

# Freescale USB Development Board USB-KW40Z User's Guide

## 1 About this guide

This manual describes the Freescale USB-KW40Z development platform. The USB-KW40Z board is a small, cost-effective evaluation and development board for application prototypes and demonstration of the MKW40Z160 SoC family of devices. This evaluation board offers an easy-to-use mass-storage device mode flash programmer, a virtual serial port, classic programming, and run-control capabilities.

The MKW40Z160 SoC is an ultra low-power, highly integrated single-chip device that enables Bluetooth Low Energy (BLE) and/or IEEE® Std. 802.15.4/RF connectivity for portable, extremely low-power embedded systems. The MKW40Z160 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+ MCU, 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

1. About this guide .....	1
1.1. Audience .....	1
2. Safety information .....	2
2.1. FCC guidelines .....	2
2.2. Regulatory approval for Canada (IC RSS 210) ...	3
2.3. Electrostatic discharge considerations .....	3
2.4. Disposal instructions .....	3
3. USB-KW40Z overview and description .....	4
3.1. Introduction .....	4
3.2. Board features .....	4
3.3. Serial and debug adapter .....	6
4. USB-KW40Z development board .....	7
4.1. USB-KW40Z board overview .....	7
4.2. Functional description .....	9
4.3. Schematic, board layout, and bill of material ...	16
5. PCB manufacturing specifications .....	21
5.1. Single PCB construction .....	21
5.2. Panelization .....	22
5.3. Materials .....	22
5.4. Solder mask .....	23
5.5. Silkscreen .....	23
5.6. Electrical PCB testing .....	23
5.7. Packaging .....	23
5.8. Hole specification/tool table .....	23
5.9. File description .....	23
6. Revision history .....	24

## 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 (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 Std. 802.15.4. 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, refer to [freescale.com/productdisposal](http://freescale.com/productdisposal).

## 3 USB-KW40Z overview and description

### 3.1 Introduction

The USB-KW40Z development platform is an evaluation environment based on the Freescale MKW40Z160 SoC device. The MKW40Z160 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 MKW40Z160 SoC with tools and software that include hardware evaluation and development boards, software development IDE, 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.

### 3.2 Board features

#### 3.2.1 USB-KW40Z board

The USB-KW40Z development board contains the MKW40Z160 device it is one of the simplest reference design utilizing the on chip USB block for power and communication. The USB-KW40Z is a small form factor self-contained board for evaluation of wireless application and can be used as a packet sniffer. The USB type-A connection is used with USB enabled hardware such as a computer.

Figure 1 shows the USB-KW40Z development platform.

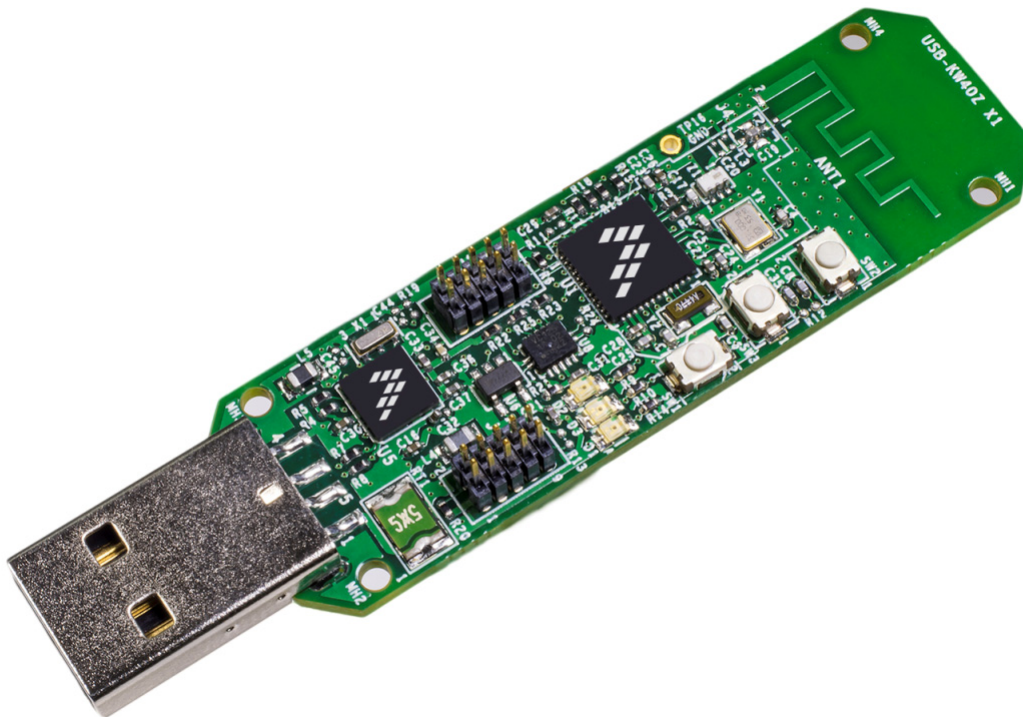


Figure 1. USB-KW40Z development board

The USB-KW40Z development board includes the following features:

- Based on the Freescale ultra low-power MKW40Z160 SoC BLE device
- Fully compliant IEEE Std. 802.15.4, 2006, transceiver supporting 250 kbit/s 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 with KSDK enable software
- 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 MMCX connector, no harmonic trap using bypass mode of operation
  - Receiver sensitivity:  $-102$  dBm, typical (@1% PER for 20 byte payload packet), for 802.15.4 at the MMCX connector
  - Receiver sensitivity:  $-91$  dBm for BLE applications at the MMCX connector
- Integrated PCB inverted meander type antenna and MMCX (Micro-Miniature Coaxial) RF port
- Bypass operation mode
- 32 MHz reference oscillator
- 32 kHz reference oscillator
- 2.4 GHz frequency operation (ISM and MBAN)
- Reset switch drive to MKW40Z160.
- Reset switch drive to debug interface (OpenSDA)
- Cortex 10-pin (0.05 inch) SWD debug port for target MCU
- Cortex 10-pin (0.05 inch) JTAG port for OpenSDA updates
- Integrated open-standard serial and debug interface (OpenSDA)
- 2 Blue LED indicators primary drive thought MKW40Z160 MCU, also connected to MK22FN512
- 1 Push button switch drive to MKW40Z160 MCU, also connected to MK22FN512

Figure 2 shows the main board features and I/O headers for the Freescale USB-KW40Z board.

