

## CC2340R SimpleLink™ 系列 2.4GHz 无线 MCU

### 1 特性

#### 无线微控制器

- 经过优化的 48MHz Arm® Cortex®-M0+ 处理器
- 高达 512KB 系统内可编程闪存
- 12KB ROM 用于引导加载程序和驱动程序
- 高达 64KB 超低泄漏 SRAM。待机模式下完全 RAM 保持
- 与低功耗 Bluetooth® 5.3 以及 IEEE 802.15.4 PHY 和 MAC 标准兼容的 2.4GHz 射频收发器
- 集成平衡-非平衡变压器
- 支持无线升级 (OTA)
- 串行线调试 (SWD)

#### 低功耗

- MCU 功耗：
  - 2.6mA 工作模式，CoreMark®
  - 53  $\mu$ A/MHz (运行 CoreMark® 时)
  - 在 CC2340R52 上处于待机模式时 < 710nA
  - 165nA 关断模式，引脚唤醒
- 无线电功耗：
  - RX : 5.3mA
  - TX : 5.1mA (在 0dBm 条件下)
  - TX : < 11.0mA (在 +8dBm 条件下)

#### 无线协议支持

- 低功耗 Bluetooth® 5.3
- Zigbee®
- Thread
- 专有系统

#### 高性能无线电

- 低功耗 Bluetooth® 125kbps 时灵敏度为 -102dBm
- 低功耗 Bluetooth® 1Mbps 时灵敏度为 -96.5dBm
- IEEE 802.15.4 (2.4Ghz) 时灵敏度为 -98dBm
- 高达 +8dBm 的输出功率，具有温度补偿

#### 法规遵从性

- 适用于符合以下标准的系统：
  - EN 300 328 (欧洲)
  - FCC CFR47 第 15 部分
  - ARIB STD-T66 (日本)

#### MCU 外设

- 多达 26 个 I/O 焊盘
  - 2 个 IO 焊盘 SWD，与 GPIO 进行多路复用
  - 2 个 IO 焊盘 LFXT，与 GPIO 进行多路复用
  - 多达 22 个 DIO (模拟或数字 IO)
- 3 个 16 位和 1 个 24 位通用计时器，支持正交解码模式
- 12 位 ADC，使用外部基准时 1.2MSPS，使用内部基准时 267ksps，多达 12 个外部 ADC 输入
- 1 $\times$  低功耗比较器
- 1 $\times$  UART
- 1 $\times$  SPI
- 1 $\times$  I<sup>2</sup>C
- 实时时钟 (RTC)
- 集成温度和电池监控器
- 看门狗计时器

#### 信息安全机制

- AES 128 位加密加速计
- 来自片上模拟噪声的随机数生成器

#### 开发工具和软件

- LP-EM-CC2340R5 LaunchPad 开发套件
- SimpleLink™ 低功耗 F3 软件开发套件
- 用于简单无线电配置的 SmartRF™ Studio
- SysConfig 系统配置工具

#### 工作温度范围

- 片上降压直流/直流转换器
- 1.71V 至 3.8V 单电源电压
- T<sub>j</sub> : -40°C 至 +125°C

#### 符合 RoHS 标准的封装

- 5mm  $\times$  5mm RKP QFN40
- 4mm  $\times$  4mm RGE QFN24
- 2.2mm  $\times$  2.6mm YBG WCSP (预发布)



## 2 应用

- 医疗
  - 居家医疗保健 - 血糖监测仪、血压监测仪、CPAP 呼吸机、电子温度计
  - 患者监护和诊断 - 医疗传感器贴片
  - 个人护理和健身 - 电动牙刷、可穿戴健身和运动监测仪
- 楼宇自动化
  - 楼宇安防系统 - 运动检测器、电子智能锁、门窗传感器、车库门系统、网关
  - HVAC - 恒温器、无线环境传感器
  - 防火安全系统 - 烟雾和热量探测器
  - 视频监控 - IP 网络摄像头
- 照明
  - LED 灯具
  - 照明控制 - 日光传感器、照明传感器、无线控制
- 工厂自动化和控制
- 零售自动化和支付 - 电子销售终端
  - 电子货架标签
- 电网基础设施
  - 智能仪表 - 水表、燃气表、电表和热量分配表
  - 电网通信 - 无线通信 - 远距离传感器应用
  - 其他替代能源 - 能量收集
- 通信设备
  - 有线网络
  - 无线 LAN 或 Wi-Fi 接入点, 边缘路由器
- 个人电子产品
  - 联网外设 - 消费类无线模块、指点设备、键盘
  - 游戏 - 电子玩具和机器人玩具
  - 可穿戴设备 (非医用) - 智能追踪器、智能服装

## 3 说明

CC2340R SimpleLink™ 系列器件为 2.4GHz 无线微控制器 (MCU)，面向低功耗 Bluetooth®5.3、Zigbee、Thread 和专有 2.4GHz 应用。这些器件针对低功耗无线通信进行了优化，并支持无线下载 (OAD) 功能，适用于楼宇自动化 (无线传感器、照明控制、信标)、资产跟踪、医疗、零售 EPOS (电子销售终端)、ESL (电子货架标签) 和个人电子产品 (玩具、HID、触控笔) 市场。该器件的突出特性包括：

- 支持蓝牙 5 特性：高速模式 (2Mbps PHY)、远距离 (LE 编码 125kbps 和 500kbps PHY)、Privacy 1.2.1 和通道选择算法 2，以及对蓝牙 4.2 和早期低功耗规范中关键特性的向后兼容性和支持。
- 完全合格的 Bluetooth 5.3 软件协议栈 (SimpleLink™ 低功耗 F3 软件开发套件 (SDK) 随附)
- SimpleLink™ 低功耗 F3 软件开发套件 (SDK) 中的 Zigbee® 协议栈支持
- SIMPLELINK TI OPENTHREAD SDK<sup>(1)</sup> 中的线程协议栈支持
- 超低待机电流不到 0.71  $\mu$ A 并具有 RTC 操作和完全 RAM 保持，可显著延长电池寿命，尤其是对于睡眠间隔较长的应用。
- 集成平衡-非平衡变压器，可减少物料清单 (BOM) 电路板布局布线
- 出色的无线电敏感度和稳健性 (选择性与阻断) 性能，适用于低功耗 Bluetooth (125kbps LE 编码 PHY 且集成平衡-非平衡变压器时为 -102dBm)

CC2340R 系列器件是 SimpleLink™ MCU 平台的一部分，该平台包括 Wi-Fi®、低功耗蓝牙、Thread、Zigbee、Sub-1GHz MCU 和主机 MCU，它们共用一个通用、易于使用的开发环境，其中包含单核软件开发套件 (SDK) 和丰富的工具集。借助一次性集成的 SimpleLink™ 平台，可以将产品组合中的任何器件组合添加至您的设计中，从而在设计要求变更时实现 100% 的代码重用。有关更多信息，请访问 SimpleLink™ MCU 平台。

## 器件信息

器件型号 <sup>(2)</sup>	闪存	RAM	温度范围	封装	状态
CC2340R53E0RKPR	512KB	64KB	-40°C 至 125°C	QFN40	已发布
CC2340R53E0YBGR <sup>(1)</sup>	512KB	64KB	-40°C 至 125°C	WCSP	预发布
CC2340R53N0RKPR	512KB	64KB	-40°C 至 85°C	QFN40	已发布
CC2340R52E0RKPR	512KB	36KB	-40°C 至 125°C	QFN40	已发布
CC2340R52E0RGER	512KB	36KB	-40°C 至 125°C	QFN24	已发布
CC2340R52N0RKPR	512KB	36KB	-40°C 至 85°C	QFN40	已发布
CC2340R52N0RGER	512KB	36KB	-40°C 至 85°C	QFN24	已发布
CC2340R22E0RKPR	256KB	36KB	-40°C 至 125°C	QFN40	已发布
CC2340R22N0RKPR	256KB	36KB	-40°C 至 85°C	QFN40	已发布
CC2340R21E0RGER <sup>(1)</sup>	256KB	28KB	-40°C 至 125°C	QFN24	预发布
CC2340R21N0RGER	256KB	28KB	-40°C 至 85°C	QFN24	已发布

(1) 在未来版本中提供

(2) 有关更多信息，请参阅节 12。

## 4 功能方框图

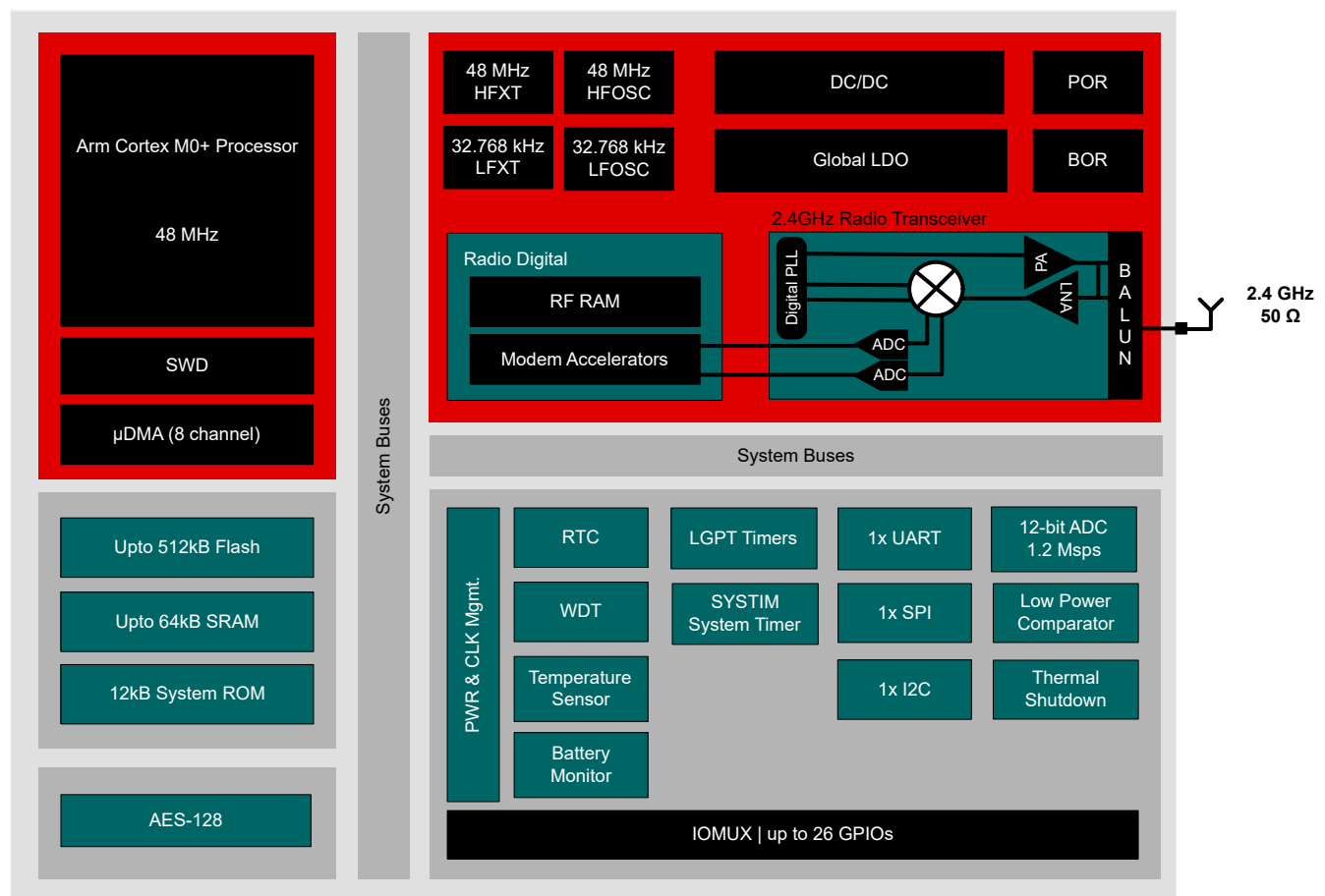


图 4-1. CC2340R 系列框图

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## 5 Device Comparison

Device	RADIO SUPPORT				FLASH (KB)	RAM + Cache (KB)	GPIO	PACKAGE SIZE		
	2.4GHz Prop.	Bluetooth® LE	ZigBee	Thread				2.2 X 2.6 mm WCSP (24)	4 X 4 mm VQFN (24)	5 X 5 mm VQFN (40)
CC2340R53	✓	✓	✓	✓	512	64	12-26	✓		✓
CC2340R52	✓	✓	✓	✓	512	36	12-26		✓	✓
CC2340R22	✓	✓	✓	✓	256	36	26			✓
CC2340R21	✓	✓	✓		256	28	12		✓	

## 6 Pin Configurations and Functions

### 6.1 Pin Diagrams

#### 6.1.1 Pin Diagram—RKP Package (Top View)

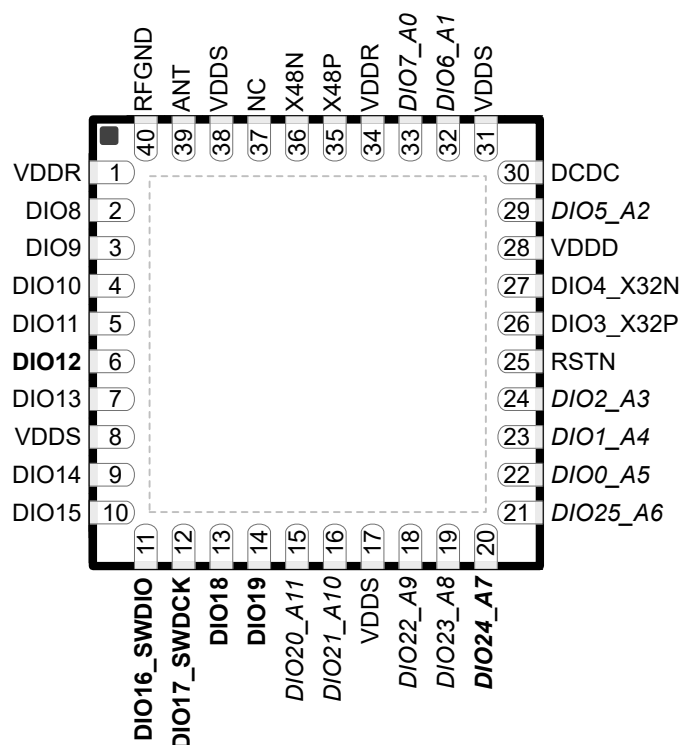


图 6-1. RKP (5mm × 5mm) Pinout, 0.4mm Pitch (Top View)

The following I/O pins marked in 图 6-1 in **bold** have high-drive capabilities:

- Pin 6, DIO12
- Pin 11, DIO16\_SWDIO
- Pin 12, DIO17\_SWDCCK
- Pin 13, DIO18
- Pin 14, DIO19
- Pin 20, DIO24\_A7

The following I/O pins marked in 图 6-1 in *italics* have analog capabilities:

- Pin 15, DIO20\_A11
- Pin 16, DIO21\_A10
- Pin 18, DIO22\_A9
- Pin 19, DIO23\_A8
- Pin 20, DIO24\_A7
- Pin 21, DIO25\_A6
- Pin 22, DIO0\_A5
- Pin 23, DIO1\_A4
- Pin 24, DIO2\_A3
- Pin 29, DIO5\_A2
- Pin 32, DIO6\_A1
- Pin 33, DIO7\_A0

### 6.1.2 Pin Diagram - RGE Package (Top View)

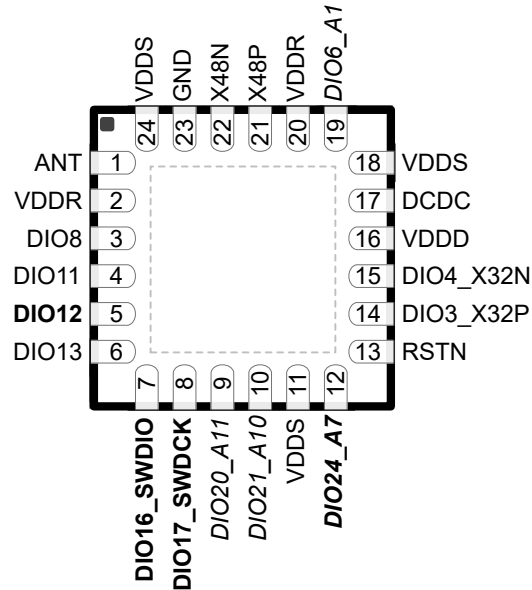


图 6-2. RGE (4mm × 4mm) Pinout, 0.5mm Pitch (Top View)

The following I/O pins marked in 图 6-2 in **bold** have high-drive capabilities:

- Pin 5, DIO12
- Pin 7, DIO16\_SWIDIO
- Pin 8, DIO17\_SWIDCK
- Pin 12, DIO24\_A7

The following I/O pins marked in 图 6-2 in *italics* have analog capabilities:

- Pin 9, DIO20\_A11
- Pin 10, DIO21\_A10
- Pin 12, DIO24\_A7
- Pin 19, DIO6\_A1

### 6.1.3 Pin Diagram—YBG Package (Top View)

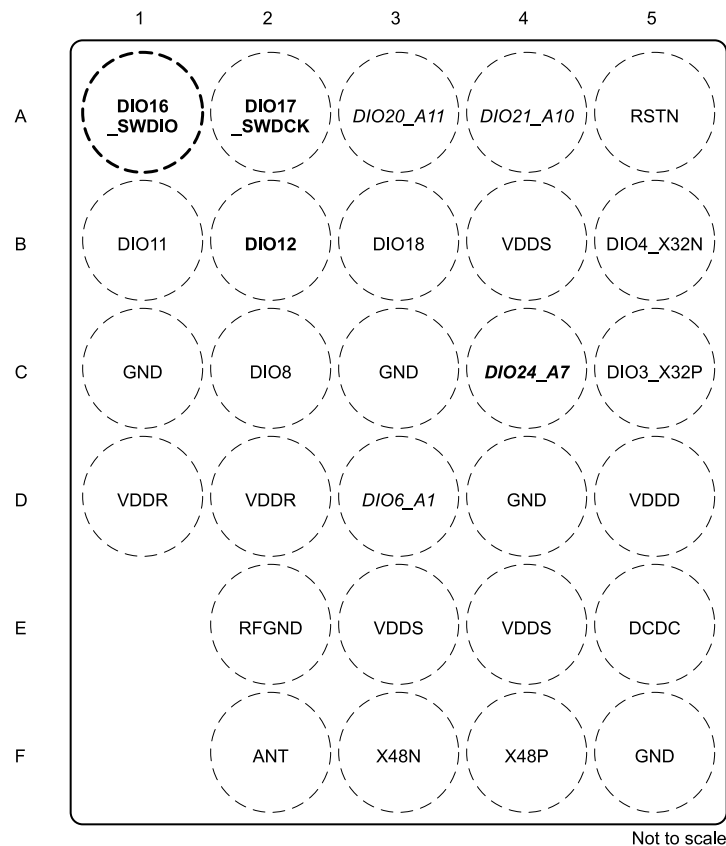


图 6-3. Preview—YBG (2.2mm × 2.6mm) Pinout, 0.4mm Pitch (Top View)

The following I/O pins marked in 图 6-2 in **bold** have high-drive capabilities:

- Pin B2, DIO12
- Pin A1, DIO16\_SWKDIO
- Pin A2, DIO17\_SWDCCK
- Pin C4, DIO24\_A7

The following I/O pins marked in 图 6-2 in *italic* have analog capabilities:

- Pin A3, DIO20\_A11
- Pin A4, DIO21\_A10
- Pin C4, DIO24\_A7
- Pin D3, DIO6\_A1

表 6-1. Pin Attributes (RKP, RGE, YBG, Packages)

RKP PIN NUMBER	RGE PIN NUMBER	YBG PIN NUMBER	SIGNAL NAME	PIN NAME	MUX ENCODING	SIGNAL TYPE
39	1	F2	ANT	ANT		RF
30	17	E5	DCDC	DCDC		PWR

**表 6-1. Pin Attributes (RKP, RGE, YBG, Packages) (续)**

RKP PIN NUMBER	RGE PIN NUMBER	YBG PIN NUMBER	SIGNAL NAME	PIN NAME	MUX ENCODING	SIGNAL TYPE
2	3	C2	DIO8	GPIO8	0	I/O
				SPI0SCLK	1	I/O
				UART0RTS	2	I/O
				T1C0N	3	I/O
				I2C0SDA	4	I/O
				T0C0N	5	I/O
				DTB3	7	I/O
3			DIO9	GPIO9	0	I/O
				T3C0	1	I/O
				LRFD3	3	I/O
22			DIO0_A5	GPIO0	0	I/O
				SPI0CSN	1	I/O
				I2C0SDA	2	I/O
				T3C2	3	I/O
				ANA5	6	ANALOG
4			DIO10	GPIO10	0	I/O
				LPCO	1	I/O
				T2PE	2	I/O
				T3C0N	3	I/O
5	4	B1	DIO11	GPIO11	0	I/O
				SPI0CSN	1	I/O
				T1C2N	2	I/O
				T0C0	3	I/O
				LRFD0	4	I/O
				SPI0POCI	5	I/O
				DTB9	7	I/O
6	5	B2	DIO12	GPIO12	0	I/O
				SPI0POCI	1	I/O
				SPI0PICO	2	I/O
				UART0RXD	3	I/O
				T1C1	4	I/O
				I2C0SDA	5	I/O
				DTB13	7	I/O
7	6		DIO13	GPIO13	0	I/O
				SPI0POCI	1	I/O
				SPI0PICO	2	I/O
				UART0TXD	3	I/O
				T0C0N	4	I/O
				T1F	5	I/O
				DTB4	7	I/O

表 6-1. Pin Attributes (RKP, RGE, YBG, Packages) (续)

RKP PIN NUMBER	RGE PIN NUMBER	YBG PIN NUMBER	SIGNAL NAME	PIN NAME	MUX ENCODING	SIGNAL TYPE
9			DIO14	GPIO14	0	I/O
				T3C2	1	I/O
				T1C2N	2	I/O
				LRFD5	3	I/O
				T1F	4	I/O
10			DIO15	GPIO15	0	I/O
				UART0RXD	1	I/O
				T2C0N	2	I/O
				CKMIN	3	I/O
11	7	A1	DIO16_SWDIO	GPIO16	0	I/O
				SPI0PICO	1	I/O
				UART0RXD	2	I/O
				I2C0SDA	3	I/O
				T1C2	4	I/O
				T1C0N	5	I/O
				DTB10	7	I/O
12	8	A2	DIO17_SWDC	GPIO17	0	I/O
				SPI0SCLK	1	I/O
				UART0TXD	2	I/O
				I2C0SCL	3	I/O
				T1C1N	4	I/O
				T0C2	5	I/O
				DTB11	7	I/O
13		B3	DIO18	GPIO18	0	I/O
				T3C0	1	I/O
				LPCO	2	I/O
				UART0TXD	3	I/O
				SPI0SCLK	4	I/O
				DTB12	7	I/O
14			DIO19	GPIO19	0	I/O
				T3C1	1	I/O
				T2PE	2	I/O
				SPI0PICO	4	I/O
				DTB0	7	I/O
23			DIO1_A4	GPIO1	0	I/O
				T3C1	1	I/O
				LRFD7	2	I/O
				T1F	3	I/O
				UART0RTS	4	I/O
				ANA4	6	ANALOG
				DTB2	7	I/O

**表 6-1. Pin Attributes (RKP, RGE, YBG, Packages) (续)**

RKP PIN NUMBER	RGE PIN NUMBER	YBG PIN NUMBER	SIGNAL NAME	PIN NAME	MUX ENCODING	SIGNAL TYPE
15	9	A3	DIO20_A11	GPIO20	0	I/O
				LPC0	1	I/O
				UART0TXD	2	I/O
				UART0RXD	3	I/O
				T1C0	4	I/O
				SPI0POCI	5	I/O
				ANA11	6	ANALOG
				DTB14	7	I/O
16	10	A4	DIO21_A10	GPIO21	0	I/O
				UART0CTS	1	I/O
				T1C1N	2	I/O
				T0C1	3	I/O
				SPI0POCI	4	I/O
				LRFD1	5	I/O
				ANA10	6	ANALOG
				DTB15	7	I/O
18			DIO22_A9	GPIO22	0	I/O
				T2C0N	1	I/O
				UART0RXD	2	I/O
				T3C1N	3	I/O
				ANA9	6	ANALOG
				DTB1	7	I/O
19			DIO23_A8	GPIO23	0	I/O
				T2C1	1	I/O
				T3C2N	3	I/O
				ANA8	6	ANALOG
20	12	C4	DIO24_A7	GPIO24	0	I/O
				SPI0SCLK	1	I/O
				T1C0	2	I/O
				T3C0	3	I/O
				T0PE	4	I/O
				I2C0SCL	5	I/O
				ANA7	6	ANALOG
				DTB5	7	I/O
21			DIO25_16	GPIO25	0	I/O
				SPI0POCI	1	I/O
				I2C0SCL	2	I/O
				T2C2N	3	I/O
				ANA6	6	ANALOG
24			DIO2_A3	GPIO2	0	I/O
				T0PE	1	I/O
				T2C1N	2	I/O
				UART0CTS	3	I/O
				ANA3	6	ANALOG

