Freescale Semiconductor, Inc.
User's Guide

Freescale Freedom Development Board FRDM-CR20A User's Guide

1 About this guide

This User's Guide describes the Freescale FRDM-CR20A development board. The FRDM-CR20A is a 2.4 GHz Industrial, Scientific, and Medical (ISM) intended for the IEEE® 802.15.4 Standard, including Thread and IPv6/6loWPAN protocols. The FRDM-CR20A contains the MCR20A transceiver that is typically combined with a software stack and a Freescale Kinetis MCU to implement an IEEE 802.15.4 Standard platform solutions.

1.1 Audience

This manual is intended for system designers.

2 Safety information

2.1 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.

Contents

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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.

2.1.1   Labeling

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

2.1.2   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.

2.1.3   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.

2.1.4   Antenna restrictions

An intentional radiator is designed to ensure that no antenna other than that furnished by the responsible party is used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator is 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 of the IEEE 802.15.4 standard. 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 is responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

2.2   Regulatory approval for Canada (IC RSS 210)

This equipment complies with Industry Canada liscence-exempt RSS standard(s). Operation is subject to the following two conditions:

1. This board may not cause interference, and
2. This board must accept any interference, including interference that may cause undesired operation of the device.

2.2.1 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.

2.3 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

2.4 Disposal instructions

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

3 MCR20A transceiver overview and description

3.1 Introduction

The FRDM-CR20A development board is an evaluation environment to support the Freescale MCR20AVHM SoC transceiver (MCR20A), a 2.4 GHz Industrial, Scientific, and Medical (ISM) transceiver intended for the IEEE 802.15.4 Standard.

The MCR20A is a highly-integrated, cost-effective radio transceiver operating in the 2.36 GHz to 2.48 GHz range, usually combined with a software stack and a Freescale Kinetis MCU to implement an IEEE 802.15.4 Standard platform solution.

Freescale supplements the MCR20A transceiver with tools and software that include hardware evaluation and development boards, software development IDE and applications, drivers, custom PHY usable with the Freescale IEEE 802.15.4 compatible MAC.

The FRDM-CR20A development board consists of one board that contains the MCR20A device with a 32 MHz reference oscillator crystal, RF circuitry including an antenna, and supporting circuitry to be mounted into the popular Freescale Freedom development board form factor. The board is not a standalone product; it requires an external MCU to support applications development, via SPI connection.

3.2   Board features

3.2.1   FRDM-CR20A board

The FRDM-CR20A development board can be plugged-into the Freescale Freedom development platform as a shield. It contains the MCR20AVHM device and all necessary I/O connections to connect with the Freedom system.

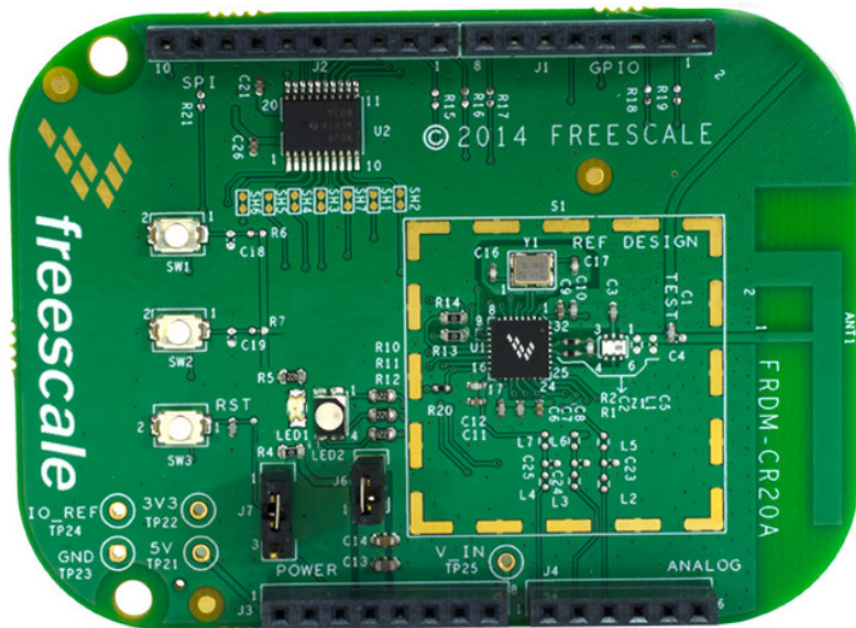Figure 1 shows the FRDM-CR20A development board.

Figure 1. FRDM-CR20A

The FRDM-CR20A development board includes the following features:
- The Freescale ultra-low-power MCR20AVHM 802.15.4 transceiver
- Full IEEE 802.15.4 compliant wireless node
- Reference design area with small footprint, low cost RF node
  — RF circuitry includes a Balun to convert the differential input/output pin of the MCR20 to single-ended for on-board signal routing
  — Low off-chip component count
  — Programmable output power from –35 dBm to +8 dBm at the SMA connector, no trap
  — Receiver sensitivity: –102 dBm, typical (@1% PER for 20 byte payload packet)
- Integrated PCB inverted F-type antenna and footprint for SMA RF port

- 32 MHz reference oscillator
- 2.4 GHz frequency operation (ISM band)
- 1 RGB LED indicator driven by external MCU
- 2 Push button switches driven by external MCU
- 1 Reset button driven by XCVR or external MCU
- Power translator for GPIOs, freescale MCU support 3.3V or external sources such as Arduino 5V
- Bit stream mode (BSM) to monitor packet data with synchronization clock
- Low-power operating modes with single SPI command device wake-up (SPI communication is enabled in LP mode
- Provides access to the MCR20AVHM set of GPIOs

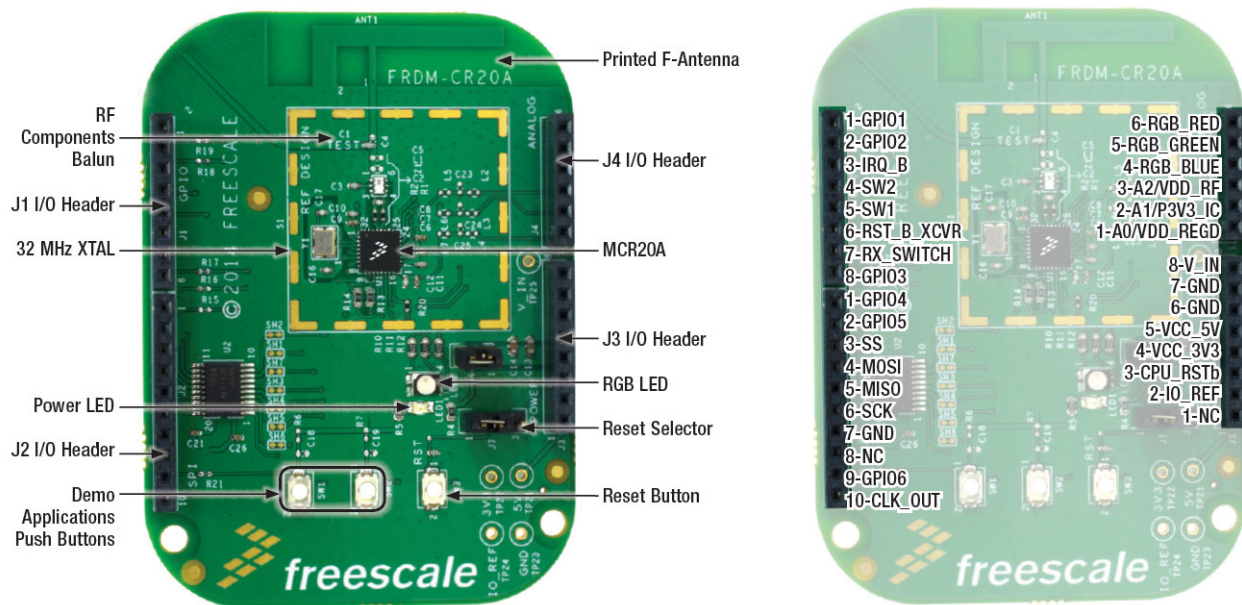Figure 2 shows the main board features and Input/Output headers for the Freescale FRDM-CR20A board.

