Contents

1 General Information

1.1 Applicant

Bosch Security Systems
130 Perinton Parkway
Fairport NY 14450 USA

1.2 Test Specification

FCC 47 CFR Part 15 Subpart C, §15.247
RSS-247, Issue 1, May 2015, Section 5

2 Device Description

The Bosch RFPR-ZB and RFDL-ZB series motion sensors are designed to operate using 3V CR123A batteries and pair with standard ZigBee based wireless security and home automation systems that operate in the 2.4GHz ISM band. The two radiative technologies on the RFDL variant of the product are the DSSS ZigBee transmitter operating in the 2.4 GHz-2.4853 GHz ISM band (for communication), and a microwave Doppler radar operating at 10.527 GHz (to detect motion). The RFPR variant of the product does not include

the microwave Doppler radar, but does include the ZigBee transmitter. (Additionally, there is a passive infrared sensor on all motion sensor products that provides the core motion detection operation, but that is not a radiating technology.)

The Bosch RFPR-ZB and RFDL-ZB series motion sensors are classified as ZigBee end points. They obey a ZigBee network controller, and upon network initiation, the controller instruct the detector to use one of a subset of 16 ZigBee channels (located every 5 MHz beginning with 2405MHz and ending with 2480MHz) to operate. The motion sensors will proceed to send transmissions when motion is sensed during normal device operation, with a hold-off lockout of 3 minutes (during which there are no microwave transmissions) after each successful detection of a motion alarm.

Note: the product will never radiate microwave and ZigBee at the same time. These lockouts are controlled using the sensor microcontroller during normal operation.

Product names are as follows:
RFPR-ZB, RFPR-ZB-MS, and RFPR-ZB-ES RFDL-
ZB, RFDL-ZB-MS and RFDL-ZB-ES

Since the primary difference in the DL and the PR versions is the existence or not of the radar, only the RFDL-ZB products have been submitted. All devices have the exact same PCB with the exact same radio layout and population. (The radar back-shield, resonator, and other radar- related circuitry is not installed on any of the PR models.) Other differences are solely cosmetic.

As of 10/23/2015, two GP units were sent: one has SMA connectors on the output of the front end module and the other is radiating through the antennas. One SL unit radiating through the antennas is provided. The connectorized SL unit will be shipped next week after a dip switch issue has been resolved.
Since this time, (as of 5/2/2016) the Engineer Responsible has visited Nemko and provided updated samples of conducted and radiated for each product. These most updated samples were what was tested for the final FCC/IC report.

3 Signal Descriptions

A. ZigBee
Modulation: Direct Sequence Spread Spectrum Offset Quadrature Phase Shift Keying
Chipping Rate: 2Mbps (2 Mchips per second)
Operational data rate (max): 250 Kbps
Channel Bandwidth (3dB): 1MHz

Channel Center Frequencies:
Only one will be chosen per network by the controller. The signal does not hop.

Channel 11: 2405 MHz	Channel 19: 2445 MHz
Channel 12: 2410 MHz	Channel 20: 2450 MHz
Channel 13: 2415 MHz	Channel 21: 2455 MHz
Channel 14: 2420 MHz	Channel 22: 2460 MHz
Channel 15: 2425 MHz	Channel 23: 2465 MHz
Channel 16: 2430 MHz	Channel 24: 2470 MHz
Channel 17: 2435 MHz	Channel 25: 2475 MHz
Channel 18: 2440 MHz	Channel 26: 2480 MHz

Maximum Conducted Power: 19.15 dBm

B. Doppler Radar

Modulation: Pulsed 1KHz sinusoid, generated by sensor microcontroller
Operating Band: 10500 MHz-10550 MHz
Center Frequency: 10527 MHz

C. Resonators on-board
   a. Crystals GP:
      32 MHz (feeds GP ZigBee transceiver)
      4 MHz (feeds sensor micro)
      13.768 KHz (feeds sensor micro precision timing, *NOT ON PIR VERSIONS*)

      SL:
      24 MHz (feeds GP ZigBee transceiver)
      4 MHz (feeds sensor micro)
      13.768 KHz (feeds sensor micro precision timing, *NOT ON PIR VERSIONS*)

   b. Ceramics
      10.4GHz ceramic resonator, *NOT ON PIR VERSIONS*

4 Antennas

4.1 ZigBee (2.4GHz ISM)

The product contains 2 antennas that operate in the 2.4 GHz ISM band (2400MHz-2483.5MHz). Both antennas are designed into the PCB using traces and are Bosch Proprietary designs, so they are internal to the device and cannot be removed. Both antennas are operational on both the SL and GP devices. The antennas were measured in an operational scenario to determine proper performance with a 50 Ohm source.

