Freescale Semiconductor, Inc.
User's Guide

Document Number: KW40HRMRDUG
Rev. 0, 10/2015

Freescale Reference Design Board KW40-HRM-RD User's Guide

1 About this guide

This manual describes the Freescale KW40 Heart Rate Monitor reference design platform. The MKW40Z family of SoCs integrate 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 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 KW40-HRM-RD board overview and description

The KW40-HRM-RD board is based on the Freescale MKW40Z device, MKW40Z160VHT4. The device incorporates 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 an ARM Cortex-M0+ MCU into a single package.

The KW40-HRM-RD is a Bluethooth® Low Energy Heart Rate Sensor. It implements heart rate calculations using ECG signals taken from the fingertips. It includes all the required circuitry for signal acquisition, processing and transmission, as well as a Li-Ion battery charger circuit.

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

2.1 KW40-HRM-RD board features

The KW40-HRM-RD board contains the MKW40Z device and demonstrates some of the available features in a reduced form factor board. With a specific application taking advantage of the MCU low power capabilities powered by a 3.6V 200 mA battery (not included) with 32 MHz reference oscillator crystal, RF circuitry including antenna, and supporting circuitry in a reduced form factor board

Figure 1 shows the KW40-HRM-RD board.

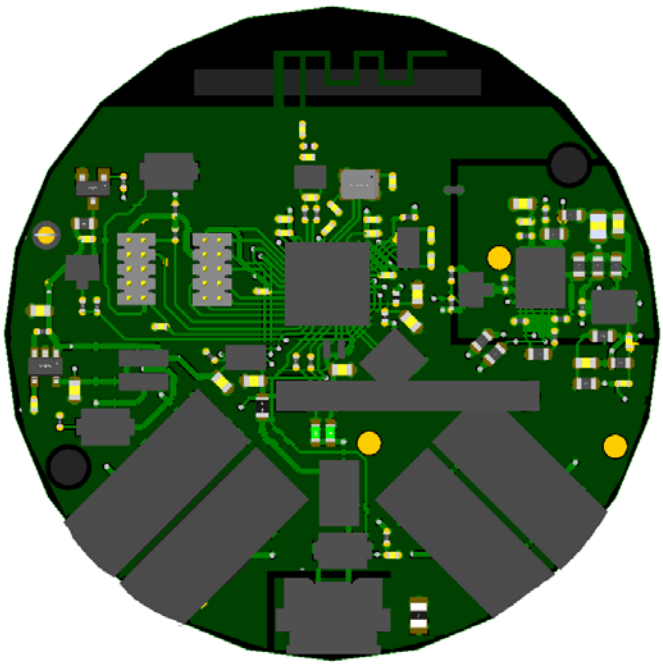


Figure 1. KW40-HRM-RD board

The KW40-HRM-RD board includes the following features:

- The Freescale ultra-low-power MKW40Z SoC BLE/ZigBee device
- 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
- Reference design area with small footprint, low-cost RF node
  - Differential I/O 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: -94 dBm, for BLE applications
- Integrated PCB meander horizontal antenna
- DC-DC converter with Buck operation mode
- 2-Layer metal, 0.062 inch thick FR4 board
- LGA footprint and power supply (DC/DC converter)
- 32.768 kHz crystal provided for optional timing oscillator
- 1 battery holder
- Small RF footprint.
- 32 MHz reference oscillator
- 32 kHz reference oscillator
- 2.4 GHz frequency operation (ISM Band and MBAN)
- Cortex 10-pin (0.05 inch) SWD debug port for target MCU
- 2 LED indicator
- 1interrupt push button switch
- 4 electrode sliders
- Signal acquisition section

Figure 2 shows the main board features for the Freescale KW40-HRM-RD board.

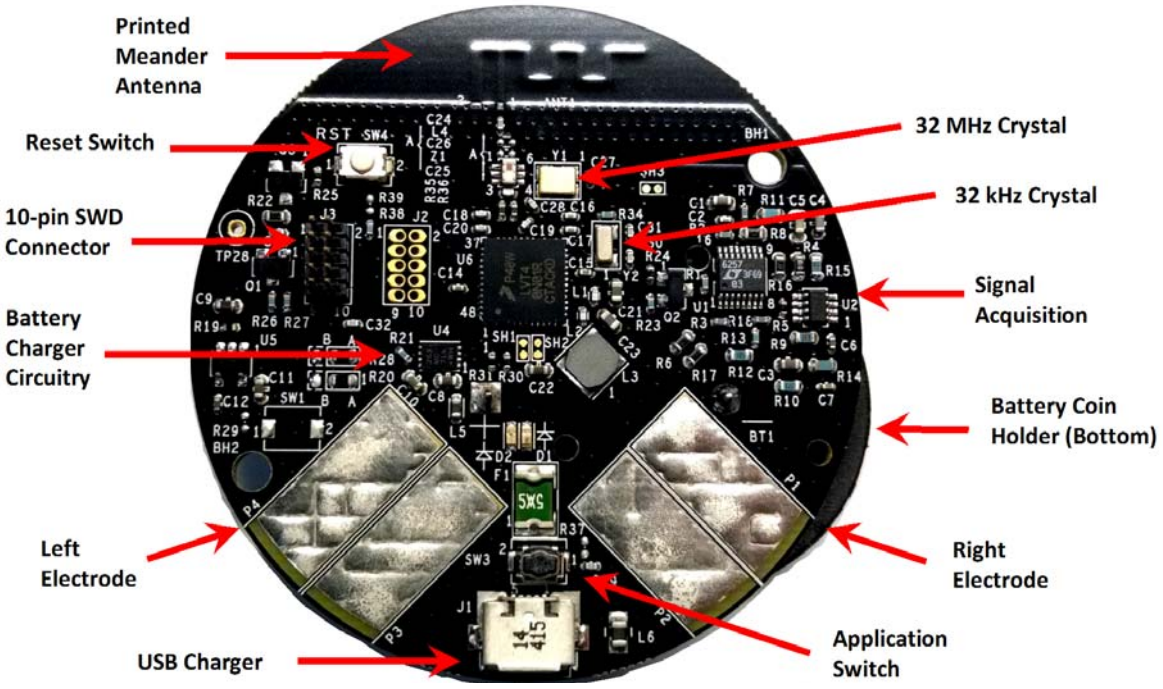


Figure 2. KW40-HRM-RD components

3 KW40-HRM-RD development platform

3.1 KW40-HRM-RD development platform overview

The KW40-HRM-RD development platform is a reference design and is based on the Freescale MKW40Z MCU. The device leverages a 32 MHz reference oscillator crystal, RF circuitry including a PCB antenna (and supporting circuitry), and a signal acquisition section in a small form factor battery-operated board. Figure 3 shows a simple block diagram.

