

# FRDM-KW019032 Freescale Freedom Development Board

## User's Guide

## 1 Introduction

This manual describes the hardware for the Freescale Freedom development board, FRDM-KW019032. The FRDM-KW019032 Freedom development board is a small, low-power, cost-effective evaluation and development board for application prototyping and demonstration of the MKW01Z128 family of devices.

The Kinetis MKW01Z128 wireless MCU is a highly integrated RF transceiver that operates over a wide frequency range including 315 MHz, 433 MHz, 470 MHz, 868 MHz, 915 MHz, 928 MHz, and 955 MHz in the license-free Industrial, Scientific and Medical (ISM) frequency bands.

### 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

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device or system. This device may not be sold to the general public. Integrators will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

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

### 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 (20 cm) 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 Standard 802.15.4. 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 licence-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, see [freescale.com/productdisposal](http://freescale.com/productdisposal).

# 3 FRDM-KW019032 overview and description

## 3.1 Introduction

The FRDM-KW019032 development board is an evaluation environment based on the Freescale MKW01Z128 device. The MKW01Z128 is a highly-integrated RF transceiver that operates over a wide frequency range including 315 MHz, 433 MHz, 470 MHz, 868 MHz, 915 MHz, 928 MHz, and 955 MHz in the license-free Industrial, Scientific and Medical (ISM) frequency bands. This configuration allows users to minimize the use of external components.

The MKW01Z128 is targeted for the following low-power wireless applications:

- Automated Meter Reading
- Wireless Sensor Networks

- Home and Building Automation
- Wireless Alarm and Security Systems
- Industrial Monitoring and Control
- Wireless MBUS Standard (EN13757-4:2005)

Freescale supplements the MKW01Z128 with tools and software that include hardware evaluation and development boards, software development IDE and applications, drivers, custom PHY usable with Freescale's IEEE Std. 802.15.4 compatible MAC, SMAC, Thread and an available wireless MBUS solution.

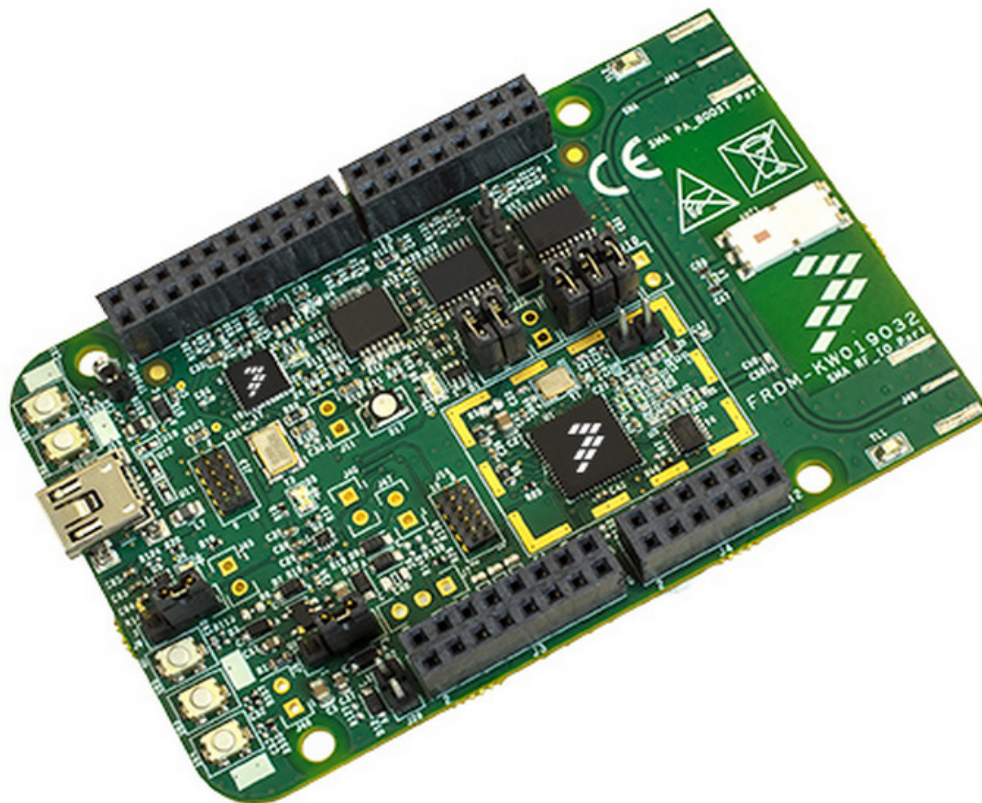
## 3.2 Board features

### 3.2.1 FRDM-KW019032 board

The FRDM-KW019032 development board is part of the Freescale Freedom development (FRDM) platform. It has a diverse reference design containing the MKW01Z128 device and all necessary I/O connections for use as a self-contained board or for connection to an application, and also has the capability to connect with other Freedom development boards.

FRDM-KW019032 evaluation board can operate in the 915MHz or 868MHz frequency bands with a 32 MHz clock source. The operation band may be changed to a different band but RF matching network needs to be optimized per BOM section (reference to chapter 4.3.1).

[Figure 1](#) shows the FRDM-KW019032 development board.



**Figure 1. FRDM-KW019032 Freedom development board**

The FRDM-KW019032 development board includes the following features:

- Based on Freescale's low-cost MKW01Z128 sub-GHz wireless node solution with an FSK, GFSK, MSK, or OOK modulation-capable transceiver and low-power ARM<sup>®</sup> Cortex<sup>®</sup> M0+CPU microcontroller, and a functional set of MCU peripherals into a 60-pin LGA package.
- Reference design area with small footprint, low-cost RF node:
  - Power Amplifier Output
  - Unbalanced I/O port
  - Flexible RF-Front End for different bands operation
  - Programmable output power from -18 dBm to +17 dBm in 1 dB steps
  - High Sensitivity: down to -120 dBm at 1.2 Kbps
- Integrated chip antenna for RFIO port, and footprint for SMA RFIO and PA\_BOOST ports
- 32 MHz reference oscillator depending on regional configuration
- 32 kHz clock oscillator
- Master reset switch
- Full power regulation and management
- Cortex 10-pin (0.05 inches) SWD debug port for target MCU

- Cortex 10-pin (0.05 inches) JTAG port for OpenSDA updates
- Integrated open-standard serial and debug interface (OpenSDA)
- 1 RGB LED indicator
- 1 Blue LED indicator
- 4 Push button switches

Figure 2 shows the main board features and I/O headers for the Freescale FRDM-KW019032 board.

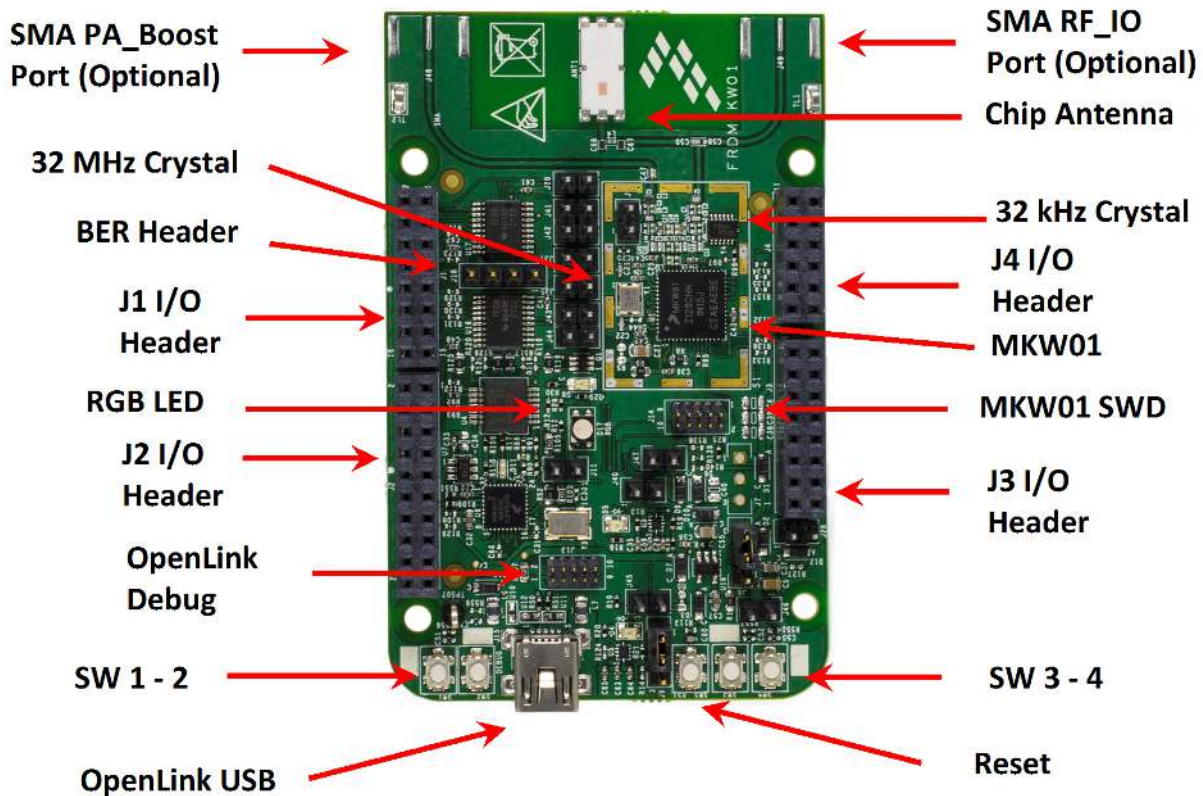


Figure 2. FRDM-KW019032 components

### 3.3 Software and driver considerations

The FRDM-KW019032 board includes an OpenSDAv2.1 (CMSIS-DAP), a serial and debug adapter circuit that includes an open-source bootloader, and debug interface software. It bridges serial and debug communications between a USB host and an embedded target processor. The hardware circuit is based on the Kinetis K20 family. More related information can be found in the following documentation:

- KW019032 Quick Start Guide

For additional information about our sub-GHz Kinetis family platforms, see the following:

- [Freescale.com/FRDM-KW019032](http://Freescale.com/FRDM-KW019032)

For ARM mbed™ drivers, see:

- <https://developer.mbed.org/handbook/Windows-serial-configuration>

## 4 FRDM-KW019032 development board

### 4.1 FRDM-KW019032 board overview

The FRDM-KW019032 is an evaluation board based on the Freescale MKW01Z128 transceiver. The FRDM-KW019032 provides a platform to evaluate the MKW01Z128, develop software, and applications. The core device is accompanied by a 32 MHz reference oscillator crystal, RF circuitry including a chip antenna, and supporting circuitry.

