TI SimpleLink™ *Bluetooth*® Smart
CC2640R2 Wireless MCU

Enabling Internet of Things

Introduction

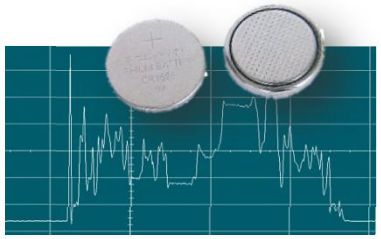
Bluetooth® SMART

Bluetooth Solutions and Branding

Bluetooth low energy (Bluetooth Smart)	Dual Mode Bluetooth	Classic Bluetooth
Bluetooth® SMART	Bluetooth® SMART READY	Bluetooth™
Connect low power applications to a smart phone or tablet	Bluetooth connection across any end point (Bluetooth low energy or classic); enables bridge between Bluetooth low energy (Bluetooth Smart) and classic	Bluetooth connection with high data rate (up to 3Mbps)
		
• Custom profile, allows any application • Multiyear on Coin Cell Battery • Less than 200Kbps data rate	• Supports new and old phones (BT and BLE) • Up to 3Mbps data rate	• A2DP Profile to stream music from phones • Up to 3Mbps data rate

Why use *Bluetooth* Smart?

Multiyear on Coin Cell

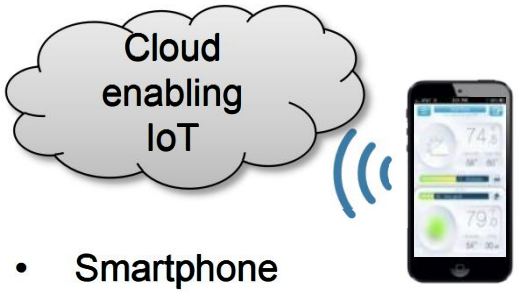


- Low peak currents reduce stress/strain on battery
- Small solution form factor
- Ultra low sleep currents
- Small protocol overhead
- Small payloads

Remote Display and Personalization

- Smart phone instead of local display -> more info, historical data etc
- Over the air upgrades from phone to end equipment
- More intuitive set-up and configuration
- Personal operator/user setup and configuration

Hub to Internet (IoT)



- Smartphone interoperability
- Access your devices from anywhere (through cloud)
- Enables real time aggregated data
- Existing ecosystem of Cloud services
- Push firmware updates

Bluetooth Smart *Target Markets*

Home Automation

Lighting
Home Automation

Industrial

Remote Display
Maintenance
Cable Replacement

Retail

Beacons
ESL / Price Tags
Locationing

Automotive

Remote Keyless Entry
Tire Pressure
Non-critical Sensors

Health & Medical

Thermometer
Patches
Blood Glucose Meter

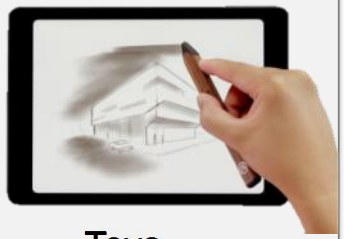
Sport & Fitness

Heart Rate
Speed / Cadence
Watches

HID

Remote Control
Keyboard & Mouse

Toys



Toys
Professional Toys

SimpleLink™

NEW *Bluetooth* Smart device:

CC2640R2

CC2640 R2

TI introduces the next generation platform

Improving the three key challenges for a *Bluetooth* low energy product:

Easiest to design with

- Qualified BT 4.2 Bluetooth Smart
- Get-Started Documentation & Wiki
- Dynamic Design Kits
- Low-cost Tools

Comprahensive Design Support

Lowest Power

- ~ 6mA Radio peaks and 1uA Sleep
- ~ 61µA/MHz ARM Cortex M3
- <10 uA avg. Current @ 1s Conn. Int
- Sensor Controller Engine (SCE)

Multi-year operation on a coin cell

Most Integrated

- 2.7x2.7 WCSP, 4x4, 5x5, 7x7 QFN
- On-Chip Flash
- Single Ended Output
- Integrated DCDC

Complete Bluetooth Smart system on a finger-tip size

"CC2640 puts Smart in Bluetooth SMART"