表 6-1. Pin Attributes (RKP, RGE, YBG, Packages) (续)

RKP PIN NUMBER	RGE PIN NUMBER	YBG PIN NUMBER	SIGNAL NAME	PIN NAME	MUX ENCODING	SIGNAL TYPE
26	14	C5	DIO3_X32P	GPIO3	0	I/O
				LFCI	1	I/O
				T0C1N	2	I/O
				LRFD0	3	I/O
				T3C1	4	I/O
				T1C2	5	I/O
				LFXT_P	6	I/O
				DTB7	7	I/O
27	15	B5	DIO4_X32N	GPIO4	0	I/O
				T0C2N	1	I/O
				UART0TXD	2	I/O
				LRFD1	3	I/O
				SPI0PICO	4	I/O
				T0C2	5	I/O
				LFXT_N	6	I/O
				DTB8	7	I/O
29			DIO5_A2	GPIO5	0	I/O
				T2C2	1	I/O
				LRFD6	3	I/O
				ANA2	6	ANALOG
32	19	D3	DIO6_A1	GPIO6	0	I/O
				SPI0CSN	1	I/O
				I2C0SCL	2	I/O
				T1C2	3	I/O
				LRFD2	4	I/O
				UART0TXD	5	I/O
				ANA1	6	ANALOG
				DTB6	7	I/O
33			DIO7_A0	GPIO7	0	I/O
				T3C1	1	I/O
				LRFD4	3	I/O
				ANA0	6	ANALOG
	23	C1, C3, D4, F5	GND	GND		GND
37			NC	NC		NC
40		E2	RFGND	RFGND		GND
25	13	A5	RSTN	RSTN		I/O
28	16	D5	VDDD	VDDD		PWR
1, 34	2, 20	D1, D2	VDDR	VDDR		PWR
17, 31, 38, 8	11, 18, 24	B4, E3, E4	VDDS	VDDS		PWR
36	22	F3	X48N	X48N		I/O
35	21	F4	X48P	X48P		I/O

## 6.2 Signal Descriptions

**表 6-2. Analog Input Signal Descriptions**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
ANA0	ANALOG	I	ADC reference (negative terminal) or ADC channel 0 input	33		
ANA1	ANALOG	I	ADC reference (positive terminal) or ADC channel 1 input	32	19	D3
ANA2	ANALOG	I	ADC channel 2 input	29		
ANA3	ANALOG	I	ADC channel 3 input	24		
ANA4	ANALOG	I	ADC channel 4 input	23		
ANA5	ANALOG	I	ADC channel 5 input	22		
ANA6	ANALOG	I	ADC channel 6 input	21		
ANA7	ANALOG	I	Low power comparator input (positive terminal) / ADC channel 7 input	20	12	C4
ANA8	ANALOG	I	Low power comparator input (positive or negative terminal) / ADC channel 8 input	19		
ANA9	ANALOG	I	ADC channel 9 input	18		
ANA10	ANALOG	I	Low power comparator input (positive terminal) / ADC channel 10 input	16	10	A4
ANA11	ANALOG	I	ADC channel 11 input	15	9	A3

**表 6-3. Clock Signal Descriptions**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
CKMIN	I/O	I	HFOSC tracking loop input	10		
LFCl	I/O	I	Low frequency clock input (LFXT bypass clock from pin)	26	14	C5
LFXT_N	I/O	I	32kHz crystal oscillator pin 2	27	15	B5
LFXT_P	I/O	I	32kHz crystal oscillator pin 1	26	14	C5
X48N	I/O	I	48MHz crystal oscillator pin 2	36	22	F3
X48P	I/O	I	48MHz crystal oscillator pin 1	35	21	F4

**表 6-4. DTB Signal Descriptions**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
DTB0	I/O	O	Digital test bus output 0	14		
DTB1	I/O	O	Digital test bus output 1	18		
DTB2	I/O	O	Digital test bus output 2	23		
DTB3	I/O	O	Digital test bus output 3	2	3	C2
DTB4	I/O	O	Digital test bus output 4	7	6	
DTB5	I/O	O	Digital test bus output 5	20	12	C4
DTB6	I/O	O	Digital test bus output6	32	19	D3
DTB7	I/O	O	Digital test bus output 7	26	14	C5
DTB8	I/O	O	Digital test bus output 8	27	15	B5
DTB9	I/O	O	Digital test bus output 9	5	4	B1
DTB10	I/O	O	Digital test bus output 10	11	7	A1

表 6-4. DTB Signal Descriptions (续)

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
DTB11	I/O	O	Digital test bus output 11	12	8	A2
DTB12	I/O	O	Digital test bus output 12	13		B3
DTB13	I/O	O	Digital test bus output 13	6	5	B2
DTB14	I/O	O	Digital test bus output 14	15	9	A3
DTB15	I/O	O	Digital test bus output 15	16	10	A4

表 6-5. GPIO Signal Descriptions

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
GPIO0	I/O	I/O	General-purpose input or output	22		
GPIO1	I/O	I/O	General-purpose input or output	23		
GPIO2	I/O	I/O	General-purpose input or output	24		
GPIO3	I/O	I/O	General-purpose input or output	26	14	C5
GPIO4	I/O	I/O	General-purpose input or output	27	15	B5
GPIO5	I/O	I/O	General-purpose input or output	29		
GPIO6	I/O	I/O	General-purpose input or output	32	19	D3
GPIO7	I/O	I/O	General-purpose input or output	33		
GPIO8	I/O	I/O	General-purpose input or output	2	3	C2
GPIO9	I/O	I/O	General-purpose input or output	3		
GPIO10	I/O	I/O	General-purpose input or output	4		
GPIO11	I/O	I/O	General-purpose input or output	5	4	B1
GPIO12	I/O	I/O	General-purpose input or output	6	5	B2
GPIO13	I/O	I/O	General-purpose input or output	7	6	
GPIO14	I/O	I/O	General-purpose input or output	9		
GPIO15	I/O	I/O	General-purpose input or output	10		
GPIO16	I/O	I/O	General-purpose input or output	11	7	A1
GPIO17	I/O	I/O	General-purpose input or output	12	8	A2
GPIO18	I/O	I/O	General-purpose input or output	13		B3
GPIO19	I/O	I/O	General-purpose input or output	14		
GPIO20	I/O	I/O	General-purpose input or output	15	9	A3
GPIO21	I/O	I/O	General-purpose input or output	16	10	A4
GPIO22	I/O	I/O	General-purpose input or output	18		
GPIO23	I/O	I/O	General-purpose input or output	19		
GPIO24	I/O	I/O	General-purpose input or output	20	12	C4
GPIO25	I/O	I/O	General-purpose input or output	21		

表 6-6. Device Grounds

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
GND	GND	N/A	Ground		23	C1, C3, D4, F5
RFGND	GND	N/A	RF ground reference	40		E2

**表 6-7. I<sup>2</sup>C Signal Descriptions**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
I2C0SCL	I/O	I/O	I2C clock	12, 20, 21, 32	12, 19, 8	A2, C4, D3
I2C0SDA	I/O	I/O	I2C data	11, 2, 22, 6	3, 5, 7	A1, B2, C2

**表 6-8. Low Power Comparator Output Signal Descriptions**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
LPCO	I/O	O	Low power comparator output	13, 15, 4	9	A3, B3

**表 6-9. No Connect**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
NC	NC	N/A	No connect	37		

**表 6-10. Device Power**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
DCDC <sup>(1)</sup>	PWR	N/A	Switch node of the internal DC/DC converter	30	17	E5
VDDD <sup>(1)</sup>	PWR	N/A	Internal 1.28V regulator decoupling capacitor	28	16	D5
VDDR	PWR	N/A	Internal supply, must be powered from the internal DC/DC converter or the internal LDO	1, 34	2, 20	D1, D2
VDDS	PWR	N/A	1.71V to 3.8V supply	17, 31, 38, 8	11, 18, 24	B4, E3, E4

(1) Do not supply external circuitry from this pin.

**表 6-11. Reset Signal Descriptions**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
RSTN	I/O	I	Global main device reset (active low)	25	13	A5

**表 6-12. Radio Digital Output Signal Descriptions**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
LRFD0	I/O	O	Radio Core Output 0	26, 5	14, 4	B1, C5
LRFD1	I/O	O	Radio Core Output 1	16, 27	10, 15	A4, B5
LRFD2	I/O	O	Radio Core Output 2	32	19	D3
LRFD3	I/O	O	Radio Core Digital Output 3	3		
LRFD4	I/O	O	Radio Core Output 4	33		
LRFD5	I/O	O	Radio Core Output 5	9		
LRFD6	I/O	O	Radio Core Output 6	29		
LRFD7	I/O	O	Radio Core Output 7	23		

表 6-13. RF Port

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
ANT	RF	I/O	50 Ω RF port	39	1	F2

表 6-14. SPI Signal Descriptions

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
SPI0CSN	I/O	I/O	SPI chip select	22, 32, 5	19, 4	B1, D3
SPI0PICO	I/O	I/O	SPI peripheral in controller out	11, 14, 27, 6, 7	15, 5, 6, 7	A1, B2, B5
SPI0POCI	I/O	I/O	SPI peripheral out controller in	15, 16, 21, 5, 6, 7	10, 4, 5, 6, 9	A3, A4, B1, B2
SPI0SCLK	I/O	I/O	SPI clock	12, 13, 2, 20	12, 3, 8	A2, B3, C2, C4

表 6-15. Timers Capture or Compare Signal Descriptions

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
T0C0	I/O	I/O	Capture or compare 0 from timer 0	5	4	B1
T0C1	I/O	I/O	Capture or compare 1 from timer 0	16	10	A4
T0C2	I/O	I/O	Capture or compare 2 from timer 0	12, 27	15, 8	A2, B5
T1C0	I/O	I/O	Capture or compare 0 from timer 1	15, 20	12, 9	A3, C4
T1C1	I/O	I/O	Capture or compare 1 from timer 1	6	5	B2
T1C2	I/O	I/O	Capture or compare 2 from timer 1	11, 26, 32	14, 19, 7	A1, C5, D3
T2C1	I/O	I/O	Capture or compare 1 from timer 2	19		
T2C2	I/O	I/O	Capture or compare 2 from timer 2	29		
T3C0	I/O	I/O	Capture or compare 0 from timer 3	13, 20, 3	12	B3, C4
T3C1 <sup>(1)</sup>	I/O	I/O	Capture or compare 1 from timer 3	14, 23, 26, 33	14	C5
T3C2	I/O	I/O	Capture or compare 2 from timer 3	22, 9		

(1) Timer 3 not available on CC2340R21.

表 6-16. Timers Complementary Output Signal Descriptions

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
T0C0N	I/O	O	Complementary compare or PWM output 0 from timer 0	2, 7	3, 6	C2
T0C1N	I/O	O	Complementary compare or PWM output 1 from timer 0	26	14	C5
T0C2N	I/O	O	Complementary compare or PWM output 2 from timer 0	27	15	B5
T1C0N	I/O	O	Complementary compare or PWM output 0 from timer 1	11, 2	3, 7	A1, C2
T1C1N	I/O	O	Complementary compare or PWM output 1 from timer 1	12, 16	10, 8	A2, A4

**表 6-16. Timers Complementary Output Signal Descriptions (续)**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
T1C2N	I/O	O	Complementary compare or PWM output 2 from timer 0	5, 9	4	B1
T2C0N	I/O	O	Complementary compare or PWM output 0 from timer 2	10, 18		
T2C1N	I/O	O	Complementary compare or PWM output 1 from timer 2	24		
T2C2N	I/O	O	Complementary compare or PWM output 2 from timer 2	21		
T3C0N	I/O	O	Complementary compare or PWM output 0 from timer 3	4		
T3C1N	I/O	O	Complementary compare or PWM output 1 from timer 3	18		
T3C2N	I/O	O	Complementary compare or PWM output 2 from timer 3	19		

**表 6-17. Timers Fault Input Signal Descriptions**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
T1F	I/O	I	Fault input for timer 1	23, 7, 9	6	

**表 6-18. Timers Prescaler Event Signal Descriptions**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
T0PE	I/O	O	Prescaler event output from timer 0	20, 24	12	C4
T2PE	I/O	O	Prescaler event output from timer 2	14, 4		

**表 6-19. UART Signal Descriptions**

SIGNAL NAME	PIN TYPE	SIGNAL DIRECTION	DESCRIPTION	RKP PIN	RGE PIN	YBG PIN
UART0CTS	I/O	I	UART clear-to-send input (active low)	16, 24	10	A4
UART0RTS	I/O	O	UART request-to-send (active low)	2, 23	3	C2
UART0RXD	I/O	I	UART receive data	10, 11, 15, 18, 6	5, 7, 9	A1, A3, B2
UART0TXD	I/O	O	UART transmit data	12, 13, 15, 27, 32, 7	15, 19, 6, 8, 9	A2, A3, B3, B5, D3

## 6.3 Connections for Unused Pins and Modules

**表 6-20. Connections for Unused Pins**

FUNCTION	SIGNAL NAME	ACCEPTABLE PRACTICE <sup>(1)</sup>	PREFERRED PRACTICE <sup>(1)</sup>
GPIO (digital)	DIO <sub>n</sub>	NC, GND, or VDD5	NC
SWD	DIO16_SWDIO	NC, GND, or VDD5	GND or VDD5
	DIO17_SWDCCK	NC, GND, or VDD5	GND or VDD5
GPIO (digital or analog)	DIO <sub>n</sub> _Am	NC, GND, or VDD5	NC
32.768-kHz crystal	DIO3_X32P	NC or GND	NC
	DIO4_X32N		

表 6-20. Connections for Unused Pins (续)

FUNCTION	SIGNAL NAME	ACCEPTABLE PRACTICE <sup>(1)</sup>	PREFERRED PRACTICE <sup>(1)</sup>
DC/DC converter <sup>(2)</sup>	DCDC	NC	NC
	VDDS	VDDS	VDDS

(1) NC = No connect

(2) When the DC/DC converter is not used, the inductor between DCDC and VDDR can be removed. VDDR must still be connected and the 10  $\mu$ F DCDC capacitor must be kept on the VDDR net.

## 7 Specifications

### 7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1) (2)</sup>

		MIN	MAX	UNIT
V <sub>DDS</sub>	Supply voltage	- 0.3	4.1	V
	Voltage on any digital pin <sup>(3)</sup>	- 0.3	V <sub>DDS</sub> + 0.3, max 4.1	V
	Voltage on crystal oscillator pins X48P and X48N	- 0.3	1.24	V
V <sub>In_adc</sub>	Voltage on ADC input	0	V <sub>DDS</sub>	V
	Input level, RF pins		5	dBm
T <sub>stg</sub>	Storage temperature	- 40	150	°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) All voltage values are with respect to ground, unless otherwise noted.
- (3) Including analog capable DIOs.

### 7.2 ESD Ratings

				VALUE	UNIT
QFN packages					
V <sub>ESD</sub>	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	All pins	±1000	V
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup>	All pins	±500	V
WCSP packages					
V <sub>ESD</sub>	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	All pins	TBD	V
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup>	All pins	TBD	V

- (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

### 7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
CC2340xxxExxxxx devices (125 °C parts)	Operating ambient temperature <sup>(1) (2)</sup>	- 40	125	°C
	Operating junction temperature <sup>(1) (2)</sup>	- 40	125	°C
CC2340xxxNxxxxx devices (85 °C parts)	Operating ambient temperature <sup>(1) (2)</sup>	- 40	85	°C
	Operating junction temperature <sup>(1) (2)</sup>	- 40	85	°C
Operating supply voltage (V <sub>DDS</sub> )		1.71	3.8	V
Rising supply voltage slew rate		0	100	mV/μs
Falling supply voltage slew rate <sup>(3)</sup>		0	1	mV/μs

- (1) Operation at or near maximum operating temperature for extended durations will result in a reduction in lifetime.
- (2) For thermal resistance details, refer to *Thermal Resistance Characteristics* table in this document.
- (3) For small coin-cell batteries, with high worst-case end-of-life equivalent source resistance, a 10-μF V<sub>DDS</sub> input capacitor must be used to ensure compliance with this slew rate.

### 7.4 DCDC

When measured on the CC2340R5 reference design with T<sub>c</sub> = 25 °C and DCDC enabled unless otherwise noted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V <sub>DDS</sub> supply voltage for DCDC operation <sup>(1) (2)</sup>		2.2	3.0	3.8	V

- (1) When the supply voltage drops below the DCDC operation min voltage, the device automatically transitions to use GLDO regulator on-chip.
- (2) A 10μH and 10μF load capacitor are required on the VDDR voltage rail. They should be placed close to the DCDC output pin.

## 7.5 Global LDO (GLDO)

When measured on the CC2340R5 reference design with  $T_c = 25\text{ }^{\circ}\text{C}$ .

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
VDDS supply voltage for GLDO operation <sup>(1)</sup>		1.71	3.0	3.8	V

(1) A 10  $\mu\text{F}$  capacitor is recommended at VDDR pin.

## 7.6 Power Supply and Modules

over operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>VDDS_BOD</b>					
Brownout rising threshold <sup>(1)</sup>			1.68		V
Brownout falling threshold <sup>(1)</sup>			1.67		V
<b>POR</b>					
power-on reset power-up level			1.5		V
power-on reset power-down level			1.45		V

(1) Brown-out Detector is trimmed at initial boot, value is kept until device is reset by a POR reset or the RSTN pin.

## 7.7 Battery Monitor

Measured on the CC2340R5 reference design with  $T_c = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Resolution			22		mV
Range		1.7		3.8	V
Accuracy	VDDS = 3.0 V		30		mV

## 7.8 Temperature Sensor

Measured on the CC2340R5 reference design with  $T_c = 25\text{ }^{\circ}\text{C}$ ,  $V_{\text{DDS}} = 3.0\text{ V}$ , unless otherwise noted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
CC2340xxxExxxxx devices (125 $^{\circ}\text{C}$ devices)					
Accuracy	-40 $^{\circ}\text{C}$ to 125 $^{\circ}\text{C}$		-15/+9 <sup>(1)</sup>		$^{\circ}\text{C}$
CC2340xxxNxxxxx devices (85 $^{\circ}\text{C}$ devices)					
Accuracy	-40 $^{\circ}\text{C}$ to 85 $^{\circ}\text{C}$		$\pm 10$ <sup>(1)</sup>		$^{\circ}\text{C}$

(1) Raw output from register.

## 7.9 Power Consumption - Power Modes

When measured on the CC2340R5 reference design with  $T_c = 25^\circ\text{C}$ ,  $V_{DD5} = 3.0\text{ V}$ , DCDC enabled, GLDO disabled, unless otherwise noted.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>Core Current Consumption with DCDC</b>						
$I_{core}$	Active	MCU running CoreMark from Flash at 48 MHz		2.6		mA
$I_{core}$	Active	MCU running CoreMark from Flash at 48MHz		53		$\mu\text{A} / \text{MHz}$
$I_{core}$	Idle	Supply Systems and RAM powered, flash disabled, DMA disabled		0.8		mA
$I_{core}$	Idle	Supply Systems and RAM powered, flash disabled, DMA enabled		0.8		mA
$I_{core}$	Idle	Supply Systems and RAM powered, flash enabled, DMA disabled		1.1		mA
$I_{core}$	Idle	Supply Systems and RAM powered, flash enabled, DMA enabled		1.2		mA
$I_{core}$	Standby	RTC running, full RAM retention LFOSC, DCDC recharge current setting (ipeak = 1)		0.71		$\mu\text{A}$
$I_{core}$	Standby	RTC running, full RAM retention LFXT, DCDC recharge current setting (ipeak = 1)		0.74		$\mu\text{A}$
<b>Core Current consumption with GLDO</b>						
$I_{core}$	Active	MCU running CoreMark from Flash at 48 MHz		4.1		mA
$I_{core}$	Idle	Supply Systems and RAM powered, flash disabled, DMA disabled		1.2		mA
$I_{core}$	Idle	Supply Systems and RAM powered, flash disabled, DMA enabled		1.3		mA
$I_{core}$	Idle	Supply Systems and RAM powered, flash enabled, DMA disabled		1.5		mA
$I_{core}$	Idle	Supply Systems and RAM powered, flash enabled, DMA enabled		1.7		mA
$I_{core}$	Standby	RTC running, full RAM retention LFOSC, default GLDO recharge current setting		1.1		$\mu\text{A}$
$I_{core}$	Standby	RTC running, full RAM retention LFXT default GLDO recharge current setting		1.15		$\mu\text{A}$
<b>Reset, Shutdown Current Consumption</b>						
$I_{core}$	Reset	Reset. RSTN pin asserted or VDD5 below power-on-reset threshold		165		nA
$I_{core}$	Shutdown	Shutdown measured in steady state. No clocks running, no retention, IO wakeup enabled		165		nA
<b>Peripheral Current Consumption</b>						
$I_{peri}$	RF	Delta current, clock enabled, RF subsystem idle		40		$\mu\text{A}$
$I_{peri}$	Timers	Delta current with clock enabled, module is idle, one LGPT timer		2.4		$\mu\text{A}$
$I_{peri}$	I2C	Delta current with clock enabled, module is idle		10.6		$\mu\text{A}$
$I_{peri}$	SPI	Delta current with clock enabled, module is idle		3.4		$\mu\text{A}$
$I_{peri}$	UART	Delta current with clock enabled, module is idle		24.5		$\mu\text{A}$
$I_{peri}$	CRYPTO (AES)	Delta current with clock enabled, module is idle		3.8		$\mu\text{A}$

## 7.10 Power Consumption - Radio Modes

When measured on the CC2340R5 reference design with  $T_c = 25^\circ\text{C}$ ,  $V_{\text{DD5}} = 3.0\text{ V}$  with DCDC enabled unless otherwise noted.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{\text{RX}}$	Radio receive current	2440 MHz, 1 Mbps, GFSK, system bus off <sup>(1)</sup>		5.3		mA
$I_{\text{RX}}$	Radio receive current	2440 MHz, 1 Mbps, GFSK, DCDC OFF, system bus off <sup>(1)</sup>		9		mA
$I_{\text{TX}}$	Radio transmit current	-8 dBm output power setting 2440 MHz system bus off <sup>(1)</sup>		4.5		mA
$I_{\text{TX}}$	Radio transmit current	0 dBm output power setting 2440 MHz system bus off <sup>(1)</sup>		5.1		mA
$I_{\text{TX}}$	Radio transmit current	0 dBm output power setting 2440 MHz DCDC OFF, system bus off <sup>(1)</sup>		9.0		mA
$I_{\text{TX}}$	Radio transmit current	+4 dBm output power setting 2440 MHz system bus off <sup>(1)</sup>		7.9		mA
$I_{\text{TX}}$	Radio transmit current	+6 dBm output power setting 2440 MHz system bus off <sup>(1)</sup>		8.9		mA
$I_{\text{TX}}$	Radio transmit current	+8 dBm output power setting 2440 MHz system bus off <sup>(1)</sup>		10.7		mA
$I_{\text{TX}}$	Radio transmit current	+8 dBm output power setting 2440 MHz DCDC OFF, system bus off <sup>(1)</sup>		19		mA

(1) System bus off refers to device idle mode, DMA disabled, flash disabled

## 7.11 Nonvolatile (Flash) Memory Characteristics

Over operating free-air temperature range and  $V_{\text{DD5}} = 3.0\text{ V}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Flash sector size			2		KB
Supported flash erase cycles before failure, full bank <sup>(1) (2)</sup>		30			k Cycles
Supported flash erase cycles before failure, single sector <sup>(3)</sup>		60			k Cycles
Maximum number of write operations per row before sector erase <sup>(4)</sup>				83	Write Operations
CC2340xxxExxxxx devices (125 °C devices)					
Flash retention	105 °C	11.4			Years
Flash retention	125 °C	10			Years
CC2340xxxNxxxxx devices (85°C devices)					
Flash retention	85 °C	11.4			Years
Flash sector erase current	Average delta current		1.2		mA
Flash sector erase time <sup>(5)</sup>	0 erase cycles		2.2		ms
Flash write current	Average delta current, full sector at a time		1.7		mA
Flash write time <sup>(5)</sup>	full sector (2kB) at a time, 0 erase cycles		8.3		ms

- (1) A full bank erase is counted as a single erase cycle on each sector
- (2) Aborting flash during erase or program modes is not a safe operation.
- (3) Up to 16 customer-designated sectors can be individually erased an additional 30k times beyond the baseline bank limitation of 30k cycles
- (4) Each wordline is 2048 bits (or 256 bytes) wide. This limitation corresponds to sequential memory writes of 4 (3.1) bytes minimum per write over a whole wordline. If additional writes to the same wordline are required, a sector erase is required once the maximum number of write operations per row is reached.
- (5) This number is dependent on Flash aging and increases over time and erase cycles

## 7.12 Thermal Resistance Characteristics

THERMAL METRIC	THERMAL METRIC	PACKAGE		UNIT <sup>(1)</sup>
		RKP (VQFN)	RGE (VQFN)	
		40 PINS	24 PINS	
$R_{\theta\text{JA}}$	Junction-to-ambient thermal resistance	31.8	40.1	°C/W
$R_{\theta\text{JC(top)}}$	Junction-to-case (top) thermal resistance	23.1	30.5	°C/W

## 7.12 Thermal Resistance Characteristics (续)

THERMAL METRIC	THERMAL METRIC	PACKAGE		UNIT <sup>(1)</sup>
		RKP (VQFN)	RGE (VQFN)	
		40 PINS	24 PINS	
$R_{\theta JB}$	Junction-to-board thermal resistance	12.7	17.2	°C/W
$\psi_{JT}$	Junction-to-top characterization parameter	0.3	0.4	°C/W
$\psi_{JB}$	Junction-to-board characterization parameter	12.7	17.1	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	3.3	3.4	°C/W

(1) °C/W = degrees Celsius per watt.

