13213 Evaluation Kits

User's Guide

Document Number: 13213EVKUG
Rev. 1.1
06/2007

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About This Book

This guide provides a detailed description of how to use the Freescale IEEE®, 802.15.4/ZigBee™ Kits. There are three different kits that contain different hardware. This allows users to build systems with varying levels of complexity as needed.

The software is available on the Freescale BeeKit Wireless Connectivity Tookit CD. See the *BeeKit Wireless Connectivity Toolkit User's Guide* (BKWCTKUG) for software installation details.

The three kits are listed in order of complexity:

- 13213-Development Starter Kit (DSK) — This kit contains two 1321x-SRB boards. (Peer-to-peer link or other custom applications.)
- 13213-Network Starter Kit (NSK) — This kit contains one 1321x-NCB and two 1321x-SRB boards. Peer to Peer link, Star network, or other applications.
- 13213-Evaluations Kit (EVK) — This kit contains three 1321x-NCB and four 1321x-SRB boards. Peer to Peer link, Star network, Clustertree network or other applications.

The 13213 kits provide a flexible demonstration and development environment for the Freescale ZigBee family of products. In addition to the hardware, the kit provides utilities and sample applications that demonstrate functionality from simple proprietary applications, 802.15.4 applications, all the way to full ZigBee compatible solutions.

For more information about the use of the Freescale Test Tool, including the Test Tool Embedded Bootloader application, see the Freescale *Test Tool User's Guide* (TTUG).

Audience

This document is intended for software, hardware, and system engineers who are developing their products or software applications making use of the MC1321x 2.4 GHz transceiver to achieve wireless connectivity capability. The MC1321x is compliant with the IEEE 802.15.4 and the ZigBee standards.

Organization

This document is organized into 7 chapters.

Chapter 1	**Safety Information** - This chapter provides operating guidelines for the 13213 Kit.
Chapter 2	**13213 Kits Board Overview** - This chapter describes the evaluation boards that ship with the 13213 Kits.
Chapter 3	**Evaluation Kit Demonstration Applications** - This chapter describes the various demonstration applications pre-loaded on the boards.
Chapter 6	**Solution Development** - This chapter shows users how to begin development of an MC1321x system solution.

Revision History

The following table summarizes revisions to this document since the previous release (Rev. 1.0).

Revision History

Location	Revision
Entire Document	Removed Test Tool chapters

Conventions

This document uses the following notational conventions:

- `Courier monospaced type` indicate commands, command parameters, code examples, expressions, datatypes, and directives.
- *Italic type* indicates replaceable command parameters.
- All source code examples are in C.

Definitions, Acronyms, and Abbreviations

The following list defines the acronyms and abbreviations used in this document.

ATD	Analog To Digital
BDM	Background Debug Module
CPU	Central Processing Unit
DSK	Development starter Kit
EEPROM	Electrical Erasable Programmable Read Only Memory
ESD	Electro Static Discharge
EVK	Evaluation Kit
GPIO	General Purpose Input Output
ICG	Internal Clock Generation
LDO	Low Drop Output
MCU	Micro Controller Unit
NCB	Network Coordinator Board
NSK	Network Starter Kit
PC	Personal Computer
PCB	Printed Circuit Board
RAM	Random Access Memory
RF	Radio Frequency
Rx	Receive
SCI	Serial Communication Interface
S19	S19' is the file extension used for the Freescale binary image format

Safe Mode Boot	The Embedded Bootloader boots up using safe default system values
HIWAVE	P&E HCS08 debugger GUI
CPROG	P&E HCS08 flash programming tool called from HIWAVE
SMA	SubMiniature version A
SPI	Serial Peripheral Interface
SRB	Sensor Reference Board
Tx	Transmit

References

The following sources were referenced to produce this book:

1. ZigBee.hlp - see Test Tool installation directory.\help
2. Freescale MC13213 Data Sheet, MC13213DS
3. Freescale Application Note, Handling MAC Address Erasure, AN2825
4. Freescale Application Note, ZigBee/802.15.4 Development Starter Kit, Quick Start Guide
5. Freescale Embedded Bootloader Reference Manual, MC13192EBRM
6. Freescale Accelerometer Demo Application, AN3232
7. Freescale Compact, Integrated Antennas, Designs and Applications, AN2731
8. IEEE™ 802.15.4 specification 1.0

Chapter 1
Safety Information

Any modifications to this product may violate the rules of the Federal Communications Commission and make operation of the product unlawful.

47 C.F.R. Sec. 15.21

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.