Figure 2. FRDM-CR20A callouts and I/O headers

3.3 Software and driver considerations

No special software required. This is not a standalone board; an external MCU is required for enablement.

4 FRDM-CR20A development board

4.1 FRDM-CR20A board overview

The FRDM-CR20A is an evaluation board based on the Freescale MCR20A transceiver. The FRDM-CR20A provides a platform to evaluate the MCR20A transceiver, and develop software and

applications. The device is accompanied by a 32 MHz reference oscillator crystal, RF circuitry including antenna, and supporting circuitry.

The FRDM-CR20A board is intended as the core PCB for MCR20A device evaluation and application development, and can be used as daughter card to other development boards within the Freescale Freedom development platform, as an application specific such as a shield card.

4.1.1   PCB features

The FRDM-CR20A board provides the following features:

- The Freescale Freedom development platform form factor
- Two-layer metal, 0.062-inch thick FR4 board
- LGA footprint
- Printed metal F-Antenna and footprint to add an SMA connector
- 32 MHz reference oscillator crystal
- Standard Freescale Freedom daughter card mounting interface (shield)
- Power level translators to support multiple voltages inputs

4.1.2   Form factor

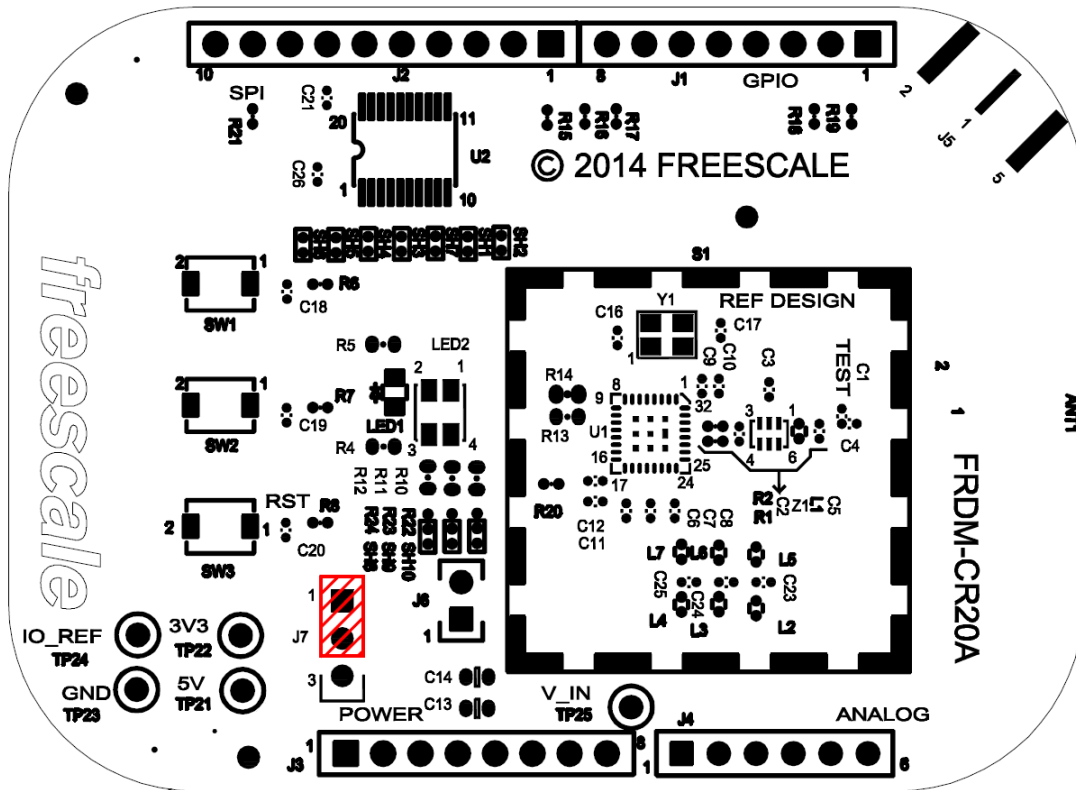Figure 3 shows the FRDM-CR20A connector and header locations.

Figure 3. FRDM-CR20A

Freescale Freedom Development Board FRDM-CR20A User's Guide, Rev. 0, 04/2015

Figure 3 also shows a footprint of the FRDM-CR20A with the location of the IO headers. The following list gives these details:

- J1, J2, J3 and J4:
    - Headers have standard 0.1 in / 2.54 mm pin spacing
    - J2 is 10-pin
    - J1 and J3 are 8-pin
    - J4 is 6-pin
    - Pin headers mounted on the top side of the FRDM-CR20A board and are intended to plug into matching receptacles on the Freescale Freedom platform board.
- J6:
    - Header has standard 0.1 in / 2.54 mm pin spacing
    - J6 is a 1x2 pin, with a cut-trace on bottom side
    - Pin headers mounted on the top side of the FRDM-CR20A and is intended to isolate for a IC current measurements.
- J7:
    - Header has standard 0.1 in / 2.54 mm pin spacing
    - J7 is 1x3 pin
    - Pin headers mounted on the top side of the FRDM-CR20A board and intended to select the Reset target main MCU or transceiver.
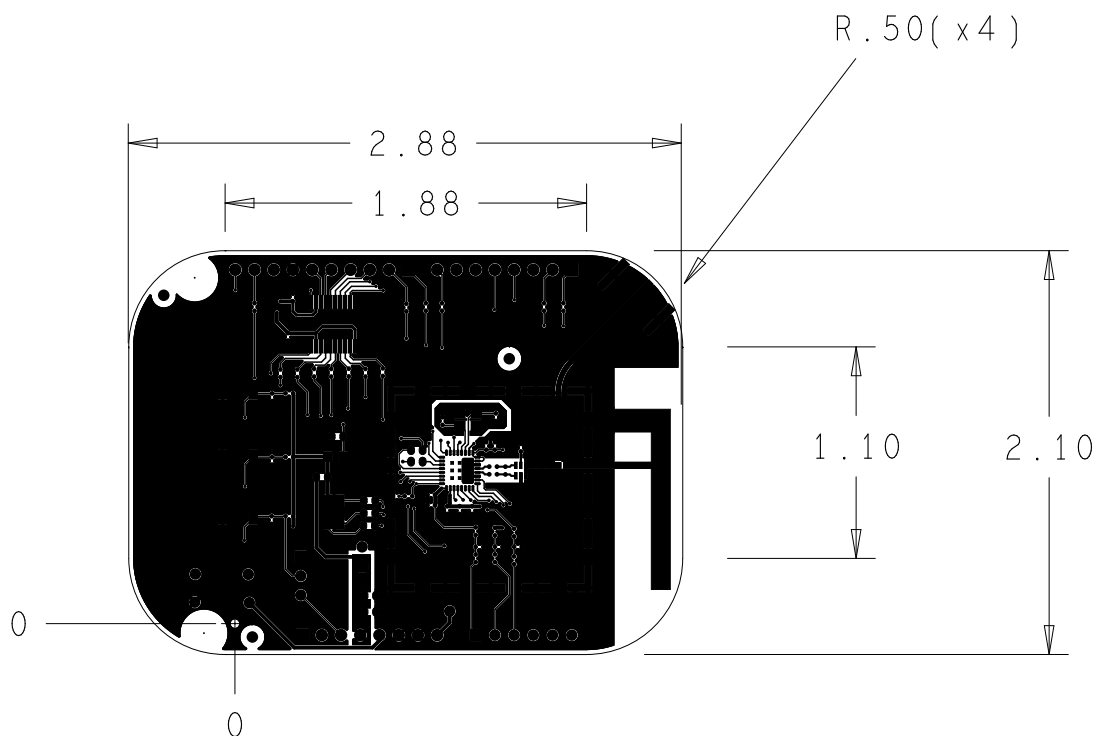

