
1322x Sensor Node

Reference Manual

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Chapter 5

Schematic, Board Layout, and Bill of Material

About This Book

This manual describes Freescale's 1322x Sensor Node evaluation board. The 1322x Sensor Node contains Freescale's third-generation MC1322x ZigBee platform which incorporates a complete, low power, 2.4 GHz radio frequency transceiver, 32-bit ARM7 core based MCU, hardware acceleration for both the IEEE 802.15.4 MAC and AES security, and a full set of MCU peripherals into a 99-pin LGA Platform-in-Package (PiP).

Audience

This manual is intended for system designers.

Organization

This document is organized into 4 chapters.

- Chapter 1 Safety Information — Highlights some of the FCC requirements.
- Chapter 2 1322x Sensor Node Overview and Description — This chapter introduces 1322x Sensor Node which is an IEEE, 802.15.4 compliant evaluation board based on the Freescale MC1322x device.
- Chapter 3 System Overview and Functional Block Descriptions — This section provides an overview of the 1322x Sensor Node and system block diagrams.
- Chapter 4 Interface Locations and Pinouts — This chapter provides a description of the interface locations and pinout of the 1322x Sensor Node PCB.
- Chapter 5 Schematic and Bill of Materials — This chapter provides the schematic, board layout, and Bill of Materials (BOM).

Revision History

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

Revision History

Location	Revision
Chapter 1	Updated FCC information.

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.
SN	Sensor Node
pcb	Printed circuit board
PiP	Platform in Package
PWM	Pulse-width modulation
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

Safety1322x Sensor Node 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 make operation of the product unlawful. NOTE: The statement above applies also to the Industry Canada Approval.

1.2 FCC Labeling

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

1.2.1 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.

1.2.2 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 three 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.

1.2.3 47 C.F.R. Sec.15.203

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.

1.3 Regulatory Approval For Canada

This Class B digital apparatus complies with Canadian ICES-003 and RSS 210, Issue 7.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada. NOTE: Section 1.1 of this manual also applies to the Industry Canada Approval

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

1322x Sensor Node Module Overview and Description

2.1 Introduction

The 1322x Sensor Node is an IEEE 802.15.4 compliant evaluation board based on the Freescale MC1322X device. The heart of the 1322x Sensor Node is Freescale's MC1322x 99-pin LGA Platform-in-Package (PiP) solution that can be used for wireless applications ranging from simple proprietary point-to-point connectivity to complete ZigBee mesh networking. The MC1322x is designed to provide a highly integrated, total solution, with premier processing capabilities and very low power consumption.

The 1322x Sensor Node provides a platform to evaluate the MC1322x device, develop software and applications, and demonstrate IEEE 802.15.4 and ZigBee networking capabilities. The Sensor Node surrounds the core device with capabilities that provide a complete 802.15.4 radio, user interface, debugging capabilities, connection to personal computers (PCs) and other devices, sensors, and portability.

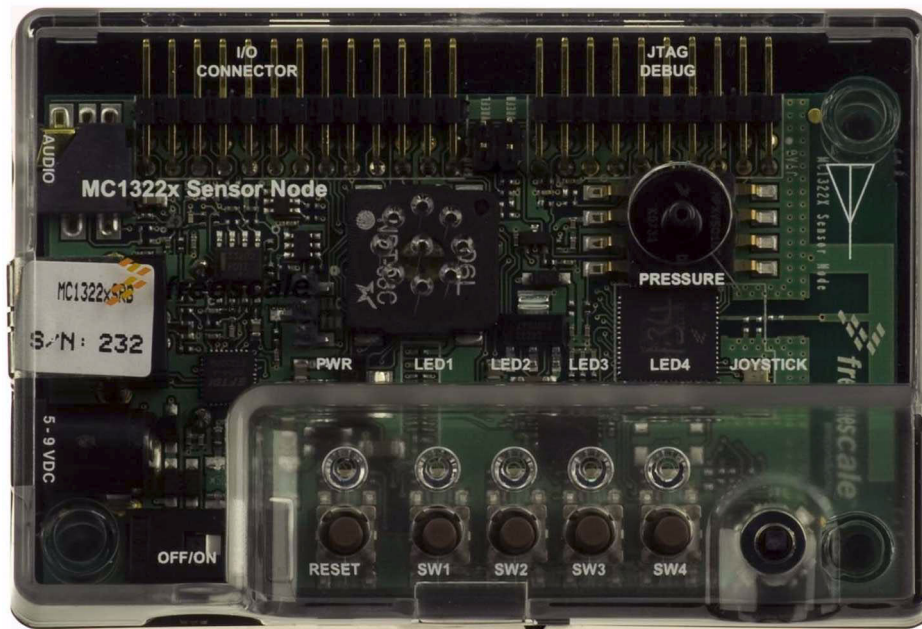


Figure 2-1. 1322x Sensor Node

2.2 Features

The 1322x Sensor Node provides the following features:

- Full IEEE 802.15.4 compliant wireless node; ZigBee capable with Freescale's BeeStack software stack
- Based on Freescale's third-generation MC1322x ZigBee platform which incorporates a complete, low power, 2.4 GHz radio frequency transceiver, 32-bit ARM7 core based MCU, hardware acceleration for both the IEEE 802.15.4 MAC and AES security, and a full set of MCU peripherals into a 99-pin LGA Platform-in-Package (PiP)
- MC1322x provides a highly integrated, low cost RF node
 - On-board balun and antenna switch in package
 - Typical -95 dBm sensitivity
 - Typical 0 dBm output power, with max approximately +3 dBm
 - Printed F-antenna
- USB interface is bus-powered and full-speed compatible to the USB 2.0 and 1.1 specifications
- Audio subsystem
 - 2.5mm audio jack for microphone and mono earpiece
 - Input amplifier and anti-aliasing filter for an electret microphone
 - Output path to second order analog filter from either 10-bit serial DAC or PWM as output signal sources
 - I2C controlled 32-position linear nonvolatile volume control for audio circuit
 - Audio output amplifier for both earpiece or on-board dynamic speaker (switched by headset jack)
- Freescale pressure sensor with 0-10 kPa range
- Temperature sensor with the full operating temperature range of the board with a $\pm 3^{\circ}\text{C}$ accuracy.
- Freescale XYZ tri-axis accelerometer for measuring changes in forces applied to the board (typical sensitivity of 800 mV/g @ 1.5g)
- 20-pin connector for standard JTAG debug/development interface
- Power management circuit with on-board regulation for multiple power sources
 - Can be powered from USB interface, DC power jack or two AA batteries
 - On/Off power switch
 - Power-on green LED
- User interface switches and LEDs
 - 4-directional TACT switch with center push for application purposes
 - 4 pushbuttons for application purposes
 - 4 processor controlled red LEDs for application purposes
 - Reset switch
- 26-pin user header for selected General Purpose Input Output signals and data interfaces
- System clock options

- Default 24 MHz crystal reference oscillator (13 to 26 MHz crystal optional)
- Reference oscillator can be driven from an external source
- Optional 32.768 kHz crystal oscillator for accurate real-time delays (not mounted)

2.3 Board Level Specifications

Table 2-1. 1322x Sensor Node Specifications

Parameter				Units	Notes/Conditions
	MIN	TYP	MAX		
General					
Size (Enclosure: X, Y, Z)			95x60x40	mm	
Size (PCB: X, Y)			85x50	mm	
Layer build (PCB)		0.8 / 0.032		mm / in	4-Layer
Dielectric material (PCB)					FR4
Power					
Voltage supply (DC)	4.4	5	12	V	
Voltage supply (USB)	4.4	5	5.25	V	USB 2.0/1.1 standard specification
Voltage supply (Batteries)		3	3.2	V	
Current consumption			100	mA	
Temperature					
Operating temperature (see note)	-20	+25	+85	°C	
Storage temperature	-30	+25	+85	°C	
USB interface					USB 2.0 and 1.1 full-speed compatible
Audio					
Audio (Input sensitivity)		-40		dB	Accepts electret microphone element
Audio (Output)					
Attenuation					
Temperature Sensor					
LM61BIM3 (National Semi)					See data sheet
Pressure Sensor					
MPXV5010GC6U (Freescale Semi)					See data sheet
Tri-axis Low-g Accelerometer					
MMA7260QR2 (Freescale Semi)					See data sheet
RF					
802.15.4 Frequency range	2405		2480	MHz	All 16 channels in the 2450 MHz band

Table 2-1. 1322x Sensor Node Specifications (continued)

Parameter				Units	Notes/Conditions
Range (outdoor / line of sight)		700		Meter	<1% PER for 20-byte packets (point-to-point in communications with 1322X Sensor Reference Board)
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 -4 dBm (power setting 0x0E) to meet FCC Part 15 requirements.
Harmonics 2 nd harmonics 3 rd harmonics			-38 -35	dBm dBm	Harmonics are compliant to ETSI and FCC regulatory approval standards
RF Receiver					
802.15.4 sensitivity		-95		dBm	<1% PER for 20-byte packets
Proprietary high-speed mode sensitivity		-80		dBm	<1% PER for a minimum data payload of 400 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

Chapter 3

System Overview and Functional Block Descriptions

This section provides an overview of the Sensor Node and block diagrams.

3.1 System Block Diagram

The following is the 1322x Sensor Node system level block diagram.