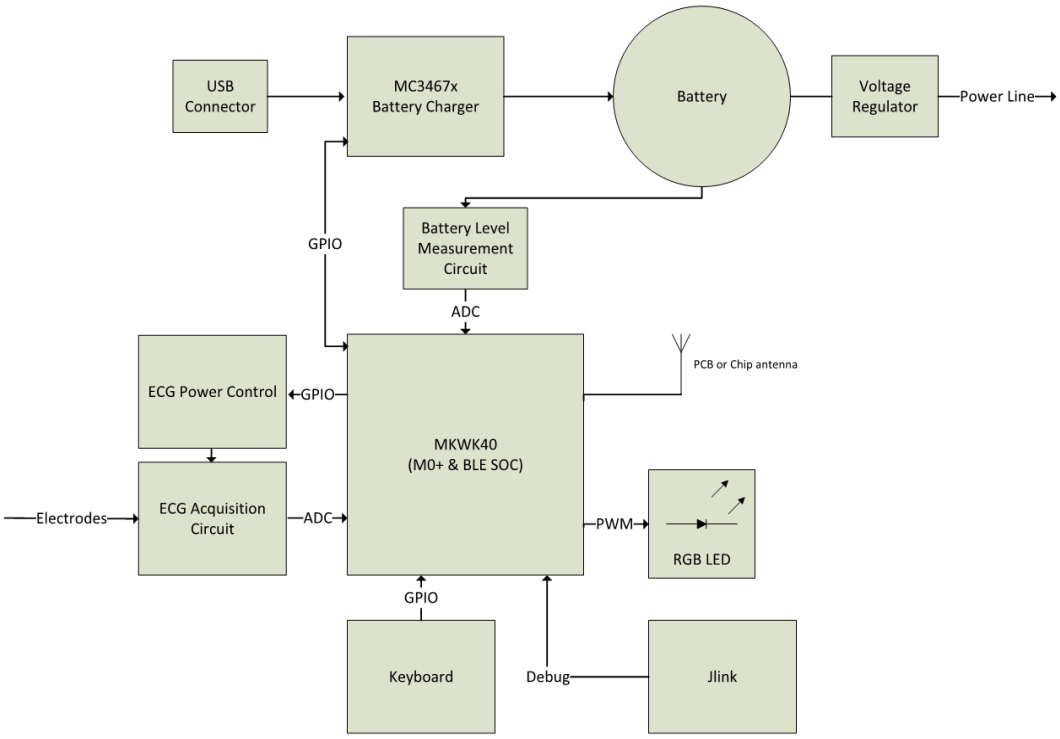


Figure 3. KW40-HRM-RD block diagram

3.2 Board level specifications

Table 1. KW40-HRM-RD specifications

Parameter	Min	Typ	Max	Units	Notes/Conditions
General					
Size (PCB: X, Y)	—	—	57.4 x 57.4 2.26 x 2.26	mm inches	—
Layer build (PCB)	—	1.57 0.062	—	mm inches	2-Layer
Dielectric material (PCB)	—	—	—	—	FR4
Power					
Current consumption	—	—	—	mA	Varies with operational mode, Refer to data sheet.
Temperature					
Operating temperature (see note)	-40	+25	+70	°C	Operating temperature is limited to +70 °C due to switches. The basic circuit is good for a maximum temperature of +85°C
Storage temperature	-30	+25	+70	°C	—
RF 802.15.4 Frequency range	2405	—	2480	MHz	All 16 channels in the 2450 MHz band
RF BLE Frequency range	2400	—	2480	MHz	All 40 channels in the 2450 MHz band
RF ISM & MBAN Frequency range	2360	—	2483	MHz	—
RF Receiver					
Saturation (maximum input level)	—	+0	—	dBm	Refer to data sheet
Sensitivity for 1% packet error rate (PER) (+25 °C) 802.15.4	—	-102	—	dBm	Refer to data sheet
Sensitivity for 1% packet error rate (PER) (+25 °C) BLE	—	-94	—	dBm	Refer to data sheet
RF Transmitter					
RF Power Output	-20	—	+5	dBm	Programmable in steps. At the antenna feed with no trap. [1]
2nd harmonic	—	<-50	<-40	dBm	Refer to data sheet
3rd harmonic	—	<-50	<-40	dBm	Refer to data sheet

[1] Trap will add 1 to 2 dB of loss* TBD.

3.3 Functional description

3.3.1 RF performance and considerations

The KW40-HRM-RD development board includes a 1 mW nominal output 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 device's transceiver are:

- Nominal output power is set to 0 dBm
- Programmable output power from –20 dBm to +5 dBm at the output RF pin
- Typical sensitivity is -102 dBm (@1% PER for 25 °C) at the RF port (802.15.4)
- Typical sensitivity is -91 dBm (@1% PER for 25 °C) at the RF port (BLE)
- Frequency range is 2360 to 2480 MHz
- Differential bidirectional RF I/O port with integrated transmit/receive switch
- Meander horizontal printed metal antenna for a small footprint, low cost design
- Uses a minimum number of RF marching components and external 50:100 balun.

The layout has provision for out-of-band signal suppression (components L4 and C26) if required. Figure 4 shows the typical topology for the RF circuitry.

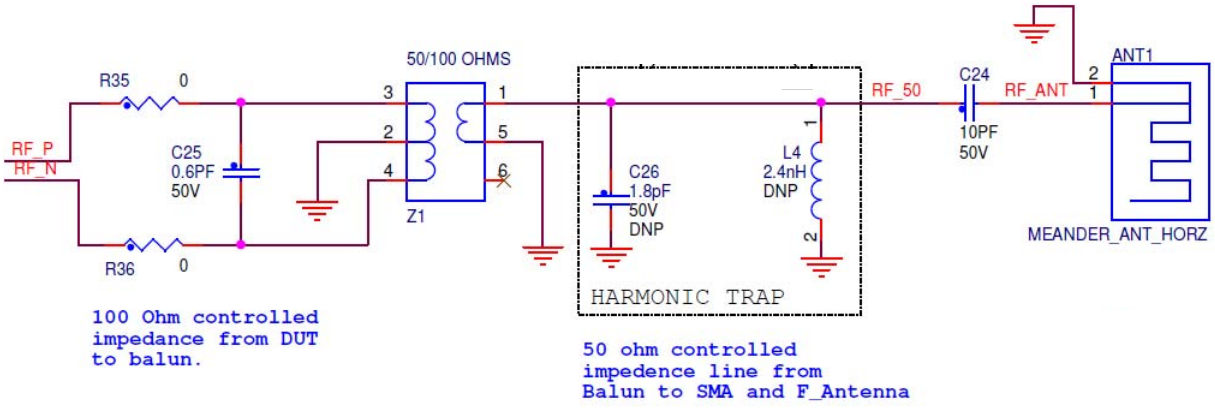


Figure 4. KW40-HRM-RD RF circuitry

3.3.2 Clocks

The KW40-HRM-RD provides two clocks:

- 32 MHz Reference Oscillator - Figure 5 shows the external 32 MHz external crystal Y1. This mounted crystal must meet the specifications outlined in the AN3251 application note. IEEE Std. 802.15.4 requires that the frequency be accurate to less than ±40 ppm.
  - Capacitors C27 and C28 provide the bulk of the crystal load capacitance. At 25 °C, the frequency must be accurate to ±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 6). This oscillator can be used for a low power accurate time base.
  - The module comes provided with this Y2 crystal and its load capacitors C30 and C31.
  - Load capacitors C30 and C31 provide the entire crystal load capacitance; there is no onboard trim capacitance.
  - The 32 kHz oscillator components are supplied.

