**Freescale Semiconductor, Inc.**
User's Guide

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# FRDM-KW40Z Freescale Freedom Development Board
## User's Guide

## 1 About this guide

This manual describes the hardware for the Freescale Freedom development board, FRDM-KW40Z. The FRDM-KW40Z Freedom development board is a small, low-power, cost-effective evaluation and development board for application prototyping and demonstration of the MKW40Z SoC family of devices. These evaluation boards offer an easy-to-use mass-storage device mode flash programmer, a virtual serial port and classic programming and run-control capabilities.

The MKW40Z SoC is an ultra low-power, highly integrated single-chip device that enables Bluetooth Low Energy (BLE) or IEEE® Std. 802.15.4/ZigBee RF connectivity for portable, extremely low-power embedded systems. The MKW40Z SoC family integrates a radio transceiver operating in the 2.36 GHz to 2.48 GHz range supporting a range of FSK/GFSK and O-QPSK modulations, and ARM Cortex®- M0+ CPU, 160 KB flash memory and 20 KB SRAM, BLE Link Layer hardware, 802.15.4 packet processor hardware and peripherals optimized to meet the requirements of the target applications.

### 1.1 Audience

This manual is intended for system designers.

**Contents**

# 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.

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 license-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 FRDM-KW40Z overview and description

## 3.1 Introduction

The FRDM-KW40Z development board is an evaluation environment to support the Freescale MKW40Z SoC transceiver.

The MKW40Z SoC integrates a radio transceiver operating in the 2.36 GHz to 2.48 GHz range, supporting a range of FSK/GFSK and O-QPSK modulations, an ARM Cortex®- M0+ MCU into a single package.

Freescale supplements the MKW40Z SoC with tools and software that include hardware evaluation and development boards, software development IDE, and applications, drivers, custom PHY usable with IEEE Std. 802.15.4 compatible MAC, BLE Link Layer, and enables the Bluetooth Low Energy protocol to be used in the MBAN frequency range for proprietary applications.

The FRDM-KW40Z development platform contains the MKW40Z device with 32 MHz reference oscillator crystal, RF circuitry including antenna, 2-Mbit external serial flash, and supporting circuitry in the popular Freedom form factor. The board is a standalone PCB and supports application development with the Freescale IEEE Std. 802.15.4 protocol stacks.

## 3.2 Board features

### 3.2.1 FRDM-KW40Z board

The FRDM-KW40Z development board is part of the Freescale Freedom development platform. It is the most diverse reference design containing the MKW40Z 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 the Freedom development platform.

Figure 1 shows the FRDM-KW40Z development platform. A similar board not shown uses the MKW40Z device.

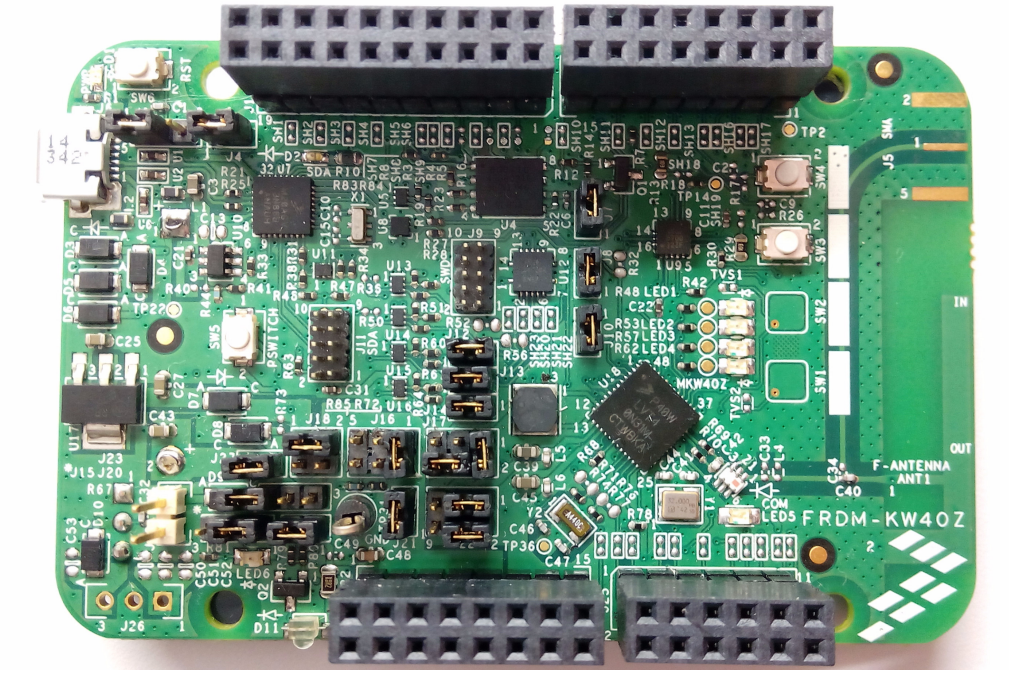


**Figure 1. FRDM-KW40Z Freedom development board**

The FRDM-KW40Z development board includes the following features:

- Freescale ultra low-power MKW40Z SoC BLE/ZigBee platform.
- Fully compliant IEEE Std. 802.15.4, 2006, transceiver supporting 250 kbps O-QPSK data in 5.0 MHz channels and full spread-spectrum encode and decode.
- Fully compliant Bluetooth v4.1 Low Energy (BLE).
- Full IEEE 802.15.4 compliant wireless node; ZigBee capable with BeeStack software stack.
- Reference design area with small footprint, low-cost RF node.
  - — Differential input/output port used with external balun for single port operation
  - — Low external component count
  - — Programmable output power from –20 dBm to +5 dBm at the SMA connector, no trap, with DC/DC bypass and buck modes of operation.
  - — Receiver sensitivity: –102 dBm, typical (@1% PER for 20 byte payload packet) at the SMA connector
  - — Receiver sensitivity: -94dBm, for BLE applications.
- Integrated PCB inverted F-type antenna and SMA RF port
- Selectable power sources
- DC-DC converter with Buck, Boost and Bypass operation modes
- 32 MHz reference oscillator
- 32 kHz reference oscillator
- 2.4 GHz frequency operation (ISM and MBAN)
- External serial flash memory for over-the-air programming (OTAP) support

- Integrated open-standard serial and debug interface (OpenSDA)
- Cortex 10-pin (0.05″) SWD debug port for target MCU
- Cortex 10-pin (0.05″) JTAG port for OpenSDA updates
- 4 red LED indicators
- 1 blue LED indicator
- 2 push button switches
- 2 TSI buttons

Figure 2 shows a simplified block diagram of the Freescale FRDM-KW40Z board.

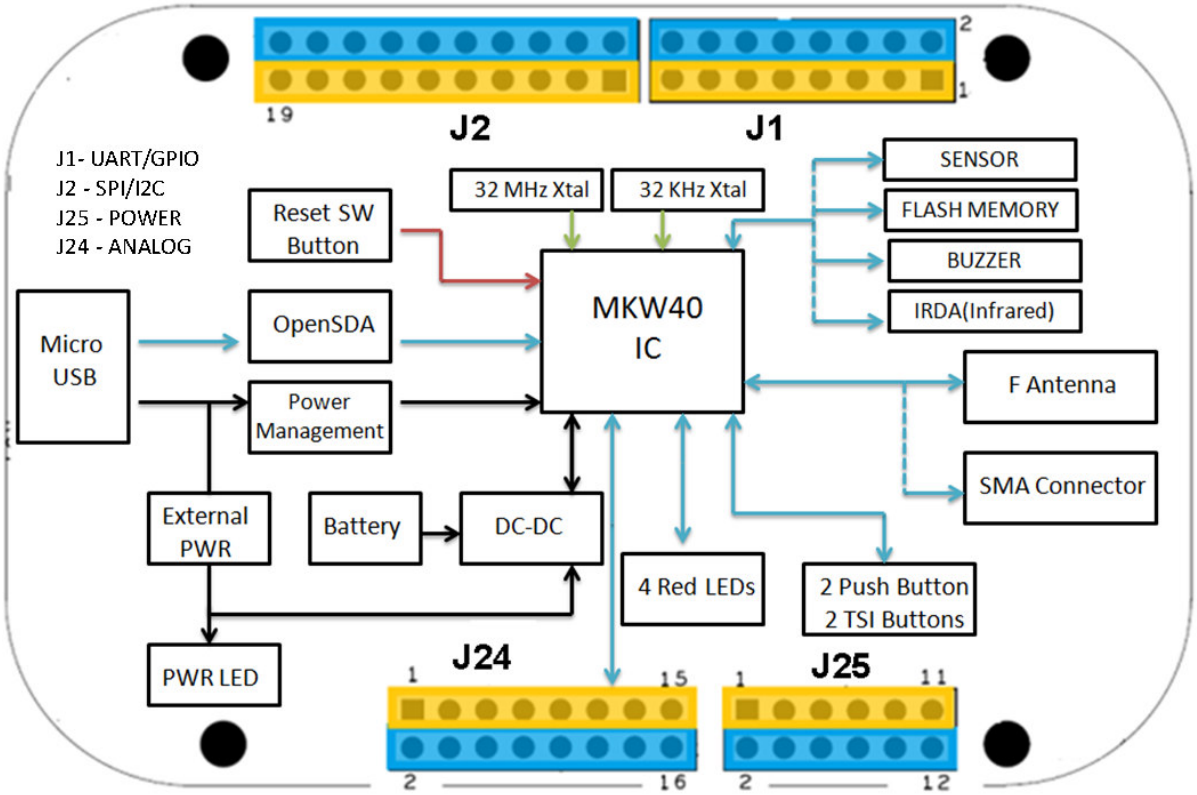


**Figure 2. FRDM-KW40Z simplified block diagram**

## 3.3 Software and driver considerations

The FRDM-KW40Z development board includes an OpenSDAv2.1, 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 bases on the Kinetis K20 family. More information is provided in the following documentation:

- MKW40Z Quick Start Guide

For additional information about our 2.4 GHz Kinetis family platforms, refer to the following:

- www.freescale.com\FRDM-KW40Z

# 4 FRDM-KW40Z development board

## 4.1 FRDM-KW40Z board overview

The FRDM-KW40Z board is an evaluation board based on the Freescale MKW40Z transceiver. The FRDM-KW40Z provides a platform to evaluate the MKW40Z SoC device, and to develop software and applications. The core device is accompanied by a the 32 MHz reference oscillator crystal, RF circuitry including antenna, and supporting circuitry.

The FRDM-KW40Z board is intended as the core PCB for MKW40Z 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-KW40Z board provides the following features:

- The Freescale Freedom development board form factor
- 4-Layer metal, 0.062 inch thick FR4 board
- LGA footprint and power supply (DC-DC converter)
- DC-DC converter with buck, boost, and bypass operation modes.
- Printed metal F-Antenna or SMA connector
- 32 MHz reference oscillator crystal
- 32.768 kHz crystal provided for optional timing oscillator
- Standard Freedom daughter card mounting interface (shield)
- External serial flash memory for OTAP support
- Combo sensor, 6-axis sensor with integrated linear accelerometer and magnetometer.

### 4.1.2 Form factor

Figure 3 shows the FRDM-KW40Z board with the location of the IO headers. The following list provides these details.

- J1, J2, J24, and J25:
  - Headers have standard 0.1 in/2.54 mm pin spacing
  - J1 is 20-pin
  - J2 and J4 are 16-pin
  - J25 is 12-pin
  - All pin headers mounted on the top side of the FRDM-KW40Z board are intended to plug into matching receptacles on the Freedom platform development board.

- J16, J17, J18, and J22:
  - Headers have standard 0.787 in/2.00 mm pin spacing
  - J18 is a 2 × 2 pin
  - J16, J17, and J22 are 2 × 3 pins
  - Pin headers mounted on the top side of the FRDM-KW40Z and are intended to select between power configurations, bypass, buck, and boost.