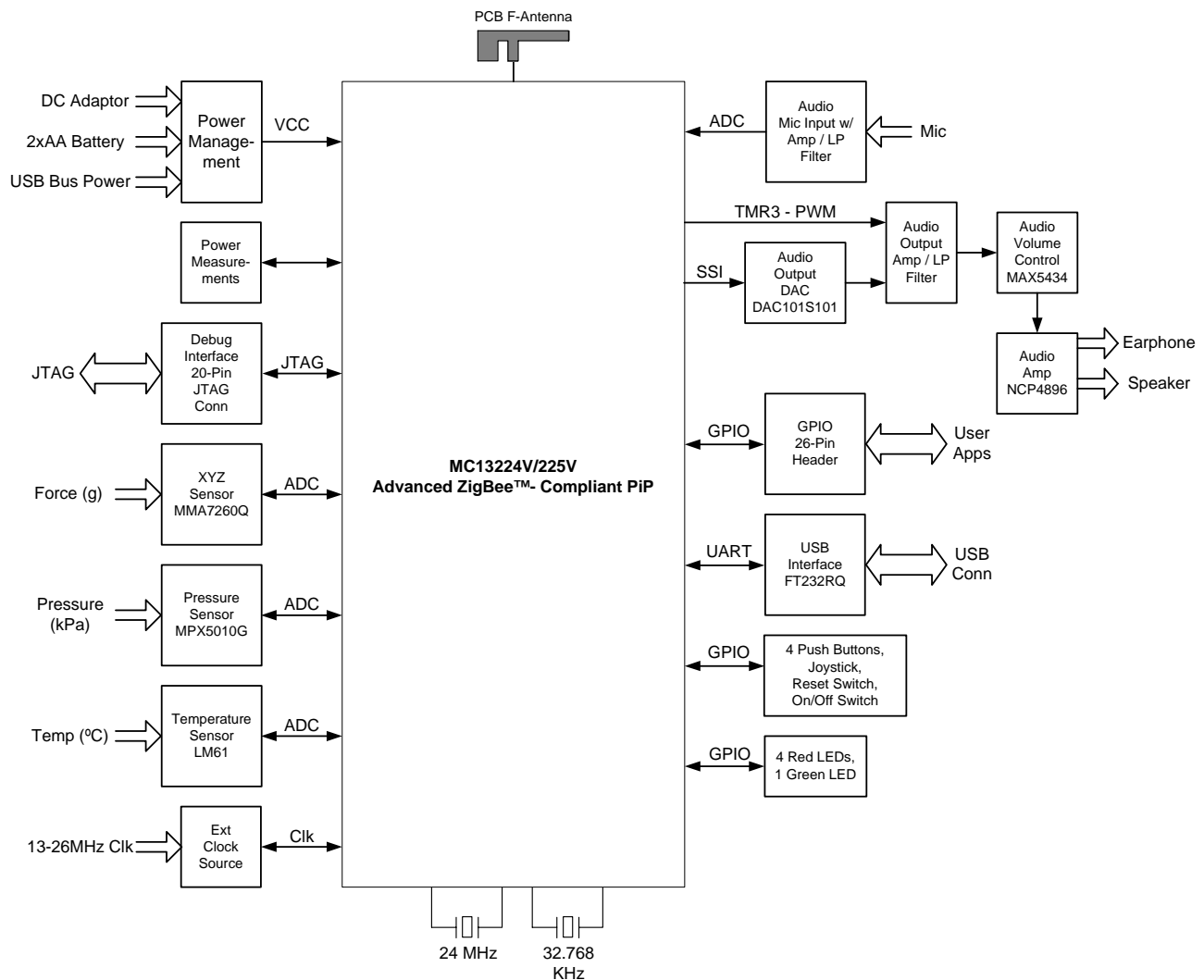


Figure 3-1. 1322x Sensor Node Block Diagram

3.2 System Overview

The heart of the 1322x Sensor Node is Freescale's MC1322x 99-pin LGA Platform-in-Package (PiP) solution that can be used for wireless applications ranging from simple proprietary point-to-point connectivity to complete ZigBee mesh networking. The MC1322x is designed to provide a highly integrated, total solution, with premier processing capabilities and very low power consumption.

The MC1322x MCU resources offer superior processing power for ZigBee and IEEE 802.15.4 applications. A full 32-bit ARM7TDMI-S core operates up to 26 MHz. A 128 Kbyte FLASH memory is mirrored into a 96 Kbyte RAM for upper stack and applications software. In addition, an 80 Kbyte ROM is available for boot software, peripheral device drivers, standardized IEEE 802.15.4 MAC and communications stack software. A full set of peripherals and Direct Memory Access (DMA) capability for transceiver packet data complement the processor core.

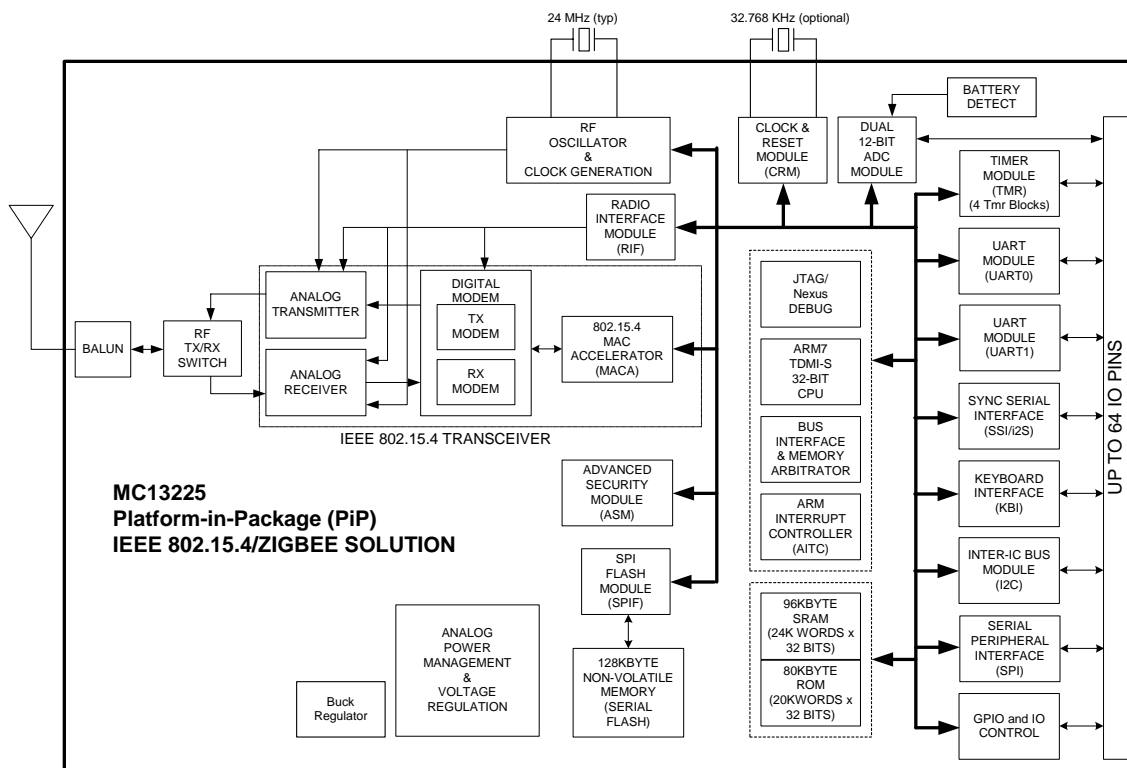


Figure 3-2. MC1322x Block Diagram

On-board peripherals include the following:

- Two dedicated UART modules capable of 2 Mbps with CTS/RTS support
- SPI port with programmable master and slave operation
- Keyboard interface capability.
- Two 12-bit analog-to-digital converters (ADCs) with 8 input channels
- Four independent 16-bit timers with PWM capability.
- Inter-integrated circuit (I2C) interface
- Synchronous Serial Interface (SSI) with I2S and SPI capability and FIFO data buffering

The RF radio interface provides for low cost and high density as shown in [Figure 3-3](#). An onboard balun along with a TX/RX switch allows direct connection to a single-ended 50-Ω antenna. The integrated PA provides programmable output power typically from -30 dBm to +4 dBm, and the RX LNA provides -95 dBm sensitivity. This solution also has onboard bypass capacitors and crystal load capacitors for the smallest footprint in the industry. All components are integrated into the package except the crystal and antenna.

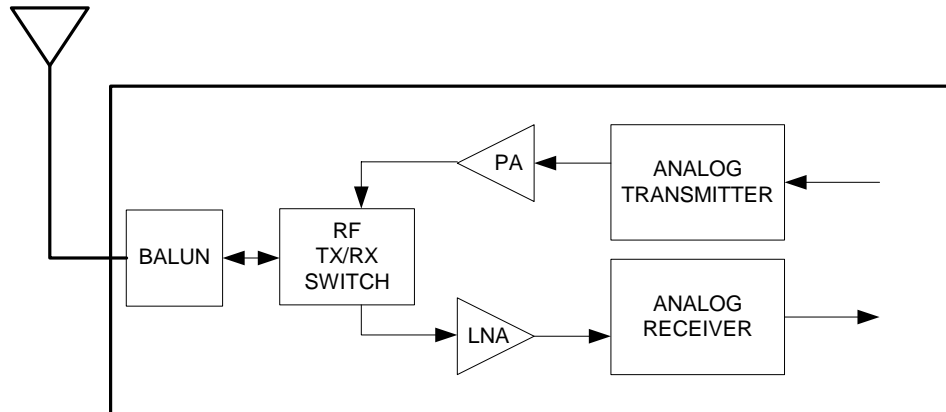


Figure 3-3. MC1322x RF Interface

Augmenting the core device on the Sensor Node are:

- Low-cost 2.4 GHz ISM Band radio
- 2.0 USB connection
- User interface with pushbuttons, and LEDs
- Versatile power sources and management
- Debug / development port
- Audio subsystem
- Pressure, temperature, and accelerometer sensors
- GPIO connector for system expansion

Users are encouraged to reference the board schematic for the topics covered in the following sections.

3.3 Power Management and Measurement

To allow maximum versatility, the Sensor Node can be powered via a DC source (typically an AC-DC converter; nominally 5 Vdc), the USB node, or an onboard battery pack with 2 AA alkaline batteries.

- The DC source or USB will automatically shutdown the battery supply.
- The DC source and the USB power are regulated to 3.3 V, however, the raw battery pack voltage directly supplies the circuitry
- All sources are isolated via diodes.
- An on/off switch and a power-on LED are provided (see [Section 4.2.2, “On/Off Switch and Power On Indicator”](#)).