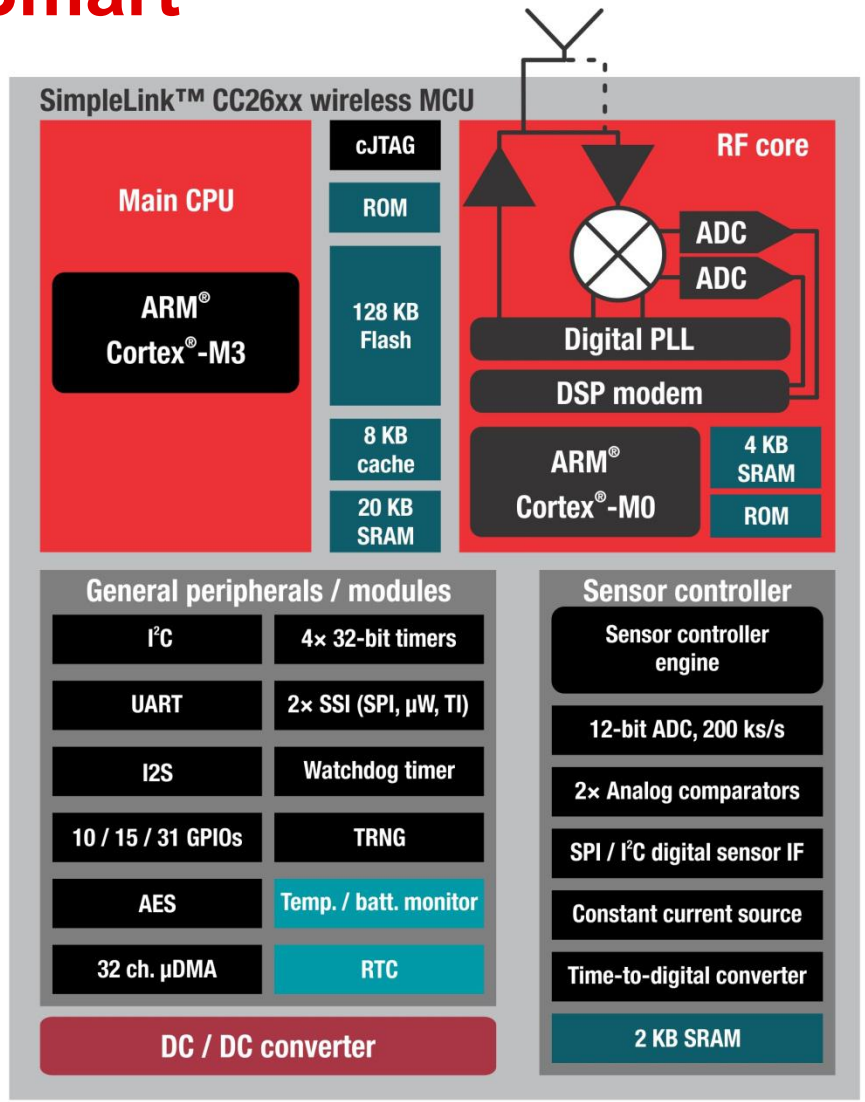
SimpleLink™ *Bluetooth*® Smart
CC2640R2 wireless MCU

Quick Facts

Ultra-low Power Consumption
- 61 µA/MHz ARM Cortex M3
- 8.2 µA/MHz Sensor Controller
- 1 µA sleep with retention and RTC
- 5.9 mA RX (single-ended)
- 6.1 mA TX (single-ended)

SoC Key Features
- Autonomous sensor controller engine
- 4x4 mm to 7x7 mm QFN
- 1.7 – 3.8 V supply range
- 128 kB Flash + 8 kB Cache
- 20 kB RAM

RF Key Features
- +5 dBm output power
- -97 dBm sensitivity



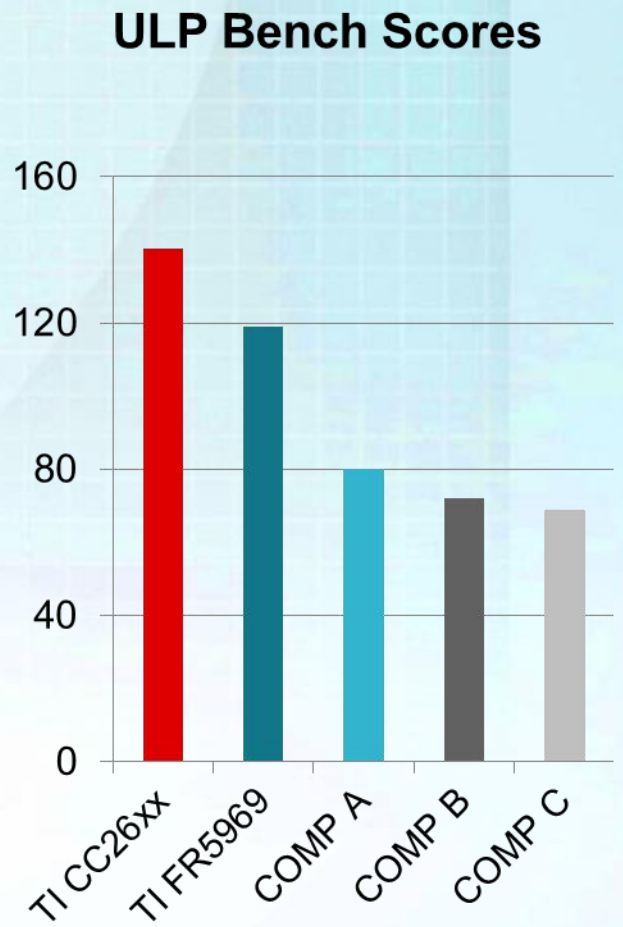
Target applications
- IoT – Connect cloud devices or directly to mobile phone tablets
- Home and building Automation – security systems, lighting
- Health, Medical, Fitness, Wearables
- Retail - Locationing, Beacon
- Smart Grid – Battery operated devices

The lowest power: Go battery-less

Designed for low-power operation

- Multi-year on a coin cell
- Faster processing
- Optimized radio
- Ultra low sleep current
- Less than 0.15 µA in shutdown
- Unique integrated Sensor Controller

Ultra-low power		
When	**Parameter @ 3V**	**Value**
While processing	µA/MHz on ARM® Cortex®-M3	61 µA/MHz
	Coremark/mA	48.5
	Coremark @ 48MHz CPU	142
While communicating	Peak current RX	5.9 mA
	Peak current TX	6.1 mA
While sleeping	µA/MHz on Sensor Controller	8.2 µA/MHz
	Sleep mode with RTC and full memory retention	1 µA
Best-in-class ULPBench score of 140.2		



Development Kits *CC2640R2 (based on CC2650)*

CC2650DK
$299

C2650EMK
$99

CC2650STK
$29

Full feature development kit with embedded TI XDS emulator for development and debugging.

