



# **EM DEVELOPMENT PLATFORM**

## **USERS GUIDE**

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**Version 0.6**

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# 1 INTRODUCTION

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## 1.1 Overview

The scope of this document is to explain the features and capabilities of the EM Development Platform. The development kit is based on a Development Platform, which is designed to support multiple members of the Embedded Module (EM) product family.

This document also covers the Evaluation Application program. It contains step-by-step instructions on how to install and utilize the Evaluation Application User Interface to communicate with the EM Module.

The purpose of the EM Development Platform is to assist the OEM during multiple stages of the product's development:

- Initial Module Evaluation
- Host Software Development
- Preliminary Hardware Integration

## 1.2 Development Kit Contents

The Development Platform package includes a number of components:

- Sierra Wireless Development Platform
- Sierra Wireless Software CD (for Windows 2000)
- Wall outlet power "brick"
- 2 DB9 serial cables

## 1.3 Regulatory Information

### 1.3.1 Statement

The following safety precautions must be observed during all phases of the operation, usage, service or repair of any cellular terminal or mobile incorporating the EM3420 wireless modem module. Manufacturers of the cellular terminal devices are advised to convey the following safety information to users and operating personnel and to incorporate these guidelines into all safety standards of design, manufacture and intended use of the product. Sierra Wireless assumes no liability for customer failure to comply with these precautions.

1. The EM3420 wireless modem module must be operated at the voltages described in this technical documentation.
2. The EM3420 wireless modem module must not be mechanically or electrically changed. Usage of the connectors should follow the guidance of this technical documentation.

3. The EM3420 wireless modem module has been designed to meet the EMC requirements of 47 CFR Part 2 and Part 15.
4. When integrating the EM 3420 wireless modem module into a system, Sierra Wireless America recommends testing the system to OET Bulletin 65 Supplement C edition 97-01.

### 1.3.2 Requirements

The Federal Communications Commission (FCC) requires application for certification of digital devices in accordance with CFR Title 47, Part 2 and Part 15. This includes electromagnetic susceptibility testing. As the EM3420 wireless modem module is not a stand-alone transceiver but is an integrated module, the EM3420 wireless modem module cannot be tested by itself for EMC/EMI certification.

This device complies with Part 15 of the FCC rules. Operation of the EM3420 wireless modem module 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.

Your mobile device is a low power radio transmitter and receiver. While ON, it receives and sends out radio frequency (RF) signals. The design of this module complies with the FCC guidelines and applicable standards.

**WARNING: Unauthorized antennas, modifications, or attachments could impair call quality, damage the EM3420 wireless modem module, or result in violation of FCC regulations. Do not use the EM3420 wireless modem module with a damaged antenna. Please contact your local authorized dealer for antenna replacement.**

### 1.3.3 Safety

#### User Operation Requirements

The antennas used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antennas or transmitters. A person or object within 8 inches (20 centimeters) of the antenna could impair call quality and may cause the phone to operate at a higher power level than necessary and expose that person to RF energy in excess of that established by the FCC RF Exposure Guidelines.

**IMPORTANT!:** The EM3420 wireless modem module must be installed in a manner that provides a minimum separation distance of 20 cm or more between the antenna and persons to satisfy FCC RF exposure requirements for mobile transmitting devices.

**IMPORTANT!:** To comply with the FCC RF exposure limits and satisfy the categorical exclusion requirements for mobile transmitters, the following requirements must be met:

1. A minimum separation distance of 20 cm must be maintained between the antenna and all persons.
2. The transmitter effective radiated power must be less than 1.5 Watts ERP, 2.0 Watts or 33.0 dBm EIRP. This requires that the combination of antenna gain and feed line loss does not exceed 6.0 dBi. (Conducted max power + cable loss + Antenna gain)

## 2 FCC MODULE ACCEPTANCE CRITERIA

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### 2.1 FCC Classification of Mobile vs. Portable Devices

For operation in the United States, your module integration is required to meet certain regulatory requirements for stand-alone operation, including 47 CFR Parts 2, 15, 22, and 24.

Part 15 testing must be performed on the “complete device” which has incorporated the EM3420 wireless modem module and is therefore your responsibility.

