Table 4-2. 1323x-RCM Voltage Sources

Source	Connector	Input Voltage Range	Description
External DC Supply	1x2 Pin Header J14	2.3 V - 6 V	The input voltage range is determined by the U8 regulator and the diode isolation circuit
Two AA Batteries	Battery Holder	2.0 V - 3.1 V[1]	• The input voltage range reflects the usable range of alkaline cells and the voltage drop incurred by the diode isolation circuit. • The battery source is disabled if another source is connected

[1] The minimum operating battery voltage is determined by use model, see Note, Section 4.2.1, “Power Management”

Again referring to Figure 4-3, a number of zero-ohm resistors are provided to isolate different circuits and to allow current measurement:

- VCC (main 1323x-RCM supply) - resistor R35
- V_LED (all LEDs supply) - resistor R36
- V_TPD (touchpad supply) - resistor R37
- V_ACC (accelerometer supply) - resistor R40
- V_BUZ (buzzer supply) - resistor R42
- V_MRB (1323x-MRB supply) - resistor R43

4.2.2 GPIO Connection to 1323x-MRB

IO Connectors J8 and J9 (see Figure 4-1) are receptacles that accept the 1323x-MRB pin headers to mount the daughter card. Figure 2-1 shows the 1323x-RCM with the 1323x-MRB mounted. Receptacles J8 and J9 connect to the MC13233 GPIO.

To provide better access and versatility to the GPIO, a secondary set of pin headers P1 and P2 is connected in series with the IO signals:

- Jumpers must be installed on P1 and P2 to connect 1323x-RCM peripherals and functions
- The pin headers provide direct access for connecting custom circuitry to the GPIO
- Power and ground to primary connectors J8 and J9 are not enabled though the pin headers

Figure 4-4 shows IO Header P1 andP2 pin mapping.

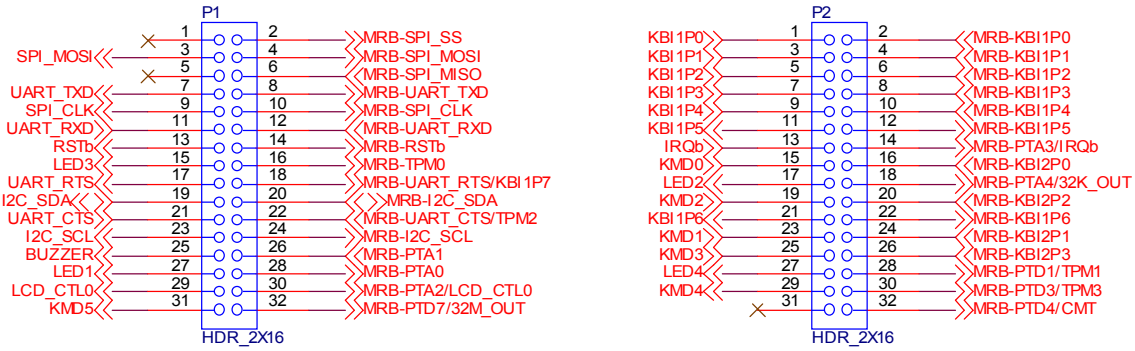

Figure 4-4. 1323x-RCM IO Connector J8 and J9 Pin Mapping

Table 4-3 list the P1 and P2 pin header function as it relates to the MC13233.

Table 4-3. 1323x-RCM P1 and P2 Pin Header Function Description

1323x-REM Header Pins	MC13233 Signal Name	Description	1323x-REM Application / Notes
P1-27, P1-28	PTA0/XTAL_32K	Port A Bit 2 / 32.768 kHz oscillator output	• Drives LED1; jumper required • 32.768 kHz oscillator can be enabled on MRB
P1-25, P1-26	PTA1/EXTAL_32K	Port A Bit 3 / 32.768 kHz oscillator input	• Drives Buzzer; jumper required • 32.768 kHz oscillator can be enabled on MRB
P1-13, P1-14	$\overline{\text{RESET}}$	Device asynchronous hardware reset. Active low. Onboard Pullup	• Drives touchpad reset; jumper required • Reset signal driven from MRB
P1-29, P1-30	PTA2	Port A Bit 2. Onboard pull-down for TM	• Drive LCD_CTL0; jumper required • Application is LCD enable clock • TM enable
P2-13, P2-14	PTA3/IRQ	Port A Bit 3 / IRQ.	• Used; jumper required • Provides interrupt request input IRQ (active low) from accelerometer and touchpad
P2-17, P2-18	PTA4/ XTAL_32KOUT	Port A Bit 4 / Buffered 32.768 kHz clock output	• Drives LED2; jumper required • Optional 32.768 kHz output clock for measuring reference oscillator accuracy (ppm)
P1-19, P1-20	PTA5/SDA	Port A Bit 5 / IIC Bus data	• Used; jumper required • Connects to accelerometer • Defaults to open drain for IIC • Pullup on MRB
P1-23, P1-24	PTA6/SCL	Port A Bit 6 / IIC Bus clock	• Used; jumper required • Connects to accelerometer • Defaults to open drain for IIC • Pullup on MRB
P2-1, P2-2	PTB0/KBI1P0	Port B Bit 0 / KBI1 Input Bit 0	RCM switch matrix; jumper required
P2-3, P2-4	PTB1/KBI1P1	Port B Bit 1 / KBI1 Input Bit 1	RCM switch matrix; jumper required

Table 4-3. 1323x-RCM P1 and P2 Pin Header Function Description (continued)

1323x-REM Header Pins	MC13233 Signal Name	Description	1323x-REM Application / Notes
P2-5, P2-6	PTB2//KBI1P2	Port B Bit 2 / KBI1 Input Bit 2	RCM switch matrix; jumper required
P2-7, P2-8	PTB3//KBI1P3	Port B Bit 3 / KBI1 Input Bit 3	RCM switch matrix; jumper required
P2-9, P2-10	PTB4//KBI1P4	Port B Bit 4 / KBI1 Input Bit 4	RCM switch matrix; jumper required
P2-11, P2-12	PTB5//KBI1P5	Port B Bit 5 / KBI1 Input Bit 5	RCM switch matrix; jumper required
P2-21, P2-22	PTB6//KBI1P6	Port B Bit 6 / KBI1 Input Bit 6	RCM switch matrix; jumper required
P1-17, P1-18	PTB7//KBI1P7	Port B Bit 7 / KBI1 Input Bit 7	• UART flow control RTS input to MCU; jumper required • Connects to RCM USB <> UART device
P2-15, P2-16	PTC0/KBI2P0	Port C Bit 0 / KBI2 Input Bit 0	RCM switch matrix; jumper required
P2-23, P2-24	PTC1/KBI2P1	Port C Bit 1 / KBI2 Input Bit 1	RCM switch matrix; jumper required
P2-19, P2-20	PTC2/KBI2P2	Port C Bit 2 / KBI2 Input Bit 2	RCM switch matrix; jumper required
P2-25, P2-26	PTC3/KBI2P3	Port C Bit 3 / KBI2 Input Bit 3	RCM switch matrix; jumper required
P1-9, P1-10	PTC4/SPICLK	Port C Bit 4 / SPI clock	• Used; jumper required • Connected to serial FLASH on MRB • Connected to serial LCD interface
P1-2	PTC5/SS	Port C Bit 5 / SPI slave select	• Unused on RCM • Must be in-active for LCD access • Connected to serial FLASH on MRB
P1-6	PTC6/MISO	Port C Bit 6 / SPI MISO	• Unused on RCM • Connected to serial FLASH on MRB
P1-3, P1-4	PTC7/MOSI	Port C Bit 7 / SPI MOSI	• Used; jumper required • Connected to serial FLASH on MRB • Connected to serial LCD interface
P1- 15, P1-16	PTD0/TPM0	Port D Bit 0 / TPM0 signal	Drives LED3; jumper required
P2-27, P2-28	PTD1/TPM1	Port D Bit 1/ TPM1 signal	Drives LED4; jumper required
P1-21, P1-22	PTD2/TPM2	Port D Bit 2 / TPM2 signal	• UART flow control CTS output from MCU; jumper required • Connects to RCM USB <> UART device
P2-29, P2-30	PTD3/TPM3	Port D Bit 3 / TPM3 signal	RCM switch matrix; jumper required
P2-32	PTD4/CMT	Port D Bit 4/ CMT output	• Not used on RCM • Connected to IR blaster on MRB
P1-7, P1-8	PTD6/RXD	Port D Bit 6 / UART RXD input	• UART RXD input to MCU; jumper required • Connects to RCM USB <> UART device
P1-11, P1-12	PTD5/TXD	Port D Bit 5 / UART TXD output	• UART TXD output from MCU; jumper required • Connects to RCM USB <> UART device
P1-31, P1-32	PTD7/32MOUT	Port D Bit 7	• RCM switch matrix; jumper required

4.2.3 1323x-RCM Onboard Peripheral Functions

The 1323x-RCM has a rich set of peripheral functions useful to evaluate the MC13233 and to implement a full featured remote control.

4.2.3.1 USB Interface

For many applications or demonstrations it is desirable to connect the 1323x-RCM to a PC or other device. A USB port is provided with a USB “B” receptacle plug. The port is connected to a FTDI FT232RQ 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 can draw all required power from the USB interface. The device is USB 2.0 full speed compatible.

The USB connector is designated as J15. Figure 4-5 shows the connector pinout.

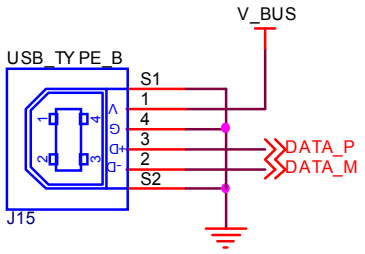

Figure 4-5. USB Connector Pinout

4.2.3.2 128x32 Graphic/Alphanumeric LCD

The 1323x-RCM supports a 128x32 pixel STN passive trans-reflective monochrome graphic LCD that provides for alphanumeric or graphic readout. The LCD module is mounted on top of the main circuit board and connects via a 16-pin connector. Figure 4-6 shows the LCD interface schematic.

- The display is an CRYSTALFONZ #CFAG12832A-YGH-N
- Viewing area is 51.0 (W) × 17.8 (H) mm
- The LCD operates from 5 Vdc generated from the main operating voltage through a boost switching regulator. The LCD module requires a highly regulated 5 V so that the high voltages generated onboard the display are consistent.
- The LCD has optional yellow-green LED backlighting
  - — Typical current of 30 mA when full on
  - — Enabled via Jumper J10
  - — Always on when enabled.
- LCD interface to the MCU is via the SPI port - although the LCD module only supports a parallel interface (8-bit or 4-bit modes), the 1323x-RCM uses a serial interface derived from the SPI port
  - — The SPI serial stream is loaded into an 8-bit shift register (74AHCT164) used as a serial-to-parallel converter

— Nibble (4-bit) parallel mode is used on the LCD and the shift register provides the 4 data bits and the RS control signal

— The 4-data and RS control are strobed into the LCD via the LCD_CTL0 control signal derived from MC13233 PTA2 output.

— LCD write mode only is supported; the LCD cannot be read.

— The SPI port is shared with the serial FLASH on the 1323x-MRB. SS must be inactive (high) when writing to the LCD

- The onboard controller is a member of the Sitronix ST7920 Series family with an integrated display data RAM and alphanumeric character set

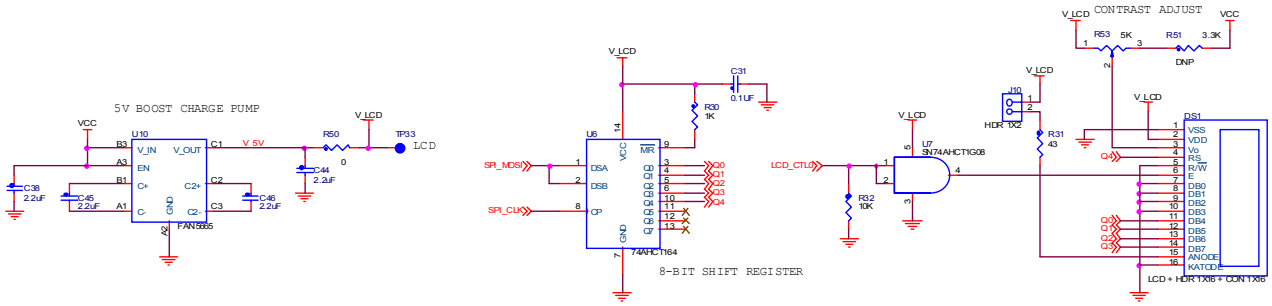

Figure 4-6. 1323x-RCM LCD Interface Circuit

4.2.3.3 36 Pushbutton 6x6 Switch Matrix

The1323x-RCM provides an 36 pushbutton 6x6 switch matrix for user application input interface.

