TWR-KW2x Hardware

Reference Manual

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About This Book

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Safety Information

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KW24D512-TWR Development Platform Overview and Description

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About This Book

This manual describes Freescale’s TWR-KW2x development platform hardware. The TWR-KW2x is an IEEE® 802.15.4 compliant evaluation environment based on the Freescale MKW2x device. The MKW2x family is Freescale's latest generation ZigBee™ platform, which incorporates a complete low power 2.4 GHz radio frequency transceiver and a Kinetis family low power, mixed-signal ARMR eCortex™- M4 MCU into a single package. This family of products is targeted to meet the higher performance requirements of ZigBee Pro and ZigBee IP based applications, especially Smart Energy and Commercial Building Automation. This product is a cost-effective solution that matches or exceeds competitive solutions.

Audience

This manual is intended for system designers.

Organization

This document is organized into the following chapters.

Chapter 1	Safety Information — Highlights some of the FCC requirements.
Chapter 2	TWR-KW2x Development Platform Overview and Description — Provides an overview of the boards that comprise the TWR-KW2x development platform.
Chapter 3	TWR-KW2x — This chapter details the TWR-KW21D256 and TWR-KW24D512 evaluation boards.
Chapter 4	PCB Manufacturing Specifications — This chapter provides the specifications used to manufacture the various TWR-KW2x printed circuit boards (PCBs).

Revision History

The following table summarizes revisions to this document since the previous release (Rev. 0.0).

Revision History

Location	Revision
Entire document	First public release

Definitions, Acronyms, and Abbreviations

The following list defines the acronyms and abbreviations used in this document.

ADC	Analog to Digital Converter
AES	Advanced Encryption Standard
CTS	Clear to Send
DAC	Digital to Analog Converter
I2C	Inter-Integrated Circuit is a multi-master serial computer bus
ISM	Industrial Scientific Medical 2.4 GHz radio frequency band
JTAG	Joint Test Action Group
LGA	Land Grid Array
MAC	Media Access Controller
MCU	Microcontroller Unit
PCB	Printed circuit board
PiP	Platform in Package
PWM	Pulse-width modulation
RCM	Remote Control Module
REM	Remote Extender Board
RTS	Request to Send
SMA Connector	SubMiniature version “A” connector
SoC	System on Chip
SPI	Serial Peripheral Interface
SSI	Synchronous Serial Interface
TACT Switch	A switch that provides a slight “snap” or “click” to the user to indicate function.
TELCO	Telephone Company
TWR	Tower System
USB	Universal Serial Bus
VCP	Virtual Com Port

Chapter 1
Safety Information

1.1 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.

1.1.1 Labeling

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

1.1.2 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.

1.1.3 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.

1.1.4 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. 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.

1.2 Regulatory Approval For Canada (IC RSS 210)

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

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

1.2.1 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.

1.3 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

1.4 Disposal Instructions

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

Chapter 2
KW24D512-TWR Development Platform Overview and Description

2.1 Introduction

The KW24D512-TWR development platform is an evaluation environment based on the Freescale MKW24D512 SIP device (MKW2x).

The MKW2x device family is Freescale's latest generation ZigBee™ platform which incorporates a complete low power IEEE® 802.15.4 Standard 2.4 GHz radio frequency transceiver and a Kinetis family low power, mixed-signal ARM Cortex™- M4 MCU into a single package.

Freescale supplements the MKW2x with tools and software that include hardware evaluation and development boards, software development IDE and applications, drivers, custom PHY usable with Freescale’s IEEE 802.15.4 compatible MAC.

The KW24D512-TWR development platform contains the MKW24D512 device with 32 MHz reference oscillator crystal, RF circuitry including antenna, 16 Mbit serial flash, and supporting circuitry in the popular Tower form factor. The board is a standalone and supports applications development with Freescale’s IEEE 802.15.4 Standard protocol stacks and supports full speed USB 2.0.

Whether the KW24D512-TWR is used in a simple standalone application or in combination with another boards, Freescale provides a complete software development environment called the Freescale BeeKit Wireless Connectivity Toolkit (BeeKit). BeeKit is a comprehensive codebase of wireless networking libraries, application templates, and sample applications. A wide range of software functionality are available to complement the KW24D512-TWR platform and these are provided as codebases within BeeKit.

2.2 Board Features

2.2.1 KW24D512-TWR Board

The KW24D512-TWR development platform is part of Freescale’s Tower System Modular Development (Tower) platform. It is the most diverse reference design containing either the MKW21D256 or the MKW24D512 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 Tower System.

Figure 2-1 shows the TWR-KW24D512 development platform. A similar board not shown uses the MKW21D256 device.

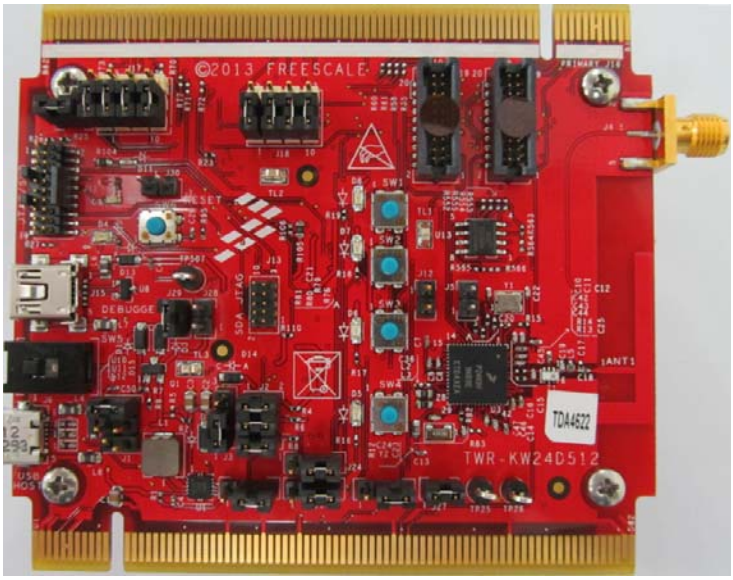


Figure 2-1. TWR-KW24D512

The TWR-KW2x development platform includes the following Features:

- Freescale's low-power MKW21D256 or MKW24D512 SIP ZigBee™ platform
- Fully compliant IEEE 802.15.4 Standard 2006 transceiver supports 250 kbps O-QPSK data in 5.0 MHz channels and full spread-spectrum encode and decode.
- Full IEEE 802.15.4 compliant wireless node; ZigBee capable with Freescale's 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 –32 dBm to +8 dBm at the SMA connector, no trap.
  - Receiver sensitivity: –100 dBm, typical (@1% PER for 20 byte payload packet) at the SMA connector
- Integrated PCB inverted F-type antenna and SMA RF port
- Selectable power sources
- 32 MHz reference oscillator
- 32 kHz reference oscillator
- 2.4 GHz frequency operation (ISM)
- Programmable frequency clock output (CLK_OUT)
- External Serial flash for Over-the-air Programming (OTP) support
- General purpose TWRPI connector
  - SPI, UART, and I^2C interface configurations
  - ADC and GPIO configurations
- Integrated open-standard serial and debug interface (OpenSDA)

- Full speed USB 2.0 (TWR-KW24D512 only)
- Cortex 20-pin (0.05”) JTAG debug port for target MCU
- Cortex 10-pin (0.05”) JTAG port for OpenSDA updates
- 4 blue LED indicators
- 4 push button switches

Figure 2-2 shows a simplified block diagram of the Freescale TWR-KW2x system.

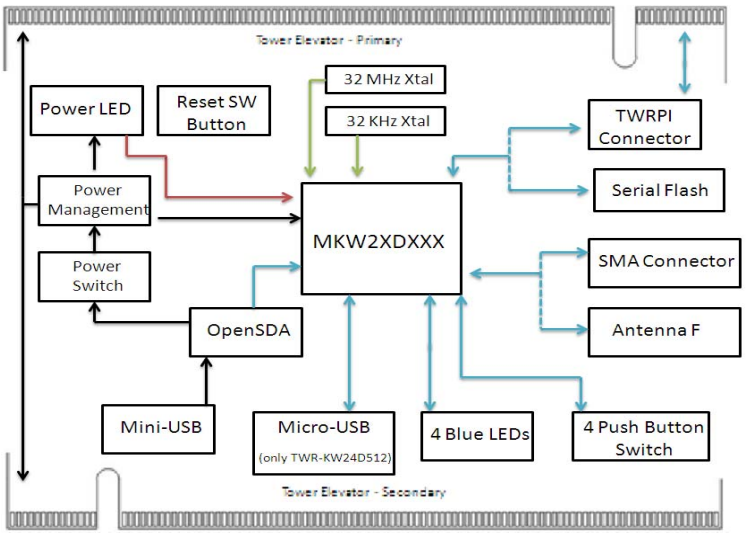


Figure 2-2. Simplified KW24D512-TWR Block Diagram

2.3 Software and Driver Considerations

Install the BeeKit Wireless Connectivity Toolkit package found under Software and Tools at the following URL before proceeding to use the boards:

- www.freescale.com\zigbee

When users first connect a TWR-KW2x based platform to a PC, they may be prompted to install drivers. Platform drivers can be found under the installation Beekit folder as denoted below. Once BeeKit is installed, do not allow Windows to automatically search for and install the drivers. Instead, select manual installation and steer Windows to the following directory:

- C:\Program Files\Freescale\Drivers

Follow the instructions as they appear on the screen to complete driver installation.

NOTE

If the BeeKit software package is installed in another drive or directory, indicate the Drivers proper folder location where BeeKit was installed.

If BeeKit is not installed, consider the following:

- When prompted, download the appropriate Windows driver and follow the instructions to complete the driver installation.
- The required drivers to be installed will depend on the reference design platform.
  - The TWR-KW2x boards come imaged with MSD OpenSDA firmware for board to PC connectivity. The target in pre-loaded with the SMAC Connectivity Test application.
  - Use the OpenSDA USB port (J15) to connect via Virtual COM Port (VCP) using P&E's OpenSDA Windows driver (See the TWR-OSDAUG.pdf guide).

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

- www.freescale.com\TWR-KW2x
- TWR-OSDAUG - OpenSDA User's Guide
- SMACDAUG - SMAC User's Guide

Chapter 3
TWR-KW2x

3.1 TWR-KW2x Overview

The TWR-KW2x is an evaluation board based on the Freescale MKW2x device. The TWR-KW2x provides a platform to evaluate the TWR-KW2x SIP IC, develop software and applications. The core device is accompanied by the 32 MHz reference oscillator crystal, RF circuitry including antenna, and supporting circuitry.

The TWR-KW2x board is intended as the core PCB for MKW21/24 device evaluation and application development, and can be used in the following modes:

- Simple standalone evaluation platform
- Daughtercard to other Development Platform boards (Tower System)
- Mothercard to an application specific dauhtercard such as a TWRPI card.

3.1.1 PCB Board Features

The TWR-KW2x provides the following features:

- Freescale's Tower System form factor
- 4-Layer metal, 0.062 inch thick FR4 board
- LGA footprint and power supply bypass
- Printed metal F-Antenna or SMA connector
- 32 MHz reference oscillator crystal
- 32.768 kHz crystal provided for optional timing oscillator
- Standard Tower TWRPI daughter card mounting interface
  - — 20-Pin primary connector
  - — 20-Pin secondary connector

3.1.2 Form Factor

Figure 3-1 shows the TWR-KW2x connector and header locations.