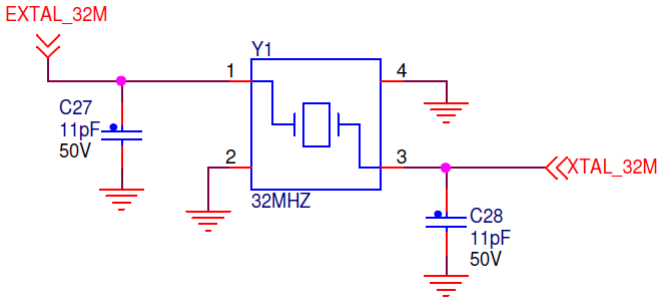


Figure 5. KW40-HRM-RD 32 MHz reference oscillator circuit

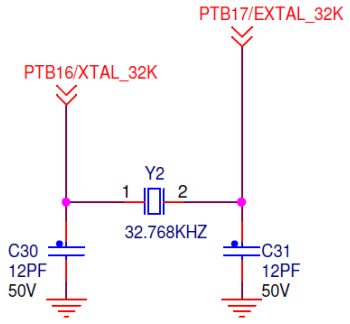


Figure 6. KW40-HRM-RD 32.768 kHz optional oscillator circuit

3.3.3 Power management

The KW40-HRM-RD board is powered by a 3.6V 200 mA battery (not included) which is charged by the Freescale MC34671AEP Li-Ion battery charger.

The USB micro port is only used to feed the MC34671AEP. It does not power the board directly and there is no USB communication. The Freescale MC34671AEP Li-Ion battery charger is disconnected when the battery is fully charged.

The board is configured to work in buck mode, the 3.6V from the battery is regulated to 1.8V for the whole circuit. In case that more current is needed, there is a backup LDO 1.8V voltage regulator.

The KW40-HRM-RD power management circuit is shown in Figure 7.

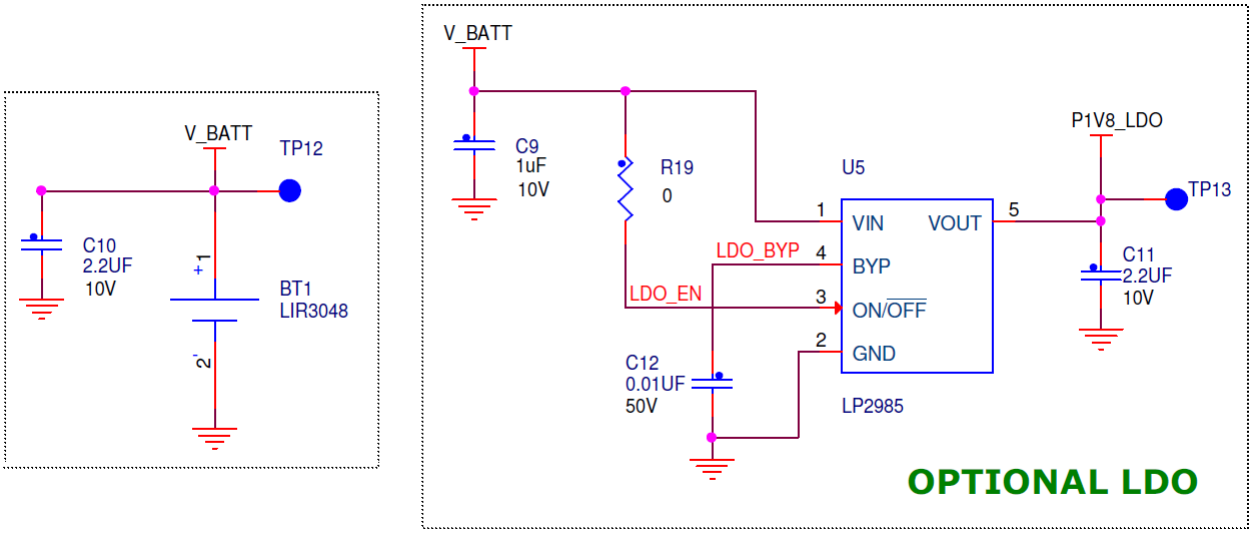


Figure 7. KW40-HRM-RD power management circuit

The KW40-HRM-RD battery charger circuit is shown in Figure 8.

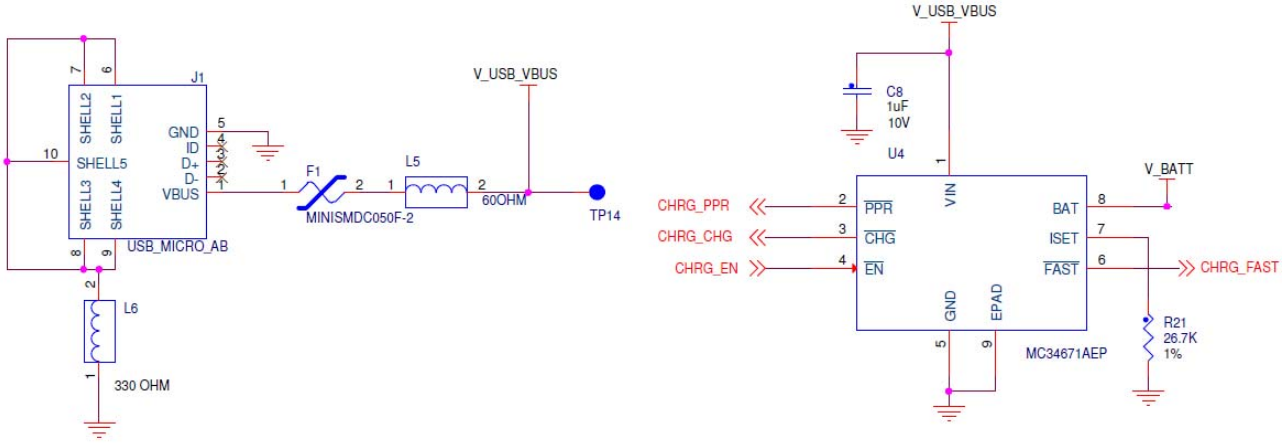


Figure 8. KW40-HRM-RD Battery charger circuit

3.3.3.1 Battery monitor and power control

The battery monitor circuit adjust the voltage from the battery to make it adequate for being read by the SoC ADC. This circuit consists in a voltage divisor and a transistor array for enabling the measurements and prevent the circuit from draining unnecessary current while not in use.

The power control circuit enables and disables the power supply for the analog acquisition system. It prevents from current to be drawn unnecessarily while the signal acquisition system is not in use.