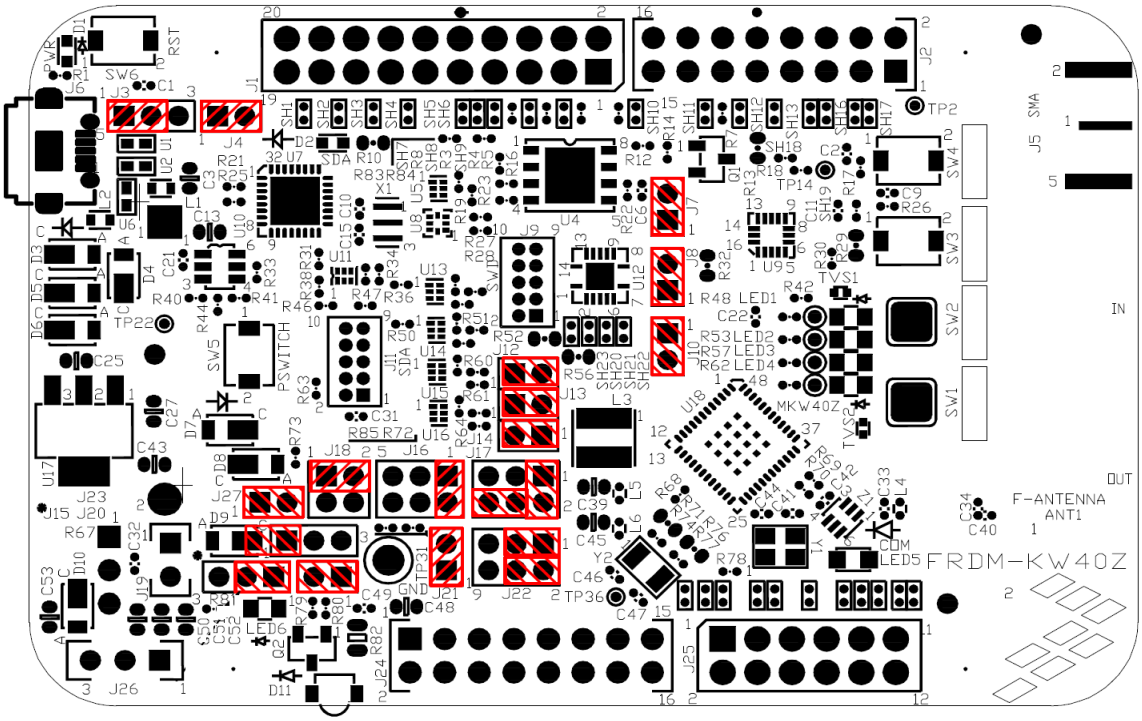


**Figure 3. FRDM-KW40Z board with IO headers locations**

Figure 4 shows the footprint of the FRDM-KW40Z board with the board dimensions.

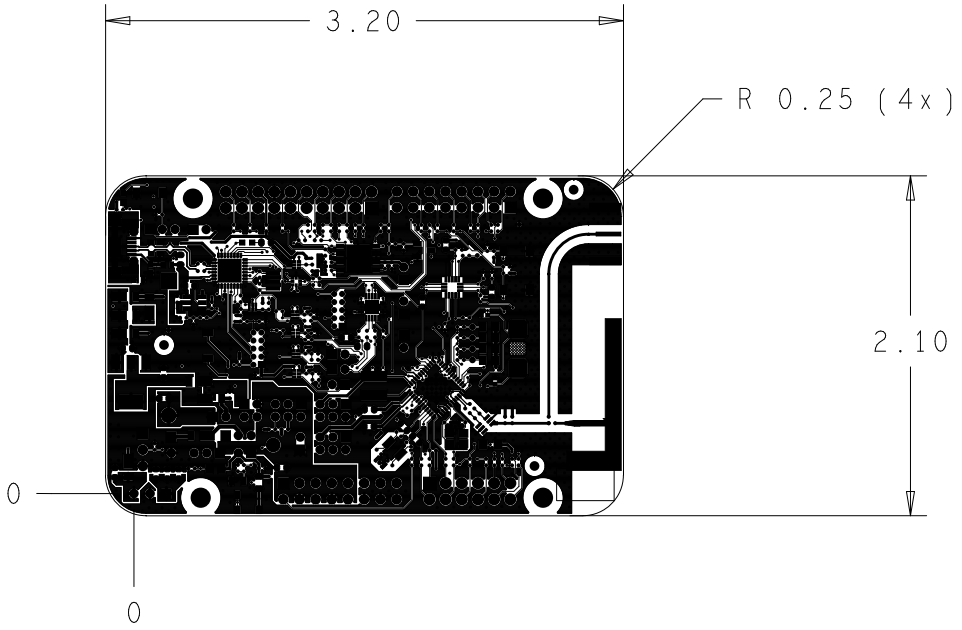


**Figure 4. FRDM-KW40Z board dimensions**

## 4.1.3 Board level specifications

**Table 1. FRDM-KW40Z board specifications**

| Parameter | Min | Typ | Max | Units | Notes/Conditions |
|---|---|---|---|---|---|
| **General** | | | | | |
| Size (PCB: X, Y) | — | — | 81.2 x 53.3<br>3.20 x 2.10 | mm<br>inches | — |
| Layer build (PCB) | — | 1.57<br>0.062 | — | mm<br>inches | 4-Layer |
| Dielectric material (PCB) | — | — | — | — | FR4 |
| **Power** | | | | | |
| Current consumption | — | — | — | mA | Refer to datasheet. |
| **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**<br>802.15.4 Frequency range | 2405 | — | 2480 | MHz | All 16 channels in the 2450 MHz band |

**Table 1. FRDM-KW40Z board specifications (continued)**

| Parameter | Min | Typ | Max | Units | Notes/Conditions |
|---|---|---|---|---|---|
| **RF**<br>BLE Frequency range | 2400 | — | 2480 | MHz | All 40 channels in the 2450 MHz band |
| **RF**<br>ISM and MBAN Frequency range | 2360 | — | 2483 | MHz | — |
| **RF Receiver** | | | | | |
| Saturation (maximum input level) | — | +0 | — | dBm | Data sheet |
| Sensitivity for 1% packet error rate (PER) (+25 ℃) 802.15.4 | — | -102 | — | dBm | Data sheet |
| Sensitivity for 1% packet error rate (PER) (+25 ℃) BLE | — | -94 | — | dBm | Data sheet |
| **RF Transmitter** | | | | | |
| RF Power Output | -20 | — | +5 | dBm | Programmable in steps.<br>At the antenna feed with no trap. [1] |
| 2nd harmonic | — | ≤50 | ≤40 | dBm | Data sheet |
| 3rd harmonic | — | ≤50 | ≤40 | dBm | Data sheet |
| **Regulatory Approval** | | | | | |
| FCC | — | — | TBD | — | Product is approved according to the FCC part 15 standard |
| CE (ETSI) | — | — | TBD | — | Product is approved according to the EN 300 328 V1.7.1 (2006-10) standard |
| CE (EMC) | — | — | TBD | — | 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 |
| **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* TBD.

## 4.2 Functional description

The FRDM-KW40Z board is built around the Freescale MKW40Z SoC in a 48-pin LGA package. It features a IEEE Std. 802.15.4 and BLE 2.4 GHz radio frequency transceiver and a Kinetis family ultra low-power, mixed-signal ARM Cortex-M0+ microcontroller in a single package. This board is intended

as a simple evaluation platform and as a building block for application development. The four-layer board provides the MKW40Z SoC with its required RF circuitry, 32 MHz reference oscillator crystal, and power supply with a DC-DC converter including bypass, buck, and boost modes. The layout for this base level functionality can be used as a reference layout for your target board. Figure 5 shows a simple functional block diagram.

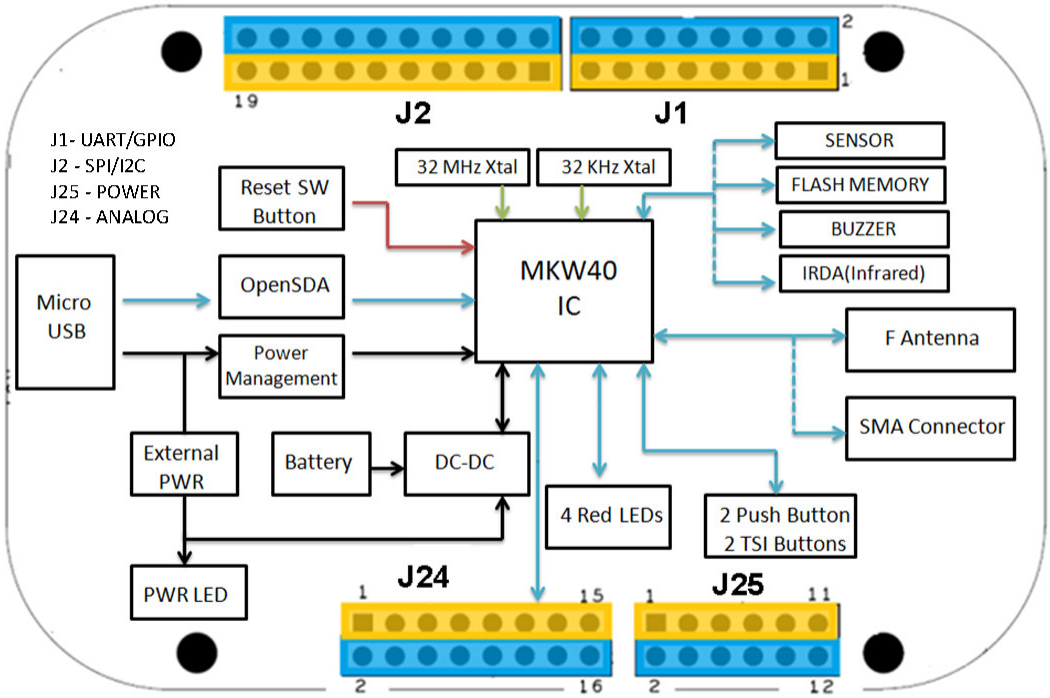


**Figure 5. FRDM-KW40Z board functional block diagram**

### 4.2.1 RF performance and considerations

The FRDM-KW40Z board's integrated transceiver includes a 1 mW nominal output power PA with internal voltage controlled oscillator (VCO), integrated transmit/receive switch, on-board power supply regulation, and full spread-spectrum encoding and decoding. Key specifications for the MKW40Z SoC are:

- Nominal output power is set to 0 dBm
- Programmable output power from -20 dBm to +5 dBm at the SMA, no trap
- Typical sensitivity is -102 dBm (@1% PER for 25 °C) at the SMA (802.15.4)
- Typical sensitivity is -94 dBm (@1% PER for 25 °C) at the SMA (BLE)
- Frequency range is 2360 to 2480 MHz
- Differential bidirectional RF input/output port with integrated transmit/receive switch
- "F" printed metal antenna for a small footprint, low cost design
- Uses a minimum number of RF marching components and external 50:100 balun

An external 50 (bal): 50 (unbal) balun connects a single-ended 50-ohm port to the differential RF port of the MKW40Z SoC's transceiver. The layout has provision for out-of-band signal suppression (components

L4 and C33) if required. Figure 6 shows the typical topology for the RF circuitry. The RF connector J5 has been designed in for measurement purposes and is used as DNP.