- The matrix utilizes MC13233 KBI inputs
- All switches have interrupt and device wake up capability
- For these 36 switches
  — Includes the pushbutton array
  — Includes two switches located to the right and two switches to the left of the LCD
  — Includes switches SW31 and SW32 located on the bottom (non-component) side of the board
  — Does not support the two switches (KB0 and KB1) located near the touchpad.

4.2.3.4 Synaptics Touchpad

A Synaptics® Touchpad™ capacitive touch sensor is mounted on the 1323x-RCM for pointing functionality.

- The touchpad is approximately 30mm tall x 45mm wide
- Interface to the MCU uses the IIC interface
- The touchpad has a separate interrupt request line that is tied to the KBI1P6 MCU input
- The MCU reset is tied to the touchpad and resets the touchpad whenever a system reset occurs
- The touchpad support two independent KBI signals that are connected to pushbuttons KB0 and KB1and used for touchpad select functions
- The touchpad is soldered to the 1323x-RCM using two SMT headers

Figure 4-7 shows the touchpad circuit.

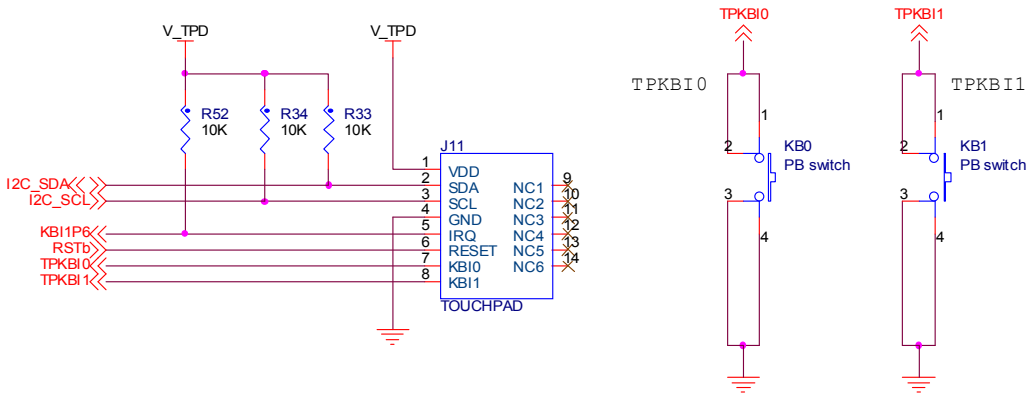

Figure 4-7. 1323x-RCM Touchpad Circuit

4.2.3.5 3-Axis Accelerometer

The 1323x-RCM contains a Freescale MMA7660 3-axis accelerometer with IIC interface.

- Uses a 3mm x 3mm x 0.9mm DFN package
- Device interface supports IIC bus and system reset
- Supports an auto-wake/sleep feature for Low power consumption.
- When the device is in auto-sleep state, if a shake interrupt, tap interrupt, Delta G, or orientation detection interrupt occurs, the device comes out of sleep mode and generates an interrupt request via the IRQ signal

Figure 4-8 shows the accelerometer circuit.

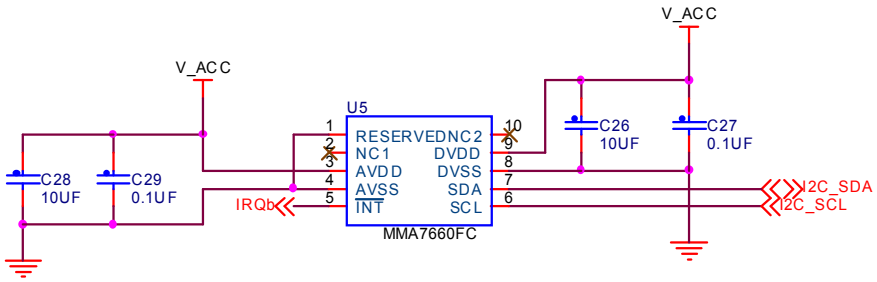

Figure 4-8. 1323x-RCM Accelerometer Circuit

4.2.3.6 Buzzer

The 1323x-RCM provides a single tone audio buzzer.

- Device LS1, CUI Inc., Part No. CMI-1240
- 4.0 kHz resonant frequency
- Device is buffered by Q2 and active when MCU output PTA1 is high (see Table 4-3)

Figure 4-9 shows the buzzer circuit.

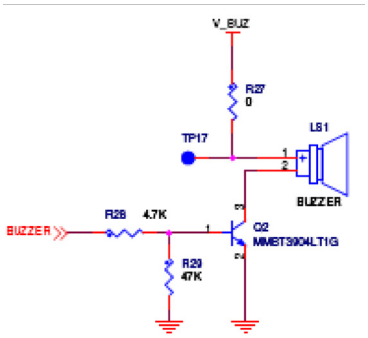

Figure 4-9. 1323x-RCM Buzzer Circuit

4.2.3.7 Blue Indicator LED

The1323x-RCM provides 4 blue LEDs for user application indicator outputs. Refer to Table 4-3 for listings of the MC13233 outputs that drive the LEDs.

4.3 Schematic, Board Layout, and Bill of Material

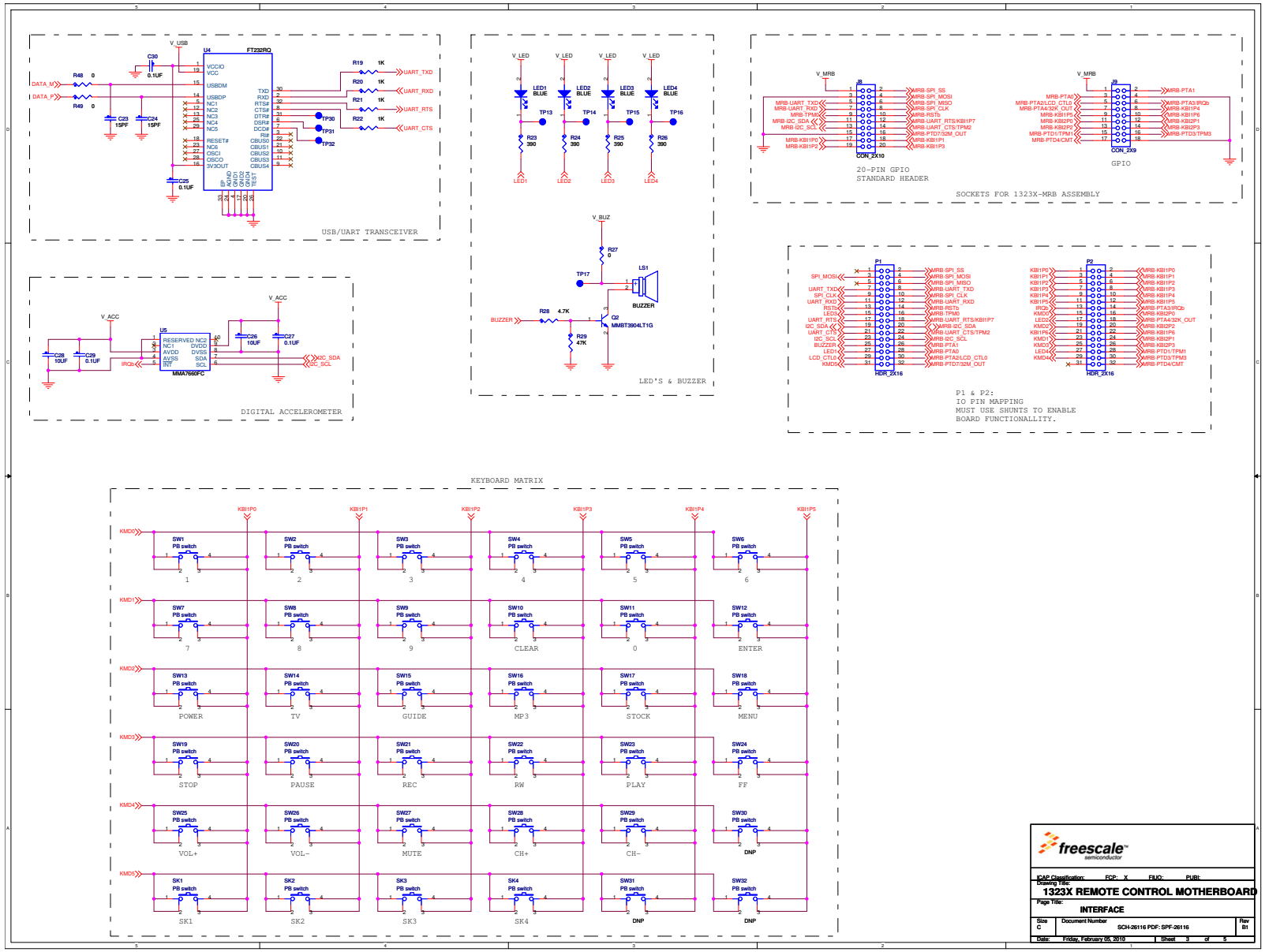

Figure 4-10. 1323x-RCM Schematic (1 of 3)

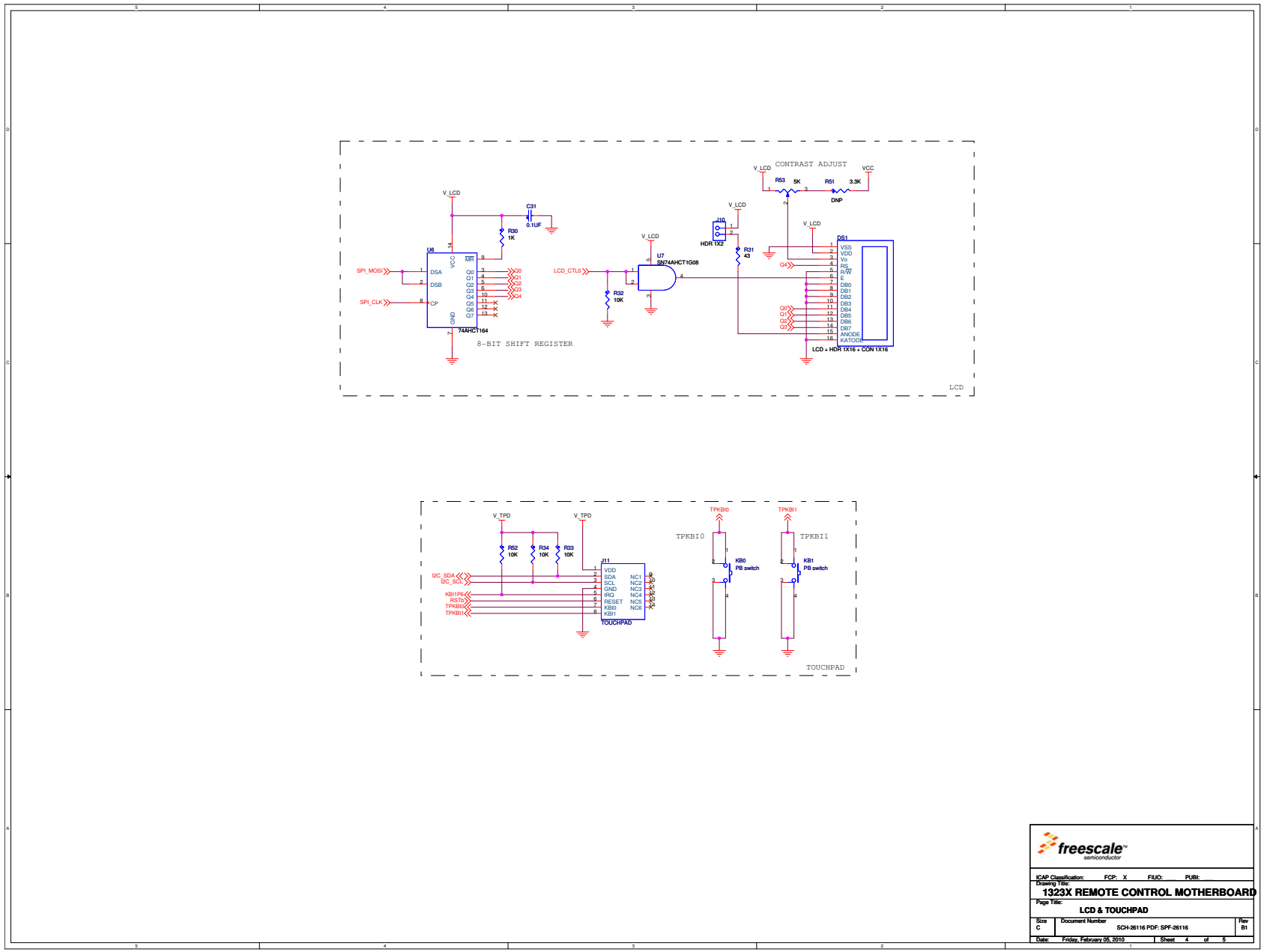

Figure 4-11. 1323x-RCM Schematic (2 of 3)

