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1323x Development Hardware

Reference Manual

Document Number: 1323xDHRM
Rev. 1.1
07/2011

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About This Book

This manual describes Freescale's MC1323x development platform hardware. The MC1323x development platform is an IEEE 802.15.4 compliant evaluation environment based on the Freescale MC1323x device. The heart of the MC1323x platform is Freescale's low cost System-on-Chip (SoC) for the IEEE® 802.15.4 Standard that incorporates a complete, low power, 2.4 GHz radio frequency transceiver with Tx/Rx switch, an 8-bit HCS08 CPU, and a functional set of MCU peripherals into a 48-pin LGA package. This family of products is targeted for wireless RF remote control and other cost-sensitive applications ranging from home TV and entertainment systems such as ZigBee BeeStack Consumer (RF4CE) to low cost, low power, IEEE 802.15.4 and ZigBee end nodes.

Audience

This manual is intended for system designers.

Organization

This document is organized into 6 chapters.

Chapter 1 — Safety Information — Highlights some of the FCC requirements.

Chapter 2 — HCS08 Development Platform Overview and Description — Provides an overview of the three boards that comprise the MC1323x development platform.

Chapter 3 — Modular Reference Board — This chapter details the 1323x-MRB which is an IEEE, 802.15.4 compliant evaluation board based on the Freescale MC1323x device.

Chapter 4 — 1323x-Remote Control Module — This chapter details the 1323x-RCM motherboard that accepts the 1323x-Modular Reference Board (1323x-MRB) plug-in module (daughter card) and supplies a power supply and a rich set of interface peripherals.

Chapter 5 — 1323x-Remote Extender Board — This chapter details the 1323x REM motherboard that accepts the 1323x-Modular Reference Board (1323x-MRB) plug-in module (daughter card) and supplies a power supply and set of interface peripherals.

Chapter 6 — PCB Manufacturing Specifications — This chapter provides the specifications used to manufacture the various MC1323x printed circuit boards (PCBs).

Revision History

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

Revision History

Location	Revision
Chapter 5	Inserted missing page 2 of REM schematic.

Definitions, Acronyms, and Abbreviations

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

ADC	Analog to Digital Converter
AES	Advanced Encryption Standard
ARM	Advanced RISC Machine
CTS	Clear to Send
DAC	Digital to Analog Converter
DMA	Direct Memory Access
I2C	Inter-Integrated Circuit is a multi-master serial computer bus
ISM	Industrial Scientific Medical 2.4 GHz radio frequency band
JTAG	Joint Test Action Group
LGA	Land Grid Array
MAC	Media Access Controller
MCU	Microcontroller Unit
NEXUS	An embedded processor development tool interface that helps design engineers identify software and hardware-level issues.
PCB	Printed circuit board
PiP	Platform in Package
PWM	Pulse-width modulation
RCM	Remote Control Module
REM	Remote Extender Board
RTS	Request to Send
SMA Connector	SubMiniature version “A” connector
SPI	Serial Peripheral Interface
SSI	Synchronous Serial Interface
TACT Switch	A switch that provides a slight “snap” or “click” to the user to indicate function.
TELCO	Telephone Company
USB	Universal Serial Bus
VCP	Virtual Com Port

Chapter 1
Safety Information

1.1 FCC Guidelines

This equipment is for use by developers for evaluation purposes only and must not be incorporated into any other device or system. This device may not be sold to the general public. Integrators will be responsible for reevaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

FCC approval of this device only covers the original configuration of this device as supplied. Any modifications to this product, including changes shown in this manual, may violate the rules of the Federal Communications Commission and Industry Canada and make operation of the product unlawful.

1.1.1 Labeling

FCC labels are physically located on the back of the board.

1.1.2 Operating Conditions

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

1.1.3 Exposure Limits

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.

1.1.4 Antenna Restrictions

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional

radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

1.2 Regulatory Approval For Canada (IC RSS 210)

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.

1.2.1 26 PART 5 – Appendix

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.

1.3 Electrostatic Discharge Considerations

Although damage from electrostatic discharge (ESD) is much less common on these devices than on early CMOS circuits, normal handling precautions should be used to avoid exposure to static discharge. Qualification tests are performed to ensure that these devices can withstand exposure to reasonable levels of static without suffering any permanent damage.

All ESD testing is in conformity with the JESD22 Stress Test Qualification for Commercial Grade Integrated Circuits. During the device qualification ESD stresses were performed for the human body model (HBM), the machine model (MM) and the charge device model (CDM).

All latch-up test testing is in conformity with the JESD78 IC Latch-Up Test.

When operating or handling the development boards or components, Freescale strongly recommends using at least the grounding wrist straps plus any or all of the following ESD dissipation methods:

- Flexible fabric, solid fixed size, or disposable ESD wrist straps
- Static control workstations, static control monitors and table or floor static control systems
- Static control packaging and transportation materials and environmental systems

1.4 Disposal Instructions

This product may be subject to special disposal requirements. For product disposal instructions, refer to www.freescale.com/productdisposal.

Chapter 2
MC1323x Development Platform Overview and Description

2.1 Introduction

The MC1323x development platform is an IEEE 802.15.4 compliant evaluation environment based on the Freescale MC1323x device. The heart of the MC1323x platform is Freescale's low cost System-on-Chip (SoC) for the IEEE® 802.15.4 Standard that incorporates a complete, low power, 2.4 GHz radio frequency transceiver with Tx/Rx switch, an 8-bit HCS08 CPU, and a functional set of MCU peripherals into a 48-pin LGA package. This family of products is targeted for wireless RF remote control and other cost-sensitive applications ranging from home TV and entertainment systems such as ZigBee BeeStack Consumer (RF4CE) to low cost, low power, IEEE 802.15.4 and ZigBee end nodes.