- Zero-ohm resistors are provided to allow isolation and measurement of various system components (see Section 4.2.3, “Power Measurement”)

3.4 Low-cost 2.4 GHz ISM Band radio

The MC1322x provides an onboard balun, antenna switch, and LNA. The only external component required for the radio is an antenna. The Sensor Node provides a pcb printed metal F-antenna for a complete solution. Figure 3-4 shows the RF network external to the MC1322x.

- Typical nominal output power is 0 dBm, with +4 dBm max
- Typical sensitivity is -95 dBm.
- Frequency range is 2405 to 2480 MHz
- Typical range (outdoors, line of sight) is 300 meters

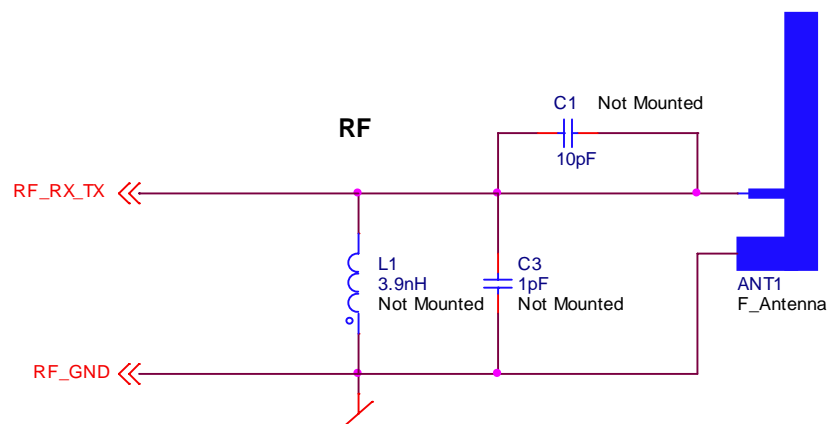


Figure 3-4. Sensor Node RF Network.

3.5 USB Interface

For many applications or demonstrations it is desirable to connect the Sensor Node to a PC or other device. A USB port is provided with a USB “B” receptacle plug. The port is connected to a FTDI FT232R USB UART device that appears as a Virtual COM port (VCP) to the PC. PC drivers are available with the module.

The USB interface is configured as a “Bus Powered” device and will therefore draw all required power from the USB interface. The device is USB 2.0 full speed compatible.

3.6 User Interface

The Sensor Node provides multiple means for user interface for both debug and demonstration.

- Four individual pushbuttons can be used as input, and a 4-direction tactile joystick switch with center push is wired in parallel with the individual pushbuttons. These pushbuttons have interrupt generation capability.
- Four individual LEDs can be used as indicators for debug or status.

3.7 Debug/Development Interface

There is a standard JTAG debug port (for pinouts see [Section 4.6, “Debug/Development Connector \(ARM JTAG Interface\)”](#)). A 20-pin connector is provided for a standard JTAG debug interface that only requires a simple interface cable to connect to the PC and uses standard ARM software development tools.

3.8 Sensors

The SN provides a temperature sensor, a pressure sensor, and a three axis low-g accelerometer. All three sensors provide analog voltage outputs and require use of the MC13224/225 ADCs.

NOTE

- There are two VREFH voltages. ADC2_VREFH is tied to the device VCC and moves with the VCC voltage, i.e., either the regulated voltage or the battery voltage. ADC2_VREFH is useful if the application wants the ADC reference to scale with the supply voltage (as for audio), however, it is unreliable for a fixed voltage reference such as the temperature sensor. In contrast, ADC1_VREFH is tied to a fixed 1.5 V reference (see [Section 4.10, “ADC Voltage References”](#)). This fixed reference should be used for battery operation where a known voltage is required.
- All sensor voltage outputs are conditioned with RC filtering to help eliminate noise.
- The user is referenced to the individual data sheets for each of the sensors for detailed information.

3.8.1 Temperature Sensor

The temperature sensor is a National Semiconductor LM61BIM3. Its accuracy is $\pm 3^{\circ}\text{C}$, and its output voltage is typically 0.600 Vdc at 0°C with a slope of $+10\text{ mV}/^{\circ}\text{C}$. The sensor requires only one ADC input and is constantly powered.

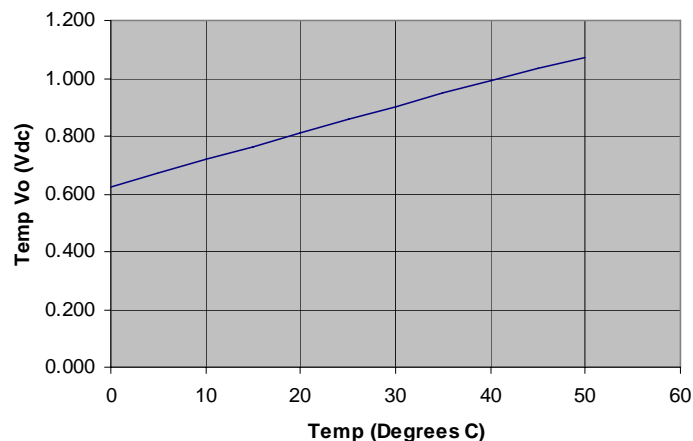


Figure 3-5. Typical Voltage Out vs. Temperature for LM61B

3.8.2 Pressure Sensor

The pressure sensor is a Freescale Semiconductor MPXV5010GC6U fully integrated device. It provides a high level analog output signal that is proportional to the applied pressure. Its accuracy is $\pm 5\%$, and its output voltage is typically 0.200 Vdc at 0 offset pressure with a slope of +450 mV/kPa (1.0 kPa [kiloPascal] equals 0.145 psi.). The sensor requires only one ADC input and is constantly powered .

The pressure sensor has an axial port (upright tube) for connecting tubing for a pressure source. The outside dimension of the tube is 3.0 mm nominal, and the tube is accessible through the top of the plastic enclosure.

3.8.3 Three-axis Accelerometer

The three-axis accelerometer is the MMA7260QR2 device from Freescale Semiconductor. The MMA7260QR2 is specified for sensitivity in four ranges (1.5g/2g/4g/6g). The range is selectable via control lines. Consult the data sheet for sensitivity and other information. Each axis requires an ADC input (three total), and the accelerometer can be powered down.

3.9 Audio Subsystem

The audio subsystem provides means for simple output sounds/tones or for TELCO voice quality audio.

- A 2.5mm stereo jack is provided to interface to a typical telephone-type headset with an electret microphone and a single earphone.
- Audio input - The audio input is taken from the headset electret microphone (mic).
 - An onboard 10 k-ohm resistor circuit biases the mic for an ~ 1 Vdc operating voltage.
 - The mic AC signal is filtered and amplified through a active low-pass filter with a voltage gain of about 30 (~ 30 dB). The filter topology is a multiple feedback (MFB) 3-pole, linear phase design. The target cutoff frequency is 3.6 kHz. The filter is intended as an anti-aliasing filter for sampled data.
 - The input amplifier output is sampled via the onboard MC1322x ADC. The sampling frequency is programmable.
- Audio output source - The audio output can be sourced from both a serial 10-bit DAC and a PWM timer output.
 - The 10-bit serial DAC uses the SSI port to send provide the digital sample data.
 - The PWM timer output is typically modulated to create a Class-D amplifier. Secondly, a simple 50% duty cycle signal can provide simple tones.
 - The audio output source is jumper selectable via J7
- Audio output processing - The DAC or PWM out signal is filtered through an active 2-pole LPF. From the filter the signal passes through a passive attenuator, and then is amplified and driven to either an on-board speaker or the headset earphone.
 - The attenuator provides a volume control that is controlled via a software 32 linear tap programmable, non-volatile digital potentiometer. The interface to the potentiometer is the I²C port.

- The onboard speaker is automatically disconnected if a headset is plugged-in.

3.10 GPIO Connector

The GPIO connector (J2) provides a number of data interfaces and GPIO for external system expansion, [Section 4.8, “GPIO Connector”](#) gives details.

- Some of the GPIO are shared with onboard devices. The user should take care to avoid conflict.
- Power supply voltage is provided
 - Current draw should be limited to 50 mA.
 - A separate regulated voltage can be enabled
- Provision is made to supply an external reference clock if desired.

3.11 Clocks

The MC1322x Sensor Mode provides for two system clock sources.

- MC1322x Reference Oscillator - The default frequency for the reference oscillator is 24 MHz and the mounted crystal X1 is a 24 MHz device that meets MC1322x specifications. There are two additional options for the module
 - X1 can be replaced by a 13-26 MHz crystal (it must meet MC1322x specifications), however, the onboard PLL must be used in this case. The pcb provides for PLL filter components, but these are not populated.
 - An external clock source can be supplied as the reference source (typically 24 MHz). The frequency must be accurate to +/-40ppm. The external clock source is supplied through GPIO Connector J2, and crystal X1 must be removed and capacitor C58 mounted (see [Chapter 5, “Schematic, Board Layout, and Bill of Material”](#), Sheet 1).
 - 32.768 kHz Crystal Oscillator - Provision is also made for an optional secondary 32.768 kHz crystal X2. This oscillator can be used for a low power accurate timebase. The module comes without this crystal and its load capacitors C7 and C12 unmounted (see [Chapter 5, “Schematic, Board Layout, and Bill of Material”](#), Sheet 1).

Chapter 4

Interface Locations and Pinouts

This chapter provides a description of the interface location and pinout of the 1322x Sensor Node printed circuit board (PCB).

4.1 Overview

This section details the locations (as shown in [Figure 4-1](#)) and descriptions of switches, jumpers, and connectors on the 1322x Sensor Node circuit board which is the main board for the 1322x Sensor Node. Users should refer to the figures in the subsequent sections while moving through this chapter. Users should also reference the circuit board schematic in [Chapter 5, “Schematic, Board Layout, and Bill of Material”](#), for additional information.