## 7.13 RF Frequency Bands

Over operating free-air temperature range (unless otherwise noted).

PARAMETER	MIN	TYP	MAX	UNIT
Frequency bands	2360		2510	MHz

## 7.14 Bluetooth Low Energy - Receive (RX)

When measured on the CC2340R5 reference design with  $T_c = 25^\circ\text{C}$ ,  $V_{DD5} = 3.0\text{ V}$ ,  $f_{RF} = 2440\text{ MHz}$  with DCDC enabled unless otherwise noted. All measurements are performed at the antenna input with a combined RX and TX path. All measurements are performed conducted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>125 kbps (LE Coded)</b>					
Receiver sensitivity	$\text{BER} = 10^{-3}$		- 102		dBm
Receiver saturation	$\text{BER} = 10^{-3}$		5		dBm
Frequency error tolerance	Difference between the incoming carrier frequency and the internally generated carrier frequency		$> (-250 / 250)^{(1)}$		kHz
Data rate error tolerance	Difference between incoming data rate and the internally generated data rate (37-byte packets)		$> (-90 / 90)^{(1)}$		ppm
Data rate error tolerance	Difference between incoming data rate and the internally generated data rate (255-byte packets)		$> (-90 / 90)^{(1)}$		ppm
Co-channel rejection <sup>(2)</sup>	Wanted signal at - 79 dBm, modulated interferer in channel, $\text{BER} = 10^{-3}$		- 6		dB
Selectivity, $\pm 1\text{ MHz}^{(2)}$	Wanted signal at - 79 dBm, modulated interferer at $\pm 1\text{ MHz}$ , $\text{BER} = 10^{-3}$		9 / 5 <sup>(3)</sup>		dB
Selectivity, $\pm 2\text{ MHz}^{(2)}$	Wanted signal at - 79 dBm, modulated interferer at $\pm 2\text{ MHz}$ , $\text{BER} = 10^{-3}$		44 / 31 <sup>(3)</sup>		dB
Selectivity, $\pm 3\text{ MHz}^{(2)}$	Wanted signal at - 79 dBm, modulated interferer at $\pm 3\text{ MHz}$ , $\text{BER} = 10^{-3}$		47 / 42 <sup>(3)</sup>		dB
Selectivity, $\pm 4\text{ MHz}^{(2)}$	Wanted signal at - 79 dBm, modulated interferer at $\pm 4\text{ MHz}$ , $\text{BER} = 10^{-3}$		49 / 45 <sup>(3)</sup>		dB
Selectivity, $\pm 6\text{ MHz}^{(2)}$	Wanted signal at - 79 dBm, modulated interferer at $\geq \pm 6\text{ MHz}$ , $\text{BER} = 10^{-3}$		52 / 48 <sup>(3)</sup>		dB
Selectivity, $\pm 7\text{ MHz}$	Wanted signal at - 79 dBm, modulated interferer at $\geq \pm 7\text{ MHz}$ , $\text{BER} = 10^{-3}$		54 / 49 <sup>(3)</sup>		dB
Selectivity, Image frequency <sup>(2)</sup>	Wanted signal at - 79 dBm, modulated interferer at image frequency, $\text{BER} = 10^{-3}$		31		dB
Selectivity, Image frequency $\pm 1\text{ MHz}^{(2)}$	Note that Image frequency + 1 MHz is the Co- channel - 1 MHz. Wanted signal at - 79 dBm, modulated interferer at $\pm 1\text{ MHz}$ from image frequency, $\text{BER} = 10^{-3}$		5 / 42 <sup>(3)</sup>		dB
<b>500 kbps (LE Coded)</b>					
Receiver sensitivity	$\text{BER} = 10^{-3}$		- 99		dBm
Receiver saturation	$\text{BER} = 10^{-3}$		5		dBm
Frequency error tolerance	Difference between the incoming carrier frequency and the internally generated carrier frequency		$> (-250 / 250)^{(1)}$		kHz
Data rate error tolerance	Difference between incoming data rate and the internally generated data rate (37-byte packets)		$> (-90 / 90)^{(1)}$		ppm
Data rate error tolerance	Difference between incoming data rate and the internally generated data rate (255-byte packets)		$> (-90 / 90)^{(1)}$		ppm
Co-channel rejection <sup>(2)</sup>	Wanted signal at - 72 dBm, modulated interferer in channel, $\text{BER} = 10^{-3}$		- 4.5		dB
Selectivity, $\pm 1\text{ MHz}^{(2)}$	Wanted signal at - 72 dBm, modulated interferer at $\pm 1\text{ MHz}$ , $\text{BER} = 10^{-3}$		9 / 5 <sup>(3)</sup>		dB
Selectivity, $\pm 2\text{ MHz}^{(2)}$	Wanted signal at - 72 dBm, modulated interferer at $\pm 2\text{ MHz}$ , $\text{BER} = 10^{-3}$		42 / 31 <sup>(3)</sup>		dB
Selectivity, $\pm 3\text{ MHz}^{(2)}$	Wanted signal at - 72 dBm, modulated interferer at $\pm 3\text{ MHz}$ , $\text{BER} = 10^{-3}$		45 / 41 <sup>(3)</sup>		dB
Selectivity, $\pm 4\text{ MHz}^{(2)}$	Wanted signal at - 72 dBm, modulated interferer at $\pm 4\text{ MHz}$ , $\text{BER} = 10^{-3}$		46 / 42 <sup>(3)</sup>		dB
Selectivity, $\pm 6\text{ MHz}^{(2)}$	Wanted signal at - 72 dBm, modulated interferer at $\geq \pm 6\text{ MHz}$ , $\text{BER} = 10^{-3}$		50 / 45 <sup>(3)</sup>		dB
Selectivity, $\pm 7\text{ MHz}$	Wanted signal at - 72 dBm, modulated interferer at $\geq \pm 7\text{ MHz}$ , $\text{BER} = 10^{-3}$		51 / 46 <sup>(3)</sup>		dB
Selectivity, Image frequency <sup>(2)</sup>	Wanted signal at - 72 dBm, modulated interferer at image frequency, $\text{BER} = 10^{-3}$		31		dB

## 7.14 Bluetooth Low Energy - Receive (RX) (续)

When measured on the CC2340R5 reference design with  $T_c = 25^\circ\text{C}$ ,  $V_{\text{DDS}} = 3.0\text{ V}$ ,  $f_{\text{RF}} = 2440\text{ MHz}$  with DCDC enabled unless otherwise noted. All measurements are performed at the antenna input with a combined RX and TX path. All measurements are performed conducted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Selectivity, Image frequency $\pm 1\text{ MHz}$ <sup>(2)</sup>	Note that Image frequency + 1 MHz is the Co- channel - 1 MHz. Wanted signal at - 72 dBm, modulated interferer at $\pm 1\text{ MHz}$ from image frequency, BER = $10^{-3}$		5 / 41 <sup>(3)</sup>		dB
<b>1 Mbps (LE 1M)</b>					
Receiver sensitivity	BER = $10^{-3}$		- 96.5		dBm
Receiver saturation	BER = $10^{-3}$		5		dBm
Frequency error tolerance	Difference between the incoming carrier frequency and the internally generated carrier frequency		> ( - 250/250) <sup>(1)</sup>		kHz
Data rate error tolerance	Difference between incoming data rate and the internally generated data rate (37-byte packets)		> ( - 90 / 90) <sup>(1)</sup>		ppm
Co-channel rejection <sup>(2)</sup>	Wanted signal at - 67 dBm, modulated interferer in channel, BER = $10^{-3}$		- 6		dB
Selectivity, $\pm 1\text{ MHz}$ <sup>(2)</sup>	Wanted signal at - 67 dBm, modulated interferer at $\pm 1\text{ MHz}$ , BER = $10^{-3}$		7 / 5 <sup>(3)</sup>		dB
Selectivity, $\pm 2\text{ MHz}$ <sup>(2)</sup>	Wanted signal at - 67 dBm, modulated interferer at $\pm 2\text{ MHz}$ , BER = $10^{-3}$		39 / 28 <sup>(3)</sup>		dB
Selectivity, $\pm 3\text{ MHz}$ <sup>(2)</sup>	Wanted signal at - 67 dBm, modulated interferer at $\pm 3\text{ MHz}$ , BER = $10^{-3}$		38 / 38 <sup>(3)</sup>		dB
Selectivity, $\pm 4\text{ MHz}$ <sup>(2)</sup>	Wanted signal at - 67 dBm, modulated interferer at $\pm 4\text{ MHz}$ , BER = $10^{-3}$		47 / 35 <sup>(3)</sup>		dB
Selectivity, $\pm 5\text{ MHz}$ or more <sup>(2)</sup>	Wanted signal at - 67 dBm, modulated interferer at $\geq \pm 5\text{ MHz}$ , BER = $10^{-3}$		40		dB
Selectivity, image frequency <sup>(2)</sup>	Wanted signal at - 67 dBm, modulated interferer at image frequency, BER = $10^{-3}$		28		dB
Selectivity, image frequency $\pm 1\text{ MHz}$ <sup>(2)</sup>	Note that Image frequency + 1 MHz is the Co- channel - 1 MHz. Wanted signal at - 67 dBm, modulated interferer at $\pm 1\text{ MHz}$ from image frequency, BER = $10^{-3}$		5 / 38 <sup>(3)</sup>		dB
Out-of-band blocking <sup>(4)</sup>	30 MHz to 2000 MHz		- 10		dBm
Out-of-band blocking	2003 MHz to 2399 MHz		- 10		dBm
Out-of-band blocking	2484 MHz to 2997 MHz		- 10		dBm
Out-of-band blocking	3000 MHz to 12.75 GHz (excluding VCO frequency)		- 2		dBm
Intermodulation	Wanted signal at 2402 MHz, - 64 dBm. Two interferers at 2405 and 2408 MHz respectively, at the given power level		- 37		dBm
Spurious emissions, 30 to 1000 MHz <sup>(5)</sup>	Measurement in a 50- $\Omega$ single-ended load.		< - 59		dBm
Spurious emissions, 1 to 12.75 GHz <sup>(5)</sup>	Measurement in a 50- $\Omega$ single-ended load.		< - 47		dBm
RSSI dynamic range <sup>(6)</sup>			70		dB
RSSI accuracy			$\pm 4$		dB
RSSI resolution			1		dB
<b>2 Mbps (LE 2M)</b>					
Receiver sensitivity	Measured at SMA connector, BER = $10^{-3}$		- 92		dBm
Receiver saturation	Measured at SMA connector, BER = $10^{-3}$		2		dBm
Frequency error tolerance	Difference between the incoming carrier frequency and the internally generated carrier frequency		> ( - 250 / 250) <sup>(1)</sup>		kHz
Data rate error tolerance	Difference between incoming data rate and the internally generated data rate (37-byte packets)		> ( - 90/ 90) <sup>(1)</sup>		ppm
Co-channel rejection <sup>(2)</sup>	Wanted signal at - 67 dBm, modulated interferer in channel, BER = $10^{-3}$		- 8		dB
Selectivity, $\pm 2\text{ MHz}$ <sup>(2)</sup>	Wanted signal at - 67 dBm, modulated interferer at $\pm 2\text{ MHz}$ , Image frequency is at - 2 MHz, BER = $10^{-3}$		9 / 5 <sup>(3)</sup>		dB

## 7.14 Bluetooth Low Energy - Receive (RX) (续)

When measured on the CC2340R5 reference design with  $T_c = 25^\circ\text{C}$ ,  $V_{\text{DDS}} = 3.0\text{ V}$ ,  $f_{\text{RF}} = 2440\text{ MHz}$  with DCDC enabled unless otherwise noted. All measurements are performed at the antenna input with a combined RX and TX path. All measurements are performed conducted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Selectivity, $\pm 4\text{ MHz}$ <sup>(2)</sup>	Wanted signal at $-67\text{ dBm}$ , modulated interferer at $\pm 4\text{ MHz}$ , $\text{BER} = 10^{-3}$		40 / 32 <sup>(3)</sup>		dB
Selectivity, $\pm 6\text{ MHz}$ <sup>(2)</sup>	Wanted signal at $-67\text{ dBm}$ , modulated interferer at $\pm 6\text{ MHz}$ , $\text{BER} = 10^{-3}$		46 / 40 <sup>(3)</sup>		dB
Selectivity, image frequency <sup>(2)</sup>	Wanted signal at $-67\text{ dBm}$ , modulated interferer at image frequency, $\text{BER} = 10^{-3}$		5		dB
Selectivity, image frequency $\pm 2\text{ MHz}$ <sup>(2)</sup>	Note that Image frequency + 2 MHz is the Co-channel. Wanted signal at $-67\text{ dBm}$ , modulated interferer at $\pm 2\text{ MHz}$ from image frequency, $\text{BER} = 10^{-3}$		- 8 / 32 <sup>(3)</sup>		dB
Out-of-band blocking <sup>(4)</sup>	30 MHz to 2000 MHz		- 10		dBm
Out-of-band blocking	2003 MHz to 2399 MHz		- 10		dBm
Out-of-band blocking	2484 MHz to 2997 MHz		- 12		dBm
Out-of-band blocking	3000 MHz to 12.75 GHz (excluding VCO frequency)		- 10		dBm
Intermodulation	Wanted signal at 2402 MHz, $-64\text{ dBm}$ . Two interferers at 2408 and 2414 MHz respectively, at the given power level		- 38		dBm

(1) Actual performance exceeding Bluetooth specification

(2) Numbers given as I/C dB

(3) X / Y, where X is +N MHz and Y is - N MHz

(4) Excluding one exception at  $F_{\text{wanted}} / 2$ , per Bluetooth Specification

(5) Suitable for systems targeting compliance with worldwide radio-frequency regulations ETSI EN 300 328 and EN 300 440 Class 2 (Europe), FCC CFR47 Part 15 (US), and ARIB STD-T66 (Japan)

(6) The device will saturate at -30dB.

## 7.15 Bluetooth Low Energy - Transmit (TX)

When measured on the CC2340R5 reference design with  $T_c = 25\text{ }^{\circ}\text{C}$ ,  $V_{DD5} = 3.0\text{ V}$ ,  $f_{RF} = 2440\text{ MHz}$  with DCDC enabled unless otherwise noted. All measurements are performed at the antenna input with a combined RX and TX path. All measurements are performed conducted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>General Parameters</b>					
Max output power	Delivered to a single-ended 50- $\Omega$ load through integrated balun		8		dBm
Output power programmable range	Delivered to a single-ended 50- $\Omega$ load through integrated balun		28		dB

## 7.16 Zigbee and Thread - IEEE 802.15.4-2006 2.4 GHz (OQPSK DSSS1:8, 250 kbps) - RX

Measured on the CC2340R5 reference design with  $T_c = 25\text{ }^{\circ}\text{C}$ ,  $V_{DD5} = 3.0\text{ V}$ ,  $f_{RF} = 2440\text{ MHz}$  with DC/DC enabled unless otherwise noted. All measurements are performed at the antenna input with a combined RX and TX path. All measurements are performed conducted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>General Parameters</b>					
Receiver sensitivity	PER = 1%		- 98		dBm
Receiver saturation	PER = 1%		> 3		dBm
Adjacent channel rejection	Wanted signal at - 82 dBm, modulated interferer at $\pm 5\text{ MHz}$ , PER = 1%		36		dB
Alternate channel rejection	Wanted signal at - 82 dBm, modulated interferer at $\pm 10\text{ MHz}$ , PER = 1%		55		dB
Channel rejection, $\pm 15\text{ MHz}$ or more	Wanted signal at - 82 dBm, undesired signal is IEEE 802.15.4 modulated channel, stepped through all channels 2405 to 2480 MHz, PER = 1%		59		dB
Blocking and desensitization, 5 MHz from upper band edge	Wanted signal at - 97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		57		dB
Blocking and desensitization, 10 MHz from upper band edge	Wanted signal at - 97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		63		dB
Blocking and desensitization, 20 MHz from upper band edge	Wanted signal at - 97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		63		dB
Blocking and desensitization, 50 MHz from upper band edge	Wanted signal at - 97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		66		dB
Blocking and desensitization, - 5 MHz from lower band edge	Wanted signal at - 97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		60		dB
Blocking and desensitization, - 10 MHz from lower band edge	Wanted signal at - 97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		60		dB
Blocking and desensitization, - 20 MHz from lower band edge	Wanted signal at - 97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		63		dB
Blocking and desensitization, - 50 MHz from lower band edge	Wanted signal at - 97 dBm (3 dB above the sensitivity level), CW jammer, PER = 1%		65		dB
Spurious emissions, 30 MHz to 1000 MHz	Measurement in a 50- $\Omega$ single-ended load <sup>(1)</sup>		- 64		dBm
Spurious emissions, 1 GHz to 12.75 GHz	Measurement in a 50- $\Omega$ single-ended load <sup>(1)</sup>		- 49		dBm
Frequency error tolerance	Difference between the incoming carrier frequency and the internally generated carrier frequency		> 80		ppm
Symbol rate error tolerance	Difference between incoming symbol rate and the internally generated symbol rate		> 80		ppm
RSSI dynamic range			90		dB
RSSI accuracy			$\pm 4$		dB

- (1) Suitable for systems targeting compliance with EN 300 328, EN 300 440 class 2 (Europe), FCC CFR47, Part 15 (US) and ARIB STD-T-66 (Japan)

## 7.17 Zigbee and Thread - IEEE 802.15.4-2006 2.4 GHz (OQPSK DSSS1:8, 250 kbps) - TX

Measured on the CC2340R5 reference design with  $T_c = 25\text{ }^{\circ}\text{C}$ ,  $V_{\text{DDS}} = 3.0\text{ V}$ ,  $f_{\text{RF}} = 2440\text{ MHz}$  with DC/DC enabled unless otherwise noted. All measurements are performed at the antenna input with a combined RX and TX path. All measurements are performed conducted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>General Parameters</b>					
Max output power <sup>(1)</sup>	Delivered to a single-ended 50- $\Omega$ load through integrated balun		8		dBm
Output power programmable range	Delivered to a single-ended 50- $\Omega$ load through integrated balun		29		dB
<b>IEEE 802.15.4-2006 2.4 GHz (OQPSK DSSS1:8, 250 kbps)</b>					
Error vector magnitude	+8 dBm setting		2		%

- (1) To ensure margins for passing FCC band edge requirements at 2483.5 MHz, a lower than maximum output-power setting or less than 100% duty cycle may be used when operating at the upper 802.15.4 channel(s).

## 7.18 Proprietary Radio Modes

Measured on the CC2340R5 reference design with  $T_c = 25\text{ }^{\circ}\text{C}$ ,  $V_{DD5} = 3.0\text{ V}$ ,  $f_{RF} = 2440\text{ MHz}$  with DCDC enabled unless otherwise noted. All measurements are performed at the antenna input with a combined RX and TX path. All measurements are performed conducted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>2 Mbps GFSK (HID), 320 kHz deviation</b>					
Receiver sensitivity	PER = 30.8%, Payload 37 bytes		-89		dBm

## 7.19 2.4 GHz RX/TX CW

When measured on the CC2340R5 reference design with  $T_c = 25\text{ }^\circ\text{C}$ ,  $V_{DD5} = 3.0\text{ V}$ ,  $f_{RF} = 2440\text{ MHz}$  with DCDC enabled unless otherwise noted. All measurements are performed at the antenna input with a combined RX and TX path. All measurements are performed conducted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>Spurious emissions and harmonics</b>					
Spurious emissions <sup>(1)</sup>	$f < 1\text{ GHz}$ , outside restricted bands	+8 dBm setting	< -36		dBm
	$f < 1\text{ GHz}$ , restricted bands ETSI		< -54		dBm
	$f < 1\text{ GHz}$ , restricted bands FCC		< -55		dBm
	$f > 1\text{ GHz}$ , including harmonics (ETSI)		< -30		dBm
Harmonics <sup>(1)</sup>	Second harmonic		< -42		dBm
	Third harmonic		< -42		dBm

(1) Suitable for systems targeting compliance with worldwide radio-frequency regulations ETSI EN 300 328 and EN 300 440 Class 2 (Europe), FCC CFR47 Part 15 (US), and ARIB STD-T66 (Japan).

## 7.20 Timing and Switching Characteristics

### 7.20.1 Reset Timing

PARAMETER	MIN	TYP	MAX	UNIT
RSTN low duration	1			$\mu\text{s}$

### 7.20.2 Wakeup Timing

Measured over operating free-air temperature with  $V_{DD5} = 3.0\text{ V}$  (unless otherwise noted). The times listed here do not include any software overhead (unless otherwise noted).

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
MCU, Reset/Shutdown to Active <sup>(1)</sup>	GLDO default charge current setting, VDDR capacitor fully charged <sup>(2)</sup>	350-450			$\mu\text{s}$
MCU, Standby to Active	MCU, Standby to Active (ready to execute code from flash). DCDC ON, default recharge current configuration	33-43 <sup>(3)</sup>			$\mu\text{s}$
MCU, Standby to Active	MCU, Standby to Active (ready to execute code from flash). GLDO ON, default recharge current configuration	33-50 <sup>(3)</sup>			$\mu\text{s}$
MCU, Idle to Active	Flash enabled in idle mode	3			$\mu\text{s}$
MCU, Idle to Active	Flash disabled in idle mode	14			$\mu\text{s}$

- (1) Wakeup time includes device ROM bootcode execution time. The wakeup time is dependent on remaining charge on VDDR capacitor when starting the device, and thus how long the device has been in Reset or Shutdown before starting up again.
- (2) This is the best case reset/shutdown to active time (including ROM bootcode operation), for the specified GLDO charge current setting considering the VDDR capacitor is fully charged and is not discharged during the reset and shutdown events; that is, when the device is in reset / shutdown modes for only a very short period of time
- (3) Depending on VDDR capacitor voltage level.

### 7.20.3 Clock Specifications

#### 7.20.3.1 48 MHz Crystal Oscillator (HFXT)

Measured on the CC2340R5 reference design with  $T_c = 25\text{ }^\circ\text{C}$ ,  $V_{DD5} = 3.0\text{ V}$ , unless otherwise noted.<sup>(4)</sup>

	PARAMETER	MIN	TYP	MAX	UNIT
	Crystal frequency		48		MHz
ESR	Equivalent series resistance $6\text{ pF} < C_L \leq 9\text{ pF}$		20	60	$\Omega$
ESR	Equivalent series resistance $5\text{ pF} < C_L \leq 6\text{ pF}$			80	$\Omega$
$C_L$	Crystal load capacitance <sup>(1)</sup>	5	7 <sup>(2)</sup>	9	pF

### 7.20.3.1 48 MHz Crystal Oscillator (HFXT) (续)

Measured on the CC2340R5 reference design with  $T_c = 25\text{ }^{\circ}\text{C}$ ,  $V_{DD5} = 3.0\text{ V}$ , unless otherwise noted.<sup>(4)</sup>

	PARAMETER	MIN	TYP	MAX	UNIT
Start-up time <sup>(3)</sup>	Until clock is qualified		200		$\mu\text{s}$

- (1) Adjustable load capacitance is integrated into the device. External load capacitors are required for systems targeting compliance with certain regulations.
- (2) On-chip default connected capacitance including reference design parasitic capacitance. Connected internal capacitance is changed through software in the SysConfig.
- (3) Start-up time using the TI-provided power driver. Start-up time may increase if driver is not used.
- (4) Tai-Saw TZ3908AAAO43 has been validated for CC2340R5 design.

### 7.20.3.2 48 MHz RC Oscillator (HFOSC)

Measured on the CC2340R5 reference design with  $T_c = 25\text{ }^{\circ}\text{C}$ ,  $V_{DD5} = 3.0\text{ V}$ , unless otherwise noted.