47 C.F.R. Sec.15.105(b)

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

The antenna(s) used for this equipment must be installed to provide a separation distance of at least 8 inches (20cm) from all persons.

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.
2. This device must accept any interference received, including interference that may cause undesired operation.
3. This device is susceptible to electrostatic discharge (ESD) and surge phenomenon.

Chapter 2
13213 Kits Board Overview

The 13213 kits contains two different boards:

- 1321x-Sensor Reference Board (SRB)
- 1321x-Network Coordinator Board (NCB)

See the packing list shipped with the kit to determine exact kit contents.

These boards are delivered with pre-loaded demonstration applications. More applications can be uploaded with either the Embedded Bootloader utility which is located in the Freescale Test Tool application, or with CodeWarrior using the USB Multilink programmer (optional).

The CodeWarrior software is not required to run the demonstrations or utilities described in this guide. However, some applications are board dependent and will only run on specific target boards. Demonstration applications for the 1321x-NCB and the 1321x-SRB include:

- SMAC Applications
  - Basic Packet Error Rate (PER)
  - Wireless UART
  - Accelerometer
  - Range
  - Lighting
  - Test Mode
  - Repeater
  - Simple Protocol Test Client
  - Over the Air Programmer (OTAP)
- 802.15.4 MAC Applications
  - PTC Demonstration
  - 802.15.4 MyStarNetwork Demo
  - 802.15.4 MyWirelessApp Demo

NOTE

Additional applications can be run with the Freescale BeeStack software. For more information, refer to the appropriate Freescale BeeStack documentation.

2.1 Demonstration Software

The demonstration software is available on the Freescale BeeKit Wireless Connectivity Toolkit CD. See the *BeeKit Wireless Connectivity Toolkit User's Guide* (BKWCTKUG) for software installation details.

See Chapter 3, "Evaluation Kit Demonstration Applications" for a complete list of demonstration applications.

2.2 Common Board Components

2.2.1 MC13213 Transceiver

The MC13213 RF transceiver is an IEEE® 802.15.4-compliant radio operating in the 2.4 GHz ISM frequency band. The transceiver includes a low noise amplifier, 1mW nominal output power, voltage controlled oscillator (VCO), integrated transmit/receive switch, on-board power supply regulation, and full spread-spectrum encoding and decoding. The microcontroller unit is based on the HCS08 Family of Microcontrollers (MCU) and provides up to 60KB of flash memory and 4KB of RAM. The onboard MCU allows the communications stack and the application to reside on the same system-in-package (SIP). For additional information, see the MC13213DS data sheet at www.freescale.com/ZigBee.

2.2.2 MMA7260Q Acceleration Sensor

The MMA7260Q Acceleration Sensor provides the 1321x-SRB with unique applications to demonstrate wireless sensing solutions. For more information about the MMA7260Q sensor, see the data sheets included with the ZigBee EVK CD or visit www.freescale.com/sensors.

2.3 1321x-NCB Network Coordinator Board Description

The 1321x-NCB is an 802.15.4/ZigBee evaluation board based on the MC13213, 2.4GHz transceiver. The 1321x-NCB board provides both USB and RS232 UART connectivity to a PC for easy evaluation. The 1321x-NCB contains the following interfaces:

- 2.0 USB port
- 4 Push buttons (SW1, SW2, SW3, and SW4)
- 1 Reset button (Reset)
- 4 LED's (LED1, LED2, LED3, and LED4)
- One power switch (S100)
- SMA RF connector
- Printed F antenna (refer to AN2731/D for more information)
- 2x3 pin, Background Debug Module (BDM) connection allowing flash programming and in-circuit debug via the included USB Multilink Cable (see the USBMULTECHSUM/D document included in the kit for more details).
- Power connector (5-9 Volts), Note that the center pin in the DC-jack connector is positive (+).
- Battery holder, 2xAA

- Four 8-pin header strip for access to specific MCU and RF pins

Figure 2-1 shows the 1321x-NCB block diagram.