4.1.1 Inverted F

Functional on both SL and GP devices
Type: Inverted F
Peak Gain (as measured operationally in enclosure): -1.3dBi

4.1.2 Circular Semi-Loop

Functional on both SL and GP devices
Type: Circular Semi-Loop
Peak Gain (as measured operationally in enclosure): 1.5dBi

4.2 Radar

4.2.1 Patch Antenna Array

The product contains 2 patch arrays of 2 patch antennas, one for transmit and one for receive. These antennas are integrated into the PCB and are Bosch Proprietary designs so that they are internal to the device and cannot be removed.

Note: the radar system is a custom system operating at a very high frequency with controlled custom impedance matching. Any attempt to measure gains or conducted measurements from this system will result in detuning the system, thereby providing incorrect results. Therefore, conducted measurements are impossible and antenna gains and transmitter power are combined into the radiated measurement results.

5 Device Set Up-*disregard after 5/1/2016*

5.1 Computer Setup

Boot the computer, login using Controls2 for the user name and Controls2 for the password.

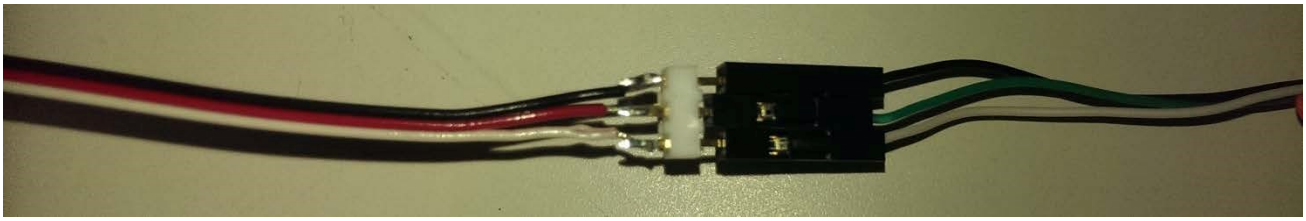
Plug in the USB to UART converter (blue connector) into the USB port as shown in the following figure.

Attach the Ember Debug Adapter to the Ethernet port as shown using the blue Ethernet cable. Attach the cream-colored USB connector as shown in the following figure. (Communications to the Ember Debug Adaoter will be using Ethernet, but the Debug Adapter is powered using USB.) For reference, the IP Address of the Ember Debug Adapter is statically set to 192.168.1.100, so the computer's IP address of the computer is statically set to 192.168.1.1. This is preconfigured so it should not need to be updated.

For reference, the Ember Adapter should have the USB cable and blue Ethernet cable connected as in the following picture

5.2 **GP radio- based motion sensor**

This device will be controlled using the provided computer over the USB←→ UART serial converter and powered using the CR123A batteries. (The device will operate using only 1 battery, but 2 batteries is preferred and recommended due to the battery life extension. (The batteries are in parallel.))
The GP devices have three wires attached to the device that will allow the device to be controlled by the computer. These need to be connected to the USB to UART converter per the following instructions so that the computer can transmit and receive data from the device. GP Black Wire connects to the USB to UART black wire. GP Red Wire connects to the USB to UART Green Wire GP White Wire Connects to the USB to UART White wire.