The FRDM-KW019032 board is intended as the primary PCB for MKW01Z128 device evaluation and application development, and can be used in the following modes:

- Simple standalone evaluation platform
- Daughter card to other development platform boards (Freedom development platform)
- Mother card to an application specific daughter card such as a shield card

#### 4.1.1 PCB features

The FRDM-KW019032 board provides the following features:

- The Freescale Freedom development platform form factor
- 4-Layer metal, 0.062 inch thick FR4 board
- LGA footprint and power supply bypass
- Chip antenna for RFIO port and footprint for installing (user supplied) SMA connectors on RFIO and PA\_BOOST ports
- 32 MHz reference oscillator crystal
- 32.768 kHz crystal provided for optional timing oscillator
- Standard FRDM daughter card mounting interface

#### 4.1.2 Form factor

Figure 3 shows the FRDM-KW019032 connector and header locations.

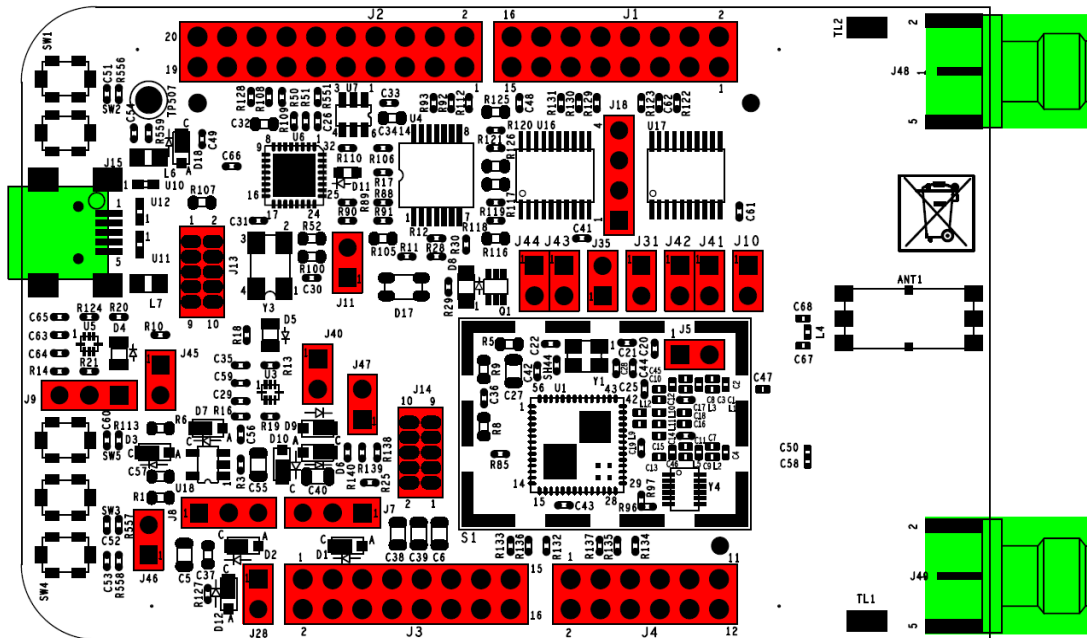


Figure 3. FRDM-KW019032 connector and header locations

Figure 4 shows a footprint of the FRDM-KW019032 with the location of the IO headers. The parameters of these headers are as follows:

- J1, J2, J3 and J4:
  - Headers have standard 0.1 inch / 2.54 mm pin spacing
  - J1 and J3 are 16-pin
  - J2 is 20-pin
  - J4 is 12-pin
  - Pin headers mounted on the top side of the FRDM-KW019032 and are intended to plug into matching receptacles on the Freescale Freedom Platform board.
- J41, J42, J10, J5, J35, J31, J44, J43, J45, J40, J47, J46, J28, J11, J8, J9, and J18:
  - Headers have standard 0.1 inch / 2.54 mm pin spacing
  - J41, J42, J10, J5, J35, J31, J44, J43, J45, J40, J47, J46, J28, and J11 are 2 x1 pin
  - J8 and J9 are 3 x 1 pin
  - J18 is a 4x1 pin



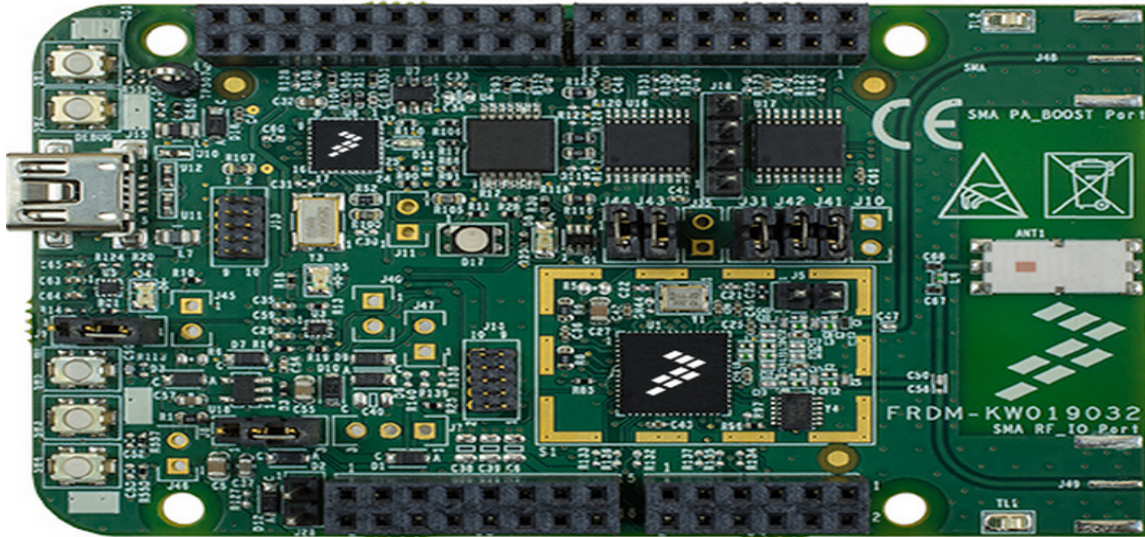


Figure 4. FRDM-KW019032 top side (component side) footprint

### 4.1.3 Board level specifications

Table 1. FRDM-KW019032 specifications

Parameter	Min	Typ	Max	Units	Notes/Conditions
<b>General</b>					
Size (PCB: X, Y)	—	—	82.8 x 53.3 3.26 x 2.10	mm inches	—
Layer build (PCB)	—	1.57 0.062	—	mm inches	4-Layer
Dielectric material (PCB)	—	—	—	—	FR4
<b>Power</b>					
Current consumption	—	—	—	mA	Varies with operational mode, see datasheet.
<b>Temperature</b>					
Operating temperature (see note)	-40	+25	+70	°C	Operating temperature is limited to +70 °C due to switches. Basic circuit is good for a maximum temperature of +85 °C.
Storage temperature	-30	+25	+70	°C	—
<b>RF Receiver</b>					
FSK Sensitivity	—	-105 to -120	—	dBm	—

**Table 1. FRDM-KW019032 specifications (continued)**

Parameter	Min	Typ	Max	Units	Notes/Conditions
OOK Sensitivity	—	-112	—	dBm	—
Adjacent channel Rejection (Offset = ±25 kHz or 50 kHz)	—	-42	—	dB	—
2nd order Intercept point	—	+75	—	dBm	—
3rd order Intercept point		+20	—	dBm	—
RSSI dynamic range	-115	—	0	—	—
<b>RF Transmitter</b>					
RF Power Output (RFIO pin)	-18	—	+13	dBm	Programmable in 1 dB steps
RF Power Output (PA_Boost pin)	—	+17	—	dBm	—
Adjacent channel Power (25 KHz offset)	—	—	-37	dBm	—
<b>Regulatory Approval</b>					
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
<b>Safety</b>					
UL	—	—	—	—	Product is approved according to the IEC 60950-1 and EN 60950-1, First Edition standards
<b>Environment</b>					
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
Frequency range	290	—	340	MHz	Programmable, using a 32 MHz clock.
	424	—	510	MHz	
	862	—	1020	MHz	

## 4.2 Functional description

The FRDM-KW019032 board is built around the Freescale MKW01Z128 transceiver in a 60-pin LGA package. It features a highly-integrated, cost-effective sub-GHz radio frequency transceiver and a Kinetis family ultra-low-power, mixed-signal ARM Cortex-M0+ MCU in a single package. The

FRDM-KW019032 board is intended as a simple evaluation platform and as a building block for application development. The four-layer board provides the MKW01Z128 transceiver with the required RF circuitry and a 32 MHz reference oscillator crystal. The layout for this base level functionality can be used as a reference layout for your target board. [Figure 5](#) shows a simple block diagram.