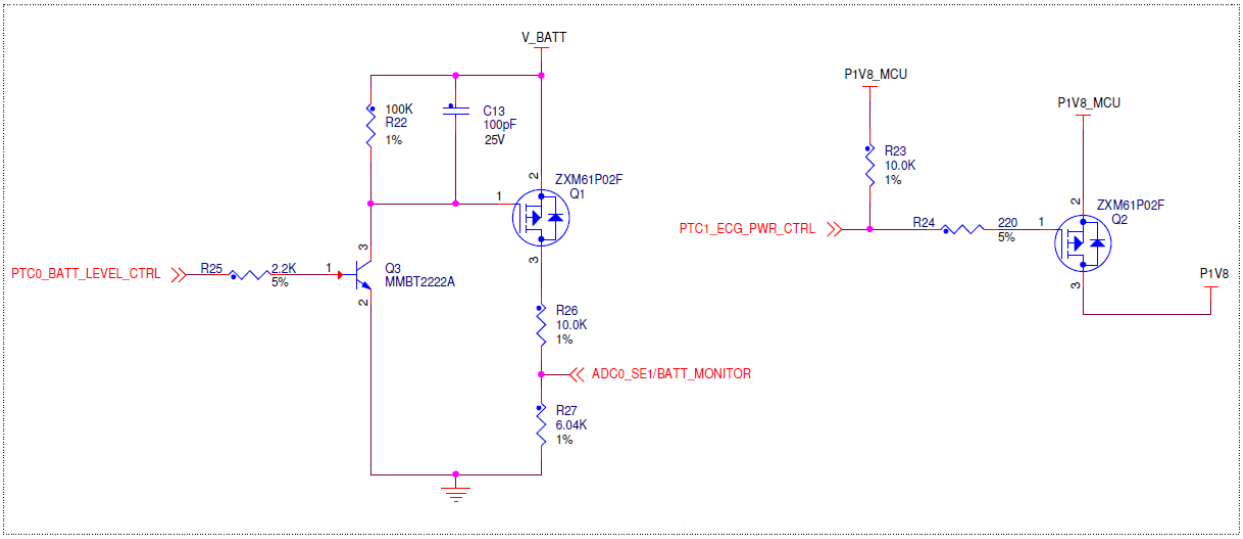


Figure 9. Battery monitor and power control

3.3.3.2 Signal acquisition system

The signal acquisition system block obtains, amplifies and processes the ECG signal from the finger tips. It is divided in three acquisition stages.

1) Acquisition and pre-amplification

Two pair of electrodes are placed in the top side of the board and connected to an instrumentation amplifier. One electrode of each pair is connected to one of the differential input of the instrumentation amplifier. The other two electrodes are connected to the reference line. The difference is obtained and amplified removing most of the common noise. This signal is passed to the next stage for filtering.

2) Filtering

The signal is passed through two different filters. The first one is a band-pass from 0.5Hz to 250Hz. This filter reduces the baseline variations and eliminates the high frequency noise. The second filter is a 60Hz notch designed to remove the wall power noise from the design.

3) Amplification

Once the signal has been filtered, it is passed through an non-inverter amplifier that adjusts the signal amplitude to be readable by the ADC.

The KW40-HRM-RD signal acquisition circuit is shown in Figure 10.

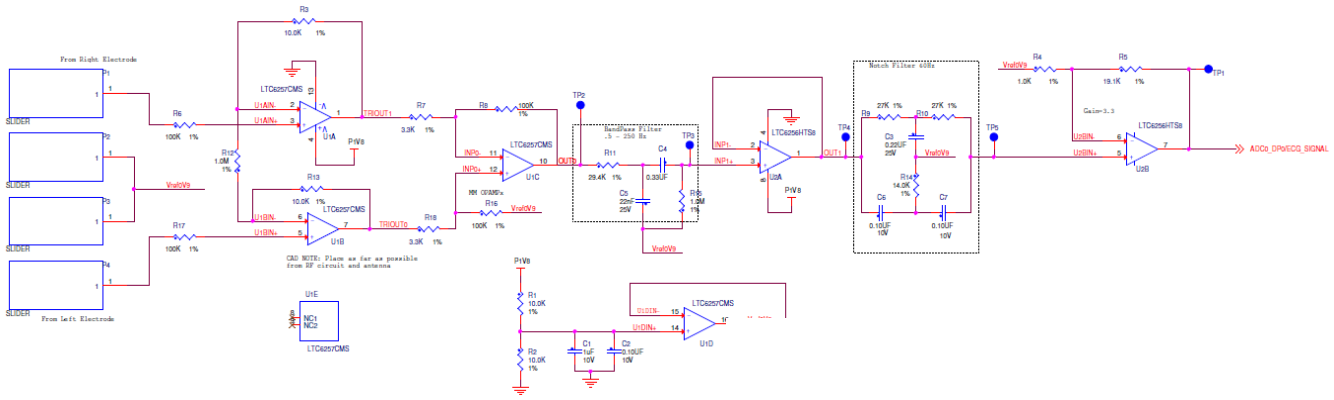


Figure 10. KW40-HRM-RD signal acquisition

3.3.3.3 Debuger / SWD Connector

The 10-pin SWD 2x5 header J3 is provided to connect the MKW40Z serial debug port to a standar Kinetis Series debug module.