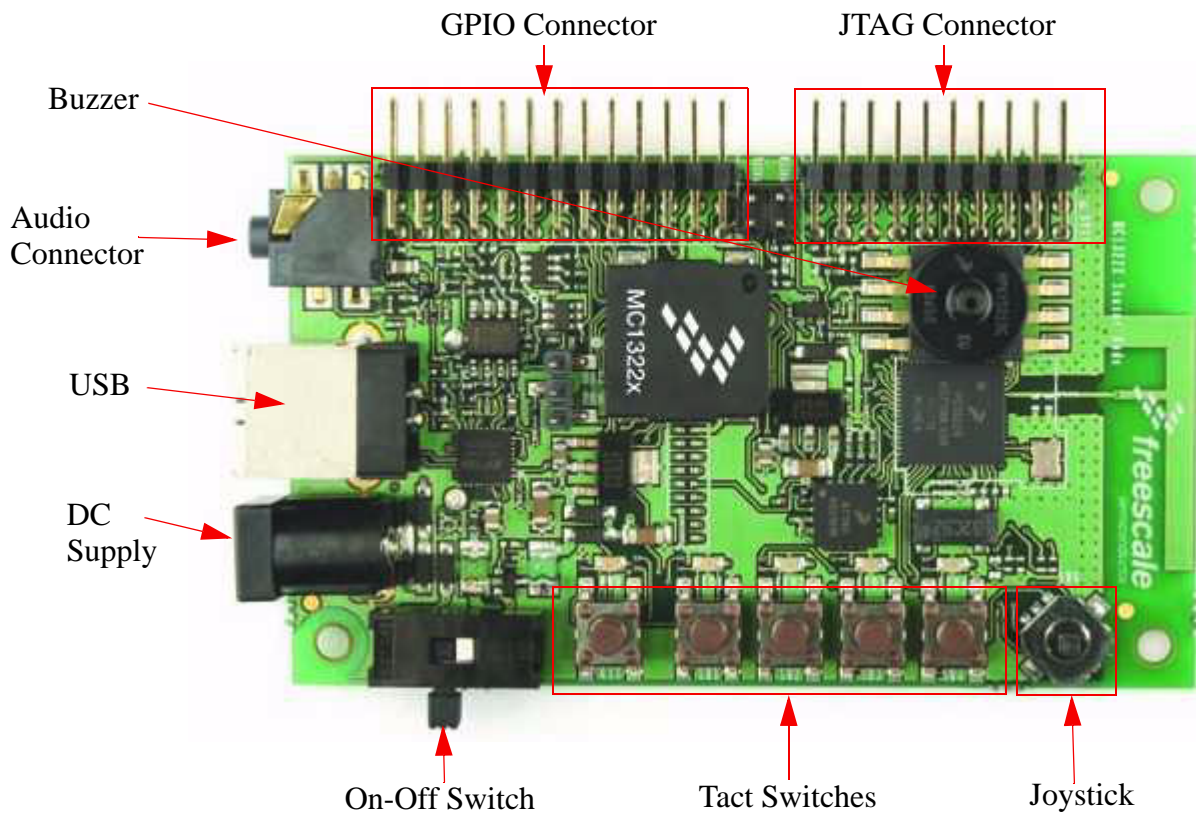


Figure 4-1. 1322x Sensor Node PCB Top View

4.2 Power Management

The module can be powered from the DC power jack, the USB port, or the battery pack.

4.2.1 Supply Sources

Table 4-1 lists the supply sources, connectors, and voltages. Board maximum current draw is rated at 100 mA.

Table 4-1. Power Supply Sources

Source	Connector	Min (Volts)	Typical (Volts)	Max (Volts)	Notes
DC Source	J5	4.4	5	12	Use DC only source. The connector is a 2 mm DC power jack; positive center conductor.
USB	J6	4.4	5	5.25	
AA Battery Pack	BC1	~2.0	3	3.2	Two AA cells. Battery pack is automatically disabled by either DC source or USB. Accessible through the door on the bottom of the plastic enclosure.

4.2.2 On/Off Switch and Power On Indicator

The following are used with the power management:

- Switch SW7 - 4-pole slide switch disconnects ALL sources
- Green LED D5 - indicates power from any source

4.2.3 Power Measurement

It is possible to isolate various circuit blocks to measure current draw via 0-ohm resistors. The resistors are all mounted as default.

Below is a list of the supplies.

- R68 -> VCC (Output from main on-board regulator)
- R65 -> VBATT (Supply for MC1322x)
- R37 -> V_PRE (Supply for pressure sensor)
- R38 -> V_XYZ (Supply for accelerometer)
- R43 -> V_AUD (Supply for audio circuit)
- R44 -> V_TMP (Supply for temp sensor)
- R64 -> 3V (Output from on-board regulator for GPIO customer access), or alternately, R66 (not mounted) can enable separate regulator U12.

4.3 RF Circuitry

The printed metal F-antenna (ANT1) is the only option for this module.

4.4 USB Connector (“B” Receptacle)

The USB connector is designated as J6. Figure 4-2 shows the connector pinout.

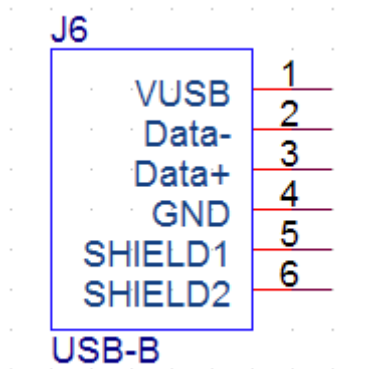


Figure 4-2. USB Connector Pinout

4.5 LEDs, Switch, Buttons and Joystick

The Sensor Node contains a total of four red LEDs and one green LED

- The four red LEDs are driven by the MCU and controlled by the software application.
- As previously discussed, the green LED is directly connected to the on-board regulation and acts as “Power On” indication.

As also previously discussed SW7 is an on/off slide switch that connects the power supplies.

There are five pushbuttons total.

- One pushbutton (SW5) is separate and provides a master hardware Reset.
- Four additional pushbuttons are connected to the MCU GPIO for software application. These buttons all have interrupt generation capability

A joystick (SW6) is also provided.

- The joystick is a “4-direction TACT Switch with Center Push”.
- The 4-directional TACT switches are connected in parallel with the four user pushbuttons.
- The center push switch is separate and does not have interrupt generation capability

Table 4-2. Switch and LED Summary

Item	GPIO Connection	Feature
PWR (green)	VCC	'Power On' indication
LED1 (red)	KBI_1	Application specific
LED2 (red)	KBI_2	Application specific
LED3 (red)	KBI_3	Application specific
LED4 (red)	TX_ON	Application specific

Table 4-2. Switch and LED Summary (continued)

Item	GPIO Connection	Feature
SW1 (pushbutton)	KBI_4	Interrupt functionality. In parallel with SW6 (right).
SW2 (pushbutton)	KBI_5	Interrupt functionality. In parallel with SW6 (down).
SW3 (pushbutton)	KBI_6	Interrupt functionality. In parallel with SW6 (left).
SW4 (pushbutton)	KBI_7	Interrupt functionality. In parallel with SW6 (up).
SW5 (RST)	RESETB	HW reset
SW6 (right)	KBI_4	Interrupt functionality. In parallel with SW1.
SW6 (down)	KBI_5	Interrupt functionality. In parallel with SW2.
SW6 (left)	KBI_6	Interrupt functionality. In parallel with SW3.
SW6 (up)	KBI_7	Interrupt functionality. In parallel with SW4.
SW6 (center)	KBI_0_HST_WK	Host wake up output functionality. No interrupt functionality

4.6 Debug/Development Connector (ARM JTAG Interface)

The MC1322x supports connection to a subset of the defined ARM JTAG connector. The JTAG interface is a standard 2.54mm/0.1inch spacing, 20-pin debug interface (J1). The 20-pin connector is clearly separated from the GPIO pin header (J2) and located at the rear side of the module. The 20-pin connector has Pin 1 marking for correct plug-in of the development cable.

Table 4-3 shows the device pins that are connected to the associated JTAG header pin outs if the JTAG connector is used.

Table 4-3. ARM JTAG 20-Pin Connector Assignments (J1)

Name ¹	Pin #	Pin #	Name
VCC	1	2	VCC
NC ²	3	4	GND
TDI	5	6	GND
TMS	7	8	GND
TCK	9	10	GND
RTCK	11	12	GND
TDO	13	14	GND
RESET ³	15	16	GND
NC	17	18	GND
NC	19	20	GND

¹ NC means No Connect.

² MC1322x does not support separate JATG reset TRST.

³ VCC through a 100k-ohm pullup.

4.7 Audio Subsystem Connections

The audio subsystem uses the following connections:

- 2.5mm stereo jack J3 - for headset mic and earphone
- Jumper J7 - selects audio output source. See [Figure 4-3](#) for connections

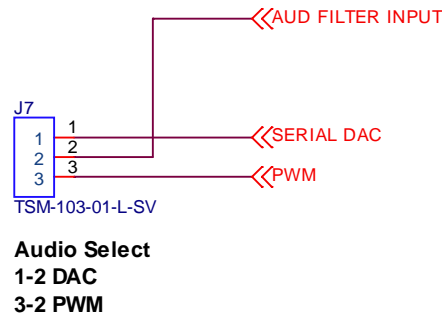


Figure 4-3. J7 Audio Output Source Jumper

4.8 GPIO Connector

The GPIO connector (J2) is a standard 2.54mm/0.1inch spacing, 26-pin header. The connector provides access to MCU GPIO, an external clock source connection, a timer output, ADC inputs, the SSI port, a UART port, the SPI port, the I²C port, and the serial DAC output. Power is also provided on the connector.