#### 2.1.1 *Mobile vs. Portable Devices*

The Office of Engineering and Technology has published a document entitled “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields”, OET Bulletin 65. This provides a detailed description of the difference between mobile and portable devices.

The FCC Guidelines differentiate between these devices according to the antenna’s proximity to people, either the user or others nearby.

**Mobile:** The FCC defines a mobile device as being designed for use “in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is maintained between radiating structures and the body of the user or nearby persons”.

Mobile devices including vehicle-mounted systems are designed to be used by people that are typically well separated from the antenna. This also includes wireless devices associated with a personal computer, provided the antenna is kept 20 centimeters away from the body.

These devices are normally evaluated for exposure potential with relation to Maximum Permissible Exposure (MPE) limits. The FCC rules for evaluating mobile devices for RF compliance are found in 47 CFR Part 2.1091 (b).

**Portable:** A portable device has a transmitter “designed to be used with any part of its radiating structure in direct contact with the user’s body or within 20 centimeters of the user or bystander under normal operating conditions”.

This category includes hand held cellular telephones with antennas built into the device.

Portable devices are evaluated with respect to Specific Absorption Rate (SAR) rules. These can be found in 47 CFR Part 2.1093 (b).

### 2.2 RF Exposure Requirements for Mobile Approval

The EM3420 wireless modem module has been approved for mobile operations only in accordance to 47 CFR Part 2.1091 (b).

**Warning:** If this module will be used as a portable device, you are responsible for separate approval to satisfy the SAR requirements of 47 CFR Part 2.1093 (b).

To ensure the module meets the current FCC exposure guidelines, a separation distance of at least 20 cm must be maintained between the module's antenna and the body of the user and any nearby person at all times and in all applications and uses. Additionally, in mobile applications, maximum antenna gain must not exceed 6.0 dBi in order to comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation.

### 2.2.1 Product Labeling Requirements

For mobile devices, using the FCC approval obtained by Sierra Wireless, a label must be attached to the outside of your product- into which the authorized module is incorporated- with a statement similar to the following:

**"This device contains TX FCC ID: N7N-EM3420P"**

You will also need to provide a manual with your end product that clearly states the operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines (as detailed above).

The warnings must appear in a prominent location in the User's Guide for your product and may include the following text:

**Caution:** Unauthorized modifications or changes not expressly permitted by the manufacturer could void compliance with regulatory rules, and thereby your authority to use this device.

**Warning (EMI):** This equipment has been test and found to comply with the limits pursuant to Part 15 of the FCC rules. These limits were design to provide reasonable protection against harmful interference in an appropriate 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 guaranty that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio and 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 suggestions:

- 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

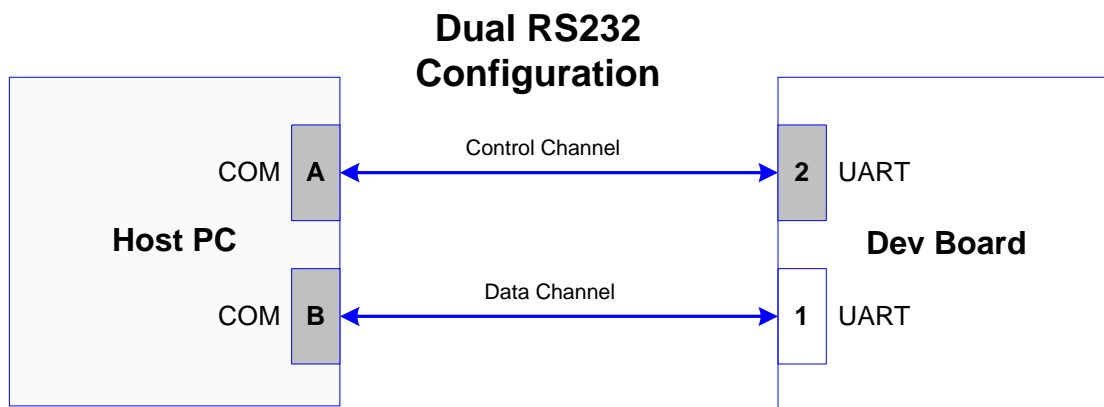


### 3 SETUP & INSTALLATION

The Development Platform setup and installation is a simple process:

1. Connect the Development Platform to a PC (or other host) via serial cable.
2. Plug wall outlet power brick AC cable into an AC receptacle, then plug the DC cable into the Development Platform.
3. Connect the cable from the Development Platform SMA connector to the antenna. If using a call box or CDMA emulator, please contact Sierra Wireless Applications Engineering for additional setup information.
4. Install the software as directed in the next section.