	MIN	TYP	MAX	UNIT
Frequency		48		MHz
Uncalibrated frequency accuracy		$\pm 3$		%
Calibrated frequency accuracy <sup>(1)</sup>		$\pm 0.25$		%

- (1) Accuracy relative to the calibration source (HFXT)

### 7.20.3.3 32 kHz Crystal Oscillator (LFXT)

Measured on the CC2340R5 reference design with  $T_c = 25\text{ }^{\circ}\text{C}$ ,  $V_{DD5} = 3.0\text{ V}$ , unless otherwise noted.

	MIN	TYP	MAX	UNIT
Crystal frequency		32.768		kHz
Supported crystal load capacitance	6		12	pF
ESR		30	100	$\text{k}\Omega$

### 7.20.3.4 32 kHz RC Oscillator (LFOSC)

Measured on the CC2340R5 reference design with  $T_c = 25\text{ }^{\circ}\text{C}$ ,  $V_{DD5} = 3.0\text{ V}$ , unless otherwise noted.

	MIN	TYP	MAX	UNIT
Calibrated frequency		32.768 <sup>(1)</sup>		kHz

- (1) When using LFOSC as source for the low frequency system clock (LFCLK), the accuracy of the LFCLK-derived Real Time Clock (RTC) can be improved by measuring LFOSC relative to HFXT and compensating for the RTC tick speed. This functionality is available through the TI-provided Power driver.

## 7.21 Peripheral Characteristics

### 7.21.1 UART

#### 7.21.1.1 UART Characteristics

over operating free-air temperature range (unless otherwise noted)

	PARAMETER	MIN	TYP	MAX	UNIT
UART rate				3	MBaud

### 7.21.2 SPI

#### 7.21.2.1 SPI Characteristics

Using TI SPI driver, over operating free-air temperature range (unless otherwise noted).

	PARAMETERS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
fSCLK 1/tsclk	SPI clock frequency	Controller Mode and Peripheral Mode <sup>(1)</sup> $2.7\text{ V} \leq V_{DD5} < 3.8\text{ V}$			12	MHz
		Controller Mode and Peripheral Mode <sup>(1)</sup> $V_{DD5} < 2.7\text{ V}$			8	MHz
DC <sub>SCK</sub>	SCK Duty Cycle		45	50	55	%

- (1) Assume interfacing with ideal SPI controller and SPI peripheral devices

### 7.21.2.2 SPI Controller Mode

Using TI SPI driver, over operating free-air temperature range (unless otherwise noted)

PARAMETERS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{\text{SCLK\_H/L}}$	SCLK High or Low time	$(t_{\text{SPI}}/2) - 1$	$t_{\text{SPI}}/2$	$(t_{\text{SPI}}/2) + 1$	ns
$t_{\text{CS\_LEAD}}$	CS lead-time, CS active to clock	1			SCLK
$t_{\text{CS\_LAG}}$	CS lag time, Last clock to CS inactive	1			SCLK
$t_{\text{CS\_ACC}}$	CS access time, CS active to PICO data out			1	SCLK
$t_{\text{CS\_DIS}}$	CS disable time, CS inactive to PICO high impedance			1	SCLK
$t_{\text{VALID\_CO}}$	PICO output data valid time <sup>(1)</sup>	SCLK edge to PICO valid, $C_L = 20$ pF		13	ns
$t_{\text{HD\_CO}}$	PICO output data hold time <sup>(2)</sup>	$C_L = 20$ pF		0	ns

(1) Specifies the time to drive the next valid data to the output after the output changing SCLK clock edge

(2) Specifies how long data on the output is valid after the output changing SCLK clock edge

### 7.21.2.3 SPI Timing Diagrams - Controller Mode

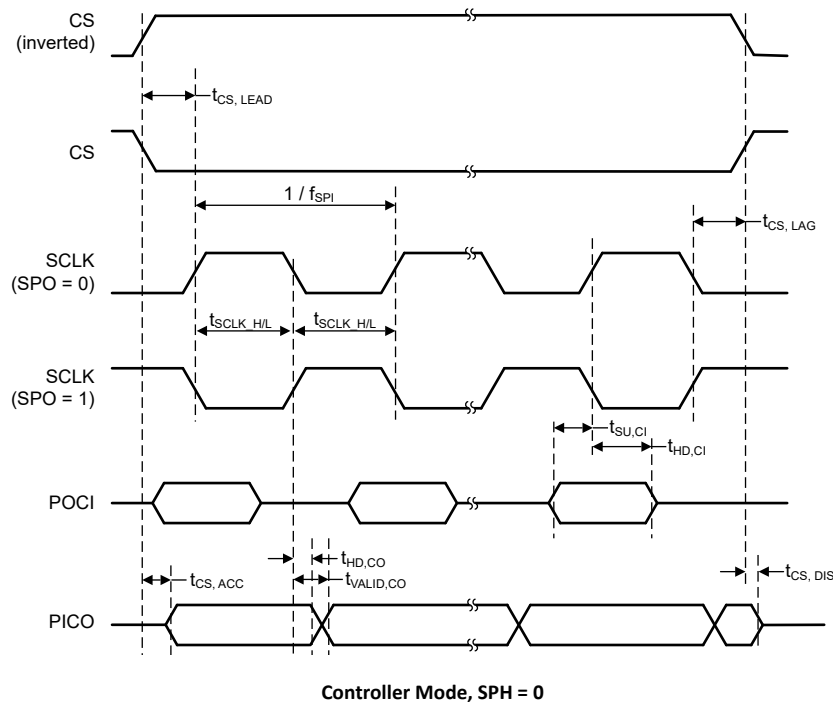


图 7-1. SPI Timing Diagram - Controller Mode, SPH = 0

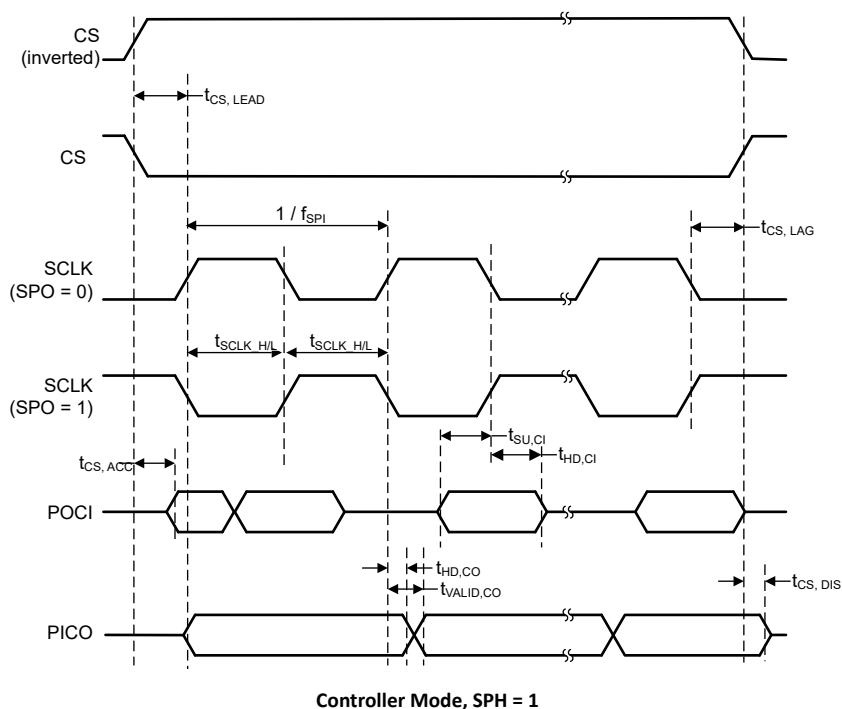


图 7-2. SPI Timing Diagram - Controller Mode, SPH = 1

#### 7.21.2.4 SPI Peripheral Mode

Using TI SPI driver, over operating free-air temperature range (unless otherwise noted)

PARAMETERS		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{CS, LEAD}$	CS lead-time, CS active to clock		1			SCLK
$t_{CS, LAG}$	CS lag time, Last clock to CS inactive		1			SCLK
$t_{CS, ACC}$	CS access time, CS active to POCI data out	VDD <sub>S</sub> = 3.3V			35	ns
$t_{CS, ACC}$	CS access time, CS active to POCI data out	VDD <sub>S</sub> = 1.8V			50	ns
$t_{CS, DIS}$	CS disable time, CS inactive to POCI high impedance	VDD <sub>S</sub> = 3.3V			35	ns
$t_{CS, DIS}$	CS disable time, CS inactive to POCI high impedance	VDD <sub>S</sub> = 1.8V			50	ns
$t_{SU, PI}$	PICO input data setup time		13			ns
$t_{HD, PI}$	PICO input data hold time		0			ns
$t_{VALID, PO}$	POCI output data valid time <sup>(1)</sup>	SCLK edge to POCI valid, $C_L = 20pF$ , 3.3V			35	ns
$t_{VALID, PO}$	POCI output data valid time <sup>(1)</sup>	SCLK edge to POCI valid, $C_L = 20pF$ , 1.8V			50	ns
$t_{HD, PO}$	POCI output data hold time <sup>(2)</sup>	$C_L = 20pF$	0			ns

(1) Specifies the time to drive the next valid data to the output after the output changing SCLK clock edge

(2) Specifies how long data on the output is valid after the output changing SCLK clock edge

### 7.21.2.5 SPI Timing Diagrams - Peripheral Mode

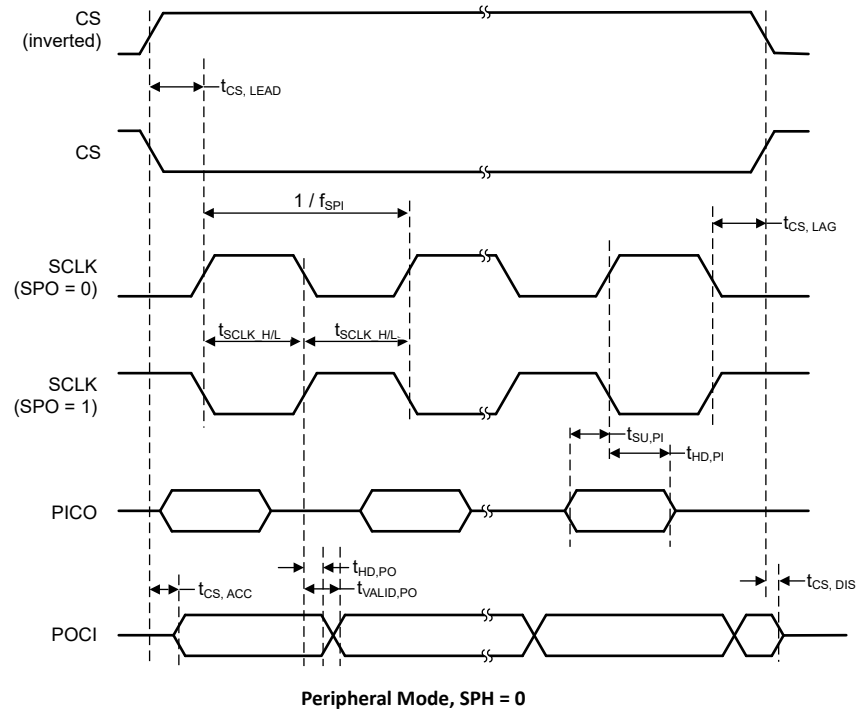


图 7-3. SPI Timing Diagram - Peripheral Mode, SPH = 0

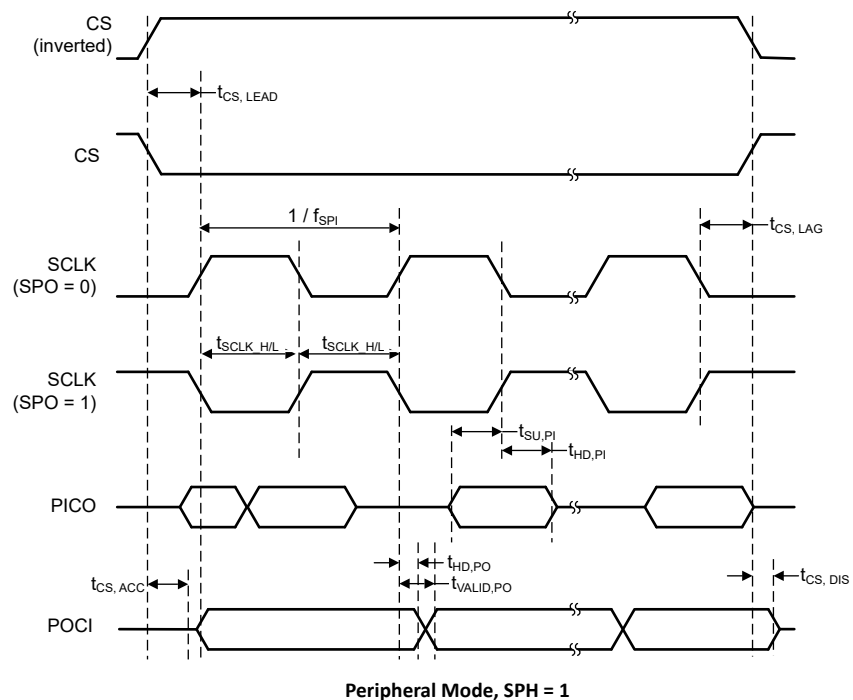


图 7-4. SPI Timing Diagram - Peripheral Mode, SPH = 1

### 7.21.3 I<sup>2</sup>C

#### 7.21.3.1 I<sup>2</sup>C

Over operating free-air temperature range (unless otherwise noted)

PARAMETERS		TEST CONDITIONS	MIN	TYP	MAX	UNIT
f <sub>SCL</sub>	SCL clock frequency		0		400	kHz
t <sub>HD,STA</sub>	Hold time (repeated) START	f <sub>SCL</sub> = 100kHz	4.0			μs
t <sub>HD,STA</sub>	Hold time (repeated) START	f <sub>SCL</sub> > 100kHz	0.6			μs
t <sub>SU,STA</sub>	Setup time for a repeated START	f <sub>SCL</sub> = 100kHz	4.7			μs
t <sub>SU,STA</sub>	Setup time for a repeated START	f <sub>SCL</sub> > 100kHz	0.6			μs
t <sub>HD,DAT</sub>	Data hold time		0			μs
t <sub>SU,DAT</sub>	Data setup time	f <sub>SCL</sub> = 100kHz	250			ns
t <sub>SU,DAT</sub>	Data setup time	f <sub>SCL</sub> > 100kHz	100			ns
t <sub>SU,STO</sub>	Setup time for STOP	f <sub>SCL</sub> = 100kHz	4.0			μs
t <sub>SU,STO</sub>	Setup time for STOP	f <sub>SCL</sub> > 100kHz	0.6			μs
t <sub>BUF</sub>	Bus free time between STOP and START conditions	f <sub>SCL</sub> = 100kHz	4.7			μs
t <sub>BUF</sub>	Bus free time between STOP and START conditions	f <sub>SCL</sub> > 100kHz	1.3			μs
t <sub>SP</sub>	Pulse duration of spikes suppressed by input deglitch filter		50			ns

#### 7.21.3.2 I<sup>2</sup>C Timing Diagram

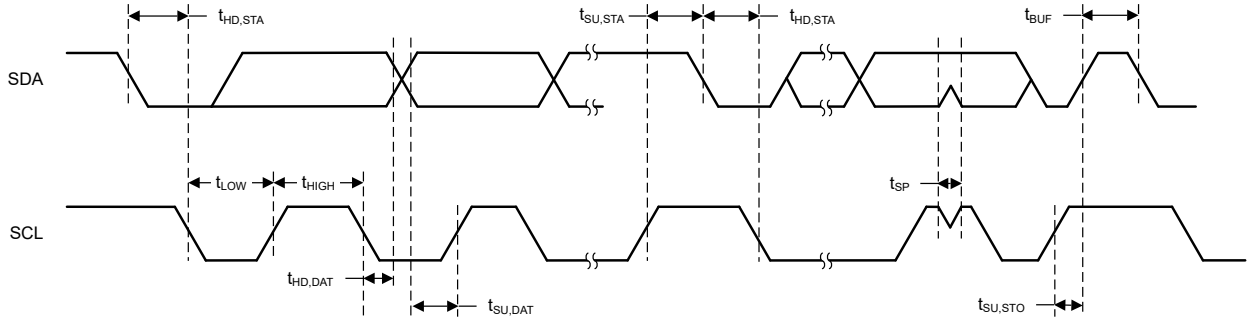


图 7-5. I<sup>2</sup>C Timing Diagram

### 7.21.4 GPIO

#### 7.21.4.1 GPIO DC Characteristics

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>T<sub>A</sub> = 25 °C, V<sub>DDs</sub> = 1.8 V</b>					
GPIO pullup current	Input mode, pullup enabled, V <sub>pad</sub> = 0 V	39	66	109	μA
GPIO pulldown current	Input mode, pulldown enabled, V <sub>pad</sub> = V <sub>DDs</sub>	10	21	40	μA
GPIO low-to-high input transition, with hysteresis	I <sub>H</sub> = 1, transition voltage for input read as 0 → 1	0.91	1.11	1.27	V
GPIO high-to-low input transition, with hysteresis	I <sub>H</sub> = 1, transition voltage for input read as 1 → 0	0.59	0.75	0.91	V
GPIO input hysteresis	I <sub>H</sub> = 1, difference between 0 → 1 and 1 → 0 points	0.26	0.35	0.44	V
<b>T<sub>A</sub> = 25 °C, V<sub>DDs</sub> = 3.0 V</b>					
GPIO VOH at 10 mA load	high-drive GPIOs only, max drive setting	2.47			V
GPIO VOL at 10 mA load	high-drive GPIOs only, max drive setting			0.25	V

### 7.21.4.1 GPIO DC Characteristics (续)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
GPIO VOH at 2 mA load	standard drive GPIOs	2.52			V
GPIO VOL at 2 mA load	standard drive GPIOs			0.20	V
<b>T<sub>A</sub> = 25 °C, V<sub>DDs</sub> = 3.8 V</b>					
GPIO pullup current	Input mode, pullup enabled, Vpad = 0 V	170	262	393	μA
GPIO pulldown current	Input mode, pulldown enabled, Vpad = VDDs	60	110	172	μA
GPIO low-to-high input transition, with hysteresis	IH = 1, transition voltage for input read as 0 → 1	1.76	1.98	2.27	V
GPIO high-to-low input transition, with hysteresis	IH = 1, transition voltage for input read as 1 → 0	1.26	1.52	1.79	V
GPIO input hysteresis	IH = 1, difference between 0 → 1 and 1 → 0 points	0.40	0.47	0.54	V
<b>T<sub>A</sub> = 25 °C</b>					
VIH	Lowest GPIO input voltage reliably interpreted as a <i>High</i>	0.8*V <sub>DDs</sub>			V
VIL	Highest GPIO input voltage reliably interpreted as a <i>Low</i>	0.2*V <sub>DDs</sub>			V

## 7.21.5 ADC

### 7.21.5.1 Analog-to-Digital Converter (ADC) Characteristics

$T_c = 25^\circ\text{C}$ ,  $V_{\text{DDS}} = 3.0\text{V}$ , unless otherwise noted.<sup>(2)</sup>

Performance numbers require use of offset and gain adjustments in software by TI-provided ADC drivers.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>ADC Power Supply and Input Range Conditions</b>					
$V_{(\text{Ax})}$	Analog input voltage range	All ADC analog input pins Ax	0	$V_{\text{DDS}}$	V
$I_{(\text{ADC})}$ single-ended mode	Operating supply current into $V_{\text{DDS}}$ terminal	RES = 0x0 (12Bit mode), $F_s = 1.2\text{MSPS}$ , Internal reference OFF (ADCREF_EN = 0), $V_{\text{REF+}} = V_{\text{DDS}}$	480		$\mu\text{A}$
		RES = 0x0 (12Bit mode), $F_s = 266\text{ksps}$ , Internal reference ON (ADCREF_EN = 0), ADCREF = 2.5V	365		
$C_{\text{GPIO}}$	Input capacitance into a single terminal		5	7	pF
$R_{\text{GPIO}}$	Input MUX ON-resistance		0.5	1	k $\Omega$
<b>ADC Switching Characteristics</b>					
$F_{\text{S ADC REF}}$	ADC sampling frequency when using the internal ADC reference voltage	ADCREF_EN = 1, RES = 0x0 (12-bit), $V_{\text{DDS}} = 1.71\text{V}$ to $V_{\text{DDSmax}}$		267 <sup>(1)</sup>	ksps
$F_{\text{S ADC REF}}$	ADC sampling frequency when using the internal ADC reference voltage	ADCREF_EN = 1, RES = 0x1 (10-bit), $V_{\text{DDS}} = 1.71\text{V}$ to $V_{\text{DDSmax}}$		308 <sup>(1)</sup>	ksps
$F_{\text{S ADC REF}}$	ADC sampling frequency when using the internal ADC reference voltage	ADCREF_EN = 1, RES = 0x2 (8-bit), $V_{\text{DDS}} = 1.71\text{V}$ to $V_{\text{DDSmax}}$		400 <sup>(1)</sup>	ksps
$F_{\text{S EXTR EF}}$	ADC sampling frequency when using the external ADC reference voltage	ADCREF_EN = 0, $V_{\text{REF+}} = V_{\text{DDS}}$ , RES = 0x0 (12-bit), $V_{\text{DDS}} = 1.71\text{V}$ to $V_{\text{DDSmax}}$		1.2 <sup>(1)</sup>	MSPS
$F_{\text{S EXTR EF}}$	ADC sampling frequency when using the external ADC reference voltage	ADCREF_EN = 0, $V_{\text{REF+}} = V_{\text{DDS}}$ , RES = 0x1 (10-bit), $V_{\text{DDS}} = 1.71\text{V}$ to $V_{\text{DDSmax}}$		1.33 <sup>(1)</sup>	MSPS
$F_{\text{S EXTR EF}}$	ADC sampling frequency when using the external ADC reference voltage	ADCREF_EN = 0, $V_{\text{REF+}} = V_{\text{DDS}}$ , RES = 0x2 (8-bit), $V_{\text{DDS}} = 1.71\text{V}$ to $V_{\text{DDSmax}}$		1.6 <sup>(1)</sup>	MSPS
$N_{\text{CONVERT}}$	Clock cycles for conversion	RES = 0x0 (12-bit)	14		cycles
$N_{\text{CONVERT}}$	Clock cycles for conversion	RES = 0x1 (10-bit)	12		cycles
$N_{\text{CONVERT}}$	Clock cycles for conversion	RES = 0x2 (8-bit)	9		cycles
$t_{\text{Sample}}$	Sampling time	RES = 0x0 (12-bit), $R_S = 25\ \Omega$ , $C_{\text{pext}} = 10\text{pF}$ , +/- 0.5 LSB settling	250		ns
$t_{\text{VSUPPLY/3(sample)}}$	Sample time required when $V_{\text{supply/3}}$ channel is selected		20		$\mu\text{s}$
<b>ADC Linearity Parameters</b>					
$E_{\text{I}}$	Integral linearity error (INL) for single-ended inputs	12-bit Mode, $V_{\text{R+}} = V_{\text{REF+}} = V_{\text{DDS}}$ , $V_{\text{DDS}} = 1.71\text{V} \rightarrow 3.8$	+/- 2		LSB
$E_{\text{D}}$	Differential linearity error (DNL)	12-bit Mode, $V_{\text{R+}} = V_{\text{REF+}} = V_{\text{DDS}}$ , $V_{\text{DDS}} = 1.71\text{V} \rightarrow 3.8$	+/- 1		LSB
$E_{\text{O}}$	Offset error	12-bit Mode, External reference, $V_{\text{R+}} = V_{\text{REF+}} = V_{\text{DDS}}$ , $V_{\text{DDS}} = 1.71\text{V} \rightarrow 3.8$	1.98		LSB
$E_{\text{O}}$	Offset error	12-bit Mode, Internal reference, $V_{\text{R+}} = \text{ADCREF} = 2.5\text{V}$	1.02		LSB
$E_{\text{G}}$	Gain error	External Reference, $V_{\text{R+}} = V_{\text{REF+}} = V_{\text{DDS}}$ , $V_{\text{DD}} = 1.71\text{V} \rightarrow 3.8$	+/- 2		LSB
$E_{\text{G}}$	Gain error	Internal reference, $V_{\text{R+}} = \text{ADCREF} = 2.5\text{V}$	+/- 40		LSB
<b>ADC Dynamic Parameters</b>					
ENOB	Effective number of bits	ADCREF_EN = 0, $V_{\text{REF+}} = V_{\text{DDS}} = 3.3\text{V}$ , $V_{\text{REF-}} = 0\text{V}$ , RES = 0x2 (8-bit)	8		bit
ENOB	Effective number of bits	ADCREF_EN = 0, $V_{\text{REF+}} = V_{\text{DDS}} = 3.3\text{V}$ , $V_{\text{REF-}} = 0\text{V}$ , RES = 0x1 (10-bit)	9.9		bit

### 7.21.5.1 Analog-to-Digital Converter (ADC) Characteristics (续)

$T_c = 25^\circ\text{C}$ ,  $V_{DD5} = 3.0\text{V}$ , unless otherwise noted.<sup>(2)</sup>