- VCC is the main supply voltage. Current draw should be limited to 50 mA.
- CLKIN can be used to supply an external reference clock (nominally 24 MHz). The onboard crystal must be removed and an ac-coupling capacitor added.
- Some of the GPIO are shared with onboard devices. Check for any conflict.
- The serial DAC output is available at the connector. The DAC output should not be selected as the output audio source (J7) when used off board.

Table 4-4. GPIO Connector J2 Pinouts

Pin	Name	Function	Notes
1	TMR1	Timer I/O or GPIO	Hardwired to accelerometer G-SEL1.
2	CLKIN	Source for external clock to reference oscillator	<ul style="list-style-type: none"> • 13-26 MHz reference clock with <40 ppm accuracy • Onboard crystal must be removed • Enable signal to MC1322x by adding C58, 10pF; see schematic
3	VCC	Voltage supply from module	3V output from on-board regulation
4	GND	System ground	
5	ADC1	ADC Analog Input Channel or GPIO	
6	ADC2	ADC Analog Input Channel or GPIO	Hardwired to accelerometer XOUT. Disable accelerometer.
7	ADC3	ADC Analog Input Channel or GPIO	Hardwired to accelerometer YOUT. Disable accelerometer.
8	ADC4	ADC Analog Input Channel or GPIO	Hardwired to accelerometer ZOUT. Disable accelerometer

Table 4-4. GPIO Connector J2 Pinouts (continued)

9	ADC5	ADC Analog Input Channel or GPIO	Hardwired to pressure out.
10	DAC_OUT	Serial DAC Output	Jumper J7 selects DAC output as audio output source
11	SSI_TX	SSI Port or GPIO	Hardwired to serial DAC
12	SSI_RX	SSI Port or GPIO	
13	SSI_FSYN	SSI Port or GPIO	Hardwired to serial DAC
14	SSI_BITCLK	SSI Port or GPIO	Hardwired to serial DAC
15	KBI_0_HST_WK		Hardwired to “center” on joystick
16	KBI_4		Hardwired to “right” on joystick and SW1
17	UART2_TX	UART2 or GPIO	
18	UART2_RX	UART2 or GPIO	
19	UART2_RTS	UART2 or GPIO	
20	UART2_CTS	UART2 or GPIO	
21	I2C_SCL	I ² C Port or GPIO	Hardwired to audio volume circuit. MAX5434L device has I ² C address 0x50
22	I2C_SDA	I ² C Port or GPIO	Hardwired to audio volume circuit. MAX5434L device has I ² C address 0x50
23	SPI_SCK	SPI Port or GPIO	
24	SPI_SS	SPI Port or GPIO	
25	SPI_MOSI	SPI Port or GPIO	
26	SPI_MISO	SPI Port or GPIO	

4.9 FLASH Memory Recovery Jumpers and Erase

The MC1322x has an onboard serial FLASH that stores the memory image that gets loaded into RAM at boot. If it becomes necessary to change or update the image in FLASH, there are two possible means of doing so:

- JTAG Debug Port - Using the JTAG debug port and the ARM debug tools, the FLASH image can be changed.
- Load new FLASH image via UART1 port -

NOTE

The 1322x Sensor Node provides access for UART1 through the USB connection. If users need to employ UART1 with the Test Tool running on a PC, they must access the UART through the USB port as a virtual COM port.

- The Freescale BeeKit IDE suite download provides a software tool called “Test Tool”. This application runs on a PC and can be used with a client running on the MC1322x to test the platform.

— Test Tool also has the capability to load a new image into the FLASH.

NOTE

The FLASH must first be cleared before loading a new image.

The 1322x Sensor Node has two jumper sites (J19 and J20, [Figure 4-4](#)) that must be used to erase the FLASH:

1. Short Jumper J19 Pin 1 to Pin 2 with a shorting bar.
2. Short Jumper J20 Pin 1 to Pin 2 with another shorting bar.
3. Turn on power, push the reset button and wait a few seconds.
4. Turn off power and remove the jumpers.
5. The board is now ready for boot operation.

After the FLASH is erased, the module can be loaded with a new image through the USB port using Test Tool. Refer to the Test Tool User's Guide as supplied with Test Tool in the BeeKit download.

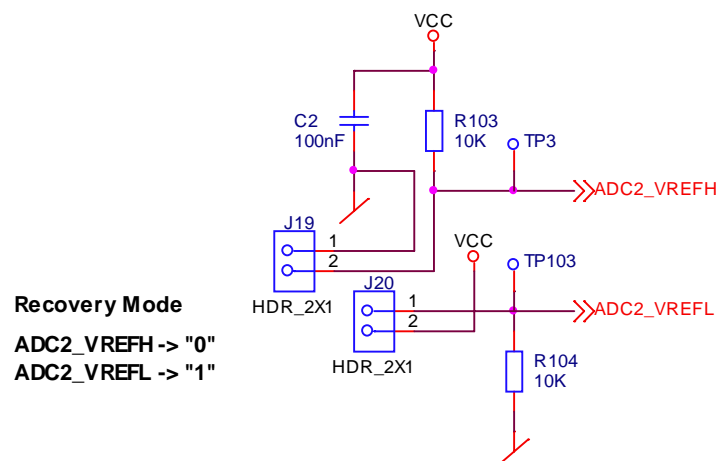


Figure 4-4. FLASH Erase Headers

4.10 ADC Voltage References

Two ADC reference voltages are provided:

- The reference voltage for ADC2_VREFH is tied to VCC which is regulated when the board is supplied from the DC source or the USB port. However, this voltage moves with VCC when power is supplied via the battery source.
- A fixed voltage reference for ADC1_VREFH is provided (see [Figure 4-5](#)).
 - The fixed voltage is 1.5 Vdc.
 - The LM285M (U17) is programmed via R120 and R121 to provide a constant reference
 - The reference can be enabled via Jumper J18.
 - This reference is useful for battery operation where a known, fixed high reference voltage for the ADC is required.

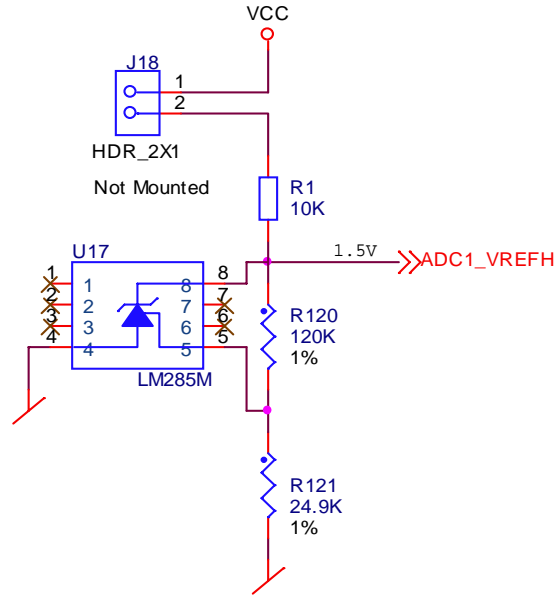


Figure 4-5. ADC Voltage 1.5 Vdc Voltage Reference

4.11 Jumper Selection

Table 4-5 lists all the possible jumper selections for the Sensor Node. The jumpers available on the board are:

- J7 - Selects audio output source
- J18 - Sets fixed ADC reference voltage
- J19, J20- Clears MC1322x onboard FLASH. See Table 4-5.

Table 4-5. Sensor Node Jumper Selection

Pin Header	Pin Number Connection	Description	Default Setting
J7	1-2	Connect to enable audio path from DAC	Not mounted
	2-3	Connect to enable audio path from PWM	Mounted
J18	1-2	Connect to enable ADC 1.5V reference	Not mounted
J19, J20	1-2, 1-2	Connect both to recover/clear FLASH. See Section 4.9, “FLASH Memory Recovery Jumpers and Erase”	Not mounted