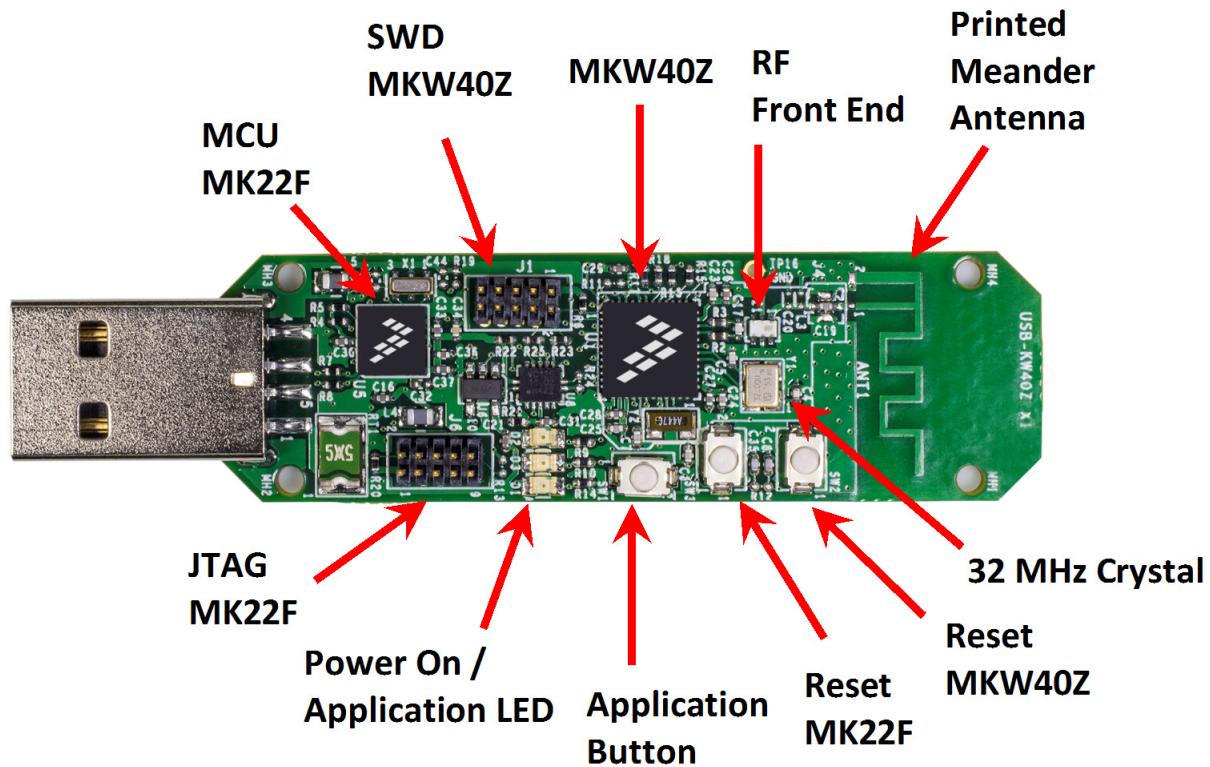


Figure 2. USB-KW40Z component placement

### 3.3 Serial and debug adapter

The USB-KW40Z development board can be enabled with OpenSDA v2.1, a serial and debug adapter circuit that includes an open-source hardware design, 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 a Freescale Kinetis K22F family microcontroller (MCU). OpenSDAv2.1 enables the CMSIS-DAP bootloader, an open-source mass storage device (MSD) bootloader, and the CMSIS-DAP Interface firmware (also known as the mbed interface), that provides a MSD flash programming interface, a virtual serial port interface, and a CMSIS-DAP debug protocol interface. For more information on the OpenSDAv2.1 software, see [mbed.org](http://mbed.org) and <https://github.com/mbedmicro/CMSIS-DAP>.

#### NOTE

Driver considerations, you must install a windows driver that can be downloaded from the following link:

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

USB-KW40Z comes pre-programmed with a sniffer application. In order to enable this board with OpenSDA feature and as a development board, refer to the following:

[freescale.com/USB-KW40Z/startnow](http://freescale.com/USB-KW40Z/startnow)

## 4 USB-KW40Z development board

### 4.1 USB-KW40Z board overview

The USB-KW40Z board is an evaluation board based on the Freescale MKW40Z160 SoC. The USB-KW40Z provides a platform to evaluate the MKW40Z160 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 USB-KW40Z board is intended as the core PCB for MKW40Z160 device evaluation and application development, and can be used as a simple standalone valuation solution or as packet sniffer.

#### 4.1.1 PCB features

The USB-KW40Z board provides the following features:

- USB small form factor
- 4-Layer metal, 0.062 inch thick FR4 board
- LGA footprint and power supply bypass mode
- Printed Meander Antenna and footprint for installing a (user supplied) MMCX connector
- 32 MHz reference oscillator crystal
- 32 kHz crystal provided for optional timing oscillator
- Secondary (MK22FN512) device to use as voltage regulator and MCU processor for BLE sniffer.

#### 4.1.2 Form factor

Figure 3 shows the USB-KW40Z development board layout and footprint.

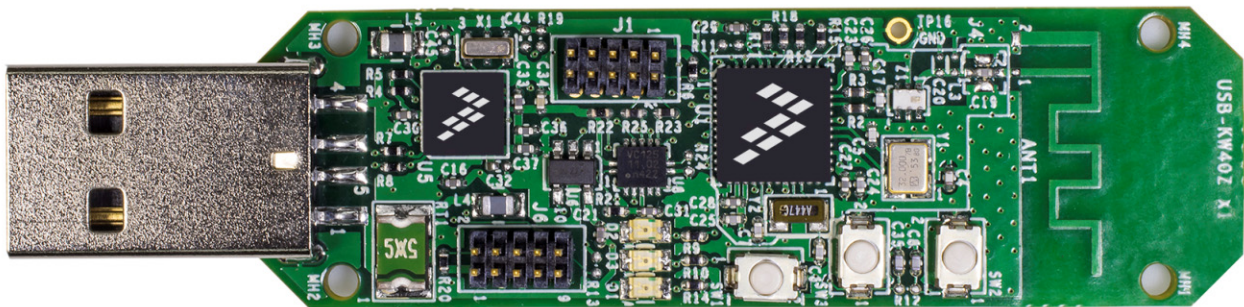


Figure 3. USB-KW40Z top side (component side) footprint

Figure 4 shows a footprint of the USB-KW40Z with the location of the headers.