Performance numbers require use of offset and gain adjustments in software by TI-provided ADC drivers.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
ENOB	Effective number of bits	ADCREF_EN = 0, $V_{REF+} = V_{DD5} = 3.3\text{V}$ , $V_{REF-} = 0\text{V}$ , RES = 0x0 (12-bit)		11.2		bit
ENOB	Effective number of bits	ADCREF_EN = 1, ADCREF_VSEL = {2.5V, 1.4V}, RES = 0x2 (8-bit)		8		bit
ENOB	Effective number of bits	ADCREF_EN = 1, ADCREF_VSEL = {2.5V, 1.4V}, RES = 0x1 (10-bit)		9.6		bit
ENOB	Effective number of bits	ADCREF_EN = 1, ADCREF_VSEL = {2.5V, 1.4V}, RES = 0x0 (12-bit)		10.4		bit
ENOB	Effective number of bits	VDD5 reference, RES = 0x0 (12-bit)		11.2		bit
SINAD	Signal-to-noise and distortion ratio	ADCREF_EN = 0, $V_{REF+} = V_{DD5} = 3.3\text{V}$ , $V_{REF-} = 0\text{V}$ , RES = 0x0 (12-bit)		69.18		dB
SINAD	Signal-to-noise and distortion ratio	ADCREF_EN = 1, ADCREF_VSEL = {2.5V, 1.4V}, RES = 0x0 (12-bit)		64.37		dB
SINAD	Signal-to-noise and distortion ratio	VDD5 reference, RES = 0x0 (12-bit)		69.18		dB
<b>ADC External Reference</b>						
EXTREF	Positive external reference voltage input	ADCREF_EN=0, ADC reference sourced from external reference pin ( $V_{REF+}$ )	1.4		$V_{DD5}$	V
EXTREF	Negative external reference voltage input	ADCREF_EN=0, ADC reference sourced from external reference pin ( $V_{REF-}$ )			0	V
<b>ADC Temperature Diode, Supply Monitor</b>						
Temp_diode Accuracy	Temperature Error	ADC input channel: Temp diode voltage, Error calculated in temperature range: -30C to +40C, with single point calibration <sup>(2)</sup>		+/- 3		C
ADC Internal Input: $V_{SUPPLY}/3$ Accuracy	$V_{supply}$ voltage divider accuracy for supply monitoring	ADC input channel: $V_{supply}$ monitor		+/- 1		%
ADC Internal Input: $I_{Vsupply}/3$	$V_{supply}$ voltage divider current consumption	ADC input channel $V_{supply}$ monitor. $V_{supply}=V_{DD5}=3.3\text{V}$		10		$\mu\text{A}$
<b>ADC Internal and VDD5 Reference</b>						
VDDSR EF	Positive ADC reference voltage	ADC reference sourced from VDD5		$V_{DD5}$		V
ADCRE F	Internal ADC Reference Voltage	ADCREF_EN = 1, ADCREF_VSEL = 0, $V_{DD5} = 1.71\text{V} - V_{DD5max}$		1.4		V
		ADCREF_EN = 1, ADCREF_VSEL = 1, $V_{DD5} = 2.7\text{V} - V_{DD5max}$		2.5		V
$I_{ADCRE F}$	Operating supply current into VDDA terminal with internal reference ON	ADCREF_EN = 1, $V_{DDA} = 1.7\text{V}$ to $V_{DDAmax}$ , ADCREF_VSEL = {0,1}		80		$\mu\text{A}$
$t_{ON}$	Internal ADC Reference Voltage power on-time	ADCREF_EN = 1		2		$\mu\text{s}$

(1) Measured with 48MHz HFOSC

(2) Using IEEE Std 1241-2010 for terminology and test methods

## 7.21.6 Comparators

### 7.21.6.1 Ultra-Low Power Comparator

$T_c = 25^\circ\text{C}$ ,  $V_{\text{DDS}} = 3.0\text{V}$ , unless otherwise noted.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input voltage range		0		$V_{\text{DDS}}$	V
Clock frequency			32		KHz
Voltage Divider Accuracy	Input voltage range is between $V_{\text{DDS}}/4$ and $V_{\text{DDS}}$ .		98%		
Offset	Measured at $V_{\text{DDS}} / 2$ (Errors seen when using two external inputs)		$\pm 27.3$		mV
Decision time	Step from $-50\text{mV}$ to $50\text{mV}$		1	3	Clock Cycle
Comparator enable time	COMP_LP disable $\rightarrow$ enable, VIN+, VIN- from pins, Overdrive $\geq 20\text{mV}$		70		$\mu\text{s}$
Current consumption	Including using $V_{\text{DDS}}/2$ as internal reference at VIN - comparator terminal		370		nA

## 7.22 Typical Characteristics

All measurements in this section are done with  $T_c = 25^\circ\text{C}$  and  $V_{\text{DDS}} = 3.0\text{V}$ , unless otherwise noted. See *Recommended Operating Conditions* for device limits. Values exceeding these limits are for reference only.

### 7.22.1 MCU Current

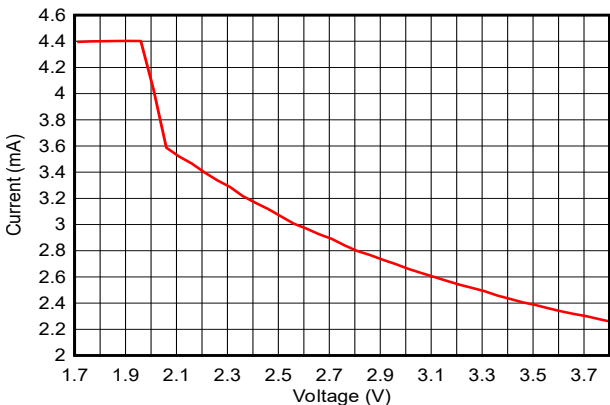


图 7-6. Active Mode (MCU) Current vs. Supply Voltage ( $V_{\text{DDS}}$ ) (Running CoreMark)

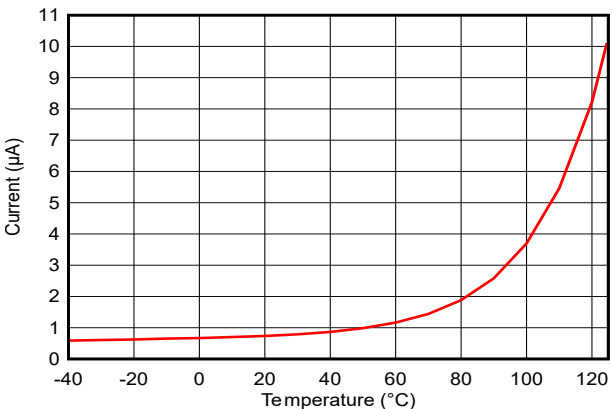


图 7-7. Standby Mode (MCU) Current vs. Temperature (RAM and partial register retention, RTC)

## 7.22.2 RX Current

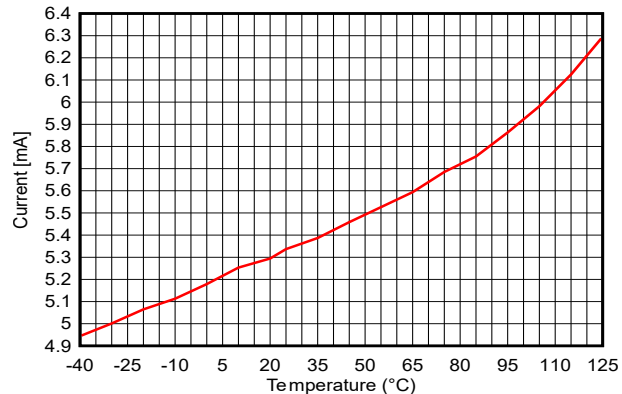


图 7-8. RX Current vs. Temperature (BLE 1Mbps, 2.44GHz)

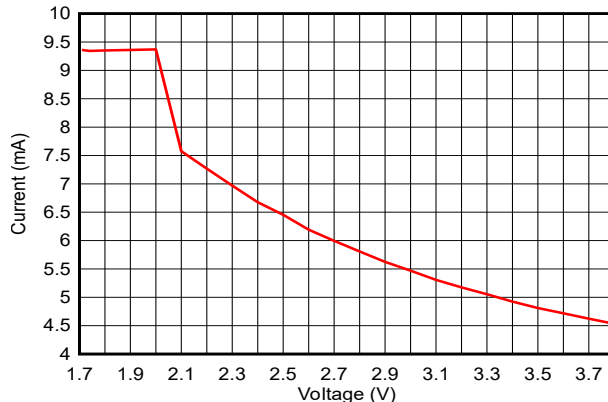


图 7-9. RX Current vs. Supply Voltage (VDD) (BLE 1Mbps, 2.44GHz)

### 7.22.3 TX Current

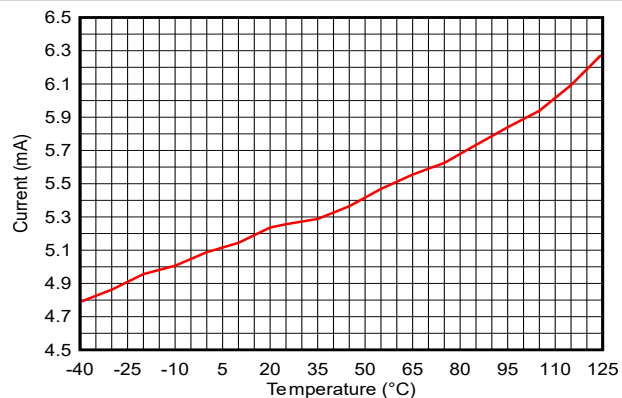


图 7-10. TX Current vs. Temperature (BLE 1Mbps, 2.44GHz, 0dBm)

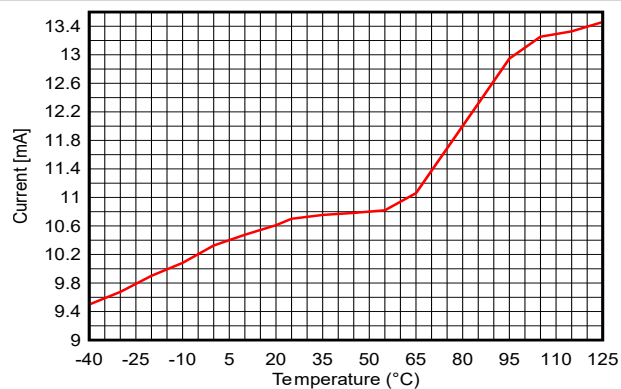


图 7-11. TX Current vs. Temperature (BLE 1Mbps, 2.44GHz, +8dBm)

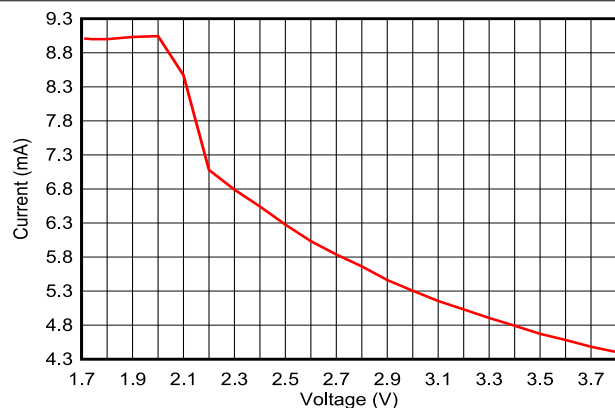


图 7-12. TX Current vs. Supply Voltage, VDD5 (BLE 1Mbps, 2.44GHz, 0dBm)

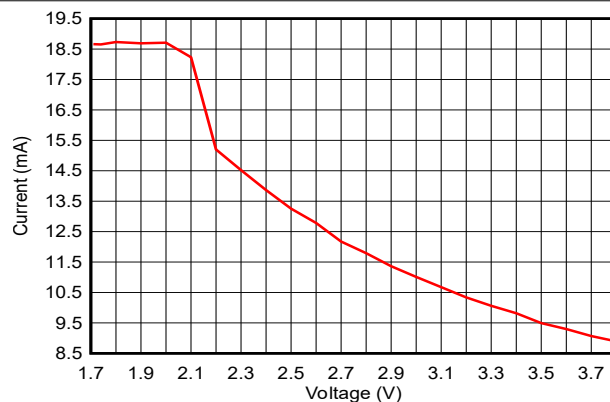


图 7-13. TX Current vs. Supply Voltage, VDD5 (BLE 1Mbps, 2.44GHz, +8dBm)

表 7-1 shows typical TX current and output power for different output power settings.

**表 7-1. Typical TX Current and Output Power**

2.4 GHz, VDD5 = 3.0 V, DCDC=On, Temperature = 25 °C (Measured on LP-EM-CC2340R5)			
txPowerTable Index	TX Power Setting [dBm] (SmartRF Studio)	Typical Output Power [dBm]	Typical Current Consumption [mA]
13	8	7.7	10.7
12	7	7.1	9.5
11	6	6.3	8.9
10	5	5.5	8.3
9	4	4.5	7.9
8	3	3.7	7.5
7	2	2.4	7.1
6	1	1.0	5.4
5	0	0.4	5.1
4	-4	-3.1	4.8
3	-8	-7.3	4.5
2	-12	-10.9	4.2
1	-16	-15.1	4.0
0	-20	-19.0	3.8

## 7.22.4 RX Performance

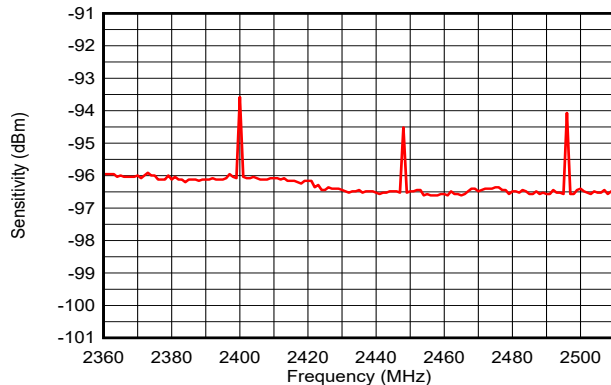


图 7-14. Sensitivity vs. Frequency (BLE 1Mbps)

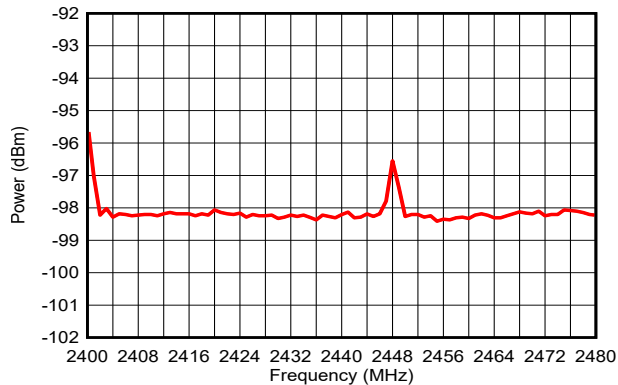


图 7-15. Sensitivity vs. Frequency (IEEE 802.15.4 PHY )

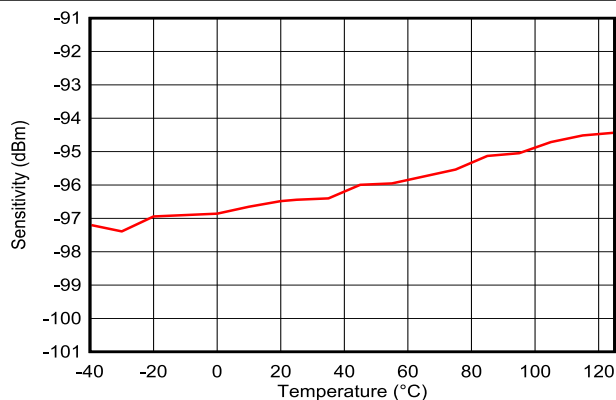


图 7-16. Sensitivity vs. Temperature (BLE 1Mbps, 2.44GHz)

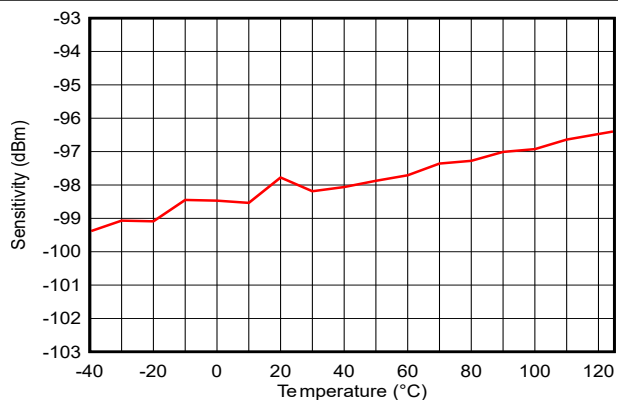


图 7-17. Sensitivity vs. Temperature (IEEE 802.15.4 PHY, 2.44GHz)

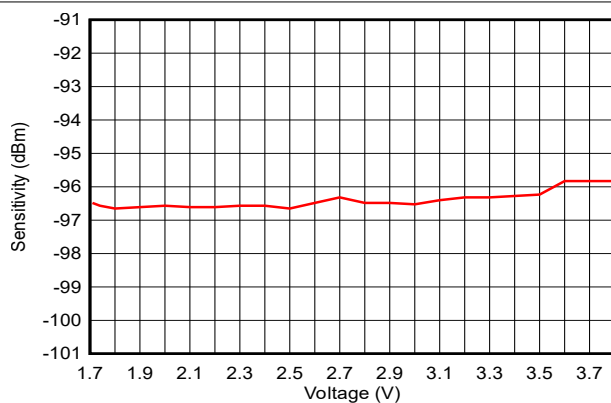


图 7-18. Sensitivity vs. Supply Voltage (VDD) (BLE 1Mbps, 2.44GHz)

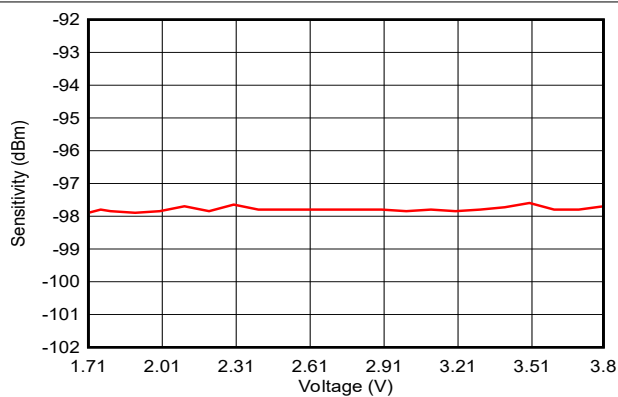


图 7-19. Sensitivity vs. Supply Voltage (VDD) (IEEE 802.15.4 PHY, 2.44GHz)

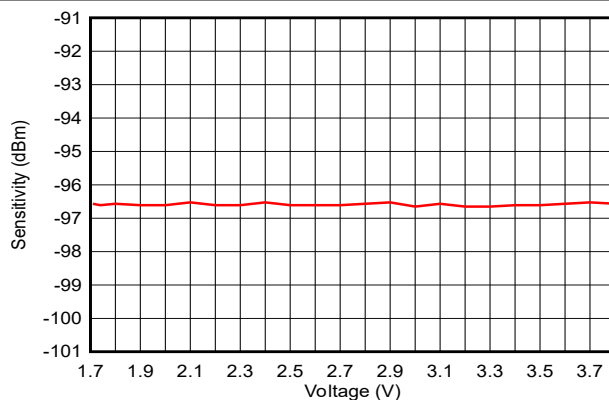


图 7-20. Sensitivity vs. Supply Voltage (VDDS) (BLE 1Mbps, 2.44GHz, DCDC Off)

### 7.22.5 TX Performance

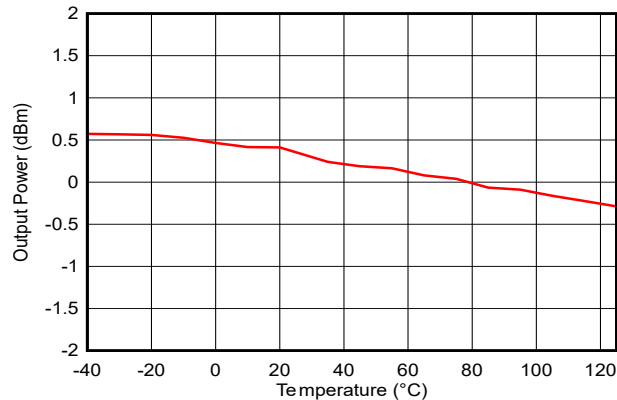


图 7-21. Output Power vs. Temperature (BLE 1Mbps, 2.44GHz, 0dBm)

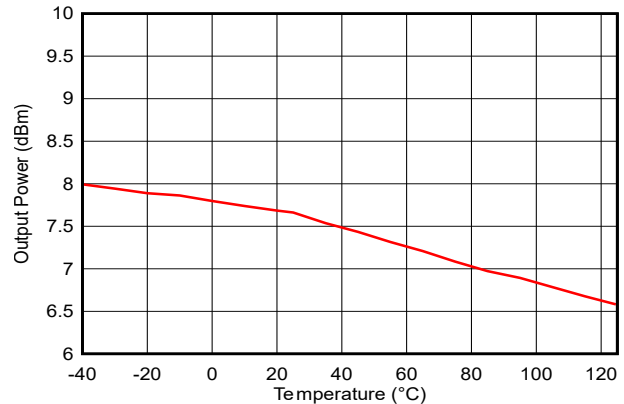


图 7-22. Output Power vs. Temperature (BLE 1Mbps, 2.44GHz, +8dBm)

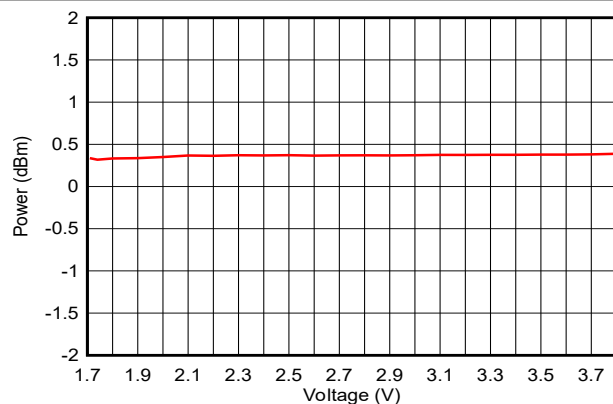


图 7-23. Output Power vs. Supply Voltage (VDD5) (BLE 1Mbps, 2.44GHz, 0dBm)

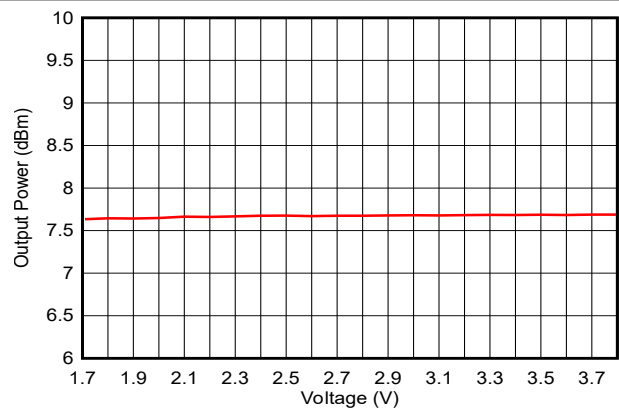


图 7-24. Output Power vs. Supply Voltage (VDD5) (BLE 1Mbps, 2.44GHz, +8dBm)

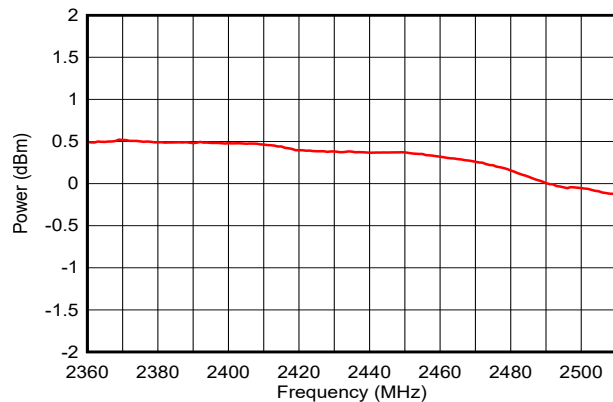


图 7-25. Output Power vs. Frequency (BLE 1Mbps, 0dBm)

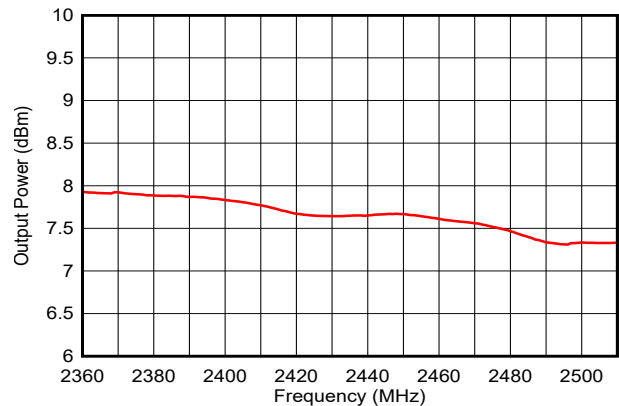


图 7-26. Output Power vs. Frequency (BLE 1Mbps, +8dBm)