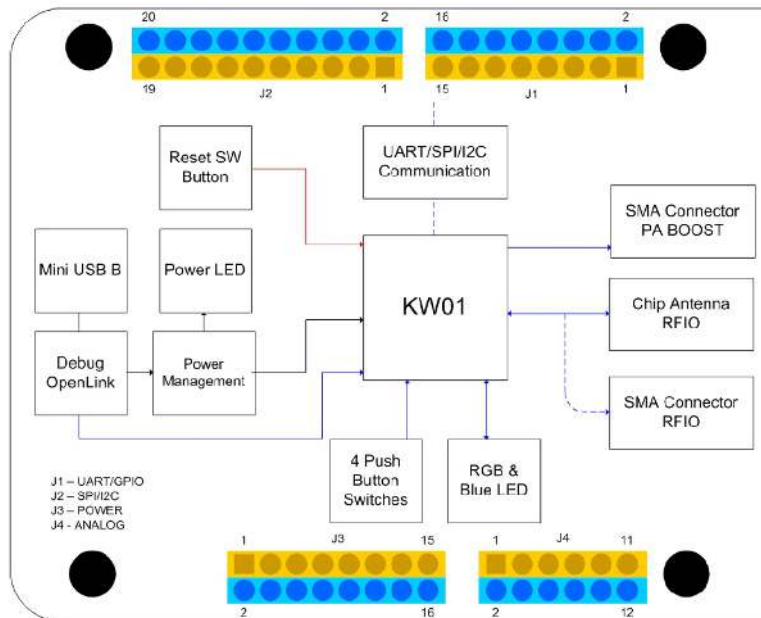


Figure 5. FRDM-KW019032 block diagram

## 4.2.1 RF performance and considerations

The MKW01Z128 transceiver is a single-chip integrated circuit ideally suited for high performance ISM band RF applications. It is intended for use as a high-performance, low-cost FSK and OOK RF transceiver for robust, frequency agile, half-duplex bi-directional RF links. The MKW01Z128CHN is intended for applications over a wide frequency range, including the 433 MHz and 868 MHz European and the 902–928 MHz North American ISM bands.

- Output power -18 to +17 dBm, depending on output and setting

The FRDM-KW019032 uses a flexible RF path topology that make it suitable for working in different frequency bands by replacing a minimum number of components while providing good RF performance. The tables in [Section 4.3.1](#), “[Bill of materials](#)” show the different BOM according to different frequency bands of operation.

[Figure 6](#) shows the typical topology for the RF circuitry. A footprint is available to install SMA connector J49 for measurement purposes. When using J49, C58 must be installed and C50 must be removed.

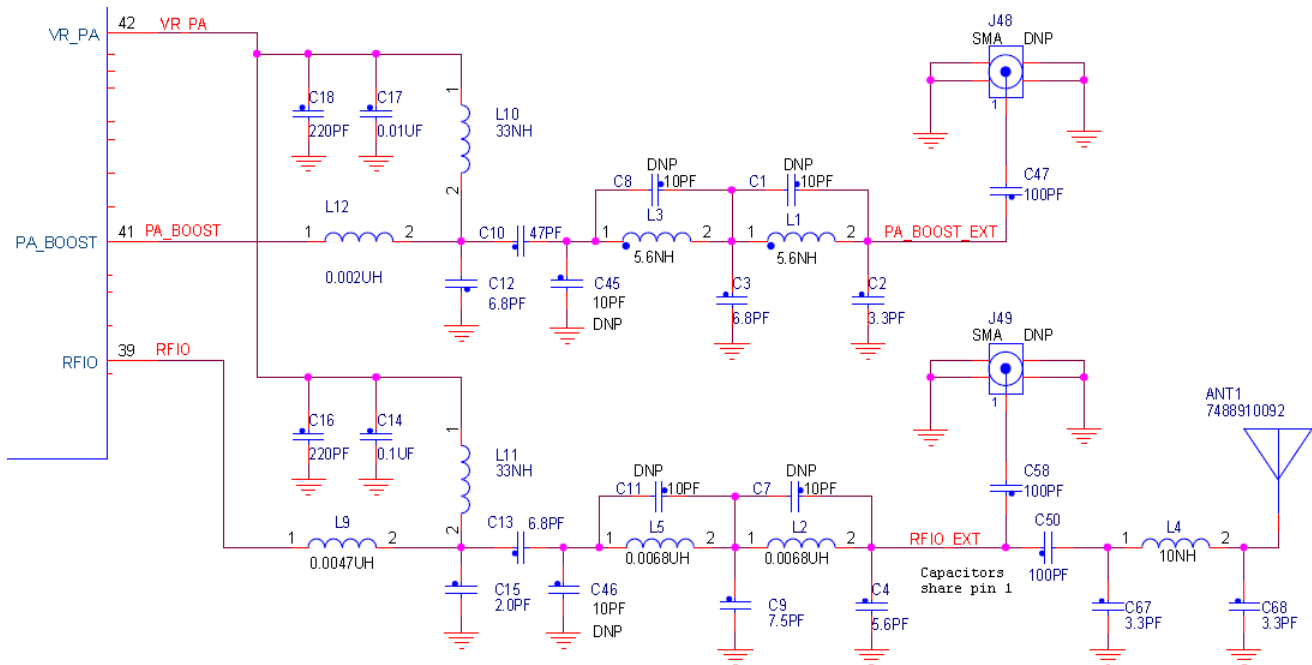


Figure 6. FRDM-KW019032 RF circuitry

## 4.2.2 Clocks

The FRDM-KW019032 board provides two clocks:

- 32 MHz Reference Oscillator: [Figure 7](#) shows the external 32 MHz external crystal Y1. This mounted crystal must meet the MKW01Z128 specifications.
  - Capacitors C22 and C21 provide the bulk of the crystal load capacitance. At 25 °C it is desired to have the frequency accurate to  $\pm 10$  ppm or less to allow for temperature variation.
  - Signal DIO5/CLKOUT can be used to supply an external clock to MCU die and to measure the 32 MHz oscillator frequency.
  - The FRDM-KW019032 has provision for injecting an external 32 MHz clock source as an alternative to use of the onboard crystal:
    - The 0 Ohm shunt SH44 must be removed to disconnect Y1
    - C20 must be mounted
    - The external 32 MHz source is connected to the 2-pin header J5
- Optional 32.768 kHz Crystal Oscillator - Provision is also made for a secondary 32.768 kHz crystal Y4 (see [Figure 8](#)). This oscillator can be used as a low power accurate time base.
  - To disconnect Y4 and use PTC1 as a GPIO port:
    - The 0 Ohm resistor R96 must be removed
    - The 0 Ohm resistor R97 must be populated

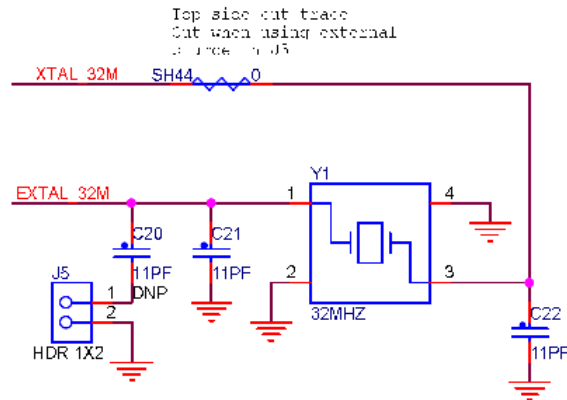


Figure 7. FRDM-KW019032 32 MHz reference oscillator circuit

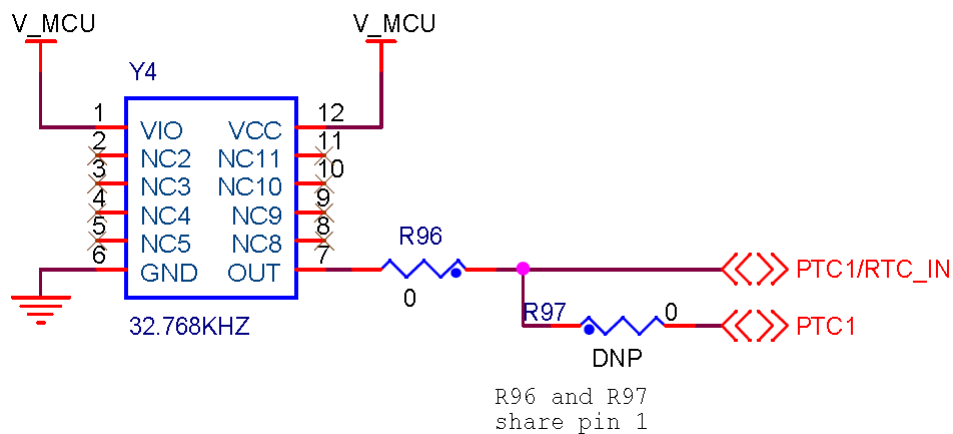


Figure 8. FRDM-KW019032 32.768 kHz optional oscillator circuit

### 4.2.3 Power management

There are several different ways to power and measure current on the FRDM-KW019032 board. The FRDM-KW019032 power management circuit is shown in Figure 9.

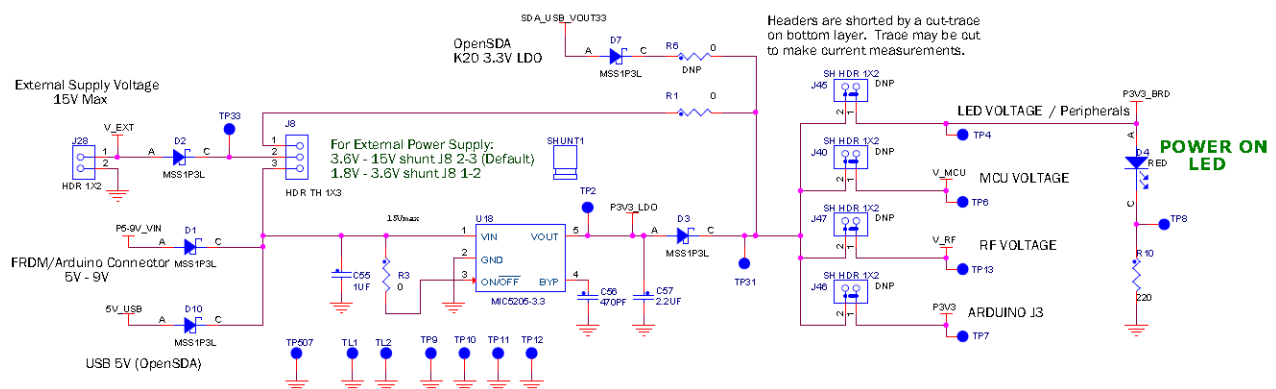


Figure 9. FRDM-KW019032 board's power management circuit

The FRDM-KW019032 board has the flexibility to be powered in several configurations:

- The board can be supplied through the mini USB type B connector (J15) which provides 5V\_USB to LDO 3V3.
- The board can be supplied through the development board’s headers which provides either P3.3V or P5-9V\_VIN on header J3 pin 16 to LDO 3V3.
- The board can be supplied from an external DC supply in the following ways:
  - Connect an adaptor capable of supplying 3.3 VDC to J28 pins, J8 selector 1-2.
  - Connect an adaptor capable of supplying more than 3.3 VDC (15 V maximum) to J28 pins, J8 selector 2-3.