The SWD port connector is shown in Figure 11

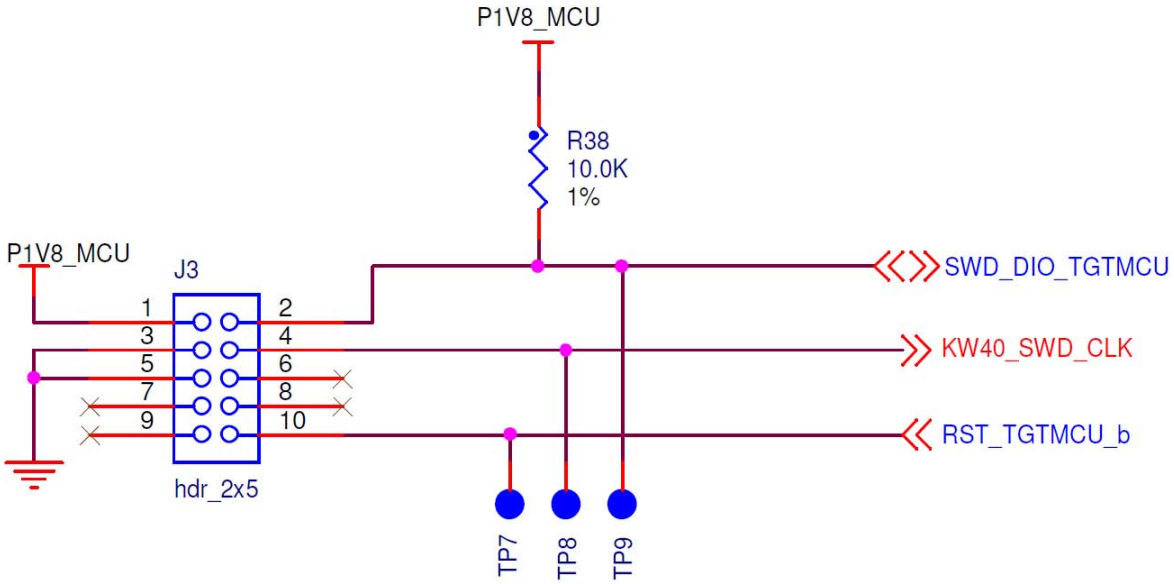


Figure 11. KW40-HRM-RD SWD Connector

3.4 Schematic, board layout, and bill of material

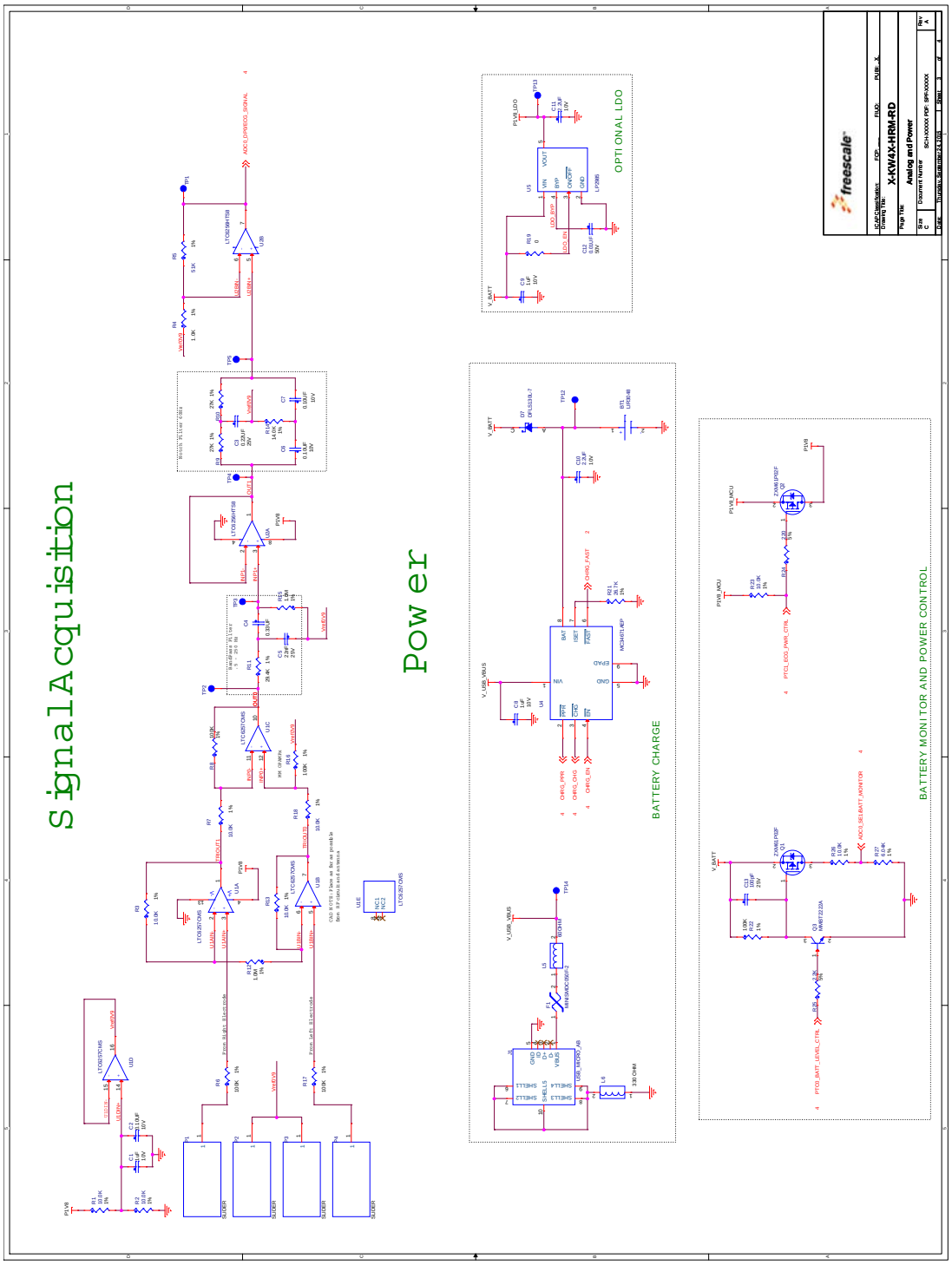
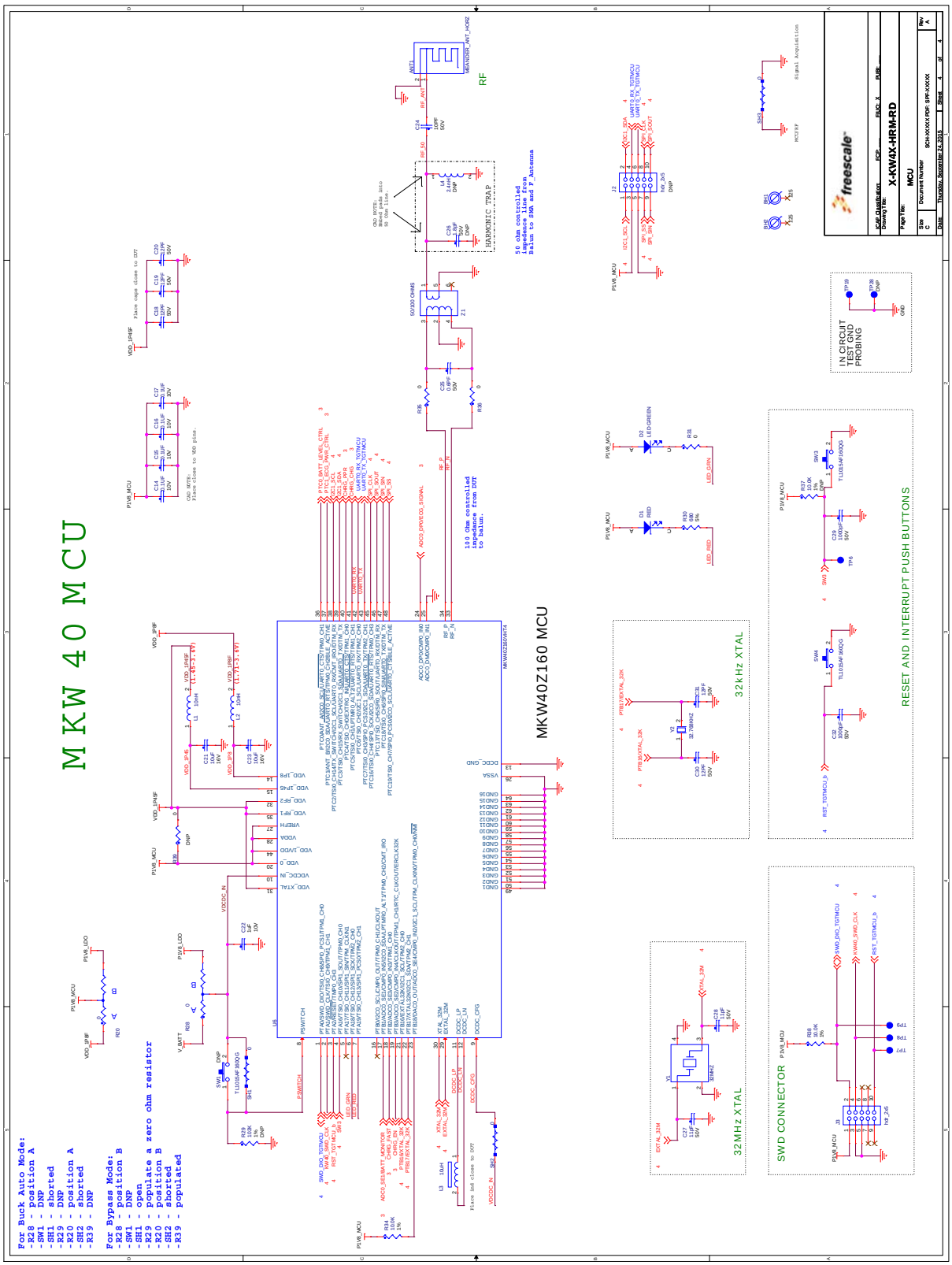