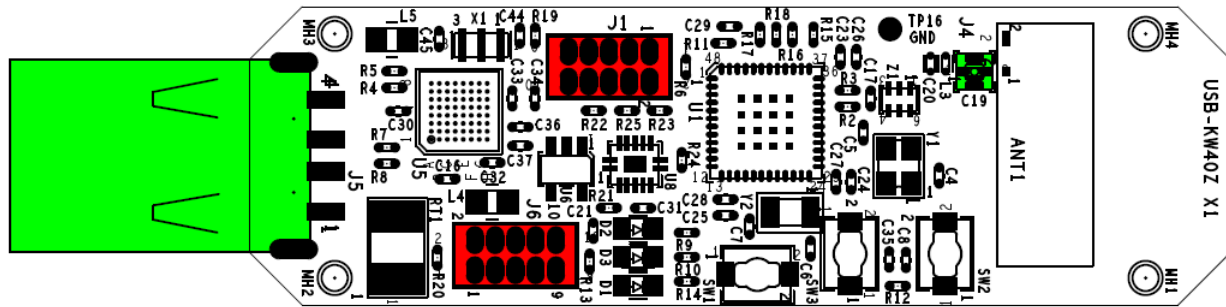


Figure 4. USB-KW40Z I/O headers location

### 4.1.3 Board level specifications

Table 1. USB-KW40Z specifications

Parameter	Min	Typ	Max	Units	Notes/Conditions
<b>General</b>					
Size (PCB: X, Y)	—	—	18.5 x 61.4 0.73 x 2.42	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, Refer to 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</b>					
802.15.4 Frequency range	2405	—	2480	MHz	All 16 channels in the 2450 MHz band
BLE Frequency range	2400	—	2483	MHz	All 40 channels in the 2450 MHz band
ISM and MBAN Frequency range	2360	—	2483	MHz	
<b>RF Receiver</b>					
Saturation (maximum input level)	—	+0	—	dBm	Refer to datasheet
Sensitivity for 1% packet error rate (PER) (+25 °C) 802.15.4	—	-102	—	dBm	Refer to datasheet



**Table 1. USB-KW40Z specifications (continued)**

Parameter	Min	Typ	Max	Units	Notes/Conditions
Sensitivity for 1% packet error rate (PER) (+25 °C) BLE	—	-94	—	dB	Refer to datasheet
<b>RF Transmitter</b>					
RF Power Output	-20	—	+5	dBm	Programmable in steps. At the MMCX connector with no trap. <sup>1</sup>
2nd harmonic	—	≤50	≤40	dBm	—
3rd harmonic	—	≤50	≤40	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

<sup>1</sup>) Trap will add 1 to 2 dB of loss.

## 4.2 Functional description

The USB-KW40Z is built around the Freescale MKW40Z160 SoC in a 48-pin LGA package. The USB-KW40Z 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 MKW40Z160 with its 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.

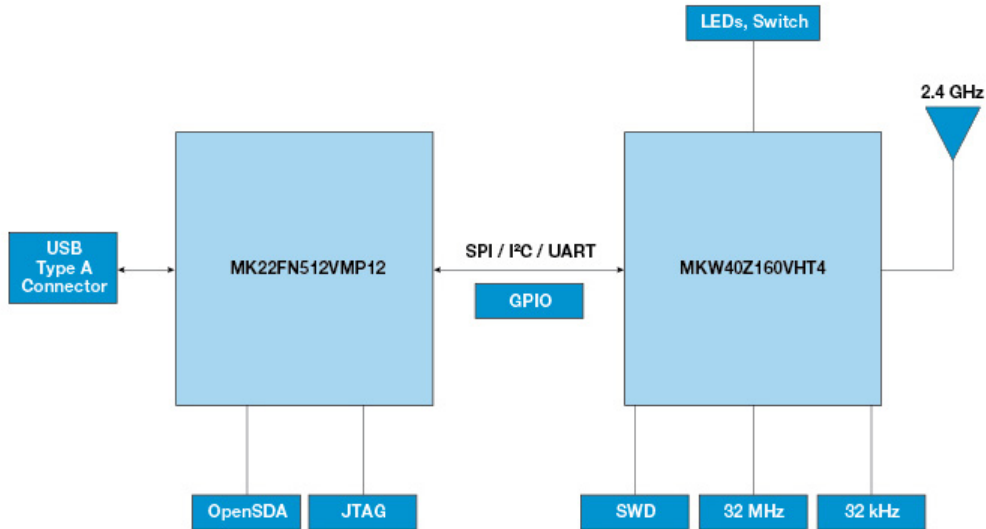


Figure 5. USB-KW40Z block diagram

### 4.2.1 RF performance and considerations

The USB-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 MKW40Z160 SoC are:

- Nominal output power is set to 0 dBm
- Programmable output power from -20 dBm to +5 dBm at the MMCX, no harmonic trap
- Typical sensitivity is -102 dBm (@1% PER for 25 °C) at the MMCX (802.15.4)
- Typical sensitivity is -91 dBm (@1% PER for 25 °C) at the MMCX (BLE)
- Frequency range is 2360 to 2480 MHz
- Differential bidirectional RF I/O port with integrated transmit/receive switch
- Meander 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): 100 (unbal) balun connects a single-ended 50 ohm port to the differential RF port of the MKW40Z160 SoC’s transceiver. The layout has provision for out-of-band signal suppression (components L3 and C20) if required. [Figure 6](#) shows the typical topology for the RF circuitry. The RF connector J4 has been included in the design for measurement purposes and is used as a DNP.

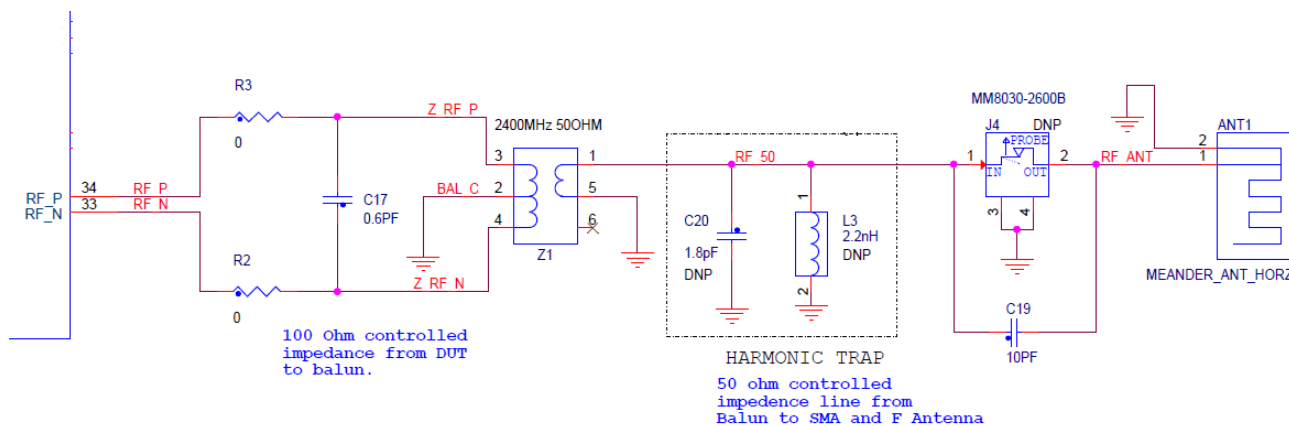


Figure 6. USB-KW40Z RF circuitry

## 4.2.2 Clocks

The USB-KW40Z provides two clock sources to the MKW40Z160:

- 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  $\pm 40$  ppm.
  - Capacitors C4 and C5 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.
- 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 C6 and C7.
  - Load capacitors C6 and C7 provide the entire crystal load capacitance; there is no onboard trim capacitance.