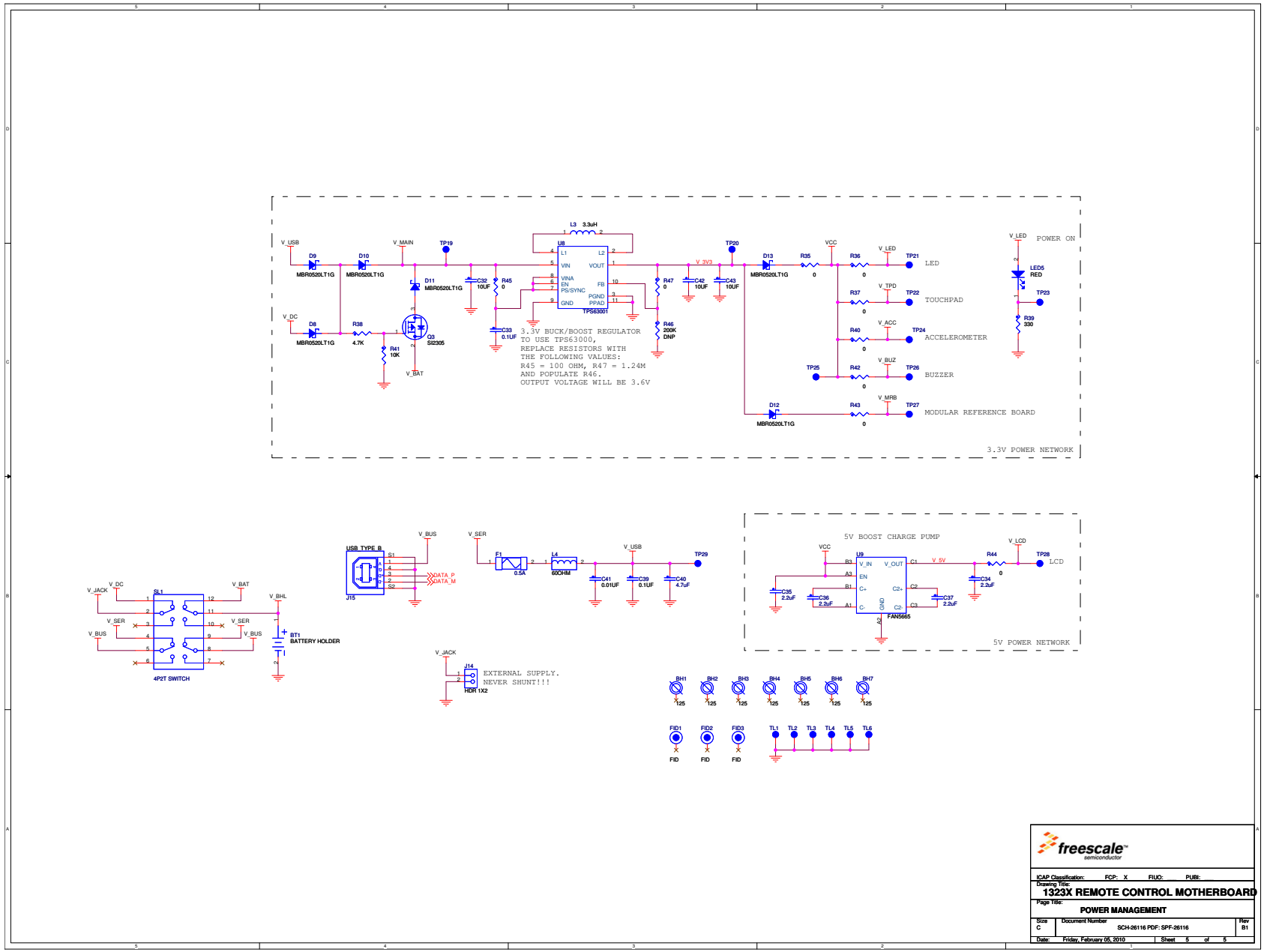

Figure 4-12. 1323x-RCM Schematic (3 of 3)

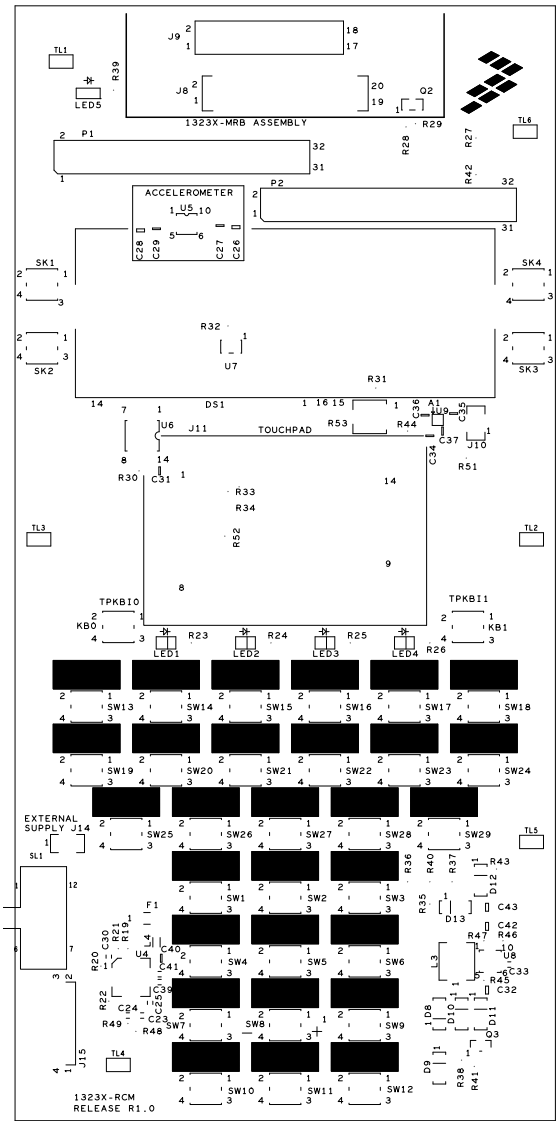

Figure 4-13. 1323x-RCM PCB Component Location (Top View)

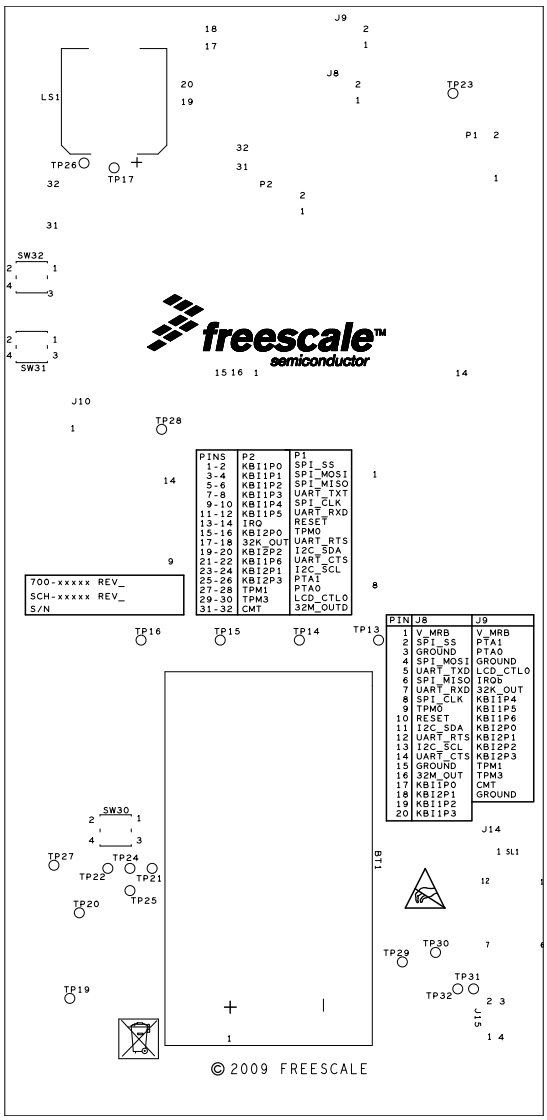

Figure 4-14. 1323x-RCM PCB Test Points

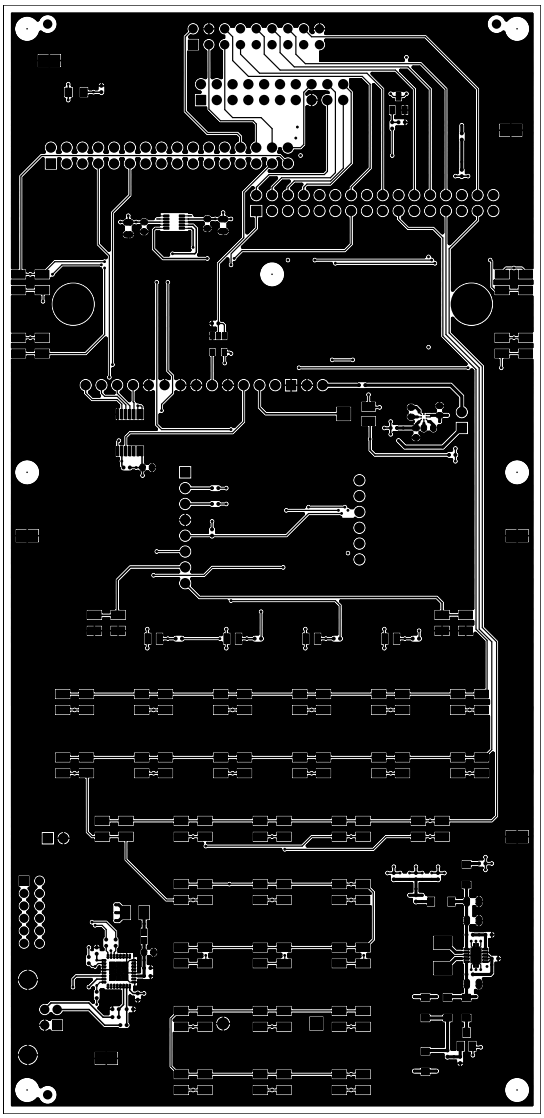

Figure 4-15. 1323x-RCM PCB Layout (Top View)

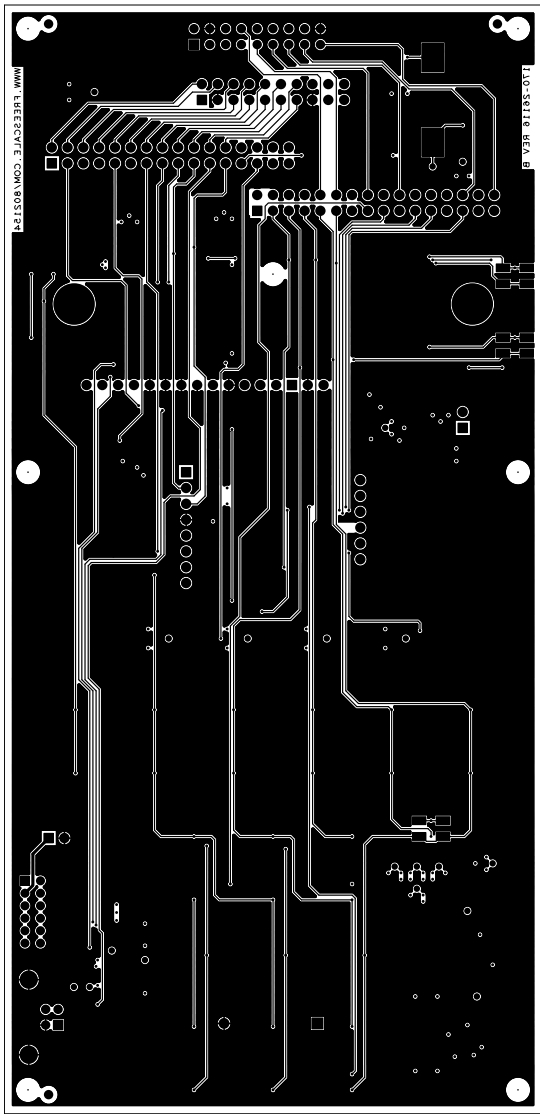

Figure 4-16. 1323x-RCM PCB Layout (Bottom View)