The MC1323x development platform is comprised of three boards:

- 1323x-Modular Reference Board (1323x-MRB) - this board contains the MC1323x device with 32 MHz reference oscillator crystal, RF circuitry including antenna, and supporting circuitry. The board can be used as a simple standalone evaluation platform or as a daughter card to the other MC1323x development platform boards or to a custom, application specific motherboard. See Chapter 3, "1323x-Modular Reference Board" for detailed information.
  - Provides compact reference design for device footprint and RF layout
  - Provides pre-designed MC1323x hardware (device and function)
  - Provides access to the MC1323x full set of GPIO
  - Provides MCU BDM debug port
  - Provides optional local 2 Mbit serial FLASH, 32.768 kHz oscillator crystal, IR "blaster" LED and power management.
- 1323x-Remote Control Motherboard (1323x-RCM) - this board accepts the 1323x-MRB as a plug-in module (daughter card) and supplies a variety of peripheral functions to the MC1323x through the IO connectors. The peripheral functions are targeted primarily to a consumer TV or entertainment remote control application. See Chapter 4, "1323x Remote Control Motherboard" for detailed information.
  - Provides 36-switch matrix for remote control pushbuttons
  - USB <> serial interface for communication to a PC and provides board power
  - Touchpad for user interface
  - Onboard 128 x 32 pixel graphic LCD for menus and host feedback - a unique feature to RF-based remote controls
  - Accelerometer for motion detection and game play
- 1323x-Remote Extender Motherboard (1323x-REM) - this board also accepts the 1323x-MRB plug-in module (daughter card) and supplies a very simple set of peripheral functionality. See

Chapter 5, "1323x Remote Extender Motherboard" for detailed information. A small 8-switch matrix, IR receiver, and USB interface provides means for communication to the MC1323x for:

— Simple keypad-only applications
— Connection to a PC
— Host connection such as for a remote control extender or remote control receiver

Whether the 1323x-MRB is used in a simple standalone application or in combination with another host card, Freescale provides a complete software development environment called the Freescale BeeKit Wireless Connectivity Toolkit (BeeKit). BeeKit is a comprehensive codebase of wireless networking libraries, application templates, and sample applications. The BeeKit Graphical User Interface (GUI) allows users to create, modify, and update various wireless networking implementations. A wide range of software functionality is available to complement the 1323x-MRB and these are provided as codebases within BeeKit.

2.2 Features

The MC1323x development platform is built around the concept of having a single daughter card (1323x-MRB) that contains the MC1323x IC and all necessary I/O connections for use as a self-contained module or for connection to an application motherboard. Figure 2-1 shows a simplified block diagram of the more powerful Freescale configuration of the 1323x-MRB combined with the 1323x-RCM.

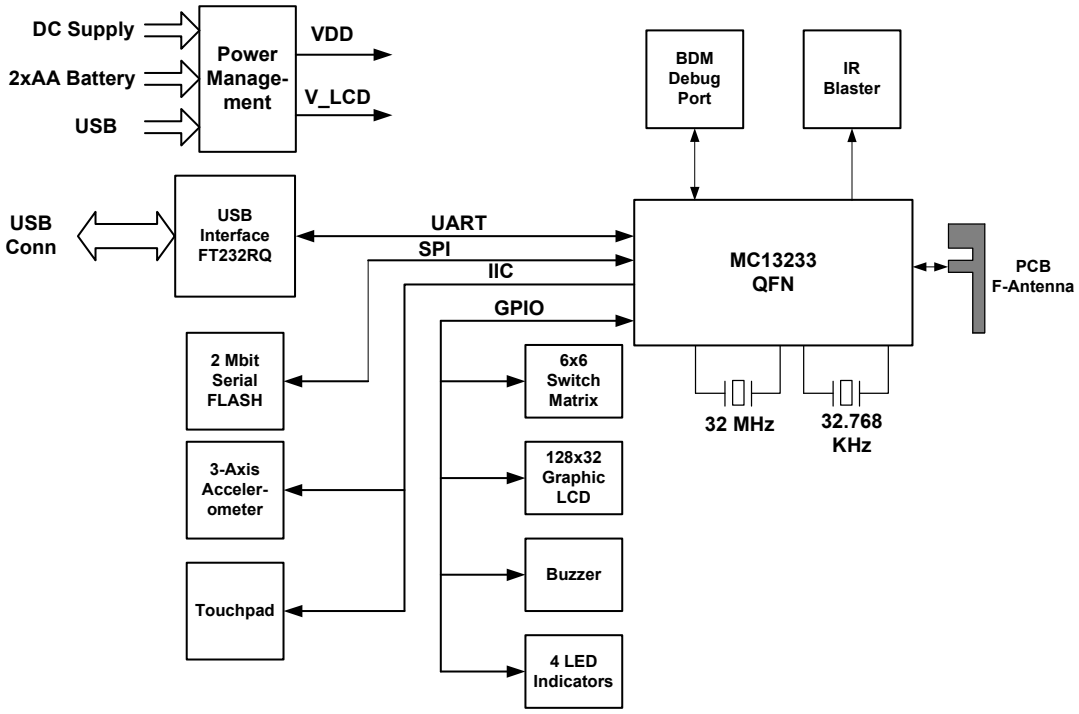

Figure 2-1. Simplified RCM+MRB Block Diagram

Figure 2-2 shows a photo of the combined boards with the 1323x-MRB mounted on the 1323x-RCM.