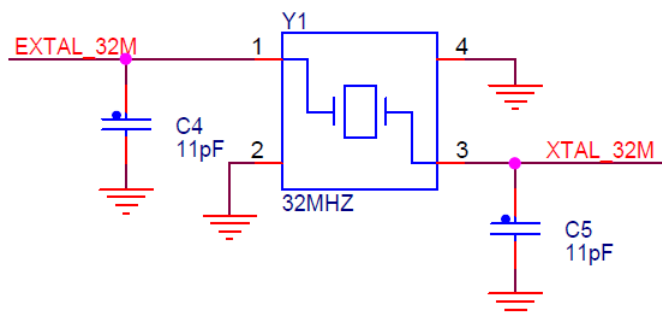


Figure 7. USB-KW40Z board's 32 MHz reference oscillator circuit

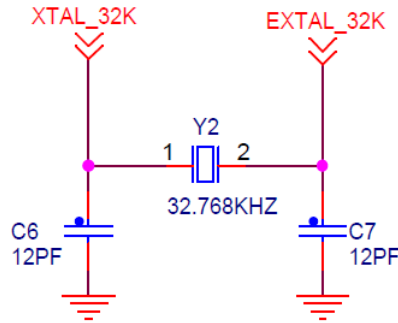


Figure 8. USB-KW40Z board's optional 32.768 kHz oscillator circuit

### 4.2.3 Power management

There is one way to power on the USB-KW40Z board, a J5 type-A connector to supply 5 V(V\_USB) directly to the secondary MCU, that includes an internal regulator, 3.3 V output to enable theMKW40Z160 device. The USB-KW40Z power management circuit is shown in Figure 9.

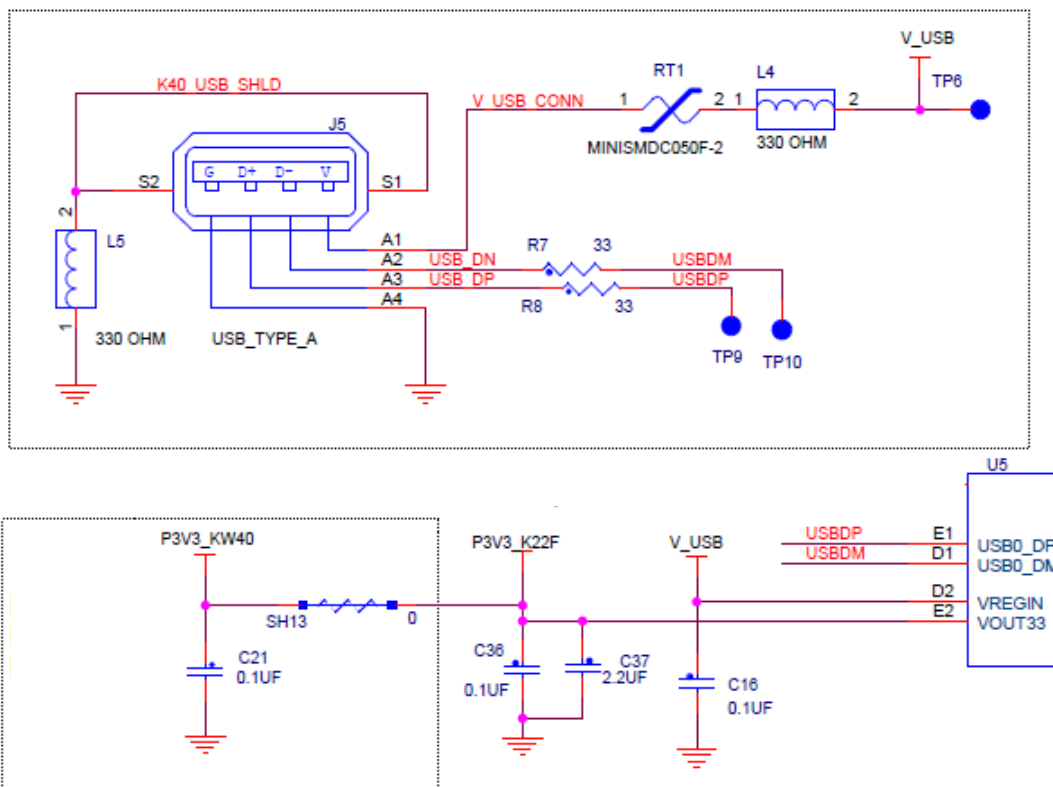


Figure 9. USB-KW40Z power management circuit

Additionally, a green LED marked as D1 is available as a power indicator. For current measurements, users can isolate the MKW40Z160 device, through SH13 cut-trace, this will disable the VCC path (including LED).

## 4.2.4 USB-KW40Z peripheral functions

The board includes two different MCUs, one dedicated to RF (MKW40Z160) acquisition and the second features an OpenSDA debugger and processor for BLE sniffer application (MK22FN512).

### 4.2.4.1 MKW40Z160 peripheral functions

The USB-KW40Z development board includes two push buttons: one for a general purpose peripheral function to assist in implementing targeted applications and the other dedicated to MKW40Z160 hardware reset.

The board also include three LEDs, two for general purposes and the other as a Power-On indicator. [Figure 10](#) shows the push buttons and LEDs for MKW40Z160.

The application LEDs (D2 and D3) are connected not only with MKW40Z, they also share this connection with the MK22FN512 MCU. You can isolate LEDs to remove or cut the trace over SH5 and SH6.