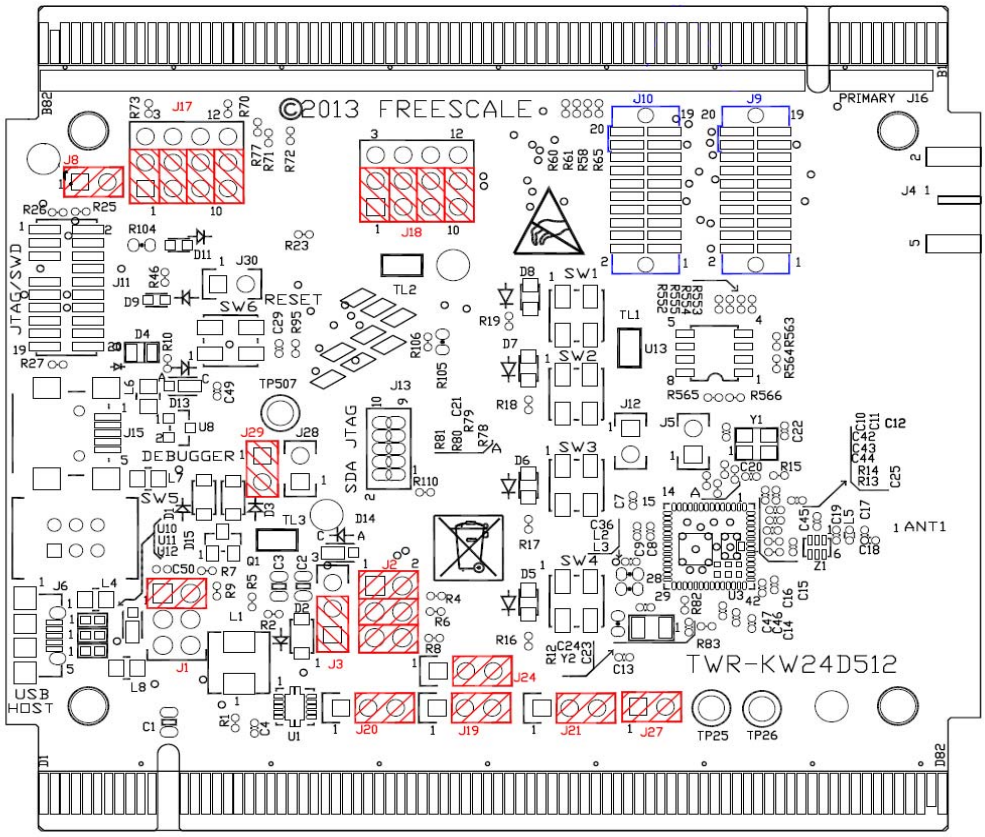


Figure 3-1. TWR-KW2x

Figure 3-2 shows a footprint of the TWR-KW2x with the location of the IO Headers. The following list gives these details:

- J9 and J10:
  - Both headers have standard 0.05in / 1.27 mm pin spacing
  - J9 and J10 are 20-pin
  - Both are pin headers mounted on the Top side of the TWR-KW2x and are intended to plug into matching receptacles on the TWRPI standard.
- J17 and J18:
  - Both headers have standard 0.10in / 2.54 mm pin spacing
  - J17 and J18 are 3x4-pin
  - Both are pin headers mounted on the Top side of the TWR-KW2x and are intended to have the capability for SPI/TWR_Elevator Selector (J17) and UART1/TWR_Elevator Selector (J18).
- J19, J20, J20, J21, and J24:
  - Headers have standard 0.10in / 2.54 mm pin spacing
  - J19, J20, J20, J21, and J24 are 3-pin
  - 19, J20, J20, J21, and J24 are pin headers mounted on the Top side of the TWR-KW2x and are intended to select between UART0/LED.

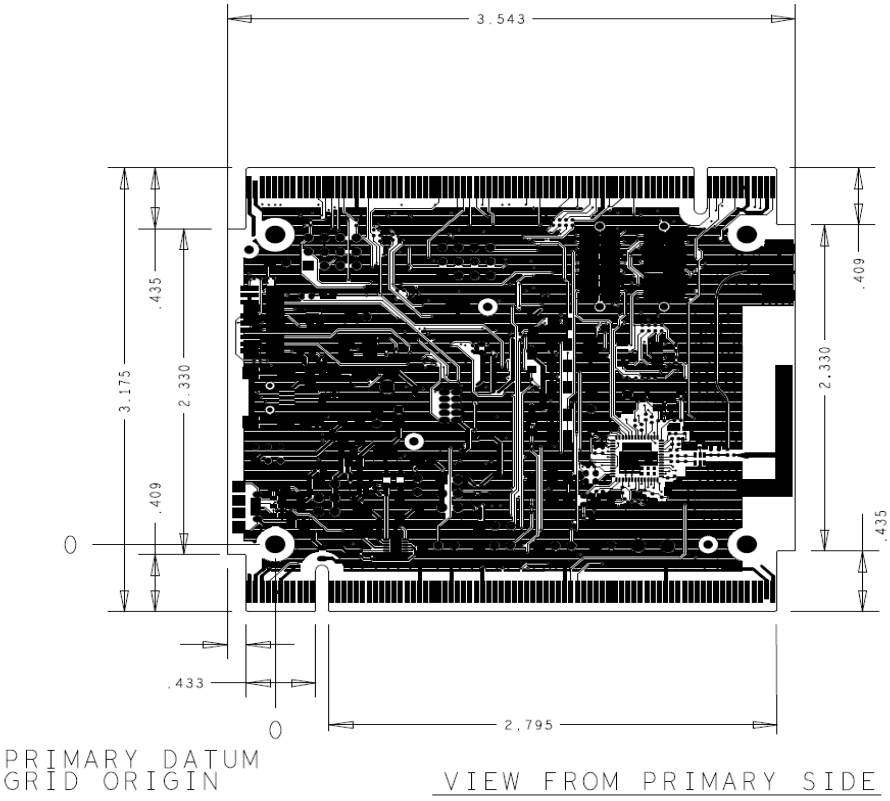


Figure 3-2. TWR-KW2x Top Side (Component Side) Footprint

3.1.3 Board Level Specifications

Table 3-1. TWR-KW2x Specifications

Parameter	Min	Typ	Max	Units	Notes/Conditions
General					
Size (PCB: X, Y)			90 x 80.6 3.54 x 3.175	mm inches	
Layer build (PCB)		1.57 0.062		mm inches	4-Layer
Dielectric material (PCB)					FR4
Power					
Current consumption				mA	Refer to datasheet.
Temperature					
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	

Table 3-1. TWR-KW2x Specifications (continued)

Parameter	Min	Typ	Max	Units	Notes/Conditions
RF 802.15.4 Frequency range	2405		2480	MHz	All 16 channels in the2450 MHz band
RF Receiver					
Saturation (maximum input level)		+10		dBm	Datasheet
Sensitivity for 1% packet error rate (PER) (+25 °C)		-102		dBm	Datasheet
RF Transmitter					
RF Power Output	-32		+8	dBm	Programmable in 2dB steps. At the antenna feed with no trap. [1]
2nd harmonic		<-50	<-40	dBm	Datasheet
3rd harmonic		<-50	<-40	dBm	Datasheet
Regulatory Approval					
FCC					Product is approved accordingly to the FCC part 15 standard
CE (ETSI)					Product is approved accordingly to the EN 300 328 V1.7.1 (2006-10) standard
CE (EMC)					Product is approved accordingly 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 accordingly 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 all 1 to 2 dB of loss.

3.2 Functional Description

The TWR-KW2x is built around Freescale's MKW2x 63-pin (56-pin usable) LGA platform and features a IEEE® 802.15.4 Standard 2.4 GHz radio frequency transceiver and a Kinetis family low power, mixed-signal ARM Cortex™- M4 MCU into a single package. This board is intended as a simple evaluation platform and as a building block for application development. The 4-layer board provides the MKW2x with its required RF circuitry, 32 MHz reference oscillator crystal, and power supply bypassing. The layout for this base level functionality can be used as a reference layout for the users target board. Figure 3-3 shows a simple block diagram.

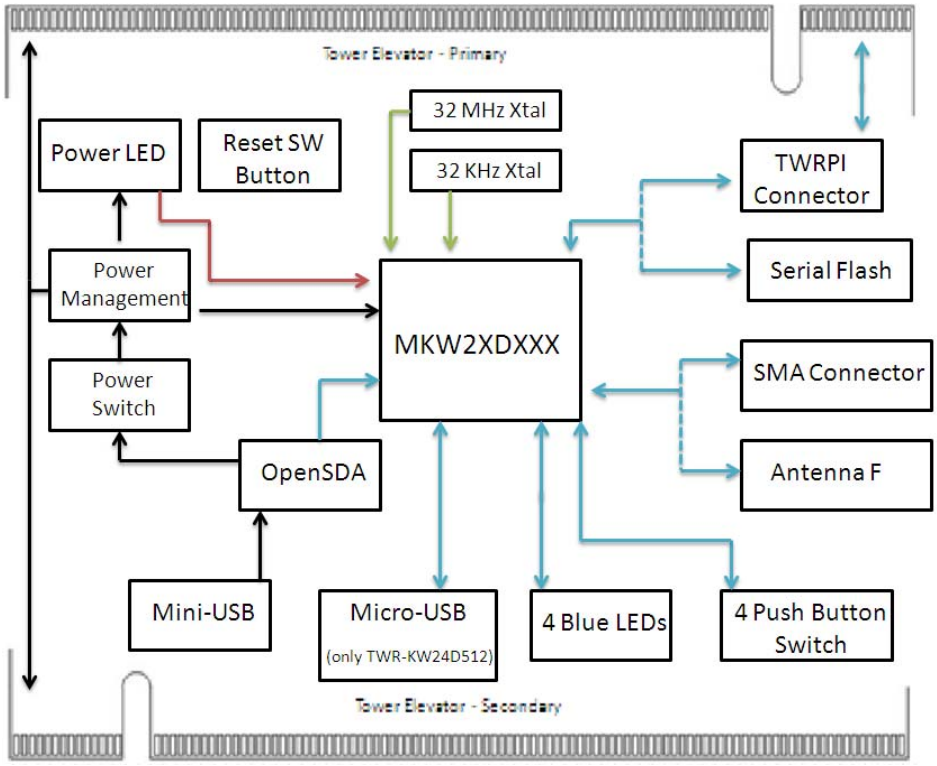


Figure 3-3. TWR-KW24D512 Block Diagram

3.2.1 RF Performance and Considerations

TWR-KW2x transceiver includes a 1mW 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 MKW2x are:

- Nominal output power is set to 0 dBm
- Programmable output power from –32 dBm to +8 dBm at the SMA, no trap
- Typical sensitivity is -100 dBm (@1% PER for 25 °C) at the SMA
- 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 50:50 balun.