## 7.22.6 ADC Performance

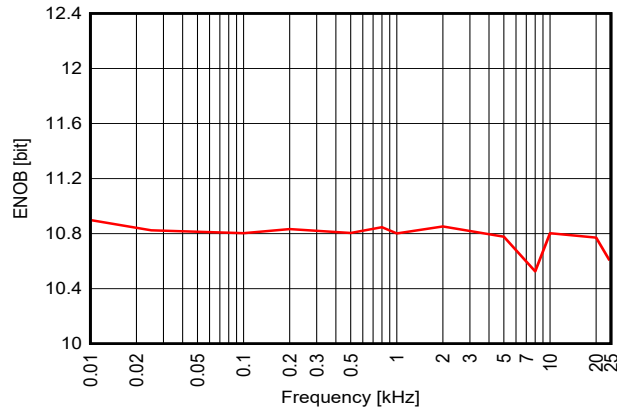


图 7-27. ENOB vs. Input Frequency (Internal Reference)

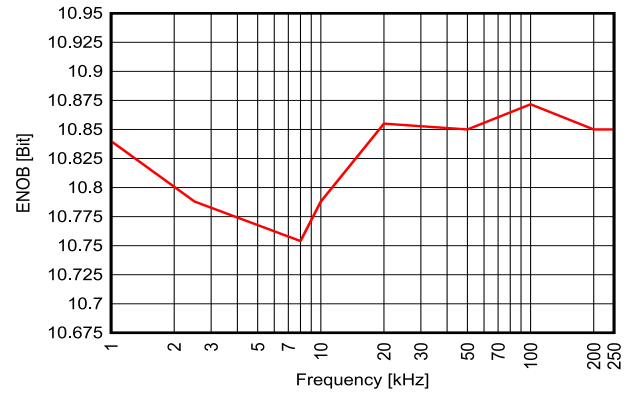


图 7-28. ENOB vs. Sampling Frequency ( $V_{in} = 3V$  Sine Wave, Internal Reference,  $F_{in} = F_s/10$ )

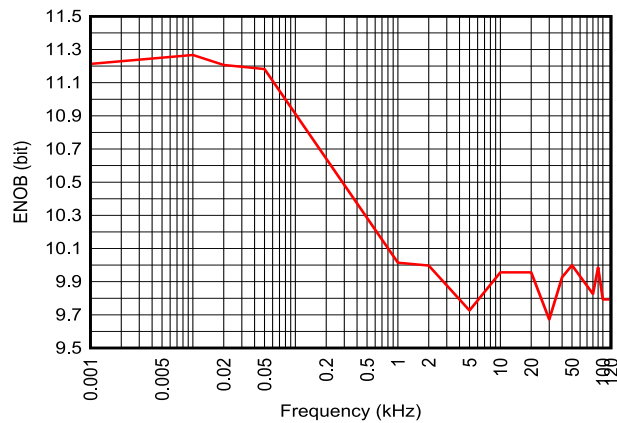


图 7-29. ENOB vs. Input Frequency (External Reference = 3.0V)

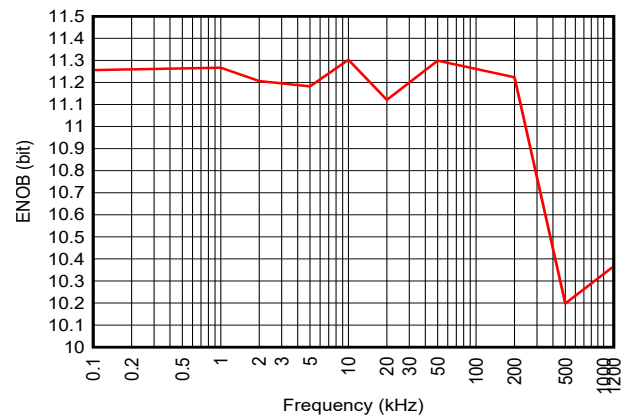


图 7-30. ENOB vs. Sampling Frequency ( $V_{in} = 3V$  Sine Wave, External Reference = 3.0V,  $F_{in} = F_s/10$ )

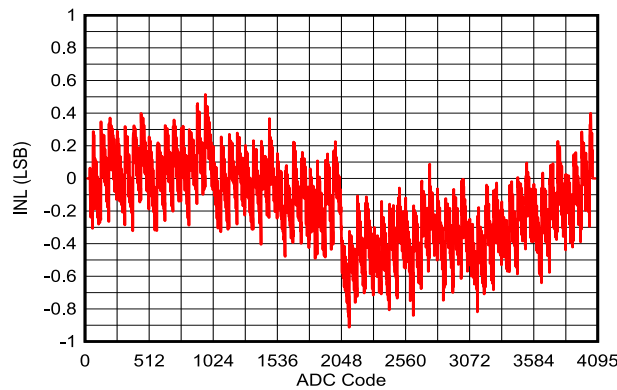


图 7-31. INL vs. ADC Code ( $V_{in} = 3V$  Sine Wave, Internal Reference, 200ksps)

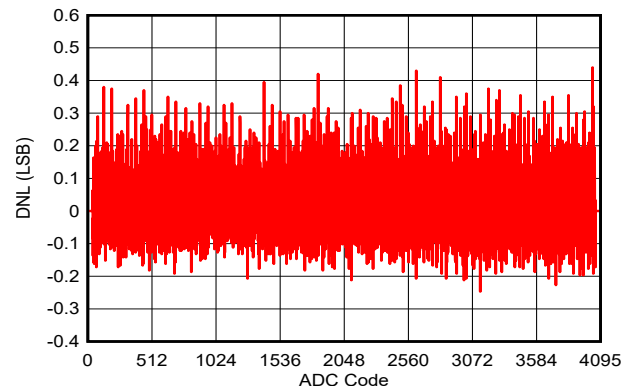


图 7-32. DNL vs. ADC Code ( $V_{in} = 3V$  Sine Wave, Internal Reference, 200ksps)

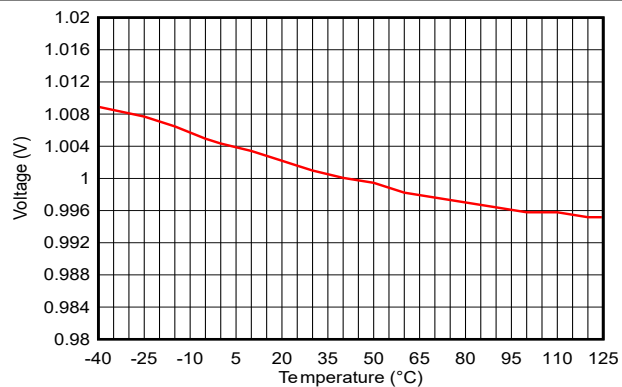


图 7-33. ADC Accuracy vs. Temperature ( $V_{in}=1V$ , Internal Reference, 200ksps)

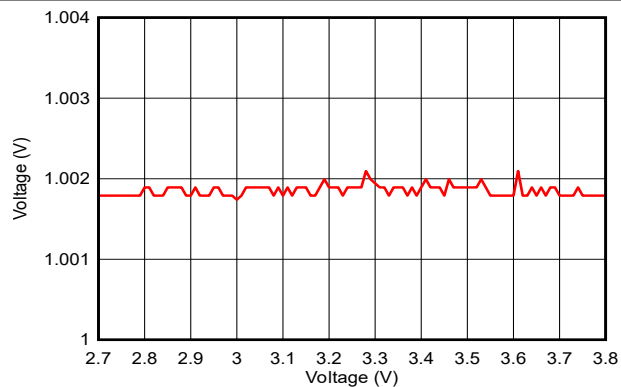


图 7-34. ADC Accuracy vs. Supply Voltage ( $V_{in}=1V$ , Internal Reference, 200ksps)

## 8 Detailed Description

### 8.1 Overview

节 4 shows the core modules of the CC2340R device.

### 8.2 System CPU

The CC2340R SimpleLink™ Wireless MCU contains an Arm® Cortex®-M0+ system CPU, which runs the application, the protocol stacks, and the radio. The Cortex-M0+ processor is built on a highly area and power optimized 32-bit processor core, with a 2-stage pipeline Von Neumann architecture. The processor delivers exceptional energy efficiency through a small but powerful instruction set and extensively optimized design, providing high-end processing hardware including a single-cycle multiplier. The Cortex-M0+ processor offers multiple benefits to developers including:

- Ultra-low power, energy efficient operation
- Deterministic, high-performance interrupt handling for time-critical applications
- Upward compatibility with the Cortex-M processors family

The Cortex-M0+ processor provides the excellent performance expected of a modern 32-bit architecture core, with higher code density than other 8-bit and 16-bit microcontrollers. Its features include the following:

- ARMv6-M architecture optimized for small-footprint embedded applications
- Subset of Arm Thumb/Thumb-2 mixed 16- and 32-bit instructions delivers the high performance expected of a 32-bit Arm
- Single-cycle multiply instruction
- VTOR supporting offset of the vector table base address
- Serial Wire debug with HW break-point comparators
- Ultra-low-power consumption with integrated sleep modes
- SysTick timer
- 48MHz operation
- 0.99DMIPS/MHz

Additionally, the CC2340R devices are compatible with all ARM tools and software.

### 8.3 Radio (RF Core)

The low-power RF Core (LRF) implements a high performance and highly flexible RF sub system containing RF and baseband circuitry in addition to a software defined digital radio (LRFD). LRFD provides a high-level, command-based API to the main CPU and handles all of the timing critical and low-level details of many different radio PHYs. Several signals are also available to control external circuitry such as RF switches or range extenders autonomously.

The software-defined modem is not programmable by customers but is instead loaded with precompiled images provided in the radio driver in the 适用于 CC23xx 器件的 SimpleLink™ 低功耗 F3 软件开发套件 (SDK). This mechanism allows the radio platform to be updated for support of future versions of standards with over-the-air (OTA) updates while still using the same silicon. LRFD stores the code images in the RF SRAM and does not make use of any ROM memory, thus image loading from NV memory only occurs once after boot and also, no patching is required when exiting power modes.

#### 8.3.1 Bluetooth 5.3 Low Energy

The RF Core offers full support for Bluetooth 5.3 Low Energy, including the high-speed 2Mbps physical layer and the 500kbps and 125kbps long range PHYs (Coded PHY) through the TI provided Bluetooth 5.3 stack or through a high-level Bluetooth API.

The new high-speed mode allows data transfers up to 2Mbps, twice the speed of Bluetooth 4.2 and five times the speed of Bluetooth 4.0, without increasing power consumption. In addition to faster speeds, this mode offers significant improvements in energy efficiency and wireless coexistence with reduced radio communication time.

Bluetooth 5.3 also enables unparalleled flexibility for adjustment of speed and range based on application needs, which capitalizes on the high-speed or long-range modes respectively. Data transfers are now possible at 2Mbps, enabling the development of applications using voice, audio, imaging, and data logging that were not previously an option using Bluetooth low energy. With high-speed mode, existing applications deliver faster responses, richer engagement, and longer battery life. Bluetooth 5.3 enables fast, reliable firmware updates.

### **8.3.2 802.15.4 (Thread and Zigbee)**

Through a dedicated IEEE radio API, the RF Core supports the 2.4GHz IEEE 802.15.4-2011 physical layer (2 Mchips per second Offset-QPSK with DSSS 1:8), used in Thread and Zigbee protocols. TI also provides royalty-free protocol stacks for Thread and Zigbee, enabling a robust end-to-end solution.

## **8.4 Memory**

Up to 512KB nonvolatile (Flash) memory provides storage for code and data. The flash memory is in-system programmable and erasable. A special flash memory sector must contain a Customer Configuration section (CCFG) that is used by boot ROM and TI provided drivers to configure the device. This configuration is done through the `ccfg.c` source file that is included in all TI provided examples.

Up to 64KB ultra-low leakage system static RAM (SRAM) can be used for both storage of data and execution of code. Retention of SRAM contents in Standby power mode is enabled by default and included in Standby mode power consumption numbers. System SRAM is always initialized to zeroes upon code execution during boot.

The ROM includes device bootcode firmware handling initial device trimming operations, security configurations, and device lifecycle management. The ROM also contains a serial (SPI and UART) bootloader that can be used for the initial programming of the device.

## 8.5 Cryptography

The CC2340R device comes with AES-128 cryptography hardware accelerator, reducing code footprint and execution time for cryptographic operations. It also has the benefit of being lower power and improves availability and responsiveness of the system because the cryptography operations run in a background hardware thread. The AES hardware accelerators supports the following block cipher modes and message authentication codes:

- AES ECB encrypt
- AES CBC encrypt
- AES CTR encrypt/decrypt
- AES CBC-MAC
- AES GCM
- AEC CCM (uses a combination of CTR + CBC-MAC hardware via software drivers)

The AES hardware accelerator can be fed with plaintext/ciphertext from either CPU or using DMA. Sustained throughput of one 16 byte ECB block per 23 cycles is possible corresponding to > 30Mbps.

The CC2340R device supports Random Number Generation (RNG) using on-chip analog noise as the non-deterministic noise source for the purpose of generating a seed for a cryptographically secure counter deterministic random bit generator (CTR-DRBG) that in turn is used to generate random numbers for keys, initialization vectors (IVs), and other random number requirements. Hardware acceleration of AES CTR-DRBG is supported.

The CC2340R device includes a complete SHA 256 library in ROM, reducing the code footprint of the application. Uses cases may include generating digests for use in digital signature algorithms, data integrity checks, and password storage.

Together with a large selection of open-source cryptography libraries provided with the Software Development Kit (SDK), this allows for secure and future proof IoT applications to be easily built on top of the platform.

## 8.6 Timers

A large selection of timers are available as part of the CC2340R device. These timers are:

- **Real-Time Clock (RTC)**

The RTC is a 67-bit, 2-channel timer running on the LFCLK system clock. The RTC is active in STANDBY and ACTIVE power states. When the device enters the RESET or SHUTDOWN state the RTC is reset.

The RTC accumulates time elapsed since reset on each LFCLK. The RTC counter is incremented by LFINC at a rate of 32.768kHz. LFINC indicates the period of LFCLK in  $\mu$ s, with an additional granularity of 16 fractional bits.

The counter can be read from two 32-bit registers. RTC.TIME8U has a range of approximately 9.5 hours with an LSB representing 8 microseconds. RTC.TIME524M has a range of approximately 71.4 years with an LSB representing 524 milliseconds.

There is hardware synchronization between the system timer (SYSTIM) and the RTC so that the multichannel and higher resolution SYSTIM remains in synchronization with the RTC's time base.

The RTC has two channels: one compare channel and one capture channel and is capable of waking the device out of the standby power state. The RTC compare channel is typically used only by system software and only during the standby power state.

- **System Timer (SYSTIM)**

The SYSTIM is a 34-bit, 5-channel wrap-around timer with a per-channel selectable 32b slice with either a 1  $\mu$ s resolution and 1h11m35s range or 250ns resolution and 17m54s range. All channels support both capture and single-shot compare (posting an event) operation. One channel is reserved for system software, three channels are reserved for radio software and one channel is freely available to user applications.

For software convenience, a hardware synchronization mechanism automatically ensures that the RTC and SYSTIM share a common time base (albeit with different resolutions/spans). Another software convenience feature is that SYSTIM qualifies any submitted compare values so that the timer channel will immediately trigger if the submitted event is in the immediate past (4.294s with 1  $\mu$ s resolution and 1.049s with 250ns resolution).

#### • General Purpose Timers (LGPT)

The CC2340R device provides up to four LGPTs with 3  $\times$  16 bit timers and 1  $\times$  24 bit timer, all running up to 48MHz. The LGPTs support a wide range of features such as:

- Three capture/compare channels
- One-shot or periodic counting
- Pulse width modulation (PWM)
- Time counting between edges and edge counting
- Input filter implemented on each of the channels for all timers
- IR generation feature available on Timer-0 and Timer-1
- Dead band feature available on Timer-1

The timer capture/compare and PWM signals are connected to IOs through the IO controller module (IOC) and the internal timer event connections to CPU, DMA, and other peripherals are through the event fabric, which allows the timers to interact with signals such as GPIO inputs, other timers, DMA and ADC. Two LGPTs (2  $\times$  16-bit timers) support quadrature decoder mode to enable buffered decoding of quadrature-encoded sensor signals. The LGPTs are available in device Active and Idle power modes.

**表 8-1. Timer Comparison**

Feature	Timer 0	Timer 1	Timer 2	Timer 3
Counter Width	16-bit	16-bit	16-bit	24-bit
Quadrature Decoder	Yes	No	Yes	No
Park Mode on Fault	No	Yes	No	No
Programmable Dead-Band Insertion	No	Yes	No	No

**表 8-2. Timer Availability**

Part Number	Timer 0	Timer 1	Timer 2	Timer 3
CC2340R21	Yes	Yes	No	No
CC2340R22	Yes	Yes	Yes	Yes
CC2340R52	Yes	Yes	Yes	Yes
CC2340R53	Yes	Yes	Yes	Yes

#### • Watchdog timer

The watchdog timer is used to regain control if the system operates incorrectly due to software errors. Upon counter expiry, the watchdog timer resets the device when periodic monitoring of the system components and tasks fails to verify proper functionality. The watchdog timer runs on a 32kHz clock rate and operates in device active, idle, and standby modes and cannot be stopped once enabled.

## 8.7 Serial Peripherals and I/O

The CC2340R device provides 1xUART, 1xSPI, and 1xI2C serial peripherals.

The SPI module supports both SPI controller and peripheral up to 12MHz with configurable phase and polarity.

The UART module implements universal asynchronous receiver and transmitter functions. They support flexible baud-rate generation up to a maximum of 3Mbps and IRDA SIR mode of operation.

The I<sup>2</sup>C module is used to communicate with devices compatible with the I<sup>2</sup>C standard. The I<sup>2</sup>C interface can handle 100kHz and 400kHz operation and can serve as both controller and target.

The I/O controller (IOC) controls the digital I/O pins and contains multiplexer circuitry to allow a set of peripherals to be assigned to I/O pins in a fixed manner over DIOs. All digital I/Os are interrupt and wake-up capable, have a programmable pullup and pulldown function, and can generate an interrupt on a negative or positive edge (configurable). When configured as an output, pins can function as either push-pull, open-drain, or open-source. Some GPIOs have high-drive capabilities, which are marked in **bold** in *Pin Configurations and Functions*.

For more information, see the [CC23xx SimpleLink™ Wireless MCU Technical Reference Manual](#).

## 8.8 Battery and Temperature Monitor

A combined temperature and battery voltage monitor is available in the CC2340R device. The battery and temperature monitor allows an application to continuously monitor on-chip temperature and supply voltage and respond to changes in environmental conditions as needed. The module contains window comparators to interrupt the system CPU when temperature or supply voltage go outside defined windows. These events can also be used to wake up the device from Standby mode through the Always-On (AON) event fabric.

## 8.9 $\mu$ DMA

The device includes a direct memory access ( $\mu$ DMA) controller. The  $\mu$ DMA controller provides a way to offload data-transfer tasks from the system CPU, thus allowing for more efficient use of the processor and the available bus bandwidth. The  $\mu$ DMA controller can perform a transfer between memory and peripherals. The  $\mu$ DMA controller has dedicated channels for each supported on-chip module and can be programmed to automatically perform transfers between peripherals and memory when the peripheral is ready to transfer more data.

Some features of the  $\mu$ DMA controller include the following (this is not an exhaustive list):

- Channel operation of up to 8 channels, with 6 channels having dedicated peripheral interface and 2 channels having ability to be triggered via configurable events.
- Transfer modes: memory-to-memory, memory-to-peripheral, peripheral-to-memory, and peripheral-to-peripheral
- Data sizes of 8, 16, and 32 bits
- Ping-pong mode for continuous streaming of data

## 8.10 Debug

On-chip debug is supported through the serial wire debug (SWD) interface, which is an ARM bi-directional 2-wire protocol that communicates with the JTAG Test Access Port (TAP) controller and allows for complete debug functionality. SWD is fully compatible with Texas Instruments' XDS family of debug probes.

## 8.11 Power Management

To minimize power consumption, the CC2340R supports a number of power modes and power management features (see 表 8-3).

表 8-3. Power Modes

MODE	SOFTWARE CONFIGURABLE POWER MODES <sup>(1)</sup>				RESET PIN HELD
	ACTIVE	IDLE	STANDBY	SHUTDOWN	
<b>CPU</b>	Active	Off	Off	Off	Off
<b>Flash</b>	On	Available	Off	Off	Off
<b>SRAM</b>	On	On	Retention	Off	Off
<b>Radio</b>	Available	Available	Off	Off	Off
<b>Supply System</b>	On	On	Duty Cycled	Off	Off
CPU register retention	Full	Full	Full <sup>(2)</sup>	No	No
SRAM retention	Full	Full	Full	Off	Off
48 MHz high-speed clock (HFCLK)	HFOSC (tracks HFXT)	HFOSC (tracks HFXT)	Off	Off	Off
32 kHz low-speed clock (LFCLK)	LFXT or LFOSC	LFXT or LFOSC	LFXT or LFOSC	Off	Off
Peripherals	Available	Available	IOC, BATMON, RTC, LPCOMP	Off	Off
Wake-up on RTC	N/A	Available	Available	Off	Off
Wake-up on pin edge	N/A	Available	Available	Available	Off
Wake-up on reset pin	On	On	On	On	On
Brownout detector (BOD)	On	On	Duty Cycled	Off	Off
Power-on reset (POR)	On	On	On	On	On
Watchdog timer (WDT)	Available	Available	Available	Off	Off

(1) “Available” indicates that the specific IP or feature can be enabled by user application in the corresponding device operating modes. “On” indicates that the specific IP or feature is turned on irrespective of the user application configuration of the device in the corresponding device operating mode. “Off” indicates that the specific IP or feature is turned off and not available for the user application in the corresponding device operating mode.

(2) Software-based retention of CPU registers with context save and restore when entering and exiting standby power mode

In the **Active** mode, both of MCU and AON power domains are powered. Clock gating is used to minimize power consumption. Clock gating to peripherals/subsystems is controlled manually by the CPU.

In **Idle** mode the CPU is in sleep but selected peripherals and subsystems (such as the radio) can be active. Infrastructure (Flash, ROM, SRAM, bus) clock gating is possible depending on state of the DMA and debug subsystem.

In **Standby** mode, only the always-on (AON) domain is active. An external wake-up event, RTC event, or comparator event (LP-COMP) is required to bring the device back to active mode. Pin Reset will also drive the device from Standby to Active. MCU peripherals with retention do not need to be reconfigured when waking up again, and the CPU continues execution from where it went into standby mode. All GPIOs are latched in standby mode.

In **Shutdown** mode, the device is entirely turned off (including the AON domain), and the I/Os are latched with the value they had before entering shutdown mode. A change of state on any I/O pin defined as a *wake from shutdown pin* wakes up the device and functions as a reset trigger. The CPU can differentiate between reset in this way and reset-by-reset pin or power-on reset by reading the reset status register. The only state retained in this mode are the latched I/O state, 3V register bank, and the flash memory contents.

### 备注

The power, RF and clock management for the CC2340R device require specific configuration and handling by software for optimized performance. This configuration and handling is implemented in the TI-provided drivers that are part of the CC2340R software development kit (SDK). Therefore, TI highly recommends using this software framework for all application development on the device. The complete [SDK](#) with FreeRTOS, device drivers, and examples are offered free of charge in source code.

## 8.12 Clock Systems

The CC2340R device has the following internal system clocks.

The 48MHz HFCLK is used as the main system (MCU and peripherals) clock. This is driven by the internal 48MHz RC Oscillator (HFOSC), which can track its accuracy against an external 48MHz crystal (HFXT). Radio operation requires an external 48MHz crystal.

The 32.768kHz LFCLK is used as the internal low-frequency system clock. It is used for the RTC, the watchdog timer (if enabled in standby power mode), and to synchronize the radio timer before or after Standby power mode. LFCLK can be driven by the internal 32.8kHz RC Oscillator (LFOSC), a 32.768kHz watch-type crystal, or clock input in LFXT bypass mode. When using a crystal or the internal RC oscillator, the device can output the 32kHz LFCLK signal to other devices, thereby reducing the overall system cost.

## 8.13 Network Processor

Depending on the product configuration, the CC2340R device can function as a wireless network processor (WNP), a device running the wireless protocol stack with the application running on a separate host MCU, or as a system-on-chip (SoC), with the application and protocol stack running on the system CPU inside the device.

In the first case, the external host MCU communicates with the device using SPI or UART. In the second case, the application must be written according to the application framework supplied with the wireless protocol stack.

## 9 Application, Implementation, and Layout

### 备注

Information in the following applications sections 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, as well as validating and testing their design implementation to confirm system functionality.