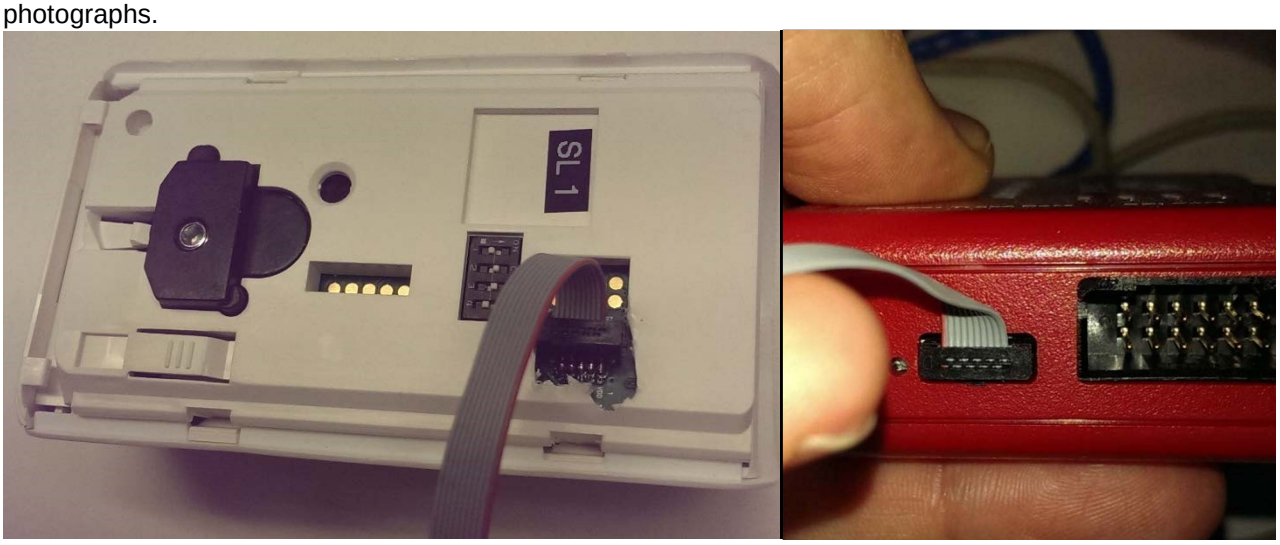


Insert the battery into the unit, press the battery tray to make sure the battery tray is flush with the enclosure (there will probably be a light click to know the tray is locked in place).

Note: if the microwave is on when the device is powered on, the LED will cycle colors a few times.

5.3 **SL radio-based motion sensor**

This device will be controlled using the provided computer over the Ember Debug Adapter and powered using the CR123A batteries. (The device will operate using only 1 battery, but 2 batteries is preferred and recommended due to the battery life extension. (The batteries are in parallel.))
The SL devices have a debug/ programming pin header attached to the device that will allow the device to be controlled by the computer through the debug adapter. It is important to make sure the pin headers line up, as there is not polarity protection for this test connection. Ensure the device is connected as in the following photographs.



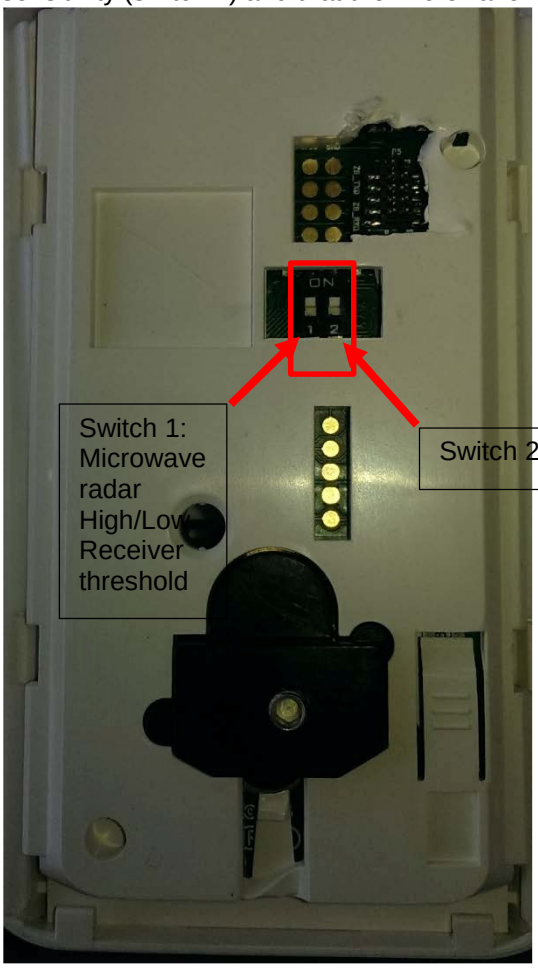
Insert the battery into the unit, press the battery tray to make sure the battery tray is flush with the enclosure (there will probably be a light click to know the tray is locked in place).

Note: if the microwave is on when the device is powered on, the LED will cycle colors a few times.

6 Enable/Disable the Microwave Radar

Control of the Microwave Radar is performed with the DIP switch. The GP versions and SL2 have a 2 position DIP switch. SL1 has a 4 position DIP switch. On SL1, the outer two positions are to be ignored. They serve no purpose.