An external 50 (unbal): 50(bal) balun connects a single-ended 50-ohm port to the differential RF port of the MKW2x radio. The layout has provision for out-of-band signal suppression (components L5 and C19) if required. Figure 3-4 shows the typical topology for the RF circuitry. The RF switch J4 has been designed in for measurement purposes and is left as DNP.

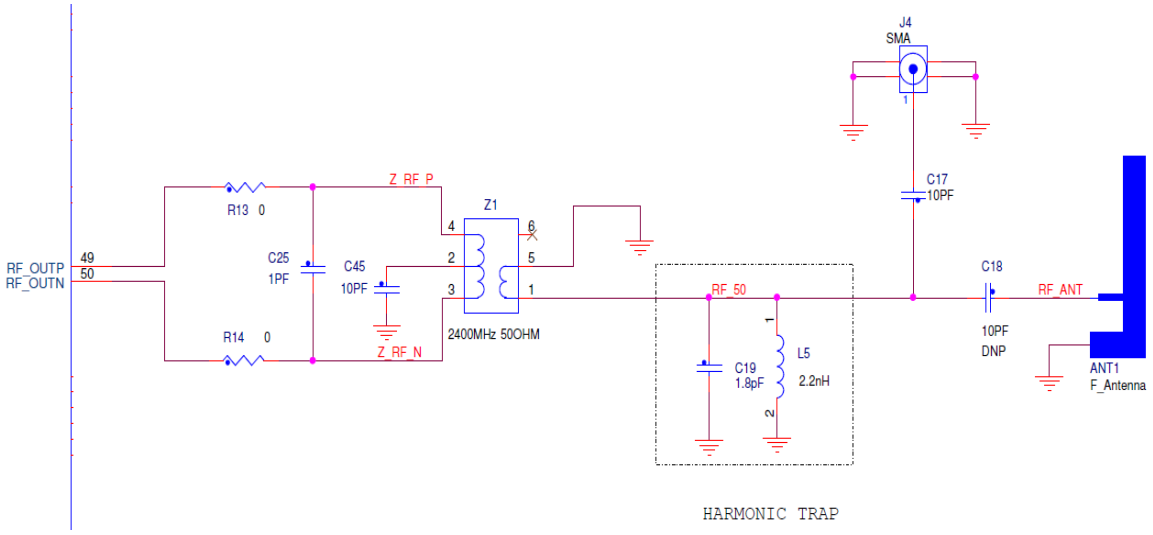


Figure 3-4. TWR-KW24D512 RF Circuitry

3.2.2 Clocks

The TWR-KW2x provides two clocks:

- 32 MHz Reference Oscillator - Figure 3-5 shows the external 32 MHz external crystal Y1. This mounted crystal must meet the specifications outlined in the AN3251 application note. The IEEE 802.15.4 Standard requires that the frequency be accurate to less that +/-40 ppm.
  - Capacitors C21 and C22 provide the bulk of the crystal load capacitance. Onboard trim capacitors can be programmed to center the frequency. At 25°C, it is desired to have the frequency accurate to +/-10 ppm or less to allow for temperature variation.
  - To measure the 32 MHz oscillator frequency, signal CLK_OUT (PTA18) can optionally be programmed to provide a buffered output clock signal
  - The TWR-KW2x has a provision for injecting an external 32 MHz clock source as an alternative to use of the onboard crystal:
    - The crystal Y1 should be removed
    - Resistor R83 must be mounted
    - Resistors R82 and R15 should be removed
    - C20 must be mounted
    - The external 32 MHz source is connected to 2-pin header J5; the frequency accuracy of the external source must meet the +/-40 ppm of the IEEE 802.15.4
- Optional 32.768 kHz Crystal Oscillator - Provision is also made for a secondary 32.768 kHz crystal Y2 (see Figure 3-6). This oscillator can be used for a low power accurate time base.
  - The module comes provided with this Y1 crystal and its load capacitors C4 and C15.
  - Load capacitors C23 and C24 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 R82 to enable the 32.768 kHz crystal and disable 32MHz.

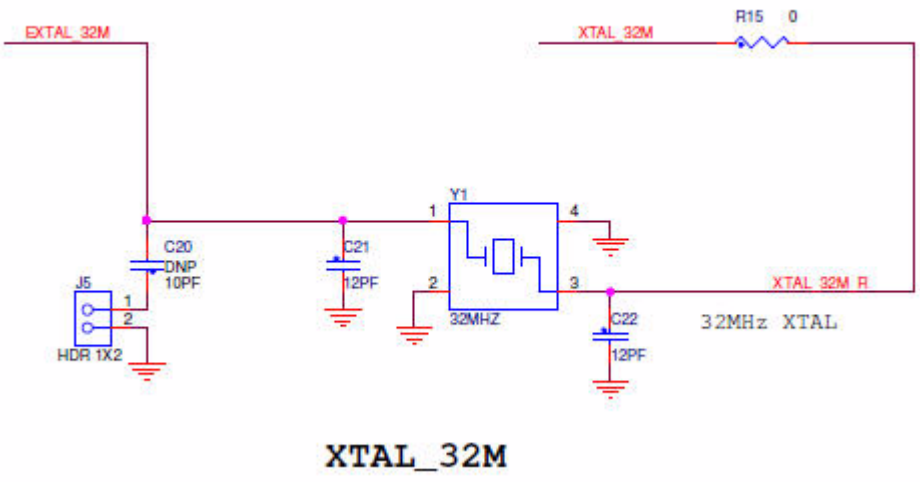


Figure 3-5. TWR-KW24D512 32 MHz Reference Oscillator Circuit

Figure 3-6. TWR-KW24D512 32.768 kHz Optional Oscillator Circuit

3.2.3 Power Management

For user convenience, there are several different ways to power and measure current on the TWR-KW2x board. The TWR-KW24D512 power management circuit is shown in Figure 3-7.

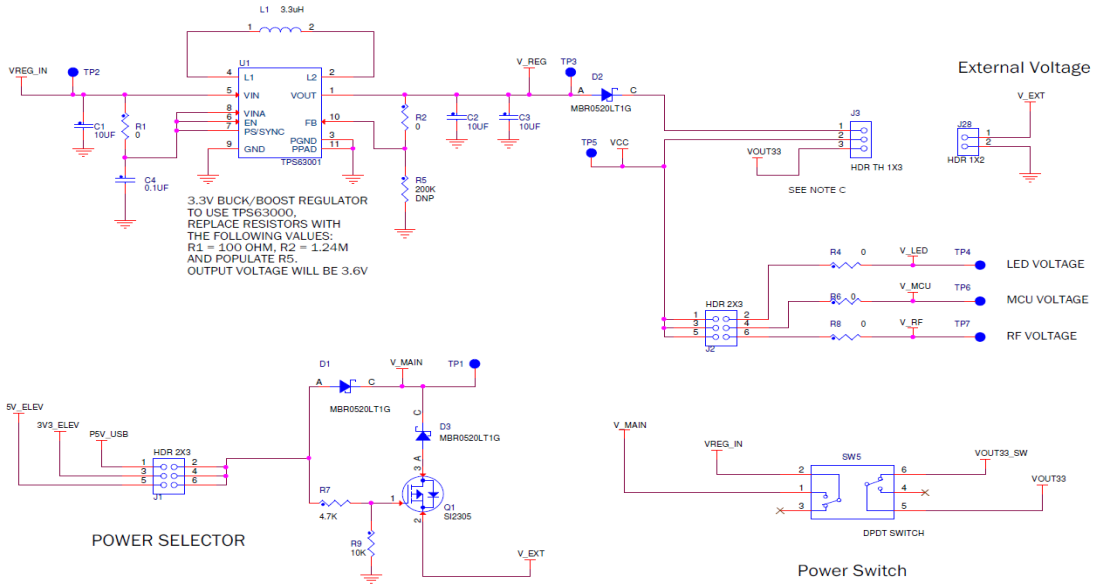


Figure 3-7. TWR-KW24D512 Power Management Circuit

The TWR-KW2x has the flexibility to be powered in several configurations:

- Board can be supplied through the mini USB type B connector (J15) which provides P5V_USB to J1 1-2.
- Board can be supplied through the micro USB AB (J6) (TWR-KW24D512 only) providing P5V_KW24_USB to J27 1-2 and VOUT33 to J3 2-3.
- Board can be supplied through the TWR System Elevator headers which provides either 3.3V_ELEV or 5V_ELEV to header J1 3-4 or J1 5-6 respectively.
- Board can be supplied from an external DC supply in the following ways:
  - Connect an USB battery adaptor capable of suppling 1.8 to 5.5 VDC to the micro USB AB (J6) (TWR-KW24D512 only)
  - An external unregulated supply up to 5.5VDC can be supplied to J1 pins 2,4 or 6 and a GND pin making use of the onboard 3.3 V LDO regulator

Additionally, 6-Pin 2x3 header J2 provides the means to supply current to various board components and current measurements if desired. Green LED D4 is available as a power indicator.

Header J2 provides the means to supply either the LED, MCU or radio circuits. Current measurements can be made by inserting a current meter in place of a designated jumper. Connections configurations are described in Table 3-2.

Table 3-2. Power Distribution Header J2

Supply Designation	Header Pins	Description
V_LED	1 - 2	Supply voltage to power indicator LED • Normally jumpered • Jumper used to enable LEDs on board • Leave open for lowest power • Usage: Measure LED current
V_MCU	3 - 4	Supply voltage to MKW2xDxxx • Normally jumpered • Supplies only the MKW2xDxxx MCU • Usage: Measure or supply MCU current
V_RF	5 - 6	Supply voltage to MKW2xDxxx • Normally jumpered • Supplies only the MKW2xDxxx transceiver • Usage: Measure or supply radio current

3.2.4 TWR-KW2x Peripheral Functions

The TWR-KW2x includes the TWRPI general purpose peripheral function to assist in implementing targeted applications. The TWR-KW2x board also has alternate port functions routed to the elevator interface where off board tower system peripherals can be used if desired.

3.2.4.1 Serial FLASH (SPI Interface)

Component U13 is an AT45DB161E-SSHD 16 Mbit (2 Mbyte) serial Flash memory with SPI interface. The memory is useful for over-the-air programming (OTAP) and for storage of non-volatile system data or parameters. Figure 3-8 shows the memory circuit.

- Memory power supply is V_MCU
- Discrete pullup resistors for the SPI port are provided
- The SPI can be shared with another peripheral with the TWRPI J10 connector - an additional IO signal would be required as a chip enable (CS or SS) for the peripheral. The normal SPI_SS and the second chip select should NOT be active at the same time.
- The SPI Write Protect and Reset has a discrete pullup resistors, but has been routed with an DNP resistors to a signals, for control

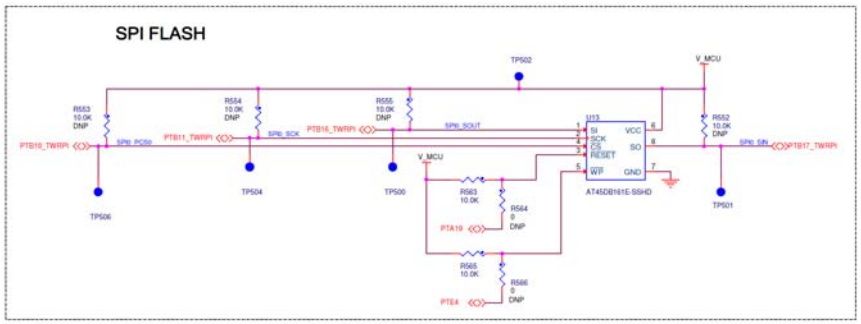


Figure 3-8. AT45DB161E-SSHD 16Mbit (2 Mbyte) Serial FLASH memory

3.2.4.2 TWRPI Connectors J9 and J10

The two connectors J9 and J10 are 50 mil pin headers mounted on the front (component side) supporting the standard TWRPI general purpose connector. The primary header J9 and secondary header J10 are 20-pin and they are mounted physically in such a manner as to prevent reverse insertion of any TWRPI card into the motherboard receptacle (see Figure 3-1).