### 9.1 Reference Designs

The following reference designs should be followed closely when implementing designs using the CC2340R devices.

Special attention must be paid to RF component placement, decoupling capacitors, and DCDC regulator components, as well as ground connections for all of these.

<a href="#">LP-EM-CC2340R5 Design Files</a>	The CC2340R5 LaunchPad Design Files contain detailed schematics and layouts to build application-specific boards using the CC2340R devices in the 5mm x 5mm RKP package.
<a href="#">LP-EM-CC2340R5-RGE-4x4-IS24 Design Files</a>	The CC2340R5 RGE 4x4 LaunchPad Design Files contain detailed schematics and layouts to build application-specific boards using the CC2340R devices in the 4mm x 4mm RGE package. The CC2340R5x and CC2340R2x devices in RGE packages are pin-to-pin compatible.
<a href="#">Sub-1 GHz and 2.4 GHz Antenna Kit for LaunchPad™ Development Kit and SensorTag</a>	<p>The antenna kit allows real-life testing to identify the optimal antenna for your application. The antenna kit includes 16 antennas for frequencies from 169MHz to 2.4GHz, including:</p> <ul style="list-style-type: none"> <li>• PCB antennas</li> <li>• Helical antennas</li> <li>• Chip antennas</li> <li>• Dual-band antennas for 868MHz and 915MHz combined with 2.4GHz</li> </ul> <p>The antenna kit includes a JSC cable to connect to the Wireless MCU LaunchPad Development Kits and SensorTags.</p>

## 9.2 Junction Temperature Calculation

This section shows the different techniques for calculating the junction temperature under various operating conditions. For more details, see [Semiconductor and IC Package Thermal Metrics](#).

There are two recommended ways to derive the junction temperature from other measured temperatures:

1. From package temperature:

$$T_J = \psi_{JT} \times P + T_{\text{case}} \quad (1)$$

2. From board temperature:

$$T_J = \psi_{JB} \times P + T_{\text{board}} \quad (2)$$

P is the power dissipated from the device and can be calculated by multiplying current consumption with supply voltage. Thermal resistance coefficients are found in *Thermal Resistance Characteristics*.

### Example:

In this example, we assume a simple use case where the radio is transmitting continuously at 0dBm output power. Let us assume we want to maintain a junction temperature equal or less than 85°C and the supply voltage is 3V. Using Equation 1, the temperature difference between the top of the case and junction temperature is calculated. To calculate P, look up the current consumption for Tx at 85°C. At 85°C the current consumption is approximately 5.5mA. This means that P is 5.5mA × 3V = 16.5mW.

The maximum case temperature to maintain and junction temperature of 85°C is then calculated as:

$$T_{\text{case}} < T_J - 0.4^\circ\text{C}/\text{W} \times 23.4\text{mW} = 84.99^\circ\text{C} \quad (3)$$

For various application use cases, current consumption for other modules may have to be added to calculate the appropriate power dissipation. For example, the MCU may be running simultaneously as the radio, peripheral modules may be enabled, and so on. Typically, the easiest way to find the peak current consumption, and thus the peak power dissipation in the device, is to measure as described in the [Measuring CC13xx and CC26xx Current Consumption](#) application report.

## 10 Device and Documentation Support

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 as follows.

### 10.1 Device Nomenclature

To designate the stages in the product development cycle, TI assigns prefixes to all part numbers and/or date-code. Each device has one of three prefixes/identifications: X, P, or null (no prefix) (for example, X is in preview; therefore, an X prefix/identification is assigned).

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.

Production devices have been characterized fully, and the quality and reliability of the device have been demonstrated fully. TI's standard warranty applies.

Predictions show that prototype devices (X or P) have a greater failure rate than the standard production devices. Texas Instruments recommends that these devices not be used in any production system because their expected end-use failure rate still is undefined. Only qualified production devices are to be used.

TI device nomenclature also includes a suffix with the device family name. This suffix indicates the package type (for example, *RKP*).

For orderable part numbers of devices in the RHB (5-mm x 5-mm) package type, see the *Package Option Addendum* of this document, the Device Information in 节 3, the TI website ([www.ti.com](http://www.ti.com)), or contact your TI sales representative.

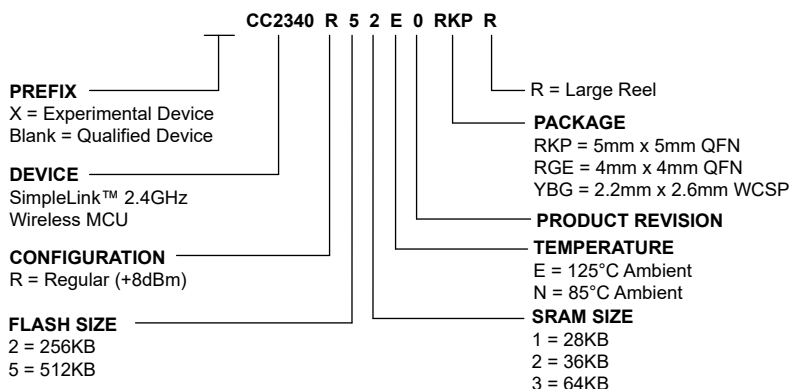


图 10-1. Device Nomenclature

### 10.2 Tools and Software

The CC2340R device is supported by a variety of software and hardware development tools.

#### Development Kit

[CC2340R5  
LaunchPad™  
Development Kit](#)

The CC2340R5 LaunchPad™ Development Kit enables development of high-performance wireless applications that benefit from low-power operation. The kit features the CC2340R53 SimpleLink Wireless MCU, which allows you to quickly evaluate and prototype 2.4GHz wireless applications such as Bluetooth 5 Low Energy, Zigbee, and

Thread. The kit works with the LaunchPad ecosystem, enabling additional functionality like sensors, display, and more.

## Software

### SimpleLink™ Low Power F3 software development kit (SDK)

The SimpleLink™ Low Power F3 software development kit (SDK) provides a complete package for the development of wireless applications on the CC2340R family of devices. The SDK includes a comprehensive software package for the CC2340R device, including the following protocol stacks:

- Bluetooth Low Energy 5.3
- Zigbee 3.x

The SimpleLink Low Power F3 SDK is part of TI's SimpleLink MCU platform, offering a single development environment that delivers flexible hardware, software, and tool options for customers developing wired and wireless applications. For more information about the SimpleLink MCU Platform, visit <https://www.ti.com/simplelink>.

## Development Tools

### Code Composer Studio™ Integrated Development Environment (IDE)

Code Composer Studio is an integrated development environment (IDE) that supports TI's Microcontroller and Embedded Processors portfolio. Code Composer Studio comprises a suite of tools used to develop and debug embedded applications. It includes an optimizing C/C++ compiler, source code editor, project build environment, debugger, profiler, and many other features. The intuitive IDE provides a single user interface taking you through each step of the application development flow. Familiar tools and interfaces allow users to get started faster than ever before.

CCS has support for all SimpleLink Wireless MCUs and includes support for EnergyTrace™ software (application energy usage profiling).

Code Composer Studio is provided free of charge when used in conjunction with the XDS debuggers included on a LaunchPad Development Kit.

### Code Composer Studio™ Cloud IDE

Code Composer Studio (CCS) Cloud is a web-based IDE that allows you to create, edit, and build CCS projects. After you have successfully built your project, you can download and run on your connected LaunchPad. Basic debugging, including features like setting breakpoints and viewing variable values, is now supported with CCS Cloud.

### IAR Embedded Workbench® for Arm®

IAR Embedded Workbench® is a set of development tools for building and debugging embedded system applications using Assembler, C and C++. It provides a completely integrated development environment that includes a project manager, editor, and build tools. IAR has support for all SimpleLink Wireless MCUs. It offers broad debugger support, including XDS110, IAR I-jet™, and Segger J-Link™. IAR is also supported out-of-the-box on most software examples provided as part of the SimpleLink SDK.

### SmartRF™ Studio

SmartRF™ Studio is a Windows® application that can be used to evaluate and configure SimpleLink Wireless MCUs from Texas Instruments. The application will help designers of RF systems to easily evaluate the radio at an early stage in the design process. It is especially useful for generation of configuration register values and for practical testing and debugging of the RF system. SmartRF Studio can be used either as a standalone application or together with applicable evaluation boards or debug probes for the RF device. Features of the SmartRF Studio include:

- Link tests - send and receive packets between nodes

- Antenna and radiation tests - set the radio in continuous wave TX and RX states
- Export radio configuration code for use with the TI SimpleLink SDK RF driver
- Custom GPIO configuration for signaling and control of external switches

### UniFlash

UniFlash is a standalone tool used to program on-chip flash memory on TI MCUs. UniFlash has a GUI, command line, and scripting interface. UniFlash is available free of charge.

## 10.2.1 SimpleLink™ Microcontroller Platform

The SimpleLink microcontroller platform sets a new standard for developers with the broadest portfolio of wired and wireless Arm® MCUs (System-on-Chip) in a single software development environment. Delivering flexible hardware, software and tool options for your IoT applications. Invest once in the SimpleLink software development kit and use throughout your entire portfolio. Learn more at [ti.com/simplelink](https://ti.com/simplelink).

## 10.3 Documentation Support

To receive notification of documentation updates on data sheets, errata, application notes and similar, navigate to the device product folder ([CC2340R5](#)). 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 MCU, related peripherals, and other technical collateral is listed as follows.

### TI Resource Explorer

#### TI Resource Explorer

Software examples, libraries, executables, and documentation are available for your device and development board.

### Errata

#### CC2340R Silicon Errata

The silicon errata describes the known exceptions to the functional specifications for each silicon revision of the device and description on how to recognize a device revision.

### Application Reports

All application reports for the CC2340R devices are found on the device product folder ([CC2340R2](#) or [CC2340R5](#)).

### Technical Reference Manual (TRM)

#### CC23xx SimpleLink™ Wireless MCU TRM

The TRM provides a detailed description of all modules and peripherals available in the device family.

## 10.4 支持资源

**TI E2E™ 中文支持论坛**是工程师的重要参考资料，可直接从专家处获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题，获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的[使用条款](#)。

## 10.5 Trademarks

SimpleLink™, LaunchPad™, Code Composer Studio™, EnergyTrace™, and TI E2E™ are trademarks of Texas Instruments.

I-jet™ is a trademark of IAR Systems AB.

J-Link™ is a trademark of SEGGER Microcontroller Systems GmbH.

Arm® and Cortex® are registered trademarks of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

Bluetooth® is a registered trademark of Bluetooth SIG.

CoreMark® is a registered trademark of Embedded Microprocessor Benchmark Consortium Corporation.

Wi-Fi® is a registered trademark of Wi-Fi Alliance.

IAR Embedded Workbench® is a registered trademark of IAR Systems AB.

Windows® is a registered trademark of Microsoft Corporation.

所有商标均为其各自所有者的财产。

## 10.6 静电放电警告



静电放电 (ESD) 会损坏这个集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

## 10.7 术语表

### TI 术语表

本术语表列出并解释了术语、首字母缩略词和定义。

## 11 Revision History

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision D (June 2024) to Revision E (September 2024)	Page
• 更新了整个数据表中的 SDK 名称。.....	1
• 将 CC2340R53E0RKPR 从“预发布”更新为“已发布”.....	2
• 将 CC2340R53N0RKPR 从“预发布”更新为“已发布”.....	2
• Corrected pin pitch in pin diagram title.....	6
• Corrected pin pitch in diagram title.....	8
• Updated the description of software and tools.....	58

Changes from Revision C (June 2023) to Revision D (June 2024)	Page
• 将所有 CC2340R 系列器件合并到单个数据表中.....	1
• 添加了 CC2340R 系列中的所有器件.....	2
• Changed the comparison table to the CC2340R family of devices.....	5
• Added preview for YBG package.....	8
• Removed "Untrimmed brownout rising threshold".....	20
• Updated parameter name of "Trimmed brownout rising threshold".....	20
• Updated parameter name of "Trimmed brownout falling threshold".....	20
• Changed Temperature Sensor "Accuracy".....	20
• Changed DCDC "Idle Current - Supply Systems and RAM powered, flash disabled, DMA disabled".....	21
• Changed DCDC "Idle Current - Supply Systems and RAM powered, flash disabled, DMA enabled".....	21
• Changed DCDC "Idle Current - Supply Systems and RAM powered, flash enabled, DMA disabled".....	21
• Changed DCDC "Idle Current - Supply Systems and RAM powered, flash enabled, DMA enabled".....	21
• Changed GLDO "Idle Current - Supply Systems and RAM powered, flash disabled, DMA disabled".....	21
• Changed GLDO "Idle Current - Supply Systems and RAM powered, flash disabled, DMA enabled".....	21
• Changed GLDO "Idle Current - Supply Systems and RAM powered, flash enabled, DMA disabled".....	21
• Changed GLDO "Idle Current - Supply Systems and RAM powered, flash enabled, DMA enabled".....	21
• Changed "Reset current".....	21
• Changed "Shutdown Current".....	21
• Changed "Radio transmit current at -8 dBm".....	22
• Changed "Radio transmit current at 0 dBm, DCDC OFF".....	22

• Changed "Radio transmit current at +4 dBm".....	22
• Changed "Flash write time".....	22
• Change "Frequency error tolerance" for 125kbps BLE PHY.....	24
• Change "Frequency error tolerance" for 500kbps BLE PHY.....	24
• Changed "Frequency error tolerance" for 1Mbps BLE PHY.....	24
• Changed "Data rate error tolerance" for 1Mbps BLE PHY.....	24
• Updated footnote 1 in Section 8.14 "Bluetooth Low Energy - Receive (RX)".....	24
• Changed "Selectivity, +3MHz" for 1Mbps BLE PHY.....	24
• Changed "Frequency error tolerance" for 2Mbps BLE PHY.....	24
• Changed "Data rate error tolerance" for 2Mbps BLE PHY.....	24
• Changed "f > 1 GHz, including harmonics".....	31
• Changed min value of "Crystal load capacitance".....	31
• Removed "Temperature coefficient".....	32
• Changed "SPI clock frequency".....	32
• Added footnote (1).....	32
• Changed "CS access time, CS active to POCI data out - VDDSD=3.3V".....	34
• Changed "CS access time, CS active to POCI data out - VDDSD=1.8V".....	34
• Changed "CS disable time, CS inactive to POCI high impedance - VDDSD=3.3V".....	34
• Changed "CS disable time, CS inactive to POCI high impedance - VDDSD=1.8V".....	34
• Changed "PICO input data setup time".....	34
• Changed "POCI output data valid time" at 3.3V.....	34
• Removed "(4)" from test conditions.....	34
• Changed "POCI output data valid time" at 1.8V.....	34
• Removed "(4)" from test conditions.....	34
• Added "Data setup time" at f <sub>SCL</sub> = 100kHz.....	36
• Changed "Data setup time" at f <sub>SCL</sub> > 100kHz.....	36
• Changed "GPIO pullup current" at 1.8V.....	36
• Changed "GPIO pulldown current" at 1.8V.....	36
• Changed "GPIO low-to-high input transition, with hysteresis" at 1.8V.....	36
• Changed "GPIO high-to-low input transition, with hysteresis" at 1.8V.....	36
• Changed "GPIO input hysteresis" at 1.8V.....	36
• Changed "GPIO VOH at 10 mA load" at 3.0V.....	36
• Changed "GPIO VOL at 10 mA load" at 3.0V.....	36
• Changed "GPIO VOH at 2 mA load" at 3.0V.....	36
• Changed "GPIO VOL at 2 mA load" at 3.0V.....	36
• Changed "GPIO pullup current" at 3.8V.....	36
• Changed "GPIO pulldown current" at 3.8V.....	36
• Changed "GPIO low-to-high input transition, with hysteresis" at 3.8V.....	36
• Changed "GPIO high-to-low input transition, with hysteresis" at 3.8V.....	36
• Changed "GPIO input hysteresis" at 3.8V.....	36
• Added "Temperature Error" of Temp diode inside ADC.....	38
• Changed "Ultra-low power comparator current consumption".....	40
• Added performance plots.....	40
• Corrected timer features.....	51
• Updated descriptions.....	54

## 12 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.

**PACKAGING INFORMATION**

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">CC2340R21N0RGER</a>	Active	Production	VQFN (RGE)   24	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2340 R21
CC2340R21N0RGER.A	Active	Production	VQFN (RGE)   24	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2340 R21
<a href="#">CC2340R22E0RKPR</a>	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	CC2340 R22
CC2340R22E0RKPR.A	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	CC2340 R22
CC2340R22E0RKPR.B	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	CC2340 R22
<a href="#">CC2340R22N0RKPR</a>	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2340 R22
CC2340R22N0RKPR.A	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2340 R22
CC2340R22N0RKPR.B	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2340 R22
<a href="#">CC2340R52E0RGER</a>	Active	Production	VQFN (RGE)   24	3000   LARGE T&R	Yes	Call TI   Nipdau	Level-3-260C-168 HR	-40 to 125	CC2340 R52
CC2340R52E0RGER.A	Active	Production	VQFN (RGE)   24	3000   LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 125	CC2340 R52
CC2340R52E0RGER.B	Active	Production	VQFN (RGE)   24	3000   LARGE T&R	Yes	Call TI	Level-3-260C-168 HR	-40 to 125	CC2340 R52
<a href="#">CC2340R52E0RKPR</a>	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU   SN	Level-3-260C-168 HR	-40 to 125	CC2340 R52
CC2340R52E0RKPR.A	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	CC2340 R52
CC2340R52E0RKPR.B	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 125	CC2340 R52
<a href="#">CC2340R52N0RGER</a>	Active	Production	VQFN (RGE)   24	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2340 R52
CC2340R52N0RGER.A	Active	Production	VQFN (RGE)   24	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2340 R52

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
CC2340R52N0RGER.B	Active	Production	VQFN (RGE)   24	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2340 R52
<a href="#">CC2340R52N0RKPR</a>	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2340 R52
CC2340R52N0RKPR.A	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2340 R52
CC2340R52N0RKPR.B	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-3-260C-168 HR	-40 to 85	CC2340 R52
<a href="#">CC2340R53E0RKPR</a>	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU   NIPDAU	Level-2-260C-1 YEAR	-40 to 125	CC2340 R53
CC2340R53E0RKPR.A	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	CC2340 R53
<a href="#">CC2340R53N0RKPR</a>	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU   NIPDAU	Level-2-260C-1 YEAR	-40 to 85	CC2340 R53
CC2340R53N0RKPR.A	Active	Production	VQFN (RKP)   40	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	CC2340 R53

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

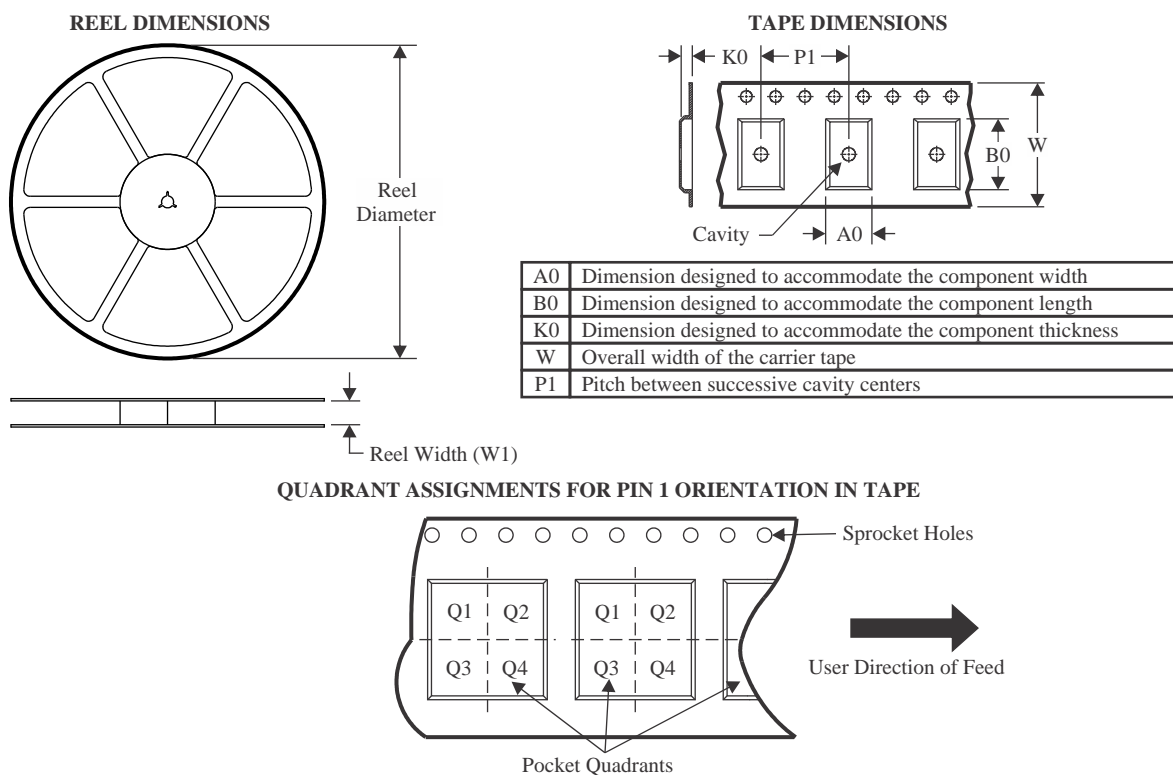
**OTHER QUALIFIED VERSIONS OF CC2340R5 :**

- Automotive : [CC2340R5-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

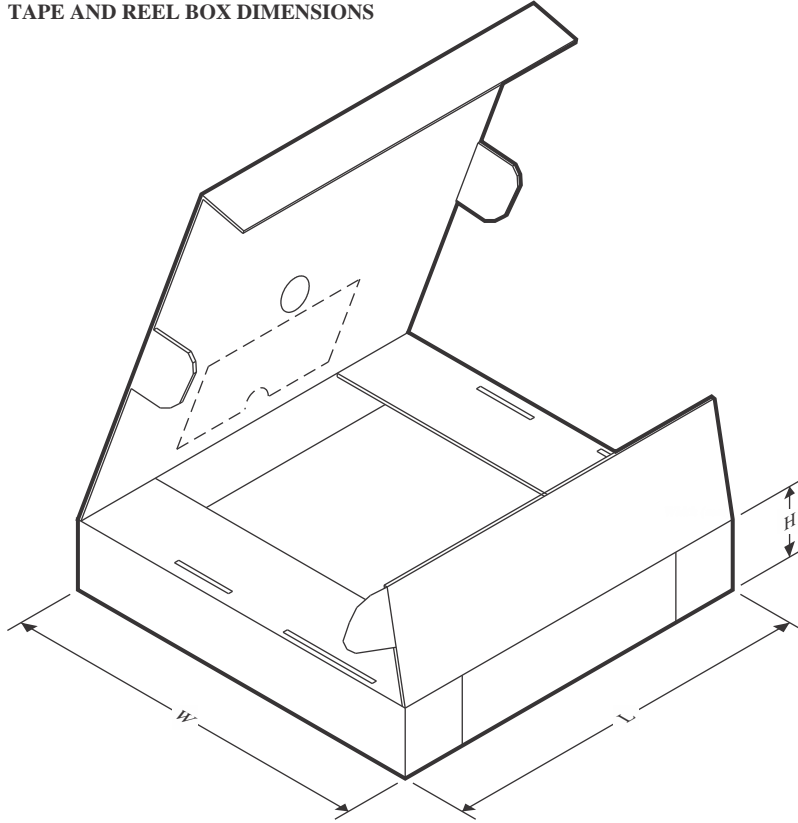
## TAPE AND REEL INFORMATION



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CC2340R21N0RGER	VQFN	RGE	24	3000	330.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2
CC2340R22E0RKPR	VQFN	RKP	40	3000	330.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2
CC2340R22N0RKPR	VQFN	RKP	40	3000	330.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2
CC2340R52E0RGER	VQFN	RGE	24	3000	330.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2
CC2340R52E0RKPR	VQFN	RKP	40	3000	330.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2
CC2340R52N0RGER	VQFN	RGE	24	3000	330.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2
CC2340R52N0RKPR	VQFN	RKP	40	3000	330.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2
CC2340R53E0RKPR	VQFN	RKP	40	3000	330.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2
CC2340R53E0RKPR	VQFN	RKP	40	3000	330.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2
CC2340R53N0RKPR	VQFN	RKP	40	3000	330.0	12.4	5.3	5.3	1.1	8.0	12.0	Q2