4.3.1 1323x-RCM Bill of Materials

Table 4-4. Bill of Materials

Item	Qty.	Reference	Value	Description	Mfg. Name	Mfg. Part Number
1	8	BH1,BH2,BH3,BH4,BH5,BH6,BH7,BH8	125	NON-PLATED MOUNTING HOLE 125 DRILL / 160 KEEPOUT NO PART TO ORDER		
2	1	BT1	BATTERY HOLDER	BATTERY HOLDER 2XAA TH	Keystone Electronics	2462
3	2	C23,C24	15PF	CAP CER 15PF 50V 5% C0G 0402	Kemet	C0402C150J5GAC
4	4	C25,C30,C33,C39	0.1UF	CAP CER 0.1UF 16V 10% X7R 0402	Murata	GRM155R71C104KA88D
5	5	C26,C28,C32,C42,C43	10UF	CAP CER 10UF 10V 10% X7R 0805	Murata	GRM21BR71A106KE51L
6	3	C27,C29,C31	0.1UF	CAP CER 0.1UF 50V 10% X7R 0603	Murata	GRM188R71H104KA93D
7	4	C34,C35,C36,C37	2.2uF	CAP CER 2.2UF 6.3V 10% X5R 0603	Murata	GRM188R60J225KE19D
8	1	C40	4.7uF	CAP CER 4.7UF 10V 10% X5R 0603	Taiyo Yuden	LMK107BJ475KA-T
9	1	C41	0.01UF	CAP CER 0.01UF 10V 20% X7R 0402	Avx	0402ZC103MAT2A
10	1	DS1	LCD + HDR 1X16 + CON 1X16	SUBASSY LCD 128X32 DOT 4.5-5V TH + HDR 1X16 TH 100MIL SP 330H AU + CON 1X16 SKT TH 100MIL SP 335 AU	Freescale Semiconductor	370-76474, 210-75955, 210-77812
11	6	D8,D9,D10,D11,D12,D13	MBR0520LT1G	DIODE SCH 0.5A 20V SOD-123	On Semiconductor	MBR0520LT1G
12	3	FID1,FID2,FID3	FID	FIDUCIAL 060 MIL PAD W/120 SOLDERMASK AND 040 MIL PAD W/90 MIL SOLDERMASK NO PART TO ORDER	Generic	FID-040
13	1	F1	0.5A	FUSE FAST 0.5A 63V SMT 1206	Littelfuse	0437.500WR
14	1	J8	CON_2X10	CON 2X10 SKT TH 100MIL CTR 335H AU 104L	Samtec	SSW-110-01-G-D
15	1	J9	CON_2X9	CON 2X9 SKT TH 100MIL SP 335H AU 194L	Samtec	SSW-109-02-G-D
16	2	J10,J14	HDR_1X2	HDR 1X2 TH 100MIL SP 375H AU	Tyco Electronics	826629-2
17	1	J11	TOUCHPAD	TOUCHPAD SERIAL 3V TH	Synaptics, Inc	515-000188-0110

Table 4-4. Bill of Materials

Item	Qty.	Reference	Value	Description	Mfg. Name	Mfg. Part Number
18	1	J15	USB_TYPE_B	CON 2X2 USB_TYPE_B SKT RA SHLD TH 2.5MM SP 453H AU	Tyco Electronics	292304-2
19	35	SW1,SK1,KB1,SW2,SK2,SW3,SK3,SW4,SK4,SW5,SW6,SW7,SW8,SW9,SW10,SW11,SW12,SW13,SW14,SW15,SW16,SW17,SW18,SW19,SW20,SW21,SW22,SW23,SW24,SW25,SW26,SW27,SW28,SW29,KB0	PB switch	SW SMT 4.0MM FMS 0.1A MAX 16V MAX ROHS COMPLIANT	Bourns	7914J-1-000E
20	4	LED1,LED2,LED3,LED4	BLUE	LED BLUE SGL 20MA SMT 0805	Lite On	LTST-C171TBKT-5A
21	1	LED5	RED	LED RED CLEAR SGL 30MA SMT 0805	Lite On	LTST-C171KRKT
22	1	LS1	BUZZER	BUZZER PIEZO AUDIO 83DB 4KHZ 8MA 12V SMT	Cui Stack	CMI-1240
23	1	L3	3.3uH	IND PWR 3.3UH@100KHZ 3.3A 20% SMT	Vishay Intertechnology	IHLP2020BZER3R3M01
24	1	L4	60OHM	IND FER BEAD 60OHM@100MHZ 500MA -- 0603	Murata	BLM18PG600SN1_
25	2	P1,P2	HDR_2X16	HDR 2X16 TH 100MIL CTR 330H AU 100L	Samtec	TSW-116-07-S-D
26	1	Q2	MMBT3904LT1G	TRAN NPN GEN 200MA 40V SOT-23	On Semiconductor	MMBT3904LT1G
27	1	Q3	SI2305	TRAN PMOS PWR 4.1A 8V SOT23	Vishay Intertechnology	SI2305ADS-T1-GE3
28	5	R19,R20,R21,R22,R30	1K	RES MF 1.0K 1/16W 5% 0402	Vishay Intertechnology	CRCW04021K00JNED
29	4	R23,R24,R25,R26	390	RES MF 390 OHM 1/16W 5% 0402	Bourns	CR0402-JW-391GLF
30	2	R27,R45	100	RES MF 100 OHM 1/16W 5% 0402	Vishay Intertechnology	CRCW0402100RJNED
31	10	R28,R35,R36,R37,R40,R42,R43,R44,R48,R49	0	RES TF ZERO OHM 1/16W RC0402	Vishay Intertechnology	CRCW04020000ZS
32	6	R29,R32,R33,R34,R41,R52	10K	RES MF 10K 1/16W 5% 0402	Vishay Intertechnology	CRCW040210K0JNED

Table 4-4. Bill of Materials

Item	Qty.	Reference	Value	Description	Mfg. Name	Mfg. Part Number
33	1	R31	39	RES MF 39 OHM 1/16W 5% 0402	Smec	RC73L2Z390JTF
34	1	R38	4.7K	RES MF 4.7K 1/16W 5% 0402	Smec	RC73L2Z472JTF
35	1	R39	330	RES MF 330 OHM 1/16W 5% 0402	Vishay Intertechnology	CRCW0402330RJNED
36	1	R46	200K	RES MF 200K 1/16W 5% 0402	Yageo America	RC0402JR-07200KL
37	1	R47	1.24M	RES MF 1.24M 1/16W 1% 0402	Vishay Intertechnology	CRCW04021M24FKED
38	1	R50	5K	RES POT 5.0K 1/4W 20% SMT	Bourns	3314J-1-502E
39	1	R51	3.3K	RES MF 3.3K 1/16W 5% 0402	Vishay Intertechnology	CRCW04023K30JNED
40	1	SL1	4PDT SWITCH	SW 4PDT SLD TH RA 30V 100MA --	Tyco Electronics	1-1437575-1
41	3	SW30,SW31,SW32	PB switch	SW SMT 4.0MM FMS 0.1A MAX 16V MAX ROHS COMPLIANT	Bourns	7914J-1-000E
42	19	TP13,TP14,TP15, TP16,TP17,TP19, TP20,TP21,TP22, TP23,TP24,TP25, TP26,TP27,TP28, TP29,TP30,TP31, TP32	TPAD_040	TEST POINT PAD 40MIL DIA SMT, NO PART TO ORDER	Notacomponent	NOTACOMPONENT
43	1	U4	FT232RQ	IC XCVR USB TO UART CTLR 3.3-5.25V QFN32	Future Technology Devices International Ltd.	FT232RQ
44	1	U5	MMA7660FC	IC SENSOR ACCELEROMETER 2.4-3.6V DFN10	Freescale Semiconductor	MMA7660FC
45	1	U6	74AHCT164	IC REG SHIFT SER/PAR 8BIT 4.5-5.5V TSSOP14	Nxp Semiconductors	74AHCT164PW,112
46	1	U7	SN74AHCT1G08	IC GATE AND SGL 2-INPUT POSITIVE 4.5-5.5V SOT23-5	Texas Instruments	SN74AHCT1G08DBVR
47	1	U8	TPS63001	IC LIN DCDC SYNC 3.3V OUTPUT 1250-1800KHZ 1.8-5.5V QFN-10	Texas Instruments	TPS63001DRCT

Table 4-4. Bill of Materials

Item	Qty.	Reference	Value	Description	Mfg. Name	Mfg. Part Number
48	1	U9	FAN5665	IC LIN DCDC SWT 5V 2.9-5.5V WLCSP-8	Fairchild	FAN5665UCX

Chapter 5
1323x Remote Extender Motherboard

5.1 1323x-REM Overview

The 1323x-Remote Extender Motherboard (1323x-REM) is a motherboard that accepts the 1323x-Modular Reference Board (1323x-MRB) plug-in module (daughtercard) and supplies a power supply and set of interface peripherals. The two boards in combination provide a simple platform to evaluate the MC1323x, develop software, and demonstrate IEEE 802.15.4 based networking capabilities.

5.1.1 Features

The 1323x-REM provides the following features:

- Small form factor (3.1 x 3.1 inches)
- 2-Layer metal, 0.034 inch thick FR4 board
- Two connectors provide daughter card mounting
  - — 20-Pin primary connector
  - — 18-Pin secondary connector
  - — Provide main supply voltage to board
  - — Provide access to all MC13233 GPIO
- Flexible power supply
  - — Sources include USB port, two AA batteries, or DC source
  - — Power-On LED
  - — On-Off switch
- USB <> UART serial port
- 2x4 Switch matrix
- IR receiver
- Four application controlled blue indicator LEDs
- Secondary set of pin headers uses jumpers to enable/disable IO connections and allows user application connection to MC13233 GPIO

5.1.2 Form Factor

Figure 5-1 shows a photo of the 1323x-REM showing the locations of connectors and headers.

