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

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# TWR-K80F150M User's Guide

## 1 Introduction

The K80F150M Tower MCU Module (TWR-K80F150M) is a low-cost evaluation, demonstration, and development board, which features the Kinetis 150 MHz K80 low-power MCU. The TWR-K80F150M microcontroller module can operate in stand-alone mode or as part of the Freescale Tower System, a modular development platform that enables rapid prototyping and tool re-use through reconfigurable hardware. Take your design to the next level and begin constructing your Tower System today by visiting freescale.com/tower for additional Tower System microcontroller modules and compatible peripherals.

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## 1.1 Features

The following list summarizes the features of the K80F150M Tower MCU boards:

- MK80FN256VDC15 MCU
- 150 MHz Cortex-M4 core, 256KB Flash, 256 KB SRAM, 121 XFBGA, with QuadSPI controller, ROM Bootloader, SDRAM controller and USB
- Tower compatible processor board
- Onboard debug circuit: K20DX128VFM5 OpenSDA with virtual serial port
- 2 x 32 Mbit (4 MB) Dual On-board QuadSPI memory @ 1.8 V
- 64 Mbit (8 MB) SDRAM Memory
- Five user-controlled status LEDs
- Two capacitive touch pads
- Two mechanical push buttons
- Standalone full-speed USB host and device function
- Potentiometer
- MicroSD Card Slot
- EMVSIM Card Interface
- Ten axis sensor system
    - FXOS8700CQ 3D Accelerometer + 3D Magnetometer
    - MPL3115A2 Digital Pressure Sensor
    - FXAS21002C 3-axis gyroscope
- Socket for Touch Keypad plug-in (TWRPI-TOUCH-STR)
- Board power select with 3.3 V or 1.8 V MCU operation
- Independent, battery-operated power supply for real-time clock (RTC) module
- Battery holder for 20 mm lithium battery (e.g. 2032, 2025)