- V_MCU provides the TWRPI connector its supply voltage
  - — Depending on power supply configuration, this voltage may supply the TWRPI card from the TWR-KW2x. See Section 3.2.3, “Power Management”.
  - — Peripherals IO to the TWR-KW2x and the TWRPI card supply should use this same voltage avoiding potential damage.

The pin definitions for the primary header J9 and the secondary header J10 are shown in Table 3-3., “TWRPI 20 Pin Primary Connector” and Table 3-4., “TWRPI 20 Pin Secondary Connector” respectively.

Table 3-3. TWRPI 20 Pin Primary Connector

Header Pin Number	TWR-MKW24D512 Pin Name	Description
1	5V_ELEV	5V VCC supply to board
2	V_MCU	3V3 VCC supply to board
3	GND	Module ground
4	V_MCU	3V3 VCC supply to board
5	GND	VSS (GND)board ground
6	GND	VSS (GND)board ground
7	GND	VSS (GND)board ground
8	PTE0_TWRPI	ADC: Analog 0
9	PTD1	ADC: Analog 1
10	GND	VSS (GND)board ground
11	GND	VSS (GND)board ground
12	PTE1_TWRPI	ADC: Analog 2
13	GND	VSS (GND)board ground
14	GND	VSS (GND)board ground
15	GND	GND board ground
16	GND	GND board ground
17	PTE2_TWRPI	ADC: TWRPI ID 0
18	PTE3_TWRPI	ADC: TWRPI ID 1
19	GND	GND board ground
20	RESET_B	RESET

Table 3-4. TWRPI 20 Pin Secondary Connector

Header Pin Number	TWR-KW24D512 Pin Name	Description
1	GND	Board ground
2	GND	Board ground
3	PTD2	I2C: SCL
4	PTD3	I2C: SDA
5	GND	Board ground
6	GND	Board ground
7	GND	Board ground
8	GND	Board ground
9	PTB17_TWRPI	SPI:MISO Master Input Slave Output
10	PTB16_TWRPI	SPI:MOSI Master Output Slave Input
11	PTB10_TWRPI	SPI: SS Slave Select
12	PTB11_TWRPI	SPI:CLK R_SClock
13	GND	Board ground
14	GND	Board ground
15	GPIO1	GPIO: GPIO0/IRQ
16	GPIO2	GPIO; GPIO1/IRQ
17	PTE17/UART2_RX	UART_RX or GPIO2
18	PTE16/UART2_TX	UART_TX or GPIO3
19	PTE18/UART2_CTS	UART_CTS or GPIO4/TIMER
20	PTE19/UART2_RTS	UART_RTS or GPIO5/TIMER

3.2.4.3 Jumper Connectors

The TWR-KW2x development platform incorporates several headers which allow different MCU port configurations assisting in the implementation of target applications. (see Figure 3-1).

- SPI0 TWRPI / TWR_ELEV Select (J17).
  - — The TWR-KW2x has the capability to support a SPI for TWRPI boards - to configure, shunt J17 pin 2-3 (SPI0_PCS), pin 5-6 (SPI0_SCK), 8-9 (SPI0_MOSI), and pin 11-12 (SPI0_MISO). See Figure 3-9.
  - — The TWR-KW2x has the capability to support a TWR_ELEV with another TWR System - to configure, shunt J17 pin 1-2 (SPI0_PCS), pin 4-5 (SPI0_SCK), 7-8 (SPI0_MOSI), and pin 10-11 (SPI0_MISO). See Figure 3-9.

- UART1 / ADC TWRPI Select (J18).
  - The TWR-KW2x has the capability to support a ADC for TWRPI boards - to configure, shunt J18 pin 2-3 (ADC0_DM1), pin 5-6 (ADC0_DP1), 8-9 (ADC0_SE11), and pin 11-12 (ADC_SE10). See Figure 3-9.
  - The TWR-KW2x has the capability to support an UART1 connection trough TWR_ELEV with another TWR System - to configure, shunt J17 pin 1-2 (UART1_TX), pin 4-5 (UART1_RX), 7-8 (UART1_CTS), and pin 10-11 (UART1_RTS). See Figure 3-9.
- UART0 / LED Select (J19/ J20/ J21/ J24).
  - The TWR-KW2x has the capability to support the Blue LEDs on board - to configure, shunt J19 pin 2-3 (PTD4_LED), J20 pin 2-3 (PTD5_LED), J21 pin 2-3 (PTD6_LED), and J24 pin 2-3 (PTD7_LED). See Figure 3-9.
  - The TWR-KW2x has the capability to support an UART0 connection trough TWR_ELEV with another TWR System - to configure, shunt J19 pin 1-2 (UART0_RTS), J20 pin 1-2 (UART0_CTS), J21 pin 1-2 (UART0_Rx), and J24 pin 1-2 (UART0_TX). See Figure 3-9.

3.2.4.4 MKW24D512 USB Supply (J6) - TWR-MK24D512 Board Only

The MKW24D512 device has an on-board USB port which is configured to provide both power and serial communication with the target MCU. (see Figure 3-1). The following jumpers allow the USB functionality:

- USB Select - Micro USB AB (J6).
  - Shunt J27 to supply 5VDC to the MKW2x device (U3 pin 24, VREGIN) through the Micro USB AB connector, This supplies the on-board USB regulator with then provides 3.3 VDC supply (U3 pin 23, VOUT33). See Figure 3-9.
  - Shunt J3 2-3 to supply power to the MKW2x device. See Figure 3-9.

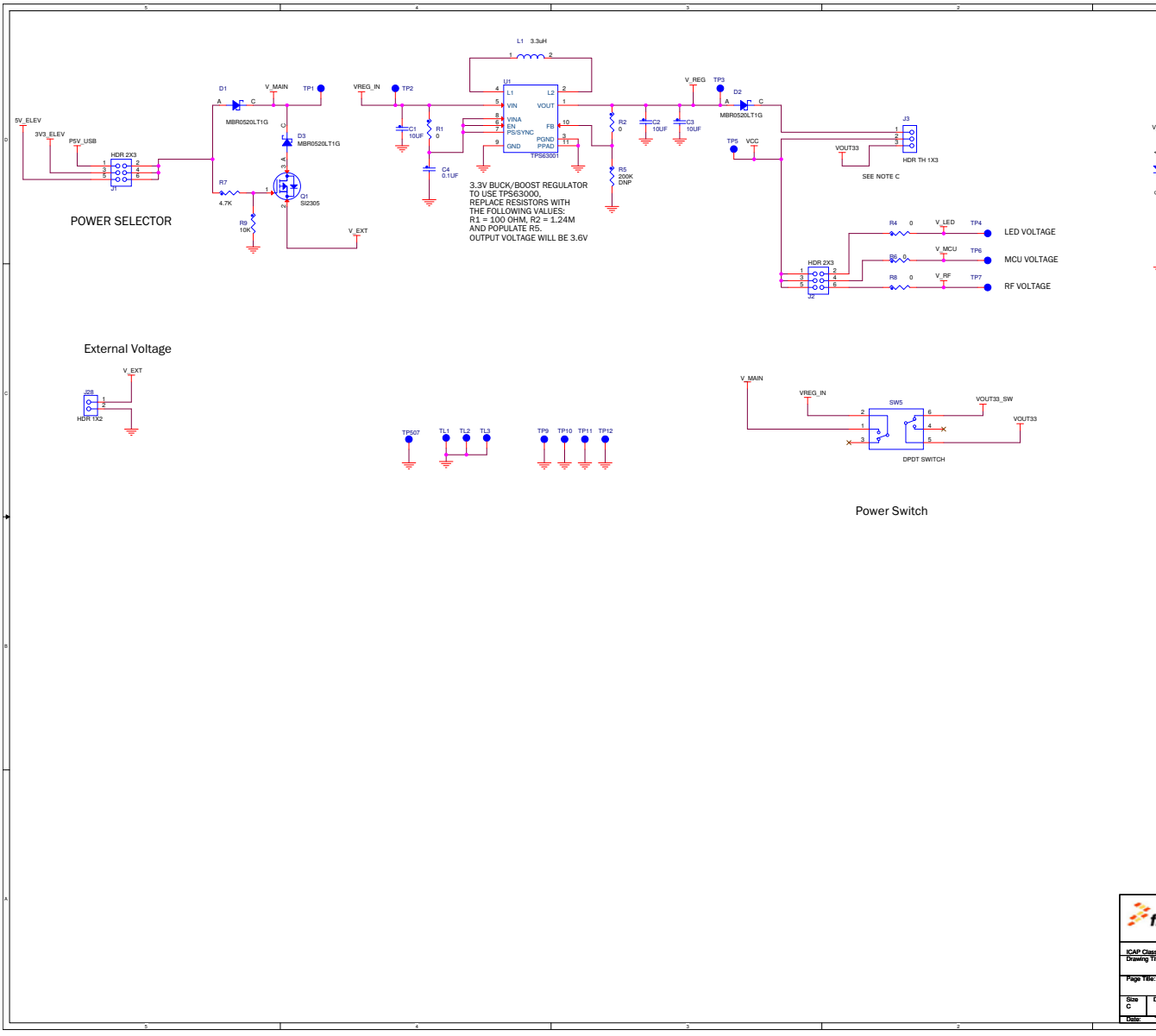
3.2.4.5 MKW21D256 (Non-USB) UART2 Support - TWR-MK21D256 Board Only