Figure 4. FRDM-CR20A top side (component side) footprint

4.1.3   Board level specifications

Table 1. FRDM-CR20A board specifications

Parameter	Min	Typ	Max	Units	Notes/Conditions
General					
Size (PCB: X, Y)			81.2 x 53.3 3.20 x 2.10	mm inches	
Layer build (PCB)		1.57 0.062		mm inches	Two-layer
Dielectric material (PCB)					FR4
Temperature					
Operating temperature (see note)	-40	+25	+70	℃	Operating temperature is limited to +70 ℃ due to switches. Basic circuit is good for a maximum temperature of +85 ℃.
Storage temperature	-30	+25	+70	℃	
RF					
802.15.4 frequency range	2405		2480	MHz	All 16 channels in the 2450 MHz band
Operation frequency	2360		2480	MHz	
RF Receiver					
Saturation (maximum input level)		+0		dBm	Refer to data sheet
Sensitivity for 1% packet error rate (PER) (+25 ℃) 802.15.4		-102		dBm	Refer to data sheet
RF Transmitter					
RF Power Output	-35		+8	dBm	Programmable in steps. At the antenna feed with no trap. [1]
2nd harmonic		<-50	<-40	dBm	Refer to data sheet
3rd harmonic		<-50	<-40	dBm	Refer to data sheet
Regulatory Approval					
FCC					Product is approved according to the FCC part 15 standard
CE (ETSI)					Product is approved according to the EN 300 328 V1.7.1 (2006-10) standard
CE (EMC)					Product is approved according 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 according to the IEC 60950-1 and EN 60950-1, first edition standards

Table 1. FRDM-CR20A board specifications (continued)

Parameter	Min	Typ	Max	Units	Notes/Conditions
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

1 Trap will add 1 to 2 dB of loss.

4.2   Functional description

The FRDM-CR20A is built around the Freescale FRDM-CR20A transceiver with a 32-pin LGA package. This board is intended as a simple evaluation platform and as a building block for application development. The two-layer board provides the MCR20A transceiver with the required RF circuitry and 32 MHz reference oscillator crystal. The layout for this base level functionality can be used as a reference layout for the user's target board. Figure 5 shows a simple block diagram.
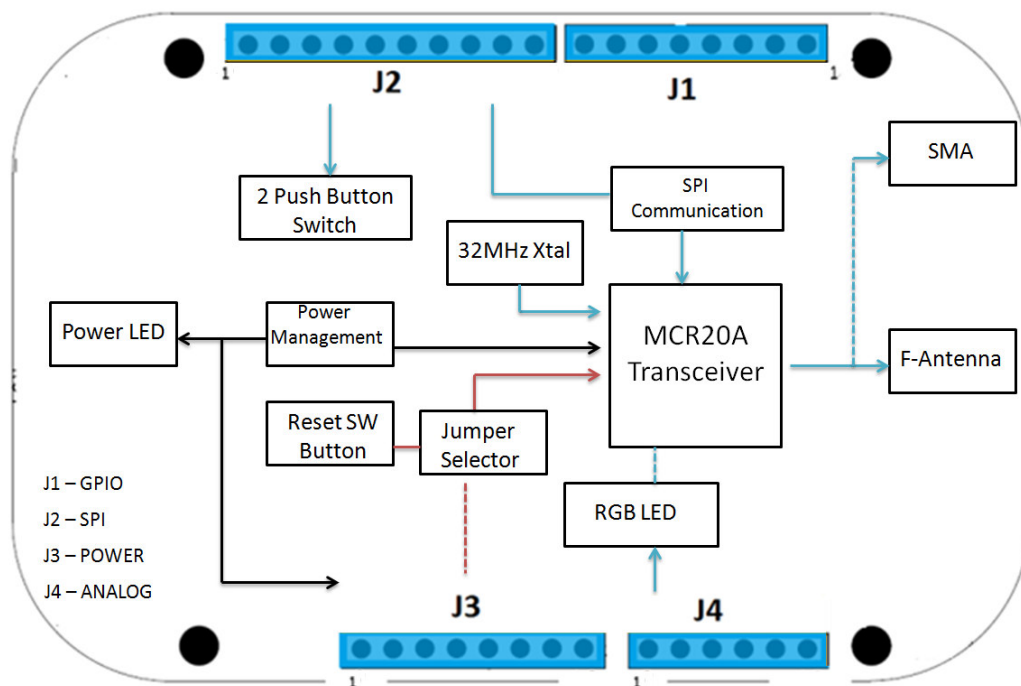
Figure 5. FRDM-CR20A block diagram

4.2.1   RF performance and considerations

The FRDM-CR20A development board includes the Freescale MCR20 2.4 GHz transceiver. Key specifications for the FRDM-CR20A development board are:

- Programmable output power from –35 dBm to +8 dBm at the SMA, no trap
- Typical sensitivity is -102 dBm (@1% PER for 20 byte payload packet)

- Frequency range is 2360 to 2480 MHz
- The MCR20 transceiver features an integrated transmit/receive switch to its differential bidirectional RF input/output pin
- Board features a low component count RF matching network with off-chip 1:1 Balun
- "F" printed metal antenna for a small footprint, low-cost design