SmartRF06 Features:

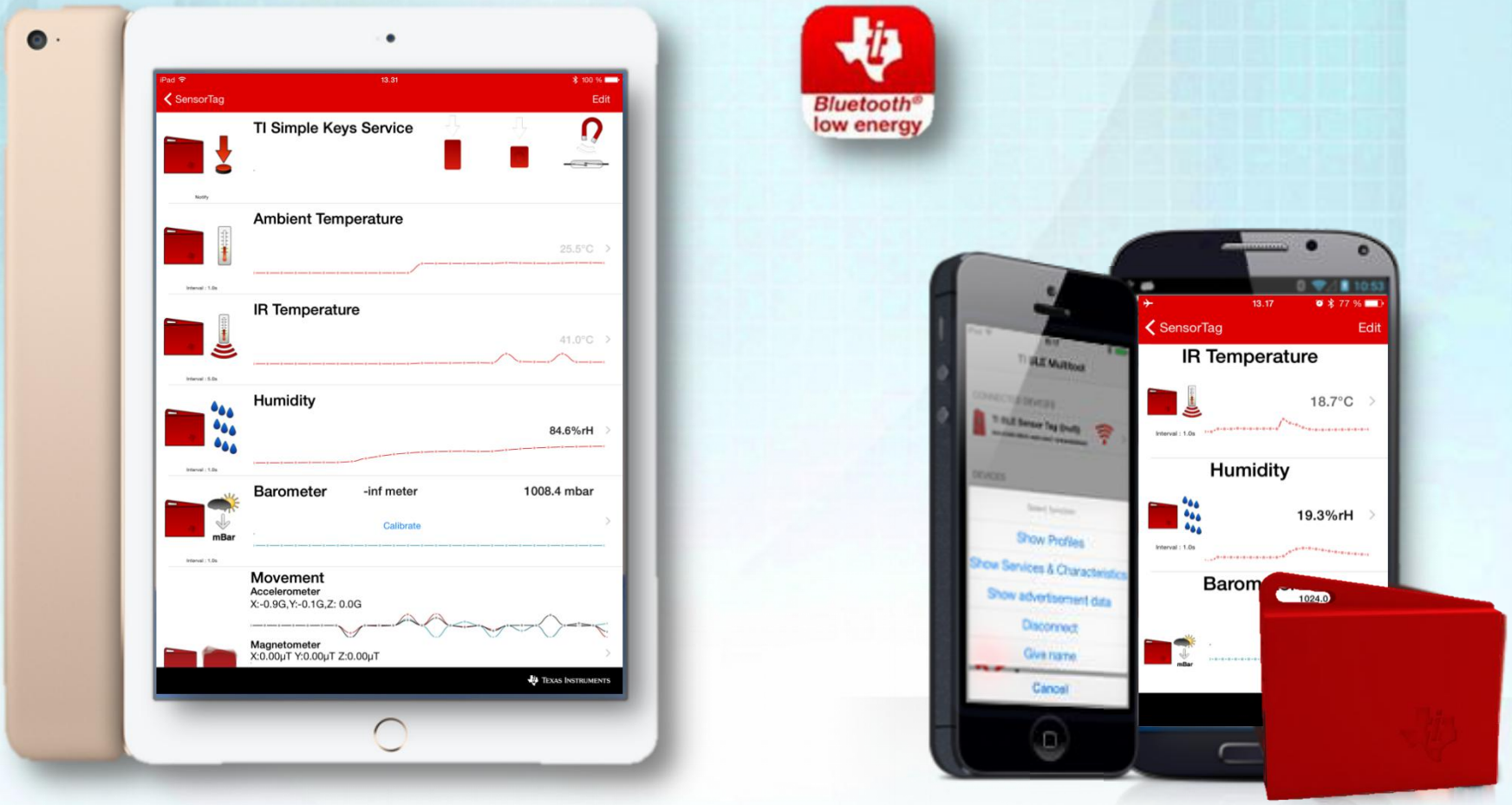
- Dot matrix LCD
- 4 LEDs
- 5 buttons
- Accelerometer
- Ambient Light Sensor
- UART backchannel
- Micro SD card reader
- I/O breakout headers

Powered by CR2032 Coin Cell Battery
Native sensor support for:

- 6-axis MEMS motion tracking (Invensense)
- Humidity (TI)
- IR temperature (TI)
- Light Sensor (TI)
- Buzzer (Changzhou Tianyin)
- Microphone (Knowles)
- Pressure (Bosch)
- Reed Relay (Meder)

Dev. Pack for custom functionality.
Supported by accompanying iOS/Android apps

Small, Simple & Splendid for the IoT – next generation SimpleLink™ **SensorTag**!

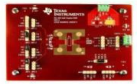


SensorTag – IoT made easy

- $29 Complete IoT development kit
- Access Sensor data in the cloud in 3 minutes
- 9 Low Power Sensors
  - 1 year battery life
- Expandable with DevPacks
  - Lowest cost $15 debugger
  - Watch/Display
  - LED/Audio
  - Interchangable between SensorTags
- Complete designs at www.ti.com/tidesign
  - Including 3D files
  - Print your own SensorTag

Existing Bluetooth Smart TI Designs

Bluetooth® Low Energy


RS-485


Haptic Feedback


Gas Sensor


Keyfob


Light Harvesting


BLE Light


Postage Stamp

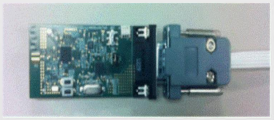

Long Range


Mini Broadcaster


Biometric Wheel


USB Dongle


SensorTag iBeacon


Heart Monitor


Body Composition


Optical Heart Rate


Weight Scale


Pulse Oximeter

CC2640R2: Reduce your time to market

Easy to design with: Do your final prototype within 10 days (checkout the wiki)