The Development Platform may be connected to a PC in a dual UART configuration as illustrated below.



Note that "COM A" and "COM B" labels are used on the host PC in the above diagram. This is to identify the physical COM ports and should not be confused with the COM port number assigned by Windows.

## 4 DEVELOPMENT PLATFORM HARDWARE

The Development Platform utilizes a number of switches for various controls and configuration options. This section discusses these switches, LED indicators and the various Development Platform headers and connectors.

### 4.1 Modes of Operation

The Development Platform supports two modes of operation, Standalone Mode and Extender Mode. In both modes of operation, the wireless modem module is mounted on the Development Platform. Standalone Mode allows for operation of the module independent of the target host system while Extender Mode assists with hardware and software integration of the module into the target host system.

Please refer to the table at the end of this section for the switch settings for each mode.

#### 4.1.1 Standalone Mode

Standalone Mode is intended for product evaluation and software development independent of the target host system. In Standalone Mode, a PC or other host can communicate with the Development Platform via serial ports. Standalone Mode also supports audio test capability via a 2.5mm headset jack.

#### 4.1.2 Extender Mode

In Extender Mode, a “dummy” module is installed in the target host in place of the wireless modem module. This “dummy” module provides a flex cable connection to the Development Platform. In this arrangement, the wireless modem module on the Development Platform is powered and controlled by the target host. This mode of operation allows for probing a number of the signals on the module host interface connector. Additionally the serial ports can be configured to allow monitoring of RX and TX communication directions for both ports using a serial port analyzer.

Switch	Standalone Mode	Extender Mode	Serial Port Analysis
SW2-1	ON	OFF	OFF
SW2-4	OFF	ON	OFF

### 4.1.3 LED indicators

CN18 sockets10 segment LED bar (Lumex part # SSA-LXB10IW-GF/LP)

Each segment is related to an IO signal as shown in the table below. The LED lights up when the signal is in the low state – off when the signal is in the high state.

Pin #	Signal Name
1	DTR1
2	CD1
3	DSR1
4	MODULE_WAKE
5	HOST_WAKE
6	HOST_STATUS
7	RESET_RADIO
8	RESET_OUT
9	VCC_RADIO
10	VCC_BRD

## 4.2 Powering the Development Platform

There are two options for powering the Development Platform, using an AC “wall-cube” or DC power from an external power supply.

### 4.2.1 AC Wall Cube Power

When using the AC “wall-cube”, the DC output jack from the wall-cube will connect to the “DC Input” back on the Development Platform.

If the “wall-cube” supplied with the Dev Platform is not suitable, another wall-cube may be used so long as it has a 5V output rated for at least 2 Amps with the jack barrel exterior grounded and 5V on the barrel interior.

The table below shows the required switch settings when using wall-cube power:

Switch	Position
SW2-8	ON

### 4.2.2 DC Power

If using a DC power source without a jack connector, the DC voltage must be between 3.6V and 4.2V and rated for at least 2 Amps. The DC voltage must be connected to the Development Platform on TP1 and ground must be connected on TP3.

The table below shows the required switch settings when using wall-cube power:

Switch	Position
SW2-8	OFF

## 4.3 Audio Testing

The Development Platform provides two methods of audio testing, a 2.5mm headset jack for a hands free headset and an RJ11 connector for a standard telephone handset.

### 4.3.1 Using a Headset

The Development Platform has a 2.5mm headset jack for a cellphone headset.

### 4.3.2 Using a Headset

**MIC Bias Voltage** – When using a headset in Standalone Mode or if the host does not provide a MIC bias voltage, set SW3-1 to the ON position, otherwise this switch should be set to the OFF position. Note that the default audio gains of the modem are set for use with a host front end which contains additional gains in the transmit path (20dB). For this reason the audio will be very faint while using the headset in standalone mode – unless additional gains are added to the modem transmit path using directed test scripts.