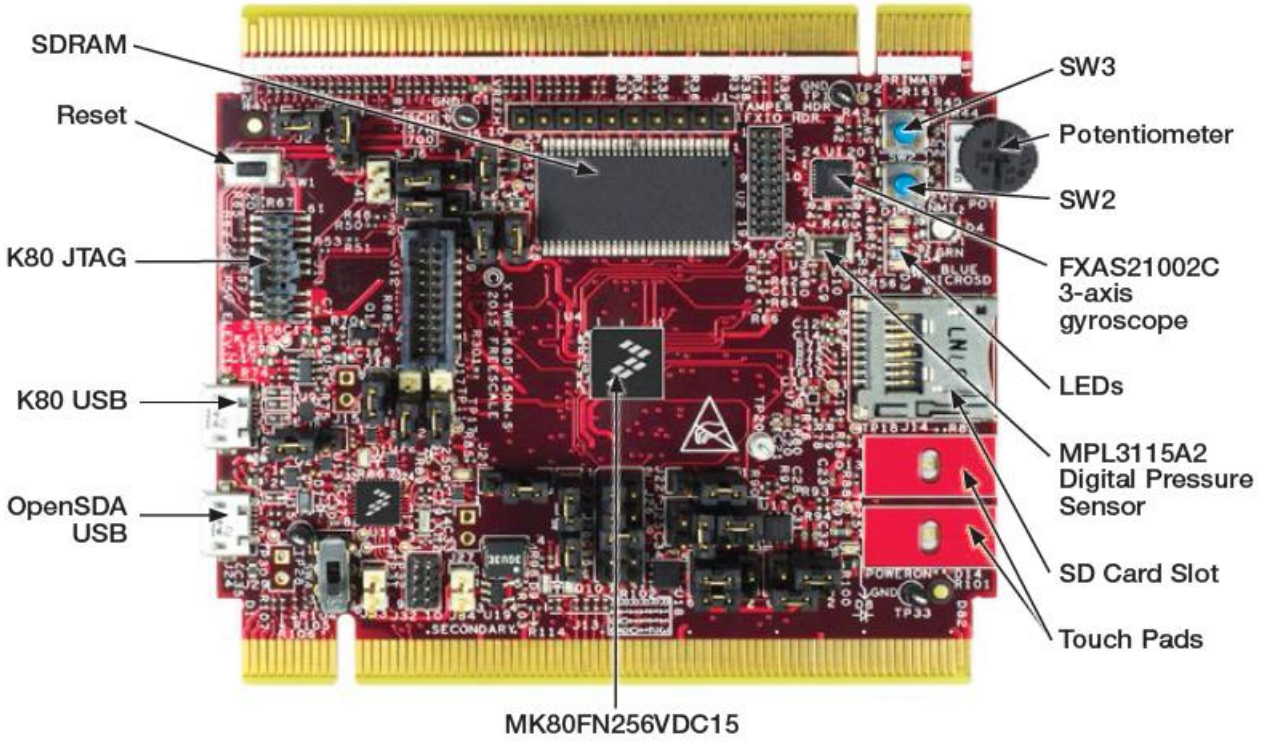


**Figure 1. Front side of the TWR-K80F150M module**

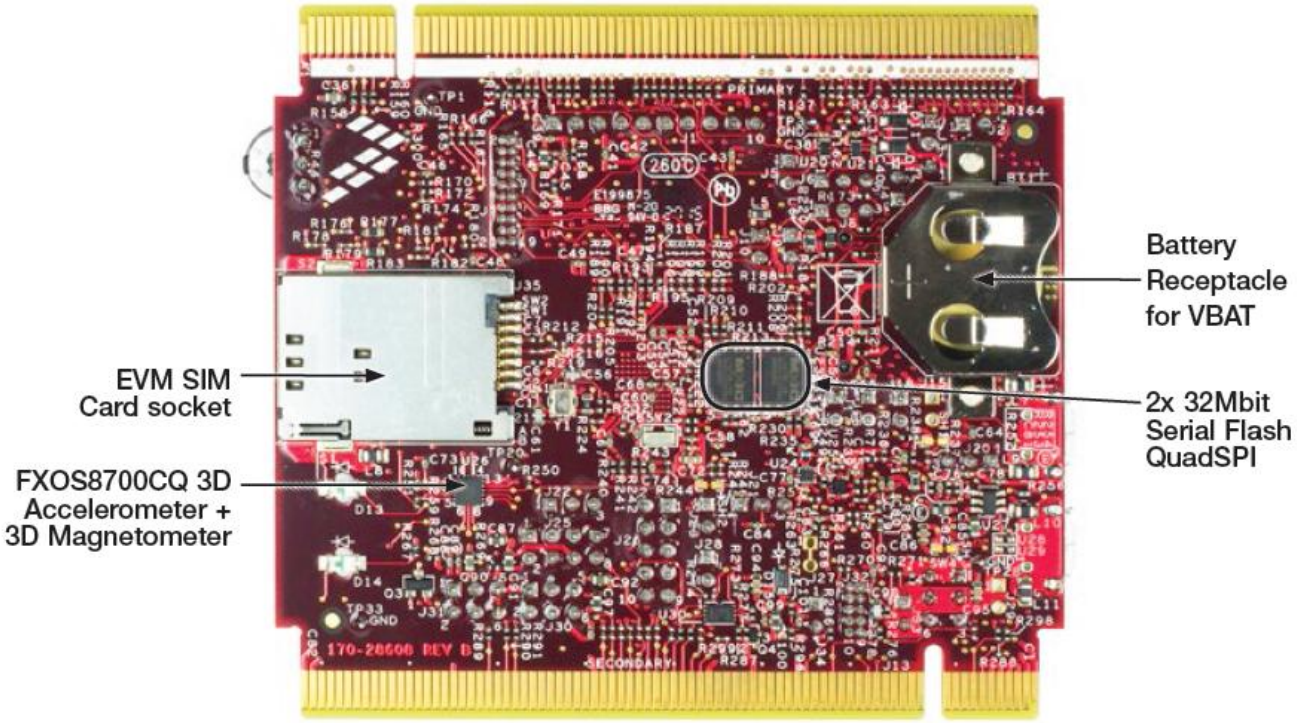


**Figure 2. Back side of the TWR-K80F150M module**

## 1.2 Getting started

You can find a printed version of the Quick Start Guide in the TWR-K80F150M box that contains the list of recommended steps for getting started. You can see http://freescale.com/twr-k80f150m/startnow for more getting started instructions, downloads, and information.

# 2 Contents

The TWR-K80F150M includes:

- TWR-K80F150M board assembly
- Quick Start Guide
- USB A to micro-B cable for debug interface and power supply

# 3 Hardware description

The TWR-K80F150M is a Tower MCU Module featuring the MK80FN256VDC15–an ARM® Cortex®-M4F based MCU with 256 KB on-chip flash, 256 KB on-chip SRAM, Dual QuadSPI controller, SDRAM controller, and USB controller in a 121 pin XFBGA package. It has a maximum core operating frequency of 150 MHz. It is intended for use in the Freescale Tower System but can operate as a stand-alone module. An on-board debug circuit, OpenSDA, provides the SWD debug interface and power supply input through a single USB micro-AB connector. The following sections describe the hardware in more detail. The following figure shows a block diagram for the TWR-K80F150M.