Chapter 5 Schematic, Board Layout, and Bill of Material

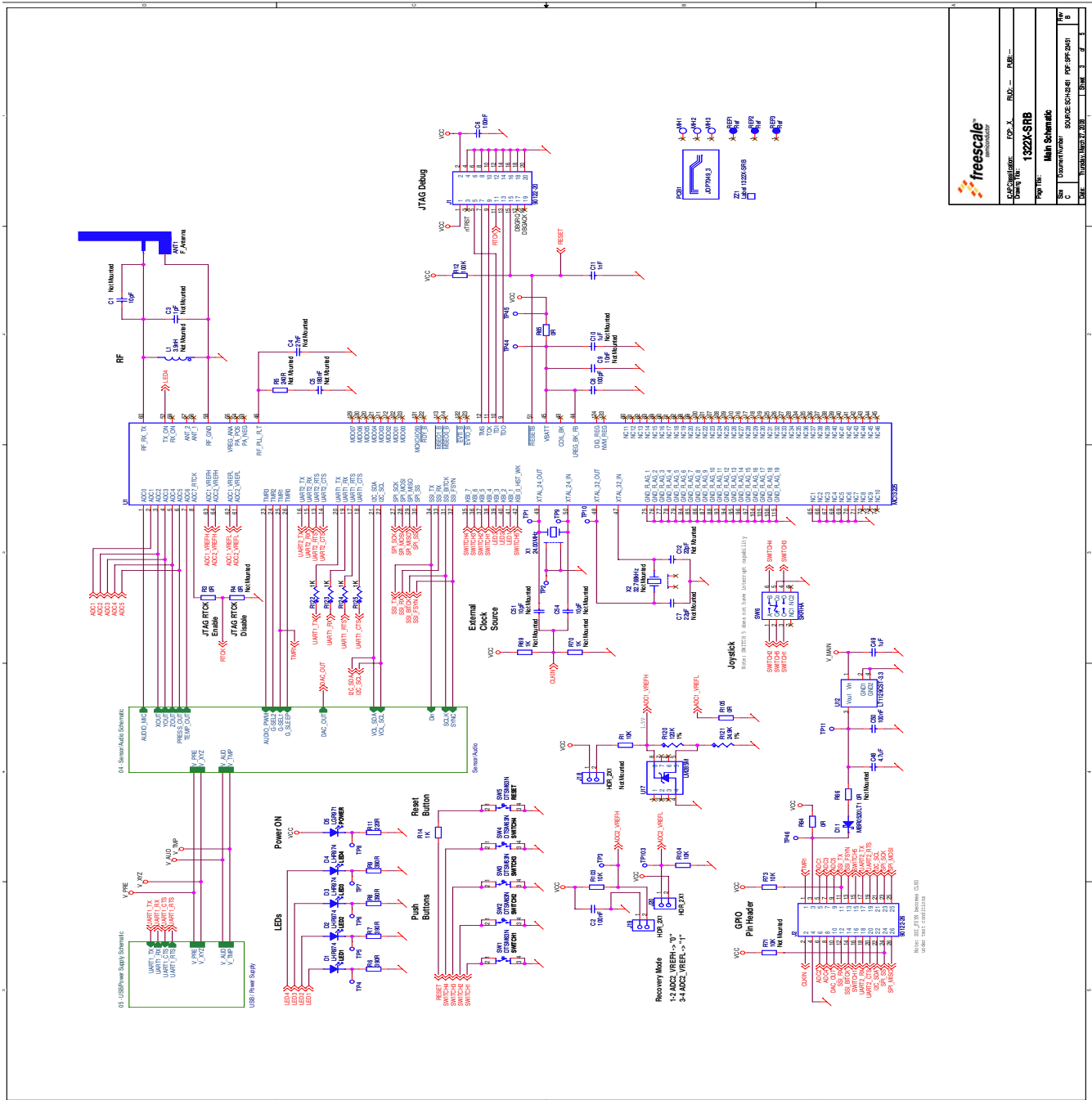


Figure 5-1. Sensor Node Schematic (1 of 3)

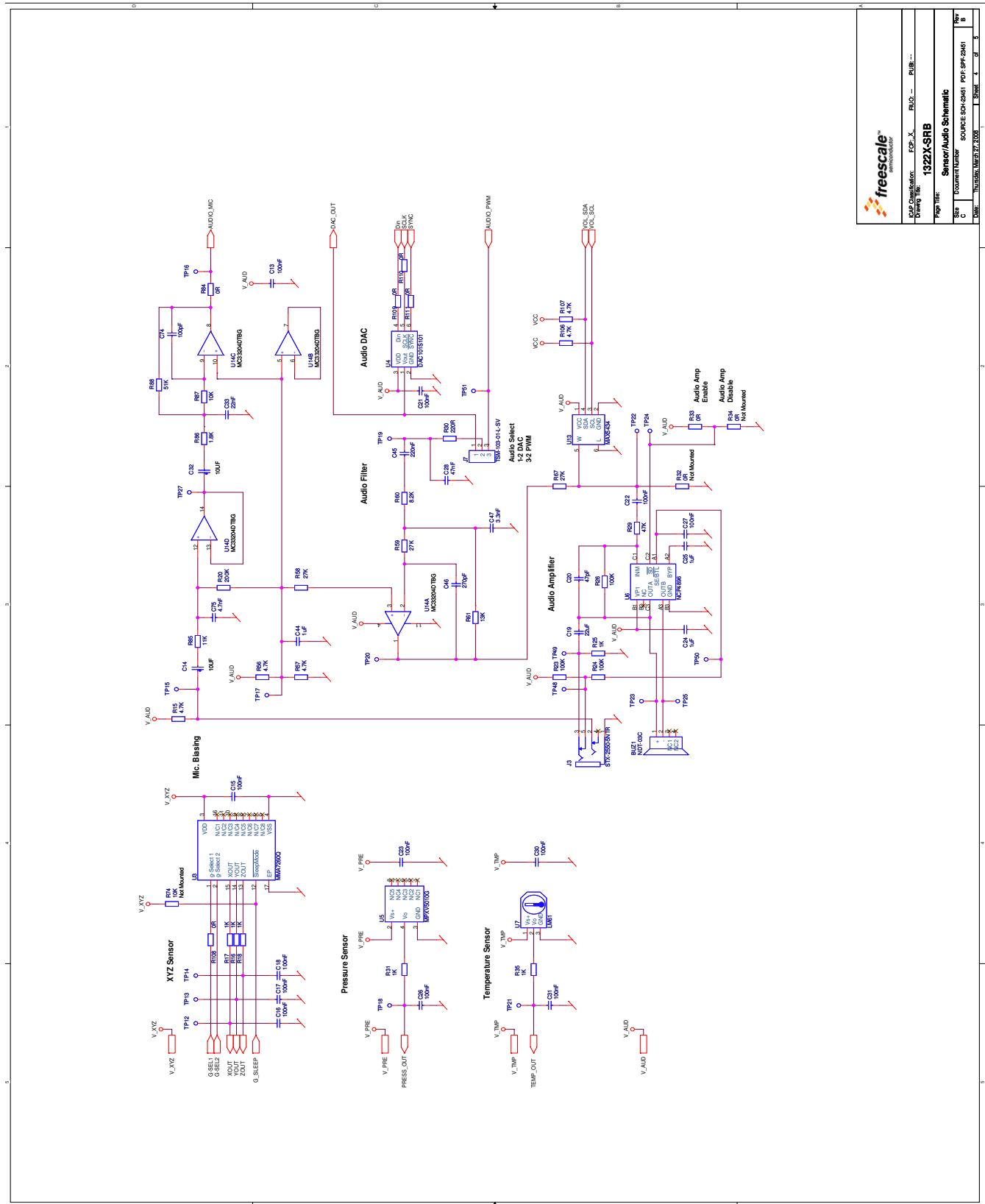


Figure 5-2. Sensor Node Schematic (2 of 3)

ESD Consideration: Human Body Model	POP-X, R010 - R018-...
1322X-SRB	
Sensor/Audio Schematics	
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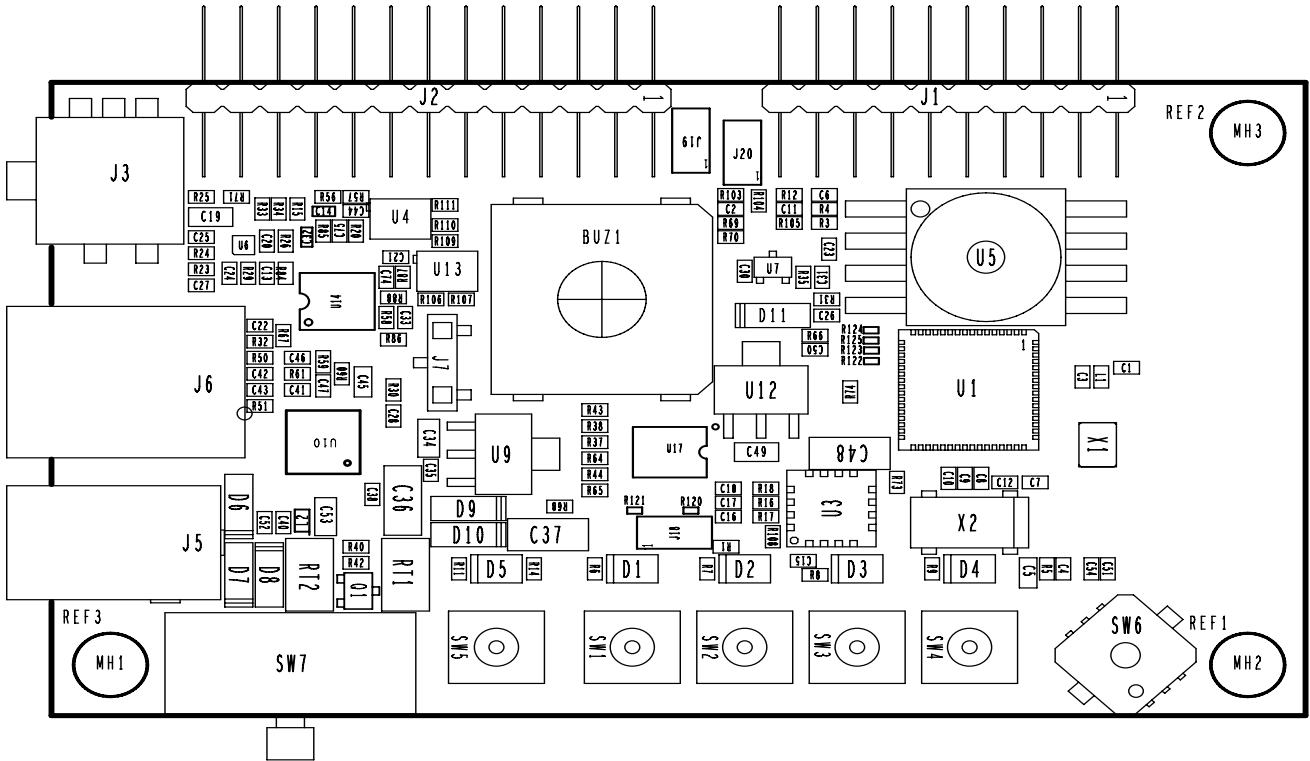


Figure 5-4. Sensor Node PCB Component Location (Top View)