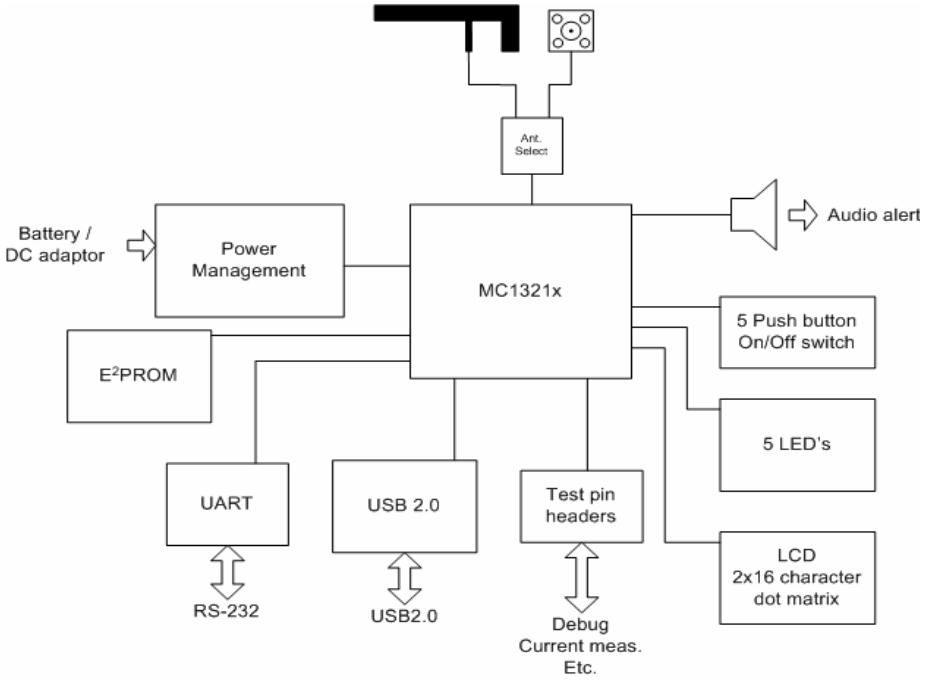

Figure 2-1. NCB Block Diagram

Figure 2-2 shows the 1321x-NCB board.

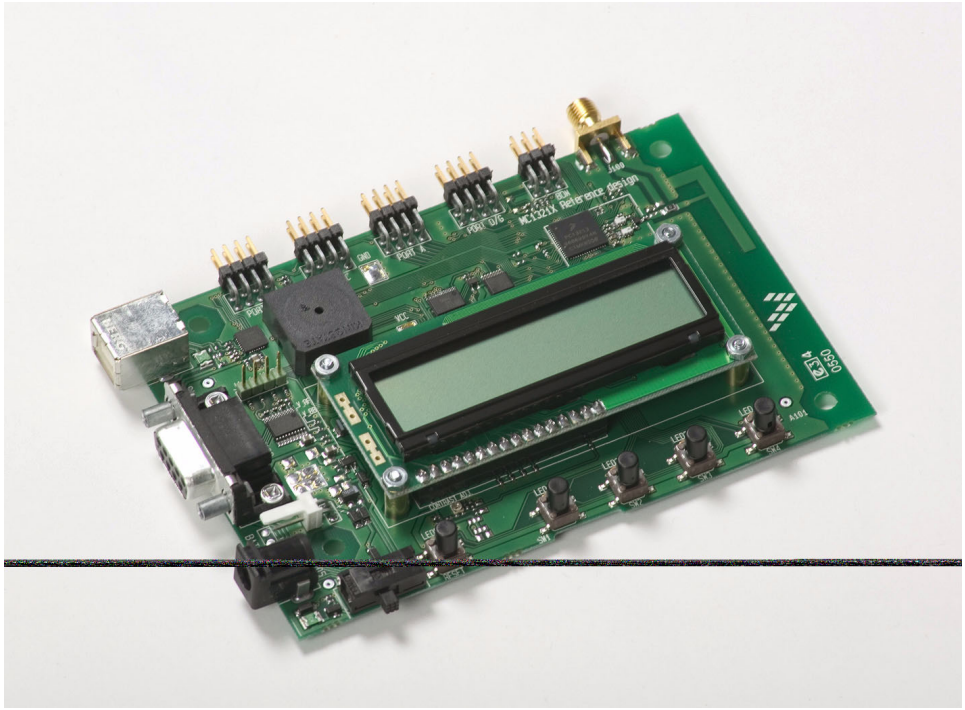

Figure 2-2. 1321x-NCB

Table 2-1 summarizes the 1321x-NCB board labels. For additional information about the board design, see the *13213-EVK Reference Manual* (1321xEVKRM)

Table 2-1. NCB Board Labels

Name	Board Designation
LED1	LED1
LED2	LED2
LED3	LED3
LED4	LED4
Button 1	SW1
Button 2	SW2
Button 3	SW3
Button 4	SW4
Reset Button	Reset
Power ON/OFF	S100