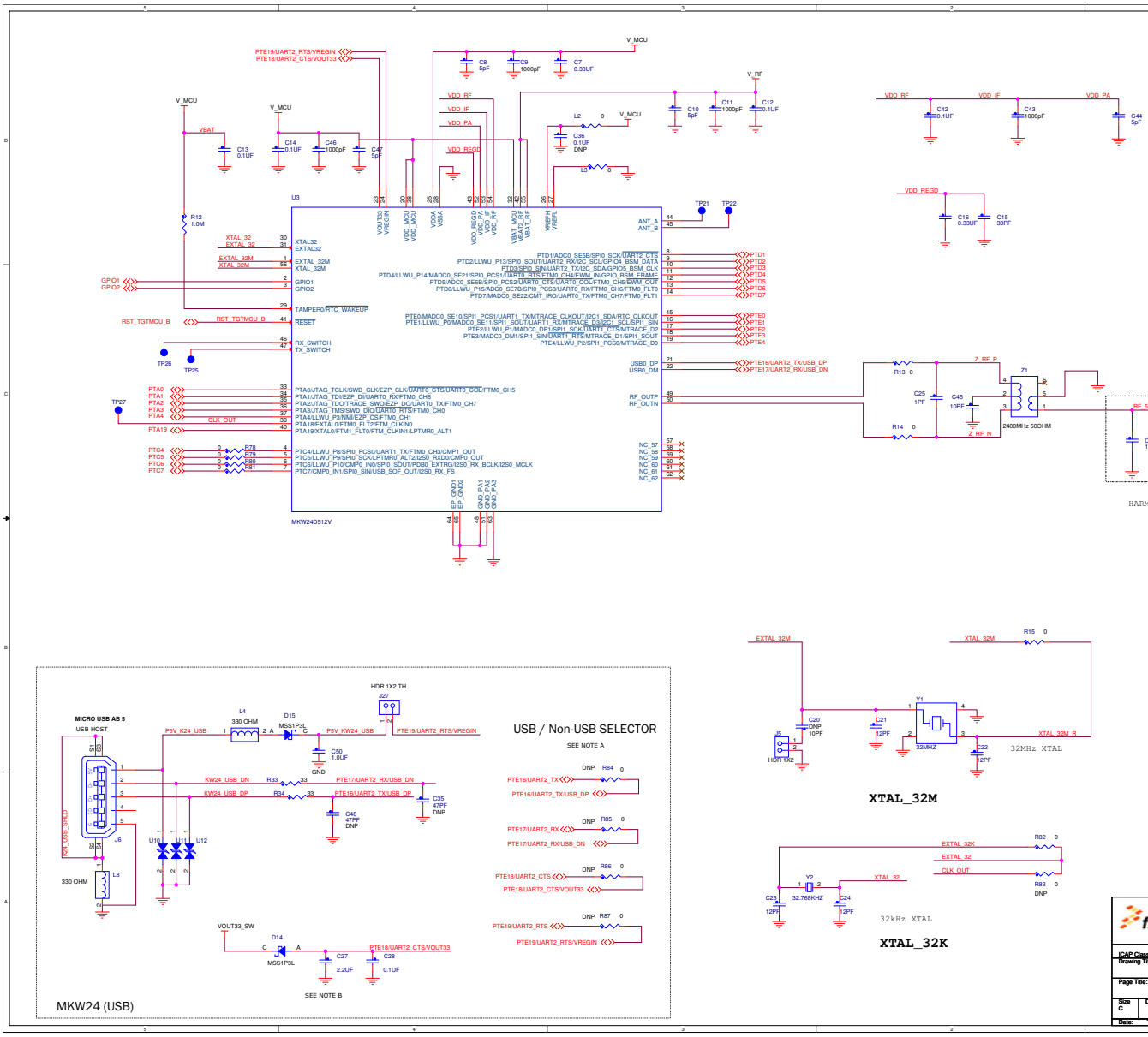
The MKW21D256 device does not support the USB interface and instead makes use of UART2 port functionality. In this case, resistors are placed configuring UART2 use for both the TWRPI connector and TWR elevator interface. (see Figure 3-1).

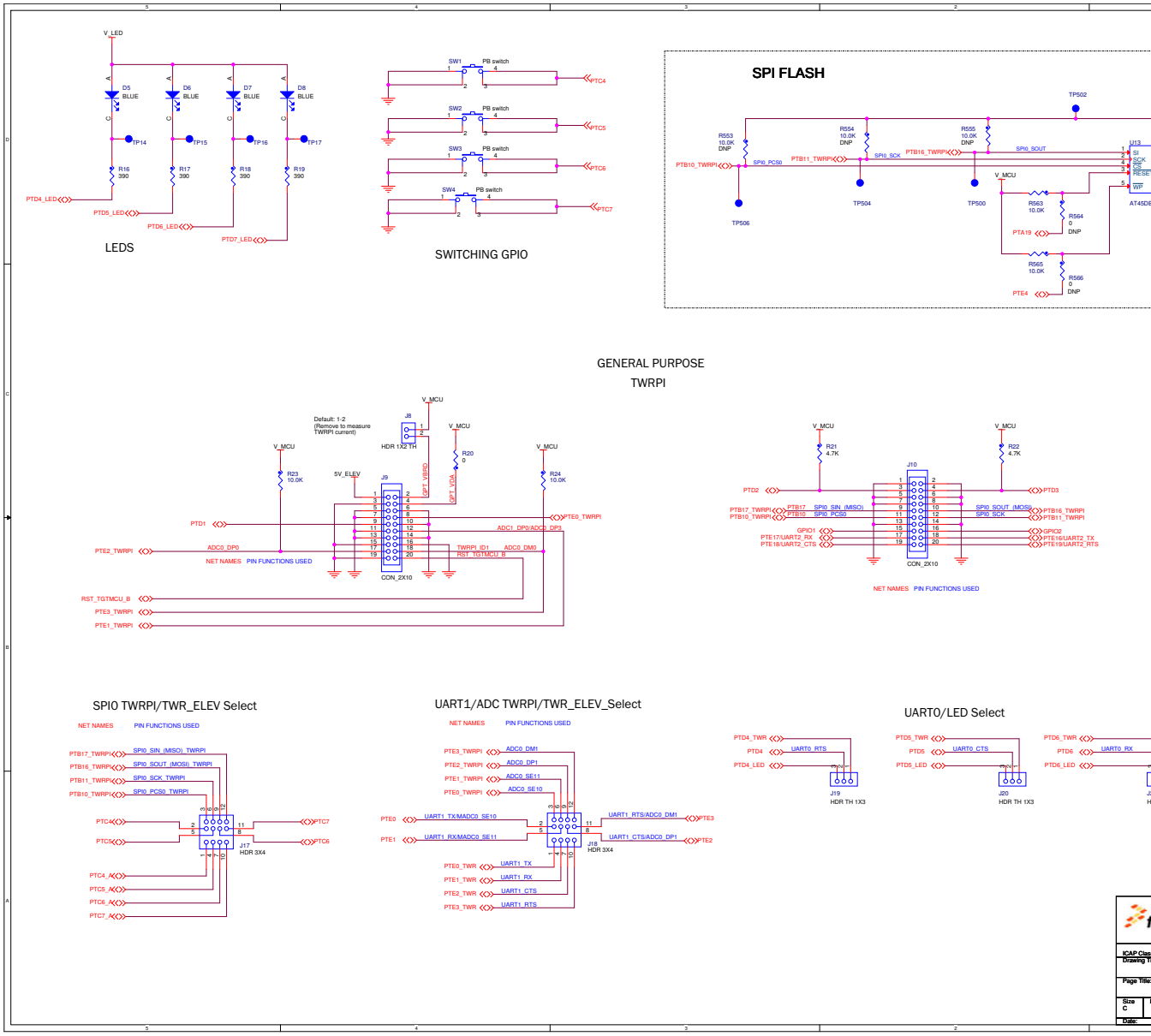
- UART2/Non USB Select
  - J27 is open, shunt J3 1-2, supply voltage required though power management configuration. See Figure 3-9, and Section 3.2.3, “Power Management”.
  - The following resistors are placed: R84, R85, R86 and R87, keep as DNP, C27 and C28. See Figure 3-9.

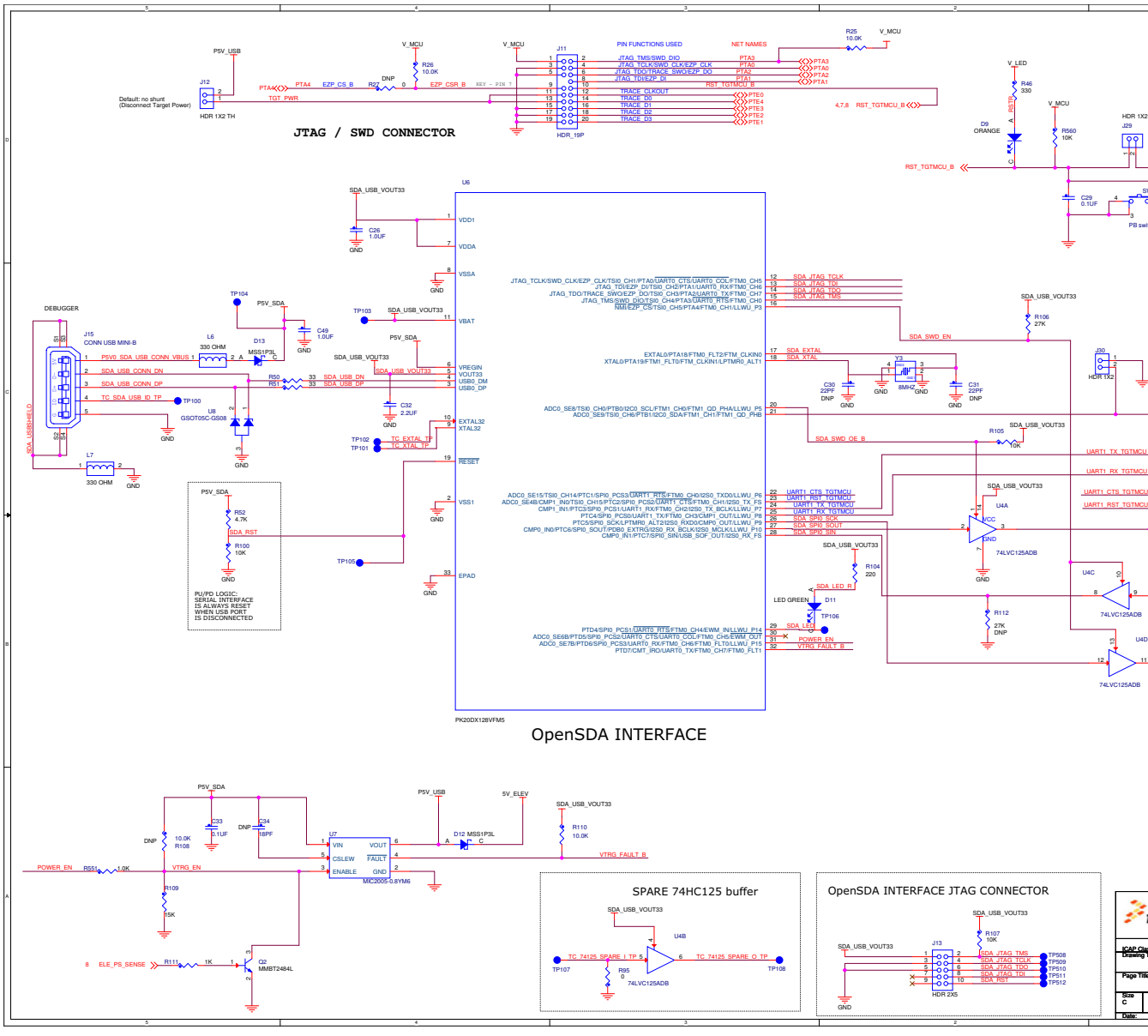
3.3 Schematic, Board Layout, and Bill of Material

