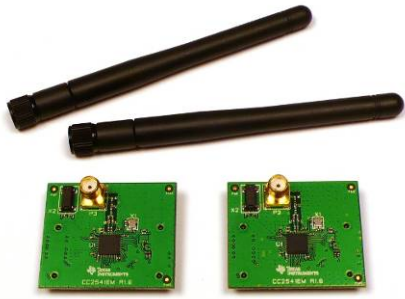


# CC2541 Evaluation Module Kit Quick Start Guide

## Opening the Box and Running the *Bluetooth*® Low Energy SimpleBLE Demo Application

### 1. Kit Contents



- 2 x CC2541 Evaluation Modules
- 2 x Pulse W1010 Antennas
- Documentation

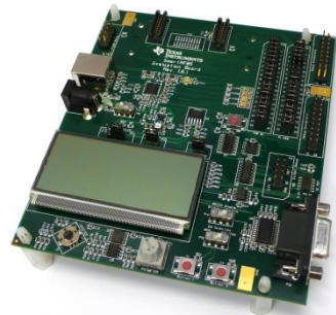
The kit is FCC and IC certified and tested/complies with ETSI/R&TTE over temperature from 0 to +35°C. The antenna, W1010 from Pulse, is a ¼ wave dipole antenna with 2 dBi gain.



**Caution!** The kit contains ESD sensitive components. Handle with care to prevent permanent damage.

### 2. Hardware Requirements

The CC2541EMK is an add-on kit to the CC2540DK. To run the example described in this Quick Start Guide, you would need two SmartRF05 Boards (Rev 1.8.1 or later). These boards are included in the CC2540DK (and not in the CC2541EMK).



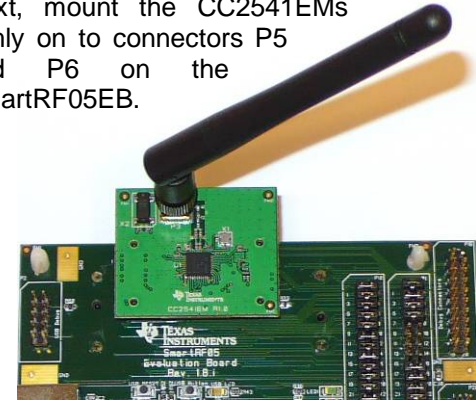
More information about the SmartRF05EB can be found in [www.ti.com/lit/swru210](http://www.ti.com/lit/swru210).

The CC2541EM boards can also be plugged into a battery board (see [www.ti.com/tool/soc-bb](http://www.ti.com/tool/soc-bb)) for standalone operation.

### 3. Hardware Setup

Connect the antenna to the SMA connector on the CC2541 evaluation module (CC2541EM). Tighten the antenna's screw firmly on to the SMA connector. If not properly connected, you might see reduced RF performance.

Next, mount the CC2541EMs firmly on to connectors P5 and P6 on the SmartRF05EB.



**Caution!** To minimize risk of injury, avoid touching components during operation if symbolized as hot.

### 4. Power Options

There are several ways of applying power to the SmartRF05EB.

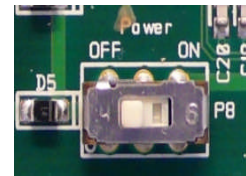
- 2 x 1.5 V AA Alkaline Batteries
- USB
- External Power Supply

For the batteries and USB, there are voltage regulators on the SmartRF05EB that will set the on-board voltage to 3.3 V. The external power supply should set a voltage that does not exceed 3.3 V. **Note that there should only be one active power source at any one time.**

**Warning!** To minimize risk of personal injury or property damage, never use rechargeable batteries to power the board.

### 5. Power the Boards

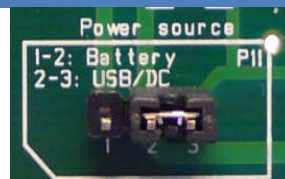
Find jumper P11 on the top side of each SmartRF05EB. This jumper is used to set the power source for the board. Set P11 to "1-2" if you are using battery power. Set P11 to "2-3" if you are using USB or an external power supply.



Once you have set P11, find switch P8 on the top side of each

SmartRF05EB. To power up the boards, flip the switch from the "OFF" position to "ON".

**Do not leave EVM powered when unattended.**



### 6. Start-up Screen

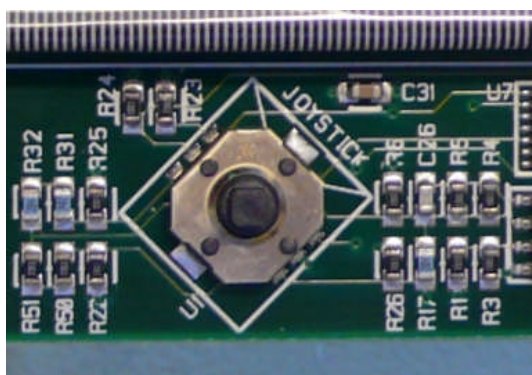
One of the CC2541EMs will be pre-loaded with the SimpleBLECentral application, while the other will be pre-loaded with the SimpleBLEPeripheral application. The LCD screens on the two SmartRF05EBs should display messages similar to those below:



The "0x..." value displayed on each board is the device address. Every CC2541 device has a unique address.