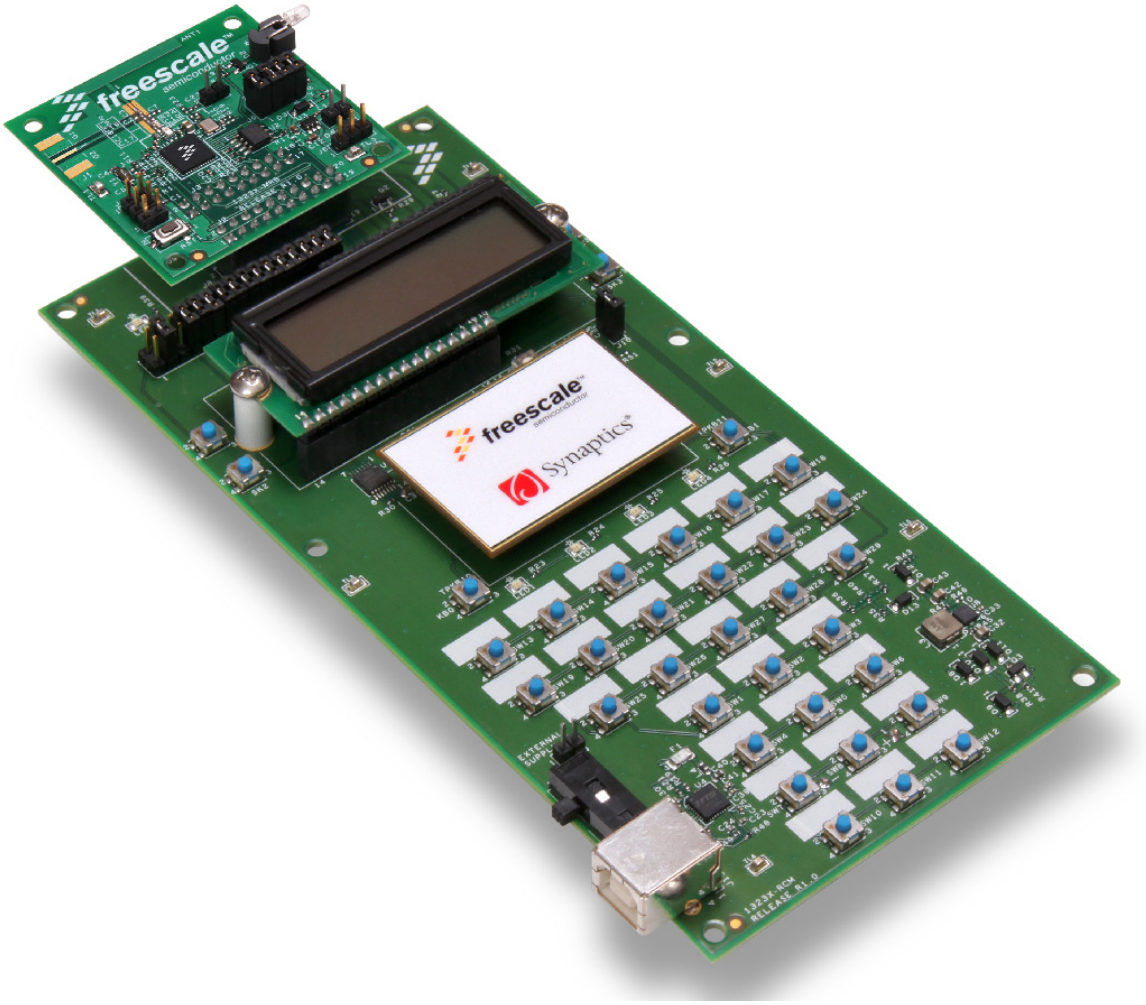

Figure 2-2. 1323x-MRB Mounted on the 1323x-RCM

Features of the MC1323x development platform include:

- Full IEEE 802.15.4 compliant wireless node; ZigBee capable with Freescale's BeeStack software stack
- Based on Freescale's low-cost MC1323x IEEE® 802.15.4 SoC platform which incorporates a complete, low power, 2.4 GHz radio frequency transceiver with Tx/Rx switch, an 8-bit HCS08 CPU, and a functional set of MCU peripherals into a 48-pin LGA package
- Reference design area with small footprint, low cost RF node
  - Integrated transmit/receive switch
  - Differential input/output port (typically used with a balun)
  - Low external component count
  - Programmable output power with 0 dBm nominal output power, programmable from -30 dBm to +3 dBm typical
  - Receive sensitivity of -93 dBm (typical) at 1% PER, 20-byte packet, much better than the IEEE 802.15.4 Standard of -85 dBm

  - Onboard printed metal F-Antenna
- 32 MHz reference oscillator
- BDM serial MCU debug port
- Optional secondary 32.768 kHz crystal oscillator for accurate low power timing
- IR blaster
- 2 Mbit serial FLASH (uses SPI interface)
- Master reset switch
- Full power regulation and management
- 1323x-MRB board provides
  - Required circuitry for MC13233 - crystals and RF circuitry including F-Antenna and optional SMA connector
  - Local power supply regulation
  - Access to all GPIO
  - Standalone or daughter card use models
  - Serial FLASH, IR blaster, and BDM functions
- 1323x-RCM when used with 1323x-MRB provides
  - USB to UART serial interface that is USB bus-powered and full-speed compatible to the USB 2.0 and 1.1 specifications
  - Power supply source from two AA batteries, USB connector, or DC source
  - 128x32 pixel graphic LCD
  - 3-axis Accelerometer (uses IIC interface)
  - Touch pad interface with interrupt capability (uses IIC interface)
  - 6x6 Switch matrix
  - Single tone buzzer
  - 4 Blue LED indicators
- 1323x-REM when used with 1323x-MRB provides
  - USB to UART serial interface that is USB bus-powered and full-speed compatible to the USB 2.0 and 1.1 specifications
  - Power supply source from two AA batteries, USB connector, or DC source
  - IR receiver
  - 4x2 Switch matrix
  - 4 Blue LED indicators

2.3 Driver Considerations

When users first connect a 1323x-RCM or 1323x-REM based platform to a PC, they may be prompted to install drivers. If BeeKit is installed and this occurs, do not allow Windows to automatically search for and install the drivers. Instead, select manual installation and steer Windows to the following directory:

```
C:\Program Files\Freescale\Drivers
```

If installing the BeeKit software package to another drive or directory, indicate the Drivers directory created by the installer in the custom location where BeeKit was installed.

Follow the instructions as they appear on the screen to complete driver installation.

If BeeKit is not installed, be aware of the following:

- The boards use the FTDI serial to USB converter, Virtual COM Port (VCP) driver for Windows, available at www.ftdichip.com/ftdrivers.htm.
  (Direct (D2XX) drivers are also available.)
- The FTDI web site offers drivers for other platforms including Windows® (98 through Vista x64 and CE), MAC OS (8 through X) and Linux.
- Download the appropriate driver and follow the instructions to complete driver installation.

