20	dBm
	π / 4-DQPSK, BER = 0.1%	–10				
	8DPSK, BER = 0.1%	–10				
Intermodulation characteristics	Level of interferers (for n = 3, 4, and 5)		–30		–39	dBm

(1) Sensitivity degradation up to 3 dB may occur for minimum and typical values where the Bluetooth frequency is a harmonic of the fast clock.

Table 4-9. Bluetooth Receiver—In-Band Signals (continued)

CHARACTERISTICS	CONDITION		MIN	TYP	MAX	BLUETOOTH SPECIFICATION	UNIT
C/I performance(2) Image = –1 MHz	GFSK, co-channel			8		11	dB
	EDR, co-channel	π / 4-DQPSK		9.5		13	
		8DPSK		16.5		21	
	GFSK, adjacent ±1 MHz			–10		0	
	EDR, adjacent ±1 MHz, (image)	π / 4-DQPSK		–10		0	
		8DPSK		–5		5	
	GFSK, adjacent +2 MHz			–38		–30	
	EDR, adjacent, +2 MHz	π / 4-DQPSK		–38		–30	
		8DPSK		–38		–25	
	GFSK, adjacent –2 MHz			–28		–20	
	EDR, adjacent –2 MHz	π / 4-DQPSK		–28		–20	
		8DPSK		–22		–13	
	GFSK, adjacent ≥ |±3| MHz			–45		–40	
	EDR, adjacent ≥ |±3| MHz	π / 4-DQPSK		–45		–40	
		8DPSK		–44		–33	
RF return loss				–10			dB
RX mode LO leakage	Frf = (received RF – 0.6 MHz)			–63			dBm

(2) Numbers show ratio of desired signal to interfering signal. Smaller numbers indicate better C/I performance.

Table 4-10. Bluetooth Transmitter—GFSK

CHARACTERISTICS	MIN	TYP	MAX	BLUETOOTH SPECIFICATION	UNIT
Maximum RF output power(1)		10			dBm
Gain control range		30			dB
Power control step	2		8	2 to 8	
Adjacent channel power |M–N| = 2		–35		≤ –20	dBm
Adjacent channel power |M–N| > 2		–45		≤ –40	

(1) To modify maximum output power, use an HCI VS command.

Table 4-11. Bluetooth Transmitter—EDR

CHARACTERISTICS			MIN	TYP	MAX	BLUETOOTH SPECIFICATION	UNIT
EDR output power	π / 4-DQPSK	VDD_IN = $V_{(BAT)}$		8			dBm
	8DPSK	VDD_IN = $V_{(BAT)}$		8			
EDR relative power			–2		1	–4 to +1	dB
Gain control range				30			
Power control step			2		8	2 to 8	
Adjacent channel power |M–N| = 1				–30		≤ –26	dBc
Adjacent channel power |M–N| = 2				–23		≤ –20	dBm
Adjacent channel power |M–N| > 2 (1)				–42		≤ –40	dBm

(1) Adjacent channel power measurements take into account specification exception of three bands, as defined by the *Test Suite Structure (TSS) and Test Purposes (TP) Bluetooth Documentation Specification*.

Table 4-12. Bluetooth Modulation—GFSK

CHARACTERISTICS		CONDITION		MIN	TYP	MAX	BLUETOOTH SPECIFICATION	UNIT
	–20 dB bandwidth	GFSK			925		≤ 1000	kHz
F1 avg	Modulation characteristics	Δf1avg	Mod data = 4 1s, 4 0s: 111100001111...		165		140 to 175	kHz
F2 max		Δf2max ≥ limit for at least 99.9% of all Δf2max	Mod data = 1010101...		130		> 115	kHz
		Δf2avg, Δf1avg			88%		> 80%	
	Absolute carrier frequency drift	DH1		–25		25	< ±25	kHz
		DH3 and DH5		–35		35	< ±40	
	Drift rate					20	< 20	kHz/ 50 µs
	Initial carrier frequency tolerance	f0–fTX		–75		+75	< ±75	kHz

Table 4-13. Bluetooth Modulation—EDR

CHARACTERISTICS	CONDITION	MIN	TYP	MAX	BLUETOOTH SPECIFICATION	UNIT
Carrier frequency stability		–10		10	≤ 10	kHz
Initial carrier frequency tolerance		–75		75	±75	kHz
RMS DEVM (1)	π / 4-DQPSK		6%		20%	
	8DPSK		6%		13%	
99% DEVM (1)	π / 4-DQPSK			30%	30%	
	8DPSK			20%	20%	
Peak DEVM (1)	π / 4-DQPSK		14%		35%	
	8DPSK		16%		25%	

(1) MAX performance refers to maximum TX power.

4.7.4.2 Bluetooth low energy RF Performance

All parameters in this section are verified using a 38.4-MHz XTAL and an RF load of 50 Ω at the BT_ANT port. These parameters are verified in a conducted mode and do not include antenna performance.

Table 4-14. Bluetooth low energy Receiver—In-Band Signals

CHARACTERISTICS	CONDITION	MIN	TYP	MAX	BLUETOOTH low energy SPECIFICATION	UNIT
Operation frequency range		2402		2480		MHz
Channel spacing			2			MHz
Input impedance			50			Ω
Sensitivity, dirty TX on (1)	PER = 30.8%; dirty TX on		–93		≤ –70	dBm
Maximum usable input power	GMSK, PER = 30.8%	–10			≥ –10	dBm
Intermodulation characteristics	Level of interferers (for n = 3, 4, 5)		–30		≥ –50	dBm
C/I performance (2) Image = –1 MHz	GMSK, co-channel		8		≤ 21	dB
	GMSK, adjacent ±1 MHz		–5		≤ 15	
	GMSK, adjacent +2 MHz		–45		≤ –17	
	GMSK, adjacent –2 MHz		–22		≤ –15	
	GMSK, adjacent ≥ |±3| MHz		–47		≤ –27	
RX mode LO leakage	Frf = (received RF – 0.6 MHz)		–63			dBm

(1) Sensitivity degradation up to 3 dB may occur where the Bluetooth low energy frequency is a harmonic of the fast clock.
(2) Numbers show wanted signal-to-interfering signal ratio. Smaller numbers indicate better C/I performance.

Table 4-15. Bluetooth low energy Transmitter

CHARACTERISTICS		MIN	TYP	MAX	BLUETOOTH low energy SPECIFICATION	UNIT
RF output power (VDD_IN = VBAT) (1)	CC2564MODN		10		≤10	dBm
	CC2564MODA		8 (2)		≤10	
Adjacent channel power |M-N| = 2			–35		≤ –20	dBm
Adjacent channel power |M-N| > 2			–45		≤ –30	

(1) To modify maximum output power, use an HCI VS command.
(2) Required to meet the power spectral density (PSD) as defined by clause 5.3.3.2 in ETSI EN 300 328 V1.9.1. The integrated antenna gain is 1.69 dBi.

Table 4-16. Bluetooth low energy Modulation

CHARACTERISTICS		CONDITION		MIN	TYP	MAX	BLUETOOTH low energy SPECIFICATION	UNIT
Δf1 avg	Modulation characteristics	Δf1avg	Mod data = 4 1s, 4 0s: 1111000011110000...		250		225 to 275	kHz
Δf2 max		Δf2max ≥ limit for at least 99.9% of all Δf2max	Mod data = 1010101...		210		≥ 185	kHz
		Δf2avg, Δf1avg			0.9		≥ 0.8	
Absolute carrier frequency drift				–25		25	≤ ±50	kHz
Drift rate						15	≤ 20	kHz/ 50 ms
Initial carrier frequency tolerance				–25		25	≤ ±100	kHz

5 Detailed Description

5.1 Overview

Table 5-1. Technology and Assisted Modes Supported

MODULE	DESCRIPTION	TECHNOLOGY SUPPORTED			ASSISTED MODES SUPPORTED(1)	
		BR/EDR	LE	ANT	HFP 1.6 (WBS)	A2DP
CC2564MODx(2)	Bluetooth 4.1 + Bluetooth low energy	√	√		√	√
	Bluetooth 4.1 + ANT	√		√	√	√

(1) The assisted modes (HFP 1.6 and A2DP) are not supported simultaneously. Furthermore, the assisted modes are not supported simultaneously with Bluetooth low energy or ANT.
(2) The device does not support simultaneous operation of LE and ANT.

5.2 Functional Block Diagram

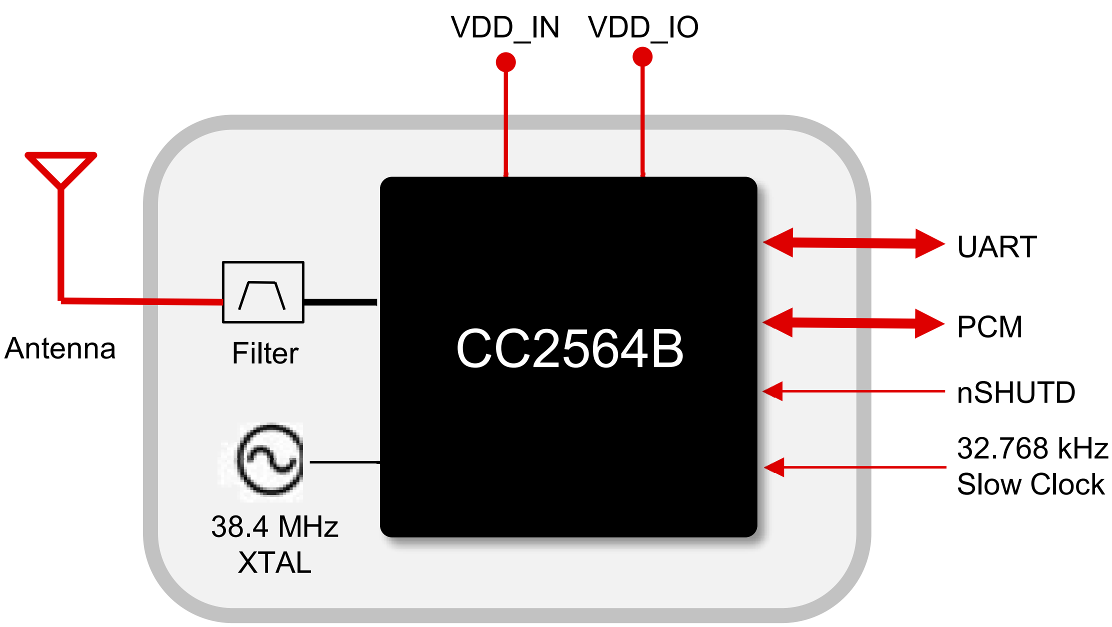


Figure 5-1. CC2564MODN Functional Block Diagram

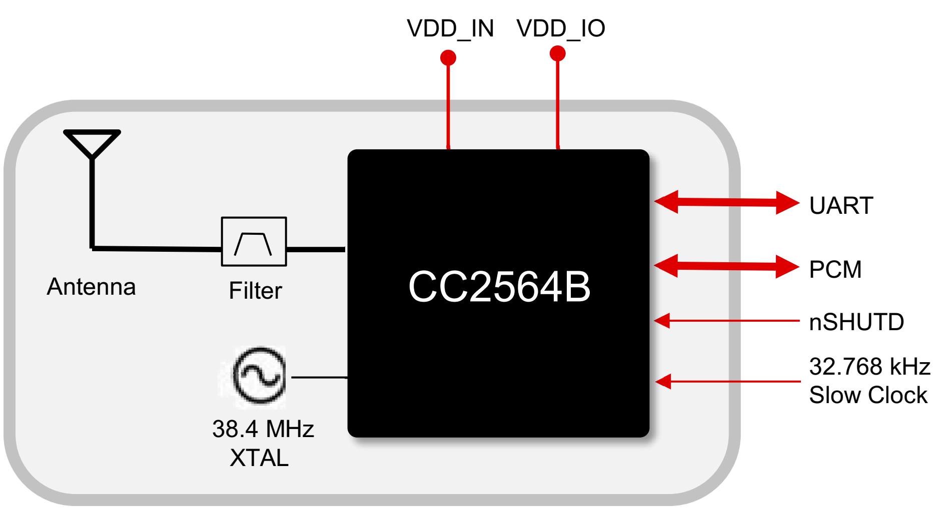


Figure 5-2. CC2564MODA Functional Block Diagram

5.3 Functional Blocks

The TI Bluetooth HCI module architecture comprises a DRP and a point-to-multipoint baseband core. The architecture is based on a single-processor ARM® ARM7TDMI™ core. The module includes several on-chip peripherals to enable easy communication with a host system and the Bluetooth BR/EDR/LE core.

5.4 Bluetooth BR and EDR Description

The CC2564MODx is Bluetooth 4.1 compliant up to the HCI level (for the technology supported, see Table 5-1):

- Up to seven active devices
- Scatternet: Up to 3 piconets simultaneously, 1 as master and 2 as slaves
- Up to two synchronous connection oriented (SCO) links on the same piconet
- Very fast AFH algorithm for asynchronous connection-oriented link (ACL) and extended SCO (eSCO) link
- Supports typically 10-dBm TX power without an external power amplifier (PA), thus improving Bluetooth link robustness
- Digital radio processor (DRP™) single-ended 50-Ω I/O for easy RF interfacing with external antenna (CC2564MODN). The CC2564MODA includes the antenna on the module.
- Internal temperature detection and compensation to ensure minimal variation in RF performance over temperature
- Includes a 128-bit hardware encryption accelerator as defined by the Bluetooth specifications
- Flexible pulse-code modulation (PCM) and inter-IC sound (I2S) digital codec interface:
  – Full flexibility of data format (linear, A-Law, µ-Law)
  – Data width
  – Data order
  – Sampling
  – Slot positioning
  – Master and slave modes
  – High clock rates up to 15 MHz for slave mode (or 4.096 MHz for master mode)
- Support for all voice air-coding
  – CVSD
  – A-Law
  – µ-Law
  – Transparent (uncoded)

5.5 Bluetooth low energy Description

- Bluetooth 4.1 compliant
- Solution optimized for proximity and sports use cases
- Multiple sniff instances that are tightly coupled to achieve minimum power consumption
- Independent buffering for LE, allowing large numbers of multiple connections without affecting BR/EDR performance.
- Includes built-in coexistence and prioritization handling for BR/EDR and LE

NOTE

ANT and the assisted modes (HFP 1.6 and A2DP) are not available when Bluetooth low energy is enabled.

5.6 Bluetooth Transport Layers

Figure 5-3 shows the Bluetooth transport layers.

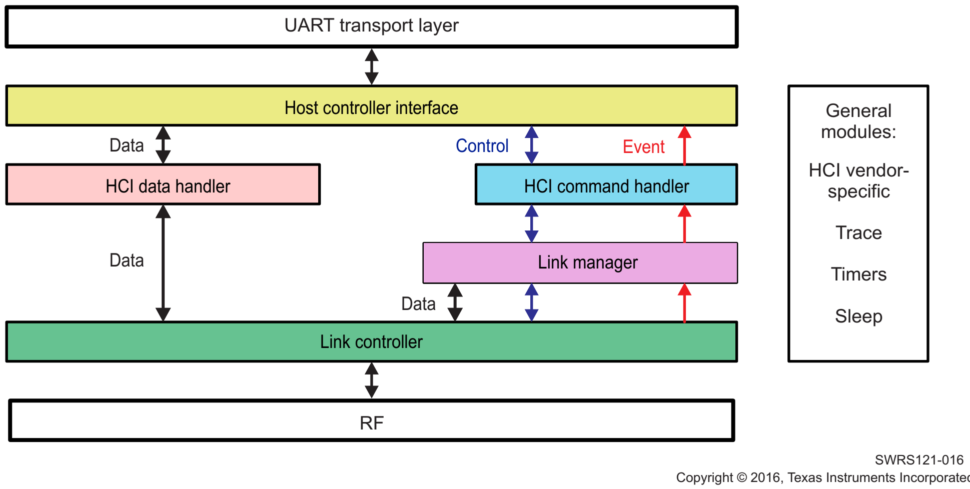


Figure 5-3. Bluetooth Transport Layers

5.7 Host Controller Interface

The TI Bluetooth HCI module incorporates one UART module dedicated to the HCI transport layer. The HCI interface transports commands, events, ACL between the device and the host using HCI data packets.

The maximum baud rate of the UART module is 4 Mbps; however, the default baud rate after power up is set to 115.2 kbps. The baud rate can thereafter be changed with a VS command. The device responds with a command complete event (still at 115.2 kbps), after which the baud rate change occurs.

The UART module includes the following features:

- Receiver detection of break, idle, framing, FIFO overflow, and parity error conditions
- Transmitter underflow detection
- CTS and RTS hardware flow control (UART Transport Layer)
- XON and XOFF software flow control (3-wire UART Transport Layer)

Table 5-2 lists the UART module default settings.

Table 5-2. UART Module Default Settings

PARAMETER	VALUE
Bit rate	115.2 kbps
Data length	8 bits
Stop bit	1
Parity	None

5.7.1 UART Transport Layer

The UART Transport Layer includes four signals:

- TX
- RX
- CTS
- RTS

Flow control between the host and the TI Bluetooth HCI module is bytewise by hardware.

Figure 5-4 shows UART Transport Layer.

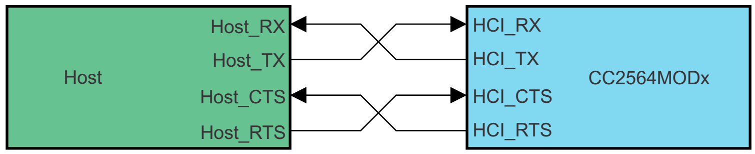


Figure 5-4. UART Transport Layer

When the UART RX buffer of the TI Bluetooth HCI module passes the flow control threshold, it sets the HCI_RTS signal high to stop transmission from the host.

When the HCI_CTS signal is set high, the module stops transmission on the interface. If HCI_CTS is set high while transmitting a byte, the module finishes transmitting the byte and stops the transmission.

The UART Transport Layer includes a mechanism that handles the transition between active mode and sleep mode. The protocol occurs through the CTS and RTS UART lines and is known as the enhanced HCI low level (eHCILL) power-management protocol.

For more information on the UART Transport Layer, see *Volume 4 Host Controller Interface, Part A UART Transport Layer of the Bluetooth Core Specifications* (www.bluetooth.org).