### 7. Using the Joystick

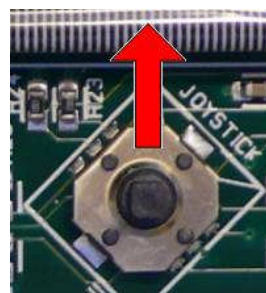
The SimpleBLEPeripheral application runs autonomously and does not require any user interaction. The SimpleBLECentral application, however, requires user interaction by means of joystick U1. Find joystick U1 on the top side of the SmartRF05EB, immediately below the LCD.



The joystick has five different movements: it can be moved up, down, left, right, and it can be pressed in, just like a button. Each movement performs different actions depending on the state of the device.

### 8. Device Discovery

Before the two devices can connect, the central device must first discover the peripheral device. To perform device discovery, press up on joystick U1 once. The LCD on the central device should display "Discovering...".



After a few seconds, it should display "Devices Found 1 / <- To Select". This means that the central device successfully discovered the peripheral. Press left on joystick U1 to view the address of the peripheral device. This address should match the address seen on the peripheral's LCD.



### 9. Establish Connection

To establish a connection with the peripheral, press joystick U1 in towards the board (push it in like it is a button). Once the connection is established, the central device will automatically perform service discovery on the peripheral using the BLE GATT protocol. This should complete within a few seconds.

The two LCD screens should appear as in the images below, with the central still displaying the peripheral's address and the peripheral having changed from "Advertising" to "Connected":

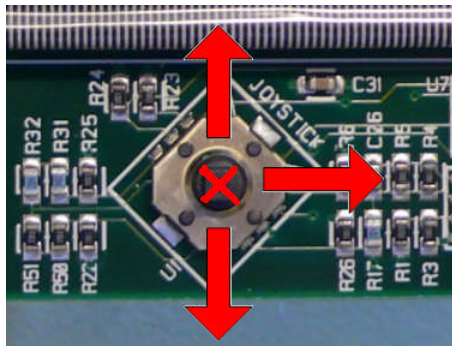


Be careful that you don't double tap U1 which would terminate the connection immediately, giving *Disconnected Reason: 22*.

## 10. Connected Operations

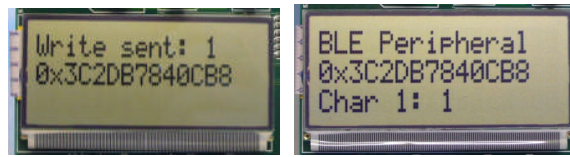
Once the connection has been established and service discovery is complete, you can perform the following operations using joystick U1 on the central device:

- Read / Write Data – U1 **UP**
- RSSI Monitoring – U1 **DOWN**
- Connection Parameter Update – U1 **RIGHT**
- Terminate Link – U1 **IN** (towards the board)



## 11. Read / Write Data

Pressing up on U1 will send a read request to the peripheral device. One byte of data will be read, and the value will be displayed. Pressing up again will send a write request, and one byte of data will be written to the peripheral. The peripheral's LCD should display the written value each time this is done.

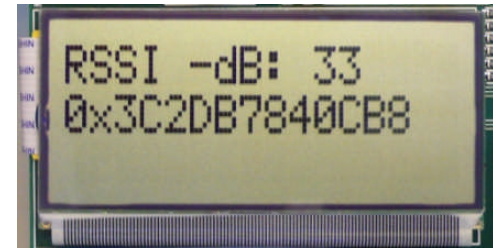


Bluetooth low energy is an ideal technology for transmission of small amounts of data between two devices while consuming very little power, as is demonstrated here.

Continuing to press up on the joystick will alternate between reads and writes, with the value incrementing each time.

## 12. Monitor RSSI

Pressing down on U1 will turn on RSSI (received signal strength indication) monitoring. The RSSI will be displayed on the LCD in units of negative dBm.



If the boards are moved farther apart from each other, the RSSI will drop (since the value is negative, a higher number means lower RSSI). If they are moved closer together, the RSSI should rise.

Pressing down on U1 again will turn off RSSI monitoring.

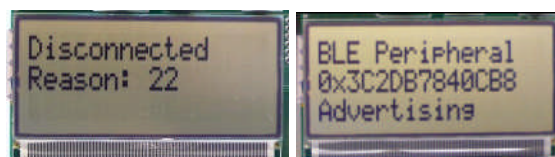
## 13. Connection Parameter Update

Pressing right on U1 will send a connection parameter update request to the peripheral to use a longer connection interval. This will result in much longer latency when performing data reads and writes; however the power consumed by both devices is significantly reduced.



## 14. Terminate Link

Pressing U1 in towards the board will terminate the link. The peripheral will return to an advertising state. The central device will display a "Reason" code, which indicates why the disconnection occurred (values are defined in the BLE stack API).



In this case, the reason code of 22 indicates that the link termination was initiated by the central device. In the event that the peripheral device goes out of range or has power disconnected from it, you will see a reason code of 8 which indicates that a link timeout has occurred.

