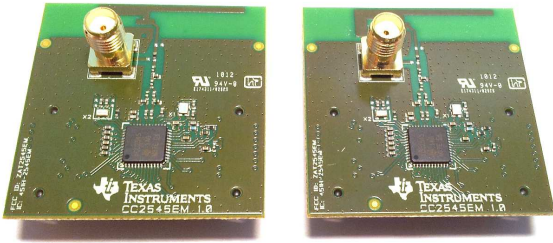TEXAS INSTRUMENTS

CC2545EMK Quick Start Guide

Opening the Box and Running the *Packet Error Rate* Test Application

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1. Kit Contents

- 2 x CC2545 Evaluation Modules (EM)
- Documentation

The RF boards in this kit are FCC and IC certified and tested/complies with ETSI/R&TTE over temperature from 0 to +35℃. There is an on-board PCB antenna on the evaluation module. This kit is a

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

2. Hardware Requirements

To run the example described in this Quick Start Guide, you would need either two CC2545EMs mounted on SmartRF05 Evaluation Boards (SmartRF05EB - Rev 1.8.1 or later). SmartRF05EB is included in the CC2543-CC2544 Development Kit.

More information about the SmartRF05EB can be found in www.ti.com/lit/swru210.

The CC2545EM boards can also be plugged into a battery board (see www.ti.com/tool/soc-bb) for standalone operation.

The source code for the PER test can be downloaded from the CC2545DK product page (www.ti.com/tool/cc2545dk).

3. Hardware Setup

Mount the CC2545EMs firmly on to connectors P5 and P6 on the SmartRF05EB.
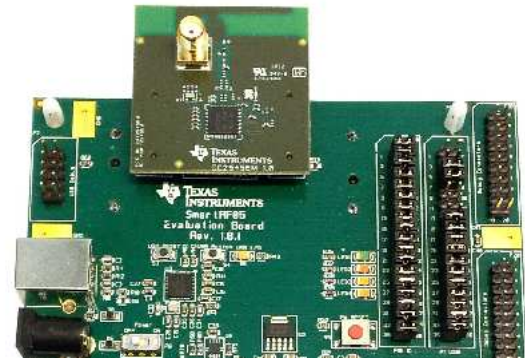
Caution! To minimize risk of injury, avoid touching components during operation if symbolized as hot.

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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

Power source
1-2: Battery   P11
2-3: USB/DC

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.
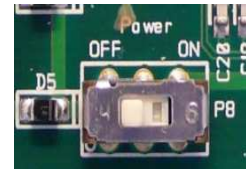
Once you have set P11, find switch P8 on the top side of each SmartRF05EB. To power up the boards, flip the switch from the "OFF" position to "ON".

Do not leave EVM powered when unattended.

6. Start-up Screen

The CC2545EMs are pre-loaded with a Packet Error Rate (PER) test application. The LCD screens on the two SmartRF05EBs should display the messages below:

CC2543 PER Test
Push 'Button 1'
To Begin

---
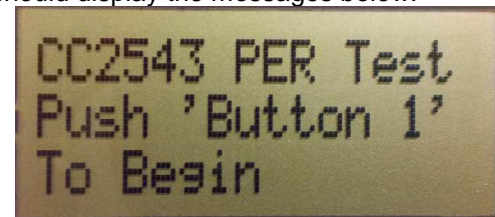
7. Choosing Mode

The application can be used between two CC2545EM's. There are two operating modes: "Remote" and "Master".

After button S1 is pushed at the start up screen, the mode selection screen (showed below) will appear. The Remote mode is shown by default. Press the joystick up and down to change between master and remote mode and press button S1 to confirm.

Mode?
Remote
▲   >>Button1

Mode?
Master
▼   >>Button1
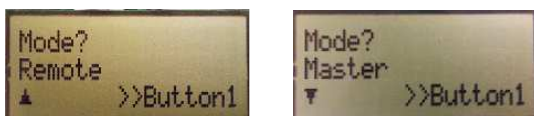
In the Remote mode all the parameters for the current PER test must be set up before the test begins (go to step 10).

8. Master Mode (Beacon)

In "Master" mode, the radio will repeatedly (once every 10 milliseconds) send out a "beacon" signal (250 kbps, GFSK modulation, 160 kHz deviation, 2402 MHz) and listen for a response from the remote device. The Green LED1 will blink continuously.