2.4 1321x-SRB Sensor Reference Board Description

The 1321x-SRB is an 802.15.4/ZigBee evaluation board based on the MC13213, 2.4GHz transceiver. The 1321x-SRB board provides USB connectivity to a PC for easy evaluation. The 1321x-SRB contains the following interfaces:

- 2.0 USB port
- 4 Push buttons (SW1, SW2, SW3, and SW4)
- 1 Reset button (Reset)
- 4 LED's (LED1, LED2, LED3, and LED4)
- One power switch (S100)
- Printed F antenna (refer to AN2731/D for more information)
- 2x3 pin, Background Debug Module (BDM) connection allowing flash programming and in-circuit debug via the included USB Multilink Cable (see the USBMULTECHSUM/D document included in the kit for more details).
- Power connector (5-9 Volts), note that the center pin in the DC-jack connector is positive (+).
- Battery holder, 2xAA. However, if using the onboard AA battery pack to power the SRB and the temperature sensor is being used, the readings will not be accurate. To obtain more accurate readings, power the SRB through its on board DC power connector.
- 26-pin header strip for access to specific MCU and RF pins

Figure 2-3 shows the 1321x-SRB block diagram.

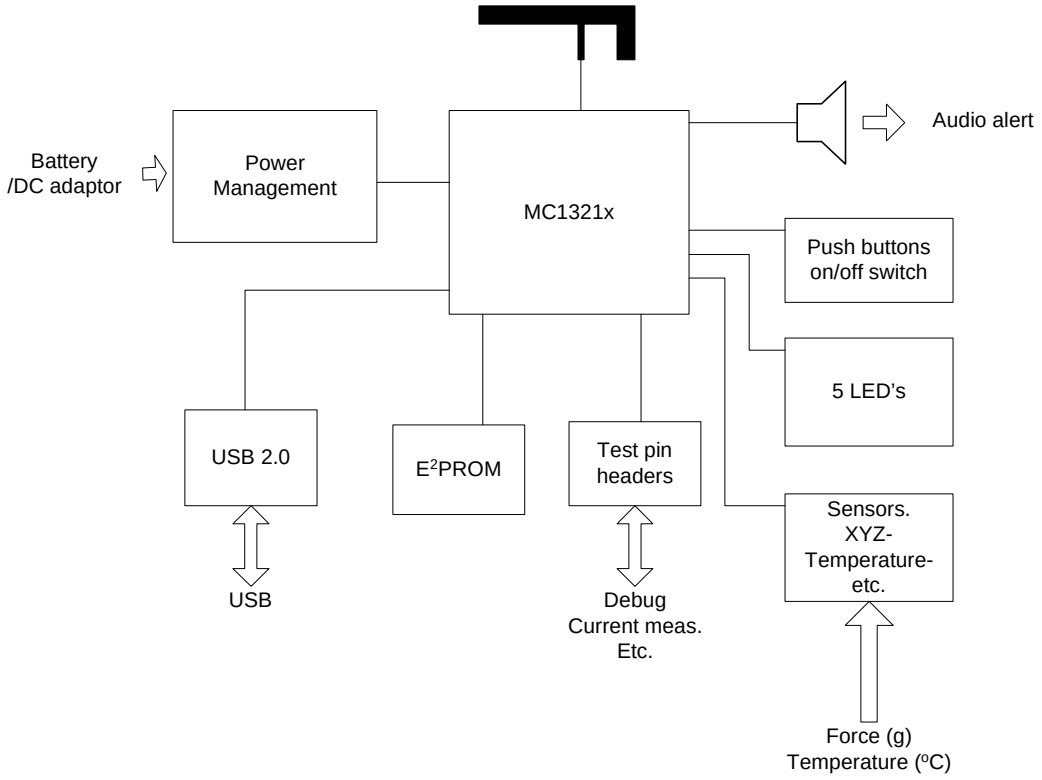

Figure 2-3. SRB Block Diagram

Figure 2-4 shows the 1321x-SRB board.

