13192EVK Evaluation Kit

(13192EVK) User's Guide

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About This Book

This guide provides a detailed description of how to use the Freescale IEEE® 802.15.4/ZigBee™ Evaluation Kit (13192EVK), part number 13192EVK.

The 13192EVK provides 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 complete software installation details, see the Freescale *BeeKit Wireless Connectivity Toolkit User's Guide* (BKWCTKUG).

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 application developers.

Organization

This document is organized into 6 chapters.

Chapter 1 **Safety Information** - This chapter provides operating guidelines for the 13192EVK.

Chapter 2 **13192-EVB Board Overview** - This chapter describes the 13192-EVB evaluation boards and system components that ship with the 13192EVK.

Chapter 3 **Evaluation Kit Demonstration Applications** - This chapter lists the various demonstration applications.

Chapter 4 **Solution Development** - This chapter shows users how to begin development of an MC13192 system solution.

Revision History

The following table summarizes revisions to this document since the previous release (Rev 1.2).

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.

BDM debugger	A debugger using the BDM interface for communication with the MCU. An example is the P&E BDM Multilink debugger for HCS08.
BDM	Background Debug Module
13192EVK	The 802.15.4/ZigBee Evaluation Kit
GUI	Graphical User Interface
MAC	Medium Access Control
MCU	MicroController Unit
NVM	None-Volatile Memory
PC	Personal Computer
PCB	Printed Circuit Board
S19	'S19' is the file extension used for the Freescale binary image format. The S19 file encapsulates the binary image as a list of ASCII records. Each record contains a length -, address -, data - and checksum field. The 16 bit address field allows a memory space for up to 64 KB. The S19 can be generated with the CodeWarrior IDE and is the product from the linking process. S19 does not contain additional information to a debugger (where to look for source files).
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. The tool is also available in a command line version where scripts can be made.

References

The following sources were referenced to produce this book:

[1] ZigBee.hlp (see Test Tool installation directory .\help)

[3] Freescale MC908HCS08GB60/GT60 MCU Data Sheet, MC9S08GB60

[4] Freescale Application Note, Handling MAC Address Erasure, AN2825

[5] Freescale Application Note, ZigBee/802.15.4 Evaluation Kit, Quick Start Guide, AN2772

[6] Freescale Embedded Bootloader Reference Manual, MC13192EBRM

[7] Freescale Switch Demo Application, AN2773

[8] Freescale Accelerometer Demo Application, AN2774

[9] Freescale Compact, Integrated Antennas, Designs and Applications, AN2731

[10] 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
13192EVK Board Overview

The 13192EVK contains two different types of boards.

1. 13192-EVB
2. 13192-SARD

These boards include the following on-board components except where noted otherwise:

- MC13192, 2.4GHz transceiver
- MC9S08GT60 Micro Controller Unit (MCU)
- MMA6261Q accelerometer (13192-SARD only)
- MMA1260D accelerometer (13192-SARD only)

2.1 13192EVK Components

The boards shipped with the 13192EVK 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 (provided). The CodeWarrior CD ROM (provided) requires users to register for a 30-day evaluation key. After this time, users must purchase a standard key to use the CodeWarrior Software (see the CodeWarrior documentation for detailed information).

The CodeWarrior software is not required to run the demonstrations or utilities described in this guide. The 13192EVK contains the 13192-EVB and the 13192-SARD boards. To see a complete list of demonstration applications, see Chapter 3, “Evaluation Kit Demonstration Applications”

NOTE

To run ZigBee specific applications, see the appropriate Freescale BeeStack documentation.

2.2 13192EVK Contents

Section 2.3, “Common Board Components” lists the board hardware and additional items contained in the 13192EVK development kit.

Table 2-1. 13192EVK Boards

P/N	Description	QTY
13192-EVB	802.15.4/ZigBee Evaluation Board	3
13192-SARD	802.15.4/ZigBee Sensor Application Board	2
	Power adaptor, 9Vdc with 4 interchange plugs	3