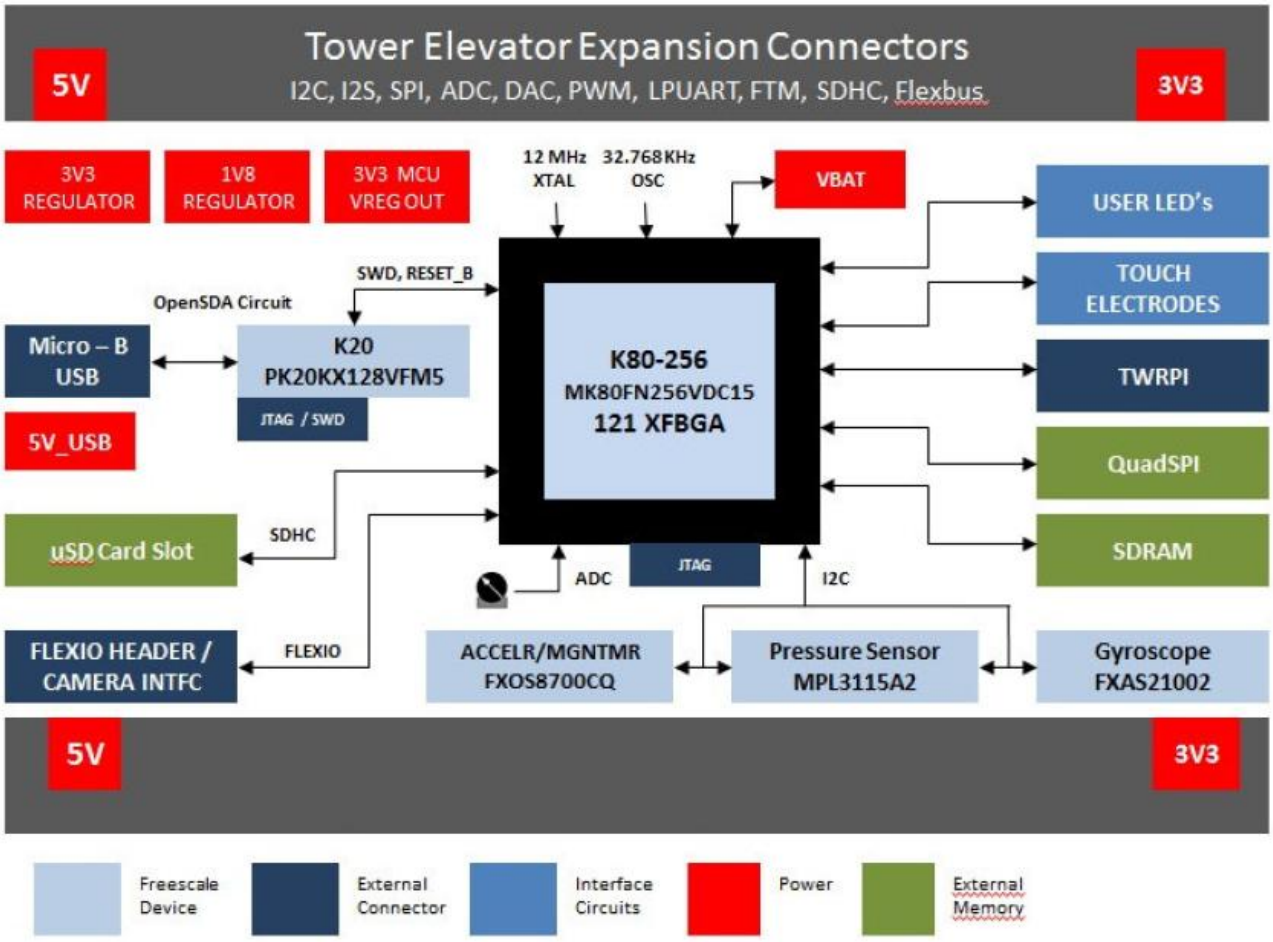


**Figure 3. TWR-K80F150M Block Diagram**

## 3.1. K80F150M microcontroller

The TWR-K80F150M module features the MK80FN256VDC15. The K80 microcontroller family is part of the Kinetis portfolio of devices built around an ARM Cortex-M4F core. Refer to the *K80 Family Reference Manual* (document K80P121M150SF5RM) for comprehensive information on the K80FN256VDC15 device. The key features of K80FN256VDC15 are as follows:

**Table 1. K80FN256VDC15 key features**

| Feature | Description |
|---|---|
| Performance | • Up to 150 MHz ARM Cortex-M4 based core with DSP instructions and Single Precision Floating Point unit |
| Memory and memory expansion | • 256 KB program flash memory and 256 KB RAM<br>• Dual QuadSPI with XIP<br>• FlexBus external bus interface and SDRAM controller |
| Analog modules | • One 16-bit SAR ADCs, two 6-bit DAC and one 12-bit DAC<br>• Two analog comparators (CMP) containing a 6-bit DAC and programmable reference input<br>• Voltage reference 1.2 V |
| Communication interfaces | • USB full-/low-speed On-the-Go controller<br>• Secure Digital Host Controller (SDHC)<br>• FlexIO<br>• One I2S module, three SPI, four I2C modules and five LPUART modules<br>• EMVSIM module with ISO7816 smart card support |
| Security | • Hardware random-number generator<br>• Supports DES, AES, SHA accelerator (CAU)<br>• Multiple levels of embedded flash security |
| Timers | • One 4-channel Periodic interrupt timer<br>• Two 16-bit low-power timer PWM modules<br>• Two 8-channel motor control/general purpose/PWM timers<br>• Two 2-channel quadrature decoder/general purpose timers<br>• Real-time clock with independent 3.3 V power domain<br>• Programmable delay block |
| Human machine interface | • Low-power hardware touch sensor interface (TSI)<br>• General-purpose input/output |
| Operating Characteristics | • Main VDD Voltage and Flash write voltage range:1.71 V – 3.6 V<br>• Temperature range (ambient): -40 to 105°C<br>• Independent VDDIO for PORTE (QuadSPI): 1.71 V – 3.6 V |

## 3.2. Clocking

The Kinetis microcontrollers start up from an internal digitally controlled oscillator (DCO). The software can enable an external oscillator if required. The external oscillator for the Multipurpose Clock Generator (MCG) module can range from 32.768 kHz up to a 32 MHz crystal or ceramic resonator. The external oscillator for the Real-Time Clock (RTC) module accepts a 32.768 kHz crystal.

Two crystals are provided on-board for clocking the K80F150M device: a 12 MHz crystal as the main oscillator to clock the MCG module and a 32.768 kHz crystal for clocking the RTC module.

## 3.3. System power

In standalone operation, the main power source for the TWR-K80F150M is derived from the 5.0 V input from either the USB micro-B connector, J24, or the debugger header, J11, when a shunt is placed on jumper J4.

There are multiple power configurations available to power both the MCU VDD domain and the VDDIO_E domain, while keeping the requirement that VDD>VDDIO_E during power up and power down. See sheet 3 of the *TWR-K80F150M Schematics* (document TWR-K80F150M-SCH) for further details.

When installed into a Tower System, the TWR-K80F150M can be powered from either an on-board power source or from another power source in the assembled Tower System.

The 3.3 V or 1.8 V power supplied to the MCU is routed through a jumper, J9. The jumper shunt can be removed to allow the following:

1) Alternate MCU supply voltages to be injected.
2) Measurement of power consumed by the MCU.

## 3.4. Real-Time Clock supply

The Real-Time Clock (RTC) module on the K80FN256VDC15 has two modes of operation: system power up and system power down. During system power down, the RTC can be powered from the backup power supply (VBAT) and electrically isolated from the rest of the MCU. The TWR-K80F150M provides a battery receptacle for a coin cell battery that can be used as the VBAT supply. The receptacle uses standard 20 mm diameter 3 V lithium coin cell batteries.

By default the VBAT supply comes from the MCU_PWR domain. This is selected via J3.