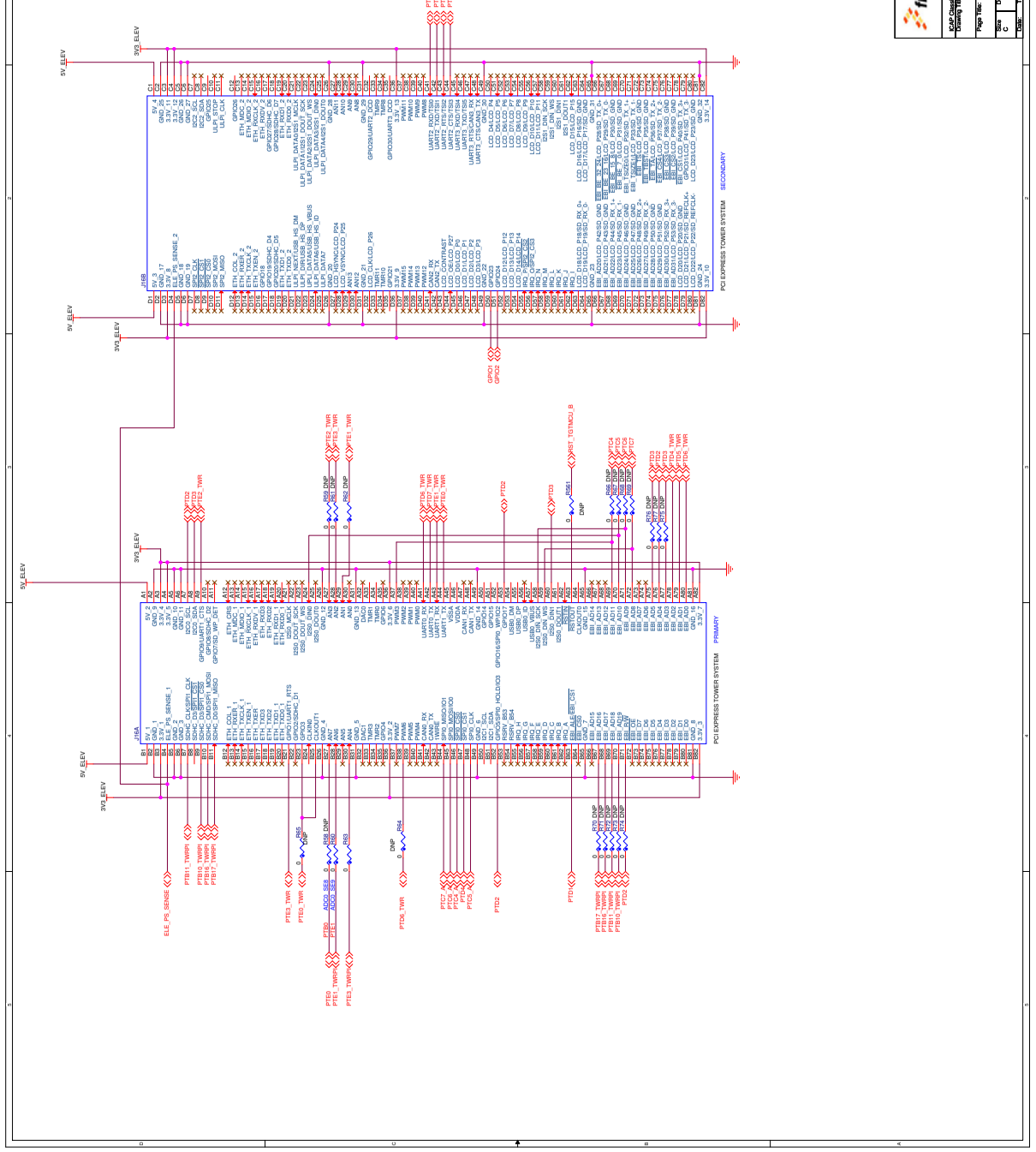
Figure 3-9. TWR-KW24D512 Schematic




MKW24D512V
MKW24 (USB)
USB / Non-USB SELECTOR
SEE NOTE A
SEE NOTE B
MICRO USB AB 5
USB HOST
HDR 1X2 TH
XTAL_32M
32MHz XTAL
XTAL_32K
32kHz XTAL
2400MHz 50OHM


LEDS
SWITCHING GPIO
SPI FLASH
GENERAL PURPOSE
TWRPI
SPI0 TWRPI/TWR_ELEV Select
UART1/ADC TWRPI/TWR_ELEV_Select
UART0/LED Select


JTAG / SWD CONNECTOR
OpenSDA INTERFACE
SPARE 74HC125 buffer
OpenSDA INTERFACE JTAG CONNECTOR
DEBUGGER
PK20DX128VFM5
MIC2005-0.8YM6
MMBT2484L
74LVC125ADB
HDR 1X2 TH
HDR_19P
HDR 2X5
CONN USB MINI-B
8MHZ
PU/PD LOGIC:
SERIAL INTERFACE
IS ALWAYS RESET
WHEN USB PORT
IS DISCONNECTED



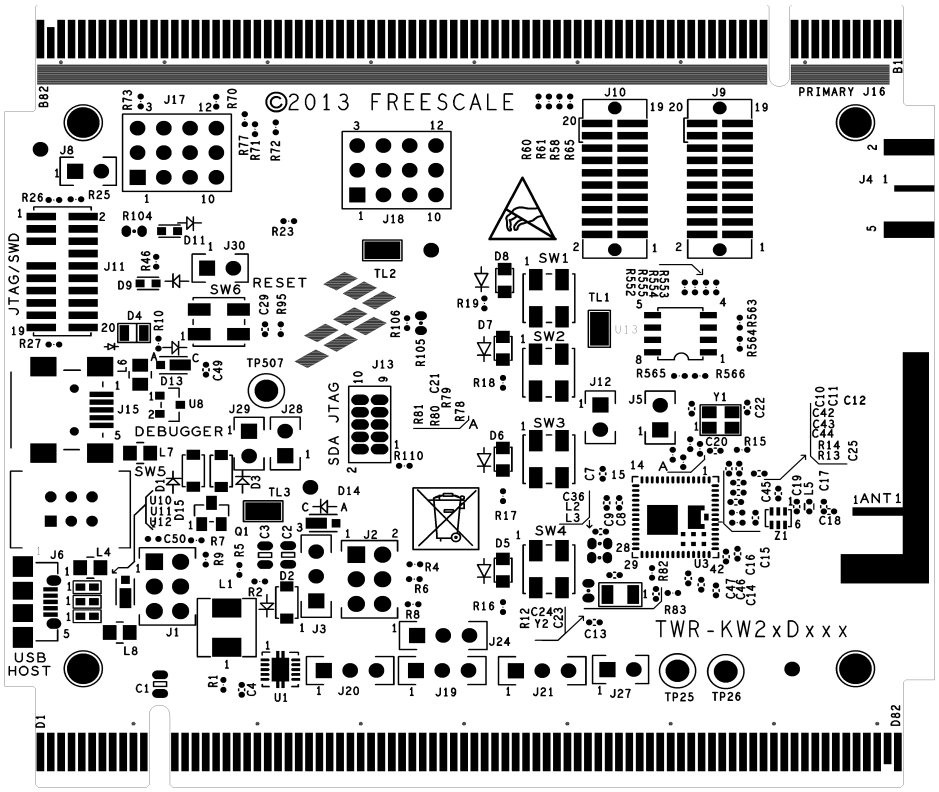


Figure 3-10. TWR-KW24D512 Reference Board PCB Component Location (Top View)

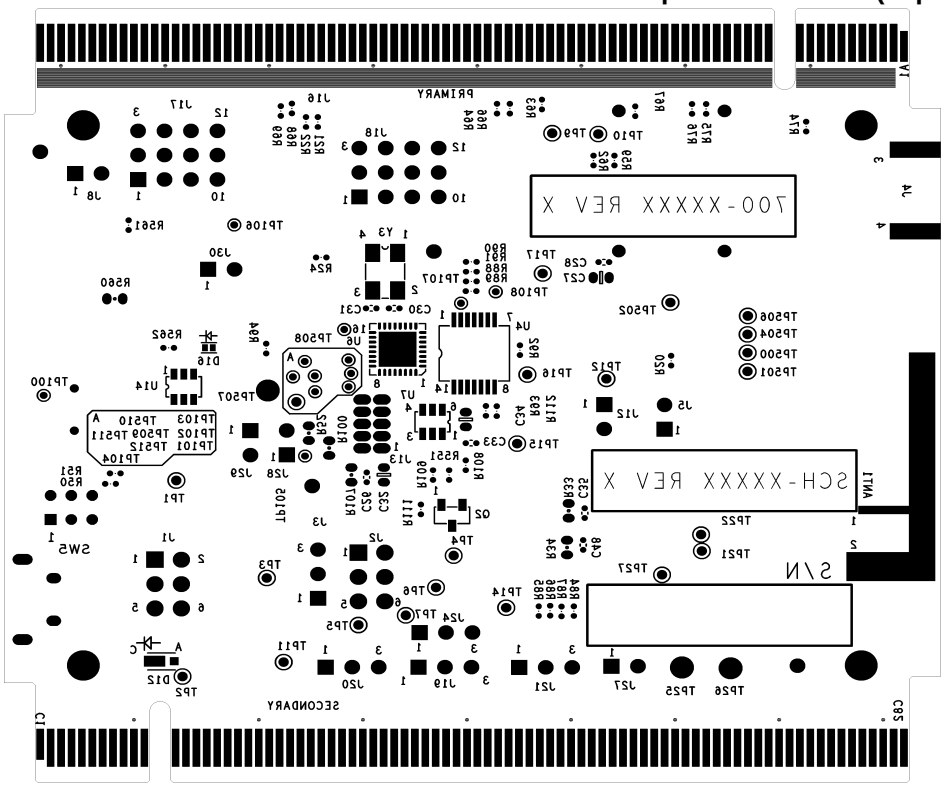


Figure 3-11. TWR-KW24D512 Reference Board PCB Test Points

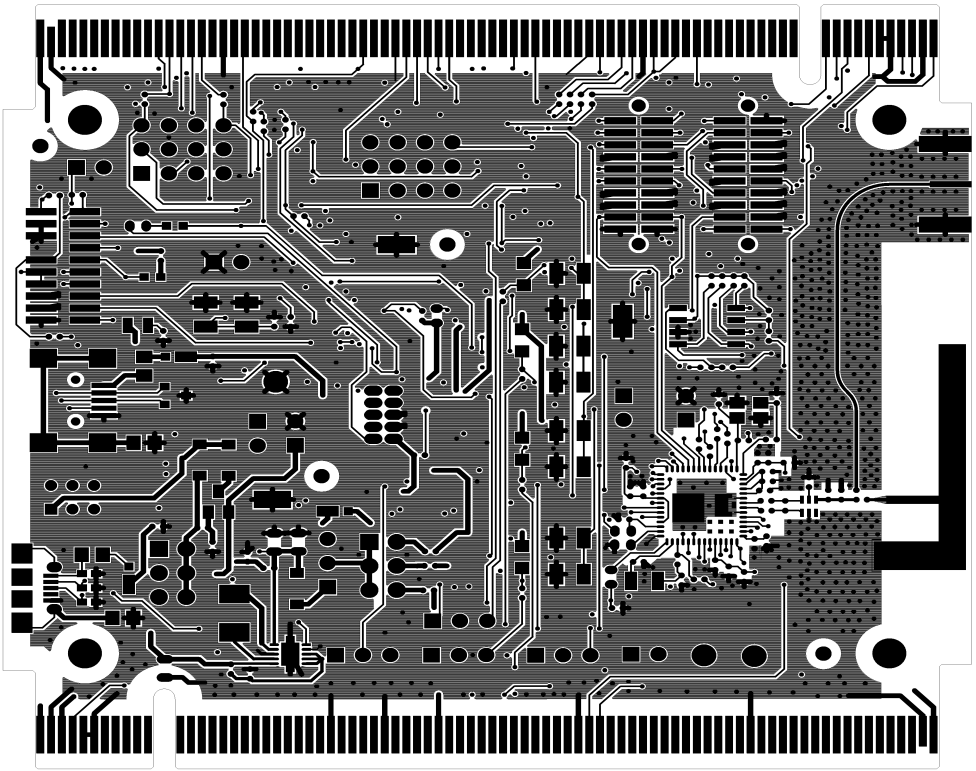


Figure 3-12. TWR-KW24D512 Reference Board PCB Layout (Top View)