Additionally, J40 and J47, a 2-pin cut-trace headers, provides current to MCU and transceiver. Red LED marked as LED D4 is available as a power indicator.

Power headers provide the means to supply either the MCU, transceiver, external J3 connector, or LED/peripheral circuits. Current measurements can be made by inserting a current meter in place of a designated jumper.

Traces may be cut to make current measurements.

Connections configurations are described in [Table 2](#).

**Table 2. Power distribution headers**

Supply Designation	Header Pins	Description
V_MCU J40	1 - 2	Supply voltage to MCU, Reset, JTAG/SWD interface, XTAL 32KHz <ul style="list-style-type: none"> <li>• Jumper is shorted by a cut-trace on bottom layer.</li> <li>• Usage: Measure MCU current.</li> </ul>
P3V3 J46	1 - 2	Supply voltage to header <ul style="list-style-type: none"> <li>• Jumper is shorted by a cut-trace on bottom layer.</li> </ul>
P3V3_BRD J45	1 - 2	Supply voltage to LEDs, switches and other modules <ul style="list-style-type: none"> <li>• Normally traced.</li> </ul>
V_RF J47	1 - 2	Supply voltage to transceiver <ul style="list-style-type: none"> <li>• Jumper is shorted by a cut-trace on bottom layer.</li> <li>• Usage: Measure radio current.</li> </ul>

## 4.2.4 FRDM-KW019032 peripheral functions

The FRDM-KW019032 development board includes the Freescale Freedom board headers to interface with the general purpose functions and to assist in implementing targeted applications. The FRDM-KW019032 board also has alternate port functions routed to those interface headers where off-board FRDM development board peripherals can be used.

### 4.2.4.1 Interface Connectors J1, J2, J3 and J4

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

- P3V3, 5V\_USB, and P5-9V\_VIN provide the headers connector its supply voltage
  - Peripheral IO to the FRDM-KW019032 and the Freedom development platform supply should use this same voltage avoiding potential damage.

The pin definitions for the headers are shown in [Table 3](#) and [Table 4](#).

**Table 3. J2 and J1 connector**

Header Pin No	J2	Description	Header Pin No	J1	Description
	MKW01Z128 Pin Name			MKW01Z128 Pin Name	
1	NC	NC	1	NC	NC
2	PTA0/SWD_CLK	D8/Int	2	PTA2/UART0_TX	D0/RX/INT
3	NC	NC	3	DIO0/PTE2	DIO0
4	PTA3/SWD_DIO	D9/Int	4	PTA1/UART0_RX	D1/TX/INT
5	NC	NC	5	DIO1/PTE3	DIO1
6	PTD4/SPI1_PCS0	D10/SPI_SS	6	PTB17/UART0_CTS	D2/INT
7	NC	NC	7	DIO2	DIO2
8	PTE1/SPI1_MOSI	D11/MOSI	8	PTB2/UART0_RTS	D3/PWM/INT
9	NC	NC	9	DIO3	DIO3
10	PTE0/SPI1_MISO	D12/MISO	10	PTB1	D4/INT
11	NC	NC	11	DIO4	DIO4
12	PTD5/SPI1_SCK	D13/SCK	12	PTC1	D5/PWM/INT
13	NC	NC	13	NC	NC
14	GND	GND	14	PTC2	D6/PWM/INT
15	NC	NC	15	NC	NC
16	P3V3	P3V3	16	PTD7	D7/CMP/INT
17	NC	NC	—	—	—
18	PTE18/I2C0_SDA	PTE18/I2C0_SDA	—	—	—
19	NC	NC	—	—	—
20	PTE19/I2C0_SCL	PTE19/I2C0_SCL	—	—	—

**Table 4. J3 and J4 connector**

Header Pin No	J3	Description	Header Pin No	J4	Description
	MKW01Z128 Pin Name			MKW01Z128 Pin Name	
1	NC	NC	1	NC	NC
2	NC	NC	2	PTA19	A0/INT
3	NC	NC	3	NC	NC
4	IO_REF	IO_REF	4	PTE16	A1/INT
5	NC	NC	5	NC	NC
6	RST_B	RST_TGTMCU_B	6	PTE17	A2/INT
7	NC	NC	7	NC	NC
8	P3V3	P3V3	8	PTD6/LLWU_P15	A3/INT
9	NC	NC	9	NC	NC
10	P5V	P5V	10	PTA4/NMI	A4/SDA/INT
11	NC	NC	11	NC	NC
12	GND	GND	12	PTB0	A5/SCL/INT
13	NC	NC	—	—	—
14	GND	GND	—	—	—
15	NC	NC	—	—	—
16	P5-9V_VIN	Unregulated voltage	—	—	—