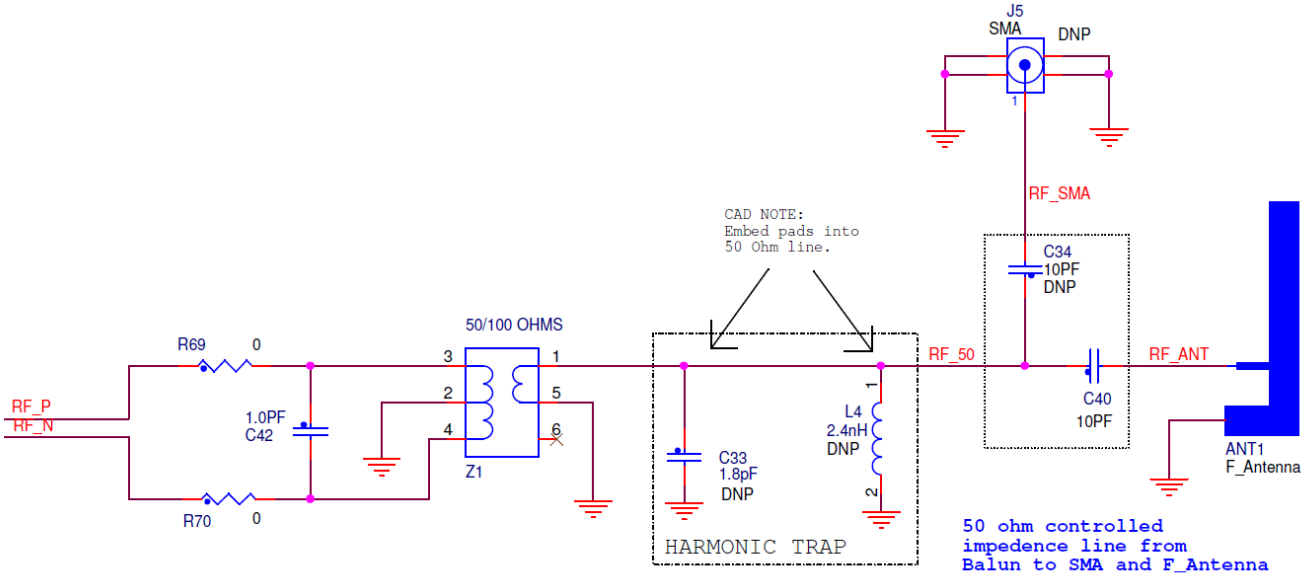


**Figure 6. FRDM-KW40Z board's RF circuitry**

## 4.2.2 Clocks

The FRDM-KW40Z board 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 Std. 802.15.4 requires that the frequency be accurate to less than ±40 ppm.
  - Capacitors C41 and C42 provide the bulk of the crystal load capacitance. At 25°C, it is desired to have the frequency accurate to ±10 ppm or less to enable temperature variation.
  - To measure the 32 MHz oscillator frequency, signal CLKOUT (PTB0) can optionally be programmed to provide a buffered output clock signal.
- Optional 32.768 kHz Crystal Oscillator: Provision is also made for a secondary 32.768 kHz crystal Y2 (see Figure 8). This oscillator can be used for a low power accurate time base.
  - The module comes provided with this Y2 crystal and its load capacitors C46 and C47.
  - Load capacitors C46 and C47 provide the entire crystal load capacitance; there is no onboard trim capacitance.
  - The 32 kHz oscillator components are supplied, but un-enabled. Zero-ohm resistors R71 and R76 to disable 32 kHz.

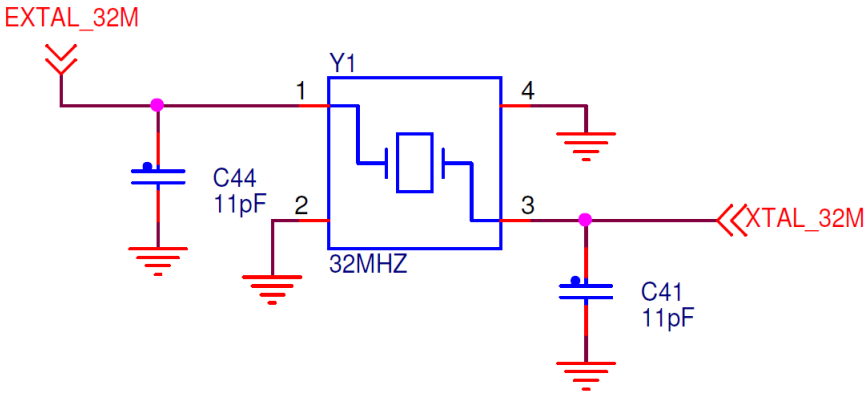


**Figure 7. FRDM-KW40Z board's 32 MHz reference oscillator circuit**

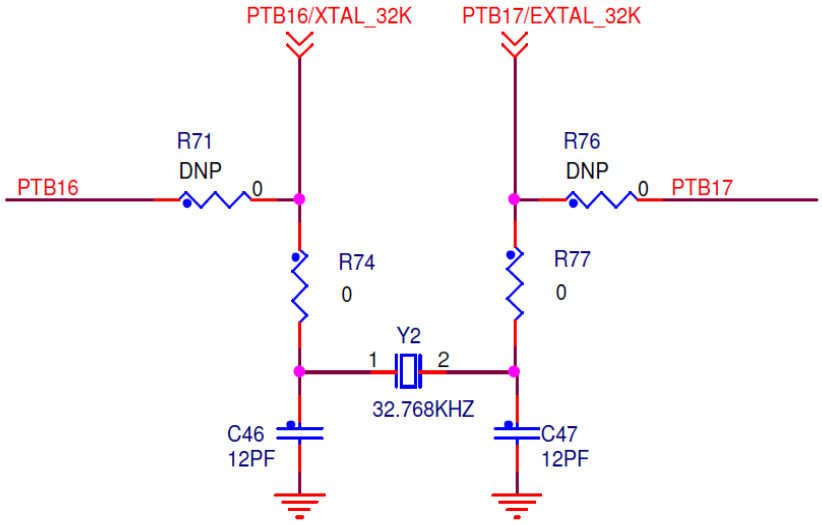


**Figure 8. FRDM-KW40Z board's optional 32.768 kHz oscillator circuit**

## 4.2.3 Power management

For your convenience, there are several different ways to power and measure current on the FRDM-KW40Z board. The FRDM-KW40Z power management circuit is shown in Figure 9.

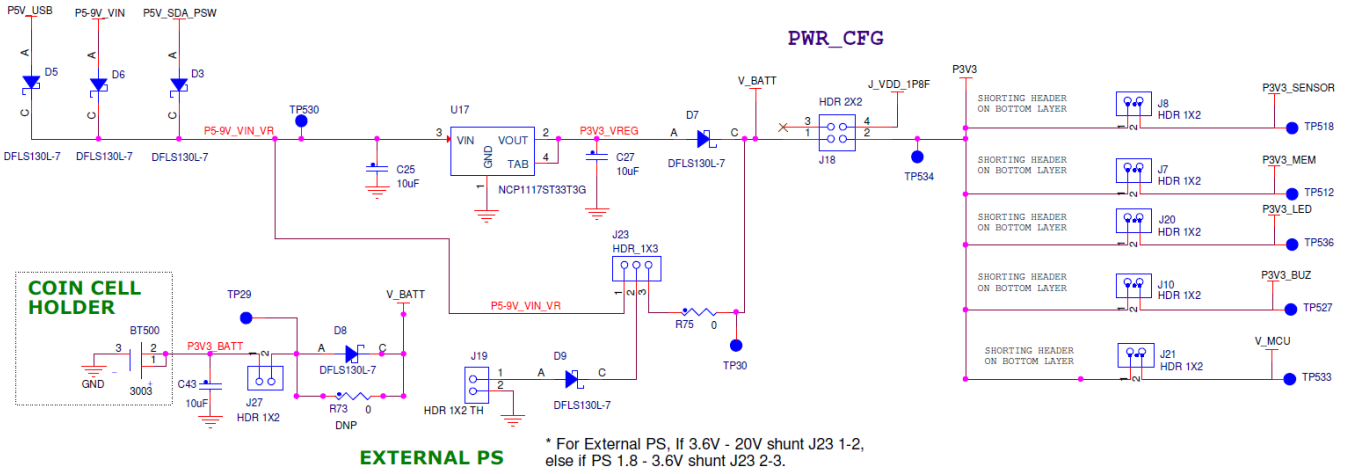


**Figure 9. FRDM-KW40Z board's power management circuit**

The FRDM-KW40Z has the flexibility to be powered in several configurations:

- Board can be supplied through the micro USB type B connector (J15) which provides P5V_USB to LDO 3V3 (U17).
- Board can be supplied through the Freedom development platform headers which provides either P3.3V or P5-9V_VIN on header J24 16 to LDO 3V3 (U17).
- Board can be supplied through a Coincell.
- Board can be supplied from an external DC supply in the following ways:
  - Connect an adaptor capable of suppling 1.8 to 3.6 VDC can be supplied to J19 pins 1 and using J23 selector 2-3.
  - An external unregulated supply up to 5.5VDC can be supplied to J19 pins 1 and a GND pin making use of the onboard 3.3 V LDO regulator using J23 selector 1-2.

Additionally, 2-pin 1×2 headers J7, J8, J10, J20, and J21 provide the means to supply current to various board components and current measurements if desired. Green LED marked as LED6 is available as a power indicator.

Power headers provide the means to supply either the LED, MCU, or peripheral 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_SENSOR<br>J8 | 1 - 2 | Supply voltage to power sensor<br>• Normally jumpered<br>• Jumper used to enable sensor on board<br>• Leave open for lowest power<br>• Usage: Measure sensor current |
| P3V3_MEM<br>J7 | 1 - 2 | Supply voltage to power indicator LED<br>• Normally jumpered<br>• Jumper used to enable external flash memory on board<br>• Leave open for lowest power<br>• Usage: Measure/disable memory current |
| P3V3_LED<br>J20 | 1 - 2 | Supply voltage to LEDs<br>• Normally jumpered<br>• Jumper used to enable LEDs on board<br>• Leave open for lowest power<br>• Usage: Measure LED current |
| P3V3_BUZ<br>J10 | 1 - 2 | Supply voltage to power Buzzer<br>• Normally jumpered<br>• Jumper used to enable Buzzer on board<br>• Leave open for lowest power<br>• Usage: Measure, usage buzzer current |
| V_MCU<br>J21 | 1 - 2 | Supply voltage to MKW40Z SoC<br>• Normally jumpered<br>• Supplies the MKW40Z SoC and transceiver<br>• Usage: Measure or supply MCU and radio current |

DC-DC power configuration headers provides the DC-DC modes and can be easily modified for the desired mode. Connections configurations are described in Table .

**Table 3. DC-DC power distribution headers**

| DC-DC Mode | Reference Designator and Header Pins | Description |
|---|---|---|
| Bypass | J18 1-2<br>J16 1-2<br>J17 3-4<br>J22 1-3, 2-4 | Supply voltage to power bypass mode<br>• Normally jumpered as primary mode<br>• Power level from 1.8 V–3.6 V |
| Buck | J18 2-4<br>J16 5-6<br>J17 3-4<br>J22 3-5 | Supply voltage to power Buck mode<br>• Alternative configuration, related to Coin cell option<br>• Power level from 1.8 V–4.2 V<br>• DC-DC converter requires 2.1 V min to start, the supply can drop to 1.8 V after the DC-DC converter settles |

**Table 3. DC-DC power distribution headers (continued)**

| DC-DC Mode | Reference Designator and Header Pins | Description |
|---|---|---|
| Buck<br>Auto-Start | J18 2-4<br>J16 3-4<br>J17 3-4<br>J22 3-5 | Supply voltage to power buck mode Auto-Start<br>• Alternative configuration, related to Coin cell option<br>• Power level from 1.8 V–4.2 V<br>• DC-DC converter requires 2.1 V min to start and the supply can drop to 1.8 V after the DC-DC converter settles |
| Boost | J18 2-4<br>J16 3-4<br>J17 1-2, 5-6<br>J22 3-5 | Supply voltage to power boost mode<br>• Alternative configuration, related to single battery option<br>• Power level from 0.9 V–1.8 V |