## 4.4 External Interfaces

### 4.4.1 UART1 - DB9

Used to access the EM3420 wireless modem module UART1, RS-232 compatible

Signals from the module connector to this DB9 will be level shifted using an RS-232 transceiver.

AMP, Part #: 747844-2 (or equivalent)

Pin #	Signal Name
1	CD
2	RXD
3	TXD
4	DTR
5	GND

6	DSR
7	RTS
8	CTS
9	RI

#### 4.4.2 UART2 - DB9

Used to access the EM3420 wireless modem module UART2. RS-232 compatible 2 wire or 4-wire interface.

Signals from the EM 3420 wireless modem module connector to this DB9 will be level shifted using an RS-232 transceiver.

AMP, Part #: 747844-2 (or equivalent)

Pin #	Signal Name
1	NC
2	RXD
3	TXD
4	NC
5	GND
6	NC
7	RTS
8	CTS
9	NC

#### 4.4.3 DC Jack

Connects to the provided AC wall adapter.

Switchcraft, Part #: RAPC712

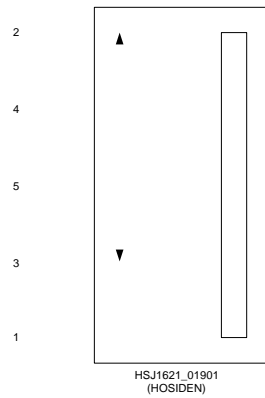
#### 4.4.4 Headset Jack

This is a standard 2.5mm headset jack.

Hosiden, Part #: HSJ1621-01901

Pin #	Signal Name
1	GND
2	MIC_P
3	SPK_P
4	MIC_DET
5	SPK_DET

Below is the schematic representation of the headset jack:



## 4.5 Debug Headers

Internal to the Development Platform are two standard 2-row 0.1" x 0.1" headers that can be used for connecting logic analyzer or scope probes to.

### 4.5.1 CN2 - Audio Test Points

Pin #	Signal Name	Pin #	Signal Name
1		11	RTS2
2		12	PCM_FRAME
3		13	PCM_DIN
4	TXD1	14	PCM_CLK
5	RXD1	15	PCM_DOUT
6	CTS1	16	RI1
7	RTS1	17	DTR1
8	TXD2	18	CD1
9	RXD2	19	DSR1
10	CTS2	20	GND

## 4.5.2 CN12 - Control/Status Signal Test Points

Pin #	Signal Name	Pin #	Signal Name
1		11	HOST_STATUS
2	VCC_RADIO	12	RESET_OUT
3		13	MIC_P
4	VCC_BB	14	SPK_P
5		15	MIC_N
6	VBATT	16	SPK_N
7	ON/OFF	17	HOST_WAKE
8	RADIO_RESET	18	
9	MODULE_WAKE	19	
10		20	GND

## 4.6 DIP Switch Settings

### 4.6.1

#### Switch 2 (SW2)

Switch Position	Function
1	UART RX Enable – This switch controls the receiver output enable for the on-board RS232 level shifters. It must be set to the ON position for Standalone Mode and must be set to the OFF position for Extender Mode.
2	NA
3	MODULE ON/OFF – This switch is used to turn the module on. Turning switch to OFF position turns modem on. Turning switch to ON position turns modem off. This switch is only used in standalone mode to control modem power state. In the extender mode this switch should be set to OFF.
4	UART Shutdown - This switch controls the power to the on-board RS232 level shifters. Turning switch to OFF position enables the UART transmit. Turning switch to ON position disables UART transmit (towards PC). It must be set to the OFF position for Standalone Mode and can be set to the ON position for Extender Mode if serial port analysis isn't required. For serial port analysis while in Extender mode – set this switch to OFF.
5	Flex_ON/OFF (INV). This switch is only used when modem is connected to a host (extender mode). This switch is only set to ON with a host with <b>active low</b> enable for modem turn on control. The modem power up control is active high – so this switch inverts the logic of the power enable control from the host. In

	standalone mode (default) always set this switch to OFF.
6	FLEX_ON/OFF – This switch passes the target adapter ON/OFF control directly to the modem on board. Set this switch to ON only for the extender mode with a host with <b>active high</b> enable for modem turn on control. In standalone mode always set this switch to OFF.
7	NA
8	On-board VBAT Regulator Enable – This switch controls the on-board regulator for the module's VBAT power. This switch is only set to ON when using the wall cube power supply to power the modem. If taking power from the host system in extender or mode – set this switch to OFF.
9	HOST_STAT Control – Set this switch to the OFF position to enable Standalone Mode (must be used with MDL_WAKE).
10	MDL_WAKE Control – Set to this switch to the ON position for Standalone Mode. Tells module on power-up to run in standalone mode (Must be used with HOST_STAT). Set to OFF for extender mode.