## 3.5. Serial and Debug Adapter version 2 (OpenSDAv2.1)

OpenSDAv2.1 is a serial and debug adapter circuit which 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 as shown in figure 4. The hardware circuit is based on a Freescale Kinetis K20 family MCU with 128 KB of embedded flash and an integrated USB controller. OpenSDAv2 comes preloaded with the CMSIS-DAP bootloader—an open-source mass storage device (MSD) bootloader—and the CMSIS-DAP interface firmware (also known as the mbed interface), which provides an MSD flash programming interface, a virtual serial port interface, and a CMSIS-DAP debug protocol interface. For more information on the OpenSDAv2 software, see http://freescale.com/opensda

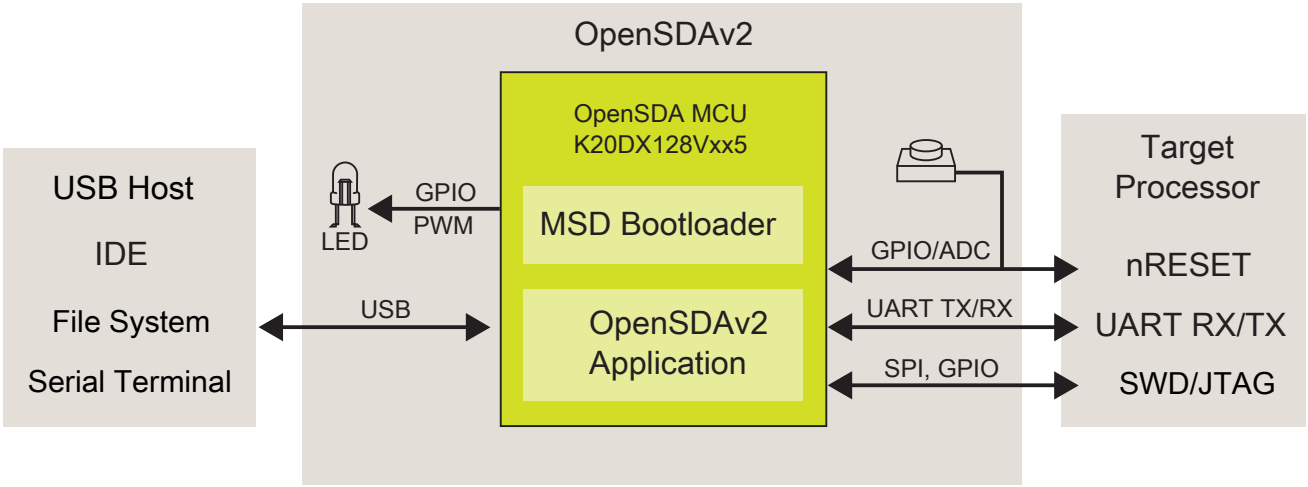


**Figure 4. OpenSDAv2 high-level block diagram**

OpenSDAv2 is managed by a Kinetis K20 MCU built on the ARM Cortex-M4 core. The OpenSDAv2 circuit includes a green status LED (D5) and a pushbutton (SW1). The pushbutton asserts the Reset signal to the K80 target MCU. It can also be used to place the OpenSDAv2 circuit into bootloader mode. SPI and GPIO signals provide an interface to either the SWD debug port or the K20. Additionally, signal connections are available to implement a UART serial channel. The OpenSDAv2 circuit receives power when the USB connector J24 is plugged into a USB host.

## 3.6. Cortex Debug connector

The Cortex Debug connector is a 20-pin (0.05 inch) connector providing access to the SWD and JTAG available on the K80 device. If using the Cortex Debug connector, it is recommended to isolate the OpenSDA circuit from the debug signals by removing the jumpers J16 and J17.

The K80 pin connections to the debug connector (J11) are shown in this table.

**Table 2. Cortex Debug connector pinout**

| Pin | Function | TWR-K80F150M connection |
|---|---|---|
| 1 | VTref | 3.3 V MCU supply (MCU_PWR) |
| 2 | TMS/SWDIO | PTA3/JTAG_TMS/SWD_DIO |
| 3 | GND | GND |
| 4 | TCK/SWCLK | PTA0/JTAG_TCLK/SWD_CLK |
| 5 | GND | GND |
| 6 | TDO/SWO | PTA2/JTAG_TDO/TRACE_SWO |
| 7 | Key | — |
| 8 | TDI | PTA1/JTAG_TDI |
| 9 | GNDDETECT | No Connect |
| 10 | nReset | RESET_b |
| 11 | Target Power | 5 V supply (via J4) |
| 12 | TRACECLK | PTA12/TRACE_CLKOUT |
| 13 | Target Power | 5 V supply (via J4) |
| 14 | TRACEDATA[0] | PTA16/TRACE_D0 |
| 15 | GND | GND |
| 16 | TRACEDATA[1] | PTA15TRACE_D1 |
| 17 | GND | GND |
| 18 | TRACEDATA[2] | PTA14/TRACE_D2 |
| 19 | GND | GND |
| 20 | TRACEDATA[3] | PTA13/TRACE_D3 |

## 3.7. QuadSPI Memory

The FRDM-K82F also includes dual QuadSPI memory with execute in place (XiP) and On The Fly AES Decryption (OTFAD) capability. The on-board QuadSPI used is Macronix MX25U3235FZNI, which are each 32 Mb (4MB) in size. The QuadSPI interface offers up to 100 MHz performance for Single Data Rate (SDR). The QuadSPI is also supported by the internal Kinetis BootROM.

## 3.8. External Bus Interface – FlexBus

The K80 device features a multi-function external bus interface called the FlexBus interface controller. This is capable of interfacing with slave-only devices. The FlexBus interface is not used directly on the TWR-K80F150M. Instead, a subset of the FlexBus is connected to the Primary Connector so that the external bus can access devices on Tower peripheral modules. Refer to Table 6 below and sheet 10 of the *TWR-K80F150M Schematics* (document TWR-K80F150M-SCH) for more details. Note that the Flexbus is muxed with the SDRAM signals.

## 3.9. SDRAM

The TWR-K80F150M board contains 64 Mb SDRAM (32-bit width) which is connected to the K80 SDRAM controller. The SDRAM signals are multiplexed with Flexbus signals. See the *K80 Family Reference Manual* (document K80P121M150SF5RM) "Flexbus signal multiplexing" section and "SDRAM SDR signal multiplexing" section on how to use the Flexbus and SDRAM in multiplexed mode.

To use the SDRAM, jumpers J6 and J8 should be removed. This is due to the UART TX/RX lines used on the TWR-K80F150M are muxed with the SDRAM signals. This does mean serial communication over OpenSDA is not possible while using the SDRAM.

## 3.10. Sensors

There are three Freescale sensors on the board, all connected via I2C0 via PTD8 (I2C0_SCL) and PTD9 (I2C0_SDA):

- FXOS8700CQ: Digital accelerometer and magnetometer
- MPL3115A2: Digital pressure sensor
- FXAS21002C: 3-axis gyroscope.