5.7.2 Three-Wire UART Transport Layer

The 3-wire UART Transport Layer consists of three signals (see Figure 5-5):

- TX
- RX
- GND

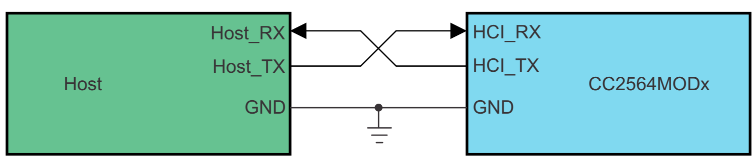


Figure 5-5. Three-Wire UART Transport Layer

The 3-Wire UART Transport Layer supports the following features:

- Software flow control (XON/XOFF)
- Power management using the software messages:
  - WAKEUP
  - WOKEN
  - SLEEP
- CRC data integrity check

For more information on the 3-Wire UART Transport Layer, see *Volume 4 Host Controller Interface, Part D Three- Wire UART Transport Layer of the Bluetooth Core Specifications* (www.bluetooth.org).

5.8 Digital Codec Interface

The codec interface is a fully programmable port to support seamless interfacing with different PCM and I2S codec devices. The interface includes the following features:

- Two voice channels
- Master and slave modes
- All voice coding schemes defined by the Bluetooth specification: linear, A-Law, and µ-Law
- Long and short frames
- Different data sizes, order, and positions
- High flexibility to support a variety of codecs
- Bus sharing: Data_Out is in a Hi-Z state when the interface is not transmitting voice data.

5.8.1 Hardware Interface

The interface includes four signals:

- Clock: configurable direction (input or output)
- Frame_Sync and Word_Sync: configurable direction (input or output)
- Data_In: input
- Data_Out: output or tri-state condition

The module can be the master of the interface when generating the Clock and Frame_Sync signals or the slave when receiving these two signals.

For slave mode, clock input frequencies of up to 15 MHz are supported. At clock rates above 12 MHz, the maximum data burst size is 32 bits.

For master mode, the module can generate any clock frequency between 64 kHz and 4.096 MHz.

5.8.2 I2S

When the codec interface is configured to support the I2S protocol, these settings are recommended:

- Bidirectional, full-duplex interface
- Two time slots per frame: time slot-0 for the left channel audio data; and time slot-1 for the right channel audio data
- Each time slot is configurable up to 40 serial clock cycles long, and the frame is configurable up to 80 serial clock cycles long.

5.8.3 Data Format

The data format is fully configurable:

- The data length can be from 8 to 320 bits in 1-bit increments when working with 2 channels, or up to 640 bits when working with 1 channel. The data length can be set independently for each channel.
- The data position within a frame is also configurable within 1 clock (bit) resolution and can be set independently (relative to the edge of the Frame_Sync signal) for each channel.
- The Data_In and Data_Out bit order can be configured independently. For example, Data_In can start with the most significant bit (MSB); Data_Out can start with the least significant bit (LSB). Each channel is separately configurable. The inverse bit order (that is, LSB first) is supported only for sample sizes up to 24 bits.
- Data_In and Data_Out are not required to be the same length.
- The Data_Out line is configured to Hi-Z output between data words. Data_Out can also be set for permanent Hi-Z, regardless of the data output. This configuration allows the module to be a bus slave in a multislave PCM environment. At power up, Data_Out is configured as Hi-Z.

5.8.4 Frame Idle Period

The codec interface handles frame idle periods, in which the clock pauses and becomes 0 at the end of the frame, after all data are transferred.

The module supports frame idle periods both as master and slave of the codec bus.

When the module is the master of the interface, the frame idle period is configurable. There are two configurable parameters:

- Clk_Idle_Start: indicates the number of clock cycles from the beginning of the frame to the beginning of the idle period. After Clk_Idle_Start clock cycles, the clock becomes 0.
- Clk_Idle_End: indicates the time from the beginning of the frame to the end of the idle period. The time is given in multiples of clock periods.

The delta between Clk_Idle_Start and Clk_Idle_End is the clock idle period.

For example, for clock rate = 1 MHz, frame sync period = 10 kHz, Clk_Idle_Start = 60, Clk_Idle_End = 90.

Between both Frame_Sync signals there are 70 clock cycles (instead of 100). The clock idle period starts 60 clock cycles after the beginning of the frame and lasts 90 – 60 = 30 clock cycles. Thus, the idle period ends 100 – 90 = 10 clock cycles before the end of the frame. The data transmission must end before the beginning of the idle period.

Figure 5-6 shows the frame idle timing.

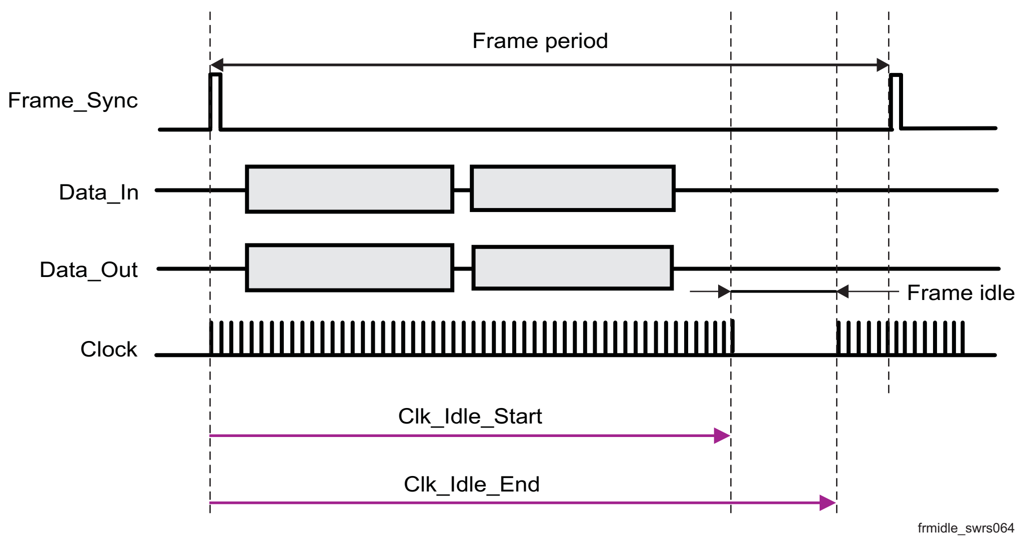


Figure 5-6. Frame Idle Period

5.8.5 Clock-Edge Operation

The codec interface of the module can work on the rising or the falling edge of the clock and can sample the Frame_Sync signal and the data at inversed polarity.

Figure 5-7 shows the operation of a falling-edge-clock type of codec. The codec is the master of the bus. The Frame_Sync signal is updated (by the codec) on the falling edge of the clock and is therefore sampled (by the module) on the next rising clock. The data from the codec is sampled (by the module) on the falling edge of the clock

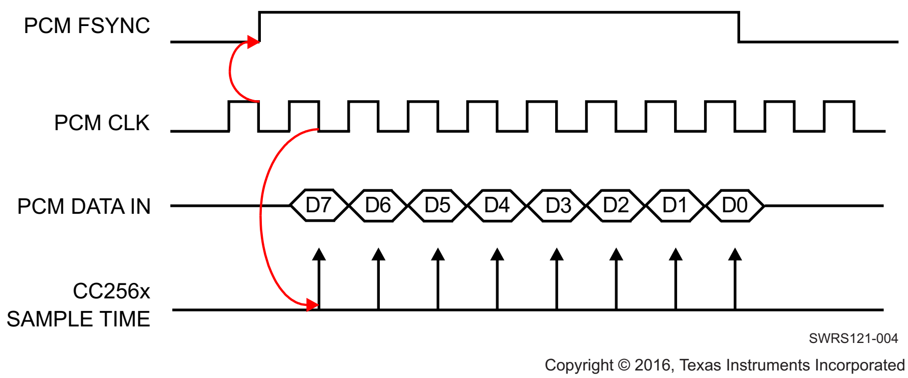


Figure 5-7. Negative Clock Edge Operation

5.8.6 *2-Channel Bus Example*

Figure 5-8 shows a 2-channel bus in which the two channels have different word sizes and arbitrary positions in the bus frame. (FT stands for frame timer.)

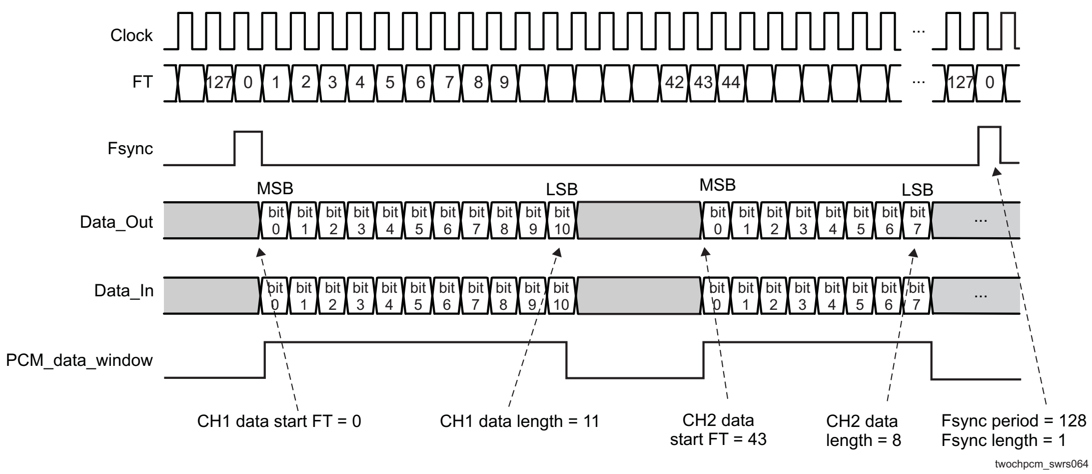


Figure 5-8. 2-Channel Bus Timing

5.9 Assisted Modes

The TI CC2564MODx module contains an embedded coprocessor that can be used for multiple purposes. The module uses the coprocessor to perform the LE or ANT functionality. The module also uses the coprocessor to execute the assisted HFP 1.6 (WBS) or assisted A2DP functions. Only one of these functions can be executed at a time because they all use the same resources (that is, the coprocessor; see Table 5-1 for the modes of operation supported by the module).

This section describes the assisted HFP 1.6 (WBS) and assisted A2DP modes of operation in the module. These modes of operation minimize host processing and power by taking advantage of the device coprocessor to perform the voice and audio SBC processing required in HFP 1.6 (WBS) and A2DP profiles. This section also compares the architecture of the assisted modes with the common implementation of the HFP 1.6 and A2DP profiles.

The assisted HFP 1.6 (WBS) and assisted A2DP modes of operation comply fully with the HFP 1.6 and A2DP Bluetooth specifications. For more information on these profiles, see the corresponding Bluetooth profile specification at Adopted Bluetooth Core Specifications.

5.9.1 Assisted HFP 1.6 (WBS)

The HFP 1.6 Profile Specification adds the requirement for WBS support. The WBS feature allows twice the voice quality versus legacy voice coding schemes at the same air bandwidth (64 kbps). This feature is achieved using a voice sampling rate of 16 kHz, a modified subband coding (mSBC) scheme, and a packet loss concealment (PLC) algorithm. The mSBC scheme is a modified version of the mandatory audio coding scheme used in the A2DP profile with the parameters listed in Table 5-3.

Table 5-3. mSBC Parameters

PARAMETER	VALUE
Channel mode	Mono
Sampling rate	16 kHz
Allocation method	Loudness
Subbands	8
Block length	15
Bitpool	26

The assisted HFP 1.6 mode of operation implements this WBS feature on the embedded coprocessor. That is, the mSBC voice coding scheme and the PLC algorithm are executed in the coprocessor rather than in the host, thus minimizing host processing and power. One WBS connection at a time is supported and WBS and NBS connections cannot be used simultaneously in this mode of operation. Figure 5-9 shows the architecture comparison between the common implementation of the HFP 1.6 profile and the assisted HFP 1.6 solution.

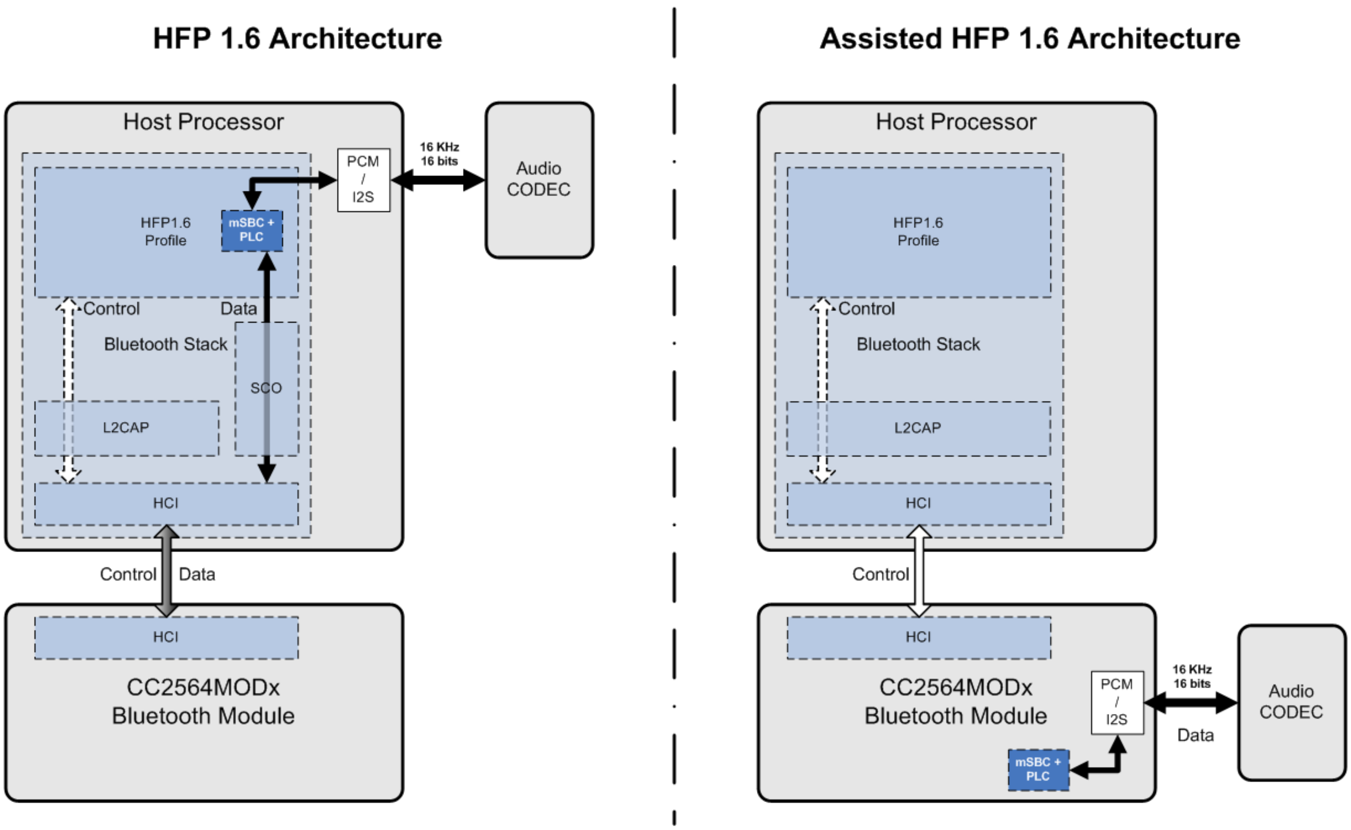


Figure 5-9. HFP 1.6 Architecture Versus Assisted HFP 1.6 Architecture

5.9.2 Assisted A2DP

The A2DP enables wireless transmission of high-quality mono or stereo audio between two devices. A2DP defines two roles:

- A2DP source is the transmitter of the audio stream.
- A2DP sink is the receiver of the audio stream.

A typical use case streams music from a tablet, phone, or PC (the A2DP source) to headphones or speakers (the A2DP sink). This section describes the architecture of these roles and compares them with the corresponding assisted-A2DP architecture. To use the air bandwidth efficiently, the audio data must be compressed in a proper format. The A2DP mandates support of the SBC scheme. Other audio coding algorithms can be used; however, both Bluetooth devices must support the same coding scheme. SBC is the only coding scheme spread out in all A2DP Bluetooth devices, and thus the only coding scheme supported in the assisted A2DP modes. Table 5-4 lists the recommended parameters for the SBC scheme in the assisted A2DP modes.

Table 5-4. Recommended Parameters for the SBC Scheme in Assisted A2DP Modes

SBC ENCODER SETTINGS(1)	MID QUALITY				HIGH QUALITY			
	MONO		JOINT STEREO		MONO		JOINT STEREO	
Sampling frequency (kHz)	44.1	48	44.1	48	44.1	48	44.1	48
Bitpool value	19	18	35	33	31	29	53	51
Resulting frame length (bytes)	46	44	83	79	70	66	119	115
Resulting bit rate (Kbps)	127	132	229	237	193	198	328	345

(1) Other settings: Block length = 16; allocation method = loudness; subbands = 8.

The SBC scheme supports a wide variety of configurations to adjust the audio quality. Table 5-5 through Table 5-12 list the supported SBC capabilities in the assisted A2DP modes.

Table 5-5. Channel Modes

CHANNEL MODE	STATUS
Mono	Supported
Stereo	Supported
Joint stereo	Supported
Dual channel	Supported

Table 5-6. Sampling Frequency

SAMPLING FREQUENCY (kHz)	STATUS
16	Supported
44.1	Supported
48	Supported

Table 5-7. Block Length

BLOCK LENGTH	STATUS
4	Supported
8	Supported
12	Supported
16	Supported

Table 5-8. Subbands

SUBBANDS	STATUS
4	Supported
8	Supported

Table 5-9. Allocation Method

ALLOCATION METHOD	STATUS
SNR	Supported
Loudness	Supported

Table 5-10. Bitpool Values

BITPOOL RANGE	STATUS
Assisted A2DP sink: 2-54	Supported
Assisted A2DP source: 2–57	Supported

Table 5-11. L2CAP MTU Size

L2CAP MTU SIZE (BYTES)	STATUS
Assisted A2DP sink: 260–800	Supported
Assisted A2DP source: 260–1021	Supported

Table 5-12. Miscellaneous Parameters

ITEM	VALUE	STATUS
A2DP content protection	Protected	Not supported
AVDTP service	Basic type	Supported
L2CAP mode	Basic mode	Supported
L2CAP flush	Nonflushable	Supported

For detailed information on the A2DP profile, see the A2DP Profile Specification at Adopted Bluetooth Core Specifications.