2.4 General System Specifications

Table 2-1. MC1323x Platform Specifications

Parameter				Units	Notes/Conditions
	MIN	TYP	MAX		
Power					
Voltage supply (DC)	2.5	5	6	V	When using REM or RCM
Voltage supply (USB)	4.4	5	5.25	V	USB 2.0/1.1 standard specification
Voltage supply (Batteries)		2.8	3.2	V	
Temperature					
Operating temperature; non-battery operation (see note)	-20	+25	+70	°C	Operating temperature is limited to +70 °C due to switches. Basic circuit is good for a maximum temperature of +85 °C.
Operating temperature; battery operation (see note)	0	+25	+50	°C	Operating temperature is limited by battery temperature range
Storage temperature	-30	+25	+70	°C	
USB interface					USB 2.0 and 1.1 full-speed compatible
RF (1323x-MRB)					
802.15.4 Frequency range	2405		2480	MHz	All 16 channels in the 2450 MHz band
Range (outdoor / line of sight)		300		Meter	<1% PER for 20-byte packets (point-to-point in communications with 1322X Sensor Reference Board)

Table 2-1. MC1323x Platform Specifications

Parameter				Units	Notes/Conditions
RF Transmitter					
802.15.4 Output power	-30	0	+3	dBm	Over range of Pout from IC control in 2 dB steps. **Note:** On channel 26, output power should not exceed -5 dBm (power setting 0x0E) to meet FCC Part 15 requirements.
Harmonics 2nd harmonics 3rd harmonics			 -30? -30?	 dBm dBm	Harmonics are compliant to ETSI and FCC regulatory approval standards
RF Receiver					
802.15.4 sensitivity		-93		dBm	<1% PER for 20-byte packets
Regulatory Approval					
FCC					Not yet certified.
CE (ETSI)					Product is approved accordingly to the EN 300 328 V1.7.1 (2006-10) standard
CE (EMC)					Product is approved accordingly to the EN 301 489-1 V1.6.1 (2005-09) and EN 301 489-17 V1.2.1 (2002-08) standards
Safety					
UL					Product is approved accordingly to the IEC 60950-1 and EN 60950-1, First Edition standards
Environment					
RoHS					Product complies with the EU Directive 2002/95/EC of 27 January 2003
WEEE					Product complies with the EU Directive 2002/95/EC of 27 January 2003

Chapter 3
1323x-Modular Reference Board

3.1 1323x-MRB Overview

The 1323x-Modular Reference Board (1323x-MRB) is an IEEE 802.15.4 compliant evaluation board based on the Freescale MC1323x device. The 1323x-MRB provides a platform to evaluate the MC1323x device, develop software and applications, and demonstrate IEEE 802.15.4 based networking capabilities. The core device is accompanied by the 32 MHz reference oscillator crystal, RF circuitry including antenna, and supporting circuitry.

This basic board is intended as the core module for MC1323x evaluation and application development and can be used in the following modes:

- Simple standalone evaluation platform
- Daughtercard to the other MC1323x Development Platform boards (1323x-RCM or 1323x-REM)
- Daughtercard to an application specific motherboard.

3.1.1 Features

The 1323x-MRB provides the following features:

- Small form factor (2 x 2 inches)
- 4-Layer metal, 0.034 inch thick FR4 board
- MC1323x reference design area
  - LGA footprint and power supply bypass
  - 32 MHz reference oscillator crystal
  - RF components and layout
- Low cost RF node
  - Integrated transmit/receive switch
  - Differential input/output port (typically used with a balun)
  - Programmable output power with 0 dBm nominal output power, programmable from -30 dBm to +3 dBm typical
  - Receive sensitivity of -93 dBm (typical) at 1% PER, 20-byte packet
  - Printed metal F-Antenna
- 32.768 kHz crystal provided for optional timing oscillator
- Two connectors provided daughter card mounting
  - 20-Pin primary connector

  - 18-Pin secondary connector
  - Provide main supply voltage to board
  - Provide access to all MC1323x GPIO
- Flexible board power supply
  - 3.3 V LDO series regulator supplied
  - Regulator bypass jumper option
  - Separate external voltage source option
  - Power-on green LED
  - Jumpers allow various block current measurements
- 6-Pin BDM serial MCU debug port
- MC1323x reset switch
- Onboard peripheral functions
  - IR blaster (The MC1323x CMT port is employed as a GPIO to drive large IR blasters. For IR blasters under 20ma, use the CMT port directly.)
  - 2 Mbit serial FLASH (uses SPI interface)

3.1.2 Form Factor

Figure 3-1 shows the 1323x-MRB connector and header locations.

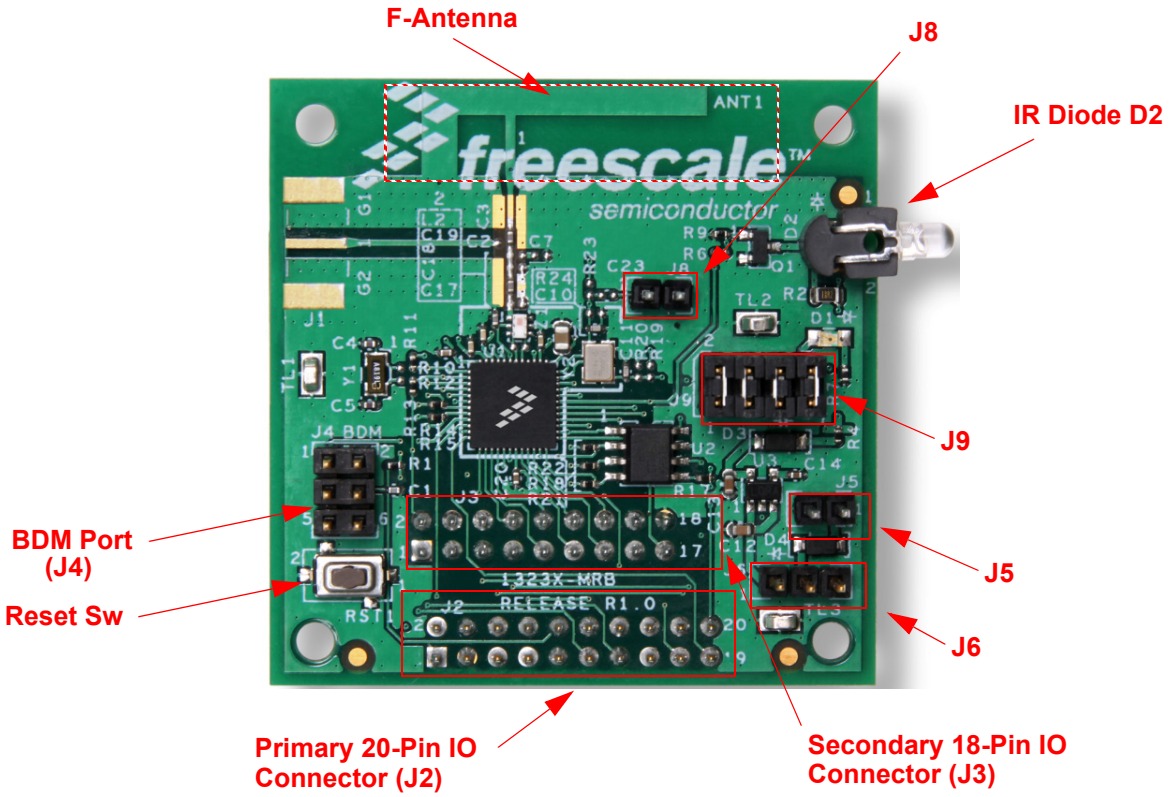

Figure 3-1. 1323x-Modular Reference Board (1323x-MRB)