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

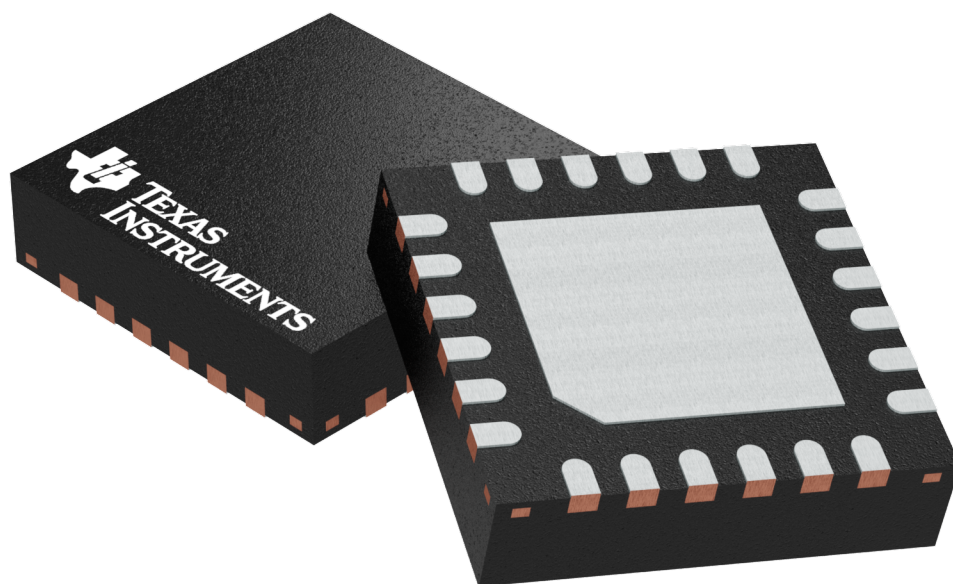
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CC2340R21N0RGER	VQFN	RGE	24	3000	367.0	367.0	35.0
CC2340R22E0RKPR	VQFN	RKP	40	3000	367.0	367.0	35.0
CC2340R22N0RKPR	VQFN	RKP	40	3000	367.0	367.0	35.0
CC2340R52E0RGER	VQFN	RGE	24	3000	367.0	367.0	35.0
CC2340R52E0RKPR	VQFN	RKP	40	3000	367.0	367.0	35.0
CC2340R52N0RGER	VQFN	RGE	24	3000	367.0	367.0	35.0
CC2340R52N0RKPR	VQFN	RKP	40	3000	367.0	367.0	35.0
CC2340R53E0RKPR	VQFN	RKP	40	3000	336.6	336.6	31.8
CC2340R53E0RKPR	VQFN	RKP	40	3000	367.0	367.0	35.0
CC2340R53N0RKPR	VQFN	RKP	40	3000	367.0	367.0	35.0

**RGE 24**

**GENERIC PACKAGE VIEW**

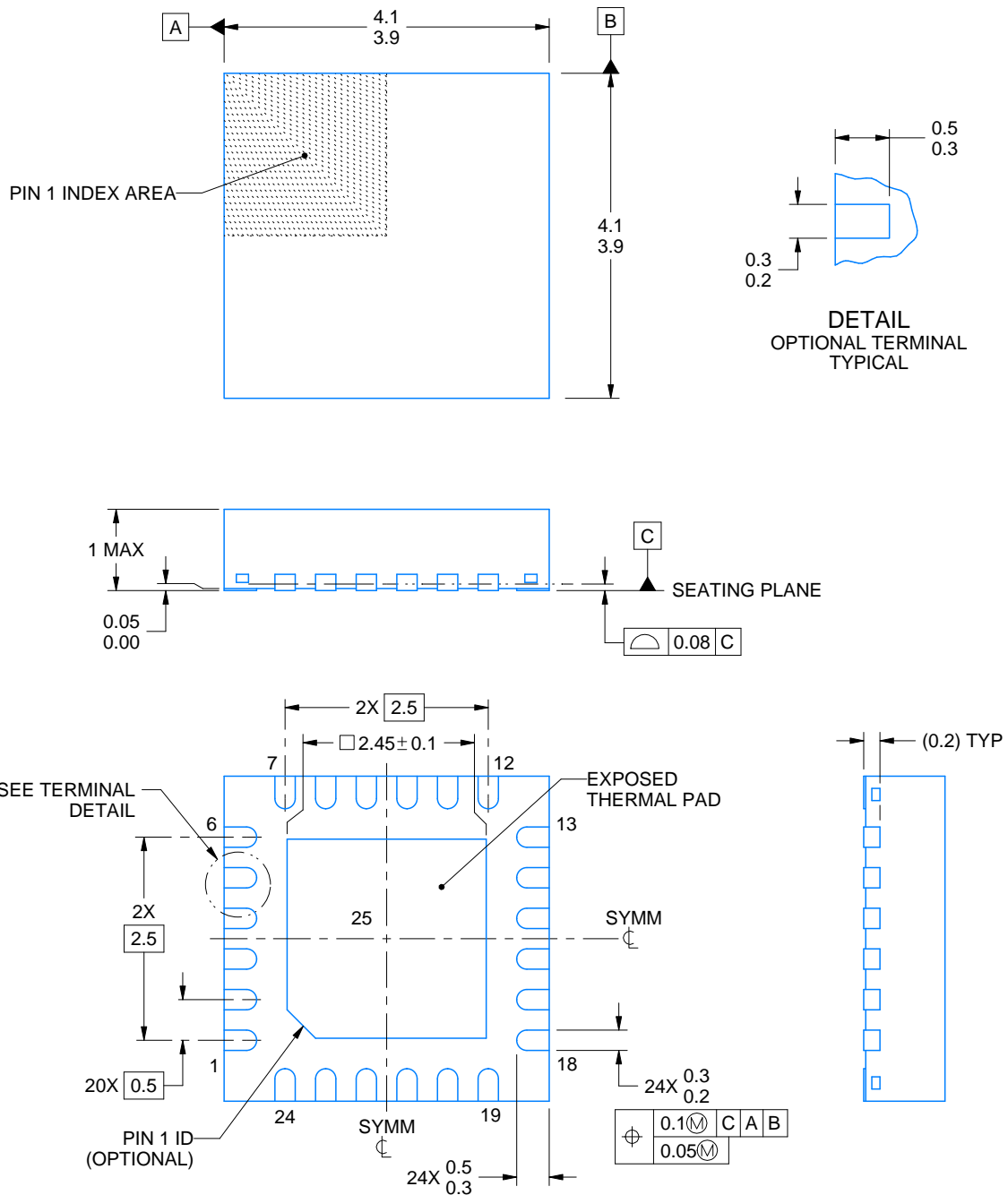
**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4204104/H



4219013/A 05/2017

## NOTES:

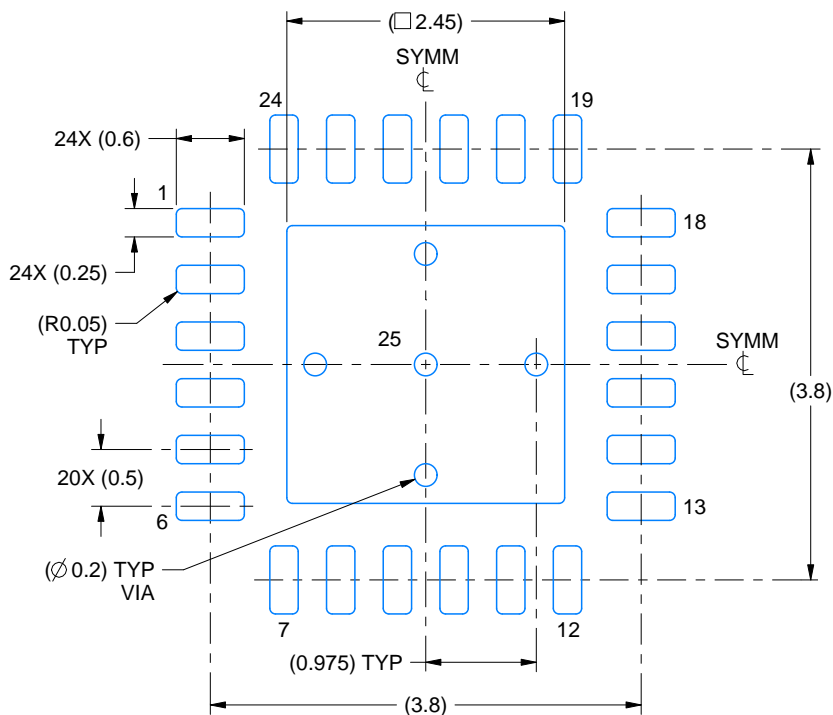
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

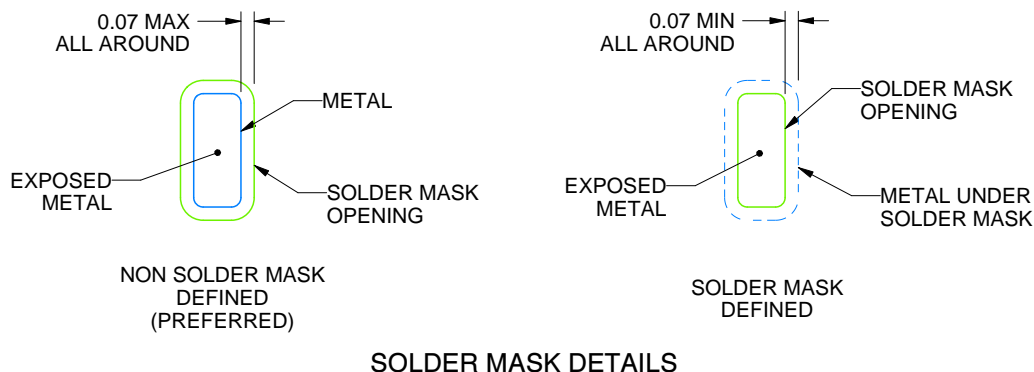
RGE0024B

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

4219013/A 05/2017

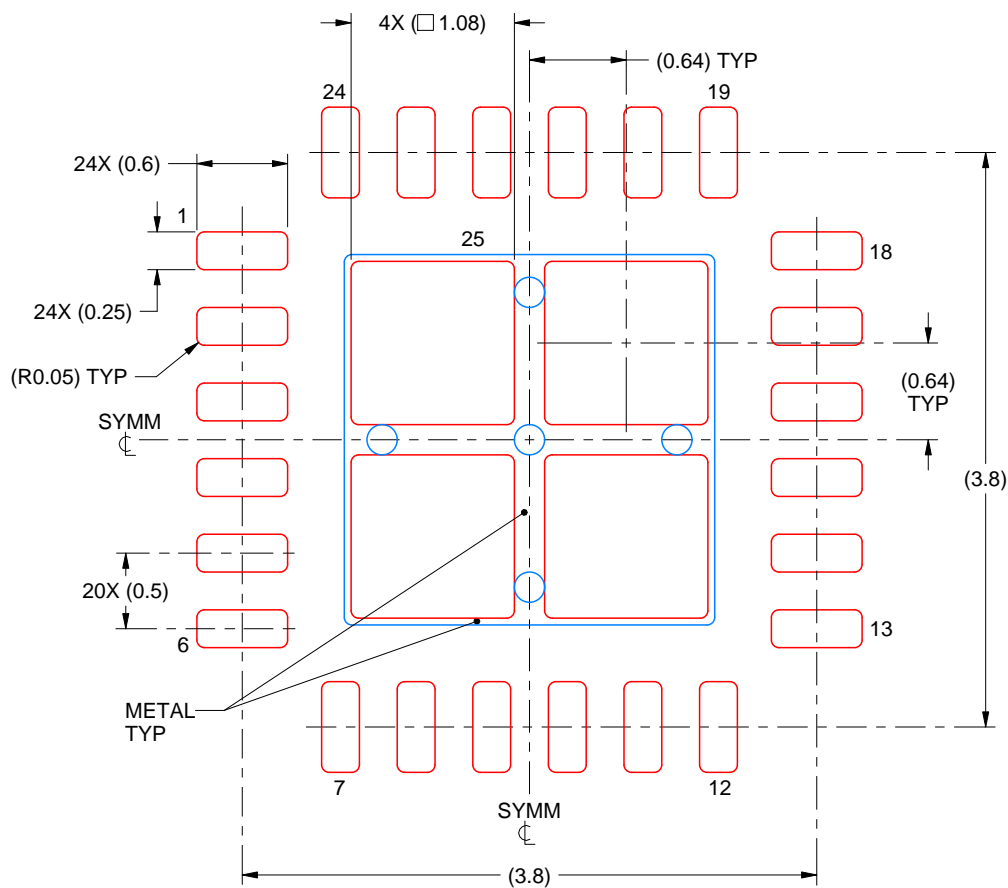
NOTES: (continued)

- 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/sluea271](http://www.ti.com/lit/sluea271)).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

**RGE0024B**

### VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



## SOLDER PASTE EXAMPLE BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 25  
78% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:20X

4219013/A 05/2017

NOTES: (continued)

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

## GENERIC PACKAGE VIEW

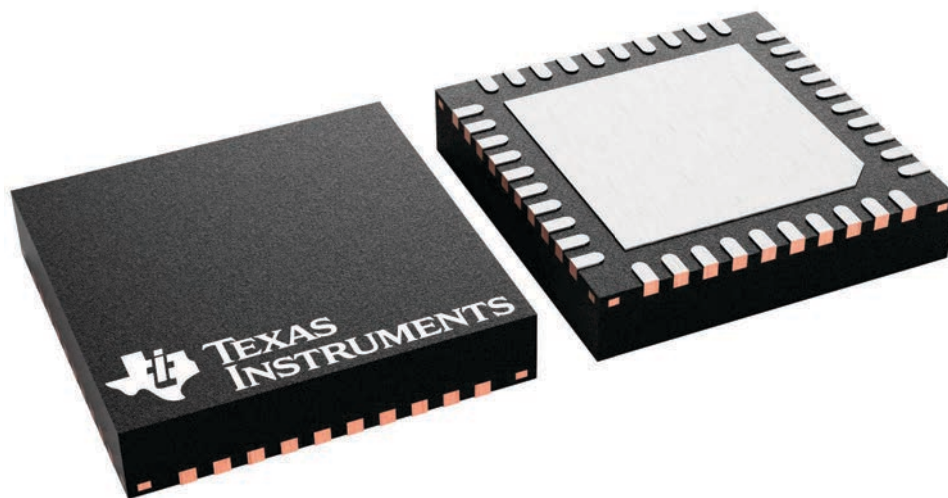
**RKP 40**

**VQFN - 1 mm max height**

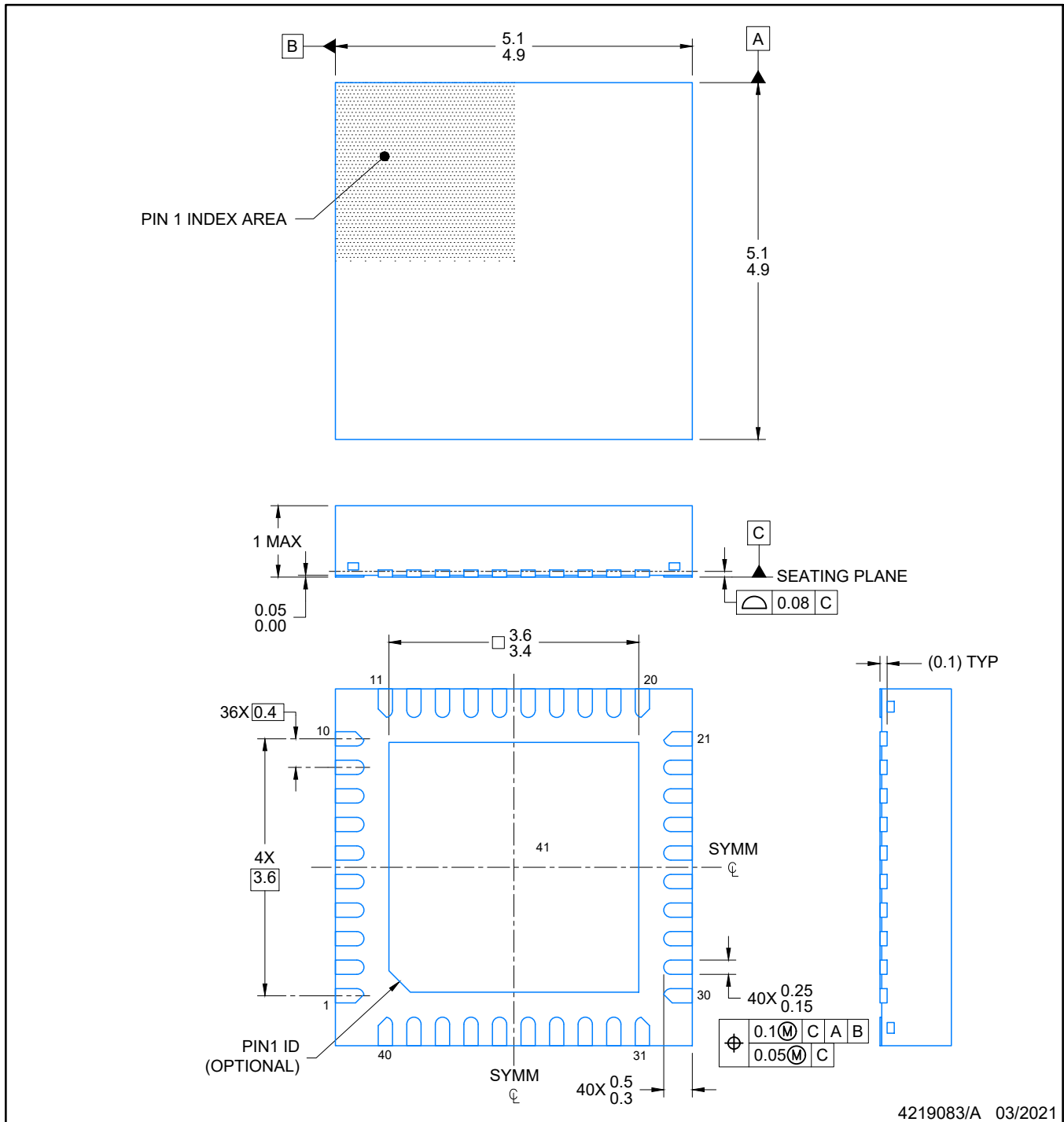
5 x 5, 0.4 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



4229305/A



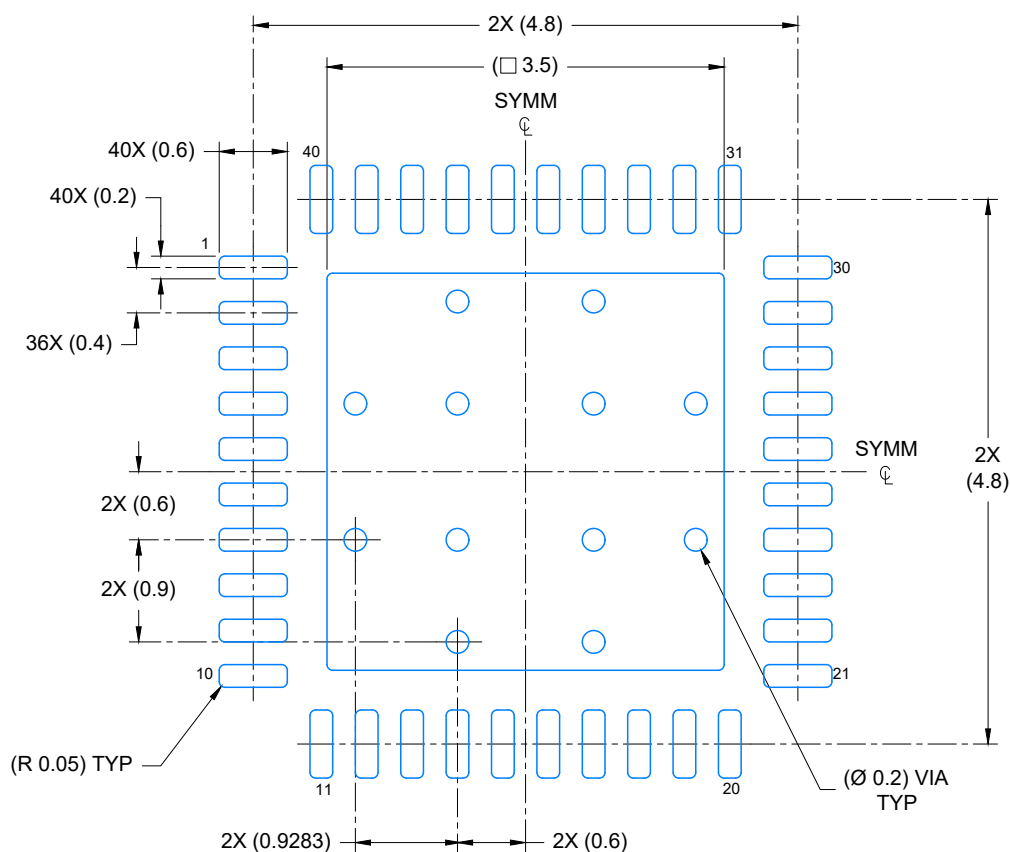
## NOTES:

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. The package thermal pad must be soldered to the printed circuit board for optimal thermal and mechanical performance.

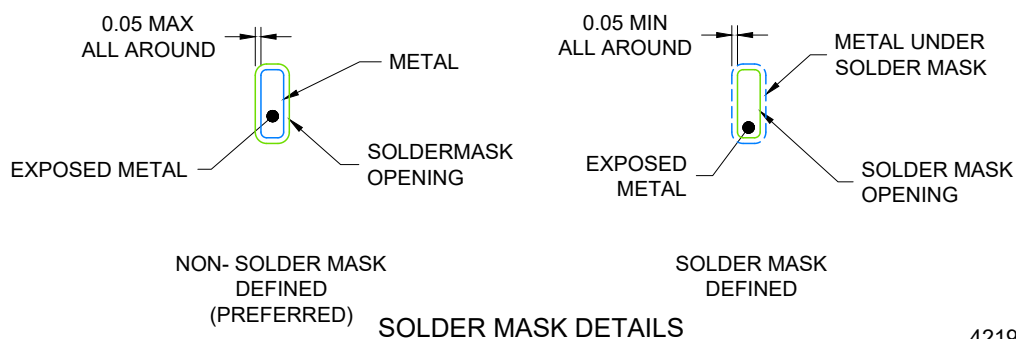
**RKP0040B**

**VQFN - 1 mm max height**

PLASTIC QUAD FLATPACK- NO LEAD



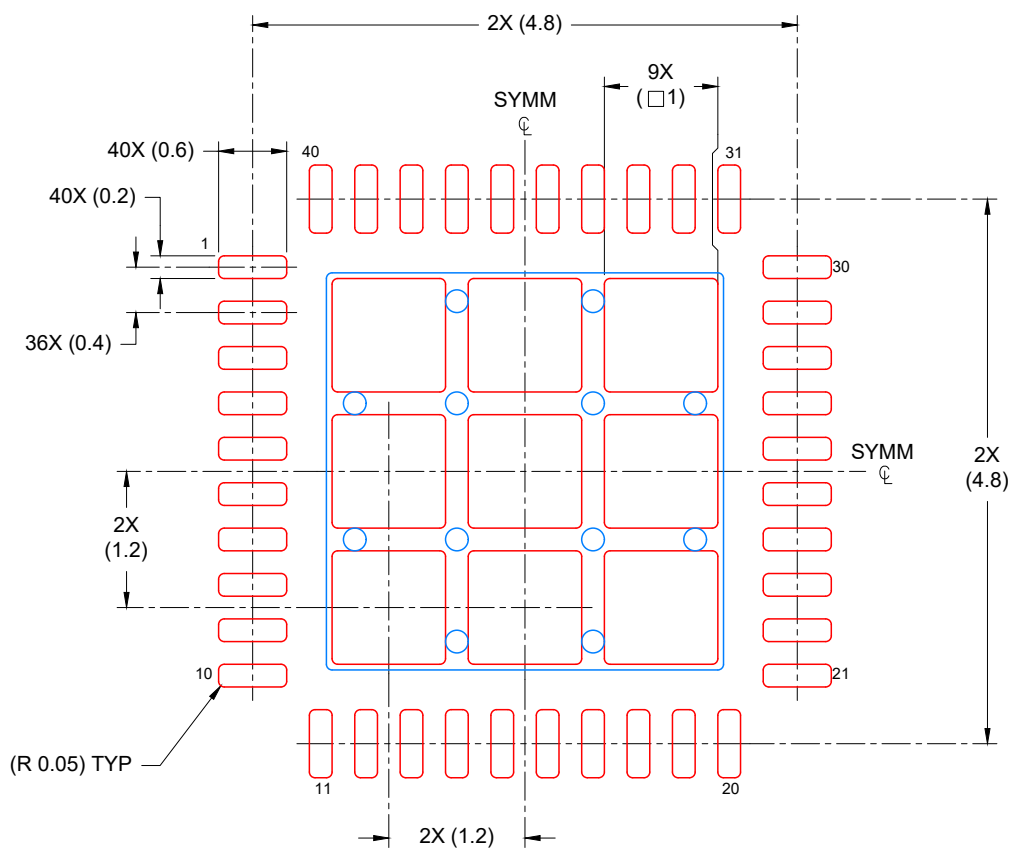
LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 15X



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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](http://www.ti.com/lit/slua271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



SOLDER PASTE EXAMPLE  
 BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD  
 74% PRINTED COVERAGE BY AREA  
 SCALE: 15X

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NOTES: (continued)

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

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