The layout has provision for out-of-band signal suppression (components L1 and C5) if required. Figure 6 shows the typical topology for the RF circuitry. A footprint is available to install RF connector J5 for measurement purposes. When using J5, C1 should be installed and C4 removed.
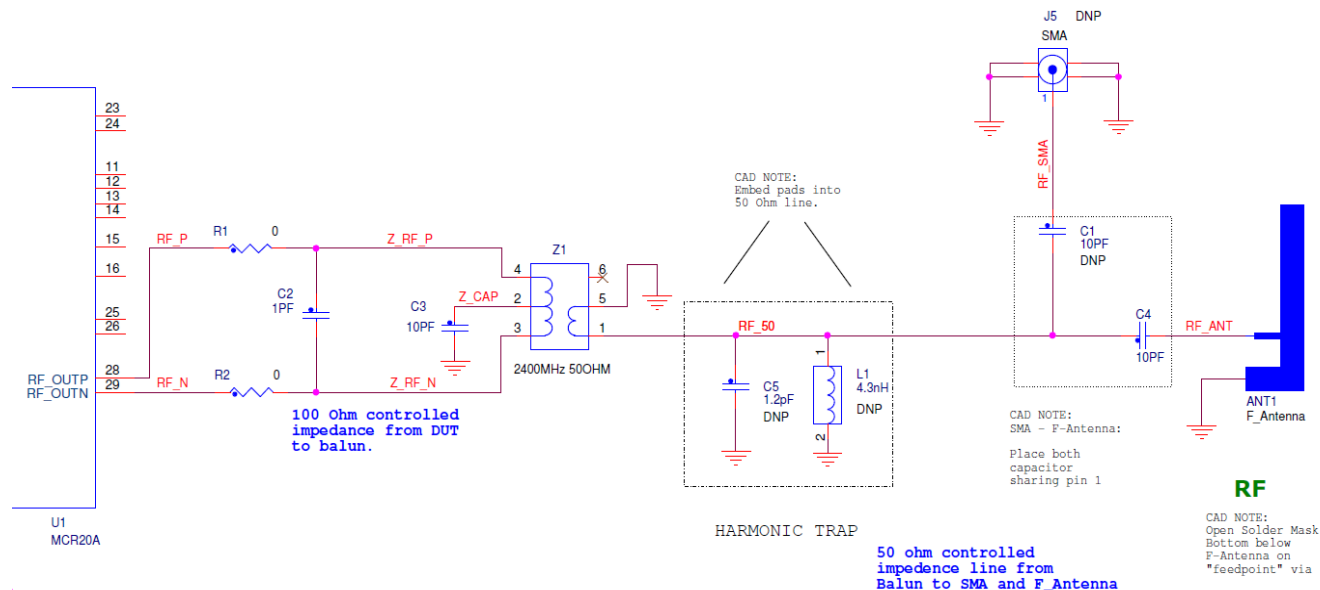

Figure 6. FRDM-CR20A RF circuitry

4.2.2   Clocks

The FRDM-CR20A provides two clocks:

- 32 MHz Reference Oscillator - Figure 7 shows the external 32 MHz external crystal Y1. This mounted crystal must meet the specifications outlined in the AN3251 application note. The IEEE 802.15.4 Standard requires that the frequency be accurate to less that +/-40 ppm.
  — At 25°C, it is desired to have the frequency accurate to +/-10 ppm or less to allow for temperature variation.
  — Capacitors C16 and C17 provide the bulk of the crystal load capacitance.
  — To measure the 32 MHz oscillator frequency, signal CLKOUT (pin-16) can optionally be configured to provide a buffered output clock signal.
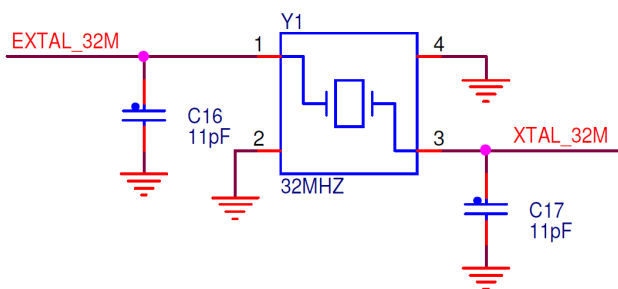
Figure 7. FRDM-CR20A 32 MHz reference oscillator circuit

4.2.3   Power management

The FRDM-CR20A development board must be powered through the edge connectors from the Freescale Freedom development platform board that it is plugged into. The FRDM-CR20A power management circuit is shown in Figure 8.
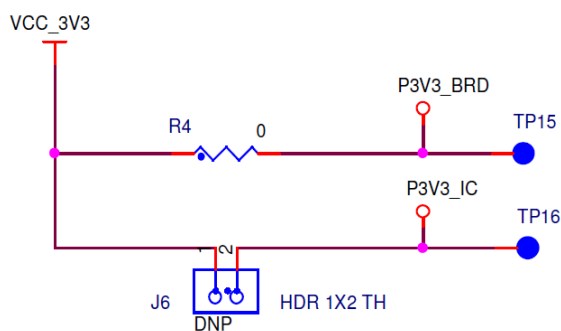

Figure 8. FRDM-CR20A power management circuit

The two-pin header J6 provides the means to supply current to various board components and current measurements if desired. The red LED marked as LED1 is available as a power indicator. The power header/0 ohm resistor provides the means to supply either the IC or board circuits. Current measurements can be made by inserting a current meter in place of a designated jumper. Connections configurations are described in Table 2.

Table 2. Power distribution headers

Supply Designation	Header Pins	Description
P3V3_BRD R4	1 - 2	Supply voltage to LEDs • Normally jumpered • Jumper used to enable LEDs, SW's and Level Translator on board • Leave open for lowest power • Usage: Measure board current
P3V3_IC J6	1 - 2	Supply voltage to MCR20A • Normally jumpered • Supplies the MCR20A tranceiver • Usage: Measure or supply radio current

4.2.4 FRDM-CR20A peripheral functions

The FRDM-CR20A development board includes the Freescale Freedom board headers enabling interface to general purpose functions to assist with to assist with application implementations. The FRDM-CR20A board also has alternate port functions routed to those interface headers where off-board Freescale Freedom development platform peripherals can be used if desired.

4.2.4.1 RGB LED

The LED feature includes an RGB (Red, Green, Blue) LED. The RGB LED is driven by the MCU on another board and not the transceiver, and therefore can be used with any application. Figure 9 shows the RGB circuit, The RGB LED circuity offers the following features:

- RGB power supply is P3V3_BRD
- GPIO driven, externally by J4 Header, J4-4 Blue, J4-5 Green, J4-6 Red
- Optionally a 0 ohm resistor can be populated (R22-R24) and be driven by GPIO6 - 8 of the transceiver
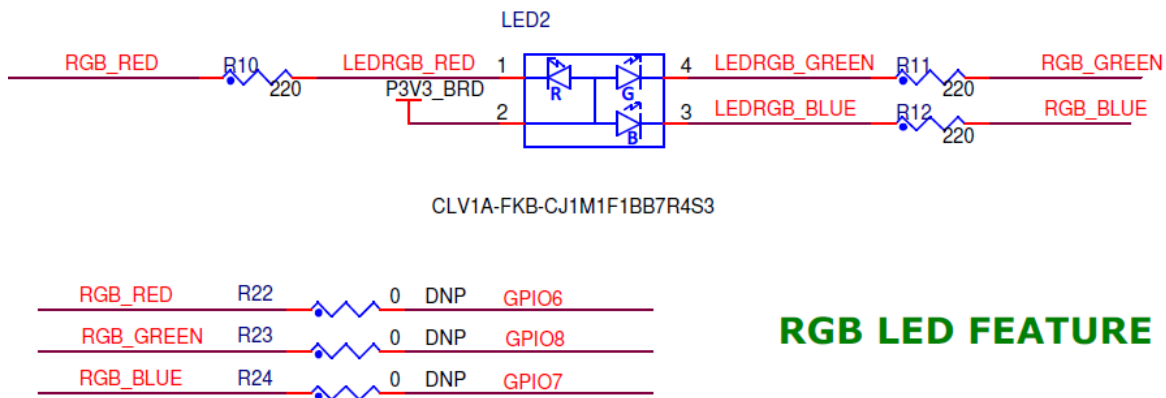

Figure 9. RGB LED feature

4.2.4.2 Push buttons

Push buttons can be used by the application to trigger events and are normally driven by an external MCU or transceiver IC. Figure 10 shows the push buttons circuit implementation.