5.9.2.1 Assisted A2DP Sink

The A2DP sink role is the receiver of the audio stream in an A2DP Bluetooth connection. In this role, the A2DP layer and its underlying layers are responsible for link management and data decoding. To handle these tasks, two logic transports are defined:

- Control and signaling logic transport
- Data packet logic transport

The assisted A2DP takes advantage of this modularity to handle the data packet logic transport in the module by implementing a light L2CAP layer (L-L2CAP) and light AVDTP layer (L-AVDTP) to defragment the packets. Then the assisted A2DP performs the SBC decoding on-chip to deliver raw audio data through the module PCM–I2S interface. Figure 5-10 shows the comparison between a common A2DP sink architecture and the assisted A2DP sink architecture.

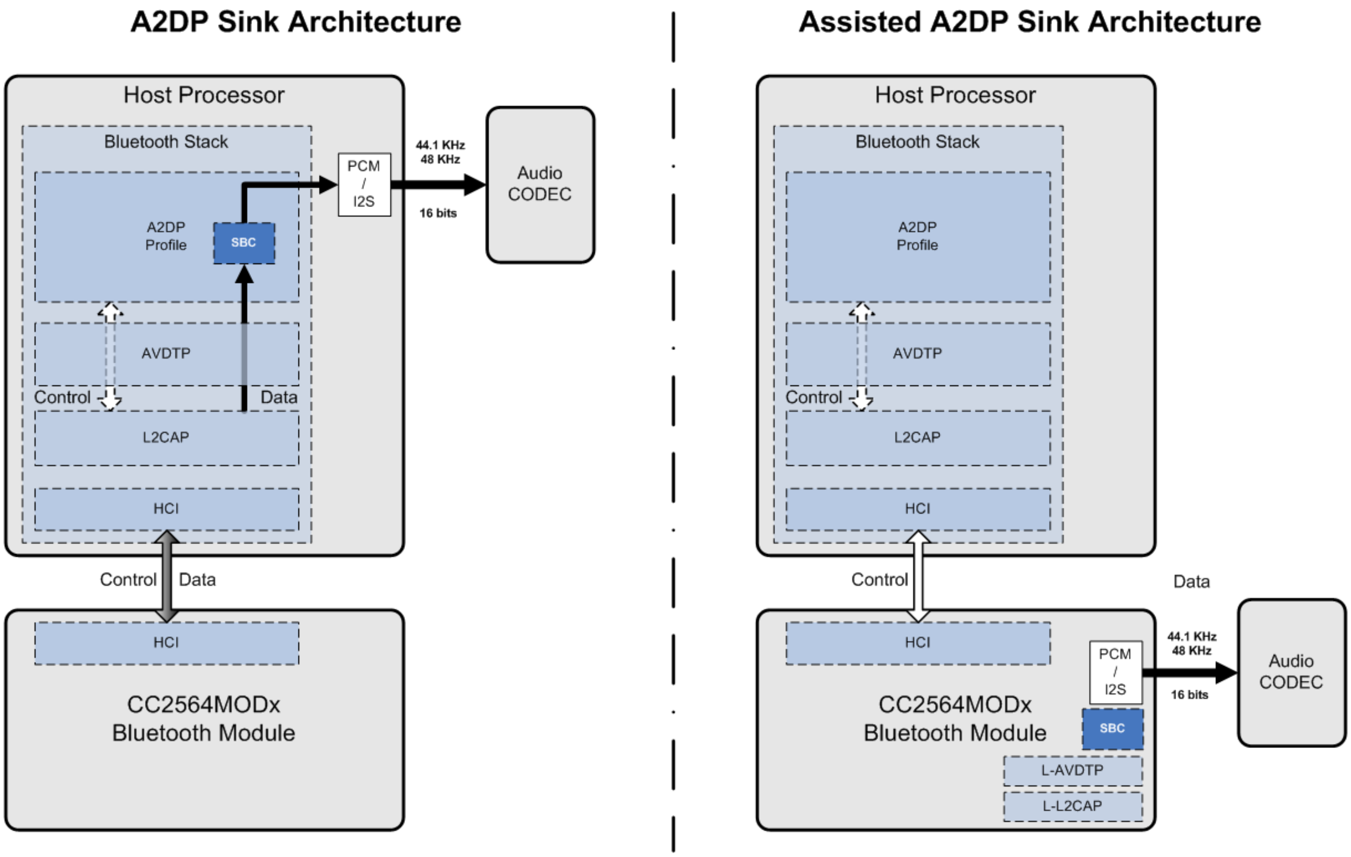


Figure 5-10. A2DP Sink Architecture Versus Assisted A2DP Sink Architecture

For more information on the A2DP sink role, see the A2DP Profile Specification at Adopted Bluetooth Core Specifications.

5.9.2.2 Assisted A2DP Source

The role of the A2DP source is to transmit the audio stream in an A2DP Bluetooth connection. In this role, the A2DP layer and its underlying layers are responsible for link management and data encoding. To handle these tasks, two logic transports are defined:

- Control and signaling logic transport
- Data packet logic transport

The assisted A2DP takes advantage of this modularity to handle the data packet logic transport in the module. First, the assisted A2DP encodes the raw data from the module PCM–I2S interface using an on-chip SBC encoder. The assisted A2DP then implements an L-L2CAP layer and an L-AVDTP layer to fragment and packetize the encoded audio data. Figure 5-11 shows the comparison between a common A2DP source architecture and the assisted A2DP source architecture.

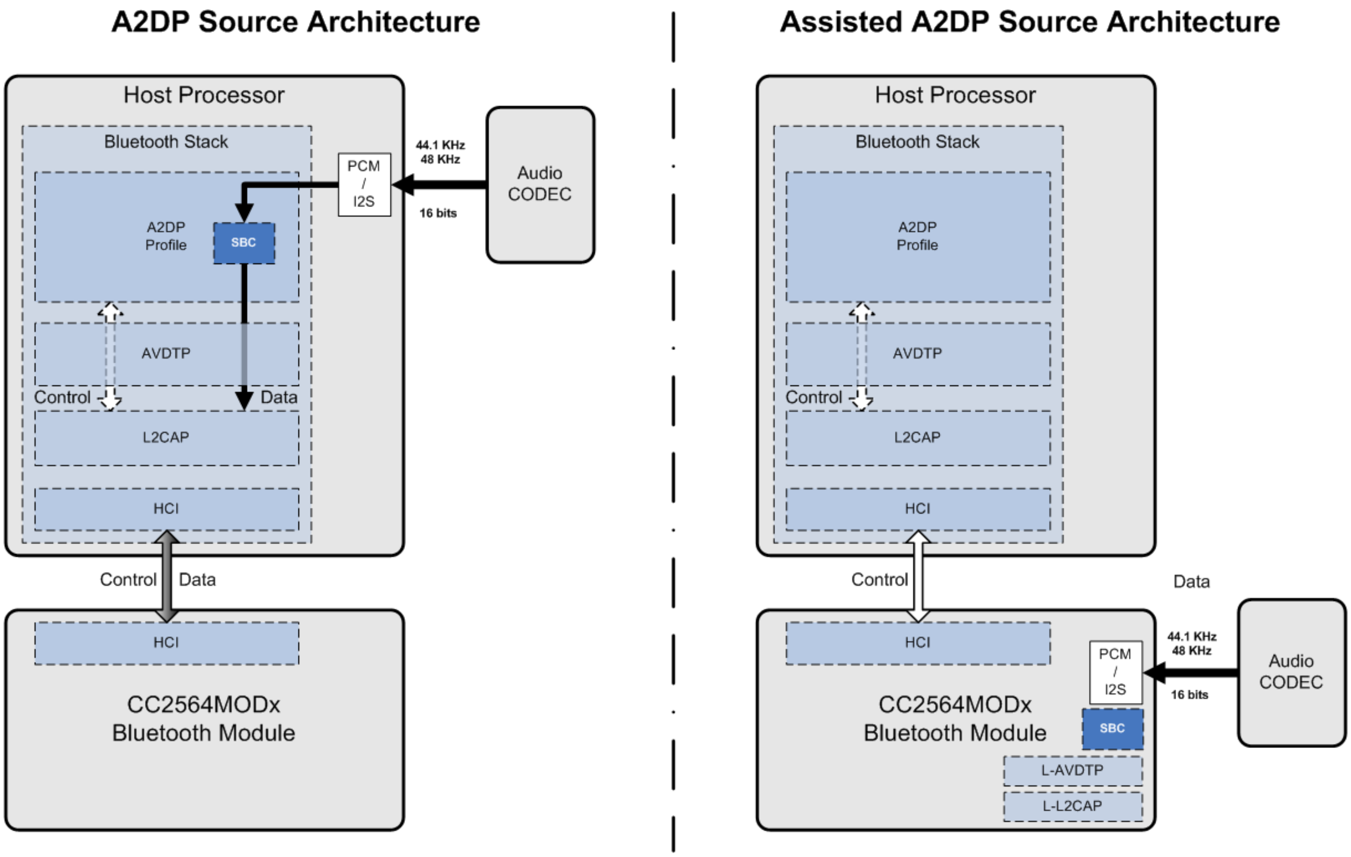


Figure 5-11. A2DP Source Architecture Versus Assisted A2DP Source Architecture

For more information on the A2DP source role, see the A2DP Profile Specification at Adopted Bluetooth Core Specifications.

6 Applications, Implementation, and Layout

NOTE

Information in the following Applications section is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

6.1 Reference Design Schematics

Figure 6-1 shows the reference schematics for the CC2564MODN module.

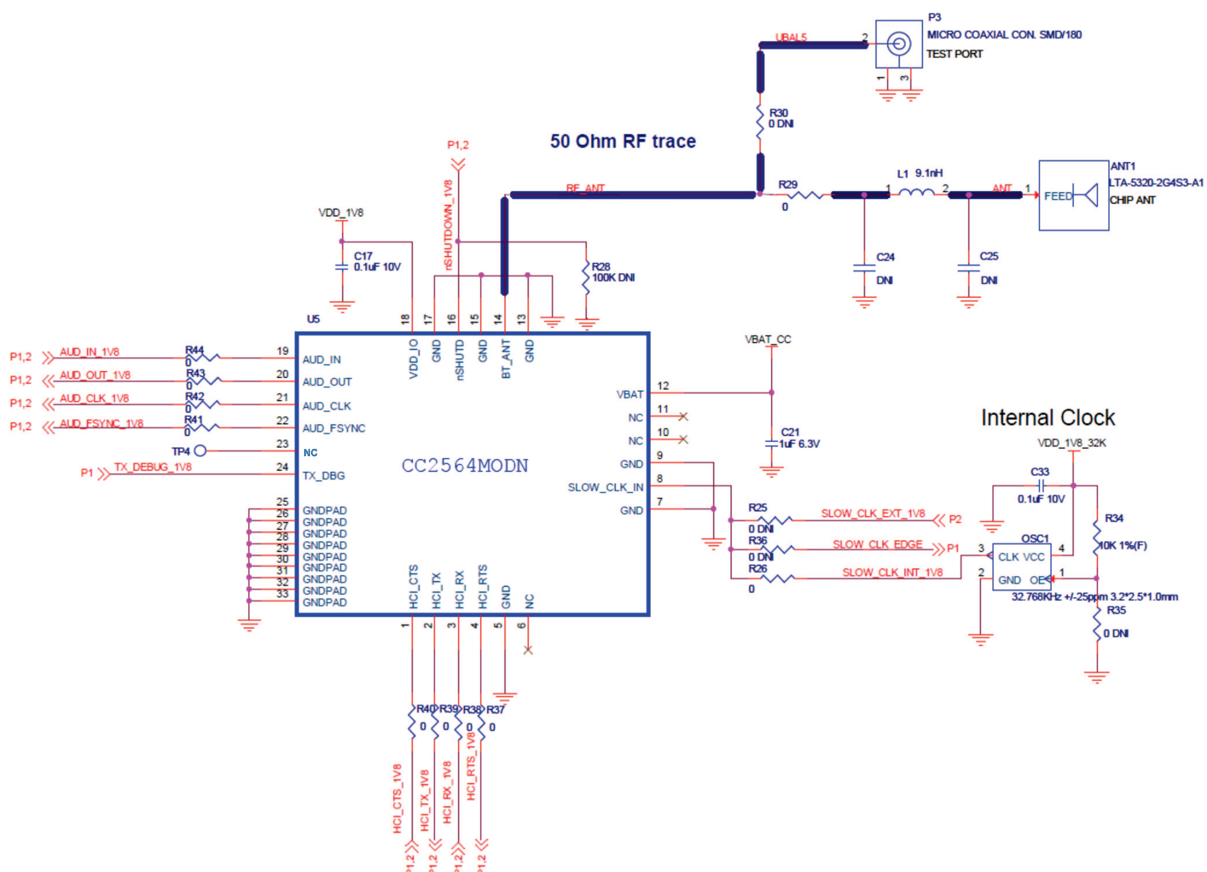


Figure 6-1. CC2564MODN Reference Schematics

Figure 6-2 shows the reference schematics for the CC2564MODA module.

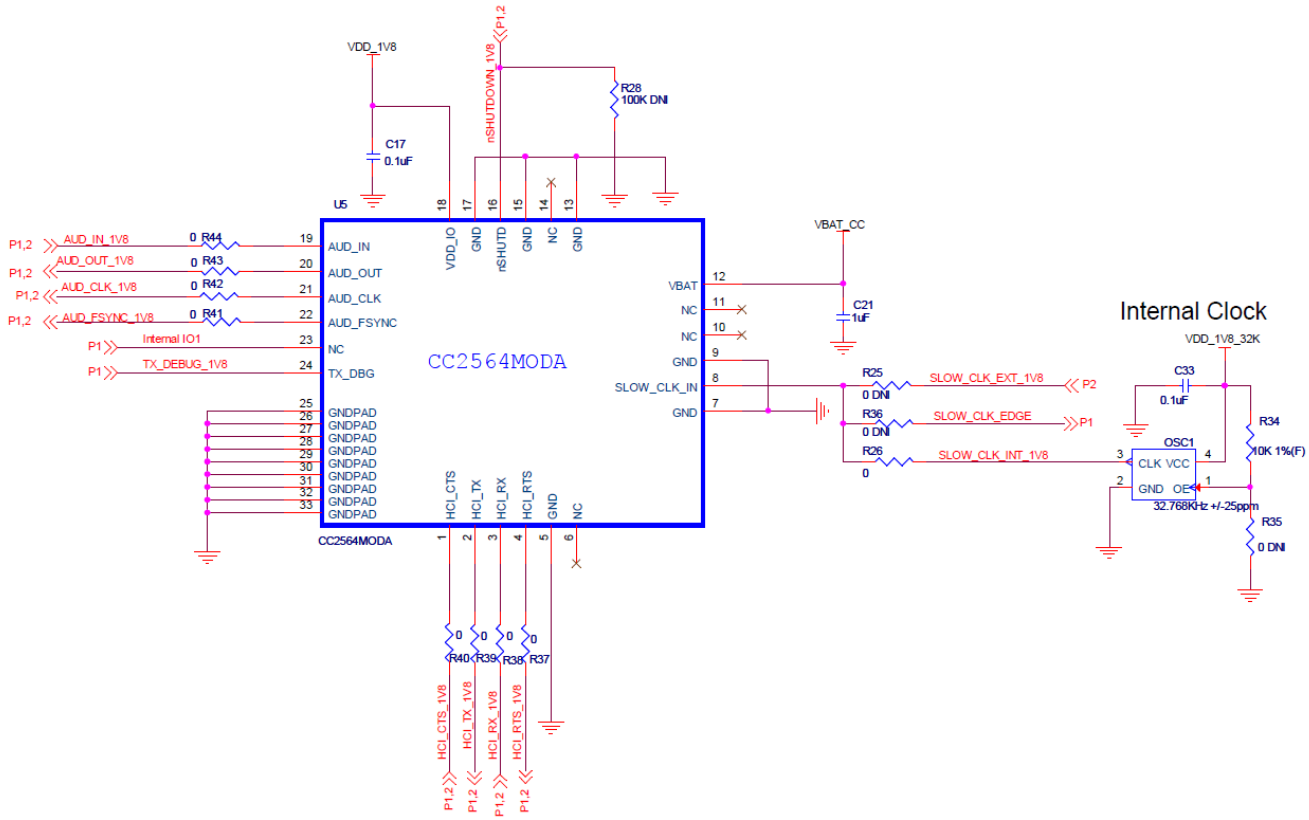


Figure 6-2. CC2564MODA Reference Schematics

6.2 Layout

This section provides the printed circuit board (PCB) layout rules and considerations, including component placement and routing guidelines, when designing a board with the CC2564MODx module.

The integrator of the CC2564MODx module must comply with the PCB layout recommendations described in the following subsections to preserve the FCC and Industry Canada (IC) modular radio certification. Moreover, TI recommends customers follow the guidelines described in this section to achieve similar performance to that obtained with the TI reference design.

6.2.1 Layout Guidelines

6.2.1.1 PCB Stack-Up

The recommended PCB stack-up is a four-layer design based on a standard flame-retardant 4 (FR4) material (see Figure 6-3):

Layer 1 (TOP – RF + Signal) Use Layer 1 to place the module on and to route signal traces. In particular, the RF trace must be run on this layer.

Layer 2 (L2 – Ground) Layer 2 must be a solid ground layer.

Layer 3 (L3 – Power) Use Layer 3 to route power traces or place power planes.

Layer 4 (BOTTOM – Signal) Use Layer 4 as a second routable layer to run signal traces (except RF signals).