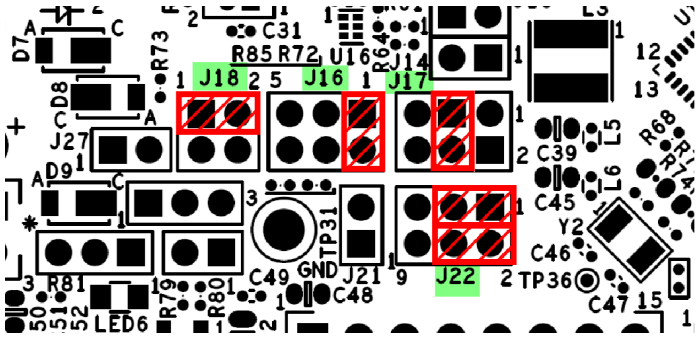


**Figure 10. Bypass headers**

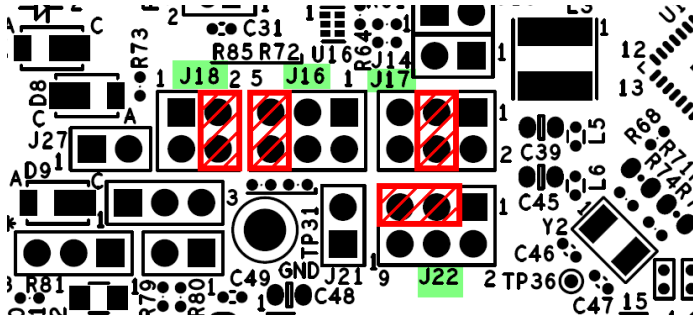


**Figure 11. Buck headers**

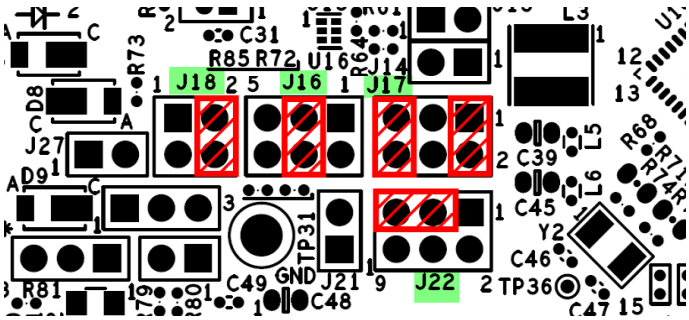


**Figure 12. Boot headers**

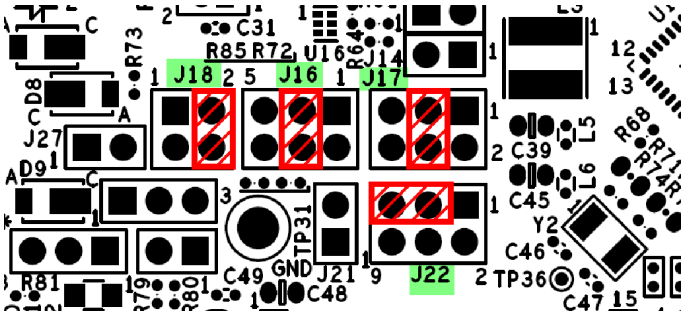


Figure 13. Buck auto-start headers

## 4.2.4 FRDM-KW40Z board's peripheral functions

The FRDM-KW40Z development board includes the Freedom development board headers to interface with the general purpose functions and to assist in the implementation of targeted applications. The FRDM-KW40Z board also has alternate port functions routed to those interface headers where off-board Freedom development platform peripherals can be used.

### 4.2.4.1 Serial flash memory (SPI interface)

Component U4 is an AT45DB021E 2-Mbit (256 Kbyte) serial flash memory with SPI interface. The memory is useful for over-the-air programming (OTAP) and for storage of nonvolatile system data or parameters. Figure 14 shows the memory circuit which includes the following.

- Memory power supply is P3V3_MEM.
- Discrete pullup resistors for the SPI port are provided.
- The SPI can be shared with another peripheral using the J1 SPI connectors. The normal SPI_SS and the second chip-select must NOT be active at the same time.
- The SPI Write Protect and Reset has a discrete pullup resistor.

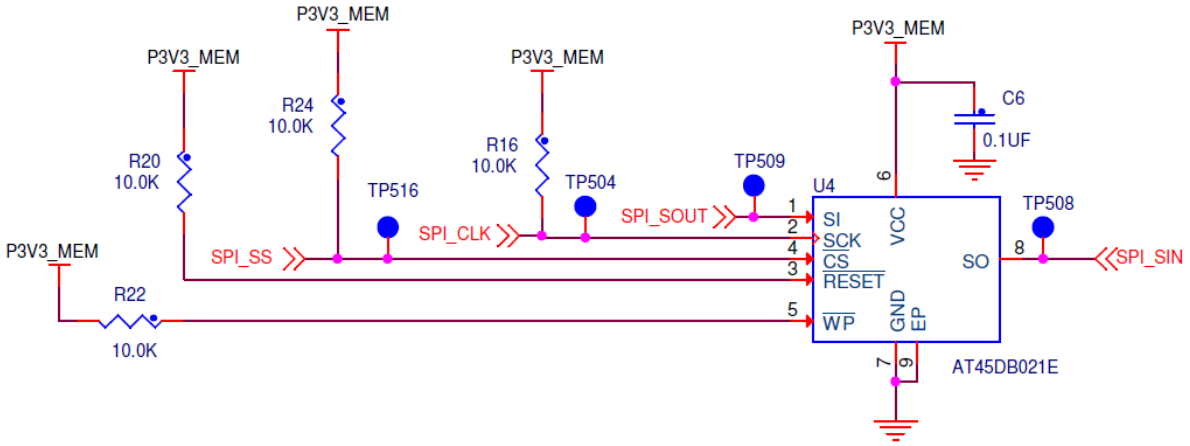


Figure 14. AT45DB021E 2-Mbit (256 Kbyte) serial flash memory circuit

### 4.2.4.2 Combo sensor ($I^2C$ interface)

Component U9 is a Freescale FXOS8700CQ sensor, a 6-axis sensor with integrated linear accelerometer and magnetometer, very low power consumption, $I^2C$ selectable. Figure 15 shows the sensor circuit.

- Sensor power supply is P3V3_SENSOR
- Discrete pullup resistors for the I2C port are provided
- One interruption signal
- The $I^2C$ can be shared with another peripheral with the J25 $I^2C1$ connectors

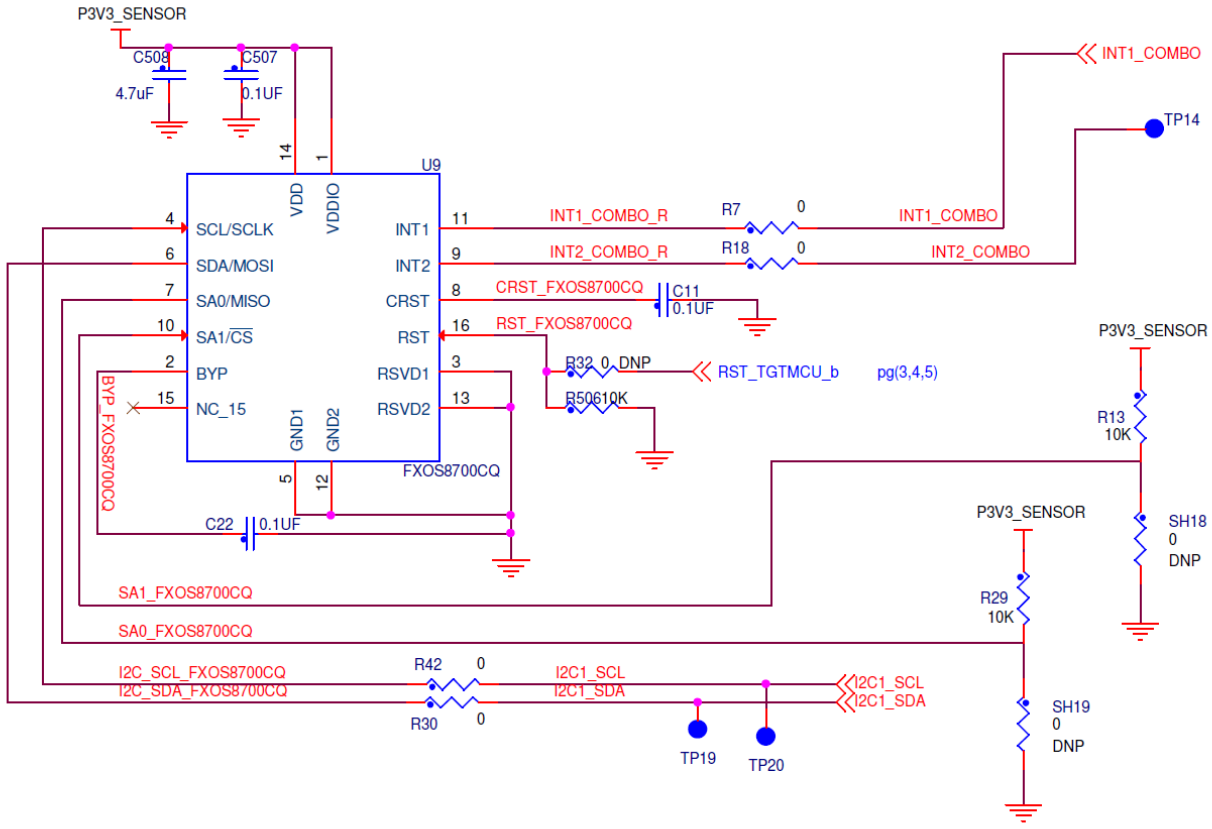


**Figure 15. FXOS8700CQ combo sensor circuit**

### 4.2.4.3 Buzzer

Component BZ500 is an AST1109MLTRQ. The buzzer is useful for sound applications. Figure 16 shows the buzzer circuit. PWM signal is required to enable the buzzer.

- Buzzer power supply is P3V3_BUZ
- 4.0 kHz resonant frequency
- Driven by Q1 and MCU output PTB3 signal
- The driven signal can be shared with another peripheral with the J2 pin 16

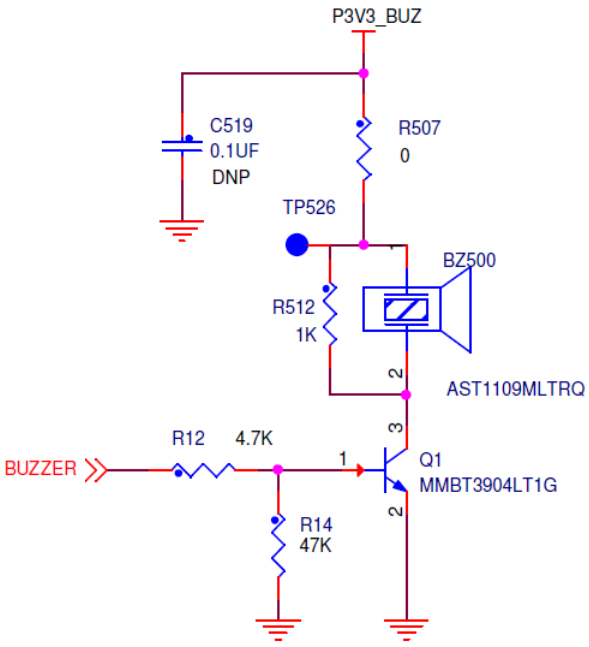


**Figure 16. Buzzer circuit**

### 4.2.4.4 Potentiometer (ADC interface)

A 5 kΩ potentiometer (R67) can be used for ADC verification and applications. Figure 17 shows the potentiometer circuit.

- POT power supply can be P3V3 or V_BATT for the input source
- A Single-Turn potentiometer is provided
- Signal is routed through ADC0_SE
- The ADC trace also can be shared with another peripheral with the J25 pin 3.

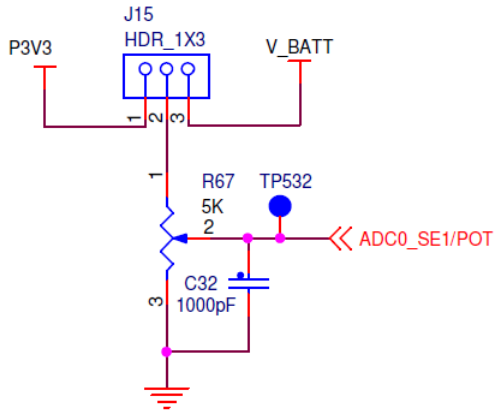


**Figure 17. Potentiometer circuit**

**NOTE**

To measure POT value, ADC must be programmed in differential mode. V_BATT will be taken as the differential input.

### 4.2.4.5 IR transmitter (CMT interface)

An infrared transmitter or blaster is provided to control IR. Figure 18 shows the IR circuit.