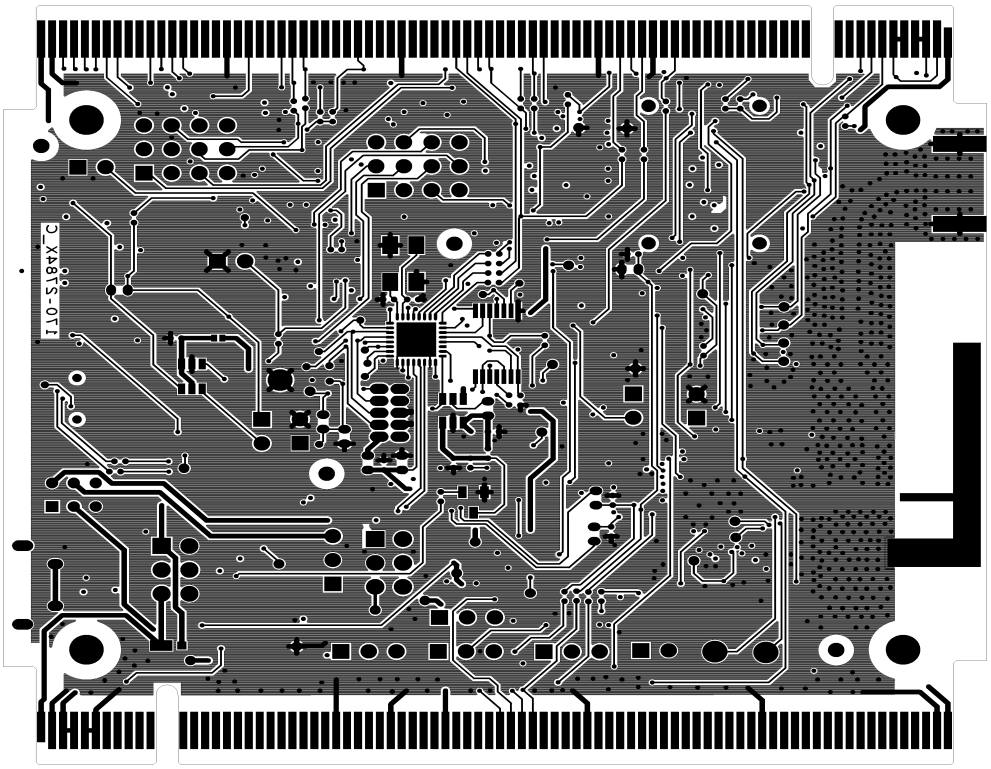


Figure 3-13. TWR-KW24D512 Reference Board PCB Layout (Bottom View)

3.3.1 Bill of Materials

Table 3-5. Bill of Materials (Common parts for all frequency bands) (Sheet 1 of 6)

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
1	1	ANT1	F_Antenna	PCB F ANTENNA, NO PART ORDER		
2	1	D16	CDSQR400B	DIODE SW 0.1A 80V SOD-923F	COMCHIP TECHNOLOGY CO.	CDSQR400B
3	3	C1,C2,C3	10UF	CAP CER 10UF 10V 10% X7R 0805	Murata	GRM21BR71A106KE51L
4	6	C4,C12,C13,C14,C29,C42	0.1UF	CAP CER 0.1UF 16V 10% X7R 0402	Kemet	C0402C104K4RAC
5	2	C7,C16	0.33UF	CAP CER 0.33UF 6.3V 10% X5R 0402	Murata	GRM155R60J334KE01D
6	4	C8,C10,C44,C47	5pF	CAP CER 5PF 16V 5% C0G CC0402	SMEC	MCCA050J0NOTF
7	5	R108,R552,R553,R554,R555 DNP	10.0K	RES MF 10.0K 1/16W 1% AEC-Q200 0402	VISHAY INTERTECHNOLOGY	CRCW040210K0FKED
8	4	C9,C11,C43,C46	1000pF	CAP CER 1000PF 50V 5% C0G 0402	MURATA	GRM1555C1H102JA01D
9	1	C15	33PF	CAP CER 33PF 50V 5% C0G 0402	VENKEL COMPANY	C0402C0G500-330JNE
10	2	C18,C20, DNP	10PF	CAP CER 10PF 50V 5% C0G 040210PF	AVX	04025A100JAT2A
11	2	C17,C45	10PF	CAP CER 10PF 50V 5% C0G 040210PF	AVX	04025A100JAT2A
12	1	C19	1.8pF	CAP CER 1.8PF 50V 0.25PF C0G 0402	KEMET	C0402C189C5GAC
13	4	C21,C22,C23,C24	12PF	CAP CER 12PF 50V 5% C0G 0402	MURATA	GRM1555C1H120JZ01D
14	1	C25	1PF	CAP CER 1PF 50V 5% C0G 0402	MURATA	GRM1555C1H1R0CA01B
15	3	C26,C49,C50	1.0UF	CAP CER 1.0UF 10V 10% X5R 0402	YAGEO AMERICA	CC0402KRX5R6BB105
16	2	C27,C32	2.2UF	CAP CER 2.2UF 10V 10% X7R 0603	MURATA	GRM188R71A225KE15D
17	2	C28,C33	0.1UF	CAP CER 0.1UF 10V 10% X5R 0402	KEMET	C0402C104K8PAC
18	2	C30,C31	22PF DNP	CAP CER 22PF 50V 5% C0G 0402	AVX	04025A220JAT2A

Table 3-5. Bill of Materials (Common parts for all frequency bands) (Sheet 2 of 6)

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
19	1	C34	18PF DNP	CAP CER 18PF 50V 5% C0G 0603	YAGEO AMERICA	CC0603JRNPO9BN180
20	2	C35,C48	47PF DNP	CAP CER 47PF 16V 5% C0G 0402	AVX	0402YA470JAT2A
21	1	C36	0.1UF DNP	CAP CER 0.1UF 16V 10% X7R 0402	KEMET	C0402C104K4RAC
22	3	D1,D2,D3	MBR0520LT1G	DIODE SCH 0.5A 20V SOD-123	ON SEMICONDUCTOR	MBR0520LT1G
23	1	D4	GREEN	LED GRN SGL 30MA SMT 0805	LITE ON	LTST-C171KGKT
24	4	D5,D6,D7, D8	BLUE	LED BLUE SGL 20MA SMT 0805	LITE ON	LTST-C171TBKT
25	1	D9	ORANGE	LED ULTRA BRIGHT ORANGE 20MA 2V SMT 0603	LITE ON	LTST-C190KFKT
26	1	D11	LED GREEN	LED GRN SGL 20MA 0603	OSRAM	LG L29K-G2J1-24-Z
27	4	D12,D13,D14,D15	MSS1P3L	DIODE SCH 1A 20V MICROSMP SMT	VISHAY INTERTECHNOLOGY	MSS1P3L-M3/89A
28	2	J1,J2	HDR 2X3	HDR 2X3 TH 100MIL CTR 335H AU 95L	SAMTEC	TSW-103-07-S-D
29	5	J3,J19,J20, J21,J24	HDR TH 1X3	HDR 1X3 TH 100MIL SP 339H AU 100L	SAMTEC	TSW-103-07-G-S
30	1	J4	SMA	CON, SMA, EDGE 0.062IN, 50 OHM FEMALE 18GHZ	JOHNSON COMPONENTS INC	142-0701-851
31	4	J5,J28,J29, J30	HDR 1X2	HDR 1X2 TH 100MIL SP 330H SN 115L	SAMTEC	TSW-102-23-T-S
32	1	J6 DNP for TWR-KW21D256	MICRO USB AB 5	CON 1X5 USB_MICRO_AB_RECEPTACLE RA SMT 0.65MM SP 105H AU	MOLEX	47589-0001
33	3	J8,J12,J27	HDR 1X2 TH	HDR 1X2 TH 100MIL SP 339H AU 98L	SAMTEC	TSW-102-07-G-S
34	2	J9,J10	CON_2X10	CON 2X10 PLUG SHRD SMT 50MIL CTR 237H AU	SAMTEC	TFC-110-02-L-D-A-K
35	1	J11	HDR_19P	HDR 19P SMT 1.27MM SP 285H AU	SAMTEC	ASP-159234-02
36	1	J13	HDR 2X5	CONN,HEAD,2X5,STR,50/50 CON-2RH-10-50	SAMTEC	FTS-105-01-F-D
37	1	J15	CONN USB MINI-B	CON 5 USB_MINI_B_RECEPTACLE RA SMT 0.8MM 168H AU	TE Connectivity Ltd	1734035-2

Table 3-5. Bill of Materials (Common parts for all frequency bands) (Sheet 3 of 6)

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
38	1	J16	PCI EXPRESS TOWER SYSTEM	CON DUAL 2X82 Edge PCI Express SMT 1MM SP 591H FOR TOWER SYSTEM NOT A PART TO ORDER		
39	2	J17,J18	HDR 3X4	HDR 3X4 TH 100MIL CTR 338H AU 100L	SAMTEC	HTSW-104-07-G-T
40	1	L1	3.3uH	IND PWR 3.3UH@100KHZ 3.3A 20% SMT	VISHAY INTERTECHNOLOGY	IHLP2020BZER3R3M01
41	2	**L2,L3**	**0 OHMS**	RES MF ZERO OHM 1/10W -- 0603	VISHAY INTERTECHNOLOGY	CRCW06030000Z0EA
42	4	L4,L6,L7,L8	330 OHM	IND FER BEAD 330OHM@100MHZ 2.5A -- SMT	TDK	MPZ2012S331A
43	1	L5	2.2nH	IND -- 0.0022UH@100MHZ 300MA 0.0003UH 0402	MURATA	LQG15HS2N2S02D
44	1	Q1	SI2305	TRAN PMOS PWR 4.1A 8V SOT23	VISHAY INTERTECHNOLOGY	SI2305ADS-T1-GE3
45	1	Q2	MMBT2484L	TRAN NPN LOW NOISE 60V 100MA SOT23	ON SEMICONDUCTOR	MMBT2484LT1G
46	14	R1,R2,R4,R6,R8,R15,R20,R60,R63,R78,R79,R80,R81,R82	0 DNP	RES MF ZERO OHM 1/16W 5% 0402	ROHM	MCR01MZPJ000
47	1	R5	200K DNP	RES MF 200K 1/16W 5% 0402	YAGEO AMERICA	RC0402JR-07200KL
48	3	R7,R21,R22	4.7K	RES MF 4.7K 1/16W 5% 0402	YAGEO AMERICA	RC0402JR-074K7L
49	1	R9	10K	RES MF 10K 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW040210K0JNED
50	1	R10	330	RES MF 330 OHM 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW0402330RJNED
51	1	R12	1.0M	RES MF 1.0M 1/10W 5% 0603	BOURNS	CR0603-JW-105ELF
52	4	R13,R14,R94,R95	0	RES TF ZERO OHM 1/16W RC0402	VISHAY INTERTECHNOLOGY	CRCW04020000ZS
53	4	R16,R17,R18,R19	390	RES MF 390 OHM 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW0402390RJNED
54	7	R23,R24,R25,R26,R110,R563,R565	10.0K	RES MF 10.0K 1/16W 1% 0402	VISHAY INTERTECHNOLOGY	CRCW040210K0FKED