Each sensor also has two interrupt signals with the option to connect to the K80 device on PTA17 and PTA29. By default they are disconnected via DNP resistors.

**Table 3. Sensor types and slave addresses**

| Sensor | I2C Slave Address |
|---|---|
| FXOS8700CQ 3D accelerometer and 3D magnetometer | 0x1D |
| MPL3115A2 Digital pressure sensor | 0x60 |
| FXAS21002C 3-axis gyroscope | 0x20 |

## 3.11. Potentiometer, pushbuttons, LEDs

The TWR-K80F150M features:

- A potentiometer connected to an ADC input signal (ADC0_DM3)
- Two pushbutton switches (SW2 and SW3 connected to PTA4 and PTA21)

- User controllable LEDs connected to GPIO signals
  - Red LED D1 connected to PTD11
  - Green LED D2 connected to PTD12
  - Blue LED D3 connected to PTD13
  - Green Touch LED D13 connected to PTD14
  - Blue Touch LED D14 connected to PTD15
  - RGB LED D5 connected via DNP resistor to PTD11, PTD12, and PTD13

## 3.12. Touch interface

The touch-sensing input (TSI) module of the Kinetis microcontrollers provides capacitive touch-sensing detection with high sensitivity and enhanced robustness. Each TSI pin implements the capacitive measurement of an electrode. There are two individual electrodes on-board the TWR-K80F150M that simulate pushbuttons. TSI0_CH9 (PTB16) and TSI0_CH10 (PTB17) are connected to the capacitive pads.

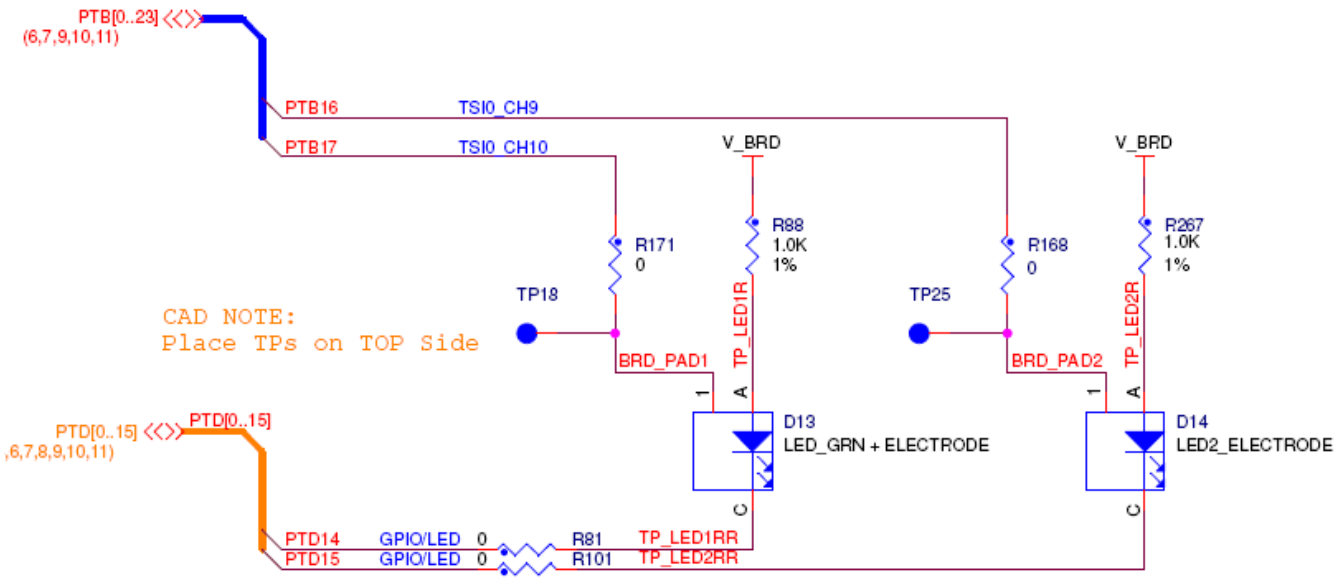


**Figure 5. Touch pad circuitry**

There is also a Touch TWRPI (Tower Plugin) header for a touch sensitive keypad to be attached on J12. For details on the connection see Table 5.

## 3.13. USB interface

The K80FN256VDC15 features a full-, low-speed USB controller with on-chip USB transceiver. The TWR-K80F150M board enables the USB to be host or device mode.

Jumper J20 is used to select whether the USB signals are connected to the on-board micro-B connector J19 (default), or sent down the elevator to be used in connection with a TWR-SER1 board or other peripheral board in a complete tower kit.

A MIC2005 device is used for over-current detection. PTC19 (connected via J28) is used to enable a 5 V VBUS signal, and PTC18 (connected via J18) is used as an over-current signal.

## 3.14. Secure digital card slot

A Micro SD card slot is available on the TWR-K80F150M connected to the SD host controller (SDHC) signals of the MCU. This slot will accept standard format SD memory cards. See Table 5 for connection details.

The SDHC signals are muxed with the QuadSPI signals, and therefore the microSD card slot is not connected to the K80 by default. To use the microSD card, populate the R198, R200, R208, R58, R196, R218, and R244 resistors on the board with 0 ohm resistors. Then remove the R231 and R227 resistors that power the QuadSPI. Finally because the microSD card slot needs to run at 3.3 V, on J31 the jumpers should be set to 1-3 and 2-4 to make both VDD and VDDIO_E at 3.3 V.

# 4 Jumper table

There are several jumpers provided for isolation, configuration, and feature selection. See the following table for details.