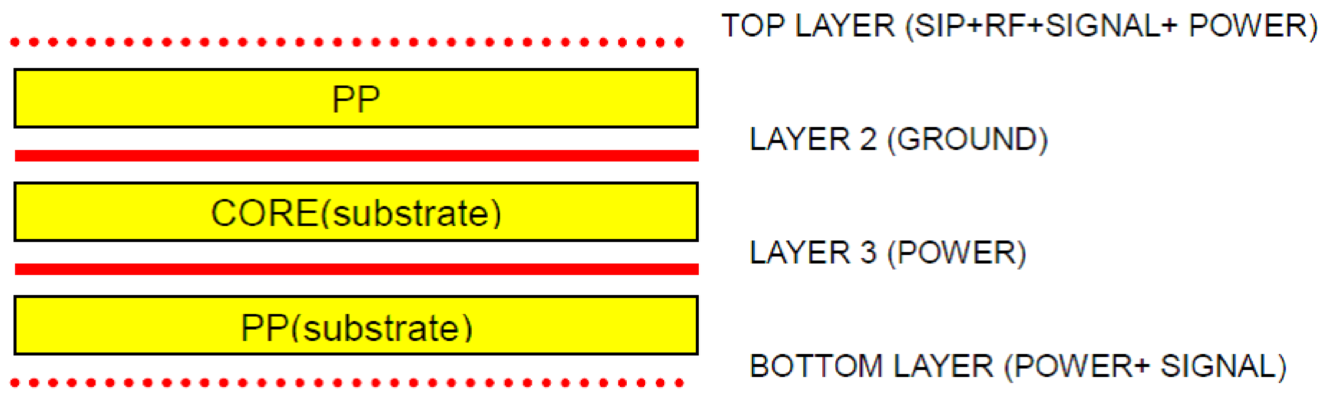


Figure 6-3. PCB Stack-Up

TI recommends a board thickness of 62.4 mils and a substrate dielectric of 4.2. For details, see Table 6-1.

NOTE

These parameters are used for the 50-Ω impedance matching of the RF trace. For more information, see Section 6.2.1.2.

Table 6-1. Recommended PCB Properties

ITEM	VALUE
Solder mask	0.4 mil
TOP copper + plating	1 oz/1.4 mil
PP (substrate)	10 mil
L2 copper + plating	1 oz/1.4 mil
Core (substrate)	36 mil
L3 copper + plating	1 oz/1.4 mil
PP (substrate)	10 mil
Bottom copper + plating	1 oz/1.4 mil
Solder mask	0.4 mil
Final thickness	62.4 mil = 1.585 mm

6.2.1.2 RF Interface Guidelines

6.2.1.2.1 RF Trace (CC2564MODN Only)

Route the RF traces on Layer 1 (top) and keep the routes as short as possible. These traces must be 50-Ω, controlled-impedance traces with reference to the solid ground in the layer 2 microstrip transmission line. The TI reference design uses an RF trace width equal to 17 mils, which conforms to a 50 Ω-±3% simulated result, based on the following PCB properties: (see Table 6-1 and Figure 6-4).

- Substrate height: 10 mils
- Substrate dielectric: 4.2
- Trace width: 17 mils
- Trace thickness: 1.4 mils
- Ground clearance: 20 mils

TI recommends the following guidelines for a good RF trace design:

- The RF traces must have via stitching on both ground planes around the RF trace (see Figure 6-4).
- Avoid placing clock signals close to the RF path.
- Place a u.FL connector (or similar) between the module and antenna if possible or during prototype phases (see Figure 6-4.)
- The RF path should look like one single path along the RF traces and matching components. See Figure 6-5 for the good (OK) case versus the not good (NG) case.
- The RF trace bends must be gradual with an approximate maximum bend of 45 degrees with the trace mitered. RF traces must not have sharp corners. In addition:
  - Avoid case (1) in Figure 6-6. A right angle leads to scattering and makes matching weak.
  - Case (2) in Figure 6-6 is not recommended. Even if this bend had a good 50 Ω, a careful simulation would be required.
  - Case (3) in Figure 6-6 is recommended. The half-arc angle reduces scattering caused by a right angle.

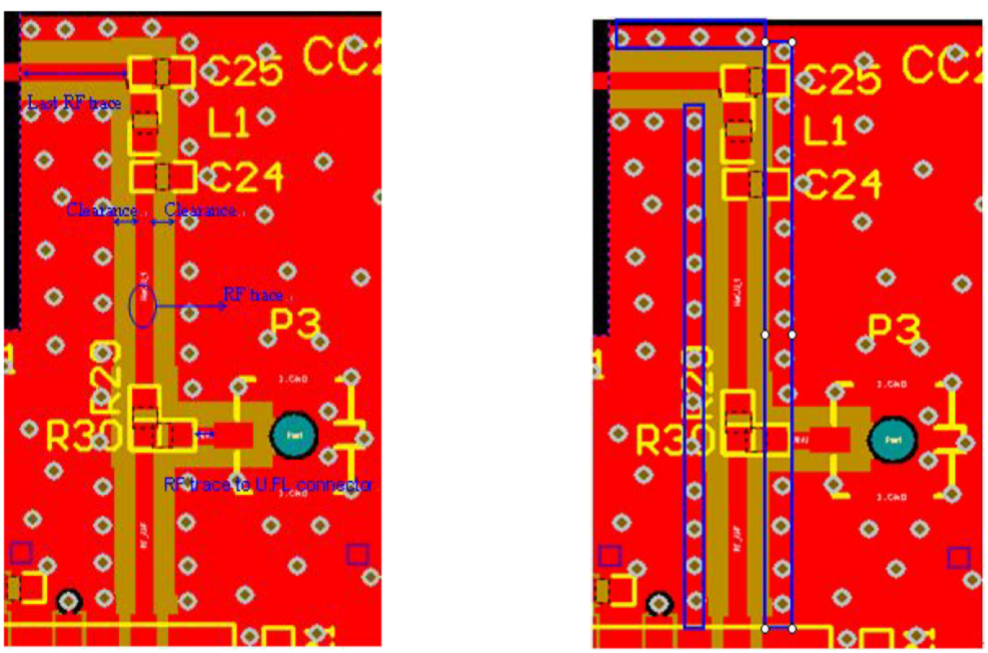


Figure 6-4. Placing a u.FL Connector Between the Module and Antenna

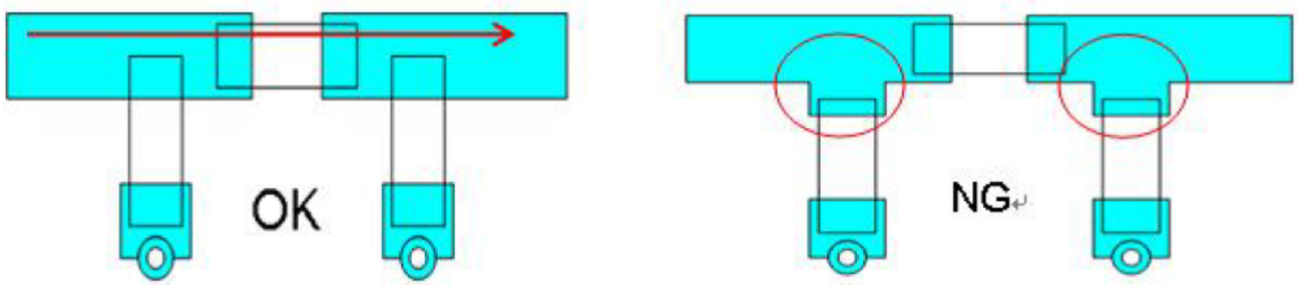


Figure 6-5. Good (OK) vs Not Good (NG) RF Path

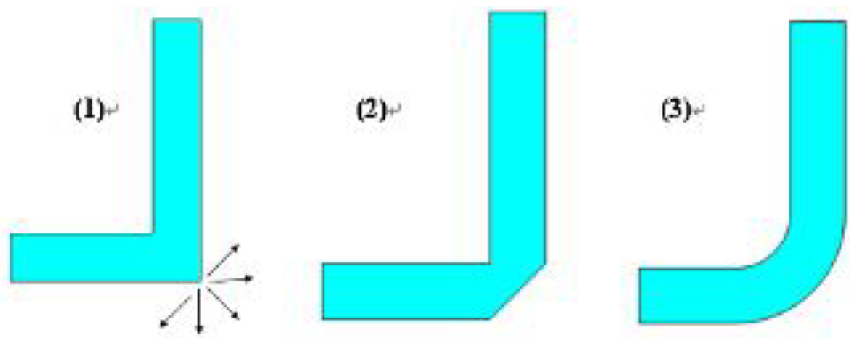


Figure 6-6. Not Recommended vs Recommended Trace Bends

6.2.1.3 Antenna

6.2.1.3.1 CC2564MODN Antenna

The CC2564MODN module must be used with the approved external chip antenna (LTA-5320-2G4S3-A) and must comply with the following guidelines to preserve the modular radio certification (see Figure 6-7).

- Antenna clearance area = 15 mm × 8 mm
- Antenna solder termination to board edge length = 186 mils
- Antenna feed point to right side ground length = 140 mils
- Antenna feed point to last component trace = 244 mils
- Antenna pads to inside ground length = 208 mils
- An inductor L1 = 9.1 nH is required to properly match the chip antenna.

In addition, follow these general recommendations for a proper design with any antenna:

- Place the matching circuit as close as possible to the antenna feed point.
- Do not place traces or ground under the antenna section.
- Place the antenna, RF traces, and modules on the edge of the PCB product. In addition, consider the proximity of the antenna to the enclosure and consider the enclosure material.

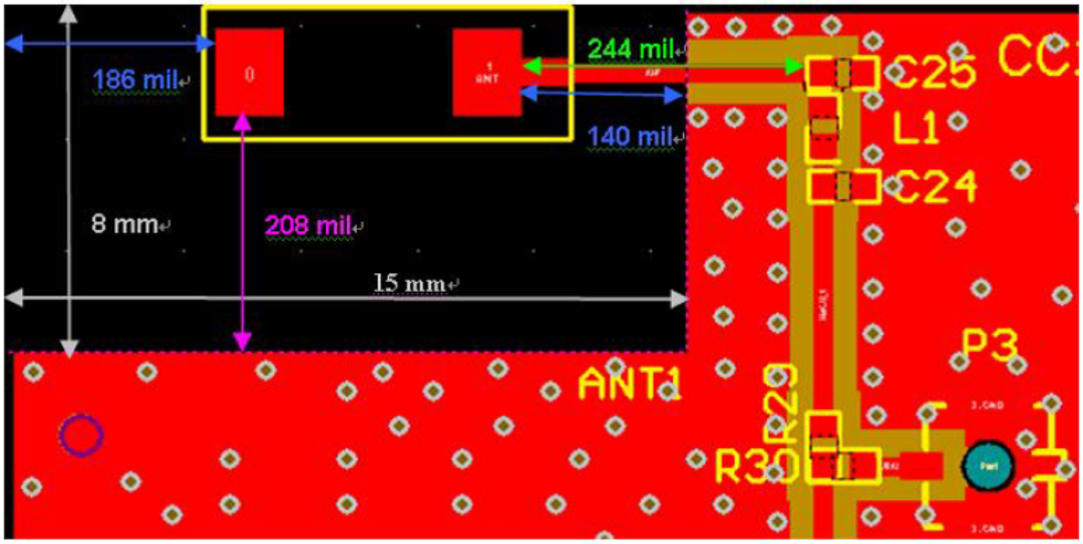


Figure 6-7. Antenna Guidelines

6.2.1.3.2 CC2564MODA Antenna

The CC2564MODA module has an integrated chip antenna (ANT3216A063R2400A). Table 6-2 lists antenna performance values in low, mid, and high frequencies of operation.

Table 6-2. Antenna Performance

ANTENNA	ANT3216A063R2400A			UNIT
Frequency	2.4	2.442	2.484	GHz
S11	–9.12	–15.19	–11.29	dB
Maximum gain	0.63	1.00	0.67	dBi
Average gain	–2.19	–1.90	–2.41	dBi
Efficiency	57.03%	64.01%	57.35%	

Figure 6-8 shows the 3-D radiation patterns.

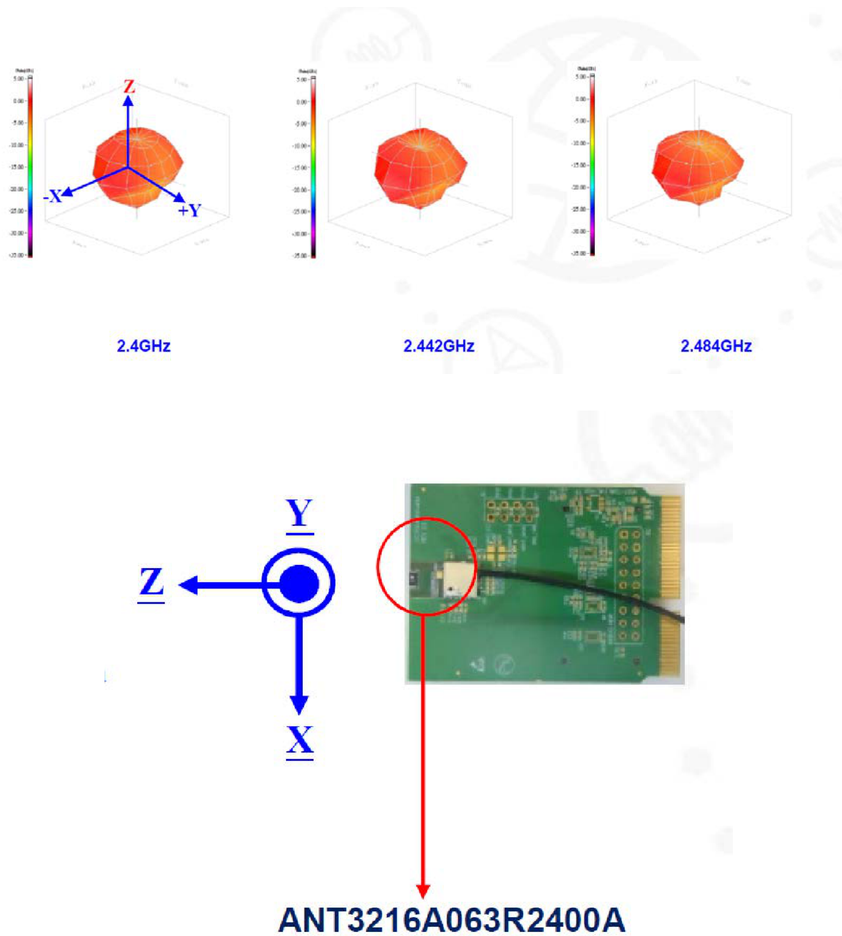


Figure 6-8. Antenna 3-D Radiation Patterns

TI recommends applying the following guidelines for a proper design:

- Do not place traces or ground under and around the antenna section.
- Provide a clearance area of approximate 5.8 × 4.8 mm under the antenna area in all the PCB layers (see Figure 6-9).
- Place the module with the antenna area fitting on the edge of the PCB (see Figure 6-9).
- Follow the ground guidelines described in Section 6.2.1.4.
- In addition, consider the proximity of the antenna to the enclosure and consider the enclosure material.

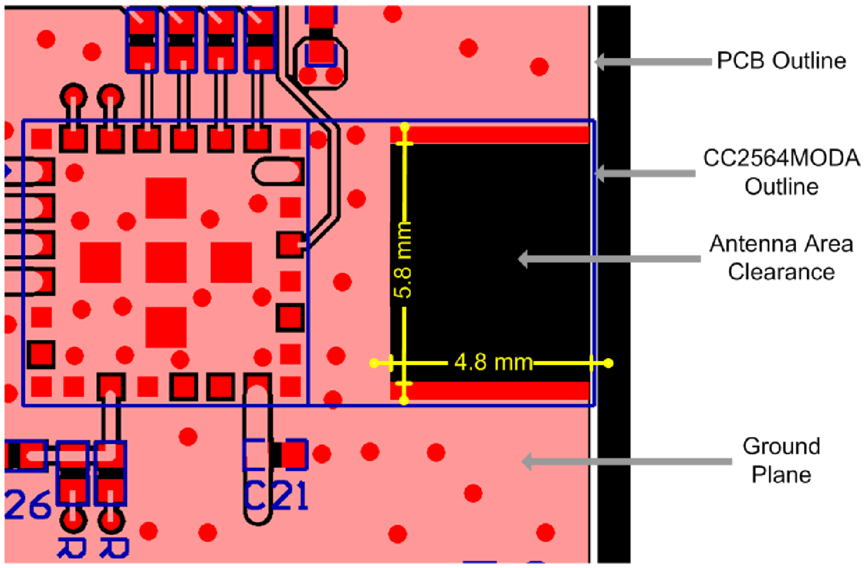


Figure 6-9. CC2564MODA Antenna layout

6.2.1.4 Power Supply and Ground Guidelines

6.2.1.4.1 Power Traces

TI recommends the following guidelines for the power supply of the CC2564MODx module:

- Use a star pattern format to supply power to the different pads of the module.
- Keep the power traces (VBAT and VIO) more than 14 mils.
- Use short power supply traces.
- Place decoupling capacitors as close as possible to the module (see Figure 6-10).

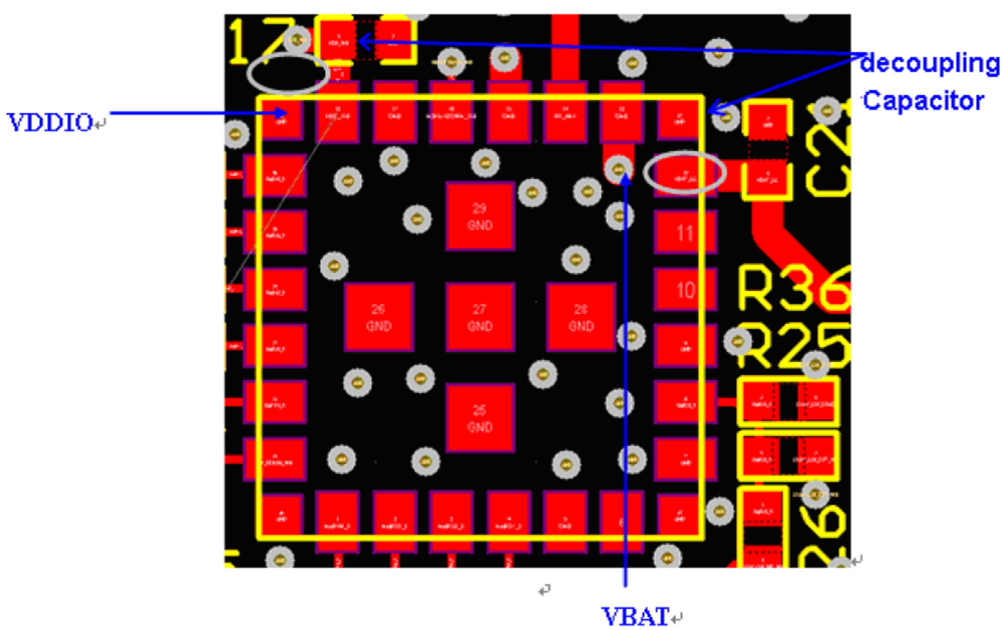


Figure 6-10. Placing Decoupling Capacitors as Close as Possible to the Module

6.2.1.4.2 Ground

The common ground must be the solid ground plane in Layer 2. TI recommends using a large ground pad under and around the module and placing enough ground vias beneath for a stable system and thermal dissipation (see Figure 6-11).