Master Mode
Tx Beacon (10ms)
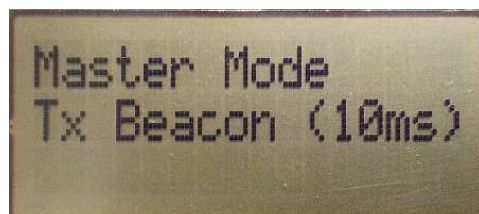
No more actions are needed from the user for the master device to work.

9. Master Mode (PER test)

Once the beacon is acknowledged by the "Remote", the actual PER test begins. The PER test configuration is included in the payload of the acknowledge packet. The Master device extracts this information and configures the radio parameters accordingly. During the PER test, packets are sent at a fixed repetition rate of 10 msec.

Master Mode
Pckts: 2500
Remote: ONLINE
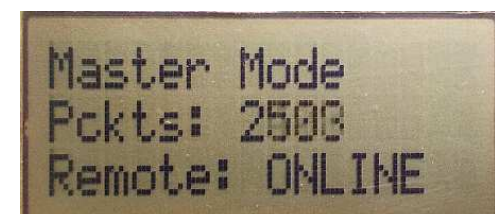
During the test the number of sent packets will be updated on the LCD display as well as the link status between the Master and Remote device.

TEXAS INSTRUMENTS

Make sure to subscribe to the Low-Power RF Newsletter to receive information about updates to documentation, new product releases, and more. Sign up on the TI web pages.

10. Frequency Selection

When the Remote mode is chosen, a series of settings must be configured to set up the link for the PER test. The frequency must be selected first (the selectable frequency range is from 2402 MHz to 2480 MHz). Move the joystick up or down to change the frequency (channel) and press S1 to confirm the choice.
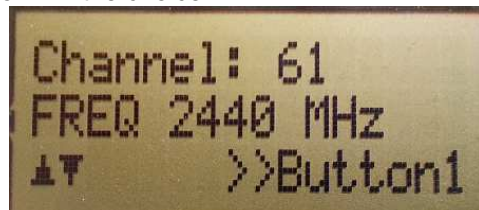
11. Modulation Setup

There are 7 different modulation schemes available. The different bitrates are 250 Kbps, 500 Kbps, 1Mbps and 2 Mbps. MSK modulation is available for 250 Kbps and 500 Kbps data rate while GFSK has all of the mentioned above. Move the joystick up or down to change the scheme and press S1 to confirm the choice.
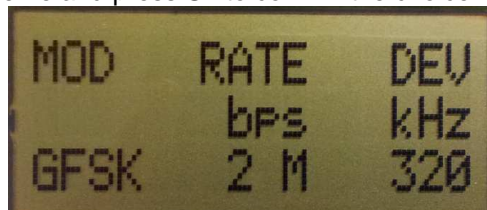
12. Packet Length

The packet length can be set to 10, 16, 32 or 63 bytes. Move the joystick up or down to change the packet length and press S1 to confirm the choice.
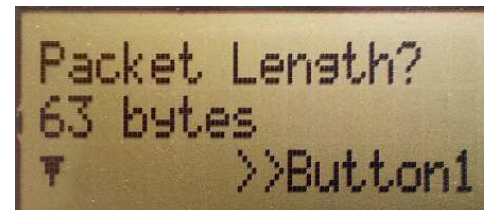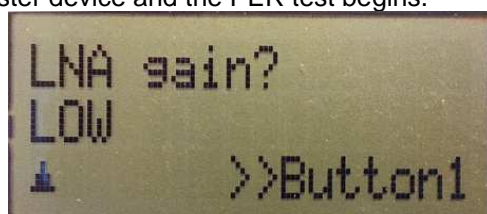
13. Number of Packets

The total number of packets to be sent for each run can be set to 100, 1000, 10000, 100000 and 1000000. Move the joystick up or down to change the number of packets and press S1 to confirm the choice.
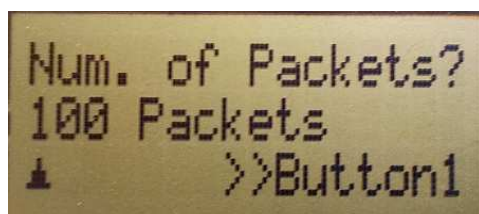
14. LNA Gain

For the 2Mbps data rates the AGC is enabled, while for lower rates the LNA gain must be set to HIGH or LOW. Move the joystick up or down to change between LOW and HIGH gain and press S1 to confirm the choice. After confirming the last choice the configuration packet will be sent to the Master device and the PER test begins.