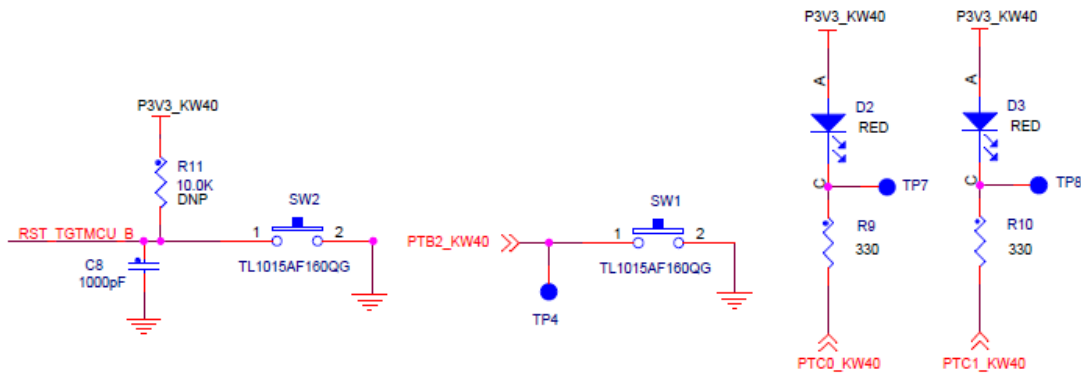


Figure 10. USB-KW40Z MKW40Z160 push button & LED

### 4.2.4.2 MK22FN512/Open SDA Interface

- The USB-KW40Z includes an OpenSDA circuitry based on the MK22FN512, that includes all the necessary components to enable communication and debugging, it also provides power output to all MKW40Z160 peripherals. [Figure 11](#) shows the OpenSDA circuitry based on the MK22FN512 MCU, and all the necessary connections to interface with MKW40Z160.

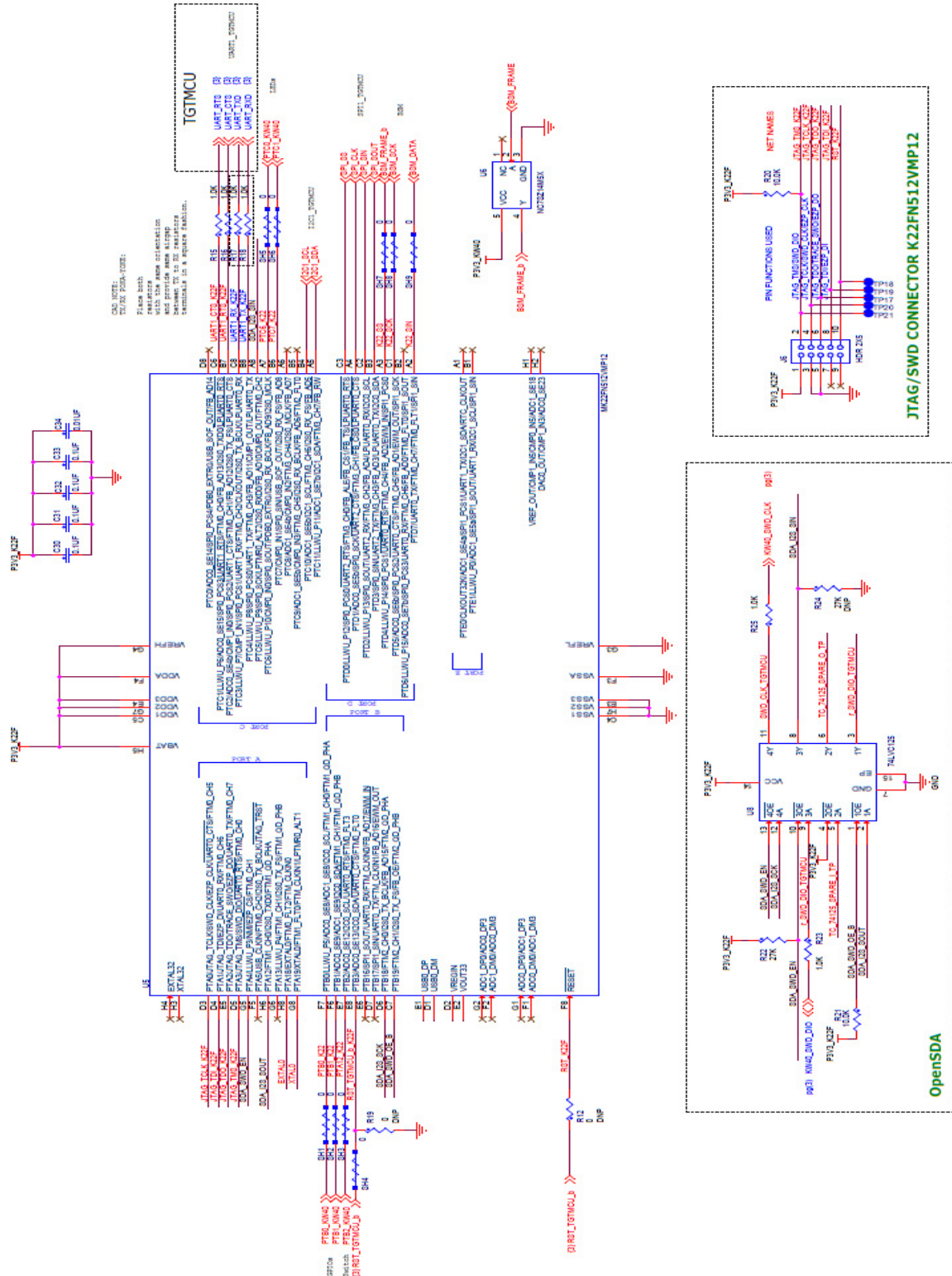


Figure 11. USB-KW40Z OpenSDA circuitry

#### 4.2.4.2.1 OpenSDA interface clock

The USB-KW40Z provides one clock source for the OpenSDA MK22FN512 MCU.

- 8 MHz Reference Oscillator - [Figure 12](#) shows the external 8 MHz external crystal X1. This mounted crystal must meet MK22FN512 specifications. It also provides C44 and C45 to the bulk of the crystal load capacitance.

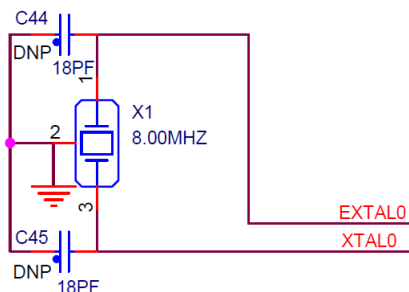


Figure 12. USB-KW40Z MK22FN512 8 MHz clock source

#### 4.2.4.2.2 MK22FN512 peripheral functions

The USB-KW40Z OpenSDA interface circuit also includes one switch button, to assist in MK22FN512 MCU hardware reset. [Figure 13](#) shows the push button for MK22FN512