### 4.3 Schematic, board layout, and bill of material

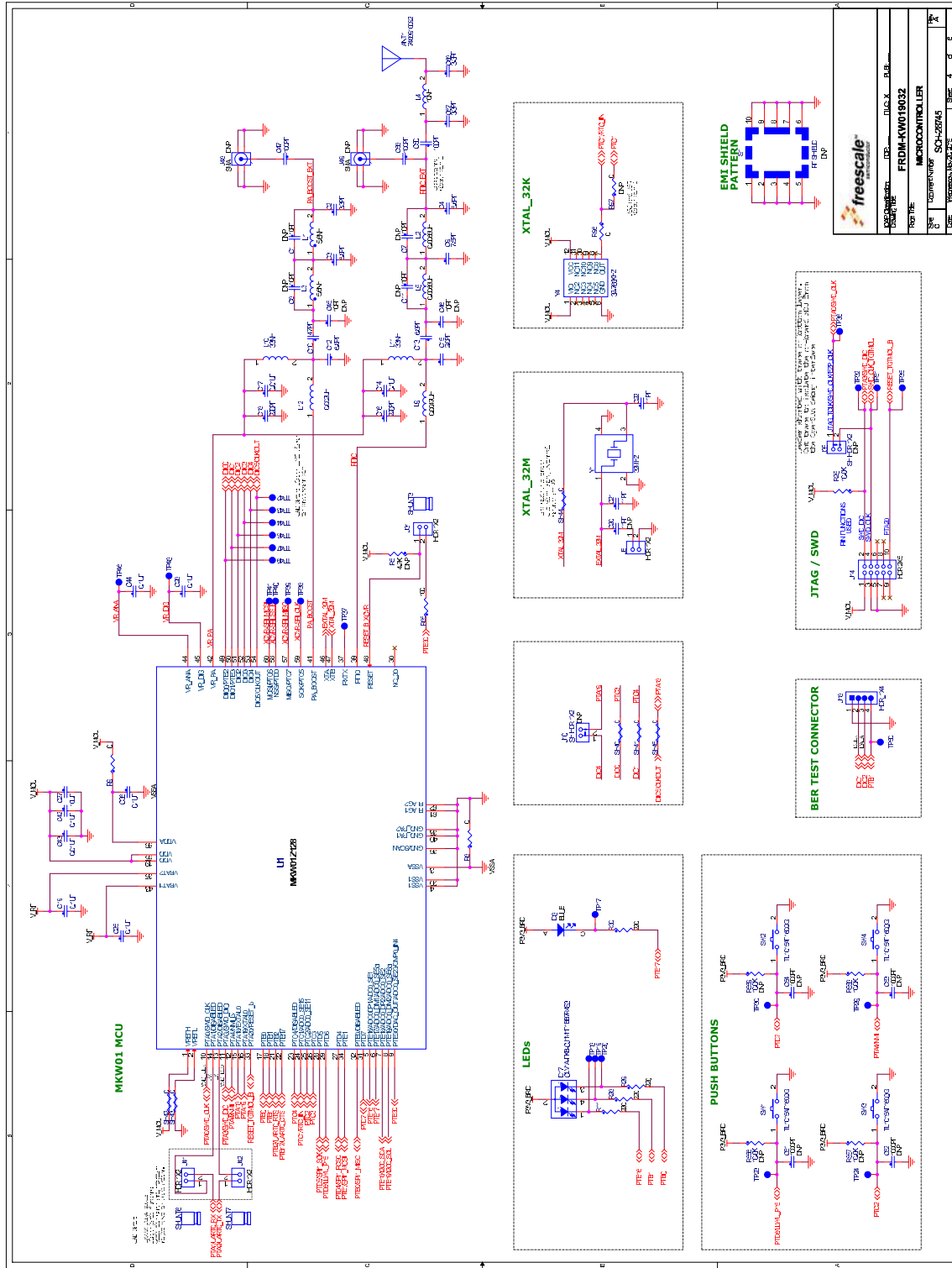
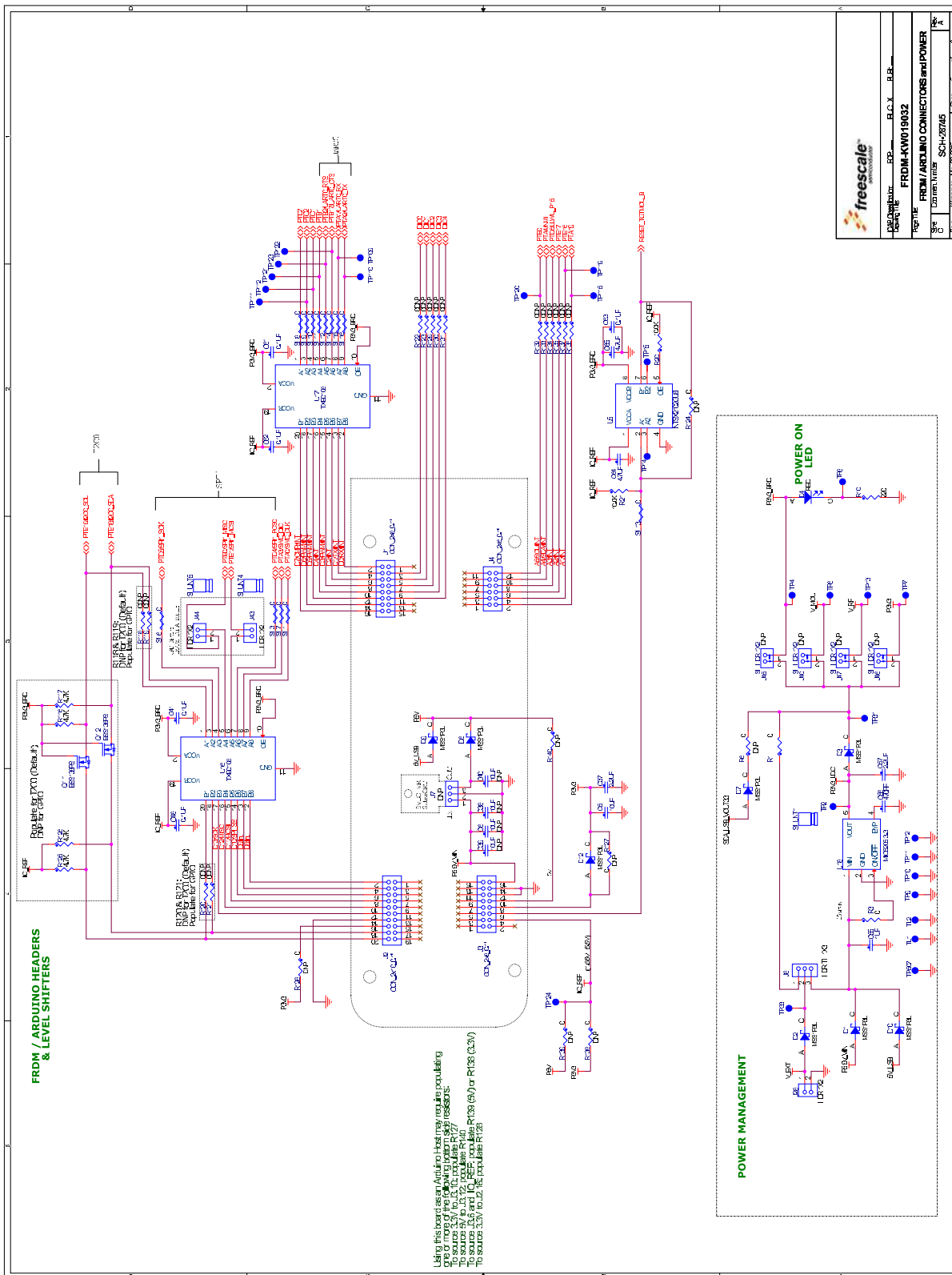
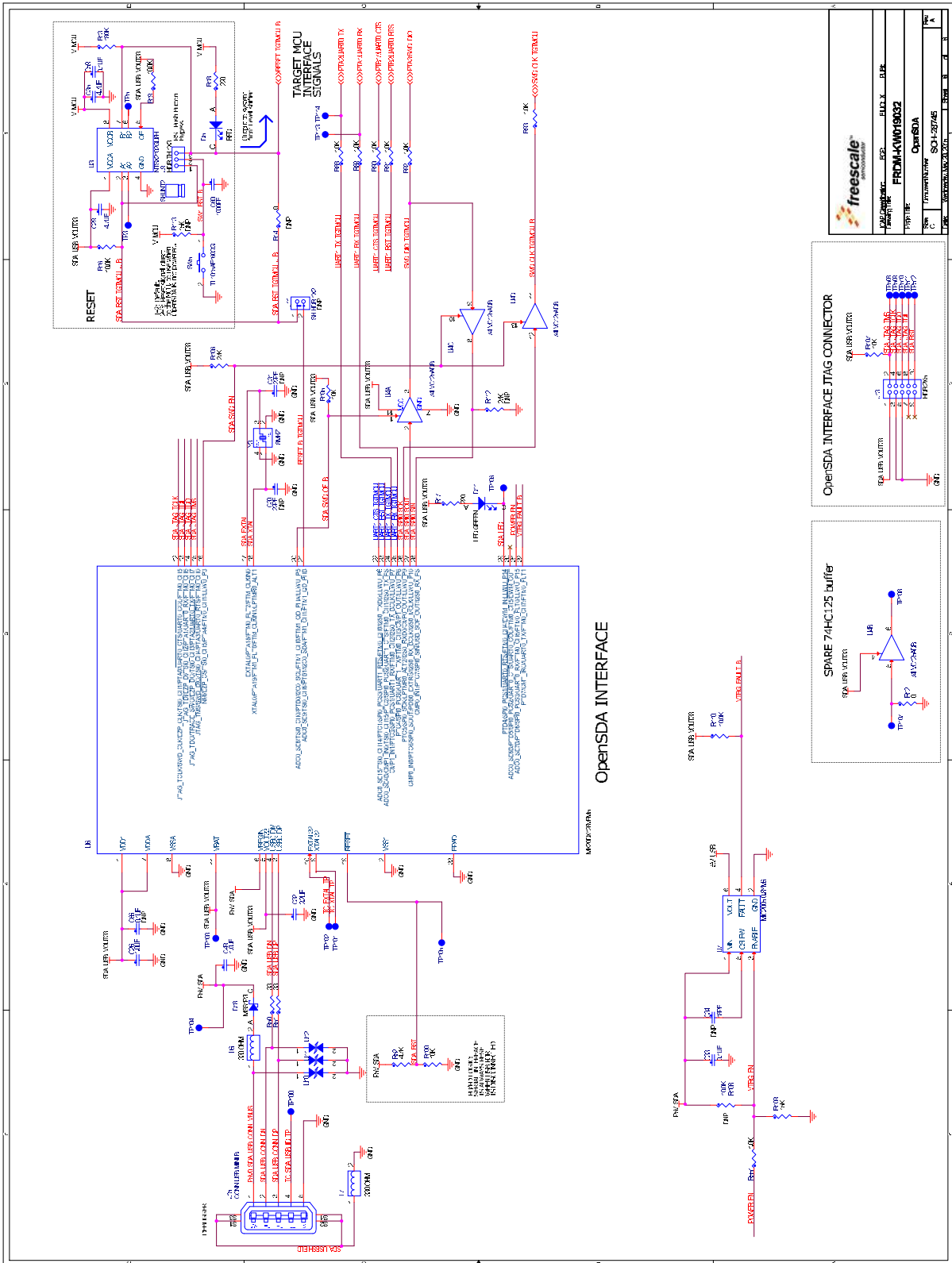
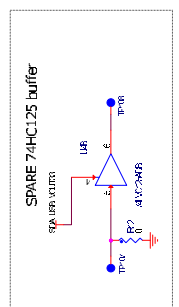
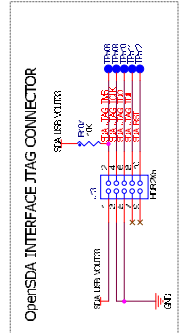


Figure 10. FRDM-KW019032 schematic rev. A





Part Number	FRDM-KW019032
Product Name	OpenSDA
Doc ID	SC1-23745
Rev	1.0



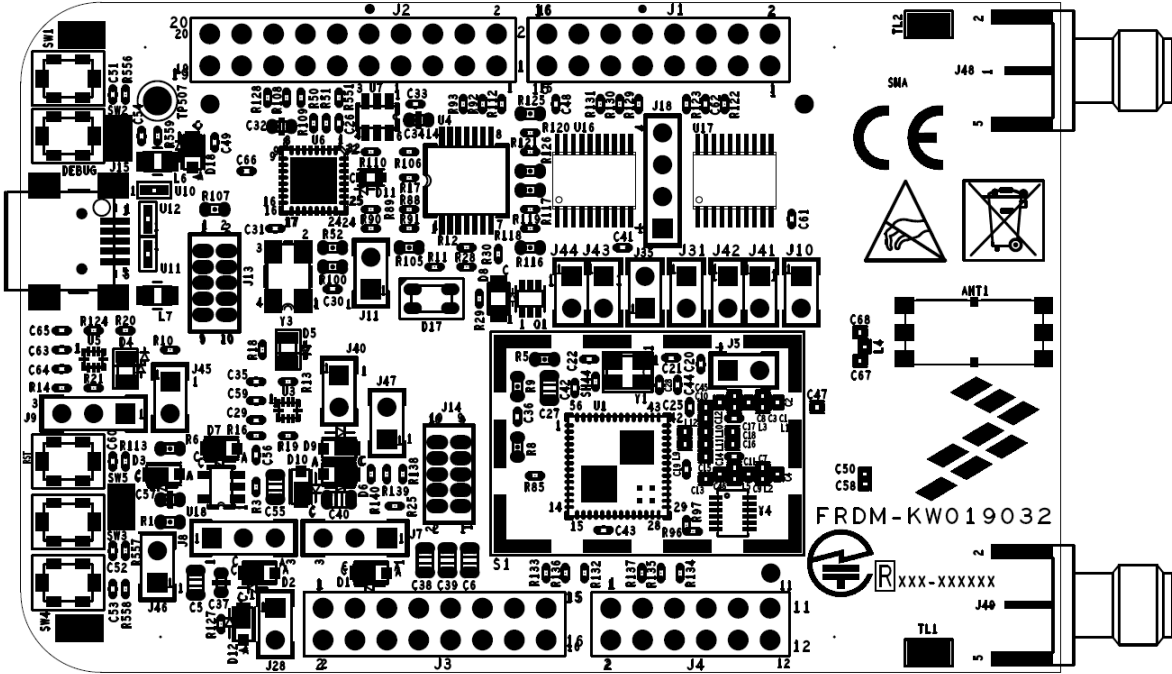


Figure 11. FRDM-KW019032 PCB component location (top view)