### Switch 3 (SW3)

Switch Position	Function
1	MIC BIAS Control – This switch is used to enable an onboard mic bias for the headset. Turn to ON position to enable bias at headset microphone. Turn to OFF position to disable bias. Turn to OFF during extender mode.
2	Test Switch – turn to OFF position
3	Test Switch – turn to OFF position
4	Test Switch – turn to OFF position
5	Test Switch – turn to OFF position
6	Test Switch – turn to OFF position
7	NA
8,9,10	<p>8,9,10 are used for extender mode. For standalone mode simply set all to OFF position. These switches determine whether the real modem on the comm. board is powered by the board itself (wall cube or DC power) or takes power from the host system.</p> <p>For host power set 8,9,10 to OFF, ON, ON</p> <p>For on board power set 8,9,10 to OFF, OFF, OFF.</p> <p>Most common configuration for extender mode is to use host power.</p>

#### Default DIP switch settings (standalone)

SW3	Title	Default
10	MOD_RF	OFF
9	MOD_RF	ON
8	MOD_BB	ON
7	NC	OFF
6	Test	OFF
5	Test	OFF
4	Test	OFF
3	Test	OFF
2	Test	OFF
1	MIC BIAS	OFF

SW2	Title	Default
10	Module Wake	ON
9	Host Stat	OFF
8	Wall Pwr Enable	ON
7	NC	OFF
6	FLEX ON/OFF	OFF
5	FLEX ON/OFF inv	OFF
4	UART_SD	OFF
3	Module On	OFF
2	NC	OFF
1	UART Enable	ON

## 5 RF INTEGRATION

### 5.1 Introduction

This chapter covers information related to the radio frequency (RF) integration of the EM3420 wireless modem module. The modem's RF performance specifications are noted below.

Maximum Transmit Power:	PCS: +24.0 dBm (251 mW) Cellular: +24.0 dBm (251mW)
Receiver Sensitivity:	PCS: >-106 Cellular: >-106
Receiver Band:	PCS: 1930 to 1990 MHz Cellular: 869 to 894 MHz
Transmit Band	PCS: 1851 to 1910 MHz Cellular: 824 to 849 MHz
Channel Spacing:	1.25 MHz
GPS Band	1575.24Mhz

### 5.2 RF Connection

The antenna connection point on the EM3420 wireless modem can be attached in several ways. The wireless modem antenna connection can be made with coaxial cable using the Hirose UFL or Murata CSG series coaxial cable connectors, a custom design antenna touch pad, or by soldering the antenna coaxial cable directly to the EM3420 antenna contact. The direct solder method may void some portions of the warranty. Check with your sales associate for clarification if this method of attachment is required. Any Coaxial connection between the EM3420 wireless modem module and the antenna requires the antenna to be correctly matched to 50 .

### 5.3 Ground Plane Isolation

Ground loops must be avoided between the host connector and the antenna.

The coaxial cable connecting the module to the antenna carries the ground connection. There must be an electrical isolation between the ground plane at the antenna and the ground plane used by the modem.

If these two ground planes were not isolated, there would be a ground loop from the modem through the coaxial cable and back through the ground plane to the modem's own ground. This must be avoided.

If your integration uses the device's case as part of the ground connection, then the external antenna connection must be isolated from the case to avoid creating a ground loop. However, in vehicle integrations, it is acceptable to have a remote antenna ground connection to the vehicle chassis.

## 5.4 Antenna and Cabling

After determining the antenna connection method the selection of antenna and cabling must be made.

### 5.4.1 Matching Antenna and Cable

Matching antenna-gain and cable loss is critical to effective RF performance.

