CC2650 Packet Error Rate Test

Quick Start Guide

Version	Updated	
0.0.2	17. September 2013	Revised for rev 0.1.0 of PER Test

Functional Overview

This guide describes how to use the Packet Error Rate (PER) test with CC2650.

Prerequisites

In order to use the PER test, please set up your SmartRF06EB according to the "CC2650 Alpha Release Quick start guide" as the silicon qual package can become damaged if not.

Uploading firmware

Upload the per_test.hex file to a CC2650 using the SmartRF Flash Programmer.

Be sure to do full erase/program/verify of uploaded code. After upload, do a power cycling or pin reset to boot the PER test.

Menu system

The menu system is based on using the buttons on SmartRF06EB to navigate.

There are 5 buttons needed

- LEFT – go back to previous menu
- UP/DOWN – navigate between menu elements
- RIGHT/SELECT – choose menu element

Start menu

The start menu contains the devices supported on the PER test, as well as a settings menu.

Settings menu

To see the difference in power consumption with and without the DC/DC converter, you can press RIGHT/SELECT on **DCDC** to toggle it on or off. A "1" indicates that it is currently on.

Channel menu

After selecting a device (e.g. CC2650EM), you can currently select the Bluetooth LE channel you would like to use for the test.

Since the PER test is implemented using BLE Advertising packages (Non-connectable undirected advertising), only the advertising channels are available. Together, they cover the allowed frequency band for Bluetooth LE.

- 37 – 2402MHz
- 38 – 2426MHz
- 39 – 2480MHz

Mode menu

In the mode menu, you can select which device is transmitting and which is receiving:

- BLE Transmitter
- BLE Receiver

After selecting “BLE Receiver”, the device goes directly into receive mode and is ready to receive packets.

Only let 1 PER test device with the advertising address 0x264026402640 transmit packages at the same time, as the receiver are based on recognizing a sequence number in the payload and will get restart the receive statistics if packets with a lower sequence number arrives.

TX Power

When selecting “BLE Transmitter”, you can also select which output power you would like to transmit with. Currently, the following options are available:

- 0 dBm
- +5dBm

Burst size

After selecting output power, you can also select the number of packets you would like to send in one test.

This is configurable between 1000 and 1 000 000 packets.

Packet rate

To test the device with different data rates, you can also select how many packets per second you would like to send.

This configures the 32k RTC timer to trigger an interrupt a number of times per second to send a package.

Note:

The PER test packet rate setting is currently using a low frequency clock derived from the 48MHz clock, meaning the packet rate is not 100% accurate. The RTC frequency is therefore 31.25kHz instead of 32.768 kHz but this will be changed in a later release.

TX Idle

The PER test is now ready to send packages but has not yet started. To start sending packages, press RIGHT/SELECT.

You can restart the test at any time by pressing RIGHT or SELECT.

Current measurement

To measure power consumption during test modes, connect a measurement device instead of the jumper ”VDD TO EM” on the SmartRF06EB. This can be e.g. a digital multi meter with the range set to mA or an oscilloscope.

To get the lowest possible current consumption, restart the SmartRF06EB after programming the device and remove all the jumpers on the "JTAG Bypass" header (to avoid leakage current to the debugger on the SmartRF06EB). Also remove the tiny current measurement circuit next to the jumper, as the instrumentation amplifier will consume several microamperes.

Note:

If using an oscilloscope, do not use more than 1 ohm in series and make sure to run the board on 2xAAA batteries and move the board switch to BAT instead of USB. The scope ground will force the supply to each potential, shorting the on-board LDO on the SmartRF06EB.

Known bugs and issues

Regulatory Information

The CC2650 evaluation module (7IDEM) is FCC and IC certified and tested to comply with ETSI R&TTE regulations over temperature from 0 to +35°C. The evaluation module has an integrated PCB antenna.

FCC/IC Regulatory Compliance

FCC Part 15 Class A Compliant
IC ICES-003 Class A Compliant

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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 are 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.

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 EVMs for RF Products 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
(address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan

http://www.tij.co.jp

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日本テキサス・インスツルメンツ株式会社
東京都新宿区西新宿６丁目２４番１号
西新宿三井ビル
http://www.tij.co.jp

EVALUATION BOARD/KIT/MODULE (EVM)
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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.
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3. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. 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.

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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.

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