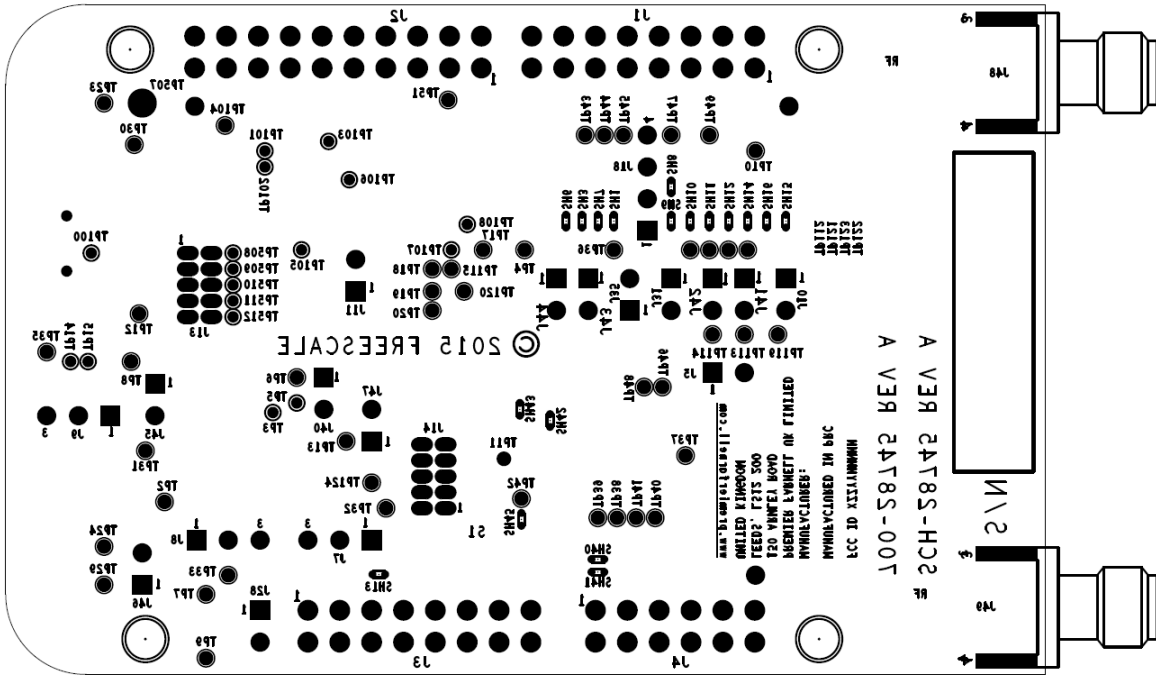


Figure 12. FRDM-KW019032 PCB test points

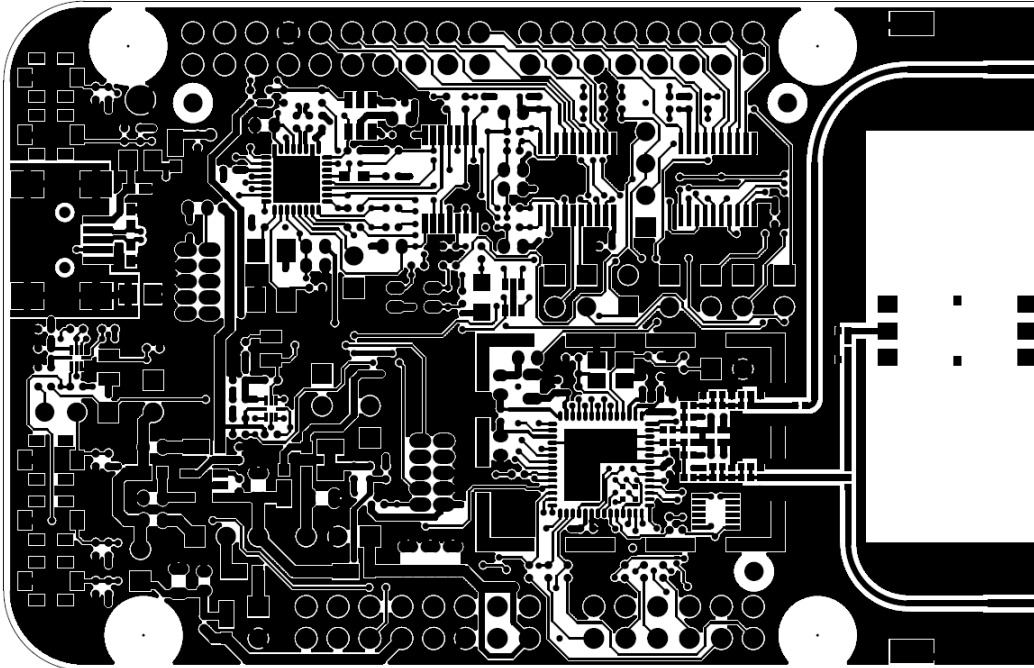


Figure 13. FRDM-KW019032 PCB layout (top view)

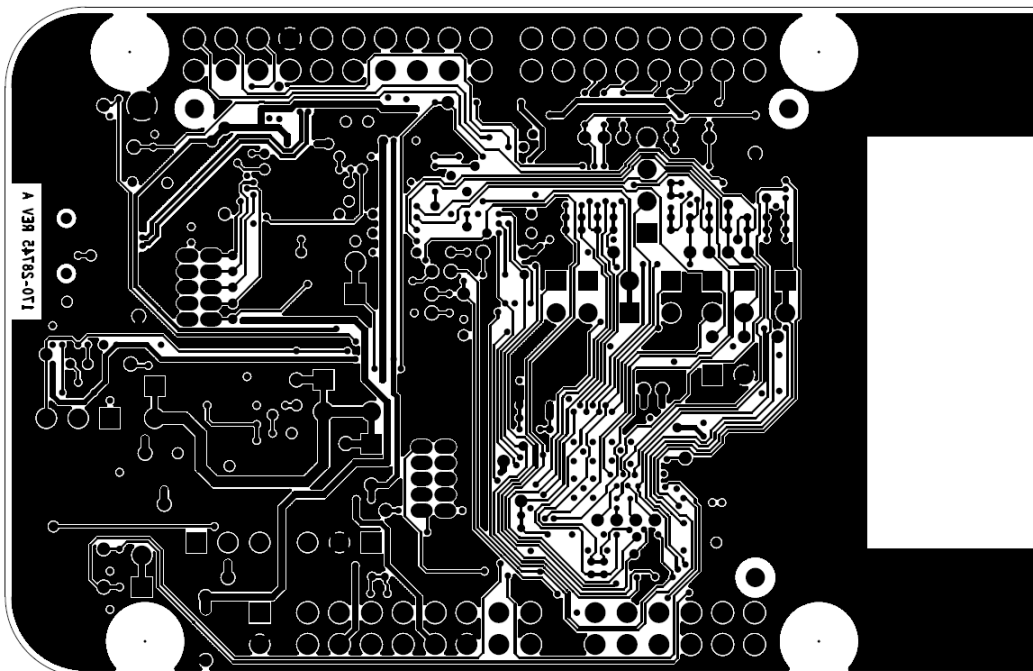


Figure 14. FRDM-KW019032 PCB layout (bottom view)

### 4.3.1 Bill of materials

The following three tables detail the bill of materials. [Table 5](#) details the common parts for all frequency bands, [Table 6](#) details the parts for the 915 MHz and 868 MHz frequency bands (default), [Table 7](#) details the parts for the 433 MHz frequency band, and [Table 8](#) details the parts for the 315 MHz frequency band.

#### CAUTION:

The ANT1 component is designed to be used in the 900 MHz and 800 MHz frequencies. The values for the components L4, C67, and C68 are calculated for those frequencies and this particular chip antenna. In case another antenna is required, those values need to be re-adjusted according to new antenna and manufacturer recommendations.

**Table 5. Bill of materials (common parts for all frequency bands) (Sheet 1 of 4)**

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
1	2	C1,C7 <b>DNP</b>	10PF	CAP CER 10PF 50V 5% C0G 0402	AVX	04025A100JAT2A
2	2	C21,C22	11PF	CAP CER 11PF 50V 1% C0G 0402	KEMET	CBR04C110F5GAC
3	1	C20 <b>DNP</b>	11PF	CAP CER 11PF 50V 1% C0G 0402	KEMET	CBR04C110F5GAC
4	1	C34 <b>DNP</b>	18PF	CAP CER 18PF 50V 5% C0G 0603	YAGEO AMERICA	CC0603JRNPO9BN180
5	2	C30,C31 <b>DNP</b>	22PF	CAP CER 22PF 50V 5% C0G 0402	AVX	04025A220JAT2A
6	2	C47, C58	100PF	CAP CER 100PF 50V 5% C0G 0402	KEMET	C0402C101J5GAC
7	2	C16,C18	220PF	CAP CER 220PF 50V 5% C0G 0402	KEMET	C0402C221J5GAC
8	1	C56	470PF	CAP CER 470PF 16V 10% X7R 0402	KEMET	C0402C471K4RACTU
9	1	C60	1000PF	CAP CER 1000PF 50V 5% C0G 0402	MURATA	GRM1555C1H102JA01D
10	4	C51,C52,C53,C54 <b>DNP</b>	1000PF	CAP CER 1000PF 50V 5% C0G 0402	MURATA	GRM1555C1H102JA01D
11	2	C17,C43	0.01UF	CAP CER 0.01UF 50V 10% X7R 0402	KEMET	C0402C103K5RAC
12	14	C14,C19,C25,C28,C33,C36,C41,C42,C44,C48,C59,C61,C62,C63	0.1UF	CAP CER 0.1UF 16V 10% X7R 0402	KEMET	C0402C104K4RAC
13	1	C66 <b>DNP</b>	0.1UF	CAP CER 0.1UF 16V 10% X7R 0402	KEMET	C0402C104K4RAC
14	2	C26,C49	1.0UF	CAP CER 1.0UF 10V 10% X5R 0402	YAGEO AMERICA	CC0402KRX5R6BB105
15	1	C55	1UF	CAP CER 1UF 10V 10% X7R 0805	MURATA	GRM21BR71A105KA01L
16	3	C32,C37,C57	2.2UF	CAP CER 2.2UF 10V 10% X7R 0603	TAIYO YUDEN	LMK107B7225KA-T
17	4	C29,C35,C64,C65	4.7UF	CAP CER 4.7UF 6.3V 20% X5R 0402	MURATA	GRM155R60J475ME47D
18	2	C5,C27	10UF	CAP CER 10UF 10V 10% X7R 0805	MURATA	GRM21BR71A106KE51L
19	4	C6,C38,C39,C40 <b>DNP</b>	10UF	CAP CER 10UF 10V 10% X7R 0805	MURATA	GRM21BR71A106KE51L
20	9	D1,D2,D3,D6,D7,D9,D10,D12,D18	MSS1P3L	DIODE SCH 1A 20V MICROSMP SMT	VISHAY INTERTECHNOLOGY	MSS1P3L-M3/89A
21	2	D4,D5	RED	LED RED SGL 20MA SMT 0805	LITE ON	LTST-C171KRKT
22	1	D8	BLUE	LED BLUE SGL 20MA SMT 0805	LITE ON	LTST-C171TBKT
23	1	D11	LED GREEN	LED GRN SGL 20MA 0603	OSRAM	LG L29K-G2J1-24-Z
24	1	D17	CLV1A-FKB-CJ1M1F1BB7R4S3	LED - RGB, CLV1A-FKB-CJ1M1F1BB7R4S3, 675/527/470MCD(TYP.), SMD	CREE	CLV1A-FKB-CJ1M1F1BB7R4S3