Figure 3-2 shows a footprint of the 1323x-MRB with the location of the IO Headers J2 and J3. The user may desire to create a motherboard on which the 1323x-MRB would be mounted, and headers J2 and J3 are used for connection to the motherboard:

- Both headers have standard 0.10in / 2.54 mm pin spacing
- J2 is 20-pin and J3 is 18-pin
- Both are pin headers mounted on the bottom side of the 1323x-MRB and are intended to plug into matching receptacles on the motherboard.
- It is recommended that 1323x-MRB be located such that it extends beyond edge of the motherboard (see Figure 3-2) so that the entire F-Antenna is exposed with no motherboard ground or voltage plane beneath it. This is to allow best results transmitting and receiving with the radio.
- With the 1323x-MRB oriented as shown in Figure 3-2, the IR blaster transmits to the right.

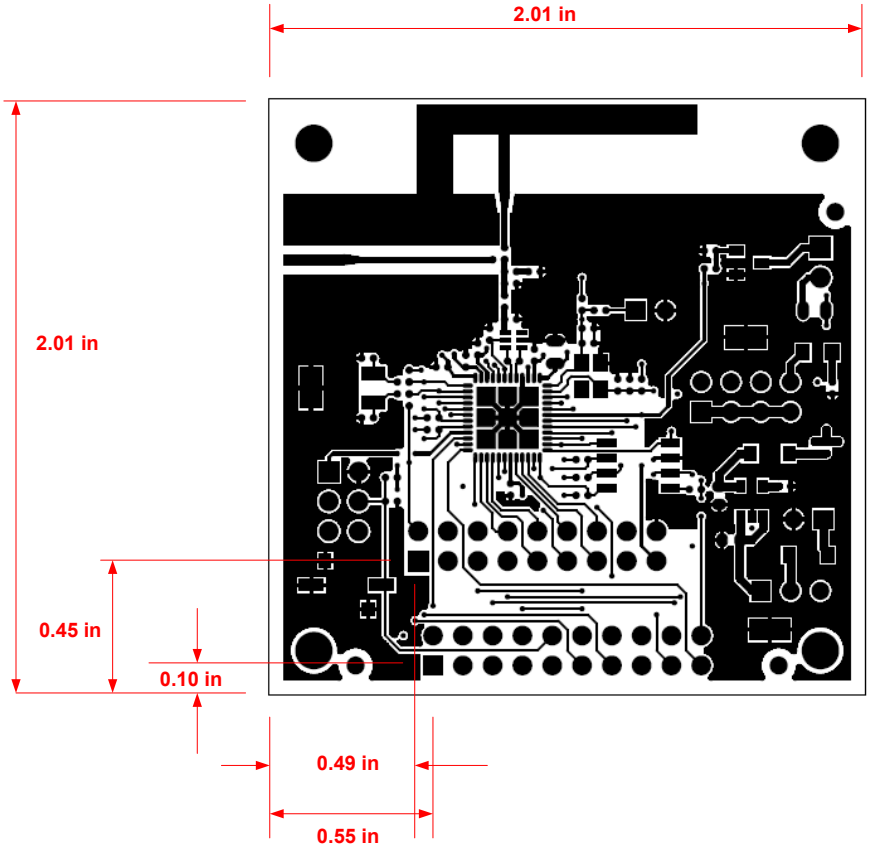

Figure 3-2. 1323x-MRB Top Side (Component Side) Footprint

3.1.3 Board Level Specifications

Table 3-1. 1323x-MRB Specifications

Parameter				Units	Notes/Conditions
	MIN	TYP	MAX		
General					
Size (PCB: X, Y)			51 x 51 2.01 x 2.01	mm inches	
Layer build (PCB)		0.8 0.034		mm inches	4-Layer
Dielectric material (PCB)					FR4
Power					
Voltage supply (DC)					
With 3.3 V regulator in use	3.50		16	V	Full module use
Not using regulator with serial FLASH and IR	2.7		3.6		Not regulated - using all features
Not using regulator with MC1323x only	1.8		3.6		Lower voltage usable only by MC1323x
Current consumption			TBD	mA	
Temperature					
Operating temperature (see note)	-20	+25	+70	°C	• Operating temperature is limited to +70 °C due to switches. Basic circuit is good for a maximum temperature of +85 °C. • Operating temperature may also be further limited when used in conjunction with REM or RCM having a battery supplied voltage source. See Table 4-1 and Table 5-1.
Storage temperature	-30	+25	+70	°C	
IR Transmitter					
Current		63		mA	
Range		10		m	
RF					
802.15.4 Frequency range	2405		2480	MHz	All 16 channels in the 2450 MHz band
Range (outdoor / line of sight)		300		Meter	<1% PER for 20-byte packets (point-to-point in communications with 1323x Sensor Reference Board)
RF Transmitter					
802.15.4 Output power	-30	0	+3	dBm	

Table 3-1. 1323x-MRB Specifications (continued)

Parameter				Units	Notes/Conditions
Harmonics 2nd harmonics 3rd harmonics			 -38 -35	 dBm dBm	Harmonics are compliant to ETSI and FCC regulatory approval standards
RF Receiver					
802.15.4 sensitivity		-93		dBm	<1% PER for 20-byte packets
Regulatory Approval					
FCC					Product is approved accordingly to the FCC part 15 standard
CE (ETSI)					Product is approved accordingly to the EN 300 328 V1.7.1 (2006-10) standard
CE (EMC)					Product is approved accordingly to the EN 301 489-1 V1.6.1 (2005-09) and EN 301 489-17 V1.2.1 (2002-08) standards
Safety					
UL					Product is approved accordingly to the IEC 60950-1 and EN 60950-1, First Edition standards
Environment					
RoHS					Product complies with the EU Directive 2002/95/EC of 27 January 2003
WEEE					Product complies with the EU Directive 2002/95/EC of 27 January 2003

3.2 Functional Description

The 1323x-MRB is built around Freescale's MC1323x 48-pin LGA IEEE 802.15.4 platform. Figure 3-2 shows a simple block diagram. This board is intended as a simple evaluation platform and as a building block for application development. The 4-layer board provides the MC1323x with its required RF circuitry, 32 Mhz reference oscillator crystal, and power supply bypassing. The layout for this base level functionality can be used as a reference layout by the user target board.