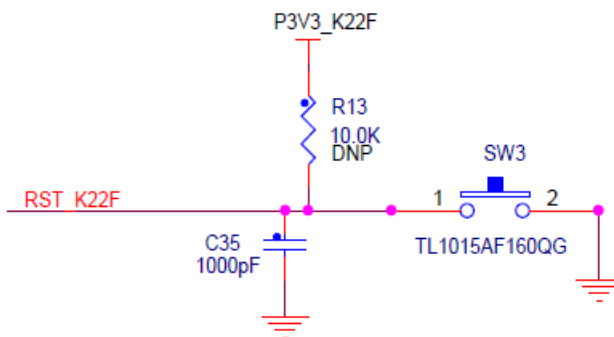


Figure 13. USB-KW40Z MK22FN512 push button & LED

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

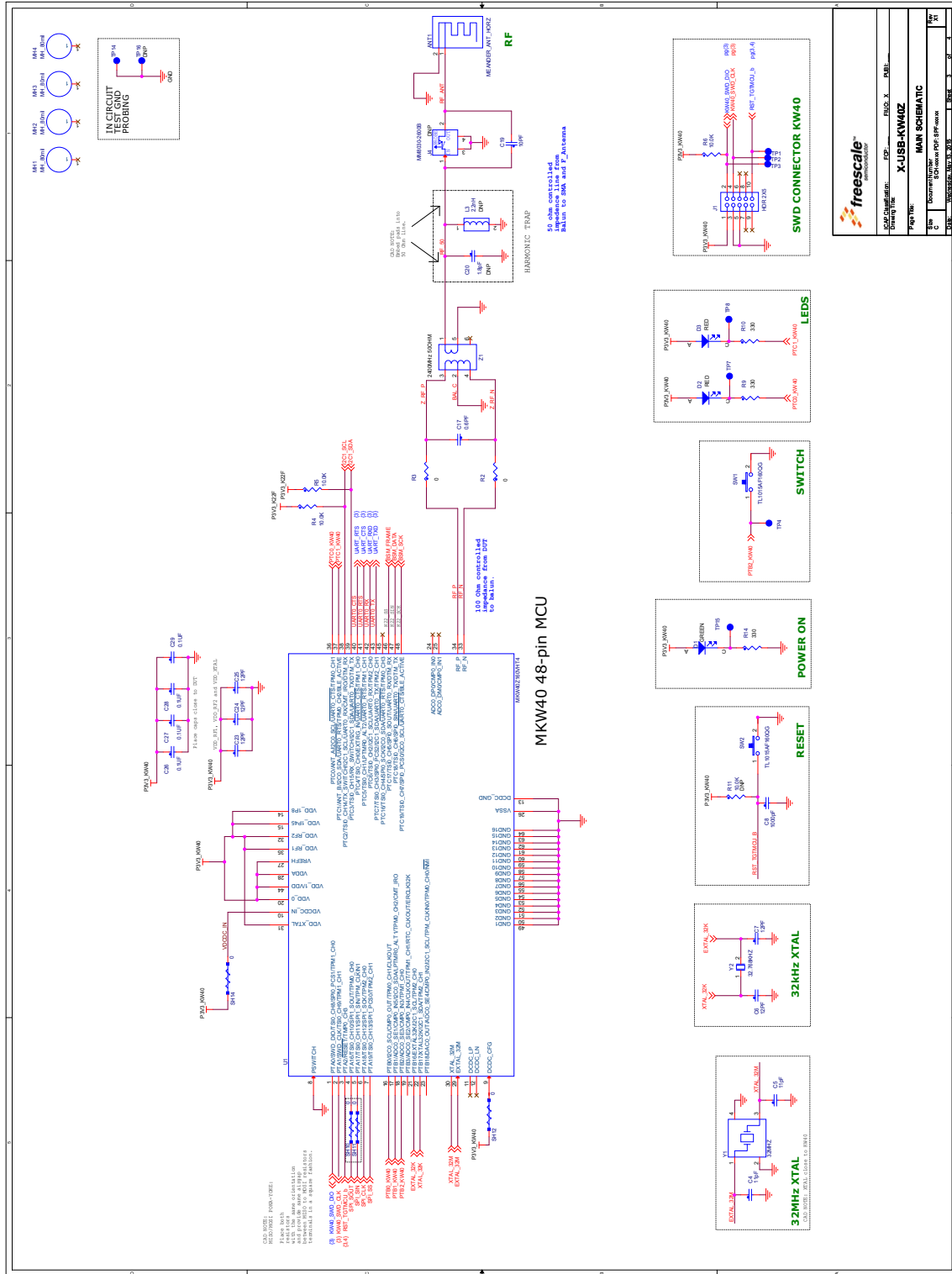


Figure 14. USB-KW40Z schematic rev. X1





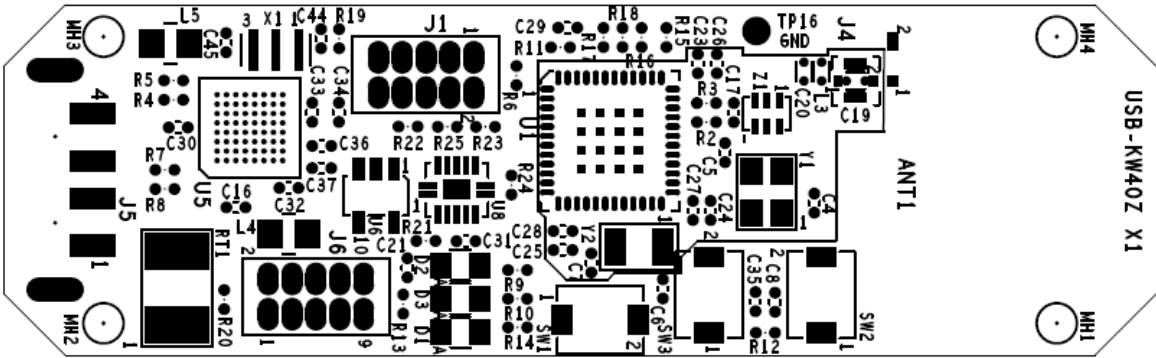


Figure 15. USB-KW40Z development board component location (top view)