**Table 5. Bill of materials (common parts for all frequency bands) (Sheet 2 of 4)**

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
25	2	J1,J3	CON_2X8_0.1"	CON 2X8 FEMALE 100MIL SP 335H 394LL AU	SAMTEC	SSQ-108-03-G-D
26	1	J2	CON_2X10_0.1"	CON 2X10 FEMALE 100MIL SP 335H 394LL AU	SAMTEC	SSQ-110-03-G-D
27	1	J4	CON_2X6_0.1"	CON 2X6 FEMALE 100MIL SP 335H 394LL AU	SAMTEC	SSQ-106-03-G-D
28	3	J5,J28,J31	HDR 1X2	HDR 1X2 TH 100MIL SP 330H SN 115L	SAMTEC	TSW-102-23-T-S
29	1	J7 <b>DNP</b>	HDR TH 1X3	HDR 1X3 TH 100MIL SP 339H AU 100L	SAMTEC	TSW-103-07-G-S
30	2	J8,J9	HDR TH 1X3	HDR 1X3 TH 100MIL SP 339H AU 100L	SAMTEC	TSW-103-07-G-S
31	11	J10,J11,J35,J40,J41, J42,J43,J44,J45,J46, J47 <b>DNP</b>	SH HDR 1X2	HDR 1X2 TH 100MIL SP 330H SN 115L (BOTTOM SIDE SHORT)	SAMTEC	TSW-102-23-T-S
32	2	J13,J14	HDR 2X5	CONN,HEAD,2X5,STR,50/50 CON-2RH-10-50	SAMTEC	FTS-105-01-F-D
33	1	J15	CONN USB MINI-B	CON 5 USB_MINI_B_RECEPTACLE RA SMT 0.8MM 168H AU	TE CONNECTIVITY	1734035-2
34	1	J18	HDR_1X4	HDR 1X4 TH 100MIL SP 205H AU 130L	SAMTEC	TSW-104-05-G-S
35	2	J48,J49 <b>DNP</b>	SMA	CON, SMA, EDGE 0.062IN, 50 OHM FEMALE 18GHZ	JOHNSON COMPONENTS INC	142-0701-851
36	2	L6,L7	330 OHM	IND FER BEAD 330OHM@100MHZ 2.5A -- SMT	TDK	MPZ2012S331A
37	1	L11	33NH	IND -- 0.033UH@100MHZ 200MA 5% 0402	MURATA	LQG15HS33NJ02D
38	1	Q1	BSS138PS	MOSFET - BSS138PS, N-CH, 60V, 0.32A, 1.6 OHM, SC-88	NXP	BSS138PS,115
39	3	R3,R12,R96	0	RES MF ZERO OHM 1/16W 5% 0402	VISHAY	CRCW04020000Z0ED
40	23	R14,R97,R118,R119, R120,R121,R122,R123, R124,R127,R128,R129, R130,R131,R132,R133, R134,R135,R136,R137, R138,R139,R140 <b>DNP</b>	0	RES MF ZERO OHM 1/16W 5% 0402	VISHAY	CRCW04020000Z0ED
41	3	R1,R8,R9	0	RES MF ZERO OHM 1/10W -- 0603	VISHAY INTERTECHNOLOGY	CRCW06030000Z0EA
42	1	R6 <b>DNP</b>	0	RES MF ZERO OHM 1/10W -- 0603	VISHAY INTERTECHNOLOGY	CRCW06030000Z0EA
43	2	R50,R51	33	RES MF 33.0 OHM 1/16W 1% 0402	VISHAY	CRCW040233R0FKED
44	1	R85	100	RES MF 100 OHM 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW0402100RJNED
45	7	R10,R11,R17,R18,R28, R29,R30	220	RES MF 220 OHM 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW0402220RJNED
46	7	R88,R89,R90,R91,R92, R93,R551	1.0K	RES MF 1.0K 1/16W 1% 0402	YAGEO AMERICA	RC0402FR-071KL
47	5	R52,R116,R117,R125, R126	4.7K	RES MF 4.7K 1/10W 5% 0603	VISHAY INTERTECHNOLOGY	CRCW06034K70JNEA

**Table 5. Bill of materials (common parts for all frequency bands) (Sheet 3 of 4)**

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
48	1	R5 DNP	4.7K	RES MF 4.7K 1/10W 5% 0603	VISHAY INTERTECHNOLOGY	CRCW06034K70JNEA
49	6	R16,R19,R20,R21,R25,R110	10.0K	RES MF 10.0K 1/16W 1% AEC-Q200 0402	VISHAY INTERTECHNOLOGY	CRCW040210K0FKED
50	5	R108,R556,R557,R558,R559 DNP	10.0K	RES MF 10.0K 1/16W 1% AEC-Q200 0402	VISHAY INTERTECHNOLOGY	CRCW040210K0FKED
51	3	R100,R105,R107	10K	RES MF 10K 1/10W 5% 0603	KOA SPEER	RK73B1JTDD103J
52	1	R109	15K	RES MF 15.0K 1/16W 1% 0402	BOURNS	CR0402-FX-1502GLF
53	1	R113 DNP	15K	RES MF 15.0K 1/16W 1% 0402	BOURNS	CR0402-FX-1502GLF
54	1	R106	27K	RES MF 27K 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW040227K0JNED
55	1	R112 DNP	27K	RES MF 27K 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW040227K0JNED
56	1	R13	180K	RES MF 180K 1/16W 1% 0402	VISHAY	CRCW0402180KFKED
57	2	SHUNT1,SHUNT2	SHUNT	SHUNT 2.54MM 2POS	3M	969102-0000-DA
58	19	SH1,SH3,SH6,SH7,SH8,SH9,SH10,SH11,SH12,SH13,SH14,SH15,SH16,SH40,SH41,SH42,SH43,SH44,SH45 DNP	0	CUT TRACE RESISTOR	NOT A COMPONENT	NOT A COMPONENT
59	5	SW1,SW2,SW3,SW4,SW5	TL1015AF160QG	SW SPST-NO 0.05A, 12V, SMT	E-SWITCH	TL1015AF160QG
60	1	S1 DNP	BMIS-S-102	SHEILD 0.65"X0.65" 1 PIECE SMD	LAIRD TECHNOLOGIES EMI	BMI-S-102
61	2	TL1,TL2	TESTLOOP	TEST POINT PAD SIZE 3.4MM X 1.8MM SMT	KEYSTONE ELECTRONICS	5015
62	52	TP2,TP4,TP6,TP7,TP8,TP9,TP10,TP11,TP12,TP13,TP17,TP18,TP19,TP20,TP23,TP24,TP29,TP30,TP31,TP32,TP33,TP35,TP36,TP37,TP38,TP39,TP40,TP41,TP42,TP43,TP44,TP45,TP46,TP47,TP48,TP49,TP50,TP51,TP104,TP109,TP110,TP111,TP112,TP113,TP114,TP115,TP119,TP120,TP121,TP122,TP123,TP124	TPAD_040	TEST POINT PAD 40MIL DIA SMT, NO PART TO ORDER	NOT A COMPONENT	NOT A COMPONENT
63	17	TP3,TP5,TP14,TP15,TP100,TP101,TP102,TP103,TP105,TP106,TP107,TP108,TP508,TP509,TP510,TP511,TP512	TPAD_030	TEST POINT PAD 30MIL DIA SMT, NO PART TO ORDER	NOT A COMPONENT	NOT A COMPONENT
64	1	TP507	TESTLOOP_BLACK	TEST POINT PC MULTI PURPOSE BLK TH	KEYSTONE ELECTRONICS	5011
65	1	U1	MKW01Z128	IC MCU ARM 48MHZ 128KB FLASH 16KB RAM 1.8-3.6V LGA60	FREESCALE SEMICONDUCTOR	MKW01Z128CHN
66	2	U3,U5	NTSX2102GU8H	IC DUAL SUPPLY XCVR 50 MBPS 5.5V XQFN8	NXP SEMICONDUCTORS	NTSX2102GU8H