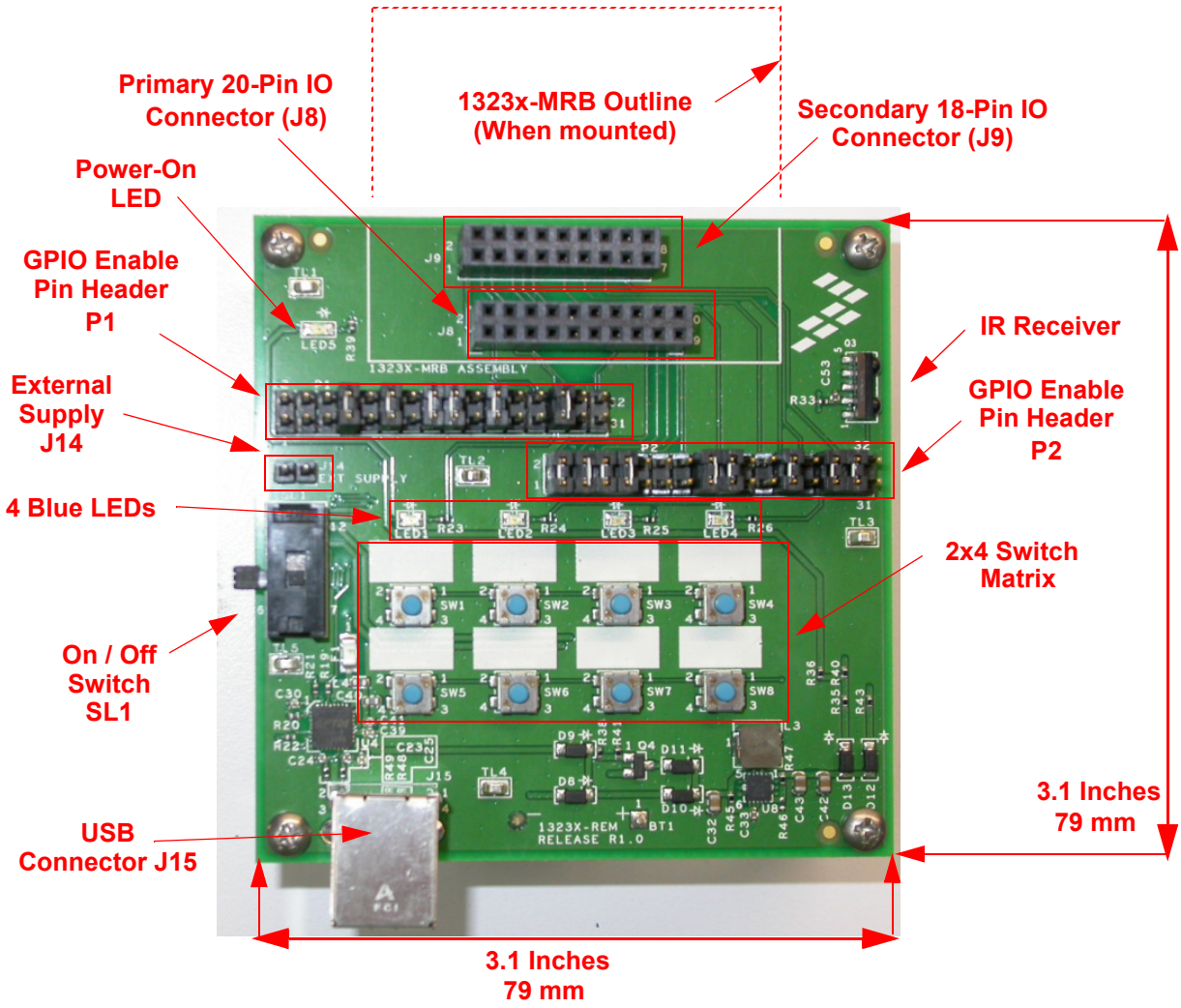

Figure 5-1. 1323x-REM

The1323x-MRB mounts on the 1323x-REM via receptacles J8 and J9. Figure 5-1 shows an outline of the 1323x-MRB placement when mounted.

5.1.3 Board Level Specifications

NOTE

Temperature range specifications apply to REM used in combination with MRB.

Table 5-1. 1323x-REM Specifications

Parameter				Units	Notes/Conditions
	MIN	**TYP**	**MAX**		
General					
Size (PCB: X, Y)			79 x 79 3.1 x 3.1	mm inches	
Layer build (PCB)		0.8 0.034		mm inches	2-Layer
Dielectric material (PCB)					FR4
Power					
Voltage supply (DC)	2.3	5	6	V	
Voltage supply (USB)	4.4	5	5.25	V	USB 2.0/1.1 standard specification
Voltage supply (Batteries)		2.8	3.2	V	
Current consumption			100	mA	
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
IR Receiver					
Carrier frequency		38			kHz
Angle of half transmission distance		+/-50			degrees
Regulatory Approval					
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					

Table 5-1. 1323x-REM Specifications (continued)

Parameter				Units	Notes/Conditions
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

5.2 Functional Description

The 1323x-REM is a simple host motherboard for the 1323x-MRB. The two-board combination provides a simple evaluation and development platform for the MC13233. Figure 5-2 shows a simple block diagram. The 2-layer board provides a flexible power supply, eight pushbutton matrix, four indicator LEDs, IR receiver, and a USB <> UART serial port.

As the board name implies this platform is useful to develop the host side (such as a DTV or entertainment console) of an RF remote control application. The MC13233 provides the RF node and an IR receiver is available to support legacy IR protocol remotes. Connection to a host is available through the USB port or any of the other generic MC13233 communications ports.

The 1323x-REM is also recommended for target development of applications where there is little periphery circuitry. There are switches and indicator LEDs onboard for user interface, and if necessary, custom circuitry can be connected via the two pin headers that allow access to the MC13233 GPIO.

In the following sections, refer to:

- Figure 5-1 for location of connectors and features
- Figure 5-2 for the functional blocks
- Figure 5-8 and Figure 5-9 for the board schematic

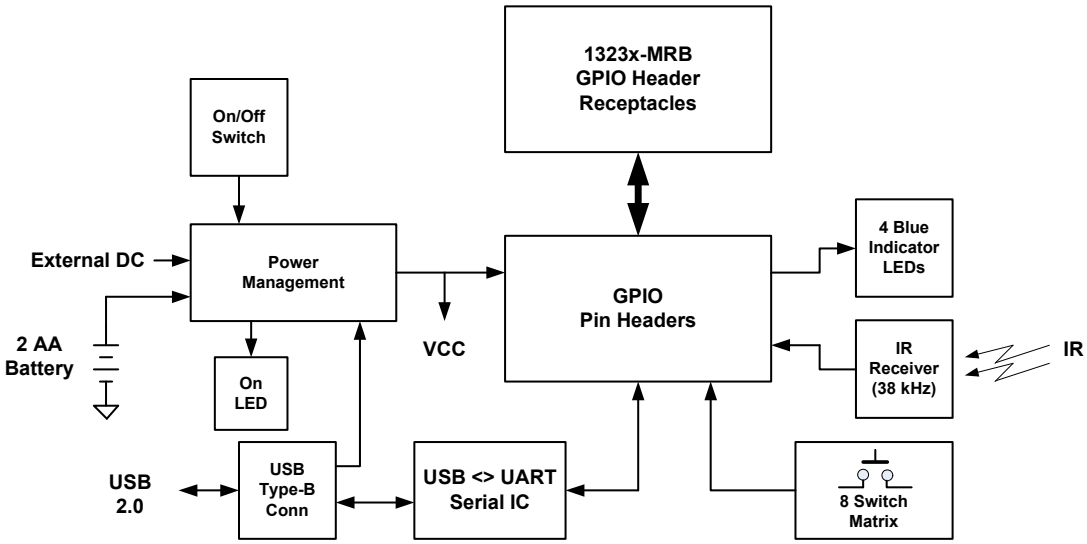

Figure 5-2. 1323x-REM Block Diagram

5.2.1 Power Management

The 1323x-REM can be powered from two AA batteries, the USB connector 5 V supply, or an external DC supply and is also intended to power the 1323x-MRB. Figure 5-3 shows the power management circuit.

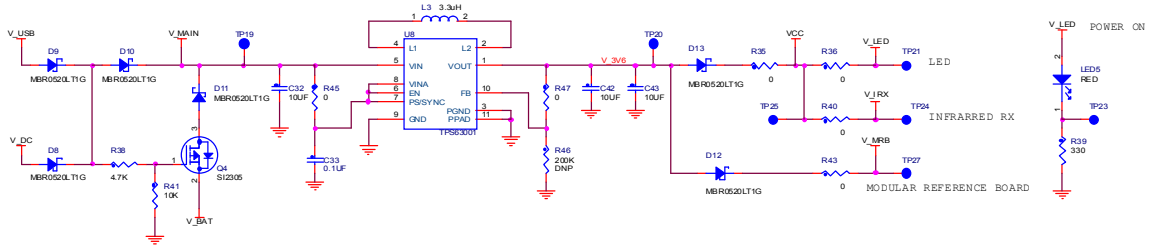

Figure 5-3. 1323x-REM Power Management Circuit

A boost-buck voltage regulator U8 is used in this design to allow operation over a relatively wide, low voltage input range, i.e., the TPS63001 regulator has input voltage range from 1.8 V to 5.5V. This allows a broad range of power supply sources. The regulated output voltage of the TPS63001 is 3.3 V which delivers about 3.05 V to the board due to the drop across the isolation Schottky diodes.

Attributes of the power management circuit include:

- Switch SL1 provides an ON/OFF function for all input voltage sources
- Red LED5 provides a POWER-ON indicator for all sources
- The 1323x-REM can derive power from three different sources -
  1. USB port Type-B connector J15 - power can be supplied from an actual USB port connection or from an AC to DC converter that uses the USB connector to supply power.
  2. External DC source via header J14 - a standard 0.1 in. spacing 1x2 pin header allows for connection of an external DC supply.

3. Battery Operation - a battery holder that accommodates two AA batteries is mounted on the non-component (back) side of the board and provides for battery operation.
   – If either the USB or external DC source is present, the battery source is disabled by MOSFET transistor Q3
   – The sources are all isolated and protected by Schottky diodes
   – The minimum effective battery operating voltage is controlled by the use the FTDI FT232RQ USB <> UART device - leakage current back through the FT232RQ UART connections to the MC13233 on the MRB can cause the Q3 MOSFET to partially turnoff at battery voltage below approximately 2.7-2.8 Vdc.

NOTE

To avoid current leakage through the USB device and lower minimum battery operating voltage for battery-only operation, remove the following jumpers:

- P1, Pins 7-8
- P1, Pins 11-12
- P1, Pins 17-18
- P1, Pins 21-22

NOTE

When battery operation is used, the temperature range of the two board system should be limited to within the specified temperature range of the battery technology. Table 5-1 limits temperature range from 0 °C to +50 °C when battery operation is applied.

Table 5-2 lists the voltage source attributes.

Table 5-2. 1323x-REM Voltage Sources

Source	Connector	Input Voltage Range	Description
USB Port	USB Type-B J15	4.4 V - 5.25 V	• The input voltage range is set to the USB specification value • The voltage can be supplied by either a standard USB cable connection or an AC to DC power adaptor that uses the USB connector J15 • If a power adaptor is in use, the USB serial port cannot be used
External DC Supply	1x2 Pin Hdr J14	2.3 V - 6 V	The input voltage range is determined by the U8 regulator and the diode isolation circuit
Two AA Batteries	Battery Holder	2.0 V - 3.1 V[1]	• The input voltage range reflects the usable range of alkaline cells and the voltage drop incurred by the diode isolation circuit. • The battery source is disabled if another source is connected

[1] The minimum operating battery voltage is determined by use model, see Note, Section 5.2.1, “Power Management”

Again referring to Figure 5-3, a number of zero-ohm resistors are provided to isolate different circuits and to allow current measurement:

- VCC (main 1323x-REM supply) - resistor R35
- V_LED (all LEDs supply) - resistor R36
- V_IRX (IR receiver supply) - resistor R40
- V_MRB (1323x-MRB supply) - resistor R43

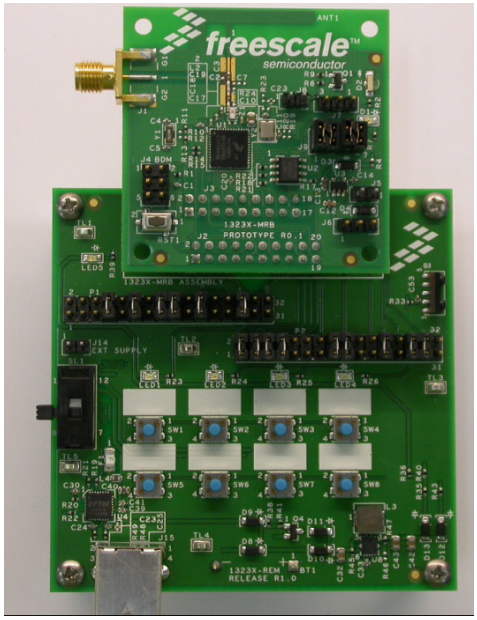

Figure 5-4. 1323x-MRB Mounted on 1323x-REM

5.2.2 GPIO Connection to 1323x-MRB

IO Connectors J8 and J9 (see Figure 5-1) are receptacles that accept the 1323x-MRB pin headers to mount the daughtercard. Figure 5-4 shows the 1323x-REM with the 1323x-MRB mounted. Receptacles J8 and J9 connect to the MC13233 GPIO.

To provide better access and versatility to the GPIO, a secondary set of pin headers P1 and P2 is connected in series with the IO signals:

- Jumpers must be installed on P1 and P2 to connect 1323x-REM peripherals and functions
- The pin headers provide direct access for connecting custom circuitry to the GPIO
- Power and ground to primary connectors J8 and J9 are not enabled though the pin headers

Figure 5-5 shows IO Header P1 andP2 pin mapping.