Figure 12. KW40-HRM-RD schematic rev. X3


MKW40 MCU
MKW40Z160 MCU
RF
HARMONIC TRAP
32kHz XTAL
32MHz XTAL
SWD CONNECTOR
RESET AND INTERRUPT PUSH BUTTONS
IN CIRCUIT TEST AND PROBING
For Buck Auto Mode:
-R28 - position A
-SW1 - DNP
-SH1 - shorted
-R29 - DNP
-R20 - position A
-SH2 - shorted
-R39 - DNP
For Bypass Mode:
-R28 - position B
-SW1 - DNP
-SH1 - open
-R29 - populate a zero ohm resistor
-R20 - position B
-SH2 - shorted
-R39 - populated
50 ohm controlled impedance line from Balun to SMA and F_Antenna
100 Ohm controlled impedance line from DUT to balun.
freescale
X-KW40X-HRM-RD
MCU

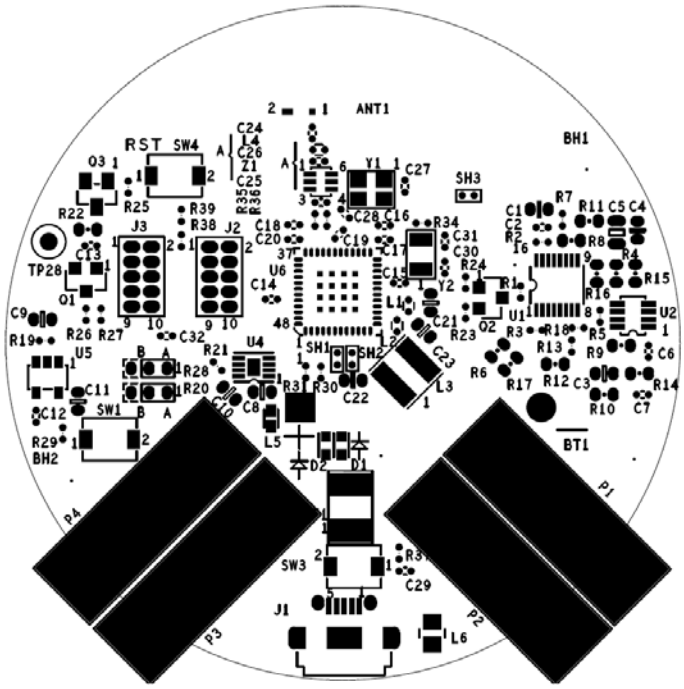


Figure 13. KW40-HRM-RD reference board component location (top view)

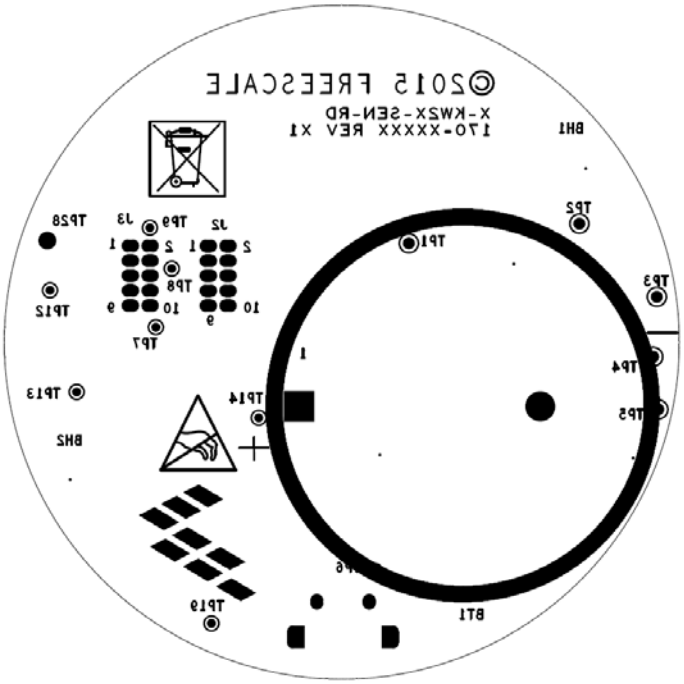


Figure 14. KW40-HRM-RD reference board test points

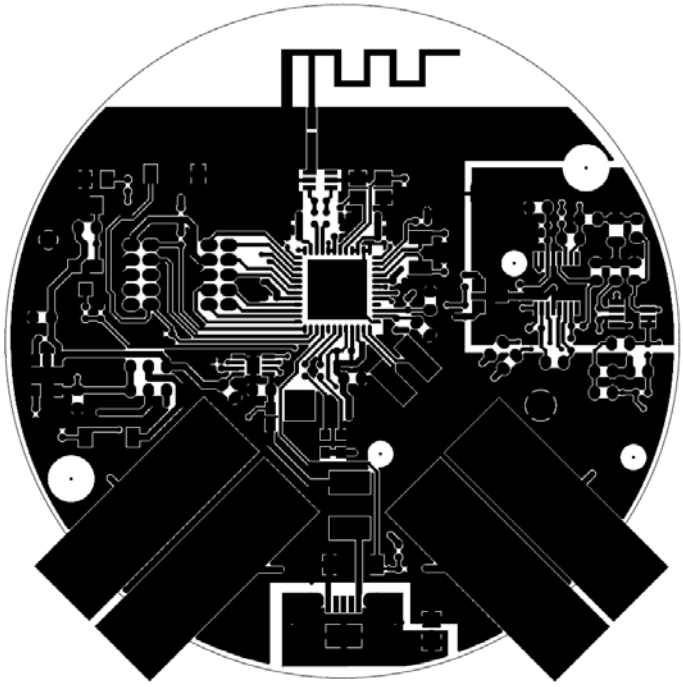


Figure 15. KW40-HRM-RD reference board layout (top view)

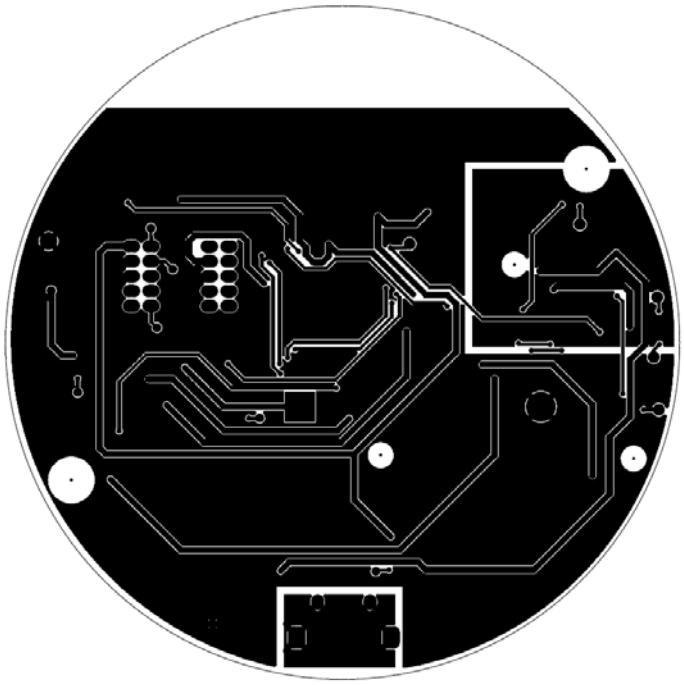


Figure 16. KW40-HRM-RD reference board layout (bottom view)