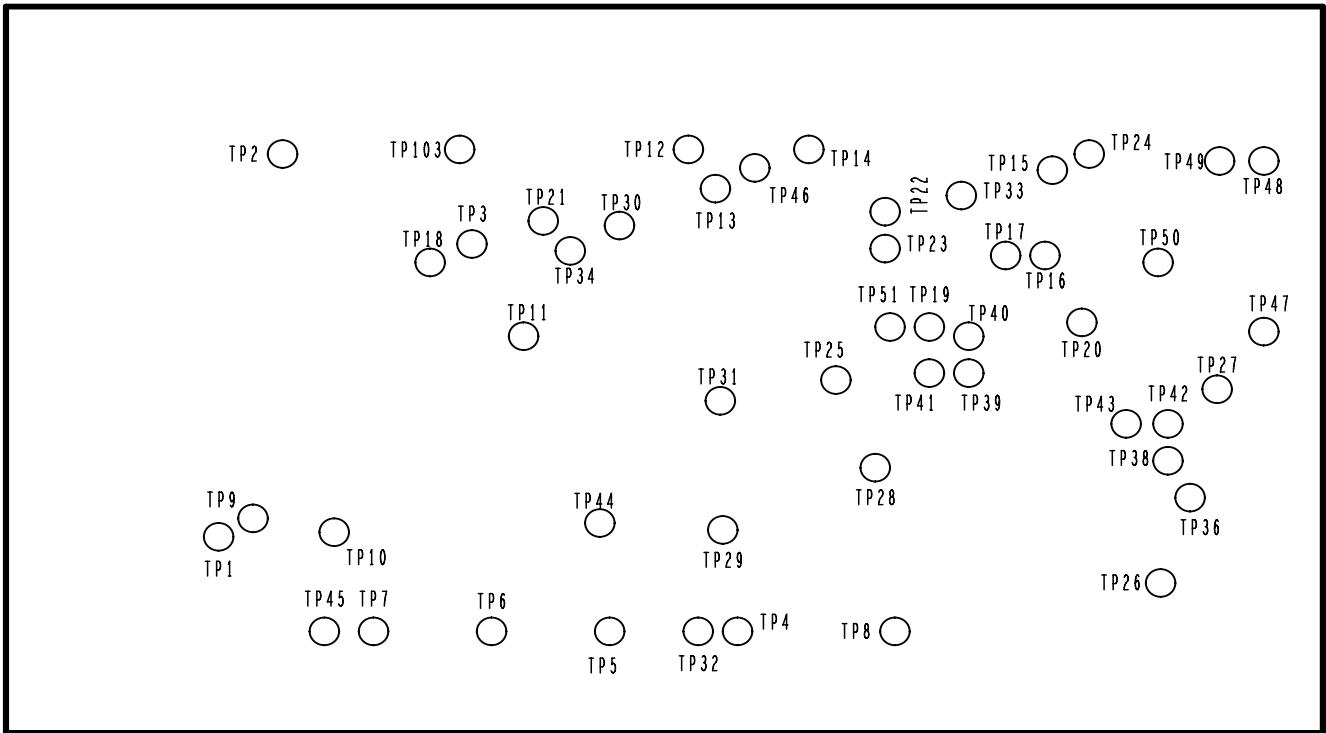


Figure 5-5. Sensor Node PCB Test Points (Bottom View)

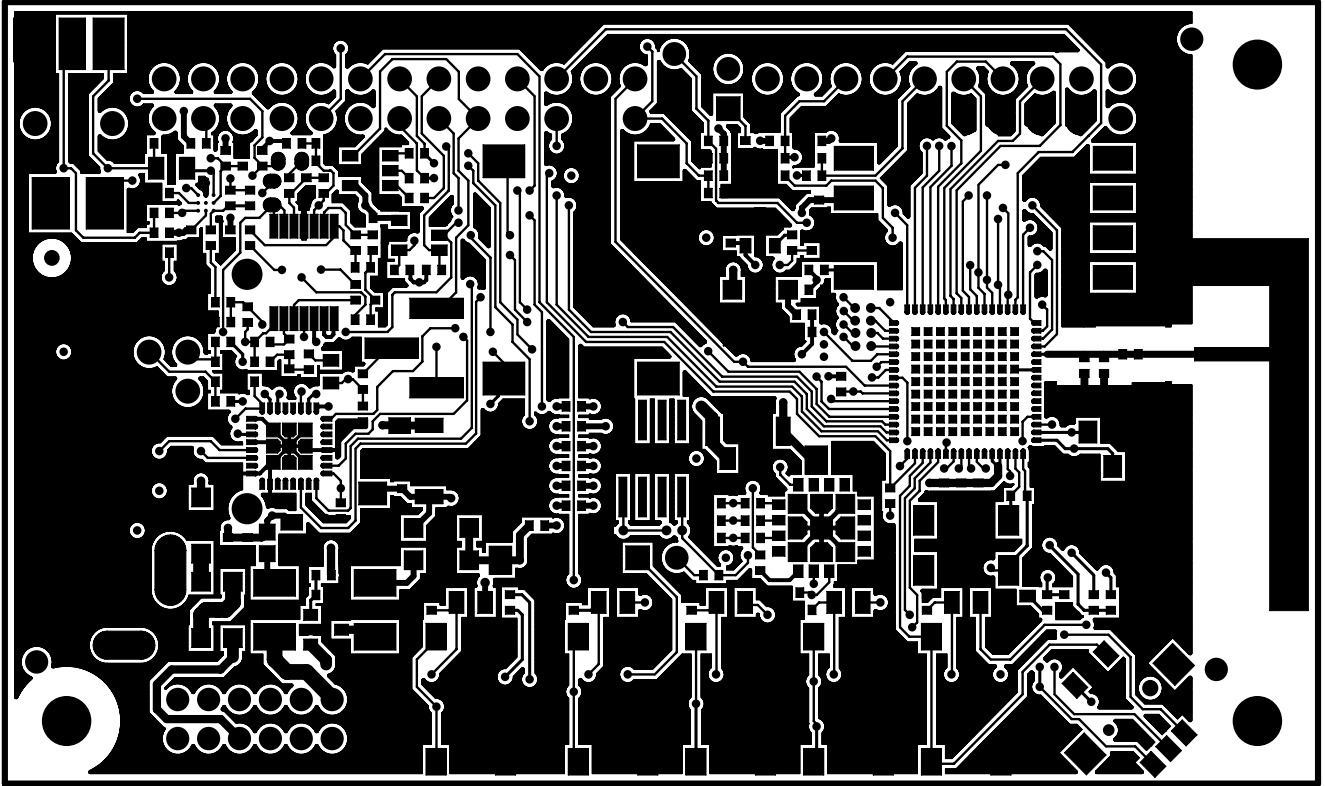


Figure 5-6. Sensor Node PCB Layout (Top View)

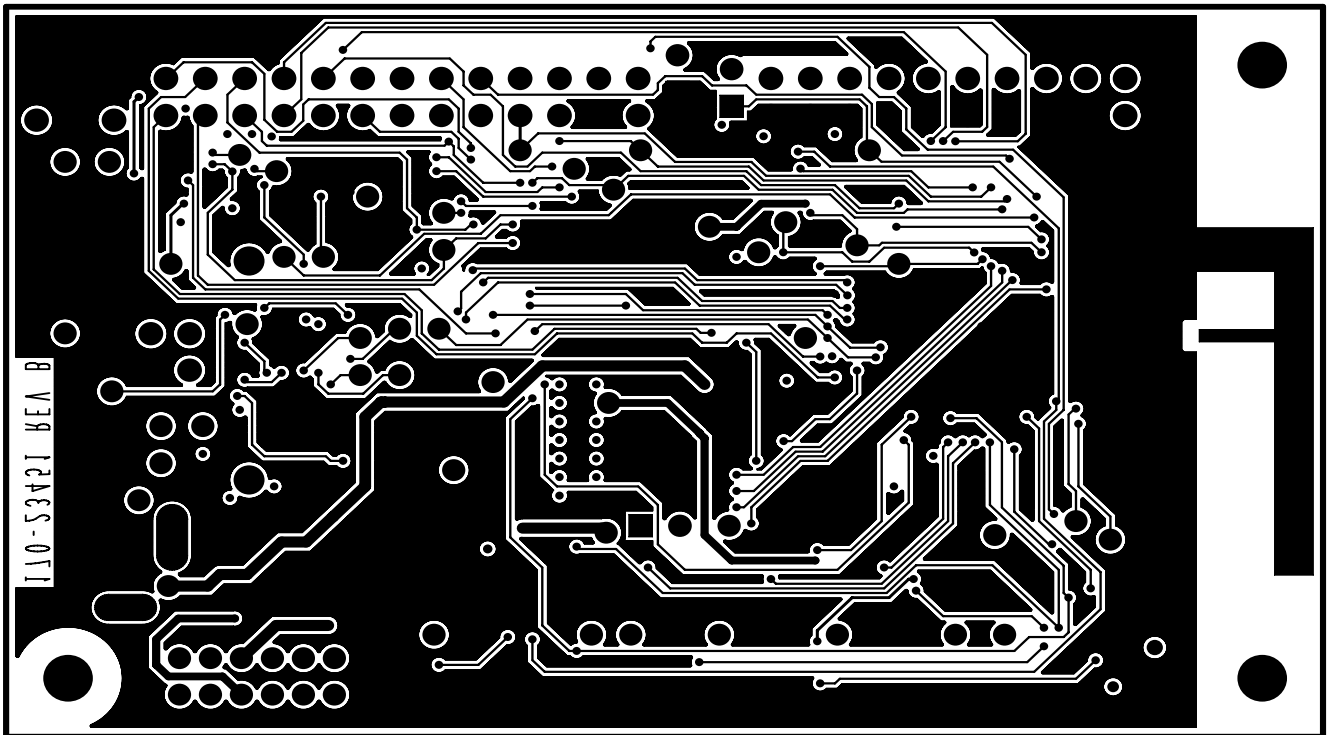


Figure 5-7. Sensor Node PCB Layout (Bottom View)