- No power supply is required, however a pull-up circuit is feasible.
- Connected to the D4 and D3 signals of connector J1 for interface to off-board circuitry.
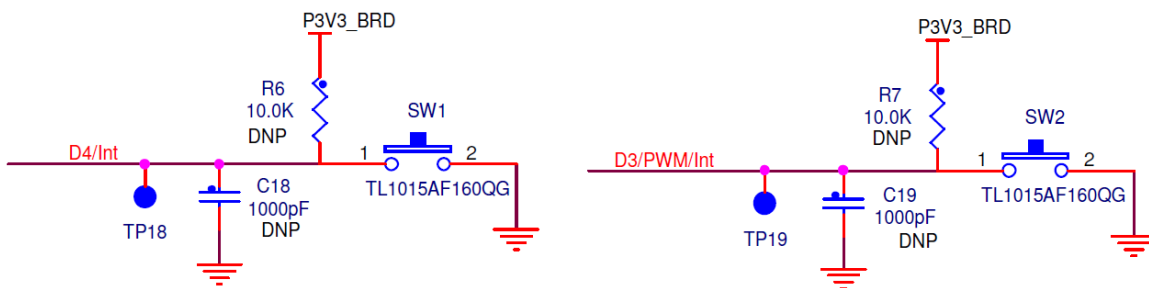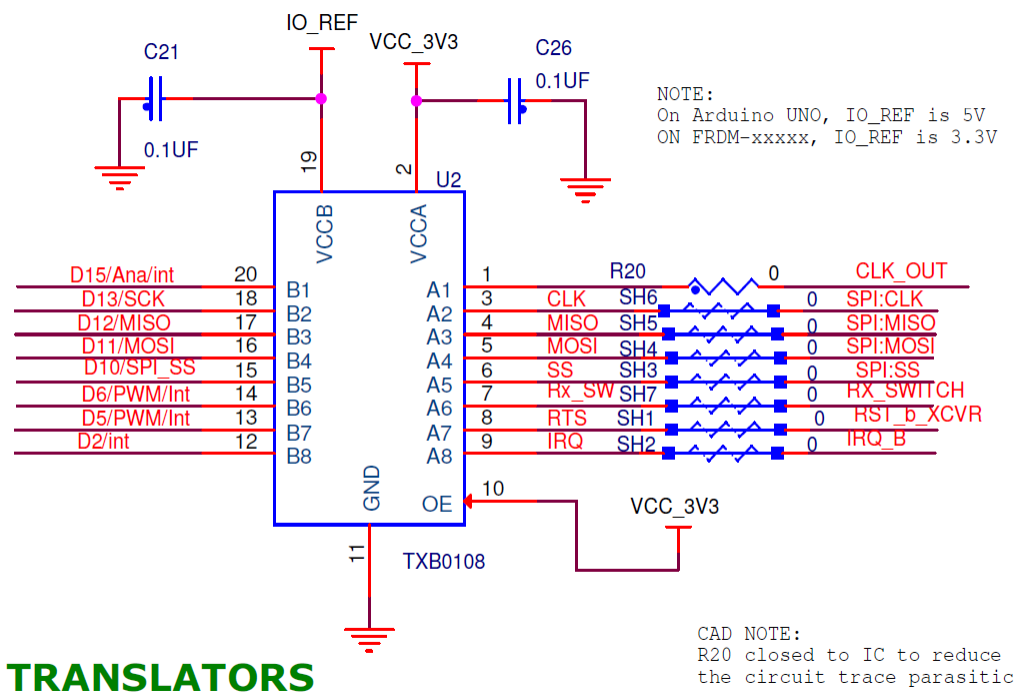
Figure 10. Push buttons

4.2.4.3 Level translator

The on-board level translator, U2, is used as a level shifter is useful when use with the Arduino system. It provides the voltage translation from the Arduino 5V system to the Freescale MCU plus transceiver 3.3V system. The level translator is supplied by the VCC_3V3 source. Figure 11 shows the translator circuit.

Figure 11. TXB0108 level translators

4.2.4.4 Interface connectors J1, J2, J3 and J4

The four connectors J1, J2, J3 and J4 are 100 mil pin headers mounted on the top (component side) supporting the FDRM standard connector.

- Voltage rails VCC_3V3, VCC_5V and V_IN(5-9V) are routed via header J3
  - To avoid damage, the exact same voltage should supply peripherals on the FRDM-CR20A that interface to the Freescale Freedom board supply, except where the level translator (U2) is used.

The pin definitions for the headers are shown in Table 3 and Table 4 respectively.

Table 3. J1 & J2 connector

	J1			J2	
Header Pin Number	Board Pin Name	Description	Header Pin Number	Board Pin Name	Description
1	GPIO1	(D0/Rx/int)	1	GPIO4	(D8/Int)
2	GPIO2	(D1/Tx/int)	2	GPIO5	(D9/Int)
3	IRQ_B	(D2/int)	3	SPI_SS	(D10/SPI_SS)
4	SW2	(D3/PWM/int)	4	SPI_MOSI	(D11/MOSI)
5	SW1	(D4/int)	5	SPI_MISO	(D12/MISO)
6	RST	(D5/PWM/int)	6	SPI_CLK	(D13/SCK)
7	RX_Switch	(D6/PWM/Int)	7	GND	VSS (GND)board ground
8	GPIO3	(D7/CMP/int)	8	NC	VREF (NC)
			9	GPIO6	(D14/Ana/Int)
			10	CLK_OUT	(D15/Ana/Int)

Table 4. J3 & J4 connector

	J3			J4	
Header Pin Number	Board Pin Name	Description	Header Pin Number	Board Pin Name	Description
1	NC	NC	1	VDD_REGD	A0
2	IO_REF	FRDM-xxxxx = 3V3 Arduino UNO = 5V	2	P3V3_IC	A1
3	CPU_RSTb	RESET External MCU	3	VDD_RF/VDD_IF/VDD_PA	A2
4	VCC_3v3	3V3 V_IN	4	RGB_BLUE	A3
5	VCC_5V	5V V_IN	5	RGB_GREEN	A4
6	GND	GND	6	RGB_RED	A5
7	GND	GND			
8	V_IN	5V - 9V Unregulated Voltage			

NXP

32MHz XTAL

POWER MANAGEMENT

POWER ON

FRDM- HEADERS

INTERRUPT PUSH BUTTONS

TRANSLATORS

RGB LED FEATURE

HARMONIC TRAP

EMI SHIE...