3.4.1 Bill of materials

Table 2. 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	MEANDER_ANT_HORZ	PCB MEANDER ANTENNA HORIZONTAL, NO PART TO ORDER	NO PART TO ORDER	NO PART TO ORDER
2	2	BH1,BH2	125	NON-PLATED MOUNTING HOLE 125 DRILL / 160 KEEPOUT NO PART TO ORDER	NO PART TO ORDER	NO PART TO ORDER
3	1	BT1	LIR3048	BATTERY HOLDER 3032 HORIZONTAL TH	Keystone Electronics	301
4	4	C1,C8,C9, C22	1uF	CAP CER 1UF 10V 10% X5R 0603	KEMET	C0603C105K8PAC
5	3	C2,C6,C7	0.10UF	CAP CER 0.10UF 10V 10% X5R 0402	AVX	0402ZD104KAT2A
6	1	C3	0.22UF	CAP CER 0.22UF 25V 10% X5R 0603	TAIYO YUDEN	TMK107BJ224KA-T
7	1	C4	0.33UF	CAP CER 0.33UF 25V 10% X7R 0603	MULTICOMP	MCCA001173
8	1	C5	22nF	CAP CER 0.022UF 25V 5% C0G 0805	TDK	C2012C0G1E223J
9	2	C10,C11	2.2UF	CAP CER 2.2UF 10V 10% X7R 0603	TAIYO YUDEN	LMK107B7225KA-T
10	1	C12	0.01UF	CAP CER 0.01UF 50V 10% X7R 0402	WALSIN TECHNOLOGY CORP.	0402B103K500CT
11	1	C13	100pF	CAP CER 100pF 25V 10% X7R 0402	YAGEO AMERICA	CC0402KRX7R8BB101
12	4	C14,C15, C16,C17	0.1UF	CAP CER 0.1UF 10V 10% X5R 0402	KEMET	C0402C104K8PAC
13	5	C18,C19, C20,C30, C31	12PF	CAP CER 12PF 50V 5% C0G 0402	MURATA	GRM1555C1H120JZ01D
14	2	C21,C23	10uF	CAP CER 10uF 16V 20% X5R 0603	TAIYO YUDEN	EMK107BBJ106MA-T
15	1	C24	10PF	CAP CER 10PF 50V 5% C0G 0402	AVX	04025A100JAT2A
16	1	C25	0.6PF	CAP CER 0.6PF 50V 0.25PF NP0 0402	MURATA	GRM1555C1HR60CA01D
17	1	C26 **DNP**	1.8pF	CAP CER 1.8PF 50V 0.25PF C0G 0402	MURATA	GRM1555C1H1R8CA01D
18	2	C27,C28	11pF	CAP CER 11pF 50V 1% C0G 0402	AVX	04025U110FAT2A

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

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
19	2	C29,C32	1000pF	CAP CER 1000PF 50V 5% C0G 0402	MURATA	GRM1555C1H102JA01D
20	1	D1	RED	LED RED SGL 20MA 0603	LITE ON	LTST-C193KRKT-5A
21	1	D2	GRN	LED GRN SGL 30MA 0603	LITE ON	LTST-C193KGKT-5A
22	1	F1	MINISMDC050F-2	FUSE PLYSW 0.5A 24V SMT	TYCO ELECTRONICS	MINISMDC050F-2
23	1	J1	USB_MICRO_AB	CON 5 USB_MICRO_AB_RECEPTACLE RA SKT SMT 0.65MM SP 122H AU	molex	475900001
24	1	J2 **DNP**	hdr_2x5	HDR 2X5 TH 50MIL CTR 254H AU 91L	SAMTEC	FTSH-105-04-F-D
25	1	J3	hdr_2x5	HDR 2X5 TH 50MIL CTR 254H AU 91L	SAMTEC	FTSH-105-04-F-D
26	2	L1,L2	10nH	IND -- 0.010uH@100MHZ 350MA 5% 0402	TDK	MLK1005S10NJT000
27	1	L3	10uH	IND WW FER 10uH@1MHz 0.99A 20% 4012	TDK	VLS4012ET-100M
28	1	L4 **DNP**	2.4nH	IND -- 0.0024UH@100MHZ 300MA 0.0003UH 0402	MURATA	LQG15HN2N4S02D
29	1	**L5**	60OHM	IND FER BEAD 60OHM@100MHZ 500MA -- 0603	MURATA	BLM18PG600SN1D
30	1	L6	330 OHM	IND FER BEAD 330OHM@100MHZ 2.5A -- SMT	TDK	MPZ2012S331A
31	4	P1,P2,P3, P4	SLIDER	ELECTRODE 800X258 MILS NO PART TO ORDER	N/A	N/A
32	2	Q1,Q2	ZXM61P02F	TRAN PMOS SW 0.9A 20V SOT23	DIODES INC	ZXM61P02FTC
33	1	Q3	MMBT2222A	TRAN NPN GEN 40VCEO	FAIRCHILD	MMBT2222A
34	8	R1,R2,R3, R13,R23, R26,R34, R38	10.0K	RES MF 10.0K 1/16W 1% 0402	WALSIN TECHNOLOGY CORP.	WR04X1002FTL
35	1	R4	1.0K	RES MF 1.00K 1/10W 1% 0603	KOA SPEER	RK73H1JTTD1001F
36	1	R5	19.1K	RES MF 19.1K 1/16W 1% 0402	KOA SPEER	RK73H1ETTP1912F
37	5	R6,R8, R16,R17, R22	100K	RES MF 100K 1/10W 1% 0603	KOA SPEER	RK73H1JTTD1003F
38	2	R7,R18	3.3K	RES MF 3.3K 1/16W 1% 0402	VISHAY INTERTECHNOLOGY	CRCW04023K30FKED

Table 2. Bill of materials (common parts for all frequency bands) (Sheet 3 of 4)