**Table 4. TWR-K80F150M jumper table**

| Jumper | Option | Setting | Description | Default setting |
|---|---|---|---|---|
| J2 | MCU reset connection on JTAG connector | ON | Connect MCU reset on pin10 of JTAG connector J11 | ON |
| | | OFF | Disconnect MCU reset on pin10 of JTAG connector J11 | |
| J3 | VBAT Power Selection | 1-2 | Connect VBAT to on board MCU supply from MCU_PWR | 1-2 |
| | | 2-3 | Connect VBAT to the higher voltage between on board MCU_PWR supply or coin cell supply | |
| J4 | JTAG Power Connection | ON | Connect on-board 5V supply to JTAG port (supports powering board from external JTAG probe) | OFF |
| | | OFF | Disconnect on-board 5V supply from JTAG port | |
| J5 | QuadSPI Power Enable | ON | Connect VDDIO_E domain to power QuadSPI flash. Should only be connected when VDDIO_E is at 1.8V | ON |
| | | OFF | Disconnect VDDIO_E domain from QuadSPI flash. | |
| J6 | UART RX Connection | 1-2 | Connect UART1_RX to elevator | 2-3 |
| | | 2-3 | Connect UART1_RX to OpenSDA UART RX | |
| J8 | UART TX Connection | 1-2 | Connect UART1_TX to elevator | 2-3 |
| | | 2-3 | Connect UART1_TX to OpenSDA UART TX | |
| J9 | MCU power connection | ON | Connect V_BRD and MCU_PWR to MCU_VDD | ON |
| | | OFF | Disconnect V_BRD and MCU_PWR from MCU_VDD | |
| J10 | VDD and VDDA connection | ON | Connect VDD and VDDA | ON |
| | | OFF | Disconnect VDD and VDDA | |
| J15 | USB ID connection | ON | Connect PTD7 to USB ID pin on micro-USB connector J19 | OFF |
| | | OFF | Disconnect PTD7 from USB ID pin on micro-USB connector J19 | |

**Table 4. TWR-K80F150M jumper table (continued)**

| Jumper | Option | Setting | Description | Default setting |
|---|---|---|---|---|
| J16 | SWD DIO OpenSDA Connection | ON | Connect SWD_DIO from OPENSDA circuit to K80 MCU to allow debugging using OPENSDA | ON |
| | | OFF | Disconnect SWD_CLK from OPENSDA circuit to K80 MCU to allow J-Link or U-Link debug | |
| J17 | SWD clock OpenSDA Connection | ON | Connect SWD_CLK from OPENSDA circuit to K80 MCU to allow debugging using OPENSDA | ON |
| | | OFF | Disconnect SWD_CLK from OPENSDA circuit to K80 MCU to allow J-Link or U-Link debug | |
| J18 | USB over-current flag connection | ON | Connect PTC18 to USB over-current flag for MIC2005 | ON |
| | | OFF | Disconnect PTC18 to USB over-current flag for MIC2005 | |
| J20 | USB Switch Selection | 1-2 | Use the on-board micro-USB connector J19 | 1-2 |
| | | 2-3 | USB signals come from elevator | |
| J21 | RESET button connection | 1-2 | When powering the OPENSDA MCU, bootloader mode can be selected | 1-2 |
| | | 2-3 | When OPENSDA MCU is not powered, RESET button can be used | |
| J22 | VREGIN Selection | 1-2 | VREGIN comes from on-board 5V source | 1-2 |
| | | 2-3 | VREGIN comes from elevator VBUS from signal A57. | |
| J23 | 5 V Connection | ON | Connect 5 V IN to the 3.3 V regulator | ON |
| | | OFF | Disconnect 5 V IN from the 3.3 V regulator | |
| J25 | Board Power and Regulator Selection | 1-3 | 3V3_BRD connected to output of 3.3 V regulator | 1-3 5-6 |
| | | 2-4 | Invalid configuration. Do not use. | |
| | | 3-4 | Invalid configuration. Do not use. | |
| | | 4-6 | 1.8 V regulator uses output of Li-Ion Battery Domain | |
| | | 5-6 | 1.8 V regulator uses output of 3.3 V regulator | |
| | | 6-8 | 1.8 V regulator uses 5 V IN directory. | |
| J26 | 5 V Input Power Selection | 1-3 | VREGIN uses USB 5 V | 1-3 5-6 |
| | | 3-4 | Raw 5 V input from K80 USB | |
| | | 5-6 | Regulated 5 V output from OpenSDA 5V input | |
| | | 7-8 | Power from P5V_ELEV input | |
| | | 9-10 | Raw 5 V input from OpenSDA USB port J24 | |
| J27 | OpenSDA Reset | ON | Connect OpenSDA reset signal to board reset. There is a board trace that makes this connection even if jumper is not populated. | OFF |
| | | OFF | Disconnect OpenSDA reset signal to board reset.<br><br>*By default there is a board trace connecting this signal even though jumper is off. | |
| J28 | USB power enable connection | ON | Connect PTC19 to USB power enable for MIC2005 | |
| | | OFF | Disconnect PTC19 to USB power enable for MIC2005 | |
| J30 | 3.3 V and 1.8 V sequencing | 1-2 | Invalid configuration. Do not use. | 3-5 4-6 |
| | | 1-3 | Option 2: 1.8 V comes up before 3.3 V.<br><br>3.3 V regulator enabled by output of 1.8 V regulator. Only used if VDD=1.8 V and VDDIO_E=3.3 V, which is not valid for QuadSPI on board. | |
| | | 2-4 | Option 2: 1.8 V comes up before 3.3 V.<br><br>1.8 V regulator enabled by input to regulator. Only used if VDD=1.8 V and VDDIO_E=3.3 V, which is not valid for | |

**Table 4. TWR-K80F150M jumper table (continued)**

| Jumper | Option | Setting | Description | Default setting |
|---|---|---|---|---|
| | | | QuadSPI on board. | |
| | | 3-5 | Option 1: 3.3 V comes up before 1.8 V.<br>3.3 V regulator enabled by input to regulator. | |
| | | 4-6 | Option 1: 3.3 V comes up before 1.8 V.<br>1.8 V regulator enabled by 3.3 V board supply. | |
| | | 5-6 | Invalid configuration. Do not use. | |
| J31 | VDDIO_E and VDD Selection | 1-3 | V_BRD/MCU_VDD is 3.3 V | 1-3<br>4-6 |
| | | 2-4 | VDDIO_E is 3.3 V | |
| | | 3-5 | V_BRD/MCU_VDD is 1.8 V | |
| | | 4-6 | VDDIO_E is 1.8 V | |
| J33 | Battery Voltage Monitoring | ON | Connect ADC0_DP3 to battery voltage | OFF |
| | | OFF | Disconnect ADC0_DP3 from battery voltage | |
| J34 | Battery Boost Regulator Input | ON | Enable 5 V Boost | OFF |
| | | OFF | Disconnect Boost Enable. | |

# 5 Input/output connectors and pin usage table

The table below provides details on which K80F150M pins are used to communicate with the TWR-K80F150M sensors, LEDs, switches, and other I/O interfaces.