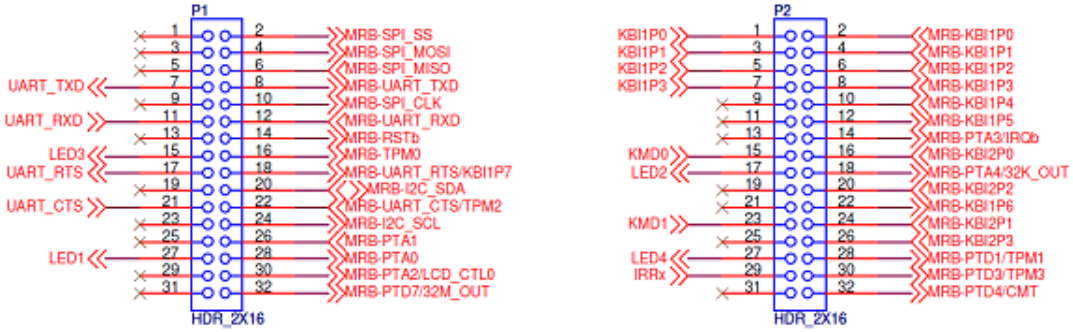

Figure 5-5. 1323x-REM IO Connector J8 and J9 Pin Mapping

Table 5-3 list the P1 and P2 pin header function as it relates to the MC13233.

Table 5-3. 1323x-REM P1 and P2 Pin Header Function Description

1323x-REM Header Pins	MC13233 Signal Name	Description	Comments
P1-27, P1-28	PTA0/XTAL_32K	Port A Bit 2 / 32.768 kHz oscillator output	• Drives LED1; jumper required • 32.768 kHz oscillator can be enabled on MRB
P1-26	PTA1/EXTAL_32K	Port A Bit 3 / 32.768 kHz oscillator input	• Unused • 32.768 kHz oscillator can be enabled on MRB
P1-14	$\overline{\text{RESET}}$	Device asynchronous hardware reset. Active low. Onboard Pullup	• Unused • Reset signal driven from MRB
P1-30	PTA2	Port A Bit 2. Onboard pullup for TM	• Unused • TM enable; leave unconnected
P2-14	PTA3/IRQ	Port A Bit 3 / IRQ.	• Unused • Provides interrupt request input IRQ (active low)
P2-17, P2-18	PTA4/ XTAL_32KOUT	Port A Bit 4 / Buffered 32.768 kHz clock output	• Drives LED2; jumper required • Optional 32.768 kHz output clock for measuring reference oscillator accuracy (ppm)
P1-20	PTA5/SDA	Port A Bit 5 / IIC Bus data	• Unused • Defaults to open drain for IIC • Pullup on MRB
P1-24	PTA6/SCL	Port A Bit 6 / IIC Bus clock	• Unused • Defaults to open drain for IIC • Pullup on MRB
P2-1, P2-2	PTB0/KBI1P0	Port B Bit 0 / KBI1 Input Bit 0	REM switch matrix; jumper required
P2-3, P2-4	PTB1/KBI1P1	Port B Bit 1 / KBI1 Input Bit 1	REM switch matrix; jumper required
P2-5, P2-6	PTB2//KBI1P2	Port B Bit 2 / KBI1 Input Bit 2	REM switch matrix; jumper required
P2-7, P2-8	PTB3//KBI1P3	Port B Bit 3 / KBI1 Input Bit 3	REM switch matrix; jumper required
P2-10	PTB4//KBI1P4	Port B Bit 4 / KBI1 Input Bit 4	Unused

Table 5-3. 1323x-REM P1 and P2 Pin Header Function Description (continued)

1323x-REM Header Pins	MC13233 Signal Name	Description	Comments
P2-12	PTB5//KBI1P5	Port B Bit 5 / KBI1 Input Bit 5	Unused
P2-22	PTB6//KBI1P6	Port B Bit 6 / KBI1 Input Bit 6	Unused
P1-17, P1-18	PTB7//KBI1P7	Port B Bit 7 / KBI1 Input Bit 7	• UART flow control RTS input to MCU; jumper required • Connects to REM USB <> UART device
P2-15, P2-16	PTC0/KBI2P0	Port C Bit 0 / KBI2 Input Bit 0	REM switch matrix; jumper required
P2-23, P2-24	PTC1/KBI2P1	Port C Bit 1 / KBI2 Input Bit 1	REM switch matrix; jumper required
P2-20	PTC2/KBI2P2	Port C Bit 2 / KBI2 Input Bit 2	Unused
P2-26	PTC3/KBI2P3	Port C Bit 3 / KBI2 Input Bit 3	Unused
P1-10	PTC4/SPICLK	Port C Bit 4 / SPI clock	• Unused on REM • Connected to serial FLASH on MRB
P1-2	PTC5/SS	Port C Bit 5 / SPI slave select	• Unused on REM • Connected to serial FLASH on MRB
P1-6	PTC6/MISO	Port C Bit 6 / SPI MISO	• Unused on REM • Connected to serial FLASH on MRB
P1-4	PTC7/MOSI	Port C Bit 7 / SPI MOSI	• Unused on REM • Connected to serial FLASH on MRB
P1- 15, P1-16	PTD0/TPM0	Port D Bit 0 / TPM0 signal	Unused
P2-27, P2-28	PTD1/TPM1	Port D Bit 1/ TPM1 signal	Drives LED4; jumper required
P1-21, P1-22	PTD2/TPM2	Port D Bit 2 / TPM2 signal	• UART flow control CTS output from MCU; jumper required • Connects to REM USB <> UART device
P2-29, P2-30	PTD3/TPM3	Port D Bit 3 / TPM3 signal	• REM IR receiver input; jumper required • Drives timer input
P2-32	PTD4/CMT	Port D Bit 4/ CMT output	• Not used on REM • Connected to IR blaster on MRB
P1-7, P1-8	PTD6/RXD	Port D Bit 6 / UART RXD input	• UART RXD input to MCU; jumper required • Connects to REM USB <> UART device
P1-11, P1-12	PTD5/TXD	Port D Bit 5 / UART TXD output	• UART TXD output from MCU; jumper required • Connects to REM USB <> UART device
P1-32	PTD7/32MOUT	Port D Bit 7	Unused

5.2.3 1323x-REM Onboard Peripheral Functions

The 1323x-REM has a simple set of peripheral functions useful to evaluate the MC13233 and to implement simple node applications, especially a remote control receiver; i.e., interface to host platform.

5.2.4 USB Interface

For many applications or demonstrations it is desirable to connect the 1323x-REM to a PC or other device. A USB port is provided with a USB “B” receptacle plug. The port is connected to a FTDI FT232RQ 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 can draw all required power from the USB interface. The device is USB 2.0 full speed compatible.

The USB connector is designated as J15. Figure 5-6 shows the connector pinout.

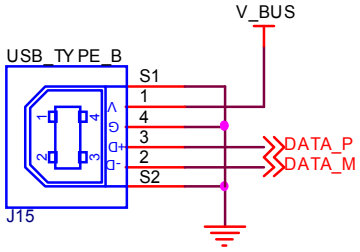

Figure 5-6. USB Connector Pinout

5.2.5 IR Receiver

The 1323x-REM provides an IR receiver that accepts IR signals from the RCM or from any IR based remote control devices.

- The IR receiver is the TSOP85238TR device (Q3)
- 38 kHz carrier frequency
- +/- 50 Degree angle of half tranmission distance
- Drives the PTD3/TPM3 signal.

Figure 5-7 shows the IR receiver schematic.

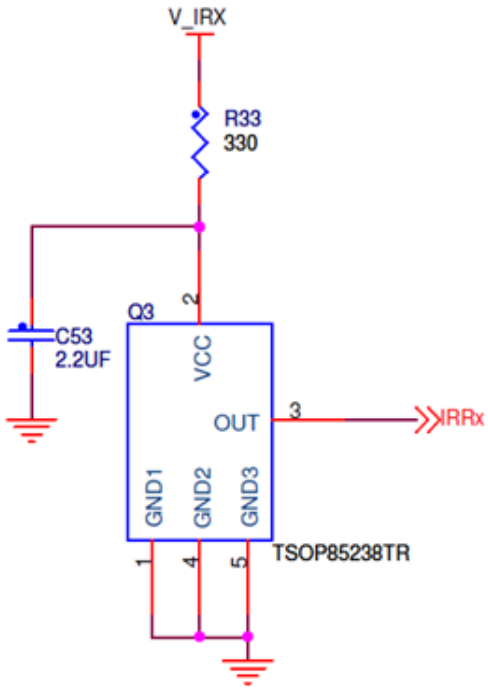

Figure 5-7. IR Receiver Circuit

5.2.6 Pushbutton 2x4 Switch Matrix

The1323x-REM provides an 8 pushbutton 2x4 switch matrix for user application input interface.

- The matrix utilizes MC13233 KBI inputs
- All switches have interrupt and device wake up capability

5.2.7 Blue Indicator LEDs

The1323x-REM provides 4 blue LEDs for user application indicator outputs. Refer to Table 5-3 for listings of the MC13233 outputs that drive the LEDs.

5.3 Schematic, Board Layout, and Bill of Material

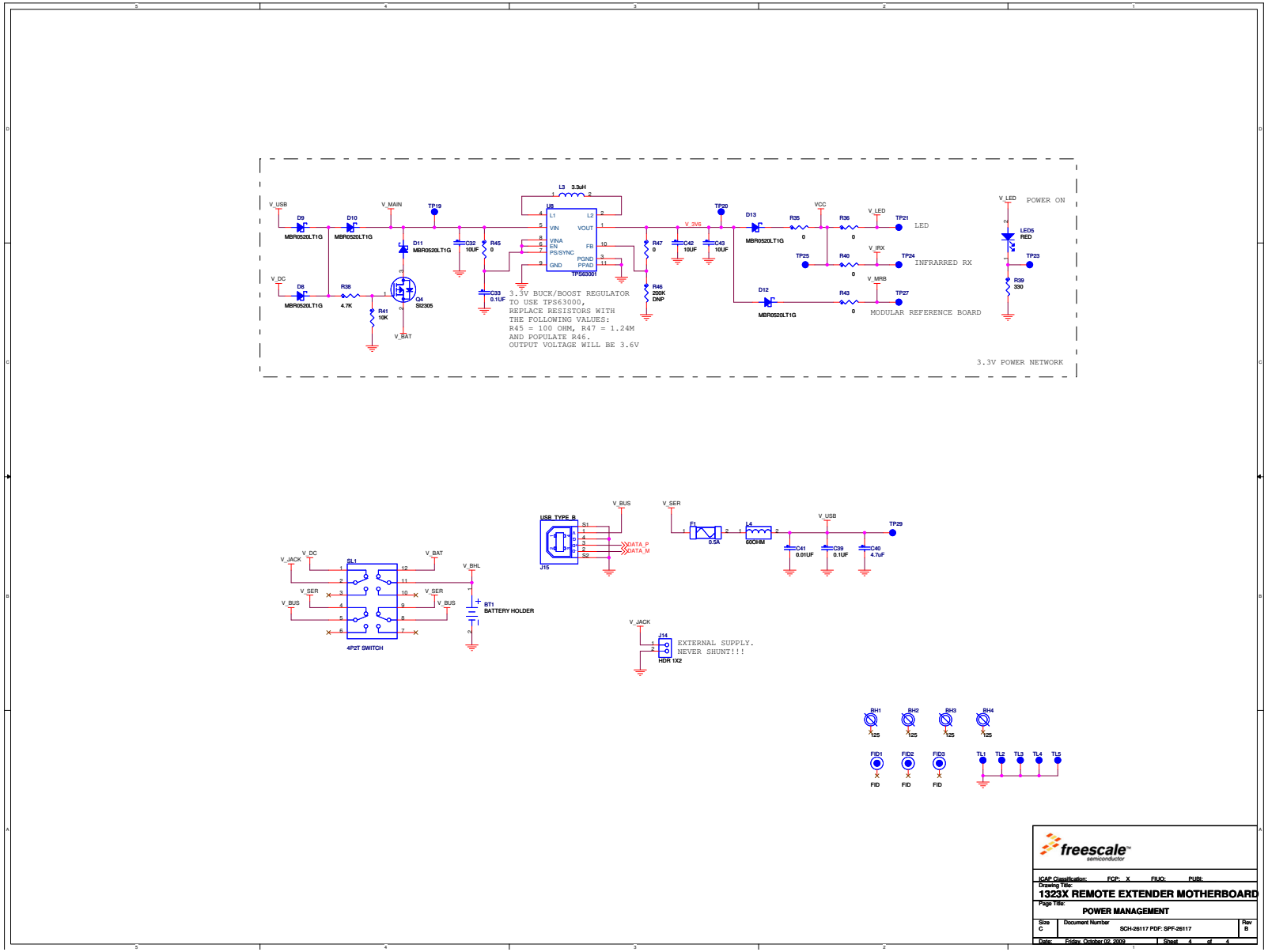

Figure 5-8. 1323x-REM Schematic (1 of 2)