Table 3-5. Bill of Materials (Common parts for all frequency bands) (Sheet 4 of 6)

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
55	27	R27,R58,R59,R61,R62,R64,R65,R66,R67,R68,R69,R70,R71,R72,R73,R74,R75,R76,R77,R83,R84,R85,R86,R87,R561,R564,R566 DNP	0	RES MF ZERO OHM 1/16W 5% 0402	ROHM	MCR01MZPJ000
56	2	R33,R34	33	RES MF 33 OHM 1/10W 5% 0603	VISHAY INTERTECHNOLOGY	CRCW060333R0JNEA
57	1	R562	100K	RES MF 100K 1/16W 1% 0402	YAGEO AMERICA	RC0402FR-07100KL
58	1	R46	330	RES MF 330 OHM 1/16W 1% 0402	VISHAY INTERTECHNOLOGY	CRCW0402330RFK
59	2	R50,R51	33	RES MF 33.0 OHM 1/16W 1% 0402	THYE MING TECH CO LTD	CR-02FL6---33R
60	1	R52	4.7K	RES MF 4.7K 1/10W 5% 0603	VISHAY INTERTECHNOLOGY	CRCW06034K70JNEA
61	7	R88,R89,R90,R91,R92,R93,R551	1.0K	RES MF 1.0K 1/16W 1% 0402	KOA SPEER	RK73H1ETTP1001F
62	4	R100,R105,R107,R560	10K	RES MF 10K 1/10W 5% 0603	KOA SPEER	RK73B1JTTD103J
63	1	R104	220	RES MF 220 OHM 1/10W 5% 0603	KOA SPEER	RK73B1JTTD221J
64	1	R106	27K	RES MF 27K 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW040227K0JNED
65	1	R109	15K	RES MF 15.0K 1/16W 1% 0402	BOURNS	CR0402-FX-1502GLF
66	1	R111	1K	RES MF 1.0K 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW04021K00JNED
67	1	R112 DNP	27K	RES MF 27K 1/16W 5% 0402	VISHAY INTERTECHNOLOGY	CRCW040227K0JNED
68	5	SW1,SW2,SW3,SW4,SW6	PB switch	SW SMT 4.0MM FMS 0.1A MAX 16V MAX ROHS COMPLIANT	BOURNS	7914J-1-000E
69	1	SW5	DPDT SWITCH	SW DPDT SLD 30V 100MA TH	TYCO ELECTRONICS	MMS22

Table 3-5. Bill of Materials (Common parts for all frequency bands) (Sheet 5 of 6)

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
70	24	TP1,TP2,TP3,TP4,TP5,TP6,TP7,TP9,TP10,TP11,TP12,TP14,TP15,TP16,TP17,TP21,TP22,TP27,TP104,TP500,TP501,TP502,TP504,TP506	TPAD_040	TEST POINT PAD 40MIL DIA SMT, NO PART TO ORDER		
71	13	TP100,TP101,TP102,TP103,TP105,TP106,TP107,TP108,TP508,TP509,TP510,TP511,TP512	TPAD_030	TEST POINT PAD 30MIL DIA SMT, NO PART TO ORDER		
72	1	U1	TPS63001	IC LIN DCDC SYNC 3.3V OUTPUT 1250-1800KHZ 1.8-5.5V QFN-10	TEXAS INSTRUMENTS	TPS63001DRCT
73	1	U3 for TWR-KW24D512	MKW24D512	IC MCU XCVR 2.4GHZ 64KB RAM 512KB FLASH - USB 1.8-3.6V LGA56	FREESCALE SEMICONDUCTOR	MKW24D512VHA5
73	1	U3 for TWR-KW21D256	MKW21D256	IC MCU XCVR 2.4GHZ 64KB RAM 256KB FLASH - USB 1.8-3.6V LGA56	FREESCALE SEMICONDUCTOR	MKW21D256VHA5
74	1	U4	74LVC125ADB	IC BUF QUAD TS 1.2-3.6V SSOP14	NXP SEMICONDUCTORS	74LVC125ADB
75	1	U6	PK20DX128VFM5	IC MCU FLASH 128KB 50MHZ 1.71-3.6V QFN32	FREESCALE SEMICONDUCTOR	MK20DX128VFM5
76	1	U7	MIC2005-0.8YM6	IC LIN SW PWR 0.8A 2.5-5.5V SOT23-6	MICREL	MIC2005-0.8YM6
77	1	U8	GSOT05C-GS08	DIODE ESD 2LINE 5V SOT23	VISHAY INTERTECHNOLOGY	GSOT05C-GS08
78	3	U10,U11,U12	0402ESDA-MLP	DIODE TVS BIDIR -- 30V 0402	COOPER BUSSMANN	0402ESDA-MLP1
79	1	Y1	32MHZ	XTAL 32MHZ 9PF -- SMT 3.2X2.5MM	NDK	EXS00A-CS02368
80	1	Y2	32.768KHZ	XTAL 32.768KHZ SMT ROHS COMPLIANT	EPSON ELECTRONICS	FC-135 32.7680KA-A3

Table 3-5. Bill of Materials (Common parts for all frequency bands) (Sheet 6 of 6)

Item	Qty	Reference	Value	Description	Mfg. Name	Mfg. Part Number
81	1	Y3	8MHZ	XTAL 8MHZ 20PPM PAR 18PF ESR 200OHM SMT	Abracon Corporation	ABM3B-8.000MHZ-B2-T
82	1	Z1	2400MHz 50OHM	XFMR BALUN 2400 +/-100MHZ SMT	MURATA	LDB212G4005C-001
83	3	TL1, TL2, TL3	TESTLOOP	TEST POINT PAD SIZE 3.4MM X 1.8MM SMT	KEYSTONE ELECTRONICS	5015
84	3	TP25,TP26 ,TP507	TESTLOOP _BLACK	TEST POINT PC MULTI PURPOSE BLK TH	KEYSTONE ELECTRONICS	5011
85	1	U13	AT45DB161 E-SSHD	IC FLASH 16MBIT 85MHZ 2.5-3.6V SOIC8	ATMEL	AT45DB161E-SSHD-T
86	1	U14	TXS0101	IC VXLTR 1BIT 1.65-3.6V/2.3-5.5V SOT23-6	TEXAS INSTRUMENTS	TXS0101DBVR

Chapter 4
PCB Manufacturing Specifications

This chapter provides the specifications used to manufacture the TWR-KW2x Development hardware printed circuit board (PCB) described in this manual.

The TWR-KW2x Development hardware PCBs must comply with the following:

- The PCB must comply with Perfag1D/3C (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 can not 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 TWR-KW2x Development hardware at the Freescale web site (http:www.freescale.com/KW2x) under the "Software and Tools" tab. This design or one of a number of other 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.

4.1 Single PCB Construction

This section describes individual PCB construction details.

- The TWR-KW2x, PCB are four-layer, multi layer designs
- The PCBs contains no blind, buried, or micro vias
- PCB data:
  - TWR-KW2x Size: Approximately 90 x 83mm (3.55 x 3.28 inches)
  - TWR-KW2x, Final thickness (Cu/Cu): 1.57 mm (0.62 inches) +/- 10% (excluding solder mask)

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

Table 4-1. TWR-KW2x Layer by Layer Overview

Layer	Artwork Identification	File Name
1	Silkscreen Top	SILK_TOP.art
2	Top Layer Metal	TOP.art
3	Ground Layer	GND.art
4	Power Layer	PWR.art
5	Bottom Layer Metal	BOTTOM.art
6	Silkscreen Bottom	SILK_BOTTOM.art

NOTE

The TWR-KW2x 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 4-1) information is provided with the reference design.

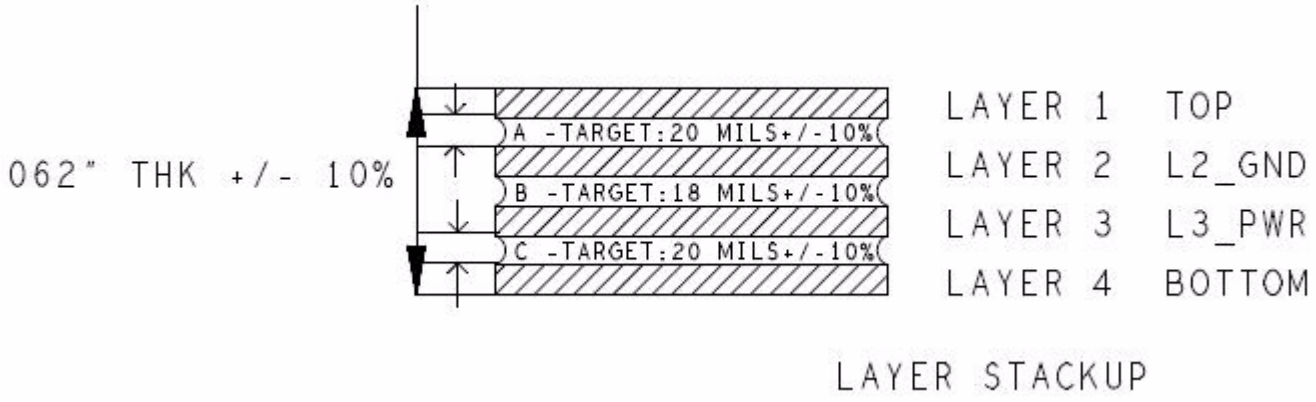


Figure 4-1. TWR-KW2x PCB Stackup Cross-Section (Four Layer)

- 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 laminate material (laminate) must be FR4. If the laminate material were 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 1oz. 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:

- Silkscreen color: White
- Silkscreen must be applied after application of solder mask if solder mask is required
- The silkscreen 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 percent tested for opens and shorts
- Impedance Measurement - An impedance measurement report is not mandatory

4.7 Packaging

Packaging for the PCBs must be 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-27694.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-27694.pdf — TWR- Board fabrication drawing
- GRB-27694.zip — TWR- Metal layers, solder mask, solder paste and silk screen
- SPF-27694.pdf — TWR- Schematic

Design files are in Allegro format with OrCAD schematic capture.

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