Table 2-1. 13192EVK Boards

	Battery, 9V	5
	Cable, BDM Interface (USB), 68HCS12/68HCS08	1
	Cable, 6ft. DB9 M/F, RS-232 Serial	2
	Cable, 6 ft. USB 2.0 A-M to B-M	3
	Cable, 9V Battery Clip to 2.1mm PLUG, SARD	2
	Cable, 9V Battery Clip to 2.1mm RECP, EVB	3
	PWA, Network Sniffer, DIG534-2	1
	PWA, 13192-SARD	2
	PWA, 13192-EVB	3
	Hardware Documentation (BeeKit CD)	1
	CD, HC(S)08 Service Pack	1
	Warranty Card, Freescale, 920-75133	1
BR1530	Technical Information Center, Freescale Semiconductor, Inc.	1
	ZigBee Evaluation Kit User's Guide (13192EVK)	1
	Technical Summary, USB HCS08/HCS12 Multilink rev. B	1
	Release Notes 13192EVK	1
	Frontline Test System Setup and Quick Start Guide	1
	CodeWarrior Development Studio HC(S)08 Special Edition	1

2.3 Common Board Components

2.3.1 MC9S08GT60 MCU

The MC9S08GT60 MCU is contained on both the 13192-SARD and 13192-EVB boards. The MC9S08GT60 MCU is a member of Freescale's 8-bit, low cost, low power family of HCS08 MCUs. It has 60KB of embedded flash and 4KB of RAM. For more information, refer to the MC9S08GB60 data sheet at www.freescale.com/mcu.

2.3.2 MC13192 RF Data Modem

The MC13192 is contained on both the 13192-SARD and 13192-EVB boards. The MC13192 is an 802.15.4 compliant, ZigBee-ready transceiver. It has a four-wire SPI interface to connect to a variety of microcontrollers, creating a low power, low cost solution for a range of applications. For more information on the MC13912, see the MC13192DS data sheet at www.freescale.com/ZigBee.

2.3.3 MMA1260D and MMA6261Q Acceleration Sensors

The MMA6261Q Acceleration Sensors are contained only on the 13192-SARD board. The MMA1260D and the MMA6261Q Acceleration Sensors provide the 13192-SARD with unique applications to

demonstrate wireless sensing solutions. For more information on the MMA1260D and the MMA6261Q sensors, see their respective data sheets included with the 13192EVK CD or visit www.freescale.com/sensors.

2.4 13192-EVB Evaluation Board Description

The 13192-EVB is an 802.15.4/ZigBee evaluation board based on the MC13192, 2.4GHz transceiver and the MC9S08GT60 MCU. The 13192-EVB board provides both serial and USB connectivity to a PC for easy evaluation. For improved sensitivity and range evaluations, the 13192-EVB includes the necessary circuitry to enable the MBC13900 Low Noise Amplifier (LNA). It is also equipped with an external SMA connector for an external antenna connection allowing easy connectivity to a scope for test and measurement. The 13192-EVB contains the following interfaces:

- 1.1 USB port
- RS232 Serial Connection
- 4 push buttons (S1, S2, S3, S4)
- 1 Reset button (Reset)
- 4 LEDs, (LED1, LED2, LED3, LED4)
- One power switch (S106)
- Printed F antenna (refer to AN2731/D for more information)
- Optional MBC13900 LNA (disabled by default, visit www.freescale.com/rf for more information)[1]
- SMA RF connector (disabled by default)
- Background Debug Module (BDM) connection allowing flash programming and in-circuit debug via the included USB Multilink Cable (see the USBMULTECHSUM document included in the kit for more details).
- Power connector (5-9 Volts)
- 10-pin header strip for access to specific MCU and RF pins

1. The MCB13900 will be discontinued as of July 2007 and is not recommended for new designs. Freescale recommends the Infineon BFP420 and the NEC NE622M04.