Get Started

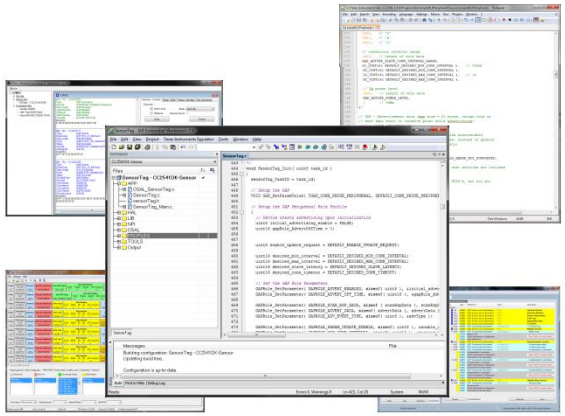
- Order Kit
- Download SDK
- Evaluate & Learn *Bluetooth* low energy

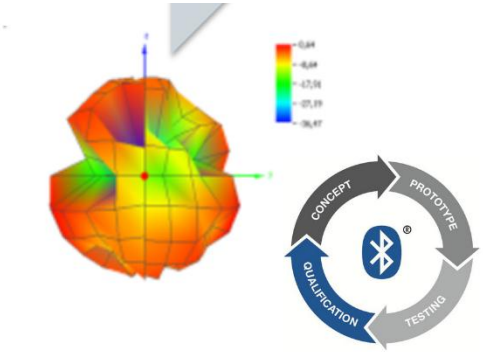
Develop

- Define Application
- Choose/Design Profiles
- Implement Prototype

Test & Release

- FCC/ETSI Certification
- *Bluetooth* Listing





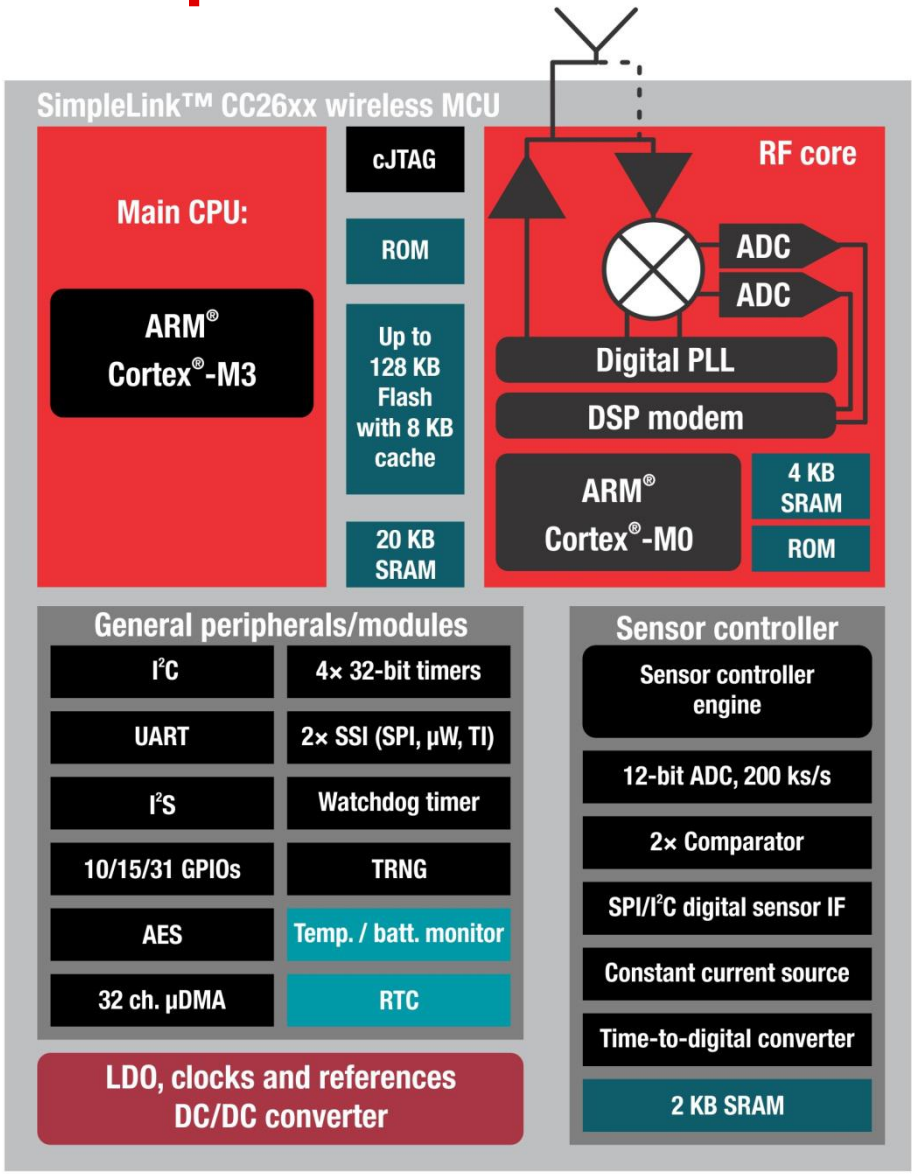
Extensive Online Knowledge Base & E2E Support – ti.com/ble-forum