RF

50 ohm controlled impedance line from Balun to SMA and F_Antenna

100 Ohm controlled impedance from DUT to balun.

U1 MCR20A

freescale

Drawing Title: **FRDM-MCR20A**

Page Title: **FRDM-MCR20A Shield**

Document Number: SCH-28535 PDF: SPF28535

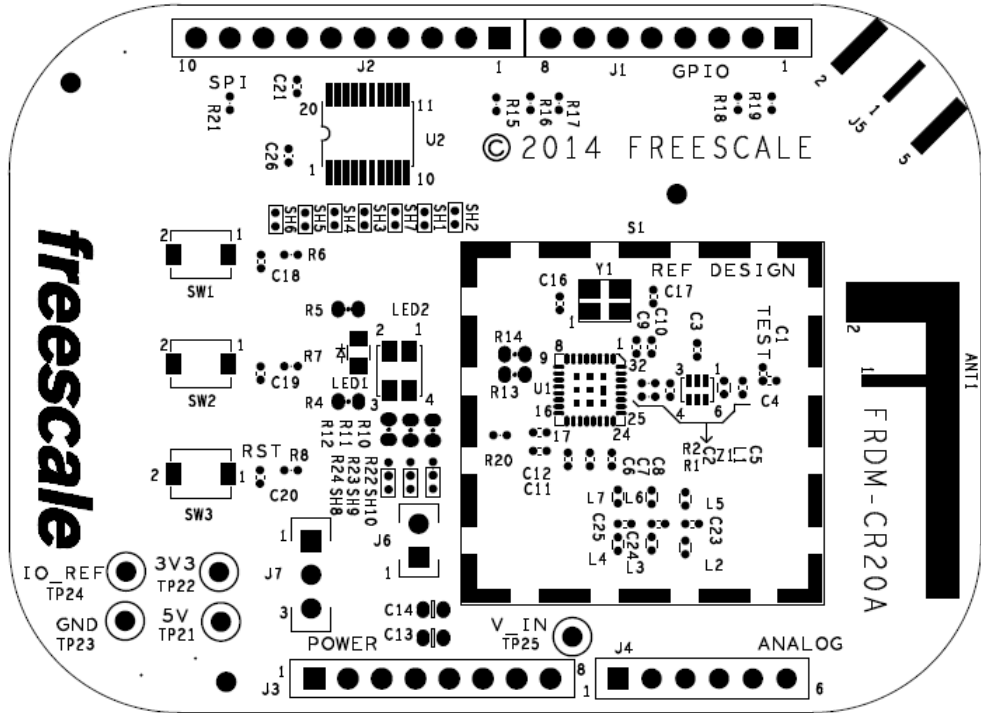Date: Wednesday, November 19, 2014

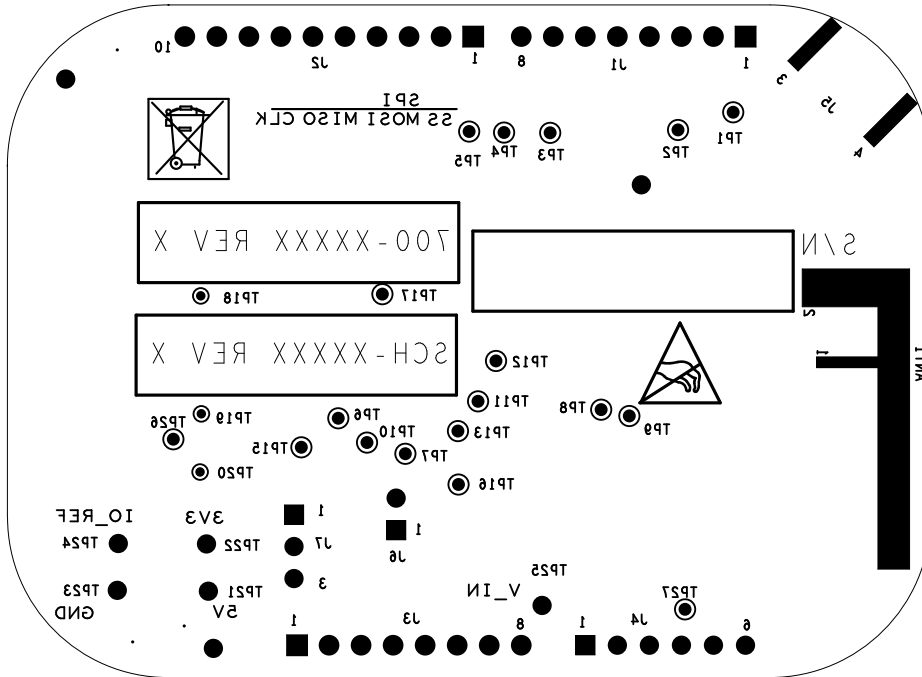**Figure 13. FRDM-CR20A reference board PCB component location (top view)**