For proper matching, the antenna along with any associated matching should have a nominal impedance of 50  $\Omega$  with a return loss  $>10$  dB between 824 – 894 MHz, 1575.24MHz, and 1851 – 1990 MHz. Overall system antenna gain, with cable loss, should be  $>0$  dBi and  $<+6$  dBi. Keep in mind that your achieved value will have an impact on radiated power and the FCC MPE/SAR test results.

### 5.4.2 Antenna Options

There are many antenna vendors who are producing dual-band antennas that may work with the EM3420 wireless modem module. Custom antenna design is also possible but requires a skilled RF engineer to ensure that the RF performance is maintained.

Location of the antenna can also have an impact on RF performance of the EM3420 wireless modem module. The modem itself is shielded to prevent interference in most applications, but this does not mean that antenna placement can be ignored.

### 5.4.3 Cables

Any connecting cables between the modem and the antenna (if required) must be 50  $\Omega$ . Mismatching the impedance of the EM3420 wireless modem module will result in a significant reduction in RF performance.

## 5.5 Interference and Sensitivity

There are several sources of interference that could impact the RF performance of the EM3420 wireless modem module. A few are discussed below.

Sierra Wireless America offers modem OTA (Over-The-Air) sensitivity testing and desense investigation. Most carriers require a certain level of receiver performance in order for the device to function properly on their network. Although the EM3420 wireless modem module has been designed to meet these carrier requirements it is still susceptible to various performance inhibitors.

### 5.5.1 Power Supply Noise

Noise in the power supply can lead to noise in the RF signal. The specification for power supply ripples should be no more than 100 mVp-p 1 Hz to 100 kHz.

### **5.5.2 Device Generated RF**

All electronic computing devices generate radio frequency (RF) interference. You should pay particular attention to RF noise as it can impact the receive sensitivity of the EM3420 wireless modem.

The proximity of host electronics to the antenna can have an adverse effect on the radio's sensitivity. There are many high-speed devices (in particular the processor itself) running at frequencies of 10's of MHz. These signals generate higher order harmonics due to the rapid rise and fall times. These harmonics often fall within the operating frequency band of the EM3420 wireless modem module and cause a decrease in receiver sensitivity.

For example, if we have a sub-system running at 40 MHz, the 22<sup>nd</sup> harmonic falls at 880 MHz, which is within the cellular receive frequency band. In reality there are usually numerous interfering frequencies and harmonics. The net effect can be a series of desense receive channels. Most device designers are familiar with having to pay attention to radiated emissions in order to meet the FCC Part 15 rules. The major culprits in causing RF desense are found to be the microprocessor and memory, display panel and display drivers, and switching mode power supplies.

Some or all of the following techniques may be followed to mitigate this type of RF desense:

- Keep the antenna as remote as possible. By moving the antenna further away from the source of the interference, the effect of the interference may be reduced. The drawback of this approach is the modem may be less convenient to use.
- Shield the host device. The EM3420 wireless modem module itself is well shielded to avoid interference, however it is not practical to shield the antenna for obvious reasons. In most instances it is necessary to employ shielding over the worst radiating elements of the host device (such as the main processor) to reduce such emissions.
- Discrete filtering may also be used on low frequency lines to filter out unwanted high order harmonic energy.
- PCB layout. Use multi-layer PCB's to form shielding layers around high-speed clock traces.

Effective integrators of wireless communication devices inside of computing devices are likely to make use of good design practices coupled with investigative techniques to locate and isolate source of localized interference. It is important to carry out these investigations as early as possible in the design cycle.

The EM 3420 wireless modem module radio circuits use a number of intermediate frequency (IF) stages. The following specific frequencies should be avoided or suppressed in the host device to maintain the best sensitivity performance:

- 183.6 MHz
- 228.6 MHz
- 263.6 MHz

### ***5.5.3 Hearing Aid Considerations***

In addition to outside frequencies interfering with the modem's sensitivity, the modem itself can cause noise in hearing aids due to the keying of the transmitter.

Most digital wireless technologies do not transmit radio frequencies continuously. They transmit in bursts, usually of specific durations, which are often described in terms of RF switching frequencies.

Unfortunately, most hearing aids are not immune to RF; they try to rectify the switching frequencies into audio. This causes unpleasant noise for hearing aid users in close proximity to transmitters, as is the case with digital wireless phones.