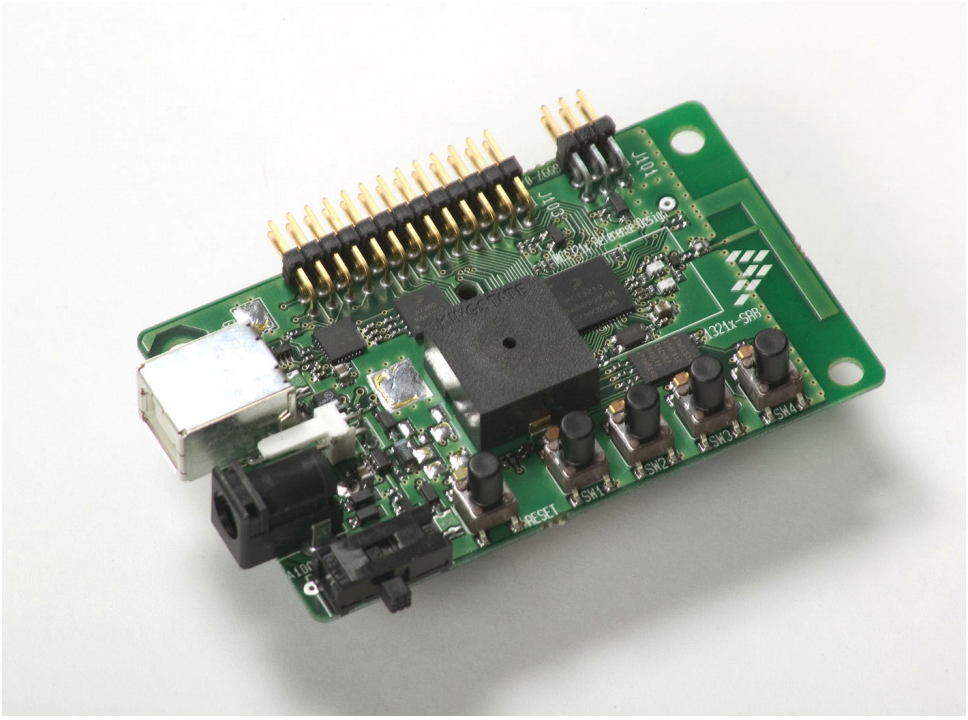

Figure 2-4. 1321x-SRB

Table 2-2 summarizes the 1321x-SRB board labels. For additional information about the board design, see the *1321xEVK Reference Manual* (1321xEVKRM).

Table 2-2. SRB Board Labels

Name	Board Designation
LED1	LED1
LED2	LED2
LED3	LED3
LED4	LED4
Button 1	SW1
Button 2	SW2
Button 3	SW3
Button 4	SW4
Reset Button	Reset
Power ON/OFF	S100

Chapter 3
Evaluation Kit Demonstration Applications

The sample applications provided with the BeeKit CD are based on Freescale's Simple MAC (SMAC) and/or the 802.15.4 MAC software. For ZigBee stack application examples, see the appropriate Freescale BeeStack documentation.

The following applications are included on the BeeKit CD:

3.1 SMAC Applications

The following list highlights currently available SMAC applications. Refer to the *Simple Media Access Controller (SMAC) User's Guide* and AN3231 for more information.

- Basic Packet Error Rate (PER)
- Wireless UART
- Accelerometer
- Range
- Lighting
- Test Mode
- Repeater
- Simple Protocol Test Client
- Over the Air Programmer (OTAP)

3.2 802.15.4 MAC/PHY Applications

The following list highlights currently available 802.15.4 MAC/PHY applications. Refer to the *802.15.4 MAC/PHY Software Reference Manual* (802154MPSRM) and other appropriate Freescale documentation for more information.

- PTC Demonstration (AN2771)
- 802.15.4 MyStarNetwork Demo (802.15.4 MyStarNetwork User's Guide)
- 802.15.4 MyWirelessApp Demo (802.15.4 MyWirelessApp User's Guide)

3.3 Windows Based Application

The following list highlights currently available Windows based applications. Refer to the *Embedded Bootloader Reference Manual* (802154EBRM), the Freescale Test Tool On-line Help, the *Test Tool User's Guide*, and other appropriate Freescale documentation for more information.

- Test Tool, which contains the following:
  - — Command Console
  - — Script Server
  - — Embedded Bootloader
  - — Radio Test

Chapter 4
Solution Development

This chapter shows how to begin development of an MC1321x system solution. Each section highlights the documentation users must read before beginning system development. Unless specifically stated, all documents described in this chapter are available at: www.freescale.com\Zigbee

4.1 Hardware Design and Layout

Before users begin their hardware design and layout, Freescale provides and recommends reading the documents shown in Hardware Design and Layout Recommended Reading. These documents contain reference design information and hardware design guidelines.