**NOTE**

Some port pins are used in multiple interfaces on-board and many are potentially connected to off-board resources via the primary and secondary Connectors. You must take care to avoid attempted simultaneous usage of mutually exclusive features.

**Table 5. I/O Connectors and Pin Usage Table**

| Feature | Connection | Port Pin | Pin Function |
|---|---|---|---|
| OPENSDA USB-to-serial bridge | OPENSDA RX data | PTC3 | UART1_RX |
| | OPENSDA TX data | PTC4 | UART1_TX |
| SD Card Slot | SD clock | PTE2 | SDHC0_DCLK |
| | SD Command | PTE3 | SDHC0_CMD |
| | SD Data0 | PTE1 | SDHC0_D0 |
| | SD Data1 | PTE0 | SDHC0_D1 |
| | SD Data2 | PTE5 | SDHC0_D2 |

**Table 5. I/O Connectors and Pin Usage Table (continued)**

| Feature | Connection | Port Pin | Pin Function |
|---|---|---|---|
| | SD Data3 | PTE4 | SDHC0_D3 |
| | SD Card Detect | PTE7 | PTE7 |
| Pushbuttons | SW2 (NMI) | PTA4 | PTA4 |
| | SW3 (LLWU) | PTA21 | PTA21 |
| | SW1 (RESET) | RESET_b | RESET_b |
| Touch Pads | Touch | PTB16 | TSI0_CH9 |
| | Touch | PTB17 | TSI0_CH10 |
| LEDs | D1 / Red LED | PTD11 | Red LED |
| | D2 / Green LED | PTD12 | Green LED |
| | D3 / Blue LED | PTD13 | Blue LED |
| | D13 / Touch Pad Green LED | PTD14 | D13 Electrode LED |
| | D14 / Touch Pad Blue LED | PTD15 | D14 Electrode LED |
| | D8 | — | Power On |
| | D5 | — | OpenSDA Power |
| Potentiometer | Potentiometer (R44) | — | ADC0_DM3 |
| Sensors | $I^2C$ SDA | PTD9 | $I^2C0$_SDA |
| | $I^2C$ SCL | PTD8 | $I^2C0$_SCL |
| | IRQ1 | PTA17 | PTA17 |
| | IRQ2 | PTA29 | PTA29 |
| RTC | RTC bypass | PTA11 | PTA11 |
| Touch TWRPI Socket | Touch TWRPI1 | — | 5 V |
| | Touch TWRPI2 | — | V_BRD |
| | Touch TWRPI3 | PTA4 | TSI0_CH5/Touch Pad ‘1’ |
| | Touch TWRPI4 | — | VDDA |
| | Touch TWRPI5 | PTB0 | TSI0_CH0/Touch Pad ‘2’ |
| | Touch TWRPI6 | — | GND |
| | Touch TWRPI7 | PTB1 | TSI0_CH6/Touch Pad ‘3’ |
| | Touch TWRPI8 | PTB2 | TSI0_CH7/Touch Pad ‘4’ |
| | Touch TWRPI9 | PTB3 | TSI0_CH8/Touch Pad ‘5’ |
| | Touch TWRPI10 | PTB16 | TSI0_CH9/Touch Pad ‘6’ |
| | Touch TWRPI11 | PTB17 | TSI0_CH10/Touch Pad ‘7’ |
| | Touch TWRPI12 | PTB18 | TSI0_CH11/Touch Pad ‘8’ |
| | Touch TWRPI13 | PTB19 | TSI0_CH12/Touch Pad ‘9’ |
| | Touch TWRPI14 | PTC0 | TSI0_CH13/Touch Pad ‘*’ |
| | Touch TWRPI15 | PTC1 | TSI0_CH14/Touch Pad ‘0’ |
| | Touch TWRPI16 | PTC2 | TSI0_CH15/Touch Pad ‘#’ |
| | Touch TWRPI17 | ADC0_DP0 | TWRPI_ID0 |
| | Touch TWRPI18 | ADC0_DM0 | TWRPI_ID1 |