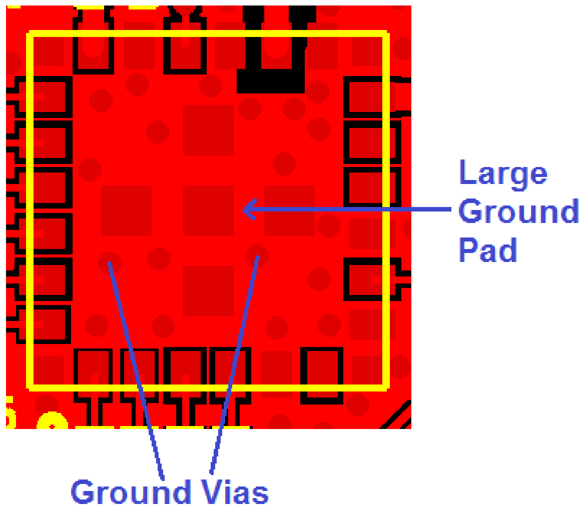


Figure 6-11. Using a Large Ground Pad Under the Module

6.2.1.5 Clock Guidelines

Remember that clock signal routing directly influences RF performance because of the signal trace susceptibility to noise.

6.2.1.5.1 Slow Clock

TI recommends the following guidelines:

- Keep the slow clock signal lines as short as possible and at least 4-mils wide.
- Traces of slow clock signals must have a ground plane on each side of the signal trace to reduce undesired signal coupling.
- To reduce the capacitive coupling of undesired signals into the clock line, do not route slow clock traces above or below other signals (especially digital signals). Figure 6-12 shows the slow clock trace in the TI reference design.

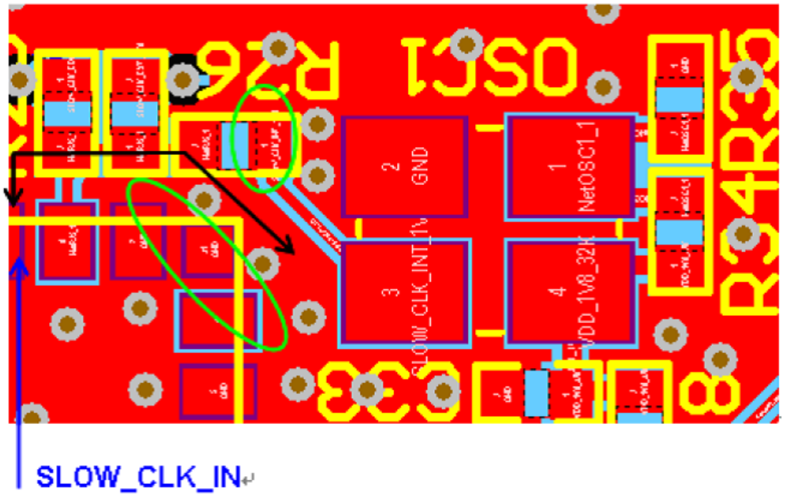


Figure 6-12. Slow Clock Trace in TI Reference Design

6.2.1.6 Digital Interface Guidelines

6.2.1.6.1 UART

The CC2564MODx UART default baud rate is 115.2 kbps but can run up to 4 Mbps. TI recommends separating these lines from the DC supply lines, RF lines, and sensitive clock lines and circuitry. To improve the return path and isolation, run the lines with ground on the adjacent layer when possible.

6.2.1.6.2 PCM

The digital audio lines (pulse-code modulation [PCM]) are high-speed digital lines in which the four wires (AUD_CLK, AUD_FSYNC, AUD_IN, and AUD_OUT) must be roughly the same length. TI recommends running these lines as a bus interface (see Figure 6-13). These lines are high-speed digital and must be separated from DC supply lines, RF lines, and sensitive clock lines and circuitry. Run the lines with ground on the adjacent layer to improve the return path and isolation.

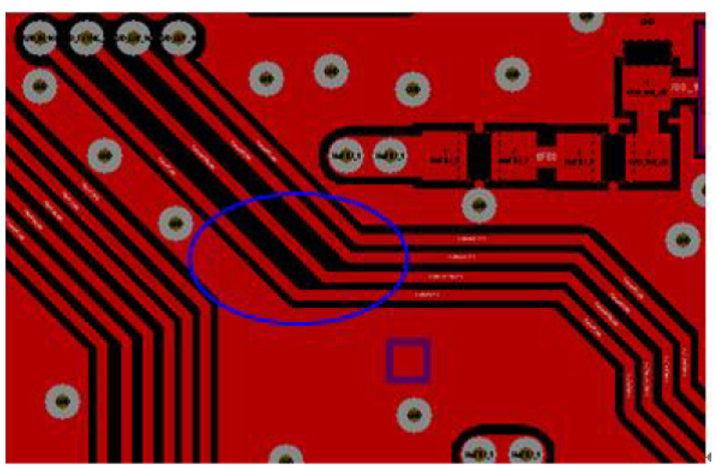


Figure 6-13. Running the Digital Audio Lines

6.2.2 Reference Design Drawings

6.2.2.1 CC2564MODN Reference Design

The dual-mode Bluetooth CC2564 module evaluation board (CC2564MODNEM) contains the CC2564MODN module and is intended for evaluation and design purposes (see Figure 6-14). For more information (such as schematics, BOM, and design files), see TI's CC2564MODNEM tool folder.

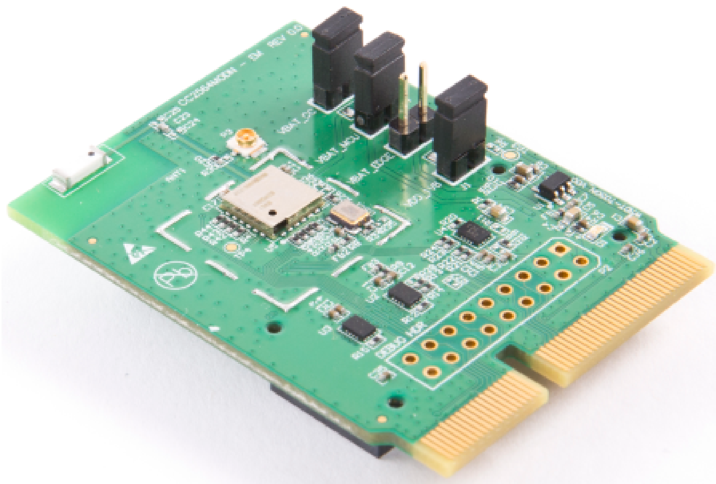


Figure 6-14. CC2564MODNEM Board

6.2.2.2 CC2564MODA Reference Design

The dual-mode Bluetooth CC2564 module with integrated antenna evaluation board (CC2564MODAEM) contains the CC2564MODA module and is intended for evaluation and design purposes (see Figure 6-15). For more information (such as schematics, BOM, and design files), see TI's CC2564MODAEM tool folder.

Figure 6-15. CC2564MODAEM Board

6.3 Soldering Recommendations

Figure 6-16 shows the recommended reflow profile.

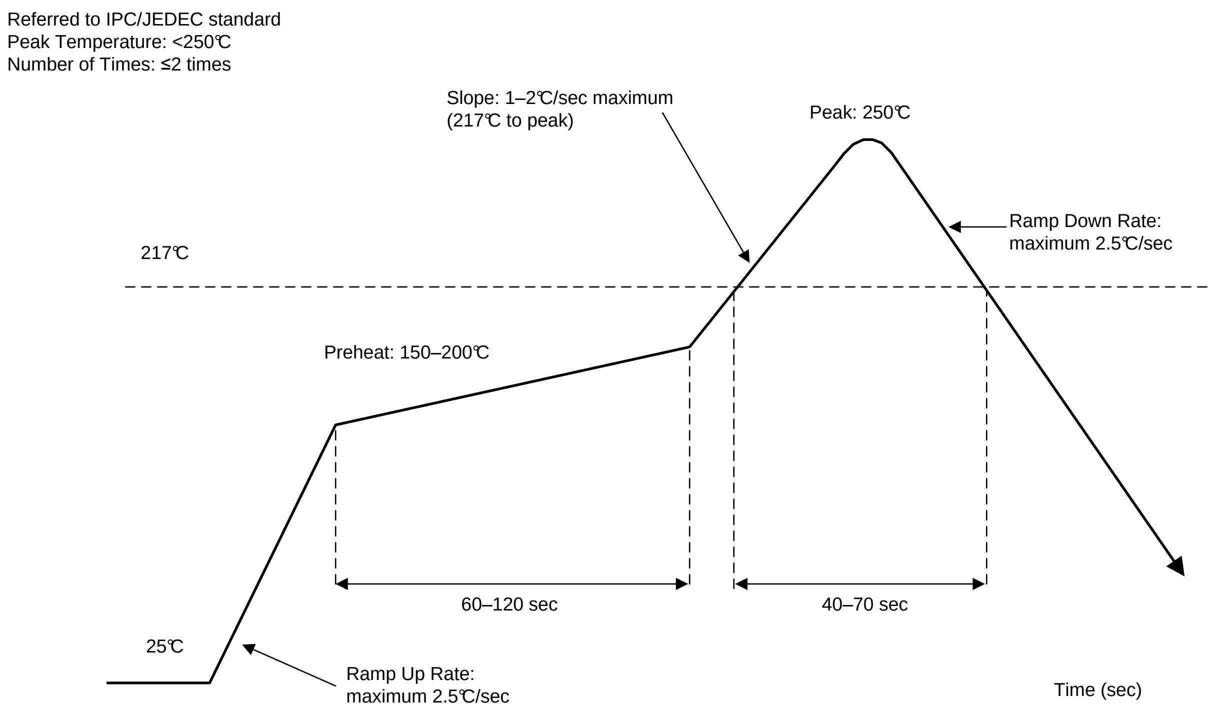


Figure 6-16. Reflow Profile

7 Device and Documentation Support

NOTE

Information in this section is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

7.1 Device Certification and Qualification

The TI CC2564MODx module is certified for the FCC, IC, and ETSI/CE. Moreover, the module is a Bluetooth Qualified Design by the Bluetooth Special Interest Group (Bluetooth SIG). TI Customers that build products based on the TI CC2564MODx module can save in testing cost and time per product family.

For more information, see the CC256x Regulatory Compliance wiki and the CC256x Bluetooth SIG Certification wiki.

7.1.1 FCC Certification

The TI CC2564MODx module is certified for the FCC as a single-modular transmitter. The module is a FCC-certified radio module that carries a modular grant. The module complies with the intentional radiator portion (Part 15c) of the FCC certification: Part 15.247 transmitter tests. For more information, see CC2564MODx Modular Grant, FCC ID: Z64-2564N. A Class 2 Permissive Change is applied to CC2564MODA.

7.1.2 IC Certification

The TI CC2564MODx module is certified for the IC as a single-modular transmitter. The TI CC2564MODx module meets IC modular approval and labeling requirements. The IC follows the same testing and rules as the FCC regarding certified modules in authorized equipment. For more information, see CC2564MODx Modular Grant, IC ID: 451I-2564N. A Class 2 Permissive Change is applied to CC2564MODA.

7.1.3 ETSI/CE Certification

The TI CC2564MODx module is CE certified with certifications to the appropriate EU radio and EMC directives summarized in the Declaration of Conformity and evidenced by the CE mark. The module is tested against the ETSI EN300-328 v1.8.1 radio tests, which is accepted by a number of countries for radio compliance. For more information, see CC2564MODN DoC and CC2564MODA DoC.

7.1.4 Bluetooth Special Interest Group Qualification

The TI CC2564MODx module is Bluetooth qualified and carries a Bluetooth 4.1 Controller Subsystem Qualification Design ID (QDID), which covers the lower layers of a Bluetooth design up to the HCI layer. TI customers that build products based on the TI CC2564MODx module can reference this QDID in their Bluetooth product Listing. For more information, see CC2564MODN Controller Subsystem, QDID 55257 and CC2564MODA Controller Subsystem, QDID 64631.

7.2 Tools and Software

Design Kits and Evaluation Modules

Dual-Mode Bluetooth® CC2564 Evaluation Board The CC256XQFNEM evaluation board contains the CC2564B device and is intended for evaluation and design purposes for the CC256x devices.

Dual-Mode Bluetooth® CC2564 Module Evaluation Board The CC2564MODNEM evaluation board contains the CC2564MODN device and is intended for evaluation and design purposes.

Dual-mode Bluetooth® CC2564 Module With Integrated Antenna BoosterPack™ Plug-in Module The BOOST-CC2564MODA BoosterPack™ plug-in module is intended for evaluation and design purposes of the dual-mode Bluetooth® CC2564 module with integrated antenna (CC2564MODA). The CC2564MODA module is based on TI's dual-mode Bluetooth® CC2564B Controller, which reduces design effort and enables fast time to market. The CC2564MODA modules provides best-in-class RF performance with a transmit power and receive sensitivity that provides range of about 2× compared to other Bluetooth low-energy-only solutions.

Dual-Mode Bluetooth® CC2564 Module With Integrated Antenna Evaluation Board The CC2564MODAEM evaluation board contains the Bluetooth BR/EDR/LE HCI solution. Based on TI's CC2564B dual-mode Bluetooth single-chip device, the bCC2564MODA is intended for evaluation and design purposes, reducing design effort and enabling fast time to market.

IoT Enabled ARM® Cortex®-M4F MCU TM4C129X Connected Development Kit The TM4C129x Connected Development Kit is a versatile and feature-rich engineering platform that highlights the 120-MHz TM4C129XNCZAD IoT Enabled ARM Cortex-M4F based microcontroller, including an integrated 10/100 Ethernet MAC + PHY as well as many other key features.

MSP430F5438 Experimenter Board The MSP430F5438 Experimenter Board (MSP-EXP430F5438) is a microcontroller development for highly integrated, high performance MSP430F5438 MCUs. It features a 100-pin socket which supports the MSP430F5438A and other devices with similar pinout. The socket allows for quick upgrades to newer devices or quick applications changes. It is compatible with many TI low-power RF wireless development kits such as the CC2520EMK. The Experimenter Board helps designers quickly learn and develop using the F5xx MCUs, which provide low power, more memory and leading integration for applications such as energy harvesting, wireless sensing and automatic metering infrastructure (AMI).

MSP430F5529 USB Experimenter's Board The MSP430F5529 USB microcontroller development kit is not supported by the Mac or Linux versions of the Code Composer Studio™ Integrated Development Environment. If you want to work with these operating systems, we suggest you select one of the many MSP LaunchPad development kits. The MSP430F5529 Experimenter Board (MSP-EXP430F5529) is a development platform for the MSP430F5529 device, from the latest generation of MSP430 devices with integrated USB. The board is compatible with many TI low-power RF wireless evaluation modules such as the CC2520EMK. The Experimenter Board helps designers quickly learn and develop using the new F55xx MCUs, which provide the industry's lowest active power consumption, integrated USB, and more memory and leading integration for applications such as energy harvesting, wireless sensing and automatic metering infrastructure (AMI).

TM4C123G USB+CAN Development Kit The Tiva C Series TM4C123G Development Kit is a compact and versatile evaluation platform for the Tiva C Series TM4C123G ARM® Cortex™-M4-based microcontroller (MCU). The development kit design highlights the TM4C123G MCU integrated USB 2.0 On-the-Go/Host/Device interface, CAN, precision analog, sensor hub, and low-power capabilities. The development kit features a Tiva C Series TM4C123GH6PGE microcontroller in a 144-LQFP package, a color OLED display, USB OTG connector, a microSD card slot, a coin-cell battery for the low-power Hibernate mode, a CAN transceiver, a temperature sensor, a nine-axis sensor for motion tracking, and easy-access through-holes to all of the available device signals.

TI Designs and Reference Designs

CC256x Bluetooth® Reference Design This CC256x Bluetooth® evaluation module reference design is an RF reference design with antenna which can be easily connected to many Microcontroller Units (MCUs), such as TI's MSP430 or Tiva C series MCUs. The reference design can be copied into your board, allowing for a cost-effective design with reduced time to market. This Bluetooth design is supported by an orderable evaluation module, royalty free software and documentation, test and certification tips, and community support resources. Visit our wiki for more information.

Software

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 is fully Bluetooth Special Interest Group (SIG) qualified, certified and royalty-free, provides simple command line sample applications to speed development, and upon request has MFI capability.

TI Dual-Mode Bluetooth Stack on MSP432 MCUs TI's Dual-mode Bluetooth stack on MSP432 MCUs software for Bluetooth + Bluetooth Low Energy enables the MSP432 MCU 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 upon request has MFI capability.

TI Dual-Mode Bluetooth® Stack on STM32F4 MCUs TI's Dual-mode Bluetooth stack on STM32F4 MCUs software for Bluetooth + Bluetooth Low Energy enables the STM32 ARM Cortex M4 and is comprised of Single Mode and Dual Mode offerings implementing the Bluetooth 4.0 specification. The Bluetooth stack is fully qualified for CC256XSTBTBLESW (QDID 69887 and QDID 69886), provides simple command line sample applications to speed development, and upon request has MFI capability.

TI Dual-Mode Bluetooth® Stack on MSP430™ MCUs TI's Dual-mode Bluetooth stack on MSP430™ MCUs software for Bluetooth + Bluetooth Low Energy enables the MSP430 MCU and is comprised of Single Mode and Dual Mode offerings implementing the Bluetooth 4.0 specification. The Bluetooth stack is fully qualified (QDID 37180 and QDID 42849), provides simple command line sample applications to speed development, and upon request has MFI capability.

TI Dual-Mode Bluetooth® Stack on TM4C MCUs TI's Dual-mode Bluetooth stack on TM4C MCUs software for Bluetooth + Bluetooth Low Energy enables the TM4C12x MCU and is comprised of Single Mode and Dual Mode offerings implementing the Bluetooth 4.0 specification. The Bluetooth stack is fully qualified (QDID 37180 and QDID 42849), provides simple command line sample applications to speed development, and upon request has MFI capability.

Bluetooth Service Pack for CC256xB The package contains Init Scripts (for BT4.0 and BT4.1) and Add-Ons (for Audio/Voice Processing and for Bluetooth low energy support). The CC256x Bluetooth Service Packs (SP) are mandatory initialization scripts that contain bug fixes and platform specific configurations. They must be loaded into the corresponding CC256x device after every power cycle. The CC256x SPs are delivered in the form of a Bluetooth Script (BTS) file. A BTS file is a scripted binary file which defines the actions that should be applied to the embedded HCI commands and HCI events within the file itself.