Table 4-1. Hardware Design and Layout Recommended Reading

Document Title	Part Number
Compact Integrated Antennas: Designs and Applications for the MC1319x/MC1320x, and MC1321x	AN2731
Accelerometer Demonstration With the Sensor Applications Reference Design (SARD)	AN3232 (MC1320x/21x)
13213EVK Evaluation Board Reference Manual	13213EVKRM
MC13201 2.4 GHz, Low Power Transceiver, Reference Manual	MC13201RM
MC13201 2.4 GHz, Low Power Transceiver, Data Sheet	MC13201
MC13202/MC13203 2.4 GHz, Low Power Transceiver, Reference Manual	MC13202RM
MC13202/MC13203 2.4 GHz, Low Power Transceiver, Data Sheet	MC13202
MC1321x 2.4 GHz, Low Power Transceiver, Reference Manual	MC1321xRM
MC1321x 2.4 GHz, Low Power Transceiver, Data Sheet	MC1321x
PCB Layout Guidelines for the MC1321x	AN3149

In addition, a complete reference design package can be provided upon request.

4.2 Software Applications Development

When building applications for the MC13213 transceiver, Freescale recommends using the CodeWarrior Software Development Tools. A trial version is shipped with the BeeKit CD.

In addition, Freescale provides and recommends reading the documents shown in Software Applications Recommended Reading. Most notably, Freescale recommends reading the documentation that describes the Embedded Bootloader implementation and the Non-volatile Memory (NVM) area used for storing information in the application.

Table 4-2. Software Applications Recommended Reading

Document Title	Part Number
Handling MAC Address Erasure, Recommendations for Restoration	AN2825
802.15.4/ZigBee Embedded Bootloader Reference Manual	802154EBRM
MC13201 2.4 GHz, Low Power Transceiver, Reference Manual	MC13201RM
MC13201 2.4 GHz, Low Power Transceiver, Data Sheet	MC13201
MC13202/MC13203 2.4 GHz, Low Power Transceiver, Reference Manual	MC13202RM
MC13202/MC13203 2.4 GHz, Low Power Transceiver, Data Sheet	MC13202
MC1321x 2.4 GHz, Low Power Transceiver, Reference Manual	MC1321xRM
MC1321x 2.4 GHz, Low Power Transceiver, Data Sheet	MC1321x
HCS08 Flash Library Integration For ZigBee and 802.15.4 Applications	AN2770
802.15.4 MAC/PHY Software Reference Manual	802154MPSRM

4.3 Proprietary Applications (SMAC)

To begin development of a proprietary application, Freescale provides and recommends reading the documents shown in Table 4-3.

Table 4-3. Proprietary Applications Recommended Reading

Document Title	Part Number
MC1321x Accelerometer Demonstration Quick Start Guide	AN3230
MC1321x Demonstration Operation: Running the Packet Error Rate, Wireless UART, Accelerometer, Range, and Lighting Demonstration Applications	AN3231
MC1321x Accelerometer Demonstration Program	AN3232
Simple Media Access Controller (SMAC) User's Guide	SMACRM

4.4 802.15.4 Specific Applications

Freescale provides and recommends reading the documents shown in 802.15.4 Specific Applications Recommended Reading. This documentation helps guide users through development of an application that sits on top of the 802.15.4 MAC.

Table 4-4. 802.15.4 Specific Applications Recommended Reading

Document Title	Part Number
802.15.4 MAC/PHY Software Reference Manual	802154MPSRM
ZigBee/802.15.4 PHY Protocol Test Client (PTC), Running the PTC Demonstration on the 13192-EVB (DIG-528 board)	AN2771
802.15.4 PHY (Physical Layer) Setup and Porting to Various Printed Circuit Boards (PCBs)	AN2769
802.15.4 Media Access Controller (MAC) MyStarNetworkApp User's Guide	802154MSNUG
802.15.4 Media Access Controller (MAC) MyWirelessApp User's Guide	802154MWAUG

4.5 ZigBee Applications

For development of ZigBee applications, refer to the appropriate Freescale BeeStack documentation.

Table 4-5. ZigBee Specific Applications Recommended Reading

Document Title	Part Number
Freescale BeeStack™ Documentation Overview	BSDO
Freescale BeeStack™ Application Development Guide	BSADG
Freescale ZigBee™ Application User's Guide	ZAUG
Freescale BeeStack™ Software Reference Manual	BSSRM
Freescale Platform Reference Manual	FSPRM
Freescale ZigBee™ Cluster Library (ZCL) Reference Manual	ZCLRM
Freescale ZigBee™ Test Client (ZTC) Reference Manual	ZTCRM