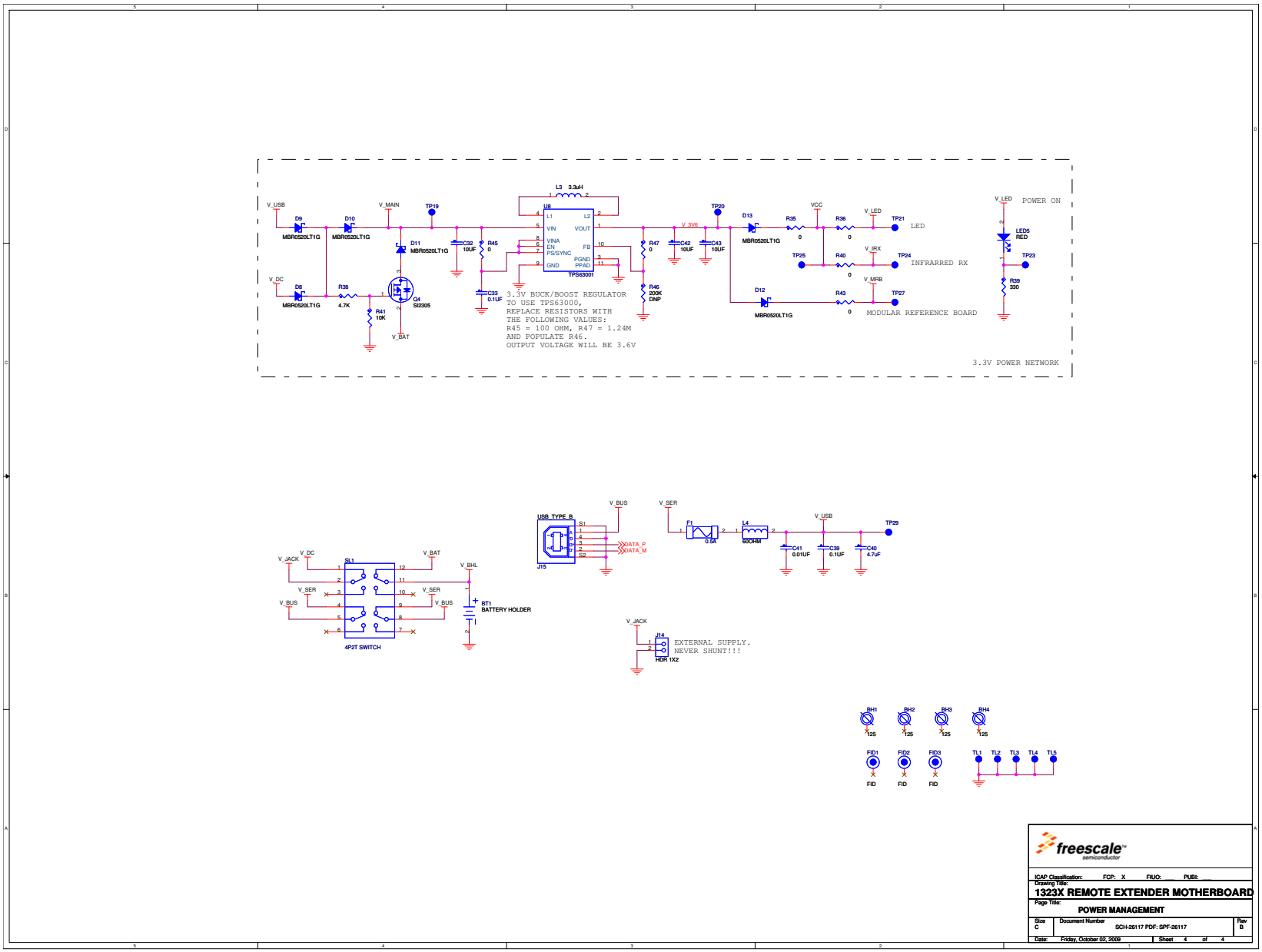

Figure 5-9. 1323x-REM Schematic (2 of 4)

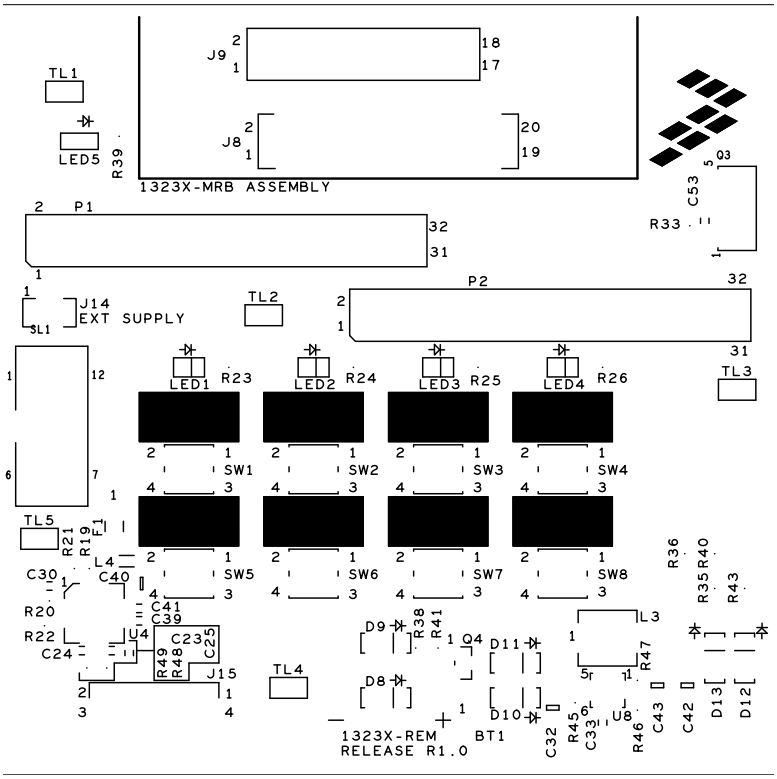

Figure 5-10. 1323x-REM PCB Component Location (Top View)

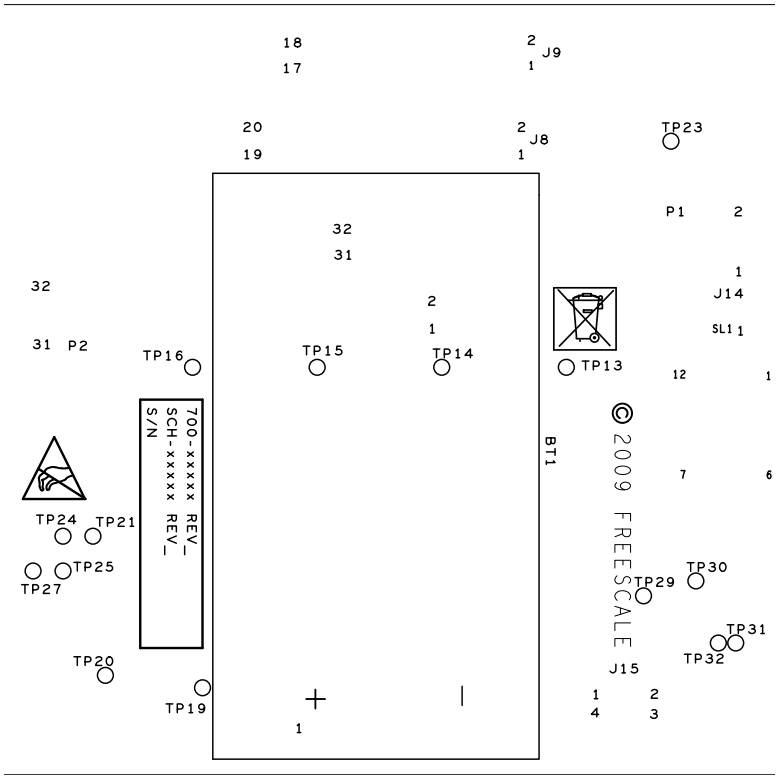

Figure 5-11. 1323x-REM PCB Test Points

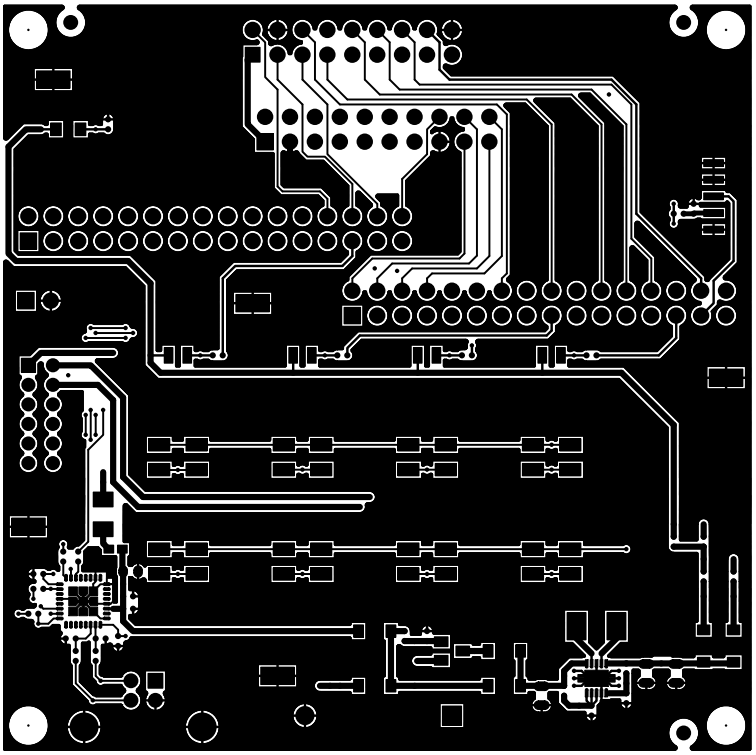

Figure 5-12. 1323x-REM PCB Layout (Top View)

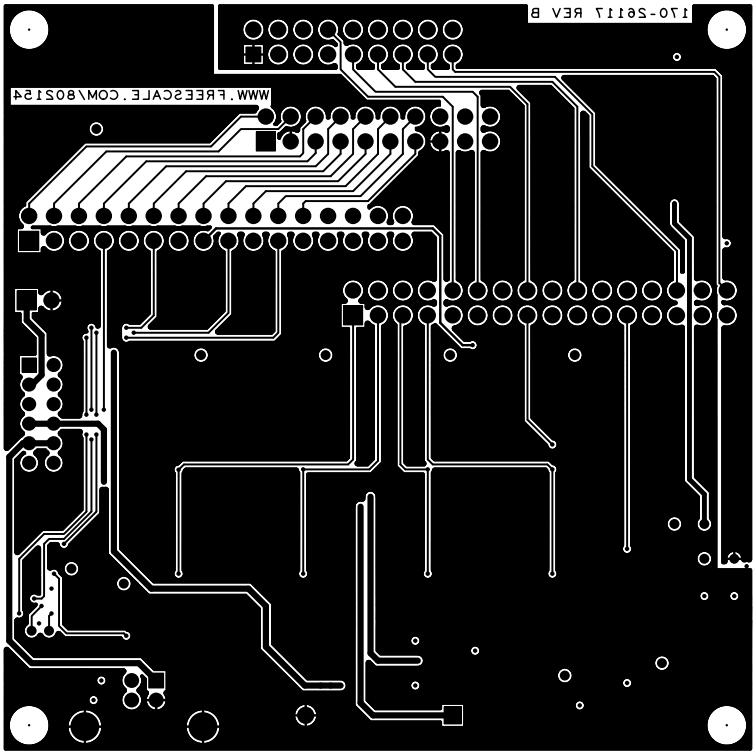

Figure 5-13. 1323x-REM PCB Layout (Bottom View)