- IR power supply is P3V3_LED
- The IR has approximately a 10 meter range
- Current draw is approximately 100 mA when active
- When using the blaster as an application, observe the proper orientation

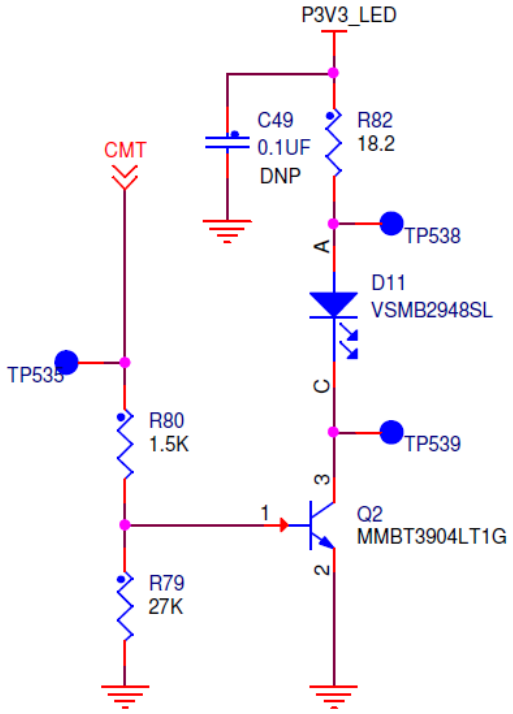


**Figure 18. IR transmitter circuit**

### 4.2.4.6 Interface connectors J1, J2, J25, and J26

The four connectors J1, J2, J35, and J26 are 100 mil pin headers mounted on the front (component side) supporting the Freedom standard connector.

- P3V3, P5V_USB and P5-9V_VIN provides the headers connector its supply voltage
  - — Peripherals IO power supply to the FRDM-KW40Z board and to the MKW40Z SoC' power supply must use the same voltage to avoid potential damage.

The pin definitions for the headers are shown in Table 4 and Table 5 respectively.

**Table 4. J2 and J1 Connector**

| Header Pin No | J2 | Description |
|---|---|---|
| | MKW40Z Pin Name | |
| 1 | NC | NC |
| 2 | UART0_RX_TGTMCU | PTC7 (D0/Rx/int) |
| 3 | NC | NC |
| 4 | UART0_TX_TGTMCU | PTC6(D1/Tx/int) |
| 5 | NC | NC |
| 6 | ELEC_IN1 | PTA16(D2/int) |
| 7 | NC | NC |
| 8 | ELEC_IN1 | PTA16(D3/PWM/int) |
| 9 | NC | NC |
| 10 | SW4 | PTA19(D4/int) |
| 11 | NC | NC |
| 12 | SW3 | PTA18(D5/PWM/int) |
| 13 | NC | NC |
| 14 | INT1_COMBO | PTB2(D6/PWM/Int) |
| 15 | NC | NC |
| 16 | BUZZER | PTB3(D7/CMP/int) |
| — | — | — |
| — | — | — |
| — | — | — |
| — | — | — |

| Header Pin No | J1 | Description |
|---|---|---|
| | MKW40Z Pin Name | |
| 1 | NC | NC |
| 2 | SWD_DIO_TGTMCU | PTA0(D8/Int) |
| 3 | NC | NC |
| 4 | KW40_SWD_CLK | PTA1(D9/Int) |
| 5 | NC | NC |
| 6 | SPI_SS | PTC19(D10/SPI_SS) |
| 7 | NC | NC |
| 8 | SPI_SIN | PTC18(D11/MOSI) |
| 9 | NC | NC |
| 10 | SPI_SOUT | PTC17(D12/MISO) |
| 11 | NC | NC |
| 12 | SPI_CLK | PTC16(D13/SCK) |
| 13 | NC | NC |
| 14 | GND | VSS (GND) board ground |
| 15 | NC | NC |
| 16 | P3V3 | VREF |
| 17 | NC | NC |
| 18 | PTC1 | PTC1(D14/Ana/Int) |
| 19 | NC | NC |
| 20 | PTC0 | PTC0(D15/Ana/Int) |

**Table 5. J24 and J25 Connector**

| Header Pin No | J24 | Description |
|---|---|---|
| | MKW40Z Pin Name | |
| 1 | NC | NC |
| 2 | PTC4 | EXTRG_IN |
| 3 | NC | NC |
| 4 | P3V3 | IO_REF |
| 5 | NC | NC |
| 6 | RST_TGTMCU_b | RESET |

| Header Pin No | J25 | Description |
|---|---|---|
| | MKW40Z Pin Name | |
| 1 | ADC_SE0/BATTERY_ MONITORING | ADC0_SE0 |
| 2 | PTB17 | PTB17/XTAL32k/I2C_SDA |
| 3 | ADC0_SE1/POT | ADC0_DM0/CMPO_IN1 |
| 4 | PTB16 | PTB16/EXTAL32k/I2C_SCL |
| 5 | NC | NC |
| 6 | CMT | PTB1/TSI_CH15/CMT_IRO |

**Table 5. J24 and J25 Connector (continued)**

| Header Pin No | J24 | Description | Header Pin No | J25 | Description |
|---|---|---|---|---|---|
| | MKW40Z Pin Name | | | MKW40Z Pin Name | |
| 7 | NC | NC | 7 | NC | NC |
| 8 | P3V3 | V_OUT | 8 | PTC5 | PTC5/TSI_CH1 |
| 9 | NC | NC | 9 | COM | PTB0/CLKOUT |
| 10 | P5V_USB | 5V | 10 | I2C1_SCL | PTC2/I2C1_SCL |
| 11 | NC | NC | 11 | PTB18 | PTB18/CMP0_IN2 |
| 12 | GND | GND | 12 | I2C1_SDA | PTC3/I2C1_SDA |
| 13 | NC | NC | — | — | — |
| 14 | GND | GND | — | — | — |
| 15 | NC | NC | — | — | — |
| 16 | P5-9V_VIN | Unregulated Voltage | — | — | — |