Figure 14. FRDM-CR20A reference board PCB test points

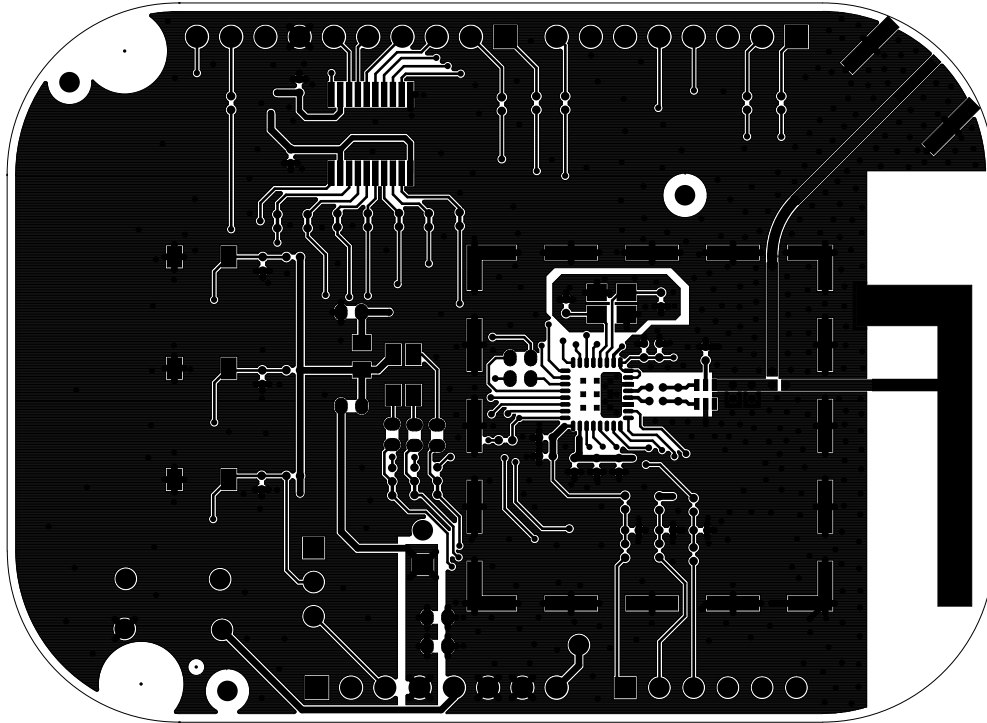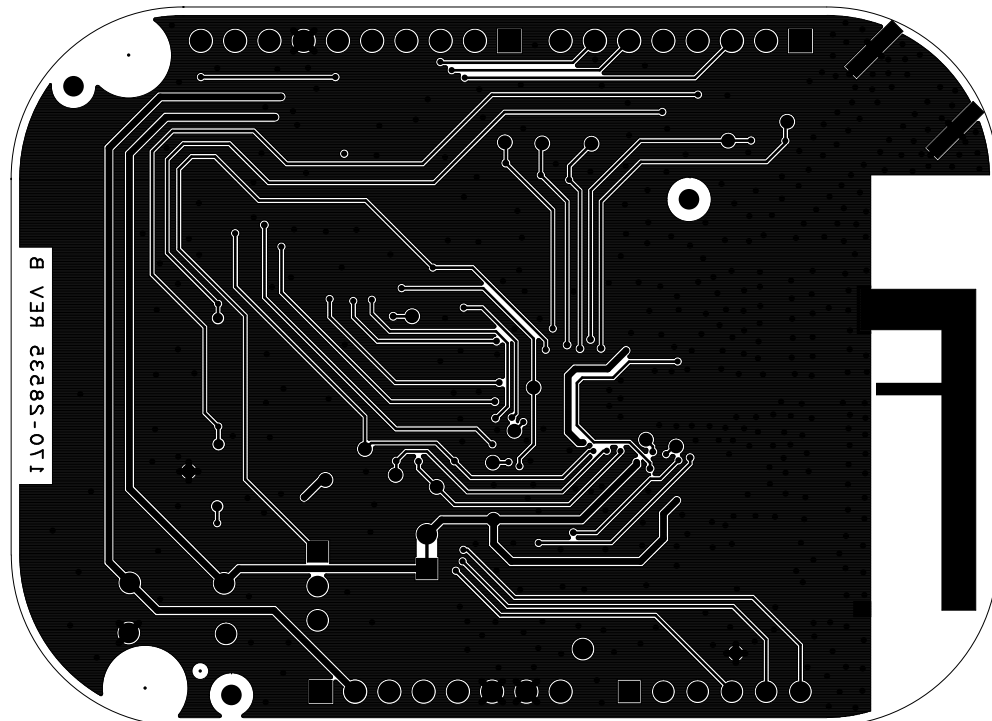**Figure 15. FRDM-CR20A reference board PCB layout (top view)**

Figure 16. FRDM-CR20A reference board PCB layout (bottom view)

Freescale Freedom Development Board FRDM-CR20A User's Guide, Rev. 0, 04/2015

4.3.1 Bill of materials

Table 5. Bill of materials (Common parts for all frequency bands) (Sheet 1 of 3)

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
1	1	ANT1	F_Antenna	PCB F ANTENNA, NO PART ORDER		
2	1	C1	10PF	CAP CER 10PF 50V 5% C0G 0402	AVX	04025A100JAT2A
3	1	C2	1PF	CAP CER 1PF 50V 5% C0G 0402	MURATA	GRM1555C1H1R0CA01B
4	2	C3,C4	10PF	CAP CER 10PF 50V 5% C0G 0402	AVX	04025A100JAT2A
5	1	C5 DNP	1.2pF	CAP CER 1.2PF 50V 21% C0G 0402	KEMET	C0402C129C5GAC
6	1	C6	5pF	CAP CER 5pF 50V 5% C0G 0402	MURATA	GJM1555C1H5R0CB01D
7	2	C7,C20	1000pF	CAP CER 1000PF 50V 5% C0G 0402	MURATA	GRM1555C1H102JA01D
8	3	C8,C21,C26	0.1UF	CAP CER 0.1UF 16V 10% X7R 0402	KEMET	C0402C104K4RAC
9	1	C9	0.47UF	CAP CER 0.47UF 6.3V 10% X5R 0402	MURATA	GRM155R60J474KE19D
10	2	C10,C12	33PF	CAP CER 33PF 50V 5% C0G 0402	VENKEL COMPANY	C0402C0G500-330JNE
11	1	C11	0.33UF	CAP CER 0.33UF 6.3V 10% X5R 0402	MURATA	GRM155R60J334KE01D
12	1	C13	10uF	CAP CER 10UF 10V 20% X5R 0603	TAIYO YUDEN	LMK107BJ106MALTD
13	1	C14	2.2UF	CAP CER 2.2UF 10V 10% X7R 0603	TAIYO YUDEN	LMK107B7225KA-T
14	2	C16,C17	11pF	CAP CER 11pF 50V 1% C0G 0402	AVX	04025U110FAT2A
15	2	C18,C19 DNP	1000pF	CAP CER 1000PF 50V 5% C0G 0402	MURATA	GRM1555C1H102JA01D
16	3	C23,C24,C25 DNP	10uF	CAP CER 10UF 6.3V 20% X5R 0402	TDK	C1005X5R0J106M050BC
17	2	J1,J3	SKT_1X8	CON 1X8 SKT TH 100MIL SP 340H AU 394L	SAMTEC	SSQ-108-03-F-S
18	1	J2	SKT_1X10	CON 1X10 SKT TH 100MIL SP 340H AU 394L	SAMTEC	SSQ-110-03-F-S
19	1	J4	SKT_1X6	CON 1X6 SKT TH 100MIL SP 340H AU 394L	SAMTEC	SSQ-106-03-F-S
20	1	J5 DNP	SMA	CON, SMA, EDGE 0.062IN, 50 OHM FEMALE 18GHZ	EMERSON NETWORK POWER CONNECTIVITY SOLUTIONS, INC	142-0701-851

Table 5. Bill of materials (Common parts for all frequency bands) (Sheet 2 of 3)