5.3.1 1323x-REM Bill of Materials

Table 5-4. Bill of Materials

Item	Qty.	Reference	Value	Description	Mfg. Name	Part Number
1	4	BH1, BH2, BH3, BH4	125	NON-PLATED MOUNTING HOLE 125 DRILL / 160 KEEPOUT NO PART TO ORDER		
2	1	BT1	BATTERY HOLDER	BATTERY HOLDER 2XAA TH	KEYSTONE ELECTRONICS	2462
3	2	C23,C24	15PF	CAP CER 15PF 50V 5% C0G 0402	KEMET	C0402C150J5GAC
4	4	C25,C30,C33, C39	0.1UF	CAP CER 0.1UF 16V 10% X7R 0402	MURATA	GRM155R71C104KA88D
5	3	C32,C42,C43	10UF	CAP CER 10UF 10V 10% X7R 0805	Murata	GRM21BR71A106KE51L
6	1	C40	4.7uF	CAP CER 4.7UF 10V 10% X5R 0603	TAIYO YUDEN	LMK107BJ475KA-T
7	1	C41	0.01UF	CAP CER 0.01UF 10V 20% X7R 0402	AVX	0402ZC103MAT2A
8	1	C53	2.2UF	CAP CER 2.2UF 6.3V 20% X5R 0402	MURATA	GRM155R60J225ME15D
9	6	D8,D9,D10,D11 ,D12,D13	MBR0520L T1G	DIODE SCH 0.5A 20V SOD-123	ON SEMICONDUCTOR	MBR0520LT1G
10	3	FID1,FID2,FID3	FID	FIDUCIAL 060 MIL PAD W/120 SOLDERMASK AND 040 MIL PAD W/90 MIL SOLDERMASK NO PART TO ORDER	GENERIC	FID-040
11	1	F1	0.5A	FUSE FAST 0.5A 63V SMT 1206	LITTELFUSE	0437.500WR
12	1	J8	CON_2X1 0	CON 2X10 SKT TH 100MIL CTR 335H AU 104L	SAMTEC	SSW-110-01-G-D
13	1	J9	CON_2X9	CON 2X9 SKT TH 100MIL SP 335H AU 194L	SAMTEC	SSW-109-02-G-D
14	1	J14	HDR_1X2	HDR 1X2 TH 100MIL SP 375H AU	TYCO ELECTRONICS	826629-2
15	1	J15	USB_TYP E_B	CON 2X2 USB_TYPE_B SKT RA SHLD TH 2.5MM SP 453H AU	TYCO ELECTRONICS	292304-2
16	4	LED1,LED2,LE D3,LED4	BLUE	LED BLUE SGL 20MA SMT 0805	LITE ON	LTST-C171TBKT-5A
17	1	LED5	RED	LED RED CLEAR SGL 30MA SMT 0805	LITE ON	LTST-C171KRKT

Table 5-4. Bill of Materials

Item	Qty.	Reference	Value	Description	Mfg. Name	Part Number
18	1	L3	3.3uH	IND PWR 3.3UH@100KHZ 3.3A 20% SMT	VISHAY INTERTECHNOLOGY	IHLP2020BZER3R3M01
19	1	L4	60OHM	IND FER BEAD 60OHM@100MHZ 500MA -- 0603	MURATA	BLM18PG600SN1_
20	2	P1,P2	HDR_2X16	HDR 2X16 TH 100MIL CTR 330H AU 100L	SAMTEC	TSW-116-07-S-D
21	1	Q3	TSOP85238TR	TRAN PHOTO 0.45MA 5.5V 950NM SMT	VISHAY INTERTECHNOLOGY	TSOP85238TR
22	1	Q4	SI2305	TRAN PMOS PWR 4.1A 8V SOT23	VISHAY INTERTECHNOLOGY	SI2305ADS-T1-GE3
23	4	R19,R20,R21,R22	1K	RES MF 1.0K 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW04021K00JNED
24	4	R23,R24,R25,R26	390	RES MF 390 OHM 1/16W 5% 0402	BOURNS	CR0402-JW-391GLF
25	2	R33,R39	330	RES MF 330 OHM 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW0402330RJNED
26	6	R35,R36,R40,R43,R48,R49	0	RES TF ZERO OHM 1/16W RC0402	VISHAY INTERTECHNOLOGY	CRCW04020000ZS
27	1	R38	4.7K	RES MF 4.7K 1/16W 5% 0402	SMEC	RC73L2Z472JTF
28	1	R41	10K	RES MF 10K 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW040210K0JNED
29	1	R45	100	RES MF 100 OHM 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW0402100RJNED
30	1	R46	200K	RES MF 200K 1/16W 5% 0402	YAGEO AMERICA	RC0402JR-07200KL
31	1	R47	1.24M	RES MF 1.24M 1/16W 1% 0402	VISHAY INTERTECHNOLOGY	CRCW04021M24FKED
32	1	SL1	4PDT SWITCH	SW 4PDT SLD TH RA 30V 100MA --	TYCO ELECTRONICS	1-1437575-1
33	8	SW1,SW2,SW3,SW4,SW5,SW6,SW7,SW8	PB switch	SW SMT 4.0MM FMS 0.1A MAX 16V MAX ROHS COMPLIANT	BOURNS	7914J-1-000E

Table 5-4. Bill of Materials

Item	Qty.	Reference	Value	Description	Mfg. Name	Part Number
34	15	TP13,TP14,TP15,TP16,TP19,TP20,TP21,TP23,TP24,TP25,TP27,TP29,TP30,TP31,TP32	TPAD_040	TEST POINT PAD 40MIL DIA SMT, NO PART TO ORDER	NOTACOMPONENT	NOTACOMPONENT
35	1	U4	FT232RQ	IC XCVR USB TO UART CTLR 3.3-5.25V QFN32	FUTURE TECHNOLOGY DEVICES INTERNATIONAL LTD.	FT232RQ
36	1	U8	TPS63001	IC LIN DCDC SYNC 3.3V OUTPUT 1250-1800KHZ 1.8-5.5V QFN-10	TEXAS INSTRUMENTS	TPS63001DRCT

Chapter 6
PCB Manufacturing Specifications

This chapter provides the specifications used to manufacture the 1323x Development hardware printed circuit boards (PCB) described in this manual.

The 1323x Development hardware PCBs must comply with the following:

- The PCB must comply with Perfag10/3C (http://www.perfag.dk/Uk/ukindex.htm)
- The PCB manufacturer's logo is required
- The PCB production week and year code is required
  - The manufacturer's logo and week/year code must be stamped on the back of the PCB solder mask
  - The PCB manufacturer can not insert text on the PCB either in copper or in silkscreen without written permission from Freescale Semiconductor, Inc.
- The required Underwriter's Laboratory (UL) Flammability Rating
  - The level is 94V-0 (http://www.ul.com/plastics/flame.html)
  - The UL information must be stamped on the back of the PCB solder mask

NOTE

- A complete set of design files is available for the 1323x Development hardware at the Freescale web site (http:www.freescale.com/802154) under reference designs. It is recommended that this design or one of a number of other reference designs be used as a starting point for a custom application.
- The *Freescale IEEE 802.15.4 / ZigBee Package and Hardware Layout Considerations Reference Manual*, (ZHDCRM) is also available at the same web site to provide additional design guidance.

6.1 Single PCB Construction

This section describes individual PCB construction details.

- The MRB and RCM PCBs are four-layer, multi layer designs
- The REM PCB is a two layer design
- The PCBs contains no blind, buried, or micro vias
- PCB data:
  - MRB Size: Approximately 51 x 51mm (2.01 x 2.01 inches)
  - RCM Size: Approximately 86 x 178 mm (3.4 x 7.0 inches)
  - REM Size: Approximately 79 x 79 mm (3.1 x 3.1 inches)

— MRB, RCM and REM Final thickness (Cu/Cu): 0.34 mm (0.8 inches) +/- 10% (excluding solder mask)

The following table defines some of the layers of the completed PCB. The artwork identification refers to the name of the layer in commonly used terms.

Table 6-1. MRB Layer by Layer Overview

Layer	Artwork Identification	File Name
1	Silkscreen Top	SILK_TOP.art
2	Top Layer Metal	TOP.art
3	Ground Layer	GND.art
4	Power Layer	PWR.art
5	Bottom Layer Metal	BOTTOM.art
6	Silkscreen Bottom	SILK_BOTTOM.art

Table 6-2. RCM Layer by Layer Overview

Layer	Artwork Identification	File Name
1	Silkscreen Top	SILK_TOP.art
2	Top Layer Metal	TOP.art
3	Ground Layer	GND.art
4	Power Layer	PWR.art
5	Bottom Layer Metal	BOTTOM.art
6	Silkscreen Bottom	SILK_BOTTOM.art

Table 6-3. REM Layer by Layer Overview

Layer	Artwork Identification	File Name
1	Silkscreen Top	SILK_TOP.art
2	Top Layer Metal	TOP.art
3	Bottom Layer Metal	BOTTOM.art
4	Silkscreen Bottom	SILK_BOTTOM.art

The 1323x MRB contains high frequency 2.4 GHz RF circuitry. As a result, RF component placement, line geometries and layout, and spacing to the ground plane are critical parameters. As a result, BOARD STACKUP GEOMETRY IS CRITICAL. Dielectric and copper thicknesses and spacing must not be changed; follow the stackup (see Figure 6-1) information is provided with the reference design.

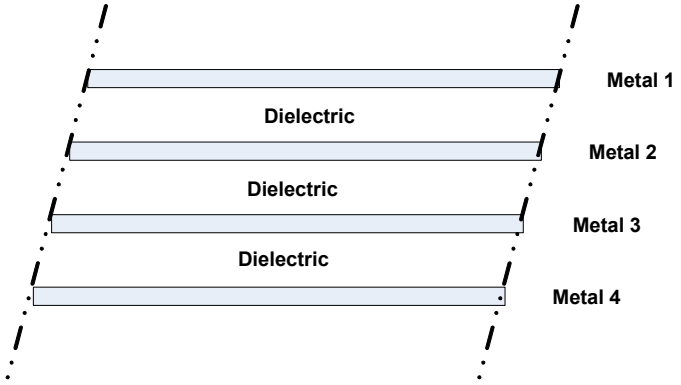

Figure 6-1. MRB PCB Stackup Cross-Section (Four Layer)

- Solder mask is required
- Silk screen is required

6.2 Panelization

The panel size can be negotiated depending on production volume.

6.3 Materials

The PCB composite materials must meet the following requirements:

- Laminate - The base laminate material (laminate) must be FR4. If the laminate material were changed the RF electrical characteristics may change and degrade RF performance.
- Copper Foil -
  - — Top and Bottom copper layers must be 1 oz. copper
  - — Interior layers must be 1/2 oz. copper
- Plating - All pad plating must be Hot Air Levelling (HAL)

6.4 Solder Mask

The solder mask must meet the following requirements:

- Solder mask type: Liquid Film Electra EMP110 or equivalent
- Solder mask thickness: 10 – 30 µm

6.5 Silk Screen

The silk screen must meet the following requirements:

- Silkscreen color: White
- Silkscreen must be applied after application of solder mask if solder mask is required
- The silkscreen ink must not extend into any plated-thru-holes
- The silk screen must be clipped back to the line of resistance

6.6 Electrical PCB Testing

- All PCBs must be 100 percent tested for opens and shorts
- Impedance Measurement - An impedance measurement report is not mandatory

6.7 Packaging

Packaging for the PCBs must be the following requirements:

- Finished PCBs must remain in panel
- Finished PCBs must be packed in plastic bags that do not contain silicones or sulphur materials. These materials can degrade solderability.

6.8 Hole Specification/Tool Table

See the `ncdrill-1-4.tap` file included with the Gerber files and the `FAB-23451.pdf` file.

6.9 File Description

Files included with the download include Design, Gerber and PDF files.

Gerber files are RS-374x format. Not all files included with the Gerber files are for PCB manufacturing.

PDF files included are:

- FAB-2611x.pdf — Board fabrication drawing
- GRB-2611x.pdf — Metal layers, solder mask, solder paste and silk screen
- SPF-2611x.pdf — Schematic

Design files are in Allegro format with OrCAD schematic capture.