You can now perform device discovery and re-connect to the peripheral if desired.

## 15. SimpleBLE Demo Source Code

The project and source code files for these applications (as well as many others) are included with the Bluetooth low energy (BLE) stack from Texas Instruments, which can be downloaded at [www.ti.com/blestack](http://www.ti.com/blestack).

The two projects implementing this demo are called SimpleBLECentral (CC2541EM Master configuration) and SimpleBLEPeripheral (CC2541 Slave configuration). These can be modified as desired, and should provide a good framework for developing your own custom BLE applications.

More details on these projects can be found within the BLE Software Developer's Guide, which is included with the stack.

## Additional Tools and Links

### BLE Packet Sniffer

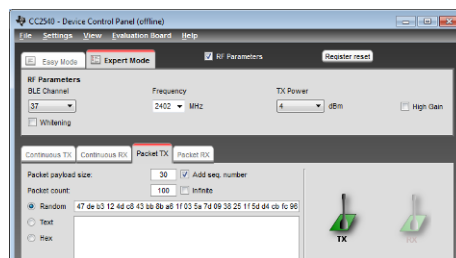
A CC2540 USB Dongle (not included) can be used as a BLE sniffer and monitor packets while the SimpleBLE Demo is running.



The SmartRF Protocol Packet Sniffer software can be downloaded from [www.ti.com/packetsniffer](http://www.ti.com/packetsniffer)

### SmartRF™ Studio

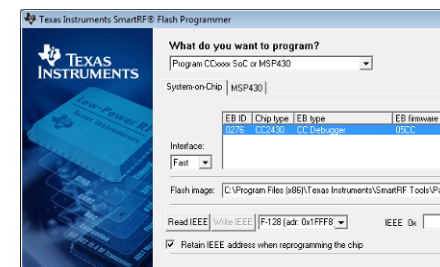
SmartRF Studio allows you to configure the radio, run RF performance tests, and run link tests between the two SmartRF05EBs.



SmartRF Studio can be downloaded from [www.ti.com/smarterfstudio](http://www.ti.com/smarterfstudio)

### SmartRF Flash Programmer

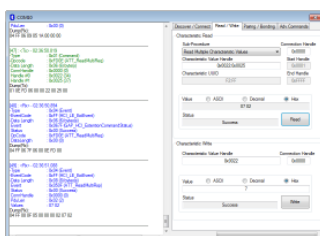
Texas Instruments has a simple tool which can be used to program and flash the CC2541



SmartRF Flash Programmer can be downloaded from [www.ti.com/tool/flash-programmer](http://www.ti.com/tool/flash-programmer)

### BTool

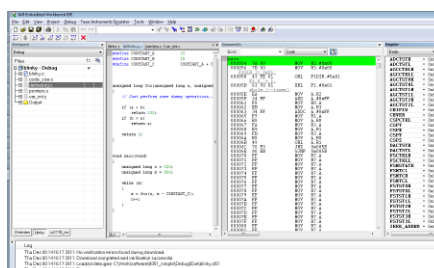
BTool is a Windows application that allows you to control a central device using the serial interface and perform various BLE functions while connected to a peripheral device.



BTool is included as part of the installation of the BLE stack (see "Useful Links" to the right).

### IAR Embedded Workbench

To develop software, program, and debug the CC2541, you should use IAR Embedded Workbench for 8051.



More information on IAR EW8051, including a free evaluation version download, can be found at [www.iar.com/ew8051](http://www.iar.com/ew8051).

### Useful Links

TI BLE Stack and Software: [www.ti.com/blestack](http://www.ti.com/blestack)

CC2540/41 Development Kit User Guide: [www.ti.com/lit/pdf/swru301](http://www.ti.com/lit/pdf/swru301)

CC2540 BLE Software Developer's Guide: [www.ti.com/lit/pdf/swru271](http://www.ti.com/lit/pdf/swru271)

CC2540/41 User's Guide: <http://www.ti.com/lit/pdf/swru191>

CC2541 Product Page: [www.ti.com/cc2541](http://www.ti.com/cc2541)

For additional help, visit the TI E2E Forums: [www.ti.com/lprf-forum](http://www.ti.com/lprf-forum)

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### General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this is strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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**For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant**

**Caution**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

**FCC Interference Statement for Class A EVM devices**

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

**FCC Interference Statement for Class B EVM devices**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
  - Increase the separation between the equipment and receiver.
  - Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
  - Consult the dealer or an experienced radio/TV technician for help.
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## **For EVMs annotated as IC – INDUSTRY CANADA Compliant**

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### **Concerning EVMs including radio transmitters**

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

### **Concerning EVMs including detachable antennas**

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

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Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

### **Concernant les EVMs avec appareils radio**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

### **Concernant les EVMs avec antennes détachables**

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

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If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

(1) Use this product in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,

(2) Use this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or

(3) Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product.

Also, please do not transfer this product, unless you give the same notice above to the transferee.

Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

**Texas Instruments Japan Limited**  
(address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan

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4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials

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