Table 5-1. Bill of Materials

QTY	Part Reference	Description	Value	Voltage	Tolerance	Manufacturer	Manufacturer Part Number
1	ANT1	F_Antenna	PCB F ANTENNA			NOT A PART	NOT A PART
1	BUZ1	SMD Speaker	NDT-03C			Star Micronics	NDT-03C
1	BC1	PCB Battery Holder 2xAA	2462			Keystone	2462
0	C1,C51,C54	Ceramic Capacitor C0G	10pF	50V	5%	Murata	GRM1555C1H100JZ01
2	C14,C32	CAP CER 10UF 6.3V 20% X5R 0603	10uF	6.3V	20%	PANASONIC	ECJ1VB0J106M
3	C24,C25,C44	Ceramic Capacitor X5R	1uF	6.3V	10%	Murata	GRM155R60J105KE19B
0	C10	Ceramic Capacitor X5R	1uF	6.3V	10%	Murata	GRM155R60J105KE19B
1	C11	Ceramic Capacitor X7R	1nF	50V	10%	Murata	GRM155R71H102KA01D
1	C19	Ceramic Capacitor X5R	22uF	6.3V	20%	Murata	GRM21BR60J226ME39L
19	C2,C6,C13,C15,C16,C17,C18,C21,C22,C23,C26,C27,C30,C31,C35,C38,C40,C41,C50	Ceramic Capacitor X5R	100nF	10V	10%	Murata	GRM155R61A104KA01D
1	C20	Ceramic Capacitor C0G	47pF	50V	5%	Murata	GRM1555C1H470JZ01D
1	C28	Ceramic Capacitor X7R	47nF	25V	10%	Murata	GRM155R71E473KA88
0	C3	Ceramic Capacitor C0G	1pF	50V	0.25pF	Murata	GRM1555C1H1R0CZ01D
1	C33	Ceramic Capacitor X7R	22nF	25V	10%	Murata	GRM155R71E223KA61D
2	C34,C49	Ceramic Multilayer Capacitor X7R NoPb	1uF	16V	15%	Murata	GRM21BR71C105
3	C36,C37,C48	Ceramic Multilayer Capacitor X5R	4.7uF	16V	15%	Phycomp	2222 781 13672

Table 5-1. Bill of Materials

QTY	Part Reference	Description	Value	Voltage	Tolerance	Manufacturer	Manufacturer Part Number
0	C4	Ceramic Multilayer Capacitor X7R	27nF	10V	5%	Vishay	VJ0402Y273JXQCW1BC
2	C42,C43	Ceramic Capacitor C0G	15pF	50V	5%	Murata	GRM1555C1H150JZ01J
1	C45	Ceramic Capacitor X7R	220nF	10V	10%	Murata	GRM188R71A224KA01
1	C46	Ceramic Capacitor C0G	270pF	50V	5%	Murata	GRM1555C1H271JA01
1	C47	Ceramic Capacitor C0G	3.3nF	50V	15%	Murata	GRM155R71H332KA01
0	C5	Ceramic Multilayer Capacitor X7R	180nF	16V	5%	Vishay	VJ0603Y184JXJCW1BC
1	C53	Ceramic Multilayer Capacitor X5R	4.7uF	10V	10%	Murata	GRM219R61A475KE34D
0	C7,C12	Ceramic Capacitor C0G	22pF	50V	5%	Murata	GRM1555C1H220JZ01J
2	C8,C74	Ceramic Capacitor C0G	100pF	50V	5%	Murata	GRM1555C1H101JZ01
1	C52	Ceramic Capacitor X7R	10nF	25V	10%	Murata	GRM155R71E103KA01D
1	C75	Ceramic Capacitor X7R	4.7nF	25V		Murata	GRM155R71E472KA01D
0	C9	Ceramic Capacitor X7R	10nF	25V	10%	Murata	GRM155R71E103KA01D
4	D1,D2,D3,D4	SMD Red topped	LHR974			OSRAM	Q62702P5182
1	D5	SMD Green topped	LGR971			OSRAM	Q65110P5179
6	D6,D7,D8,D9,D10,D11	SMD Power Schottky Rectifier	MBR0520LT1	20V		On Semiconductor	MBR0520LT1G
1	J3	2.5mm Audio stereo jack with switch	STX-2550-5NTR			Kycon	STX-2550-5NTR
1	J7	Single Row Straight Pin Header SMD w. Plastic Pick & Place Pad	TSM-103-01-L-S V			Samtec	TSM-103-01-L-SV-P-TR
2	J19,J20	HDR 1X2 TH 100MIL SP 330H AU	TSW-102-07-S-S			SAMTEC	TSW-102-07-S-S

Table 5-1. Bill of Materials

QTY	Part Reference	Description	Value	Voltage	Tolerance	Manufacturer	Manufacturer Part Number
1	J18	HDR 1X2 TH 100MIL SP 330H AU	TSW-102-07-S-S			SAMTEC	TSW-102-07-S-S
0	L1	HF Chip coil	3.9nH		5%	Murata	LQG15HS3N9S02D
1	L2	Chip Ferrite Bead	500mA			Murata	BLM11P600Sxx
1	Q1	P-channel MOSFET	ZXM61P02F	20V		Zetex	ZXM61P02F
6	R1,R40,R 73,R87,R1 03,R104	Fixed resistor RC31	10K	50V	2%	Philips	2322 705 50103
17	R3,R33,R 37,R38,R4 3,R44,R50 ,R51,R64, R65,R68, R84,R105, R108,R10 9,R110,R1 11	Fixed resistor RC31	0R	50V	2%	Philips	2322 705 91002
0	R4,R32,R 34,R66	Fixed resistor RC31	0R	50V	2%	Philips	2322 705 91002
2	R11,R30	Fixed resistor RC31	220R	50V	2%	Philips	2322 705 50221
5	R12,R23, R24,R26, R42	Fixed resistor RC31	100K	50V	2%	Philips	2322 705 50104
7	R14,R16, R17,R18, R25,R31, R35	Fixed resistor RC31	1K	50V	2%	Philips	2322 705 50102
0	R69,R70	Fixed resistor RC31	1K	50V	2%	Philips	2322 705 50102
5	R15,R56, R57,R106, R107	Fixed resistor RC31	4.7K	50V	2%	Philips	2322 705 50472
1	R20	Fixed resistor RC31	200K	50V	2%	YAGEO AMERICA	RC0402JR-07200KL
0	R71,R74	Fixed resistor RC31	10K	50V	2%	Philips	2322 705 50103
1	R29	Fixed resistor RC31	47K	50V	2%	Philips	2322 705 50473
0	R5	Fixed resistor RC31	240R	50V	2%	Philips	2322 705 50241

Table 5-1. Bill of Materials

QTY	Part Reference	Description	Value	Voltage	Tolerance	Manufacturer	Manufacturer Part Number
3	R58,R59, R67	Fixed resistor RC31	27K	50V	2%	Philips	2322 705 50273
4	R6,R7,R8, R9	Fixed resistor RC31	390R	50V	2%	Philips	2322 705 50391
1	R60	Fixed resistor RC31	8.2K	50V	2%	Philips	2322 705 50822
1	R61	Fixed resistor RC31	13K	50V	2%	Philips	2322 705 50133
1	R85	Fixed resistor RC32	11K	50V		KOA SPEER	RK73H1ETTP1102F
1	R86	Fixed resistor RC33	1.8K	50V		KOA SPEER	RK73H1ETTP1801F
1	R88	Fixed resistor RC34	51K	200V		KOA SPEER	RK73H1ETTP5102F
1	R120	RES MF 120K 1/16W 1% 0402	120K		1%	KOA SPEER	RK73H1ETTP1203F
1	R121	RES MF 24.9K 1/16W 1% 0402	24.9K		1%	KOA SPEER	RK73H1ETTP2492F
4	R122,R12 3,R124,R1 25	RES MF 1.0K 1/16W 5% 0402	1K		5%	VISHAY INTERTECHN OLOGY	CRCW04021K00JNED
2	RT1,RT2	Polyswitch Overcurrent Protection Device	500mA	13.2V		Tyco Electronics	microSMD050F
5	SW1,SW2, SW3,SW4, SW5	SMD Tact Switch 2.6N (7.0mm)	DTSM63N			Diptronic	DTSM-63N-V-B
1	SW6	4-directional TACT switch with center push SMD	SKRHA			ALPS	SKRHAAE010
1	SW7	Miniature Slide Switch 4 pole	MFP461N-RA			Knitter-Switch	MFP461N-RA
1	U1	ZigBee Wireless Transceiver and ARM7 processor	MC13225			Freescale	MC13225
1	U10	USB UART, PB-free	FT232R			FTDI	FT232RQ
1	U13	Digitally Controlled Potentiometer, 50Kohm	MAX5434			Maxim	MAX5434LEZT+T

Table 5-1. Bill of Materials

QTY	Part Reference	Description	Value	Voltage	Tolerance	Manufacturer	Manufacturer Part Number
1	U3	+/-1.5g to 6g Three axis low-g accelerometer	MMA7260Q			Freescale	MMA7260QR2
1	U4	10-bit Low Power DAC with rail to rail output	DAC101S101			National Semiconductors	DAC101S101CIMK-NoPB
1	U5	Integrated Pressure Sensor	MPXV5010G			Freescale	MPXV5010GC6U
1	U6	Audio class AB amplifier, 1,0W	NCP4896			On Semiconductor	NCP4896FCT1G
1	U7	Temperature Sensor 2,7V	LM61			National Semiconductors	LM61BIM3
2	U9,U12	LDO voltage regulator 3V3	LT1129CST-3.3			Linear Technology	LT1129CST-3.3
1	U14	IC LIN OPAMP QUAD 2.2MHZ 1.8-12V TSSOP14	MC33204DTBG			ON SEMICONDUCTOR	MC33204DTBG
1	U17	IC VREG ADJ 1.24-5.3V 20MA SOIC8	LM285M			National Semiconductors	LM285M/NOPB
1	X1	Crystal SMD	24.00MHz		+10ppm	NDK	NX3225SA-24MHz (for OA/AV and BlueTooth) / S1-3085-1510-9
0	X2	Crystal SMD	32.768kHz		+20ppm	Abracon	ABS25-32.768KHZ-T
1	J1	Dual Row Right Angle pin header 0.38um gold	90122-20			Molex	90122-0770
1	J2	Dual Row Right Angle pin header 0.38um gold	90122-26			Molex	90122-0773
1	J5	DC Power Jack PCB, 2mm	DJ-005			Taitek	2DC-0005-D100
1	J6	USB-series "B" receptacle	USB-B			AMP	292304-1