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

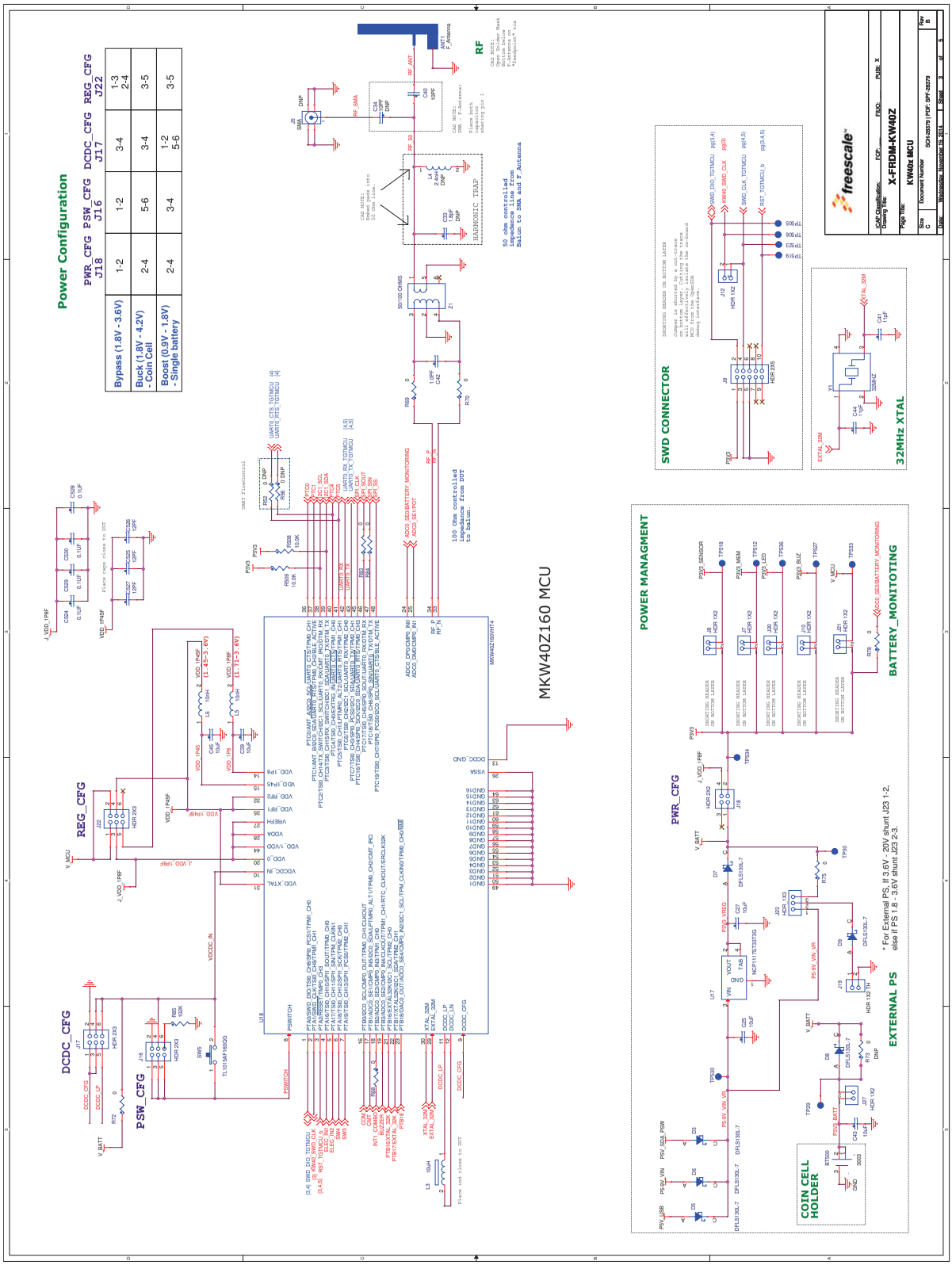


**Figure 19. FRDM-KW40Z board schematic rev. B (sheet 1 of 3)**

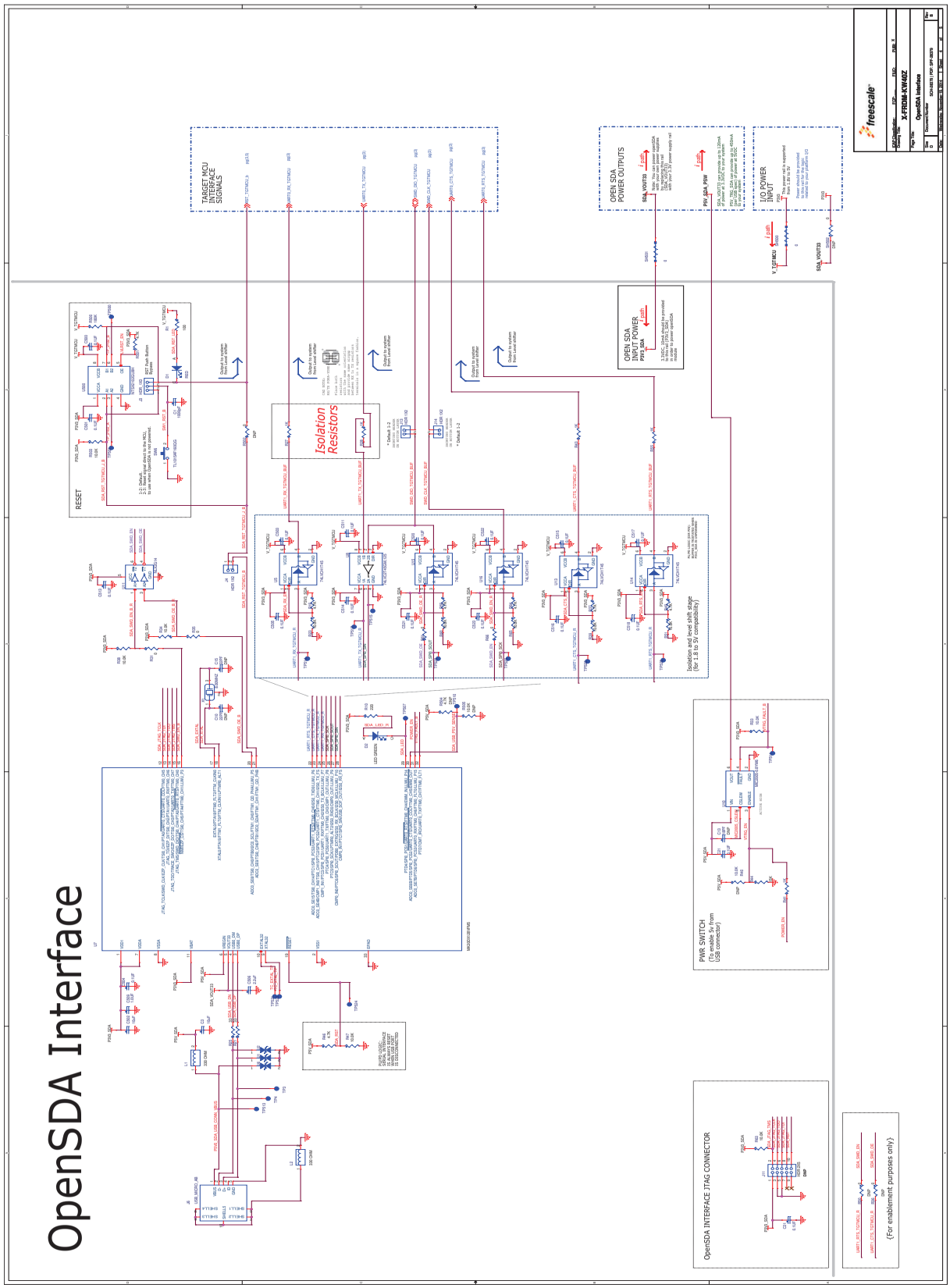


**Figure 20. FRDM-KW40Z board schematic rev. B (sheet 2 of 3)**

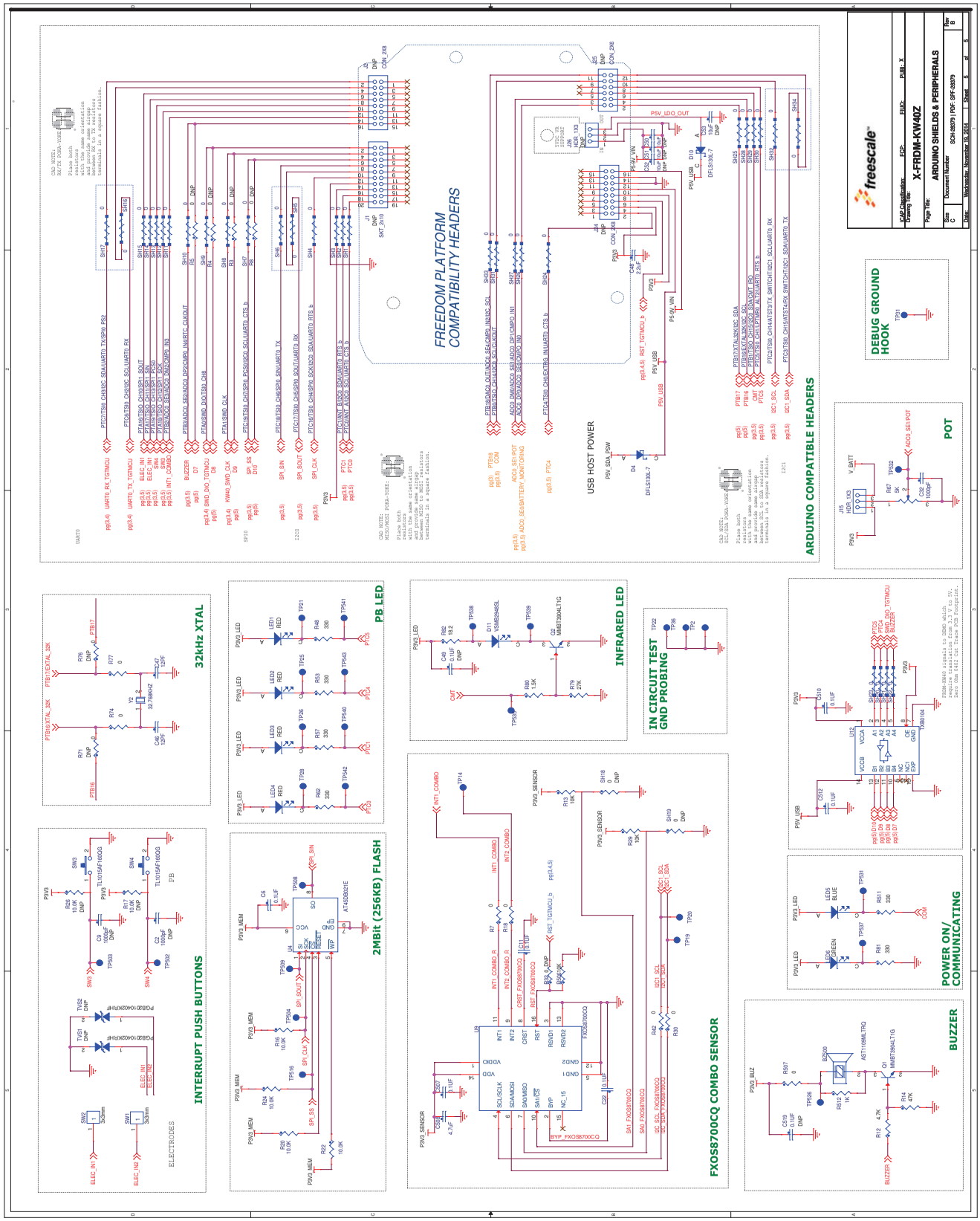


**Figure 21. FRDM-KW40Z board schematic rev. B (sheet 3 of 3)**

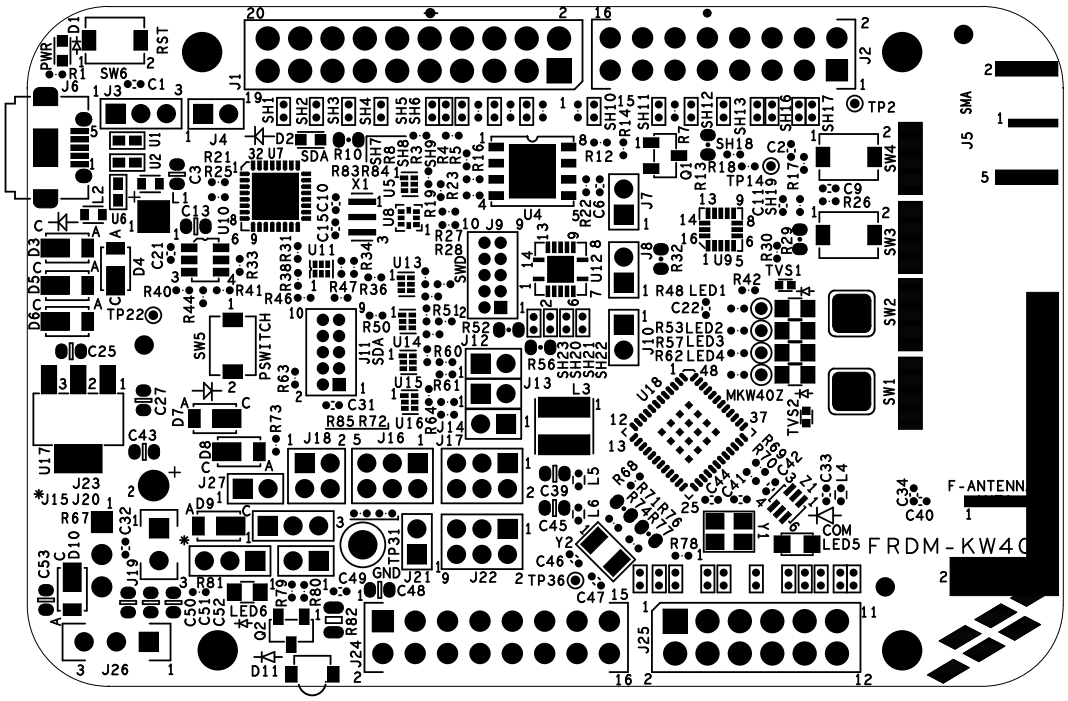


**Figure 22. FRDM-KW40Z development board component location (top view)**

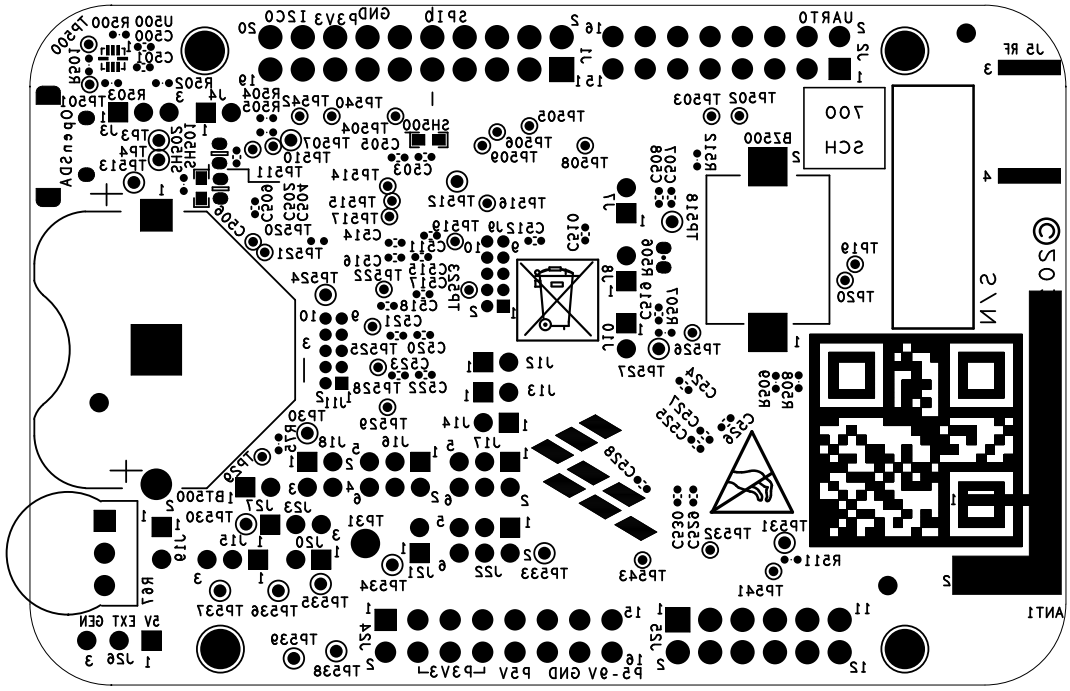

**Figure 23. FRDM-KW40Z development board test points**

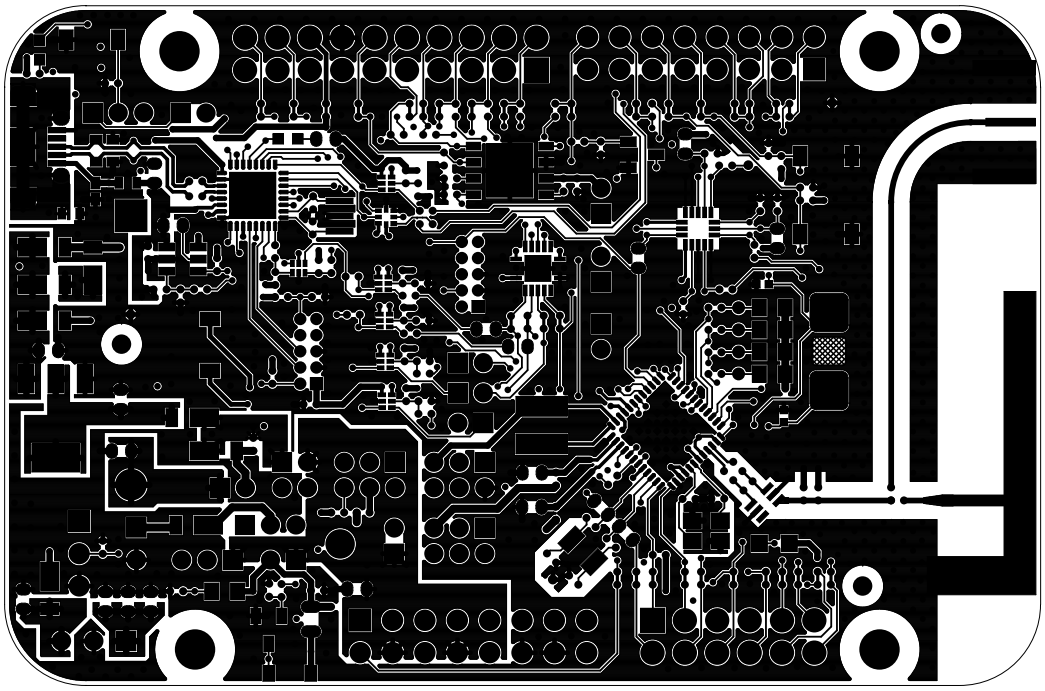

**Figure 24. FRDM-KW40Z development board layout (top view)**

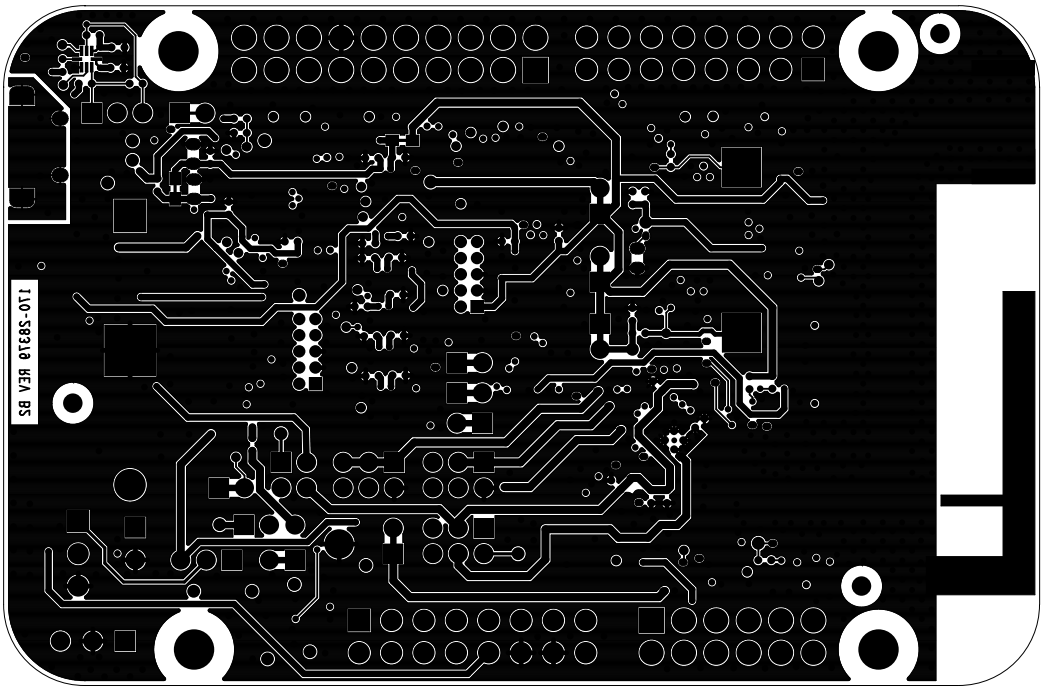


**Figure 25. FRDM-KW40Z development board layout (bottom view)**

### 4.3.1 Bill of materials

**Table 6. Bill of materials (common parts for all frequency bands) (Sheet 1 of 4)**

| Item | Qty | Reference | Value | Description | Mfg. Name | Mfg. Part Number |
|---|---|---|---|---|---|---|
| 1 | 1 | ANT1 | F_Antenna | PCB F ANTENNA, NO PART ORDER | — | — |
| 2 | 1 | BT500 | 3003 | HOLDER BATTERY 20MM DIA TH | Keystone Electronics | 3003 |
| 3 | 1 | BZ500 | AST1109MLTRQ | AUDIO DEVICE BZR PIEZO 4.1 KHZ 73DB 1-20V SMT | MALLORY | AST1109MLTRQ |
| 4 | 2 | C1,C32 | 1000pF | CAP CER 1000PF 50V 5% C0G 0402 | MURATA | GRM1555C1H102JA01D |
| 5 | 2 | C2,C9 DNP | 1000pF | CAP CER 1000PF 50V 5% C0G 0402 | MURATA | GRM1555C1H102JA01D |
| 6 | 7 | C3,C25,C27, C39,C43,C45,C502 | 10uF | CAP CER 10uF 16V 20% X5R 0603 | TAIYO YUDEN | EMK107BBJ106MA-T |
| 7 | 28 | C6,C11,C21, C22,C31,C500,C501,C503, C504,C505, C507,C510, C511,C512, C513,C514, C515,C516, C517,C518, C520,C521, C522,C523, C524,C528, C529,C530 | 0.1UF | CAP CER 0.1UF 10V 10% X5R 0402 | KEMET | C0402C104K8PAC |
| 8 | 2 | C10,C15 DNP | 22PF | CAP CER 22PF 50V 5% C0G 0402 | AVX | 04025A220JAT2A |
| 9 | 1 | C13 DNP | 18PF | CAP CER 18PF 50V 5% C0G 0603 | YAGEO AMERICA | CC0603JRNPO9BN180 |
| 10 | 1 | C33 DNP | 1.8pF | CAP CER 1.8PF 50V 0.25PF C0G 0402 | MURATA | GRM1555C1H1R8CA01D |
| 11 | 1 | C34 DNP | 10PF | CAP CER 10PF 50V 5% C0G 040210PF | AVX | 04025A100JAT2A |
| 12 | 1 | C40 | 10PF | CAP CER 10PF 50V 5% C0G 040210PF | AVX | 04025A100JAT2A |
| 13 | 2 | C41,C44 | 11pF | CAP CER 11pF 50V 1% C0G 0402 | AVX | 04025U110FAT2A |
| 14 | 1 | C42 | 1.0PF | CAP CER 1.0PF 50V 0.1PF C0G 0402 | MURATA | GJM1555C1H1R0BB01D |
| 15 | 5 | C46,C47,C525, C526,C527 | 12PF | CAP CER 12PF 50V 5% C0G 0402 | MURATA | GRM1555C1H120JZ01D |
| 16 | 2 | C48,C506 | 2.2UF | CAP CER 2.2uF 25V 10% X5R 0603 | TDK | C1608X5R1E225K |
| 17 | 2 | C49,C519 DNP | 0.1UF | CAP CER 0.1UF 10V 10% X5R 0402 | KEMET | C0402C104K8PAC |
| 18 | 4 | C50,C51,C52, C53 DNP | 10uF | CAP CER 10UF 10V 20% X5R 0603 | TAIYO YUDEN | LMK107BJ106MALTD |
| 19 | 1 | C508 | 4.7uF | CAP CER 4.7UF 6.3V 20% X5R 0402 | VENKEL COMPANY | C0402X5R6R3-475MNP |
| 20 | 1 | C509 | 1.0UF | CAP CER 1.0UF 10V 10% X5R 0402 | YAGEO AMERICA | CC0402KRX5R6BB105 |