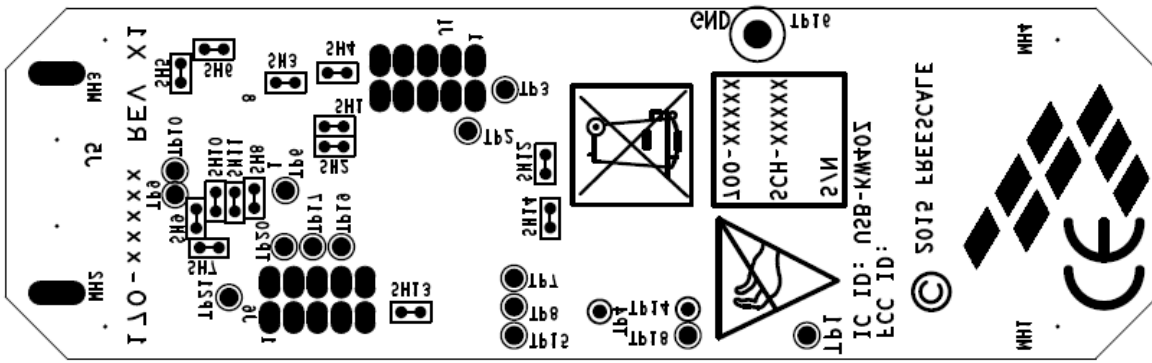


Figure 16. USB-KW40Z development board test points

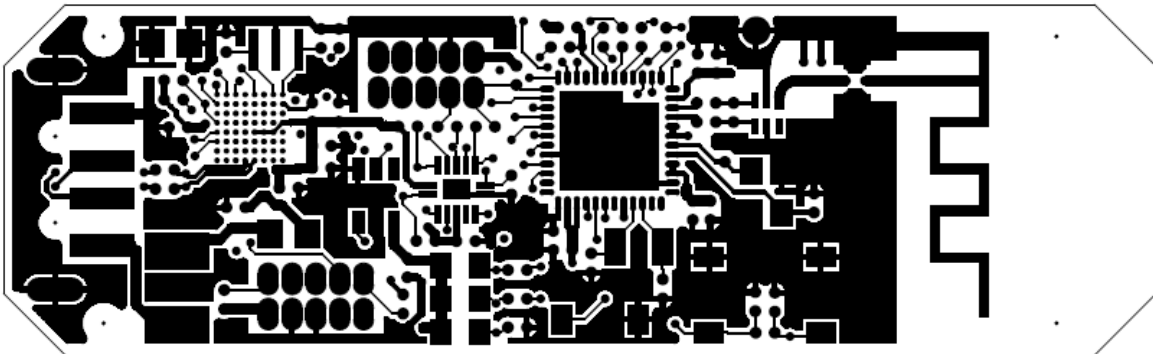


Figure 17. USB-KW40Z development board layout (top view)

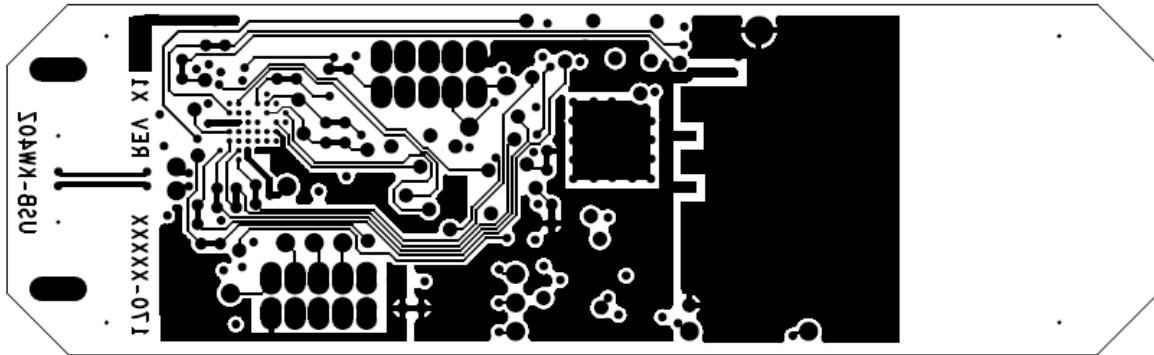


Figure 18. USB-KW40Z development board layout (bottom view)

### 4.3.1 Bill of materials

Table 2 details the common parts for all frequency bands.

Table 2. Bill of materials (common parts for all frequency bands) (Sheet 1 of 2)

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
1	1	ANT1	MEANDER_ANT_HORIZ	PCB MEANDER ANTENNA HORIZONTAL, NO PART TO ORDER	NO PART TO ORDER	NO PART TO ORDER
2	1	C17	0.6PF	CAP CER 0.6PF 50V +/-0.05PF C0G 0402	MURATA	GRM1555C1HR60WA01D
3	1	C20 DNP	1.8PF	CAP CER 1.8PF 50V 0.25PF C0G 0402	MURATA	GRM1555C1H1R8CA01D
4	1	C19	10PF	CAP CER 10PF 50V 5% C0G 0402	AVX	04025A100JAT2A
5	2	C4,C5	11PF	CAP CER 11PF 50V 1% C0G 0402	AVX	04025U110FAT2A
6	5	C6,C7,C23,C24,C25	12PF	CAP CER 12PF 50V 5% C0G 0402	MURATA	GRM1555C1H120JZ01D
7	2	C44,C45 DNP	18PF	CAP CER 18PF 50V 5% C0G 0402	KEMET	C0402C180J5GAC
8	2	C8,C35	1000PF	CAP CER 1000PF 50V 5% C0G 0402	MURATA	GRM1555C1H102JA01D
9	1	C34	0.01UF	CAP CER 0.01UF 16V 20% X7R 0402	AVX	0402YC103MAT2A
10	11	C16,C21,C26,C27,C28,C29,C30,C31,C32,C33,C36	0.1UF	CAP CER 0.1UF 10V 10% X5R 0402	KEMET	C0402C104K8PAC
11	1	C37	2.2UF	CAP CER 2.2UF 6.3V 20% X5R 0402	KEMET	C0402C225M9PACTU
12	1	D1	GREEN	LED GRN SGL 30MA SMT 0805	LITE ON	LTST-C171KGKT
13	2	D2, D3	RED	LED RED CLEAR SGL 30MA SMT 0805	LITE ON	LTST-C171KRKT
14	2	J1,J6	HDR 2X5	HDR 2X5 TH 50MIL CTR 254H AU 91L	SAMTEC	FTSH-105-04-F-D
15	1	J4 DNP	MM8030-2600B	CON COAX SMT 1.9MM SP 40H AU	MURATA	MM8030-2610B
16	1	J5	USB_TYPE_A	CON 1X4 USB_TYPE_A_MALE RA SMT -- 178H AU	SAMTEC	USB-AM-S-S-B-SM1
17	1	L3	2.2NH	IND -- 2.2NH@500MHZ 220MA 4% 0402	MURATA	LQP15MN2N2B02
18	2	L4,L5	330 OHM	IND FER BEAD 330OHM@100MHZ 2.5A -- SMT	TDK	MPZ2012S331A