15. Results I

The packet error rate (PER) is presented as the sum of lost packets and packets with CRC error per thousand. The received signal strength indication (RSSI) is presented as a running average of the five last samples. The number of received packets is continuously updated on the LCD display while the test is running.
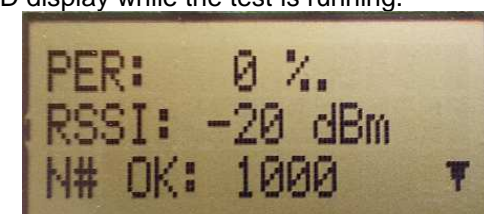
13. Results II

When the test is complete a small downward facing arrow will show in the bottom right of the LCD screen. This indicates that the test is complete and that there is an additional results screen "below". Move the joystick up and down to jump between the two test result screens. Press the S1 button to exit the test results.
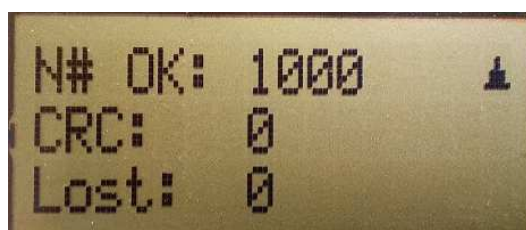
14. Repeat Test

After exiting the test results the user is presented with two choices. If "Restart Test" is chosen the same test as previously run will be repeated. The test can also be restarted at any time during the test by pushing the S1 button. Move the joystick up or down to switch between the two commands and press S1 to confirm the choice.

15. New Test

If "New Test" is chosen the application will return to setting up the configuration for a new test, starting at frequency selection. The test can also be stopped at any time during the test by pushing on the joystick like a button.
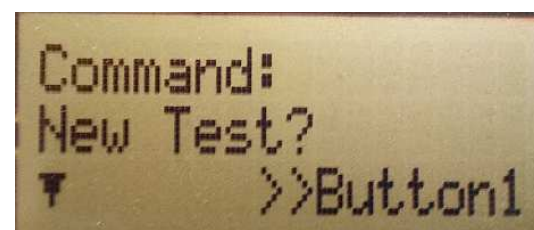
Additional Tools and Links

SmartRF™ Studio

SmartRF Studio allows you to configure the radio, run RF performance tests, and run link tests between the two SmartRF05EBs.
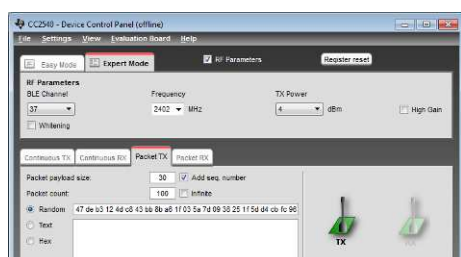
SmartRF Studio can be downloaded from www.ti.com/smartrfstudio

SmartRF Flash Programmer

Texas Instruments has a simple tool which can be used to program and flash the CC2545.
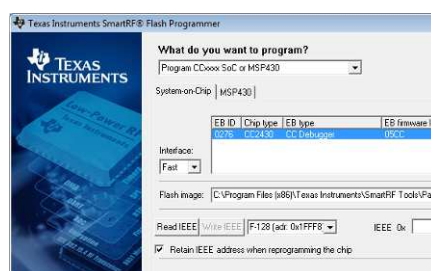
SmartRF Flash Programmer can be downloaded from www.ti.com/tool/flash-programmer

IAR Embedded Workbench

To develop software, program, and debug the CC2545, you should use IAR Embedded Workbench for 8051.
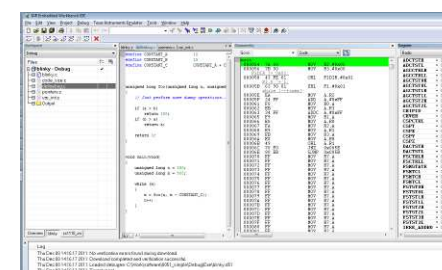
More information on IAR EW8051, including a free evaluation version download, can be found at www.iar.com/ew8051.

Useful Links

CC2545EMK Product Page:
www.ti.com/tool/cc2545emk

CC2545EMK User's Guide:
www.ti.com/lit/swruXXX

CC2543-CC2544DK User's Guide:
www.ti.com/lit/swru318

Useful Links

CC2543/44/45 User's Guide:
http://www.ti.com/lit/swru283

CC2545 Product Page:
www.ti.com/product/cc2545

For additional help, visit the TI E2E Forums:
www.ti.com/lprf-forum

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As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

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.

SSZZ027 December 2011

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.

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.

~

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.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan!

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
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http://www.tij.co.jp

EVALUATION BOARD/KIT/MODULE (EVM)
WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.

2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard.

3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.

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

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60 C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.