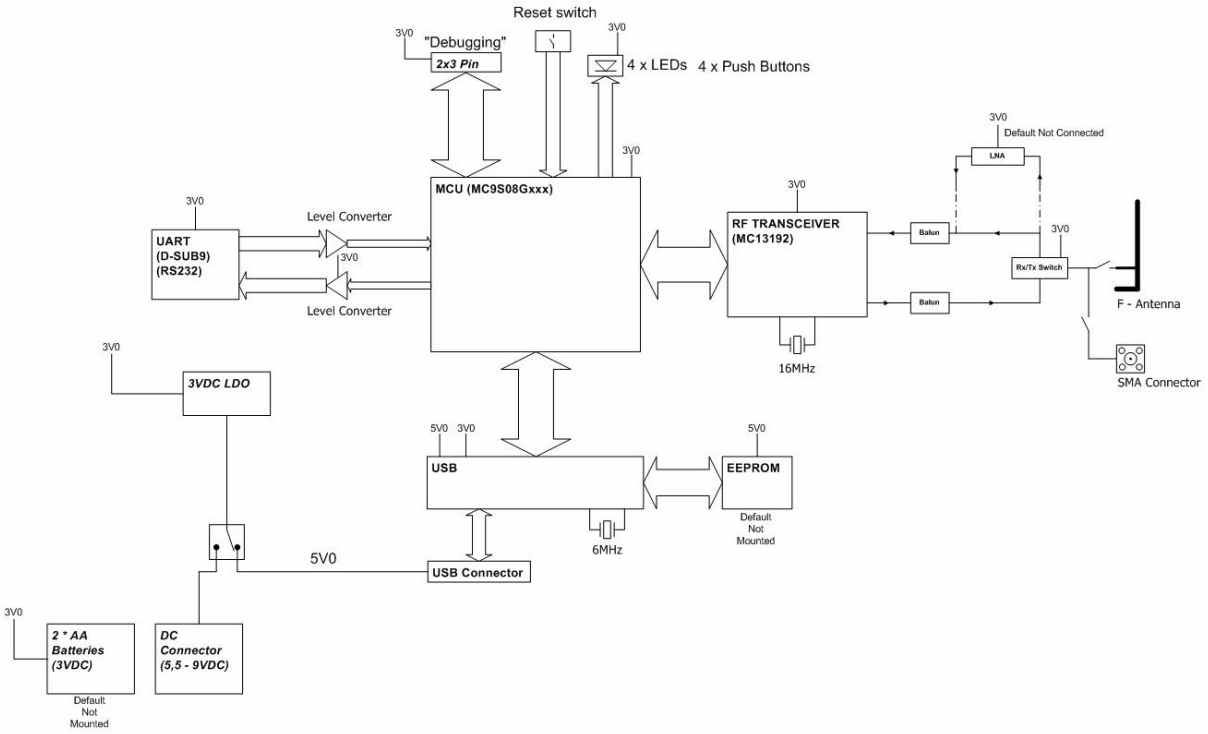

Figure 2-1. 13192-EVB Block Diagram

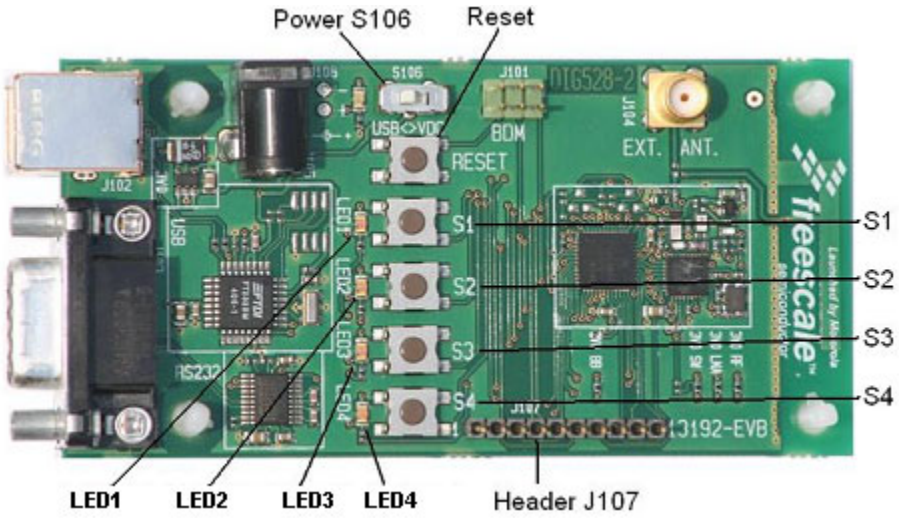

Figure 2-2. 13192-EVB Board Layout

Table 2-2. 13192-EVB Board Labels

Common Name	Board Designation
LED 1	LED1
LED 2	LED2
LED 3	LED3
LED 4	LED4
Button 1	S1
Button 2	S2
Button 3	S3
Button 4	S4
Reset Button	Reset
Power Toggle	S106

NOTE

Switch S106 toggles power between the USB connector and the power connector. Refer to the *13192 Evaluation Board Reference Manual*, 13192EVBRM for more info.