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

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
19	4	MH1,MH2,MH3,MH4	MH_80MIL	REWORK HOLE NON-PLATED 50MIL DRILL SIZE 65MIL SOLDERMASK TH, NO PART TO ORDER	NO PART TO ORDER	NO PART TO ORDER
20	2	R2,R3	0	RES MF ZERO OHM 1/16W 5% 0402	ROHM	MCR01MZPJ000
21	1	R12 <b>DNP</b>	0	RES MF ZERO OHM 1/16W 5% 0402	ROHM	MCR01MZPJ000
22	1	R19	0	RES TF ZERO OHM 1/16W AEC-Q200 RC0402	VISHAY INTERTECHNOLOGY	CRCW04020000ZS
23	2	R7,R8	33	RES MF 33 OHM 1/16W 5% 0402	SMEC	RC73L2Z330JTF
24	3	R9,R10,R14	330	RES MF 330 OHM 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW0402330RJNED
25	6	R15,R16,R17,R18,R23, R25	1.0K	RES MF 1.0K 1/16W 1% 0402	YAGEO AMERICA	RC0402FR-071KL
26	5	R4,R5,R6,R20,R21	10.0K	RES MF 10.0K 1/16W 1% AEC-Q200 0402	VISHAY INTERTECHNOLOGY	CRCW040210K0FKED
27	2	R11,R13 <b>DNP</b>	10.0K	RES MF 10.0K 1/16W 1% AEC-Q200 0402	VISHAY INTERTECHNOLOGY	CRCW040210K0FKED
28	1	R22	27K	RES MF 27K 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW040227K0JNED
29	1	R24 <b>DNP</b>	27K	RES MF 27K 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW040227K0JNED
30	1	RT1	MINISMDC050F-2	FUSE PLYSW 0.5A 24V SMT	TYCO ELECTRONICS	MINISMDC050F-2
31	14	SH1,SH2,SH3,SH4, SH5,SH6,SH7,SH8, SH9,SH10,SH11,SH12, SH13,SH14	0	ZERO OHM CUT TRACE 0402 PADS; NO PART TO ORDER	LAYOUT ELEMENT ONLY	LAYOUT ELEMENT ONLY
32	3	SW1,SW2,SW3	TL1015AF160QG	SW SPST PB 50MA 12V SMT	E SWITCH	TL1015AF160QG
33	14	TP1,TP2,TP3,TP6,TP7, TP8,TP9,TP10,TP15, TP17,TP18,TP19,TP20, TP21	TPAD_040	TEST POINT PAD 40MIL DIA SMT, NO PART TO ORDER	NOTACOMPONENT	NOTACOMPONENT
34	2	TP4,TP14	TPAD_030	TEST POINT PAD 30MIL DIA SMT, NO PART TO ORDER	NOTACOMPONENT	NOTACOMPONENT
35	1	TP16 <b>DNP</b>	TEST POINT WHITE	TEST POINT WHITE 40 MIL DRILL 180 MIL TH 109L	COMPONENTS CORPORATION	TP-105-01-09
36	1	U1	MKW40Z160VHT4	IC MCU XCVR 2.4GHZ BLUETOOTH LOW ENERGY MAPLGA64	FREESCALE SEMICONDUCTOR	MKW40Z160VHT4
37	1	U5	MK22FN512VMP1 2	IC MCU 32BIT 512KB FLASH 128KB RAM 1.71-3.6V 120MHZ MAPBGA 64	FREESCALE SEMICONDUCTOR	MK22FN512VMP12
38	1	U6	NC7SZ14M5X	IC INV SGL 1.65-5.5V SOT23-5	FAIRCHILD	NC7SZ14M5X
39	1	U8	74LVC125	IC QUAD BUF LINE DRV TS 1.2-3.6V DHVQFN14	NXP SEMICONDUCTORS	74LVC125ABQ,115
40	1	X1	8.00MHZ	XTAL 8.00MHZ RSN CERAMIC -- SMT	MURATA	CSTCE8M00G55-R0
41	1	Y1	32MHZ	XTAL 32MHZ 9PF -- SMT 3.2X2.5MM	NDK	EXS00A-CS02368
42	1	Y2	32.768KHZ	XTAL 32.768KHZ SMT ROHS COMPLIANT	EPSON ELECTRONICS	FC-135 32.7680KA-A3
43	1	Z1	2400MHZ 50OHM	XFMR BALUN 2400 +/-100MHZ SMT	MURATA	LDB212G4005C-001

## NOTES

- USB-KW40Z includes neither J4 (the MMCX connector) nor the external antenna.
- For external measurements and/or external antenna usage, J4 should be installed and soldered in place.
- A 50 ohm MMCX connector is required; recommended part number MM8030-2600B from Murata.
- When selecting an external antenna to connect to the MMCX 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 USB-KW40Z development printed circuit board (PCB) described in this guide.

The USB-KW40Z development platform 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 for the MKW40Z160 development boards is available at the Freescale website ([www.freescale.com/KW40Z](http://www.freescale.com/KW40Z)) 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.

### 5.1 Single PCB construction

This section describes individual PCB construction details.

- The USB-KW40Z PCBs are four-layer, multi-layer designs
- The PCBs contain no blind, buried, or micro vias

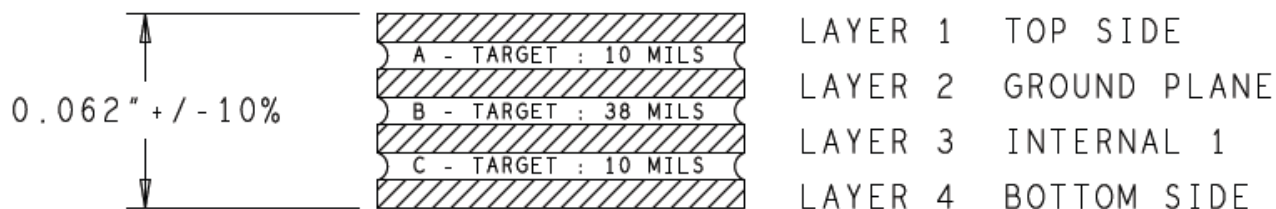
- PCB data:
  - USB-KW40Z size: Approximately 18.5x 61.4 mm (0.73 x 2.42 inches)
  - USB-KW40Z final thickness (Cu/Cu): 1.57 mm (0.62 inches) +/- 10% (excluding solder mask)

Table 3 defines some of the layers of the completed PCB. The artwork identification refers to the name of the layer in commonly used terms.

**Table 3. USB-KW40Z 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

**IMPORTANT:** The USB-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 19) information provided with the reference design.



**Figure 19. USB-KW40Z PCB stackup cross-section (four layer)**

- Solder mask is required
- Silk screen is required

## 5.2 Panelization

The panel size can be negotiated depending on production volume.

## 5.3 Materials

The PCB composite materials must meet the following requirements:

- Laminate—the base 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-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-28441.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-28441.pdf*—USB- Board fabrication drawing
- *GRB-28441.zip*—USB- Metal layers, solder mask, solder paste and silk screen

## Revision history

- *SPF-28441.pdf*—USB- Schematic

Design files are in Allegro format with OrCAD schematic capture.

## 6 Revision history

Rev. number	Date	Substantive change(s)
0	10/2015	Initial release



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#### Как с нами связаться

**Телефон:** 8 (812) 309 58 32 (многоканальный)

**Факс:** 8 (812) 320-02-42

**Электронная почта:** [org@eplast1.ru](mailto:org@eplast1.ru)

**Адрес:** 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.