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
39	2	R9,R10	27K	RES MF 27.0K 1/10W 1% 0603	KOA SPEER	RK73H1JTTD2702F
40	1	R11	29.4K	RES MF 29.4K 1/10W 1% 0603	KOA SPEER	RK73H1JTTD2942F
41	2	R12,R15	1.0M	RES MF 1.0M 1/10W 1% 0603	WALSIN TECHNOLOGY CORP.	WR06X1004FTL
42	1	R14	14.0K	RES MF 14.0K 1/10W 1% 0603	KOA SPEER	RK73H1JTTD1402F
43	3	R19,R35, R36	0	RES MF ZERO OHM 1/16W 5% 0402	ROHM	MCR01MZPJ000
44	2	R20,R28	0	RES MF ZERO OHM 1/10W -- AEC-Q200 0603	KOA SPEER	RK73Z1JTTD
45	1	R21	26.7K	RES MF 26.7K 1/16W 1% 0402	KOA SPEER	RK73H1ETTP2672F
46	1	R24	220	RES MF 220 OHM 1/16W 5% 0402	KOA SPEER	RK73B1ETTP221J
47	1	R25	2.2K	RES MF 2.2K 1/16W 5% 0402	VENKEL COMPANY	CR0402-16W-222JT
48	1	R27	6.04K	RES MF 6.04K 1/16W 1% 0402	KOA SPEER	RK73H1ETTP6041F
49	1	R29 **DNP**	102K	RES MF 102K 1/16W 1% 0402	KOA SPEER	RK73H1ETTP1023F
50	2	R30,R31	680	RES MF 680 OHM 1/16W 5% 0402	PANASONIC	ERJ-2GEJ681X
51	1	R37 **DNP**	10.0K	RES MF 10.0K 1/16W 1% 0402	WALSIN TECHNOLOGY CORP.	WR04X1002FTL
52	1	R39 **DNP**	0	RES MF ZERO OHM 1/16W 5% 0402	ROHM	MCR01MZPJ000
53	3	SH1,SH2, SH3	0	ZERO OHM CUT TRACE 0402 PADS; NO PART TO ORDER	LAYOUT ELEMENT ONLY	LAYOUT ELEMENT ONLY
54	1	SW1 **DNP**	TL1015AF160QG	SW SPST PB 50MA 12V SMT	E SWITCH	TL1015AF160QG
55	2	SW3,SW4	TL1015AF160QG	SW SPST PB 50MA 12V SMT	E SWITCH	TL1015AF160QG
56	5	**TP1,TP2,TP3,TP4,TP5**	TPAD_040	TEST POINT PAD 40MIL DIA SMT, NO PART TO ORDER	NOTACOMPONENT	NOTACOMPONENT
57	8	TP6,TP7, TP8,TP9, TP12, TP13, TP14,TP19	TPAD_030	TEST POINT PAD 30MIL DIA SMT, NO PART TO ORDER	NOTACOMPONENT	NOTACOMPONENT
58	1	TP28 **DNP**	TEST POINT WHITE	TEST POINT WHITE 40 MIL DRILL 180 MIL TH 109L	KEYSTONE ELECTRONICS	5002
59	1	U1	LTC6257CMS	IC LIN AMP QUAD 6.5MHz 1.8-5.25V MSOP16	LINEAR Technology	LTC6257CMS#PBF

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

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
60	1	U2	LTC6256HTS8	IC LIN OPAMP DUAL RAIL-TO-RAIL 1.8-5.25V TSOT23-8	LINEAR TECHNOLOGY	LTC6256HTS8#TRMPBF
61	1	U4	MC34671AEP	IC CHARGER LI-ION BATT 24V DFN8	FREESCALE SEMICONDUCTOR	MC34671AEP
62	1	U5	LP2985	IC VREG LDO 1.8V 150MA 2.8V TO 16V SOP 5	NATIONAL SEMICONDUCTOR	LP2985IM5-1.8/NOPB
63	1	**U6**	MKW40Z160VHT4	IC MCU XCVR 2.4GHZ BLUETOOTH LOW ENERGY MAPLGA64	FREESCALE SEMICONDUCTOR	MKW40Z160VHT4
64	1	Y1	32MHZ	XTAL 32MHZ 9PF -- SMT 3.2X2.5MM	NDK	EXS00A-CS02368
65	1	Y2	32.768KHZ	XTAL 32.768KHZ SMT ROHS COMPLIANT	EPSON ELECTRONICS	FC-135 32.7680KA-A3
66	1	Z1	50/100 OHMS	XFMR BALUN 2.45GHZ +/-50MHZ 50/100OHM 3W SMT	JOHANSON TECHNOLOGY	2450BL15B100_
67	1	D7	DFLS130L-7	DIODE SCH 1A 30V PowerDI123	DIODES INC	DFLS130L-7

4 PCB manufacturing specifications

This section provides the specifications used to manufacture the KW40-HRM-RD development printed circuit board (PCB) described in this guide.

The KW40-HRM-RD development platform PCBs must comply with the following:

- The PCB must comply with Perfag1D/3C (www.perfag.dk/en/)
- The PCB manufacturer's logo is required
- The PCB production week and year code is required
  - The manufacturer's logo and week/year code must be stamped on the back of the PCB solder mask
  - The PCB manufacturer cannot insert text on the PCB either in copper or in silkscreen without written permission from Freescale Semiconductor, Inc.
- The required Underwriter's Laboratory (UL) Flammability Rating
  - The level is 94V-0 (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 KW40-HRM-RD transceiver at the Freescale website (freescale.com/KW40) under "Software and Tools." These reference designs should be used as a starting point for a custom application.

4.1 Single PCB construction

This section describes individual PCB construction details.

- The KW40-HRM-RD PCBs are two-layer, multi-layer designs
- The PCBs contain no blind, buried, or micro vias
- PCB data:
  - KW40-HRM-RD size: Approximately 57.4 x 57.4 mm (2.26 x 2.26 inches)
  - KW40-HRM-RD 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. KW40-HRM-RD layer by layer overview

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

IMPORTANT: The KW40-HRM-RD 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. As a result, BOARD STACKUP GEOMETRY IS CRITICAL. Dielectric and copper thicknesses and spacing must not be changed; follow the stackup (see Figure 17) information provided with the reference design.

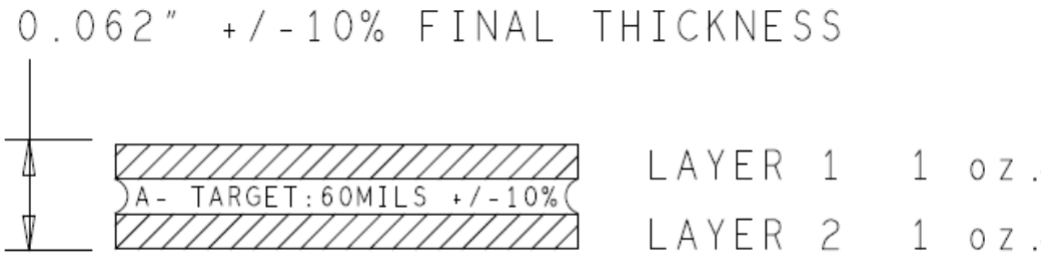


Figure 17. KW40-HRM-RD PCB stackup cross-section (two layer)

- Solder mask is required
- Silk screen is required

4.2 Panelization

The panel size can be negotiated depending on production volume.

4.3 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)

4.4 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

4.5 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

4.6 Electrical PCB testing

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

4.7 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.

4.8 Hole specification/tool table

See the *ncdrill-1-4.tap* file included with the Gerber files and the *FAB-KW40-HRM-RD.pdf* file.

4.9 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-KW40-HRM-RD.pdf*— Board fabrication drawing
- *GRB-KW40-HRM-RD.zip*— Metal layers, solder mask, solder paste and silk screen
- *SPF-KW40-HRM-RD.pdf*— Schematic

Design files are in Allegro format with OrCAD schematic capture.

5 Revision history

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

How to Reach Us:

Home Page:
freescale.com

Web Support:
freescale.com/support

Document Number: KW40HRMRDUG
Rev. 0
10/2015