2.5 13192-SARD Description

The 13192-SARD is a demonstration board based on the MC13192, 2.4GHz transceiver, MC9S08GT60 MCU, and the MMA6261Q and MMA1260D Acceleration Sensors. The 13192-SARD contains the following interfaces:

- RS232 Serial Connection
- 4 push buttons (S101, S102, S103, S104)
- 1 Reset button (S106)
- 4 LEDs (D101, D102, D103, D104)
- One power switch (S105)
- Printed Dipole antenna (refer to AN2731/D for more information)
- Background Debug Module (BDM) connection allowing flash programming and in-circuit debug via the included USB Multilink Cable (see USBMULTECHSUM/D document included in the kit for more details).
- Power Connections
- Power connector (5.5-9 Volts)
- 9-Volt battery connector
- 3-Volt power connector (MMA1260D Acceleration Sensor disabled)
- 26-pin header strip (J105), for access to specific RF, MCU, and sensor pins

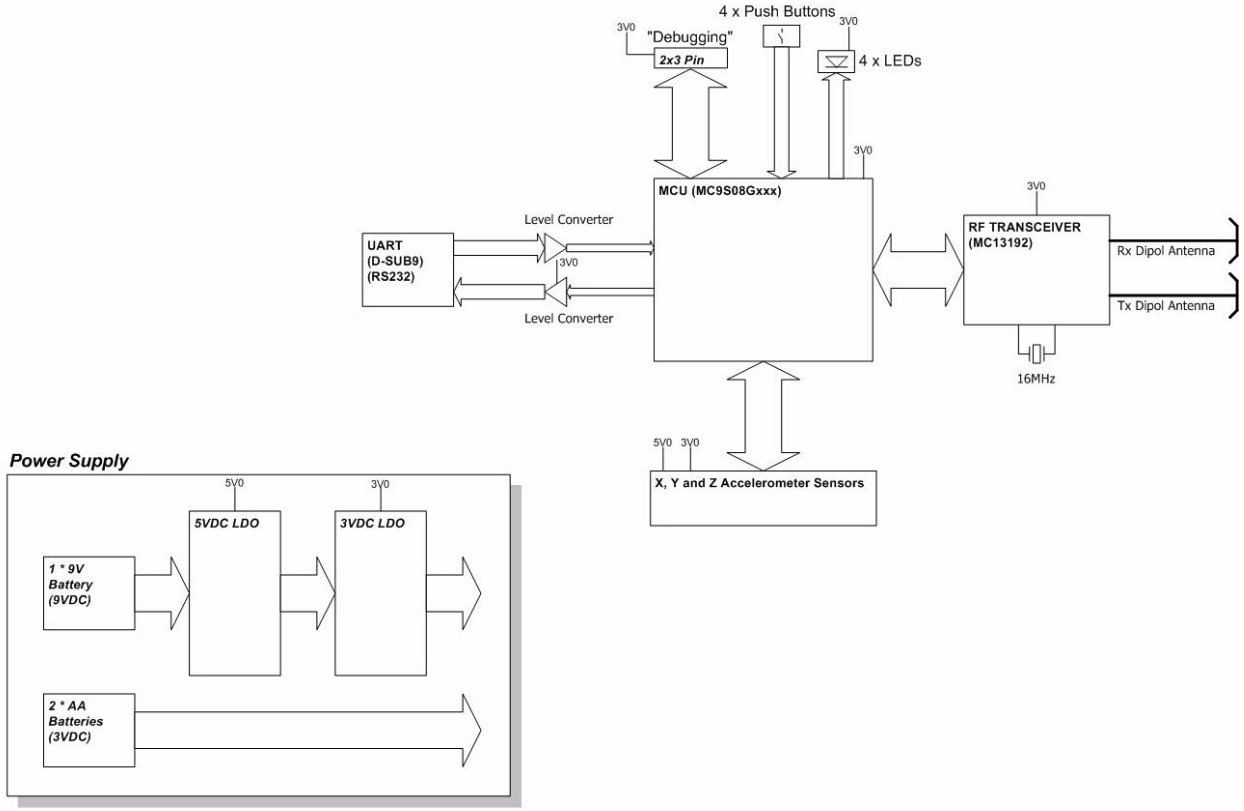

Figure 2-3. 13192-SARD Block Diagram

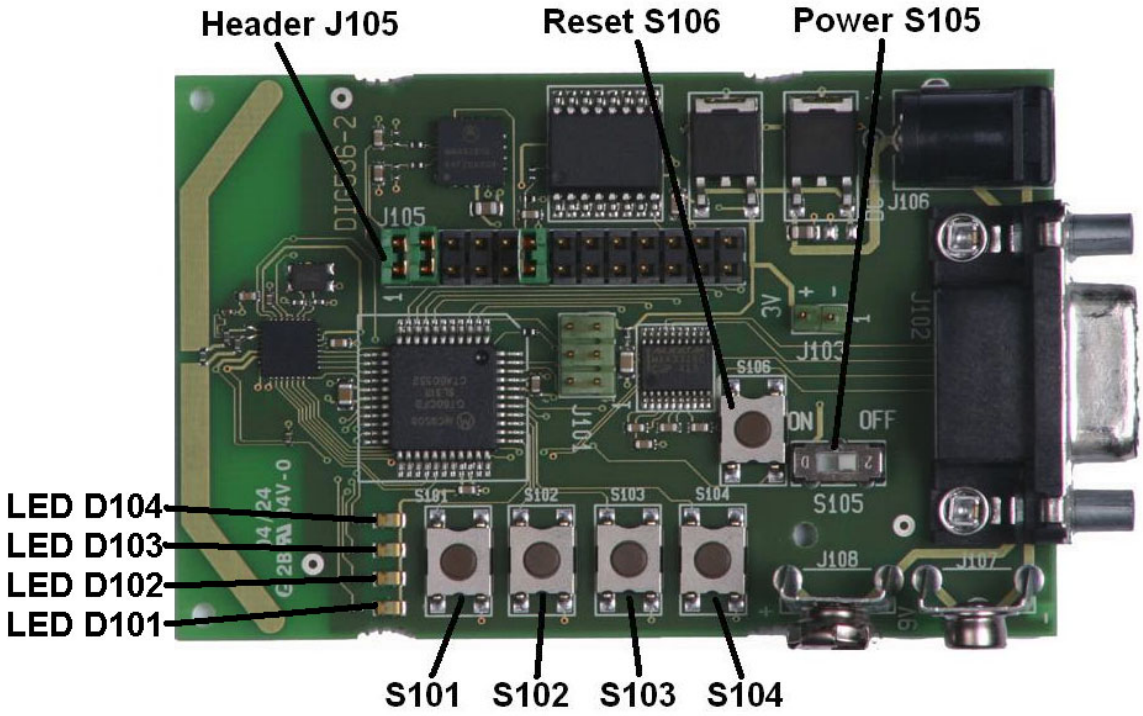

Figure 2-4. 13192-SARD Board Layout

Table 2-3. 13192-SARD Board Labels

Common Name	Board Designation
LED 1	LED D101
LED 2	LED D102
LED 3	LED D103
LED 4	LED D104
Button 1	S101
Button 2	S102
Button 3	S103
Button 4	S104
Reset Button	S106
Power Switch	S105

NOTE

See the *SARD User's Guide*, (MC13192SARDUG) for more information.

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 includes the following items:
  - Command Console
  - Script Server
  - Embedded Bootloader
  - Radio Test

Chapter 4
Solution Development

This chapter shows users how to begin development of an MC13192 system solution. Each section highlights the documentation users must read before they begin 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 Table 4-1. 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 MC13191/92.	AN2731
Accelerometer Demonstration With the Sensor Applications Reference Design (SARD)	AN3232