SimpleLink™

CC2640R2 Bluetooth Smart

Technical introduction

SimpleLink CC2640R2 *Architecture*



Quick Facts

Ultra-low Power Consumption
- 61 µA/MHz ARM Cortex M3
- 8.2 µA/MHz Sensor Controller
- 1 µA sleep with retention and RTC
- 5.9 mA RX (single-ended @ -96 dB sensitivity)
- 6.1 mA TX (single-ended @ 0 dBm output)
- <3uA while running 10 ADC samples/s

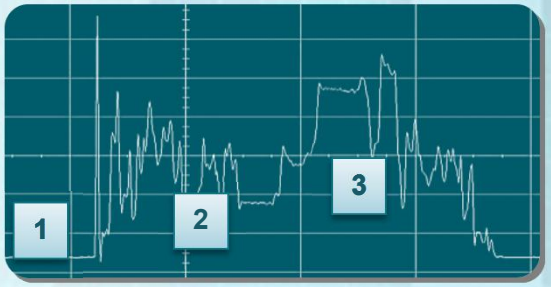
SoCKey Features
- Autonomous sensor controller engine
- 4x4, 5x5, and 7x7 mm QFN
- 1.7 - 1.95 V or 1.8 – 3.8 V supply range
- 128 KB Flash + 8 KB Cache
- 20 KB RAM

RF Key Features
- +5 output power
- -97 dBm sensitivity
- Single ended or differential output

Power Consumption

Low average power consumption

1. When in Standby (with RTC and RAM retention)
2. When processing with MCU
3. When radio is in Receive or Transmit
4. When peripheral is polled for data

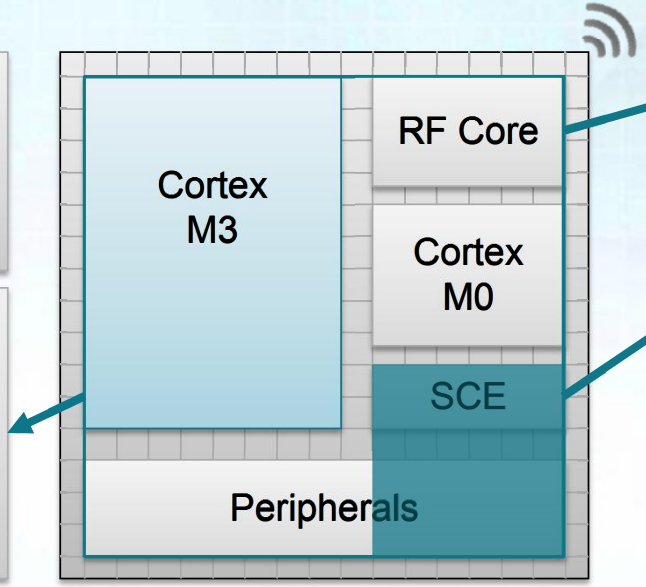


1 Standby Current

- **1 µA** Standby with RTC and full retention
- Less than **0.15 µA** in Shutdown

2 ARM Cortex M3

- Fast processing using less than **3 mA** @ 48MHz
- Less time used for stack and application processing and BLE connection events



3 Radio

- **~6mA** RX / TX current

4 Sensor Controller Engine

- Sensor controller and its peripherals can be powered while rest of system is power off.
- Run Sensor Reading with **< 5 µA** current consumption

Sensor Controller Engine *(SCE)*

A proprietary low power CPU to offload the M3

Key features

- Handles sensor polling and performs simple processing
- Operates while the rest of the system is in powered down

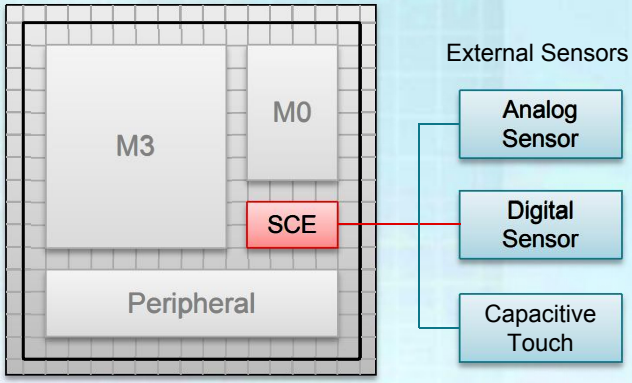
Examples of sensors that will greatly benefit from using the Sensor Controller:

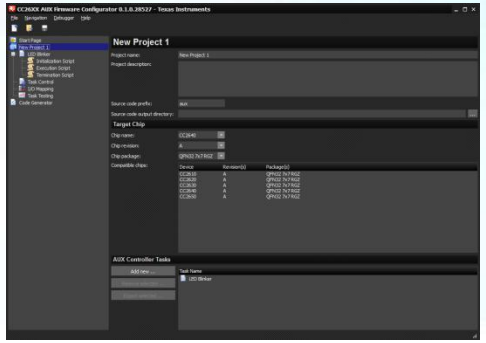
- PIR (motion detector)
- Capacitive touch keys
- Proximity sensors
- Accelerometers
- ADC measurements
- Pulse counting

- Use Sensor Controller Studio for configuration

Data Sheet – Key Features

- Autonomous 16-bit RISC CPU
- 2 KB SRAM (code + data)
- Clock Frequency:
  - 32kHz-24MHz
  - 8.2uA / MHz





Radio Frontend *Flexibility*

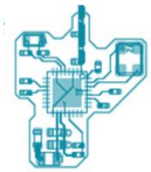
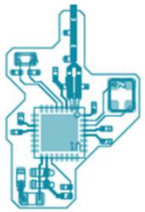
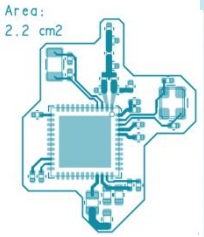
Best Performance