**Table 5. Bill of materials (common parts for all frequency bands) (Sheet 4 of 4)**

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
67	1	U4	74LVC125ADB	IC BUF QUAD TS 1.2-3.6V SSOP14	NXP SEMICONDUCTORS	74LVC125ADB
68	1	U6	MK20DX128VFM5	IC MCU FLASH 128KB 50MHZ 1.71-3.6V QFN32	FREESCALE SEMICONDUCTOR	MK20DX128VFM5
69	1	U7	MIC2005-0.8YM6	IC LIN SW PWR 0.8A 2.5-5.5V SOT23-6	MICREL	MIC2005-0.8YM6
70	3	U10,U11,U12	0402ESDA-MLP	DIODE TVS BIDIR -- 30V 0402	COOPER BUSSMANN	0402ESDA-MLP1
71	2	U16,U17	TXB0108	IC - LEVEL TRANSLATOR, BIDIRECTIONAL, 1.65V-5.5V, TSSOP-20	TEXAS INSTRUMENTS	TXB0108PWR
72	1	U18	MIC5205-3.3	LDO 3.3V FIXED 150MA 16V SOT23-5	MICREL	MIC5205-3.3YM5
73	1	Y1	32MHZ	XTAL 32MHZ 9PF -- SMT 3.2X2.5MM	NDK	EXS00A-CS02368
74	1	Y3	8MHZ	XTAL 8MHZ 20PPM PAR 18PF ESR 200OHM SMT	ABRACON CORP	ABM3B-8.000MHZ-B2-T
75	1	Y4	32.768KHZ	XTAL - 32.768KHZ, CMOS, 0.9V-3.6V, +10/-120PPM	EPSON	SG-3040LC

**Table 6. Bill of materials (FRDM-KW01 900/800 frequency bands)**

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
1	1	ANT1	0900AT43A0070	ANTENNA CER CHIP WIDE BAND 868-915MHZ	JOHANSON	0900AT43A0070
2	1	C50	100PF	CAP CER 100PF 50V 5% COG 0402	KEMET	C0402C101J5GAC
3	3	C2, C67, C68	3.3PF	CAP CER 3.3PF 25V 0.1PF -- 0402	AVX	04023J3R3BBSTR
4	1	C4	5.6PF	CAP CER 5.6PF 50V ±0.25PF C0G CC0402	MURATA	GJM1555C1H5R6CB01D
5	2	L2,L5	0.0068UH	IND -- 0.0068UH@100MHZ 300MA 5% 0402	MURATA	LQG15HS6N8J02D
6	1	C9	7.5PF	CAP CER 7.5PF 50V 0.5PF C0G 0402	MURATA	GRM1555C1H7R5DA01D
7	4	C8,C11,C45,C46 <b>DNP</b>	10PF	CAP CER 10PF 50V 5% C0G 0402	AVX	04025A100JAT2A
8	3	C3,C12,C13	6.8PF	CAP CER 6.8PF 50V 0.5PF C0G 0402	MURATA	GRM1555C1H6R8DZ01J
9	1	C15	2.0PF	CAP CER 2PF 50V 0.25PF C0G 0402	MURATA	GRM1555C1H2R0CA01B
10	2	L1,L3	5.6NH	IND AIR 5.6NH@100MHZ 300MA 0.3NH 0402	MURATA	LQG15HN5N6S02D
11	1	L9	0.0047UH	IND -- 0.0047UH@100MHZ 300MA ±0.3NF 0402	MURATA	LQG15HS4N7S02D
12	1	L12	0.002UH	IND -- 0.002UH@100MHZ 300MA 15% 0402	MURATA	LQG15HS2N0S02
13	1	L10	33NH	IND -- 0.033UH@100MHZ 200MA 5% 0402	MURATA	LQG15HS33NJ02D
14	1	C10	47PF	CAP CER 47PF 50V 5% C0G 0402	MURATA	GRM1555C1H470JA01D

**Table 7. Bill of materials (FRDM-KW01 400 MHz frequency bands)**

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
1	2	C2,C4	8.2PF	CAP CER 8.2PF 50V 0.5PF C0G 0402	AVX	04025A8R2CAT2A
2	4	C3,C9,C12,C15	15PF	CAP CER 15PF 50V 1% C0G 0402	VENKEL COMPANY	C0402C0G500-150FNE
3	2	C8,C11	2.4PF	CAP TF 2.4PF 50V 0.25PF -- 0402	MURATA	GJM1555C1H2R4BB01
4	2	C10,C13	10PF	CAP CER 10PF 50V 5% C0G 0402	AVX	04025A100JAT2A
5	3	L1,L3, L5	12 NH	IND -- 0.012UH@100MHZ 300MA 5% 0402	MURATA	LQW15AN12NJ00D
6	1	L10	22NH	IND -- 22NH@100MHZ 310MA 5% 0402	MURATA	LQW15AN22NG00D
7	1	L2	10 NH	IND -- 0.010UH@100MHZ 300MA 5% 0402	MURATA	LQW15AN10NJ00D
8	2	L9,L12	0 ohms	RES MF ZERO OHM 1/10W 0402	PANASONIC	ERJ-2GE0R00X
9	2	C45, C46 <b>DNP</b>	10PF	CAP CER 10PF 50V 5% C0G 0402	AVX	04025A100JAT2A

**Table 8. Bill of materials (FRDM-KW01 300 MHz frequency bands)**

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
1	2	C2,C4	12PF	CAP CER 12PF 50V 5% C0G 0402	MURATA	GRM1555C1H120JZ01D
2	1	C9	15PF	CAP CER 15PF 50V 5% C0G 0402	VENKEL COMPANY	C0402C0G250-150JNP
3	4	C8,C11,C45,C46 <b>DNP</b>	10PF	CAP CER 10PF 50V 5% C0G 0402	AVX	04025A100JAT2A
4	4	C15, C10,C3,C12	22pF	CAP CER 22pF 50V 5% C0G AEC-Q200 0402	MURATA	GCM1555C1H220JA16
5	1	C13	10PF	CAP CER 10PF 50V 5% C0G 0402	AVX	04025A100JAT2A
6	2	L1,L10	33NH	IND -- 0.033UH@100MHZ 200MA 5% 0402	MURATA	LQG15HS33NJ02D
7	2	L3, L5	22 NH	IND -- 22NH@100MHZ 310MA 2% 0402	MURATA	LQW15AN22NG00D
8	1	L2	18 NH	IND AIR 18NH@100MHZ 370MA 3% 0402	MURATA	LQW15AN18NH00D
9	1	L12	1.5NH	IND -- 1.5NH@500MHZ 280MA 7% 0402	MURATA	LQP15MN1N5B02D
10	1	L9	4.7NH	IND -- 4.7NH@100MHZ 300MA ±0.3nH 0402	MURATA	LQG15HN4N7S02D

**NOTES**

- The FRDM-KW019032 includes neither J48, J49 (the SMA connectors), nor the external antenna.
- For external measurements and/or external antenna usage, J48/J49 should be installed and soldered in place.
- A 50 Ohm SMA jack connector is required; recommended part number 142-0701-851 from Emmerson/Johanson.
- When selecting an external antenna to connect to the SMA connector, choose an antenna designed for the desired frequency band. Operation

with an external antenna may require a separate certification of your product.

## 5 PCB manufacturing specifications

This section provides the specifications used to manufacture the FRDM-KW019032 development printed circuit board (PCB) described in this guide.

The FRDM-KW019032 PCBs must comply with the following:

- The PCB must comply with Perfag1D/3C ([www.perfag.dk/en/](http://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 (<http://ulstandards.ul.com/standard/?id=94>).
  - 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 FRDM-KW019032 transceiver at the Freescale website ([freescale.com/KW01](http://freescale.com/KW01)) under "Software and Tools." These reference designs should 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.
- For more information, see *Hardware Design Considerations for MC12311 and MKW01x Sub-GHz Devices* ([AN4958](#)) to provide additional design guidance.

### 5.1 Single PCB construction

This section describes individual PCB construction details.

- The FRDM-KW019032 PCBs are four-layer, multi-layer designs.
- The PCBs contain no blind, buried, or micro vias.
- PCB data:
  - FRDM-KW019032 board's size: Approximately 82 x 53 mm (3.26 x 2.10 inches).
  - FRDM-KW019032 board's final thickness (Cu/Cu): 1.57 mm (0.62 inches)  $\pm 10\%$  (excluding solder mask).

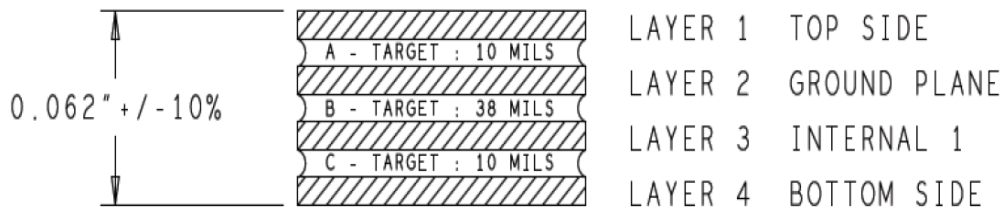
Table 9 defines some of the layers of the completed PCB. The artwork identification refers to the name of the layer in commonly used terms.

**Table 9. FRDM-KW019032 layer by layer overview**

Layer	Artwork Identification	File Name
1	Silkscreen Top	PSS.art
2	Top Layer Metal	L1_PS.art
3	Ground Layer	L2_GND.art
4	Signal Layer	L3_INT_1.art
5	Bottom Layer Metal	L4_SS.art
6	Silkscreen Bottom	SSS.art

**CAUTION:**

The FRDM-KW019032 development board contains high frequency sub-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 15) information provided with the reference design. The current board thickness is 64 mils. For a 1 dB improvement, change the thickness to 32 mils (change the intermediate dielectric on inner layer B-Target to 8 mils). The board may become fragile.



**Figure 15. FRDM-KW019032 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 the production volume.

## 5.3 Materials

The PCB composite materials must meet the following requirements:

- Laminate: the base material (laminate) 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.
  - Interior 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  $\mu\text{m}$ .

## 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-through-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-28745.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-28745.pdf*—FRDM-KW019032 board fabrication drawing.
- *GRB-28745.zip*—FRDM-KW019032 board metal layers, solder mask, solder paste, and silk screen.
- *SPF-28745.pdf*—FRDM-KW019032 board schematic diagram.

Design files are in Allegro format with OrCAD schematic capture.

## 6 Revision history

Revision number	Date	Substantive changes
0	11/2015	Initial release

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