Simple Media Access Controller (SMAC) User's Guide	SMACRM
13192EVB Evaluation Board Reference Manual	13192EVBRM
MC13191 2.4 GHz, Low Power Transceiver Reference Manual	MC13191RM
MC13192/MC13192 2.4 GHz, Low Power Transceiver Reference Manual	MC13192RM
MC13191 2.4 GHz, Low Power Transceiver, Data Sheet	MC13191DS
MC13192/MC13192 2.4 GHz, Low Power Transceiver Data Sheet	MC13192DS

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

4.2 Software Applications Development

When building applications for the MC13192 transceiver, Freescale recommends using the CodeWarrior Software Development Tools. A trial version is shipped as part of the 13192EVK. For complete documentation and help, see the Metrowerks home page at www.metrowerks.com.

In addition, Freescale provides and recommends reading the documents shown in Table 4-2. 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
MC13191 2.4 GHz, Low Power Transceiver, Reference Manual	MC13191RM
MC13192/MC13192 2.4 GHz, Low Power Transceiver, Reference Manual	MC13192RM
HCS08 Flash Library Integration For ZigBee and 802.15.4 Applications	AN2770

4.2.1 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
Demonstration Operation: Running the Packet Error Rate, Wireless UART, Accelerometer, Range, and Lighting Demonstration Applications	AN3231
MC1319x Accelerometer Demonstration Program: Quick Start Guide	AN2762
Sensor Applications Reference Design (SARD) User's Guide	MC13192SARDUG
Simple Media Access Controller (SMAC) User's Guide	SMACRM

4.2.2 802.15.4 Specific Applications

Freescale provides and recommends reading the relevant Freescale 802.15.4 MAC documents. These documents will help 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

4.2.3 ZigBee Applications

For development of ZigBee applications, refer to the appropriate 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