- Differential, external bias
- 5 dBm output power
- -97 dBm BLE sensitivity

Smallest Footprint

- Single ended, external bias
- 2 dBm output power
- -96 dBm BLE sensitivity

Other options are available. Internal biasing reduces BOM by one inductor at the cost of 1 dB sensitivity

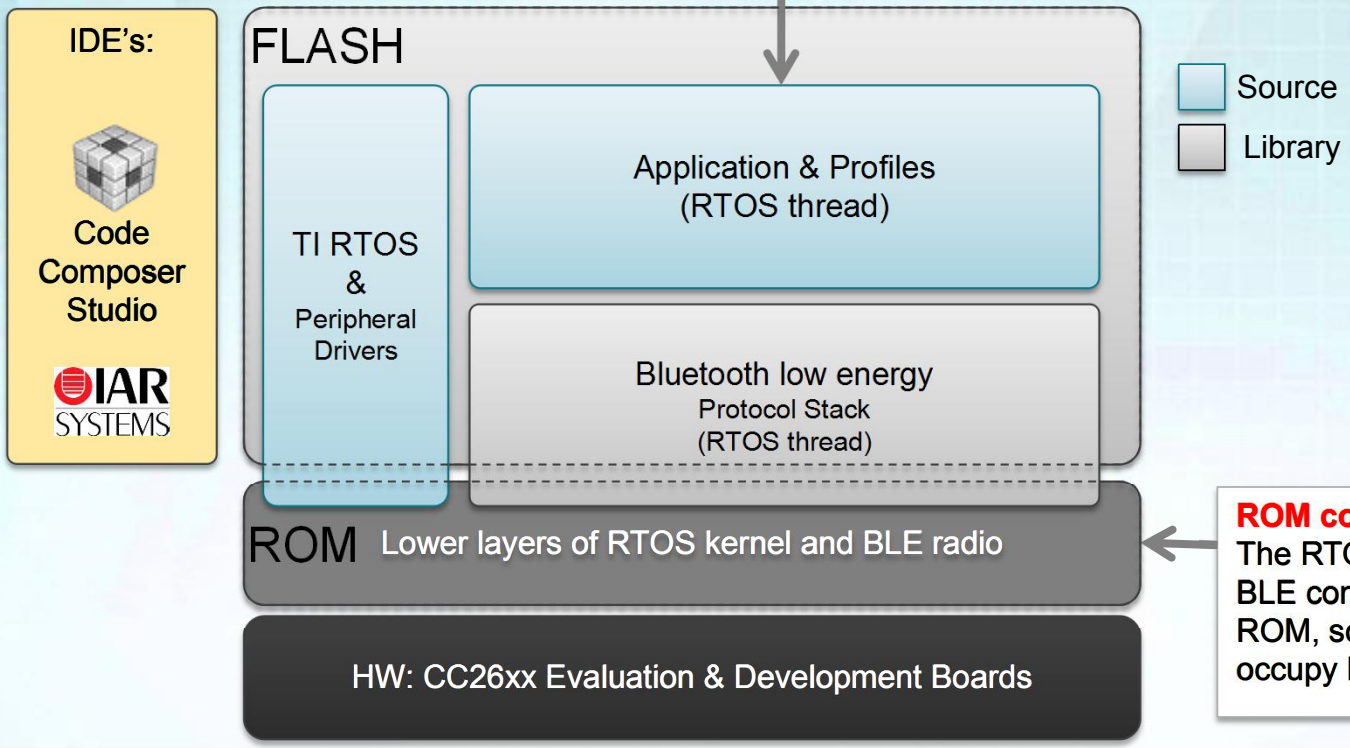
		CC2650EM-4XD	CC2650EM-5XD	CC2650EM-7ID
Evaluation Module				
CC2650 Package Type		4x4	5x5	7x7
Pitch [mm]		0.4	0.5	0.5
GPIOs		10	15	31
Design Example	RF Frontend Option	Single Ended External Bias	Differential External Bias	Differential Internal Bias
	Area [cm²]	1.3	1.5	2.3
	Illustration			
	Crystals	2	2	2
	Capacitors	14	17	18
	Inductors	3	6	5
	Resistors	1	1	1
	Total	**20**	**26**	**26**

NB! Differentiel External bias is not supported on 7x7

Software Platform *CC2640R2*

Royalty free from TI, ready for application development

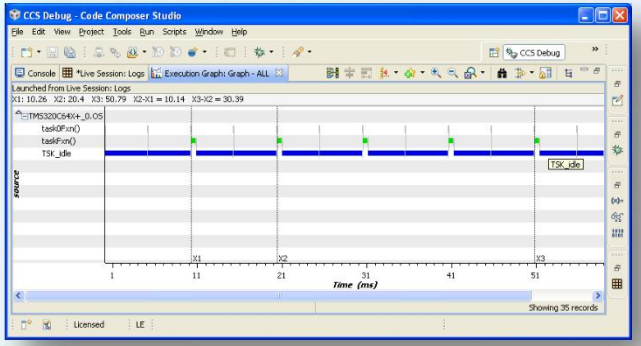
Over-the-air download
The FLASH can be partially updated over-the-air, which means that the application can be updated separately from the BLE stack.