TI Bluetooth® Linux® Add-On for AM335x EVM, AM437x EVM and BeagleBone® With WL18xx and CC256x This package contains the install package, pre-compiled object and source of the TI Bluetooth Stack and Platform Manager to easily upgrade the default LINUX EZSDK Binary on a AM437x EVM, AM335x EVM or BeagleBone. The software was built with Linaro GCC 4.7 and can be added to Linux SDKs that use similar toolchain on other platforms. The Bluetooth stack is fully qualified (QDID 69886 and QDID 69887), provides simple command line sample applications to speed development, and upon request has MFI capability.

Development Tools

CC256x Bluetooth Hardware Evaluation Tool The CC256x Bluetooth Hardware Evaluation Tool is a Texas Instruments (TI) tool which can be downloaded as a complete package from the TI web site. It is a very intuitive, user-friendly tool to evaluate TI's Bluetooth chips. More specifically, it is used to configure the BT chip's properties through the Service Pack (SP) and also allows to test RF performance.

7.3 Device Nomenclature

To designate the stages in the product development cycle, TI assigns prefixes to the part numbers of all microprocessors (MPUs) and support tools. Each device has one of three prefixes: X, P, or null (no prefix) (for example, *CC2564MODNCMOER*). Texas Instruments recommends two of three possible prefix designators for its support tools: TMDX and TMDS. These prefixes represent evolutionary stages of product development from engineering prototypes (TMDX) through fully qualified production devices and tools (TMDS).

Device development evolutionary flow:

X Experimental device that is not necessarily representative of the final device's electrical specifications and may not use production assembly flow.

P Prototype device that is not necessarily the final silicon die and may not necessarily meet final electrical specifications.

null Production version of the silicon die that is fully qualified.

For orderable part numbers of CC2564MODx devices in the MOE and MOG package types, see the Package Option Addendum of this document, ti.com, or contact your TI sales representative.

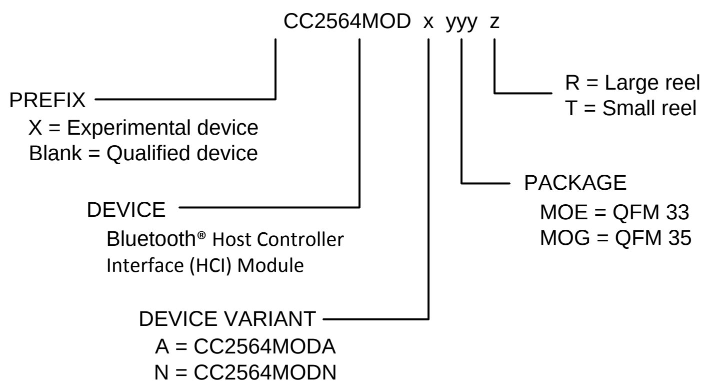


Figure 7-1. Device Nomenclature

7.4 Documentation Support

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

The current documentation that describes the DSP, related peripherals, and other technical collateral is listed below.

Application Report

Using TI Technology to Simplify Bluetooth® Pairing Via NFC Bluetooth® pairing usually involves some level of user interaction to confirm the identity of the user and/or the devices themselves. There are many pairing mechanisms available across the versions of Bluetooth (v2.0 through v4.0). This process is typically lengthy and sometimes confusing to the user, and so this application report is aimed at showing TI technology developers details on implementing a simplified pairing scheme method outlined by the NFC Forum using an MSP430F5529 (a TI ultra-low power MCU), a TRF7970A (a TI NFC transceiver IC), and an CC2560 (a TI Bluetooth radio IC).

User's Guides

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.

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

Dual-Mode Bluetooth® CC2564 Module With Integrated Antenna Evaluation Board This quick-start guide offers an overview of the CC2564MODAEM evaluation board for the dual-mode Bluetooth CC2564 module with integrated antenna (CC2564MODA), including required hardware and software tools and basic settings. For more information, see the *Dual-Mode Bluetooth CC2564 Module With Integrated Antenna Evaluation Board* user's guide.

Selection and Solution Guides

Connected Sensors Building Automation Systems Guide Monitoring devices or nodes in building control systems, fire safety systems, lighting control, and other building automation and Internet of Things (IoT) applications are becoming more prevalent in today's world.

White Papers

Wireless connectivity for the Internet of Things: One Size Does Not Fit All In the rapidly growing Internet of Things (IoT), applications from personal electronics to industrial machines and sensors are getting wirelessly connected to the Internet. Covering a wide variety of use cases, in various environments and serving diverse requirements, no single wireless standard can adequately prevail. With numerous standards deployed in the market, spreading over multiple frequency bands and using different communication protocols, choosing the right wireless connectivity technology for an IoT application can be quite challenging. In this paper we review the predominant wireless connectivity technologies in the market, discuss their key technical concepts and engineering tradeoffs and provide guidelines for selection of the right wireless technology for different applications.

Three flavors of Bluetooth®: Which one to choose? The Bluetooth® 4.0 specification brought a new form of Bluetooth technology – variously known as Bluetooth LE, Bluetooth low energy, or Bluetooth Smart in communications directed towards the consumer. This new form of Bluetooth technology was developed in order to enable new types of Bluetooth devices in areas where Bluetooth previously hadn't been widely adopted for reasons of battery life or cost. In this article, I'll provide a brief history of Bluetooth low energy and the consumer-facing positioning of Bluetooth Smart and Bluetooth Smart Ready as well as how to select which "flavor" of Bluetooth is the best option for you.

Design Files

CC2564MODAEM Design Files Design files for the CC2564MODAEM

CC2564MODNEM Design Files Design files for the CC2564MODNEM

More Literature

CC2564MODA CE Certification CC2564MODA CE Certification documentation

SimpleLink™ Bluetooth CC256x Solutions TI single- and dual-mode CC256x solutions are complete Bluetooth® BR/EDR/ low energy HCI or Bluetooth + Bluetooth low energy solutions that reduce design effort and enable fast time to market.

7.5 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 7-1. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
CC2564MODN	Click here	Click here	Click here	Click here	Click here
CC2564MODA	Click here	Click here	Click here	Click here	Click here

7.6 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

TI E2E™ Online Community The TI engineer-to-engineer (E2E) community was created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

TI Embedded Processors Wiki Established to help developers get started with Embedded Processors from Texas Instruments and to foster innovation and growth of general knowledge about the hardware and software surrounding these devices.

7.7 Trademarks

Texas Instruments, MSP430, MSP432, E2E are trademarks of Texas Instruments.
ARM7TDMI is a trademark of ARM Limited.
iPod is a registered trademark of Apple, Inc.
Bluetooth is a registered trademark of Bluetooth SIG.
Linux is a registered trademark of Linux Foundation.
All other trademarks are the property of their respective owners.

7.8 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

7.9 Glossary

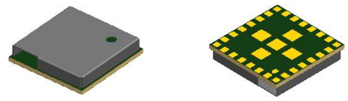
TI Glossary This glossary lists and explains terms, acronyms, and definitions.

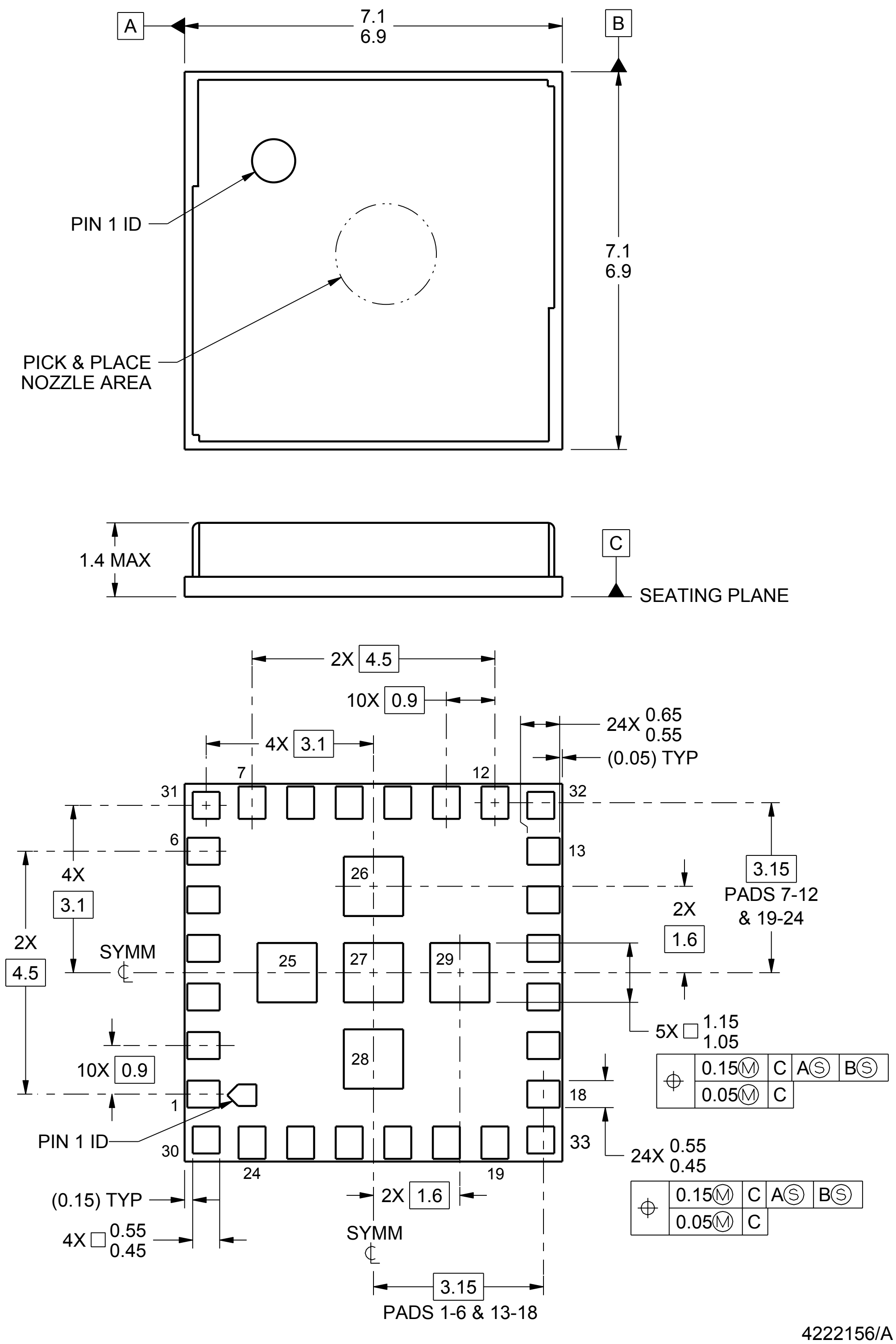
8 Mechanical, Packaging, and Orderable Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

8.1 Mechanical Data

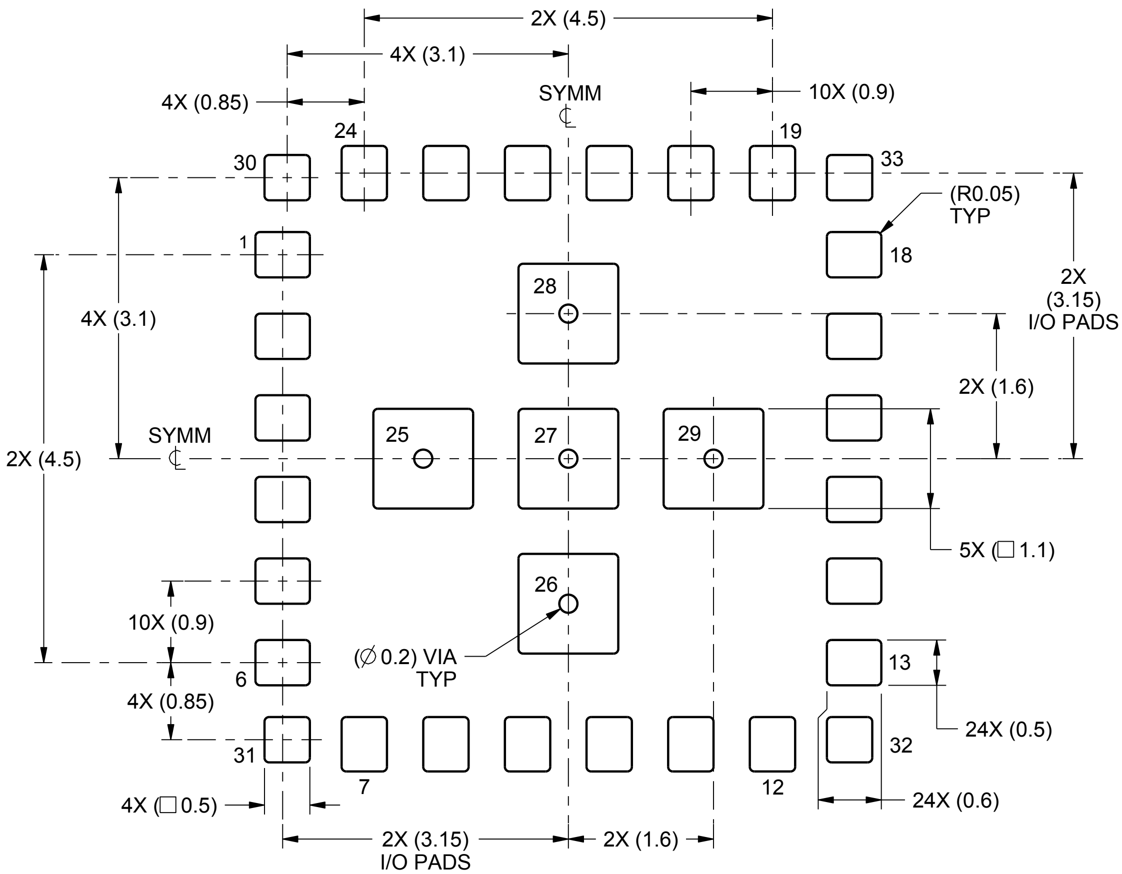
8.1.1 CC2564MODN Mechanical Data



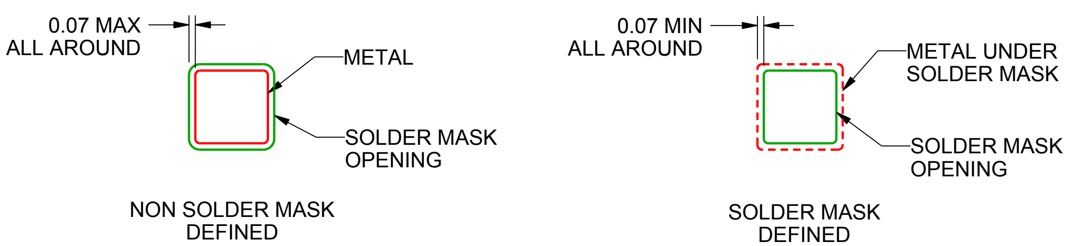


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.



LAND PATTERN EXAMPLE
SCALE:12X

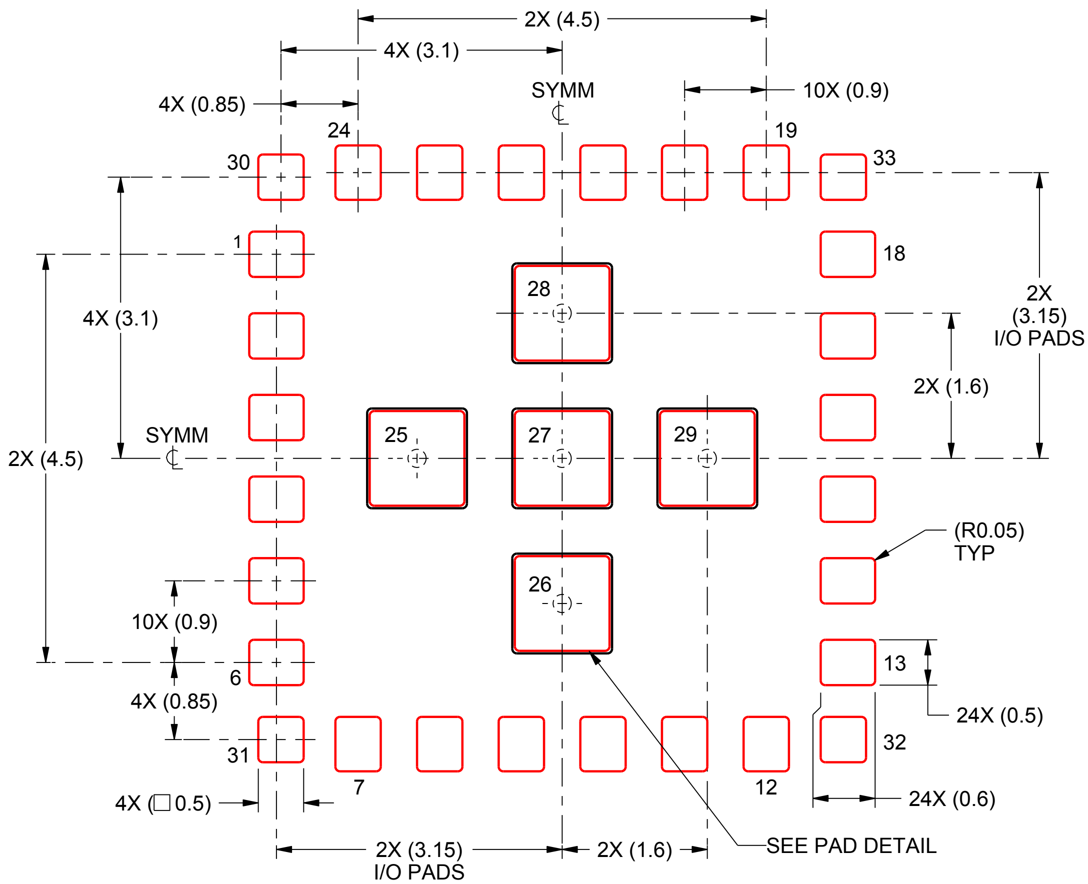


SOLDER MASK DETAILS

4222156/A 12/2015

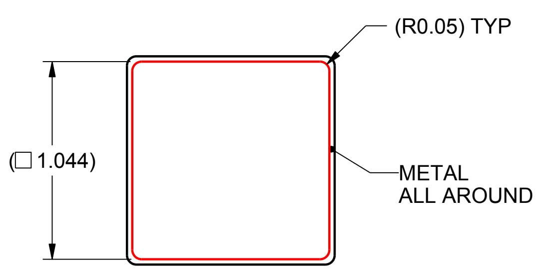
NOTES: (continued)

3. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

PRINTED SOLDER COVERAGE BY AREA
PADS 25-29: 90%
SCALE:12X



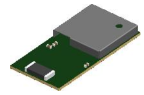
CENTER PAD DETAIL
5X,SCALE:25X

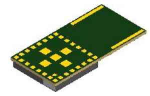
4222156/A 12/2015

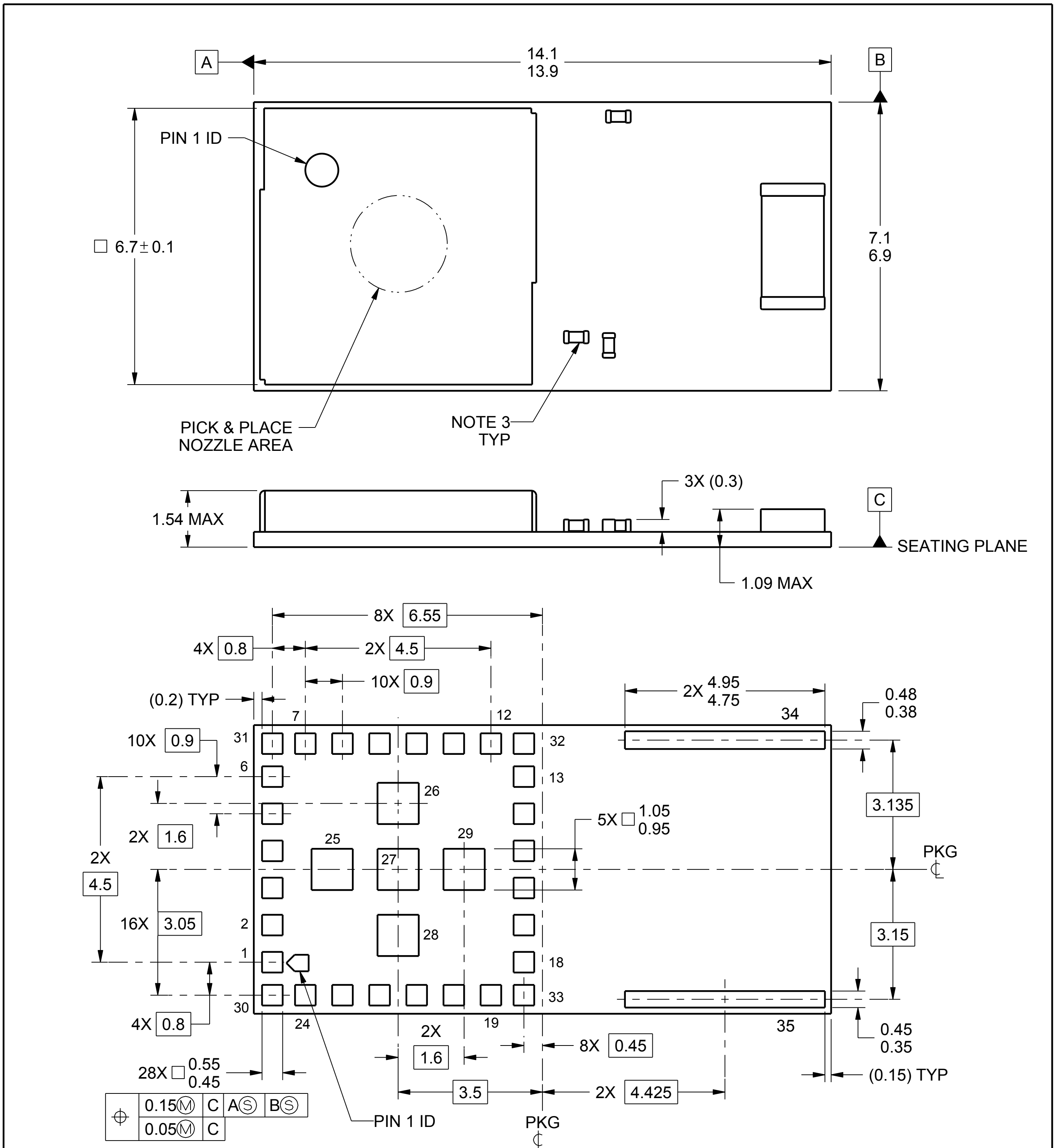
NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

8.1.2 CC2564MODA Mechanical Data

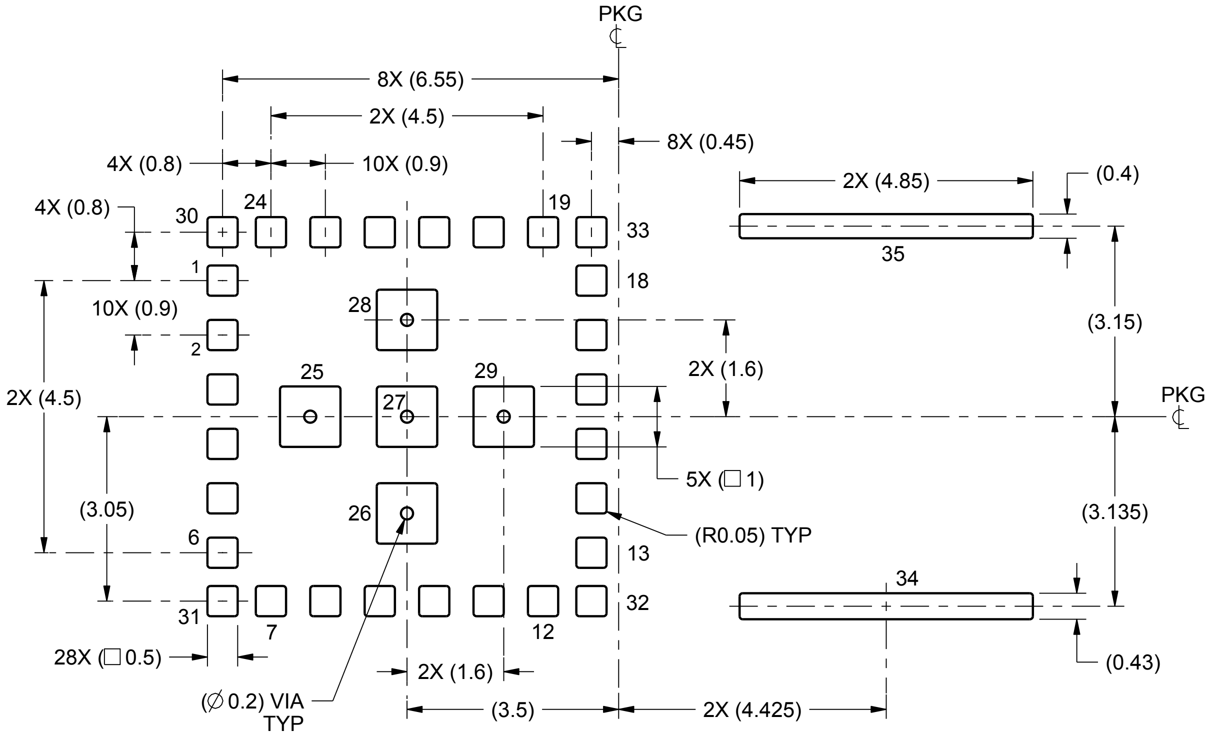




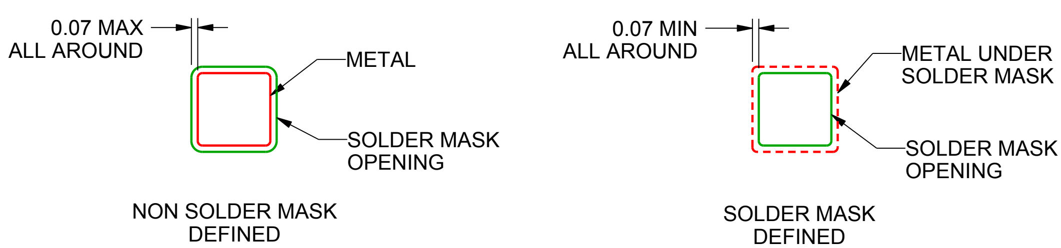


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Location, size and quantity of components are for reference only and could vary.



LAND PATTERN EXAMPLE
SCALE:8X

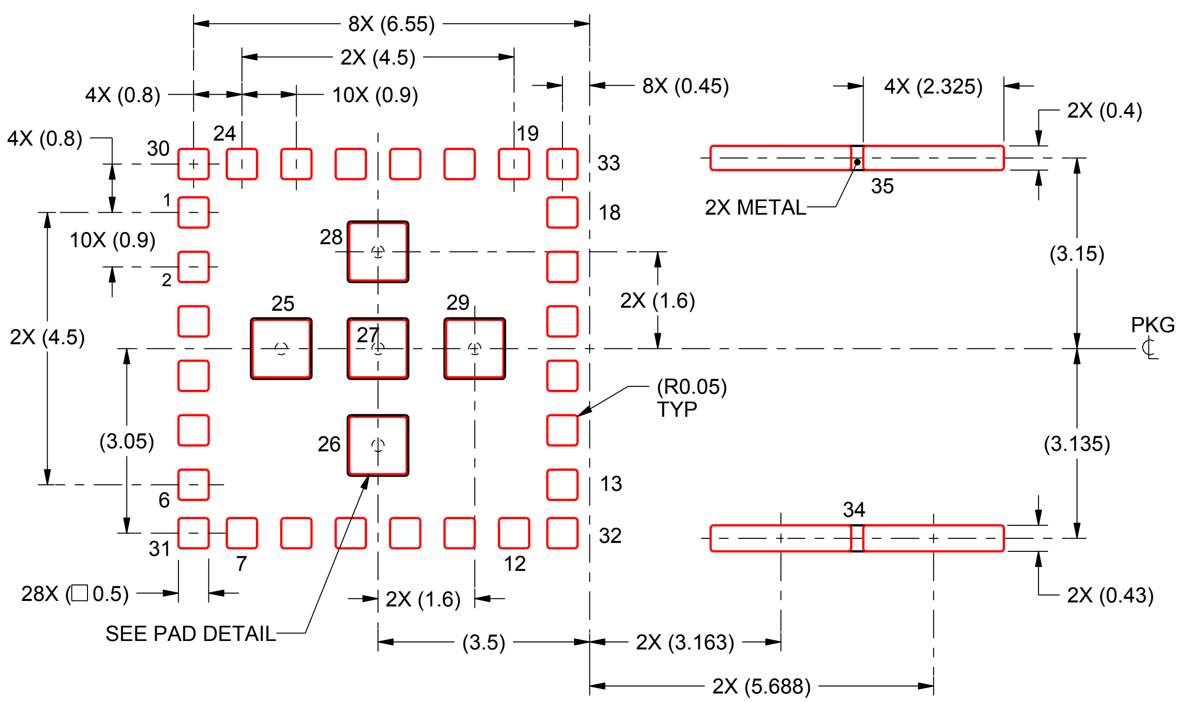


SOLDER MASK DETAILS

4221869/A 07/2015

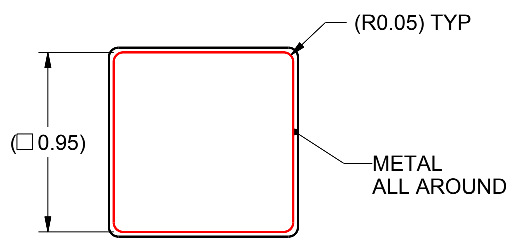
NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

PADS 25-29: 90% PRINTED SOLDER COVERAGE BY AREA
PADS 34 & 35: 96% PRINTED SOLDER COVERAGE BY AREA
SCALE:8X



PAD DETAIL
4X,SCALE:25X

4221869/A 07/2015

NOTES: (continued)

5. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

8.2 Packaging and Ordering

8.2.1 Package and Ordering Information

Table 8-1. Package and Ordering Information

PART NUMBER(1)	STATUS	PACKAGE TYPE	MINIMUM ORDERABLE QUANTITY
CC2564MODNCMOET	Active	MOE	250
CC2564MODNCMOER	Active	MOE	2000
CC2564MODACMOG	Active	MOG	216

(1) Part number marking key:
- CC2564MODx – module variant (N: external antenna; A: integrated antenna)
- C – module marking (commercial)
- MOx – module package type: MOE (33 pins); MOG (35 pins)
- x – packaging designator (R: large T&R; T: small T&R; blank: tray

Figure 8-1 shows the markings for the CC2564MODN module.

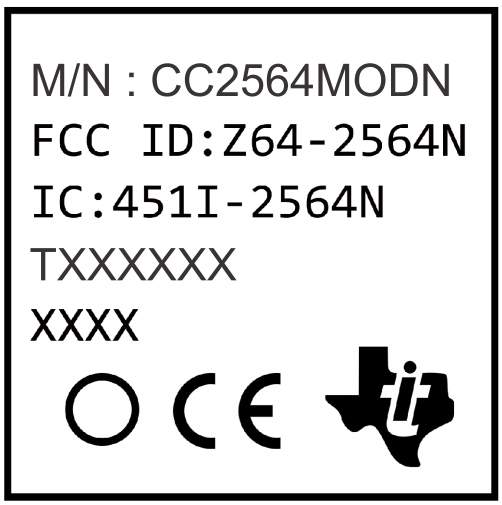


Figure 8-1. CC2564MODN Markings

Figure 8-2 shows the markings for the CC2564MODA module.

Figure 8-2. CC2564MODA Markings

Table 8-2 describes the CC2564MODx markings.

Table 8-2. CC2564MODx Markings

MARKING	DESCRIPTION
CC2564MODx	Model number • CC2564MODN: external antenna • CC2564MODA: integrated antenna
Z64 - 2564N	FCC ID: single modular FCC grant ID
451I - 2564N	IC: single modular IC grant ID
TXXXXXX	Lot order code (for example, A0A7123): • T = fixed • Second and third digits = year code by hex (for example, 0A = 2010) • Fourth digit = month code by hex (for example, 7 = July) • Fifth to seventh digit = serial number by hex (for example, 123)
XXXX	Production date code (for example, 1424): • XX = year (for example, 14 = 2014) • XX = week (for example, 24 = week 24)
CE	CE compliance mark

8.2.2 Tape and Reel Packaging Information (CC2564MODN Only)

8.2.2.1 Empty Tape Portion

Figure 8-3 shows the empty portion of the carrier tape.

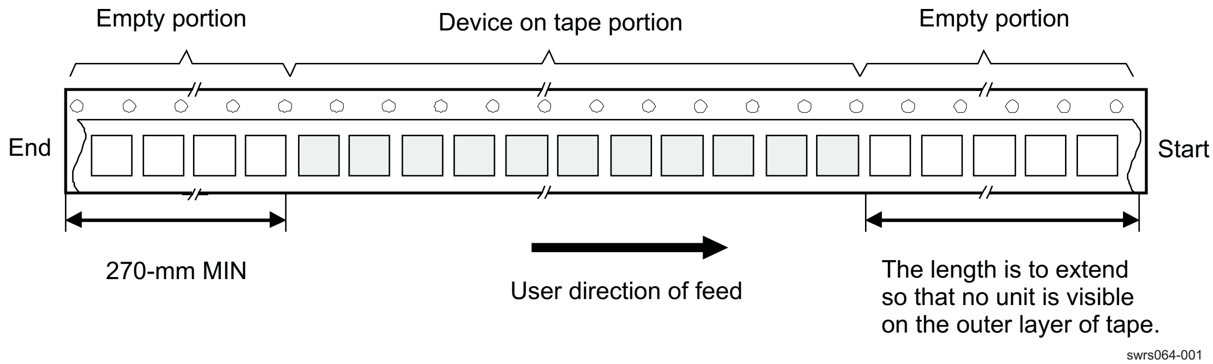


Figure 8-3. Carrier Tape and Pockets

8.2.2.2 Device Quantity and Direction

When pulling out the tape, the A1 corner is on the left side (see Figure 8-4).

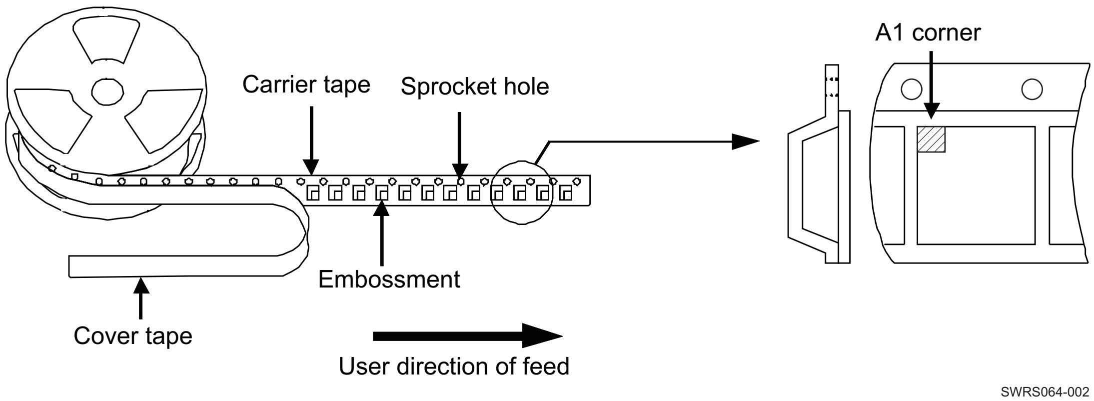


Figure 8-4. Direction of Device

8.2.2.3 Insertion of Device

Figure 8-5 shows the insertion of the device.

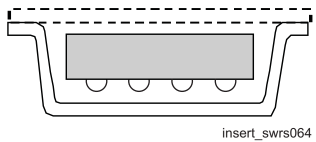


Figure 8-5. Insertion of Device

8.2.2.4 Tape Specification

Figure 8-6 shows the dimensions of the tape.