In additional to the base MC1323x functionality, the 1323x-MRB provides features to assist in debug, an IR blaster, a 2 Mbit serial FLASH, reset button, simple power manager, and expansion connectors for the GPIO. In the following sections, refer to:

- Figure 3-1 for location of connectors and features
- Figure 3-3 for the functional blocks
- Figure 3-11 for the board schematic

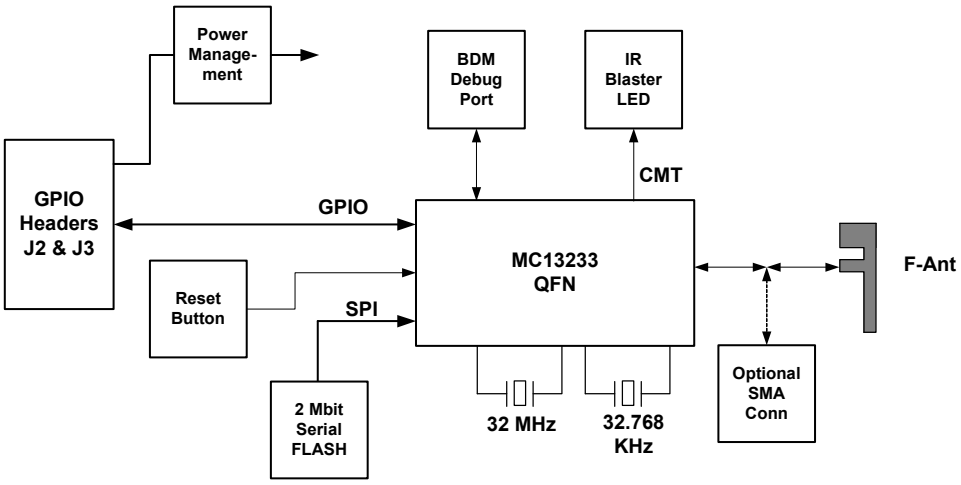

Figure 3-3. 1323x-MRB Block Diagram

3.2.1 RF Performance and Considerations

The MC1323x transceiver includes a low noise amplifier, 1mW nominal output power, PA with internal voltage controlled oscillator (VCO), integrated transmit/receive switch, on-board power supply regulation, and full spread-spectrum encoding and decoding.

- Nominal output power is 0 dBm, with +3 dBm max
- Typical sensitivity is -93 dBm
- Frequency range is 2405 to 2480 MHz
- Typical range (outdoors, line of sight) is 130 meters

The 1323x Modular Reference Board utilizes a minimum number of components while providing good RF performance:

- Uses a minimum number of RF matching components and external 50:100 balun
- “F” printed metal antenna for a small footprint, low cost design

An external 50 (unbal):100 (bal) balun connects a single-ended 50-Ω port to the differential RF port of the MC1323x radio. The layout has provision for out-of-band signal suppression (components L2 and C7) if required. Also note that control pin CT_Bias switches reference voltage to the balun as required for TX (CT_Bias = 1.5V) or RX (CT_Bias = ground).

The default RF mode is use of the “F” antenna coupled through 10 pF C3 to the single-end RF port. An alternative mode is to connect an SMA RF connector (not provided; must be mounted). This is useful for connected measurements to test radio performance.

NOTE

See the MC1323x Data Sheet and Reference Manual for more RF design information.

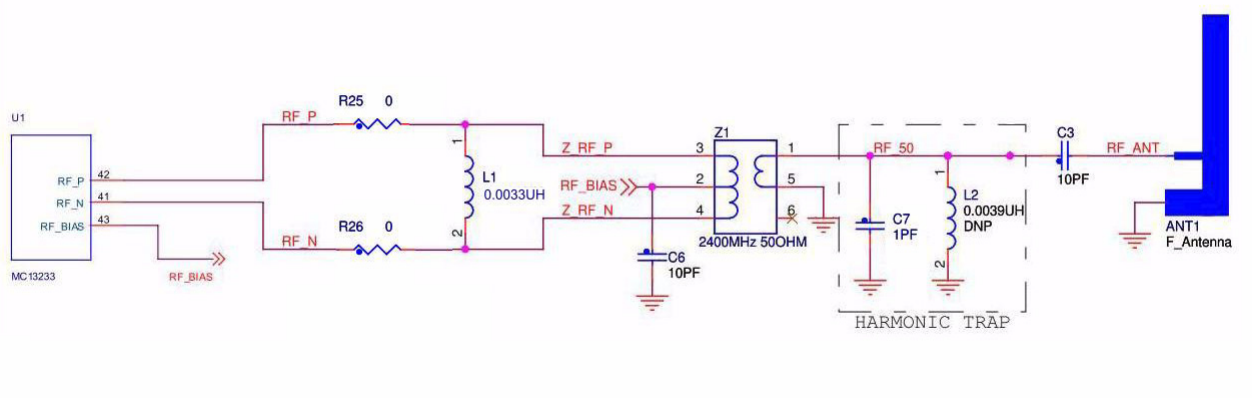

Figure 3-4. 1323x-MRB RF Circuitry

3.2.2 Clocks

The MC1323x provides for two clocks:

- 32 MHz Reference Oscillator - Figure 3-5 shows the external 32 MHz external crystal Y2. This mounted crystal must meet the MC1323x specifications. The IEEE 802.15.4 Standard requires that the frequency be accurate to less that +/-40 ppm.
  - Capacitors C10 and C11 provide the bulk of the crystal load capacitance. Onboard trim capacitors can be programmed to center the frequency. At 25°C, it is desired to have the frequency accurate to +/-10 ppm or less to allow for temperature variation.
  - To measure the 32 MHz oscillator frequency, signal PTD7/XTAL_32MOUT can optionally be programmed to provide a buffered output clock signal
  - The 1323x-MRB has provision for injecting an external 32 MHz clock source as an alternative to use of the onboard crystal:
    - The crystal Y2 should be removed
    - Resistors R23, R24, R19, and R20 must be mounted
    - C23 must be mounted
    - The external 32 MHz source is connected to 2-pin header J8; the frequency accuracy of the external source must meet the +/-40 ppm of the IEEE 802.15.4
- Optional 32.768 kHz Crystal Oscillator - Provision is also made for a secondary 32.768 kHz crystal X2 (see Figure 3-6). This oscillator can be used for a low power accurate time base.
  - The module comes provided with this Y1 crystal and its load capacitors C4 and C15.
  - Load capacitors C4 and C15 provide the entire crystal load capacitance; there is no onboard trim capacitance.
  - The 32 kHz oscillator components are supplied, but un-enabled. Zero-ohm resistors R11 and R13 enable use of IO signals PTA0 and PTA1 via the IO connector and are supplied as mounted. These must be unmounted and moved to resistor sites R10 and R12 to enable the 32.768 kHz crystal and disable PTAO and PTA1.

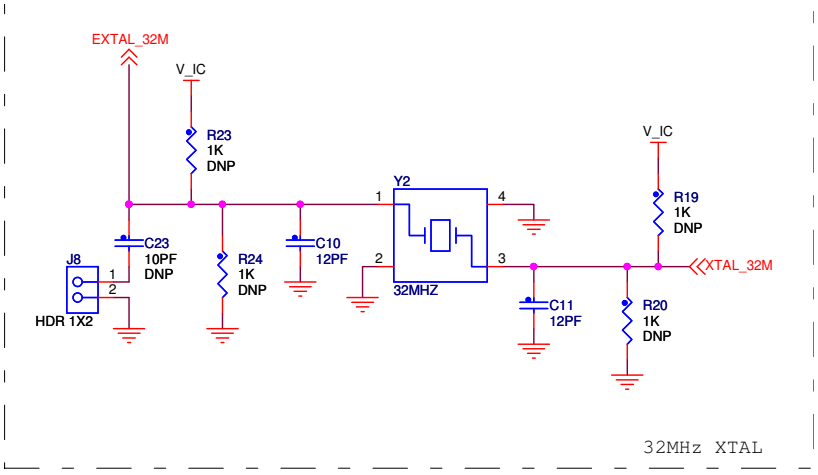

Figure 3-5. 1323x-MRB 32 MHz Reference Oscillator Circuit

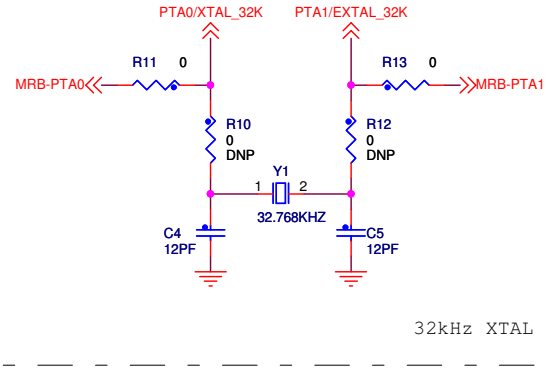

Figure 3-6. 1323x-MRB 32.768 kHz Optional Oscillator Circuit

3.3 Reset and BDM Debug Port

The reset circuit and BDM port connector are shown in Figure 3-7. See Figure 3-1 for switch and header locations.

- Reset switch RST2 is active low and provides a hardware reset to the MC1323x
- The 6-pin BDM 2x3 header J10 is provided to connect the MC1323x serial debug port to a standard HC9S08 debug module.

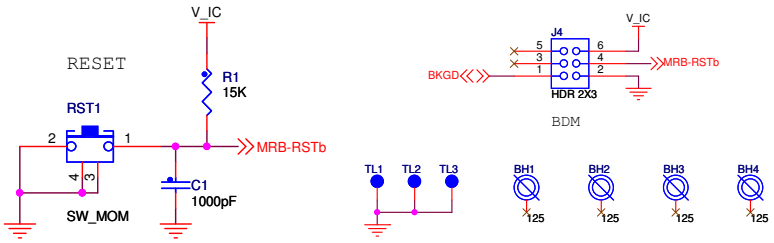

Figure 3-7. 1323x-MRB Reset Switch and BDM Port

3.3.1 Power Management

The 1323x-MRB power management circuit is shown in Figure 3-8.

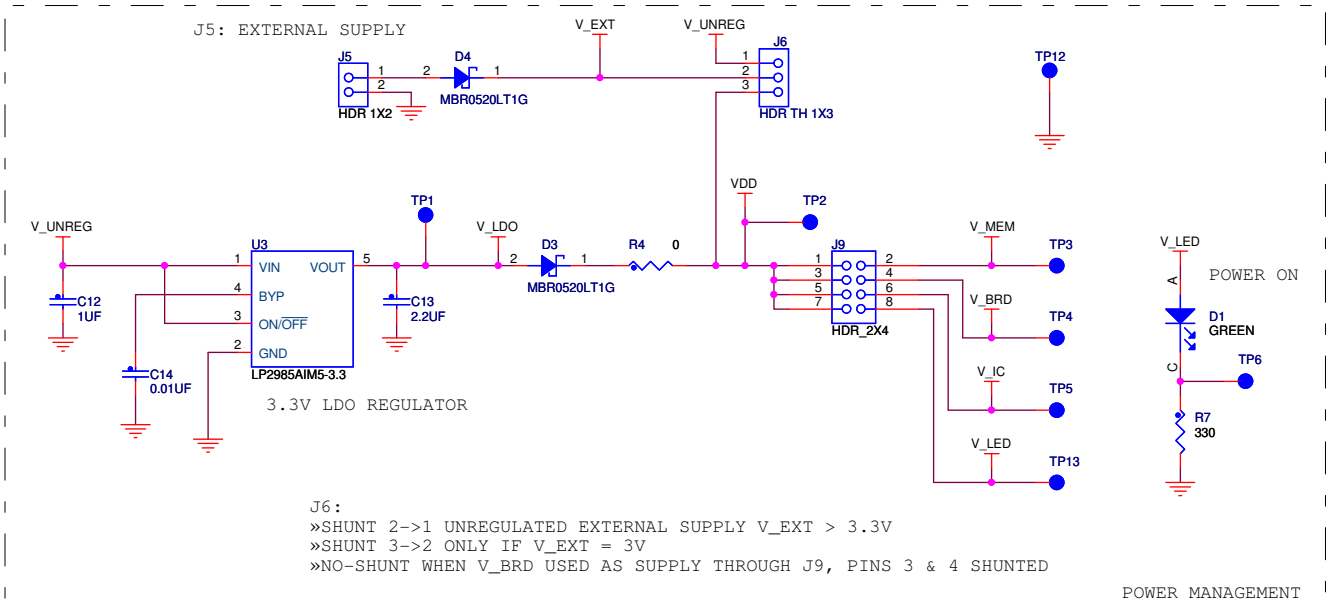

Figure 3-8. 1323x-MRB Power Management Circuit

Power to the 1323x-MRB can be configured in several ways and the circuit has the following features:

- Board can be supplied through the IO headers (V_BRD)
- Board can be supplied from an external DC supply (J5)
  - The external supply can be unregulated (V_UNREG) and make use of the onboard 3.3 V LDO regulator
  - The external supply voltage can be used directly without use of the LDO
- 8-Pin 2x4 header J9 provides means to supply current to various board components and also measure current if desired
- Green LED D1 is available as a power indicator.

Table 3-2 shows the header configuration information for the various power supply modes.

NOTE

- The Freescale 1323x-RCM and 1323x-REM development boards generate the system power supply on the motherboard and supply the voltage to the 1323x-MRB through the V_BRD pin of Headers J2 and J3. In this mode, the current flows to the 1323x-MRB through the pins.
- If an external supply is used via 1323x-MRB header J5, current flows to the motherboard through the V_BRD pin of Headers J2 and J3. THE MOTHERBOARD SUPPLY SHOULD NOT BE USED.
- In all modes, the IO voltage supply of peripherals on a motherboard must be the same voltage as V_BRD, which is also the voltage applied to the IC MC1323x.

Table 3-2. 1323x-MRB Power Configurations

Mode	Voltage Range	External Source J5	Ext Mode Select J6	Current Enable J9	Description
Source V_BRD	2.7 - 3.6 V[1]	Not used	Not used - all pins open	**Short Pins 3-4** - short other desired supplies	**Normal Operation** - The 1323x-MRB main supply is supplied by the motherboard through the J2 and J3 Headers
External Source - Using LDO	3.5 - 16 V	Connected - supplies DC Voltage	Short Pins 1-2	Short pins for all desired supplies	**External voltage w/regulation** - • Input range is set by the LDO regulator. • 3.3 V is supplied to 1323x-MRB; do not use motherboard supply • J2 and J3 Headers supply voltage to V_BRD pins when J9, Pins 3-4 are shorted
External Source - Not Using LDO	2.7 - 3.6 V[1]	Connected - supplies DC Voltage	Short Pins 2-3	Short pins for all desired supplies	**External voltage w/o regulation** - • Input range is set by the onboard circuitry • 2.7 - 3.3 V is supplied to 1323x-MRB • J2 and J3 Headers supply voltage to V_BRD pins

[1] The MC1323x can run as low as 1.8 V, however, the serial FLASH and IR blaster require 2.7 V or greater

Header J9 provides means to disable different sub-circuits or measure current and connections are described in Table 3-3. Current measurements can be made by inserting a current meter in place of a designated jumper.

Table 3-3. Power Distribution Header J9

Supply Designation	Header Pins	Description
V_MEM	1 - 2	Supply voltage to serial FLASH memory - • Jumper pins to supply memory. • If memory is not powered, it can load MC1323x SPI port
V_BRD	3 - 4	Supply voltage connected to IO Connectors J2 and J3 - • This supplies J2 and J3 if an external MRB supply is used • This voltage supplies the MRB if the motherboard is the main power • This connection is normally always jumpered
V_IC	5 - 6	Supply voltage to MC1323x - • Normally jumpered • Supplies only the MC1323x IC • Normally always same voltage as V_BRD
V_LED	7 - 8	Supply voltage to power indicator LED and IR blaster LED - • Jumper to use indicator or IR blaster • Leave open for lowest power

3.3.2 IO Connectors J2 and J3

The two IO connectors J2 and J3 are standard 100 mil pin headers mounted on the back (non-component side) of the 1323x-MRB. The primary header J2 is 20-pin and the secondary header J3 is 18-pin, and they are mounted physically in such a manner as to prevent reverse insertion of the 1323x-MRB into a motherboard receptacle (see Figure 3-2). When the 1323x-RCM or 1323x-REM or custom motherboard is plugged into these connectors, they allow access to MC1323x MCU GPIO.

- V_BRD is the connector supply voltage.
  - — Depending on power supply configuration, this voltage may supply the 1323x-MRB from the motherboard or the 1323x-MRB may supply this voltage to the motherboard. See Section 3.3.1, “Power Management”.
  - — Peripherals IO to the MC1323x and the MC1323x supply should use this same voltage

NOTE

The 1323x-RCM and 1323x-REM and 1323x-MRB are supplied configured for the motherboard to supply main power.

- Some of the GPIO are shared with onboard devices. Check for the 1323x-MRB schematic and Table 3-4 and Table 3-5 for any conflict.
- BDM port signal PTA7/BKGD is NOT connected to the IO headers to prevent possible interference with the debug port.

Table 3-4. 20 Pin Connector

Header Pin Number	MC1323x Pin Name	Description
1	V_BRD	VDD supply to module
2	PTC5/SS	SPI Bus Slave Select (SS) - shared with serial FLASH
3	GND	Module ground
4	PTC7/MOSI	SPI Bus MOSI signal - shared with serial FLASH
5	PTD5/RXD	UART RXD input to MCU
6	PTC6/MISO	SPI Bus MISO signal - shared with serial FLASH
7	PTD6/TXD	UART TXD Output from MCU
8	PTC4/SPICLK	SPI Clock (SPISCK) - shared with serial FLASH
9	PTD0/TPM0	GPIO / Timer IO
10	RESET	Reset
11	PTA5/SDA	I2C Bus data signal (SDA)
12	PTB7/KBI1P7	UART flow control RTS input into MCU (implemented in Freescale software)
13	PTA6/SCL	I2C Bus clock signal (SCL)
14	PTD2/TPM2	UART flow control CTS output from MCU (implemented in Freescale software)
15	GND	Module ground
16	PTD7/XTAL_32MOUT	Port D Bit 7