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
21	1	J6 DNP	HDR 1X2 TH	HDR 1X2 TH 100MIL SP 339H AU 98L	SAMTEC	TSW-102-07-G-S
22	1	J7	HDR TH 1X3	HDR 1X3 TH 100MIL SP 339H AU 100L	SAMTEC	TSW-103-07-G-S
23	1	LED1	RED	LED RED CLEAR SGL 30MA SMT 0805	LITE ON	LTST-C171KRKT
24	1	LED2	CLV1A-FKB -CJ1M1F1B B7R4S3	LED RED BL GRN SGL 50/25/25mA SMT	CREE, INC	CLV1A-FKB-CJ1M1F1 BB7R4S3
25	1	L1 DNP	4.3nH	IND -- 4.3NH@500MHZ 160MA 2% 0402	MURATA	LQP15MN4N3B02
26	6	L2,L3,L4,L 5,L6,L7 DNP	10nH	IND -- 0.010uH@100MHZ 350MA 5% 0402	TDK	MLK1005S10NJT000
27	3	R1,R2,R20	0	RES MF ZERO OHM 1/16W 5% 0402	ROHM	MCR01MZPJ000
28	3	R4,R13,R1 4	0	RES MF ZERO OHM 1/10W -- 0603	VISHAY INTERTECHNOLOGY	CRCW06030000Z0EA
29	4	R5,R10,R1 1,R12	220	RES MF 220 OHM 1/10W 5% 0603	KOA SPEER	RK73B1JTTD221J
30	3	R6,R7,R8 DNP	10.0K	RES MF 10.0K 1/16W 1% AEC-Q200 0402	VISHAY INTERTECHNOLOGY	CRCW040210K0FKE D
31	9	R15,R16,R 17,R18,R1 9,R21,R22, R23,R24 DNP	0	RES MF ZERO OHM 1/16W 5% 0402	ROHM	MCR01MZPJ000
32	10	SH1,SH2,S H3,SH4,SH 5,SH6,SH7 ,SH8,SH9, SH10	0	ZERO OHM CUT TRACE 0402 PADS; NO PART TO ORDER	LAYOUT ELEMENT ONLY	LAYOUT ELEMENT ONLY
33	3	SW1,SW2, SW3	TL1015AF1 60QG	SW SPST PB 50MA 12V SMT	E SWITCH	TL1015AF160QG
34	1	S1 DNP	BMI-S-103	SHIELD RF 1032X1032MIL 1 PIECE	LAIRD TECHNOLOGIES	BMI-S-103

Table 5. Bill of materials (Common parts for all frequency bands) (Sheet 3 of 3)

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
35	18	TP1,TP2,TP3,TP4,TP5,TP6,TP7,TP8,TP9,TP10,TP11,TP12,TP13,TP15,TP16,TP17,TP26,TP27	TPAD_040	TEST POINT PAD 40MIL DIA SMT, NO PART TO ORDER	NOTACOMPONENT	NOTACOMPONENT
36	3	TP18,TP19,TP20	TPAD_030	TEST POINT PAD 30MIL DIA SMT, NO PART TO ORDER	NOTACOMPONENT	NOTACOMPONENT
37	5	TP21,TP22,TP23,TP24,TP25 DNP	TEST POINT WHITE	TEST POINT WHITE 40 MIL DRILL 180 MIL TH 109L	KEYSTONE ELECTRONICS	5002
38	1	U1	MCR20A	IC XCVR 2.4GHZ 250KBPS O-QPSK 1.8-3.6V MAPLGA41	FREESCALE SEMICONDUCTOR	MCR20AVHM
39	1	U2	TXB0108	IC VXLTR 8BIT BIDIR 15KV ESD 1.2-3.6V/1.65-5.5V TSSOP20	TEXAS INSTRUMENTS	TXB0108PWR
40	1	Y1	32MHZ	XTAL 32MHZ 9PF -- SMT 3.2X2.5MM	NDK	EXS00A-CS02368
41	1	Z1	2400MHz 50OHM	XFMR BALUN 2400 +/-100MHZ SMT	MURATA	LDB212G4005C-001

NOTES

- FRDM-CR20A includes neither J5 (the SMA connector) nor the external antenna.
- For external measurements and/or external antenna usage, J5 should be installed and soldered in place.
- A 50 ohm SMA jack connector is required; recommended part number 142-0701-851 from Emerson/Johnson.
- For an external antenna, the screw terminal 2.4 GHz antenna, part number B4844-01 from Antenova is recommended.
- Other external components can be found via suppliers/distributors such as Mouser, Digikey, Newark, etc.

5   PCB manufacturing specifications

This section provides the specifications used to manufacture the FRDM-CR20A development printed circuit board (PCB) described in this guide.

The FRDM-CR20A development platform PCBs must comply with the following:

- The PCB must comply with Perfag1D/3C (www.perfag.dk/en/)

- 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 cannot 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 (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 MCR20AVHM transceiver at the Freescale website (freescale.com/MCR20A) under the "Software and Tools." These reference designs should be used as a starting point for a custom application.
- The *Application Note (AN5003)* is also available at the same web site to provide additional design guidance
- 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.

5.1   Single PCB construction

This section describes individual PCB construction details.

- The FRDM-CR20A PCBs are two-layer, multi layer designs
- The PCBs contain no blind, buried, or micro vias
- PCB data:
  — FRDM-CR20A size: Approximately 73x 53mm (2.88 x 2.10 inches)
  — FRDM-CR20A final thickness (Cu/Cu): 1.57 mm (0.62 inches) +/- 10% (excluding solder mask)

Table 6 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. MCR20AVHM Layer by Layer Overview

Layer	Artwork Identification	File Name
1	Silkscreen Top	PSS.art
2	Top Layer Metal	L1_PS.art
3	Bottom Layer Metal	L2_SS.art
4	Silkscreen Bottom	SSS.art

IMPORTANT: The FRDM-CR20A development board 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. BOARD STACKUP GEOMETRY IS CRITICAL. Dielectric and copper thicknesses and spacing must not be changed; follow the stackup (see Figure 17) information provided with the reference design.
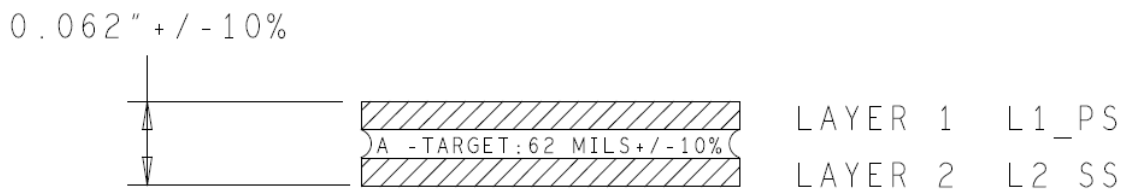

Figure 17. FRDM-CR20A PCB stackup cross-section (four layer)

- Solder mask is required
- Silk screen is required

5.2 Panelization

The panel size can be negotiated depending on production volume.

5.3 Materials

The PCB composite materials must meet the following requirements:

- Laminate—the base laminate material must be FR4. If the laminate material is changed, the RF electrical characteristics may change and degrade RF performance.
- Copper foil
  — Top and bottom copper layers must be 1 oz. copper
- Plating—All pad plating must be Hot Air Levelling (HAL)

5.4 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

5.5 Silk screen

The silk screen must meet the following requirements:

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

5.6   Electrical PCB testing

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

5.7   Packaging

Packaging for the PCBs must meet 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.

5.8   Hole specification/tool table

See the *ncdrill-1-4.tap* file included with the Gerber files and the *FAB-28535.pdf* file.

5.9   File description

Files included with the download include Design, Gerber, and PDF files. Gerber files are RS-274x format. Not all files included with the Gerber files are for PCB manufacturing.

PDF files included are:

- *FAB-28535.pdf*—FRDM- Board fabrication drawing
- *GRB-28535.zip*—FRDM- Metal layers, solder mask, solder paste and silk screen
- *SPF-28535.pdf*—FRDM- Schematic

Design files are in Allegro format with OrCAD schematic capture.

6   Revision history

Rev. number	Date	Substantive change(s)
0	03/2015	Initial public release.

Document Number: FRDMCR20AUG
Rev. 0
04/2015

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