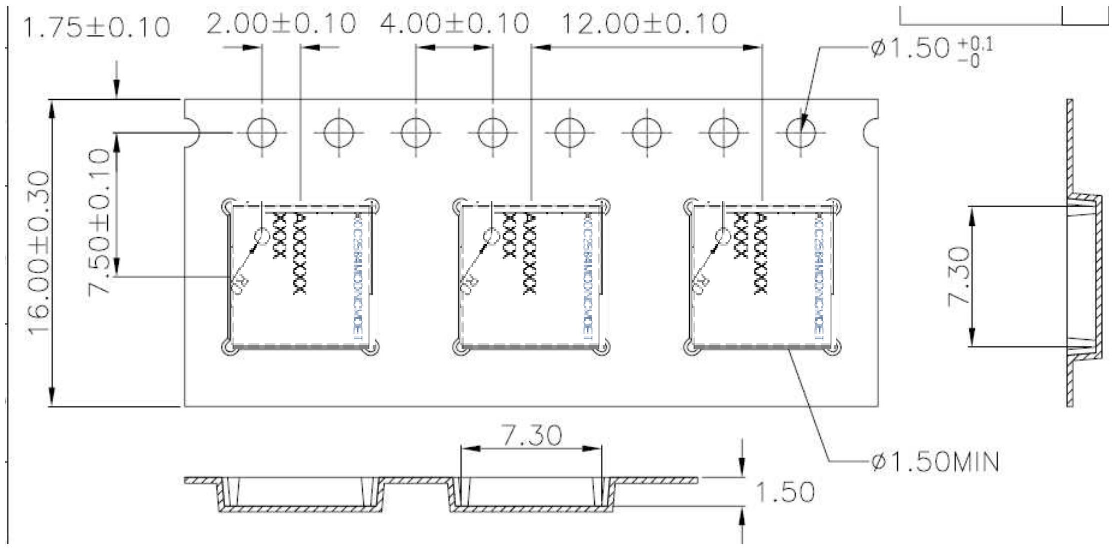


Figure 8-6. Tape Dimensions (mm)

- Cumulative tolerance of the 10-sprocket hole pitch is ±0.20.
- Carrier camber is within 1 mm in 250 mm.
- Material is black conductive polystyrene alloy.
- All dimensions meet EIA-481-D requirements.
- Thickness: 0.30 ±0.05 mm
- Packing length per 22-inch reel is 110.5 m (1:3).
- Component load per 13-inch reel is 2000 pieces.

8.2.2.5 Reel Specification

Figure 8-7 shows the reel specifications:

- 330-mm reel, 12-mm width tape
- Reel material: Polystyrene (static dissipative/antistatic)

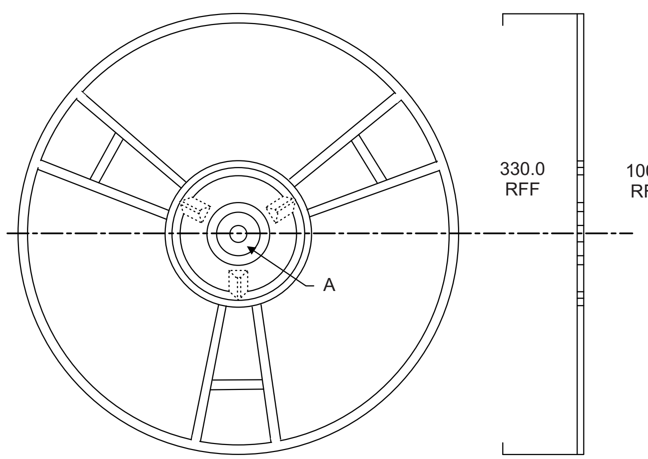


Figure 8-7. Reel Dimensions (mm)

8.2.2.6 Packing Method

Figure 8-8 shows the reel packing method.

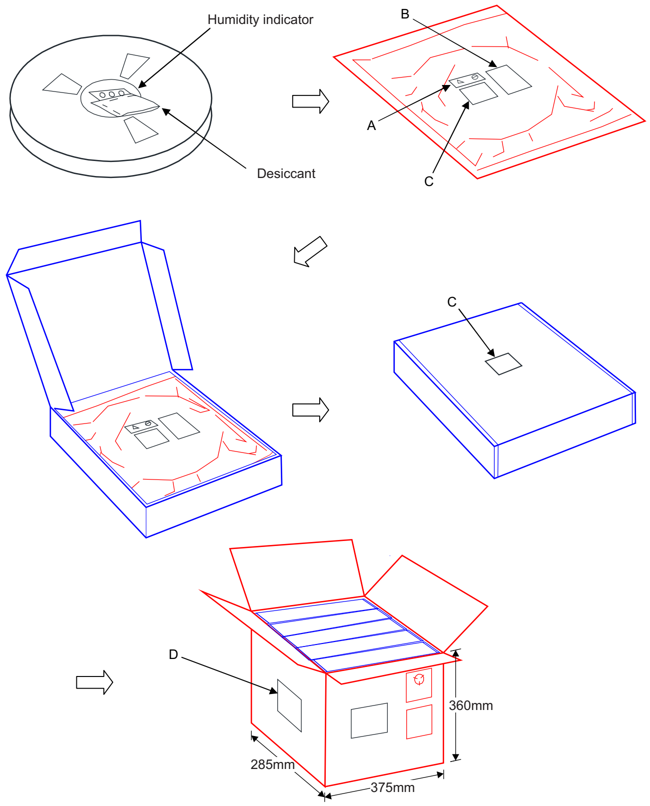


Figure 8-8. Reel Packing Method

8.2.2.7 Packing Specification

8.2.2.7.1 Reel Box

Each moisture-barrier bag is packed into a reel box, as shown in Figure 8-9.

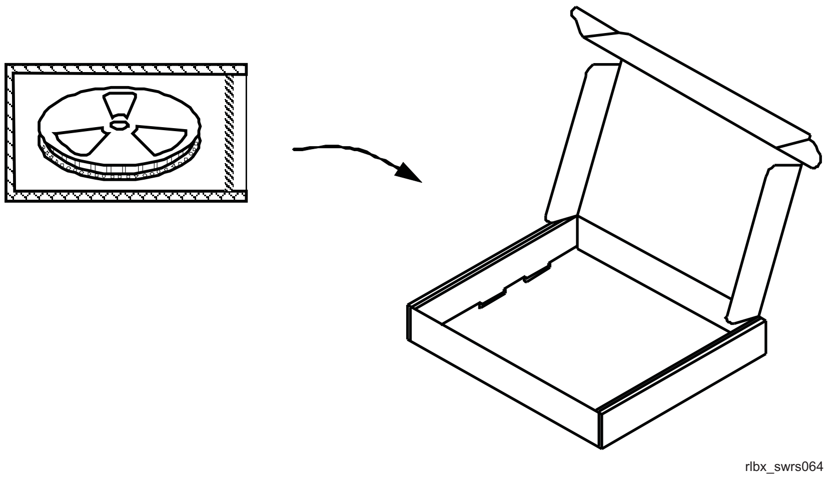


Figure 8-9. Reel Box (Carton)

8.2.2.7.2 Reel Box Material

The reel box is made from corrugated fiberboard.

8.2.2.7.3 Shipping Box

If the shipping box has excess space, filler (such as cushion) is added.

Figure 8-10 shows a typical shipping box.

NOTE

The size of the shipping box may vary depending on the number of reel boxes packed.

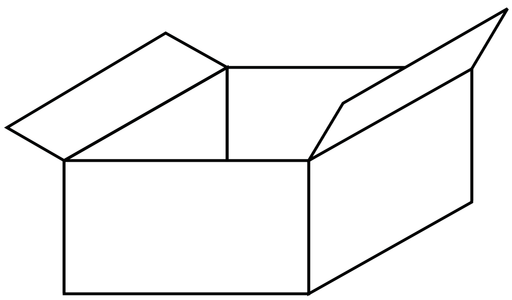


Figure 8-10. Shipping Box (Carton)

8.2.2.7.4 Shipping Box Material

The shipping box is made from corrugated fiberboard.

8.2.2.7.5 Labels

Figure 8-11 shows the antistatic and humidity notice.

Figure 8-11. Antistatic and Humidity Notice

Figure 8-12 shows the MSL caution and storage condition notice.

Figure 8-12. MSL Caution and Storage Condition Notice

Figure 8-13 shows the label for the inner box.

Figure 8-13. Inner Box Label Example

8.2.3 Tray Packing Information (CC2564MODA Only)

8.2.3.1 Tray Packing

Figure 8-14 shows the device in the tray.

Figure 8-14. Device in Tray

Figure 8-15 shows a close-up view of the device in the tray.

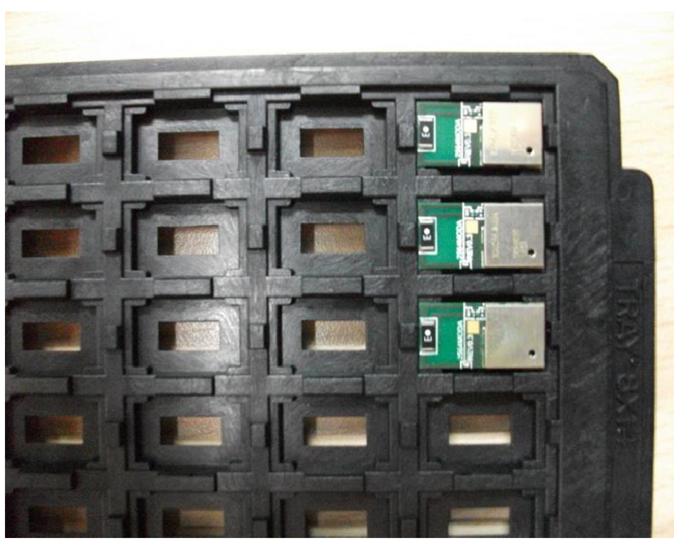


Figure 8-15. Close-Up View of Device in Tray

8.2.3.2 Pin 1 Orientation in Tray

Figure 8-16 shows the Pin 1 orientation (Quadrant 2) of the CC2564MODA device in the tray.

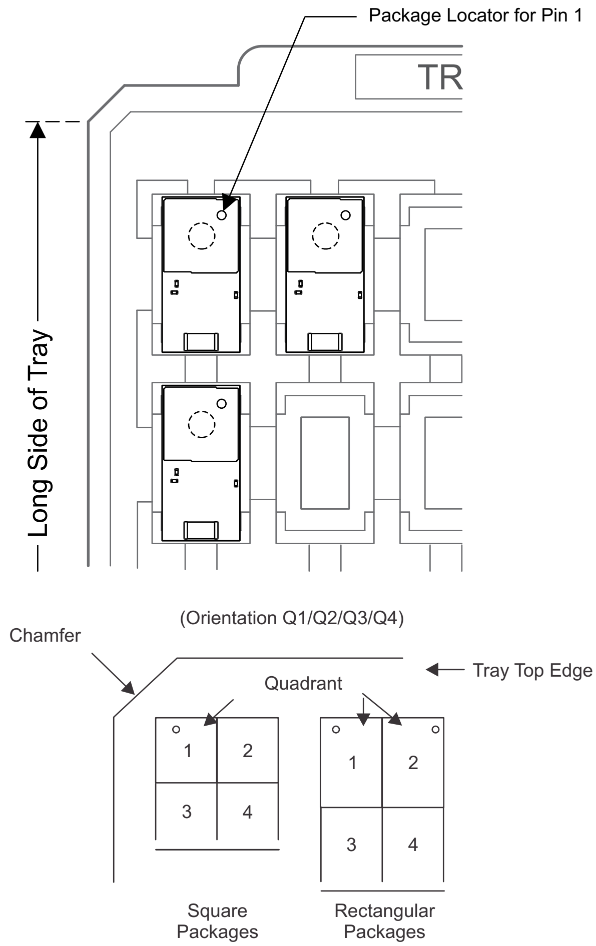


Figure 8-16. Pin 1 Orientation in Tray

8.2.3.3 Tray Specification

Figure 8-17 shows the tray specifications. Table 8-3 lists a summary of the tray dimensions.

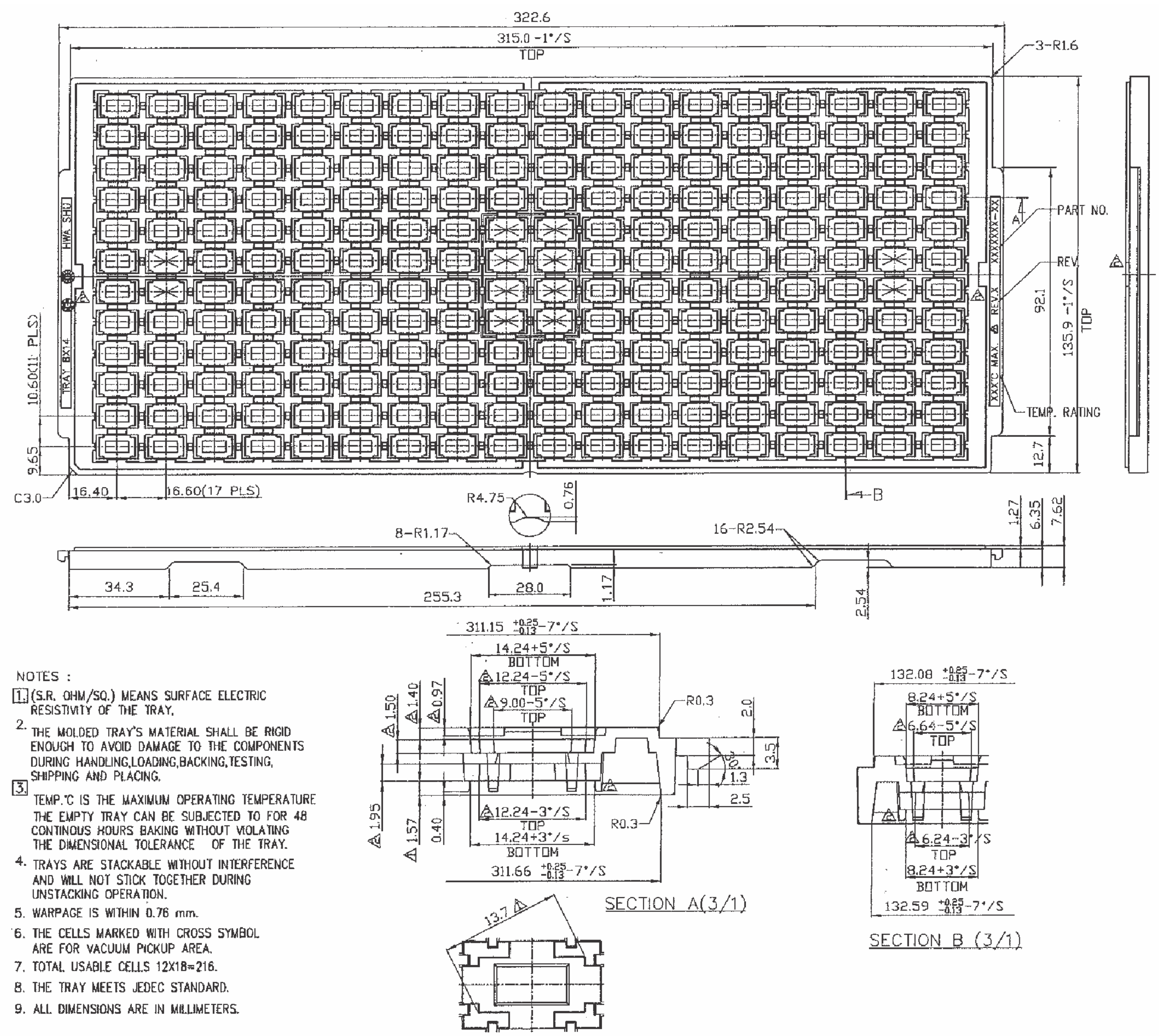


Figure 8-17. Tray Dimensions

Table 8-3. Tray Dimensions

DEVICE	PKG. TYPE	PKG. SIZE (mm)	TRAY PART NO.	TRAY MATRIX	TRAY LENGTH (mm)	TRAY WIDTH (mm)	POCKET SIZE (mm)	MAX. BAKE TEMP. (°C)
CC2564MODACMOG	MOG	7.0 × 14.0	EA70814-50	12 × 18	315.0	135.9	8.24 × 14.24	125

IMPORTANT NOTICE

Texas Instruments Incorporated (TI) reserves the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

TI's published terms of sale for semiconductor products (http://www.ti.com/sc/docs/stdterms.htm) apply to the sale of packaged integrated circuit products that TI has qualified and released to market. Additional terms may apply to the use or sale of other types of TI products and services.

Reproduction of significant portions of TI information in TI data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such reproduced documentation. Information of third parties may be subject to additional restrictions. Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyers and others who are developing systems that incorporate TI products (collectively, "Designers") understand and agree that Designers remain responsible for using their independent analysis, evaluation and judgment in designing their applications and that Designers have full and exclusive responsibility to assure the safety of Designers' applications and compliance of their applications (and of all TI products used in or for Designers' applications) with all applicable regulations, laws and other applicable requirements. Designer represents that, with respect to their applications, Designer has all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. Designer agrees that prior to using or distributing any applications that include TI products, Designer will thoroughly test such applications and the functionality of such TI products as used in such applications.

TI's provision of technical, application or other design advice, quality characterization, reliability data or other services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using TI Resources in any way, Designer (individually or, if Designer is acting on behalf of a company, Designer's company) agrees to use any particular TI Resource solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

Designer is authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS. TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY DESIGNER AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Unless TI has explicitly designated an individual product as meeting the requirements of a particular industry standard (e.g., ISO/TS 16949 and ISO 26262), TI is not responsible for any failure to meet such industry standard requirements.

Where TI specifically promotes products as facilitating functional safety or as compliant with industry functional safety standards, such products are intended to help enable customers to design and create their own applications that meet applicable functional safety standards and requirements. Using products in an application does not by itself establish any safety features in the application. Designers must ensure compliance with safety-related requirements and standards applicable to their applications. Designer may not use any TI products in life-critical medical equipment unless authorized officers of the parties have executed a special contract specifically governing such use. Life-critical medical equipment is medical equipment where failure of such equipment would cause serious bodily injury or death (e.g., life support, pacemakers, defibrillators, heart pumps, neurostimulators, and implantables). Such equipment includes, without limitation, all medical devices identified by the U.S. Food and Drug Administration as Class III devices and equivalent classifications outside the U.S.

TI may expressly designate certain products as completing a particular qualification (e.g., Q100, Military Grade, or Enhanced Product). Designers agree that it has the necessary expertise to select the product with the appropriate qualification designation for their applications and that proper product selection is at Designers' own risk. Designers are solely responsible for compliance with all legal and regulatory requirements in connection with such selection.

Designer will fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of Designer's non-compliance with the terms and provisions of this Notice.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265