| 21 | 1 | D1 | RED | LED ULTRA BRIGHT RED SGL 30MA 0603 | LITE ON | LTST-C190KRKT |
| 22 | 1 | D2 | LED GREEN | LED GRN SGL 20MA 0603 | OSRAM | LG L29K-G2J1-24-Z |
| 23 | 8 | D3,D4,D5,D6, D7,D8,D9,D10 | DFLS130L-7 | DIODE SCH 1A 30V PowerDI123 | DIODES INC | DFLS130L-7 |
| 24 | 1 | D11 | VSMB2948SL | LED IR RA 100mA 1.35V 940NM SMD | VISHAY INTERTECHNOLOGY | VSMB2948SL |

**Table 6. Bill of materials (common parts for all frequency bands) (Sheet 2 of 4)**

| Item | Qty | Reference | Value | Description | Mfg. Name | Mfg. Part Number |
|---|---|---|---|---|---|---|
| 25 | 1 | J1 DNP | SKT_2x10 | CON 2X10 SKT TH 100MIL CTR 540H SN 190L | SAMTEC | ESQ-110-23-T-D |
| 26 | 2 | J2,J4 DNP | CON_2X8 | CON 2X8 SKT TH 100MIL CTR 545H SN 190L | SAMTEC | ESQ-108-23-T-D |
| 27 | 3 | J3,J15,J23 | HDR_1X3 | HDR 1X3 TH 2MM SP 217H AU 110L | SAMTEC | TMM-103-02-G-S |
| 28 | 10 | J4,J7,J8,J10, J12,J13,J14, J20,J21,J27 | HDR 1X2 | HDR 1X2 TH 2MM SP 217H AU 110L | SAMTEC | TMM-102-02-G-S |
| 29 | 1 | J5 DNP | SMA | CON, SMA, EDGE 0.062IN, 50 Ω FEMALE 18 GHZ | EMERSON CONNECTIVITY | 142-0701-851 |
| 30 | 1 | J6 | USB_MICRO_AB | CON 5 USB_MICRO_AB_RECEPTACLE RA SKT SMT 0.65MM SP 122H AU | MOLEX | 475900001 |
| 31 | 1 | J9 | HDR 2X5 | HDR 2X5 TH 50MIL CTR 167H AU 91L | ANYTRONIC | 0922S0205011N6T-2LF |
| 32 | 1 | J11 DNP | HDR 2X5 | HDR 2X5 TH 50MIL CTR 167H AU 91L | ANYTRONIC | 0922S0205011N6T-2LF |
| 33 | 3 | J16,J17,J22 | HDR 2X3 | HDR 2X3 TH 2MM CTR 217H AU 110L | SAMTEC | TMM-103-02-G-D |
| 34 | 1 | J18 | HDR 2X2 | HDR 2X2 TH 2MM CTR 217H AU 110L | SAMTEC | TMM-102-02-G-D |
| 35 | 1 | J19 | HDR 1X2 TH | HDR 1X2 TH 100MIL SP 339H AU 98L | SAMTEC | TSW-102-07-G-S |
| 36 | 1 | J25 DNP | CON_2X6 | CON 2X6 SKT TH 100MIL CTR 540H SN 190L | SAMTEC | ESQ-106-23-T-D |
| 37 | 1 | J26 DNP | HDR_1X3 | HDR 1X3 TH 100MIL SP 330H AU 98L | SAMTEC | HTSW-103-07-S-S |
| 38 | 4 | LED1,LED2, LED3,LED4 | RED | LED RED CLEAR SGL 30MA SMT 0805 | LITE ON | LTST-C171KRKT |
| 39 | 1 | LED5 | BLUE | LED BLUE SGL 20MA SMT 0805 | LITE ON | LTST-C171TBKT |
| 40 | 1 | LED6 | GREEN | LED GRN SGL 30MA SMT 0805 | LITE ON | LTST-C171KGKT |
| 41 | 2 | **L1,L2** | 330 W | IND FER BEAD 330Ω@100MHZ 1.7A 0603 | TDK | MPZ1608S331A |
| 42 | 1 | L3 | 10uH | IND WW FER 10uH@1MHz 0.99A 20% 4012 | TDK | VLS4012ET-100M |
| 43 | 1 | L4 DNP | 2.4nH | IND—0.0024UH@100MHZ 300MA 0.0003UH 0402 | MURATA | LQG15HN2N4S02D |
| 44 | 2 | L5,L6 | 10nH | IND—0.010uH@100MHZ 350MA 5% 0402 | TDK | MLK1005S10NJT000 |
| 45 | 2 | Q1,Q2 | MMBT3904LT1G | TRAN NPN GEN 200MA 40V SOT-23 | ON SEMICONDUCTOR | MMBT3904LT1G |
| 46 | 1 | R1 | 100 | RES MF 100 Ω 1/16W 5% 0402 | VENKEL COMPANY | CR040216W101JT |
| 47 | 11 | R3,R4,R5,R8, R36,R50,R73, R502,SH18, SH19,SH502 DNP | 0 | RES MF ZERO OHM 1/16W 5% 0402 | ROHM | MCR01MZPJ000 |
| 48 | 19 | R7,R18,R30, R31,R35,R42, R61,R66,R68, R69,R70,R72, R74,R75,R77, R78,R83,R84, R507 | 0 | RES MF ZERO OHM 1/16W 5% 0402 | ROHM | MCR01MZPJ000 |
| 49 | 1 | R10 | 220 | RES MF 220 Ω 1/10W 5% 0603 | KOA SPEER | RK73B1JTTD221J |