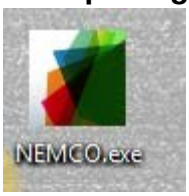
The left switch (switch 1) changes the detection threshold of the receive circuitry of the radar. It has no effect on radiated transmissions.
The right switch enables the radar if it is 'up' (ON) and disables the radar if it is 'down' (OFF).
Both switches in the figure below are shown in the 'up' or 'ON' position. This correlates to high microwave sensitivity (switch 1) and that the microwave is enabled (switch 2.)



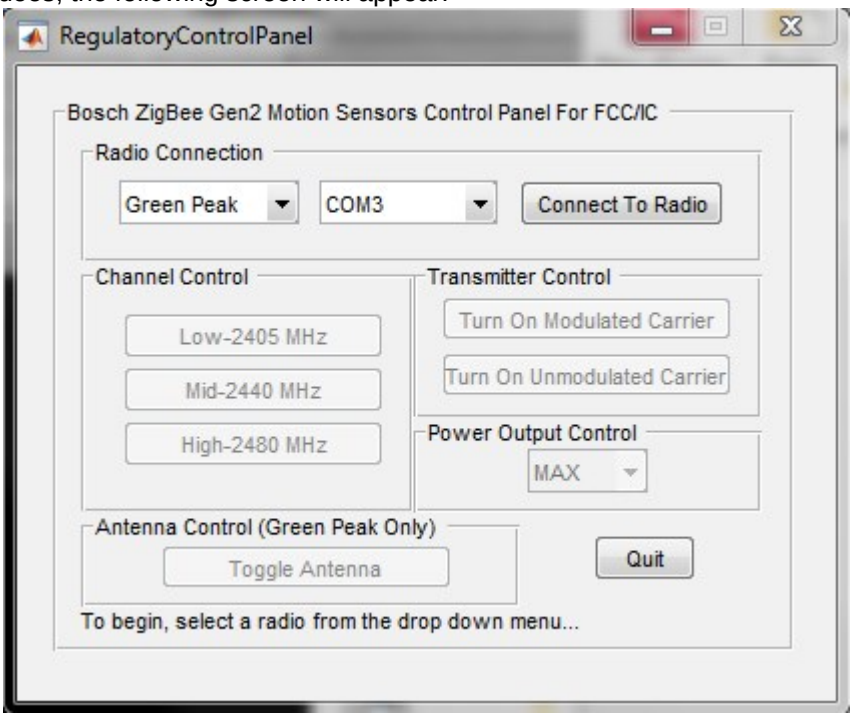
7 GUI Operation-*disregard after 5/1/2016*

The GUI provided will control both radios with their respective interface. It can be opened by double clicking on the 'NEMCO' (apologies, I was tired when I named it and used a C instead of a K) application on the desktop. **Be sure that the USB to UART and the Ember Debug adapter are connected before starting the program.**

7.1 Opening the GUI and connecting to the radio-disregard after 5/1/2016

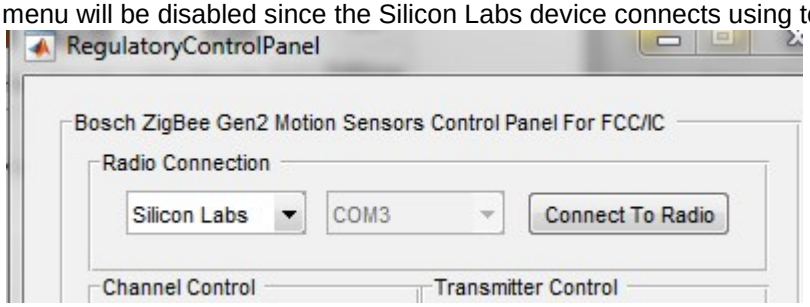


It will start and leave a command window open. It does take a while to start (45-60 seconds), but when it does, the following screen will appear:

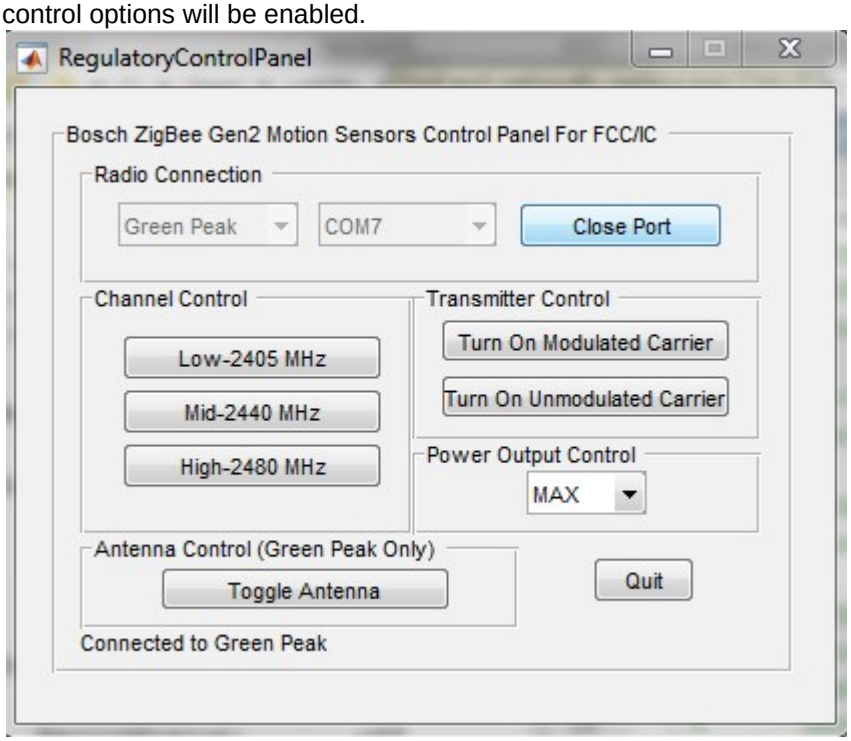


To connect to the GP device, select Green Peak from the drop down menu and then select the COM port of the USB to UART adapter from the COM drop down menu. (If it is set up identically as pictured in the section 5.1, it should be **COM18**.)

To connect to the SL device, select Silicon Labs from the radio connection drop down menu. The COM port menu will be disabled since the Silicon Labs device connects using tcpip.



Once the radio is selected, click “Connect To Radio.” The button will update with various status as it connects. Once it finishes connecting, the button will say “Close port,” the status bar will be updated, and the control options will be enabled.



All control options are available for GP. The antenna control option is disabled for SL because the firmware only currently supports one antenna. The power output control is defaulted to MAX power, which puts the front end module on each device into saturation. Realistically, the devices will never operate with a power output of greater than 17dBm radiated, but testing should occur at maximum power levels.

Note: It is advisable when closing the port or switching radios to Quit. There is currently a bug with the ‘Close Port’ function and you will not be able to re-connect to the same port without restarting the software.

7.2 **Command Section Summary**

7.2.1 Channel Control

Low-2405 MHz
This button will change the ZigBee channel of the selected radio to the lowest channel in the band.

Mid-2440 MHz
This button will change the ZigBee channel of the selected radio to the lowest channel in the band.

High-2480 MHz
This button will change the ZigBee channel of the selected radio to the lowest channel in the band.

Note: it is advisable to set the channel before turning on the carrier. When changing channels, disable the carrier before changing the channel.

7.2.2 Transmitter Control

Turn On Modulated Carrier
This button turns on and off the modulated carrier at the frequency selected by the channel. Please select the Channel and Power Output level before turning on the carrier.

Turn On Unmodulated Carrier

This button turns on and off the unmodulated carrier ("CW mode") at the frequency selected by the channel. Please select the Channel and Power Output level before turning on the carrier.

7.2.3 Power Output Control

This drop down selects the power output level of the device as measured directly on the FEM PA output pin.
MAX- selects the maximum power level output of the FEM.
17dBm- sets the FEM power output to 17dBm
10dBm- sets the FEM power output to 10dBm

Note: it is advisable to set the power output level before turning on the carrier. When changing power levels, disable the carrier before changing the power level.

7.2.4 Antenna Control

Toggles the antenna output of the FEM. This is enabled for the GP radio, but disabled for the SL radio because the SL radio firmware doesn't currently support this functionality.

7.2.5 Quit

Safely exits the program. Closes all ports before exiting.

Please email brian.vorees@us.bosch.com for any questions.

8 Change history:

Version	Date	Description	Author / Editor
0.1	10/23/2015	Initial Version	Vorees—ENG2.1
0.11	10/28/2015	Updated mw antennas, mw freq, added crystals	Vorees—ENG2.1
0.12	5/3/2016	Added comments, corrected antenna gains and models	Vorees—ENG2.1