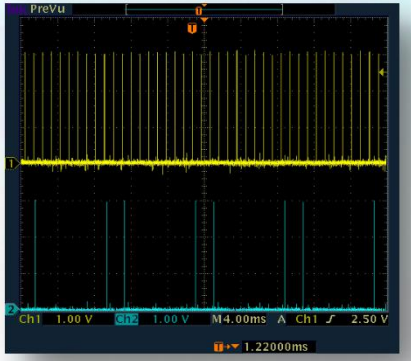
ROM code
The RTOS kernel and parts of the BLE controller are stored in CC2640 ROM, so these components do not occupy FLASH space.

TI-RTOS *Flexible Software Solution*

- Real Time Operating System (RTOS)
  - Pre-emptive multi-threading
  - Deterministic scheduler
  - Tailored SYS/BIOS Kernel
- Zero-latency interrupts
  - Hardware: Timer fuctions
  - Software: Clock functions (Ex. One shot or periodic timer)
- Semaphores
  - Task Synchronization
- Peripheral Drivers
  - GPIO, I2C, SPI, UART, WATCHDOG, LCD
- Power policy manager
  - Handles power managment



System analyzer



BLE-Stack™ v1.35

- **Mature and Robust Software Package**
  - Golden unit for Bluetooth low energy interoperability test
  - Fully BT 4.2 Qualified Solution

Example Application	Description
SimpleBLEPeripheral	Generic Peripheral using proprierary Profile example
SimpleBLECentral	Generic Central
SimpleBLEBroadcaster	Generic Broadcaster
SimpleBLEObserver	Generic Observer
SensorTag	SensorTag 2.0 Firmware
HostTestApp	Wireless Network Processor (Application via SPI/UART)
BloodPressure	Example using Blood Pressure Profile (BSP)
CyclingSensor	Example using Cycling Speed and Cadence Profile (CSCP)
GlucoseCollector	Example using Glucose Profile (GLP) as Collector
GlucoseSensor	Example using Glucose Profile (GLP) as Sensor
HeartRate	Example using Heart Rate Profile (HRP)
HIDEmuKbd	Example using HID over GATT Profile (HOGP)
ProximityTag	Example using Proximity Profile (PXP)
RunningSensor	Example using Running Speed and Cadence Profile (RSCP)
Thermometer	Example using Health Thermometer Profile (HTP)
TimeApp	Example using Time Profile (TIP)

Additional Services

Proprietary
Accelerometer
Barometer
Gyrometer
Humidity
IR Temperature
Magnetometer
Movement
Optics
Connection Control
Simple Keys

BT SIG Adopted
Find me
Alert Notification
Battery Status
Device Information

Software tools *CC2640R2*

BTool

Run and test all possible *Bluetooth* low energy functionality controlled from the PC tool.

BLE Device Monitor

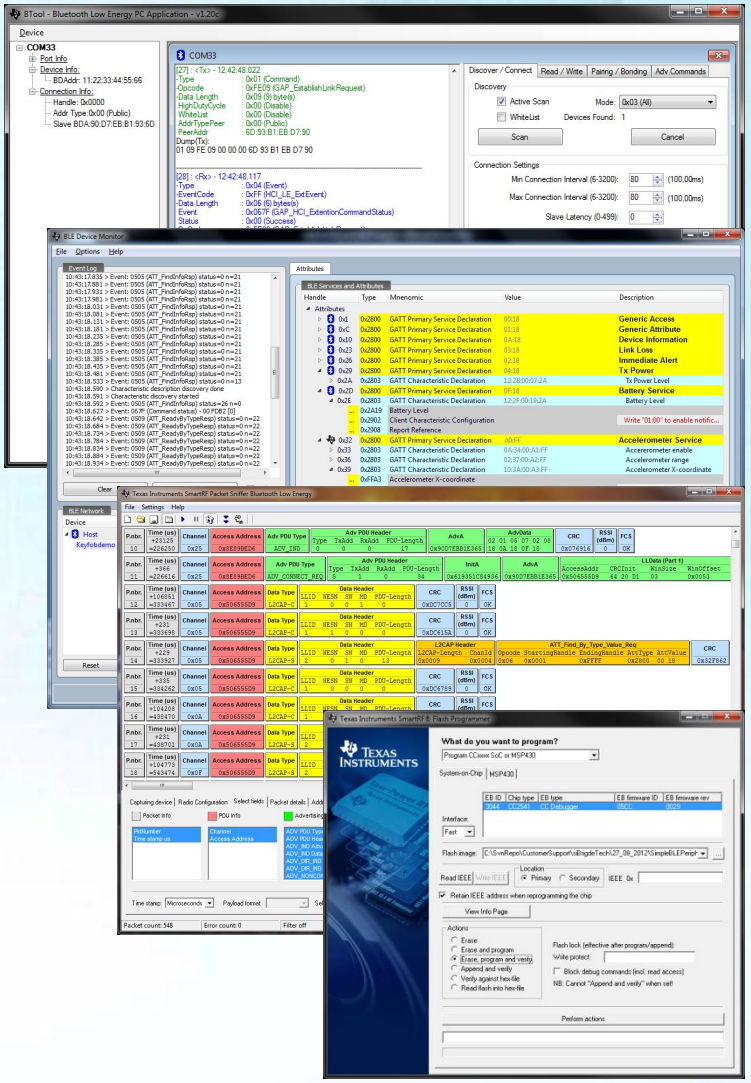
Provides an intuitive and graphical way to explore *Bluetooth* low energy Services and Characteristics.

SmartRF™ Protocol Packet Sniffer

Capture Bluetooth low energy communication live with full overview.