**Table 6. Bill of materials (common parts for all frequency bands) (Sheet 3 of 4)**

| Item | Qty | Reference | Value | Description | Mfg. Name | Mfg. Part Number |
|---|---|---|---|---|---|---|
| 50 | 8 | R12,R19,R37, R46,R49,R59, R64,R501 | 4.7K | RES MF 4.7K 1/16W 5% 0402 | YAGEO AMERICA | RC0402JR-074K7L |
| 51 | 3 | R13,R29,R506 | 10K | RES MF 10K 1/10W 5% 0603 | KOA SPEER | RK73B1JTTD103J |
| 52 | 1 | R14 | 47K | RES MF 47K 1/16W 5% 0402 | VENKEL COMPANY | CR0402-16W-473JT |
| 53 | 17 | 51,R60,R63,R65, R503,R508,R509 | 10.0K | RES MF 10.0K 1/16W 1% AEC-Q200 0402 | VISHAY INTERTECHNOLOGY | CRCW040210K0FKED |
| 54 | 4 | R17,R26,R40, R505 DNP | 10.0K | RES MF 10.0K 1/16W 1% AEC-Q200 0402 | VISHAY INTERTECHNOLOGY | CRCW040210K0FKED |
| 55 | 2 | R21,R25 | 33 | RES MF 33.0 Ω 1/16W 1% 0402 | THYE MING TECH CO LTD | CR-02FL6---33R |
| 56 | 6 | R27,R28,R41, R43,R55,R512 | 1K | RES MF 1.0K 1/16W 5% 0402 | VISHAY INTERTECHNOLOGY | CRCW04021K00JNED |
| 57 | 5 | R32,R52,R56, R71,R76 DNP | 0 | RES MF ZERO Ω 1/10W—0603 | VISHAY INTERTECHNOLOGY | CRCW06030000Z0EA |
| 58 | 1 | R44 | 15K | RES MF 15K 1/16W 1% 0402 | KOA SPEER | RK73H1ETTP1502F |
| 59 | 6 | R48,R53,R57, R62,R81,R511 | 330 | RES MF 330 Ω 1/16W 5% 0402 | VISHAY INTERTECHNOLOGY | CRCW0402330RJNED |
| 60 | 1 | R67 | 5K | RES POT 5.0K 1/4W 20% SMT | — | — |
| 61 | 1 | R79 | 27k | RES MF 27K 1/16W 5% 0402 | VISHAY INTERTECHNOLOGY | CRCW040227K0JNED |
| 62 | 1 | R80 | 1.5K | RES MF 1.5K 1/16W 5% 0402 | VISHAY INTERTECHNOLOGY | CRCW04021K50JNED |
| 63 | 1 | R82 | 18.2 | RES MF 18.2 Ω 1/4W 1% 0805 | ROHM | ESR10EZPF18R2 |
| 64 | 1 | R500 | 180K | RES MF 180K 1/16W 1% 0402 | KOA SPEER | RK73H1ETTP1803F |
| 65 | 1 | R504 DNP | 4.7K | RES MF 4.7K 1/16W 5% 0402 | YAGEO AMERICA | RC0402JR-074K7L |
| 66 | 1 | R85 | 102K | RES MF 102K 1/16W 1% 0402 | KOA SPEER | RK73H1ETTP1023F |
| 67 | 32 | SH1,SH2,SH3, SH4,SH5,SH6, SH7,SH8,SH9, SH10,SH11, SH12,SH13, SH14,SH15, SH16,SH17, SH20,SH21, SH22,SH23, SH24,SH25, SH26,SH27, SH28,SH29, SH30,SH31, SH32,SH33, SH34 | 0 | ZERO OHM CUT TRACE 0402 PADS; NO PART TO ORDER | — | — |
| 68 | 2 | SH500,SH501 | 0 | ZERO OHM CUT TRACE 0603 PADS; NO PART TO ORDER | — | — |
| 69 | 4 | SW3,SW4,SW5, SW6 | TL1015AF160 QG | SW SPST PB 50MA 12V SMT | E SWITCH | TL1015AF160QG |
| 70 | 2 | SW1,SW2 | 3x3mm | CAPACITIVE SINGLE ELECTRODE 3X3MM SQUARED ROUNDED CORNERS (NOT A PART TO ORDER) | — | — |

**Table 6. Bill of materials (common parts for all frequency bands) (Sheet 4 of 4)**

| Item | Qty | Reference | Value | Description | Mfg. Name | Mfg. Part Number |
|---|---|---|---|---|---|---|
| 71 | 50 | TP2,TP3,TP4, TP14,TP19, TP20,TP22, TP29,TP30, TP36, TP500-534, TP536, TP540-543 | TPAD_030 | TEST POINT PAD 30MIL DIA SMT, NO PART TO ORDER | — | — |
| 72 | 8 | TP21,TP25,TP26, TP28,TP535, TP537,TP538, TP539 | TPAD_040 | TEST POINT PAD 40MIL DIA SMT, NO PART TO ORDER | — | — |
| 73 | 1 | TP31 | TESTLOOP_ BLACK | TEST POINT PC MULTI PURPOSE BLK TH | KEYSTONE ELECTRONICS | 5011 |
| 74 | 2 | TVS1,TVS2 DNP | PGB2010402 KRHF | DIODE ESD SUPPRESSOR BIDIR—12V 0402 | LITTELFUSE | PGB2010402KRHF |
| 75 | 3 | U1,U2,U6 | 0402ESDA-M LP | DIODE TVS BIDIR—30V 0402 | COOPER BUSSMANN | 0402ESDA-MLP1 |
| 76 | 1 | U4 | AT45DB021E | IC MEM SPI SERIAL 2MBIT FLASH 85MHZ 1.65-3.6V UDFN8 | ADESTO TECHNOLOGIES | AT45DB021E-MHN2B-T |
| 77 | 5 | U5,U13,U14, U15,U16 | 74LVCH1T45 | IC XCVR 1BIT 3-STATE DUAL 1.2–5.5V XSON6 | NXP SEMICONDUCTORS | 74LVCH1T45GM,132 |
| 78 | 1 | U7 | MK20DX128V FM5 | IC MCU FLASH 128KB 50MHZ 1.71–3.6V QFN32 | FREESCALE SEMICONDUCTOR | MK20DX128VFM5 |
| 79 | 1 | U8 | 74LVC2T45G M,125 | IC XCVR DUAL SUPPLY 1.2–5.5V XQFN8 | NXP SEMICONDUCTORS | 74LVC2T45GM,125 |
| 80 | 1 | U9 | FXOS8700CQ | IC ACCELEROMETER AND MAGNETOMETER SENSOR 3-AXIS 2.5V QFN16 | FREESCALE SEMICONDUCTOR | FXOS8700CQ |
| 81 | 1 | U10 | MIC2005-0.8Y M6 | IC LIN SW PWR 0.8A 2.5-5.5V SOT23-6 | MICREL | MIC2005-0.8YM6 |
| 82 | 1 | U11 | NLX2G14 | IC INV DUAL SCHMITT TRIGGER 1.65-5.5V ULLGA6 | On Semiconductor | NLX2G14AMX1TCG |
| 83 | 1 | U12 | TXB0104 | IC VXLTR 4BIT BIDIRECTIONAL 1.2-3.6V/1.65-5.5V QFN14 | TEXAS INSTRUMENTS | TXB0104RGYRG4 |
| 84 | 1 | U17 | NCP1117ST3 3T3G | IC VREG LDO 1A 3.3V SOT223 | ON Semiconductor | NCP1117ST33T3G |
| 85 | 1 | U18 | MKW40Z160V HT4 | IC MCU XCVR 2.4GHZ BLUETOOTH LOW ENERGY MAPLGA64 | FREESCALE SEMICONDUCTOR | MKW40Z160VHT4 |
| 86 | 1 | U500 | NTSX2102GU 8H | IC DUAL SUPPLY XCVR 50 MBPS 5.5V XQFN8 | NXP Semiconductors | NTSX2102GU8H |
| 87 | 1 | X1 | 8.00MHZ | XTAL 8.00MHZ RSN CERAMIC—SMT | MURATA | CSTCE8M00G55-R0 |
| 88 | 1 | Y1 | 32MHZ | XTAL 32MHZ 9PF—SMT 3.2X2.5MM | NDK | EXS00A-CS02368 |
| 89 | 1 | Y2 | 32.768KHZ | XTAL 32.768 KHZ SMT ROHS COMPLIANT | EPSON ELECTRONICS | FC-135 32.7680KA-A3 |
| 90 | 1 | Z1 | 50/100 W | XFMR BALUN 2.45GHZ ±50MHZ 50/100 Ω 3W SMT | JOHANSON TECHNOLOGY | 2450BL15B100_ |

# 5 PCB manufacturing specifications

This section provides the specifications used to manufacture the FRDM-KW40Z development printed circuit board (PCB) described in this guide.

The FRDM-KW40Z development boards 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 (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 FRDM-KW40Z development boards at the Freescale website (freescale.com/KW40Z) under the "Software and Tools" tab. These reference designs must 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.

## 5.1 Single PCB construction

This section describes individual PCB construction details.

- The FRDM-KW40Z PCBs are four-layer, multi-layer designs.
- The FRDM-KW40Z PCBs contain no blind, buried, or micro vias.
- PCB data:
  - FRDM-KW40Z board's size: Approximately 81 × 53 mm (3.20 × 2.10 inches)
  - FRDM-KW40Z board's final thickness (Cu/Cu): 1.57 mm (0.62 inches) ±10% (excluding solder mask)

Table 7 defines some of the layers of the completed PCB. The artwork identification refers to the name of the layer in commonly used terms.

**Table 7. FRDM-KW40Z layer by layer overview**

| Layer | Artwork Identification | File Name |
|---|---|---|
| 1 | Silkscreen Top | PSS.art |
| 2 | Top Layer Metal | L1_PS.art |

**Table 7. FRDM-KW40Z layer by layer overview (continued)**

| Layer | Artwork Identification | File Name |
|---|---|---|
| 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-KW40Z 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. Therefore, BOARD STACKUP GEOMETRY IS CRITICAL. Dielectric and copper thicknesses and spacing must not be changed; follow the stackup information provided with the reference design (see Figure 26).

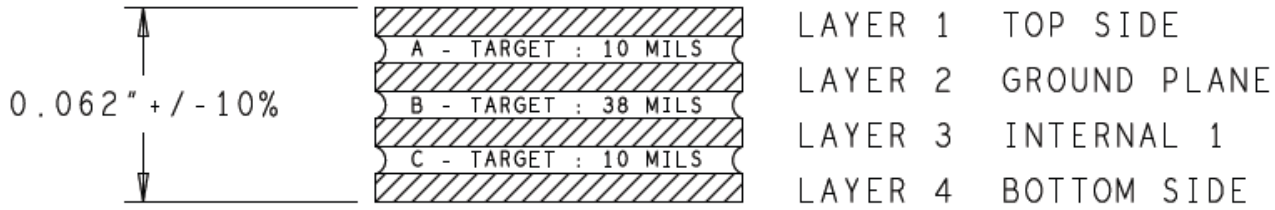


**Figure 26. FRDM-KW40Z PCB layer stackup cross-section (four layer)**

- 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 material (laminate) must be FR4. If another laminate material is used, then 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 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-28379.pdf* file.

## 5.9 File descriptions

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-28379.pdf*—FRDM-KW40Z board fabrication drawing
- *GRB-28379.zip*—FRDM-KW40Z board metal layers, solder mask, solder paste and silk screen
- *SPF-28379.pdf*—FRDM-KW40Z board schematic diagram

Design files are in Allegro format with OrCAD schematic capture.

# 6 Revision history

| Rev. number | Date | Substantive change(s) |
|---|---|---|
| 1 | 06/2015 | Schematic, layout and block diagram update; initial release. |

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