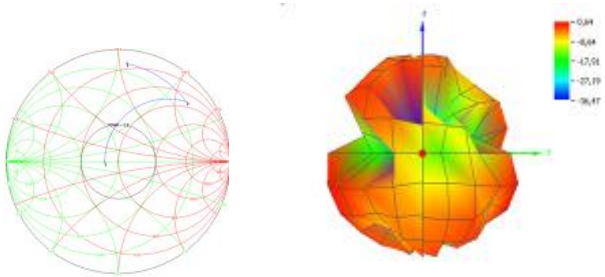
SmartRF™ Flash Programmer

Program devices and Read/write IEEE addresses



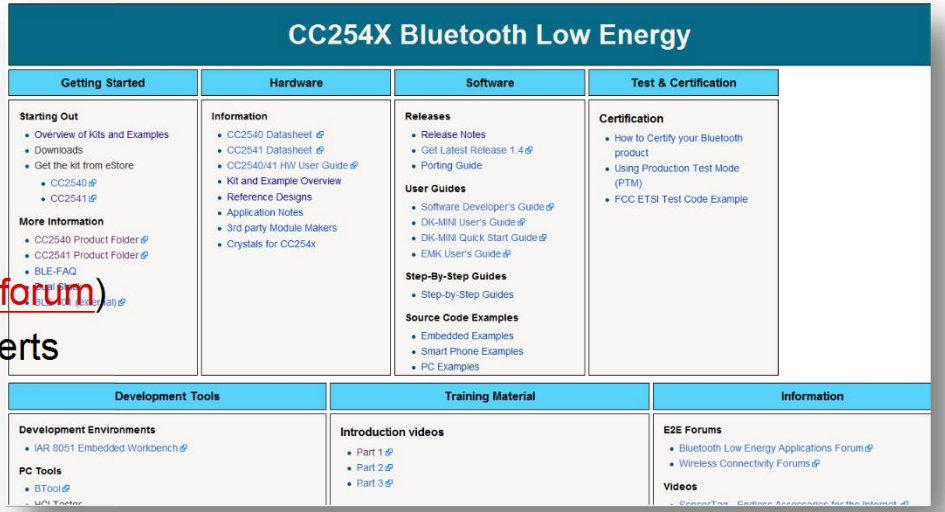
Bluetooth low energy *Support*

- Guides included in the BLE installer
  - Software Developers Guide
  - Sample Applications Guide
  - Vendor Specific HCI Guide

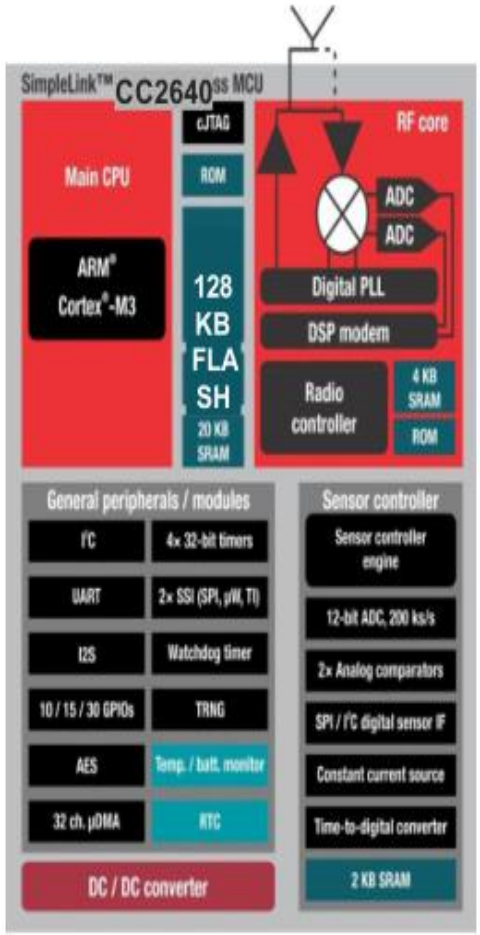


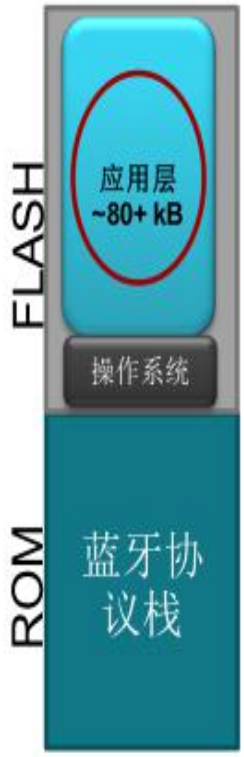
- Online documentation (**www.ti.com/ble-wiki**)
  - Code Examples
  - Training videos
  - Walkthorugh Guides

- Online E2E Support Community (www.ti.com/ble-forum)
  - Supervised by TI Software and Hardware Experts



德州仪器超低功耗蓝牙芯片CC2640R2特点





TI CC2640R2

- 80k+ 用户可编程空间
- 与CC2640蓝牙芯片管脚兼容
- 固化蓝牙4.2协议于芯片内部ROM区域
- 支持蓝牙4.2所有特性
  - (大数据传输，ECDH秘钥交换，隐私保护)
- 硬件支持蓝牙5.0
  - (远距离传输,2Mbps数据传输,Mesh组网)
- 工业界射频性能最好的蓝牙芯片
- 三核融一，助力高性能超低功耗蓝牙应用开发
- 多种封装，2.7x2.7 WCSP，4x4，5x5，7x7 QFN
- 无需外挂32768赫兹晶振
- 多种射频输出方式：单端或者差分
- 支持多连接协议,可同时连接多个主设备或者从设备[7]