**Table 5. I/O Connectors and Pin Usage Table (continued)**

| Feature | Connection | Port Pin | Pin Function |
|---|---|---|---|
| | Touch TWRPI19 | — | GND |
| | Touch TWRPI20 | Reset | Reset |
| EMVSIM | Reset | PTB8 | EMVSIM_SRST |
| | CLK | PTB5 | EMVSIM_SCLK |
| | I/O | PTB4 | EMVSIM_IO |
| | VCC_EN | PTB6 | EMVSIM_VCC_EN |
| | Card Detection | PTB7 | EMVSIM_PD |
| Serial NOR Flash | QSPI_CLK1 | PTE1 | QPSI0A_SCLK |
| | QSPI_S_1 | PTE5 | QSPI0A_SS0_B |
| | QSPIA_DQ0 | PTE2 | QSPI0A_DATA0 |
| | QSPIA_DQ1 | PTE4 | QSPI0A_DATA1 |
| | QSPIA_DQ2 | PTE3 | QSPI0A_DATA2 |
| | QSPIA_DQ3 | PTE0 | QPSI0A_DATA3 |
| | QSPI_SCLK | PTE7 | QSPI0B_SCLK |
| | QSPI_S_2 | PTE11 | QSPI0B_SS0_B |
| | QSPIB_DQ0 | PTE8 | QSPI0B_DATA0 |
| | QSPIB_DQ1 | PTE10 | QSPI0B_DATA1 |
| | QSPIB_DQ2 | PTE9 | QSPI0B_DATA2 |
| | QSPIB_DQ3 | PTE6 | QSPI0B_DATA3 |
| SDRAM | DQ0 | PTB17 | SDRAM_D16 |
| | DQ1 | PTB16 | SDRAM_D17 |
| | DQ2 | PTB11 | SDRAM_D18 |
| | DQ3 | PTB10 | SDRAM_D19 |
| | DQ4 | PTB9 | SDRAM_D20 |
| | DQ5 | PTB8 | SDRAM_D21 |
| | DQ6 | PTB7 | SDRAM_D22 |
| | DQ7 | PTB6 | SDRAM_D23 |
| | DQ8 | PTC15 | SDRAM_D24 |
| | DQ9 | PTC14 | SDRAM_D25 |
| | DQ10 | PTC13 | SDRAM_D26 |
| | DQ11 | PTC12 | SDRAM_D27 |
| | DQ12 | PTB23 | SDRAM_D28 |
| | DQ13 | PTB22 | SDRAM_D29 |
| | DQ14 | PTB21 | SDRAM_D30 |
| | DQ15 | PTB20 | SDRAM_D31 |
| | A0 | PTC7 | SDRAM_A16 |
| | A1 | PTC8 | SDRAM_A15 |
| | A2 | PTC9 | SDRAM_A14 |

**Table 5. I/O Connectors and Pin Usage Table (continued)**

| Feature | Connection | Port Pin | Pin Function |
|---|---|---|---|
| | A3 | PTC10 | SDRAM_A13 |
| | A4 | PTD2 | SDRAM_A12 |
| | A5 | PTD3 | SDRAM_A11 |
| | A6 | PTD4 | SDRAM_A10 |
| | A7 | PTD5 | SDRAM_A9 |
| | A8 | PTC6 | SDRAM_A17 |
| | A9 | PTC5 | SDRAM_A18 |
| | A10 | PTC4 | SDRAM_A19 |
| | A11 | PTC2 | SDRAM_A20 |
| | BA0 | PTC1 | SDRAM_A21 |
| | BA1 | PTC0 | SDRAM_A22 |
| | CKE | PTD7 | SDRAM_CKE |
| | CLK | PTC3 | CLKOUT |
| | CS_b | PTB3 | SDRAM_CS0_b |
| | WE_b | PTB2 | SDRAM_WE |
| | CAS_b | PTB0 | SDRAM_CAS_b |
| | RAS_b | PTB1 | SDRAM_RAS_b |
| | DQMH | PTC17 | SDRAM_DQM3 |
| | DQML | PTC16 | SDRAM_DQM2 |

# 6 Elevator connections

The TWR-K80F150M features two expansion card-edge connectors that interface to Elevator boards in a Tower System: the primary and secondary Elevator connectors. The pinout for the primary Elevator Connector is provided in this table. The values in **bold** are either power or ground.

**Table 6. TWR-K80F150M Primary Connector Pinout**

| Pin # | Side B | | Pin # | Side A | |
|---|---|---|---|---|---|
| | Name | Usage | | Name | Usage |
| B1 | **5 V** | **5.0 V Power** | A1 | **5 V** | **5.0 V Power** |
| B2 | **GND** | **Ground** | A2 | **GND** | **Ground** |
| B3 | **3.3 V** | **3.3 V Power** | A3 | **3.3 V** | **3.3 V Power** |
| B4 | ELE_PS_SENSE | Elevator Power Sense | A4 | **3.3 V** | **3.3 V Power** |
| B5 | **GND** | **Ground** | A5 | **GND** | **Ground** |
| B6 | **GND** | **Ground** | A6 | **GND** | **Ground** |
| B7 | SDHC_CLK / SPI1_CLK | PTE2 | A7 | SCL0 | PTD8 |
| B8 | SDHC_D3 / SPI1_CS1_b | PTE4 | A8 | SDA0 | PTD9 |

**Table 6. TWR-K80F150M Primary Connector Pinout (continued)**

| | | | | | |
|---|---|---|---|---|---|
| B9 | SDHC_D3 / SPI1_CS0_b | PTE5 | A9 | GPIO9 / CTS1 | PTC2 |
| B10 | SDHC_CMD / SPI1_MOSI | PTE3 | A10 | GPIO8 / SDHC_D2 | PTE5 |
| B11 | SDHC_D0 / SPI1_MISO | PTE1 | A11 | GPIO7 / SD_WP_DET | PTD6 |
| B12 | ETH_COL | — | A12 | ETH_CRS | — |
| B13 | ETH_RXER | — | A13 | ETH_MDC | — |
| B14 | ETH_TXCLK | — | A14 | ETH_MDIO | — |
| B15 | ETH_TXEN | — | A15 | ETH_RXCLK | — |
| B16 | ETH_TXER | — | A16 | ETH_RXDV | — |
| B17 | ETH_TXD3 | — | A17 | ETH_RXD3 | — |
| B18 | ETH_TXD2 | — | A18 | ETH_RXD2 | — |
| B19 | ETH_TXD1 | — | A19 | ETH_RXD1 | — |
| B20 | ETH_TXD0 | — | A20 | ETH_RXD0 | — |
| B21 | GPIO1 / RTS1 | PTC1 | A21 | I2S0_MCLK | PTA17 |
| B22 | GPIO2 / SDHC_D1 | PTE0 | A22 | I2S0_DOUT_BCLK | PTA5 |
| B23 | GPIO3 | PTC9 | A23 | I2S0_DOUT_FS | PTA13 |
| B24 | CLKIN0 | PTA5 | A24 | I2S0_RXD0 | PTA15 |
| B25 | CLKOUT1 | — | A25 | I2S0_TXD0 | PTA12 |
| B26 | **GND** | **Ground** | A26 | **GND** | **Ground** |
| B27 | AN7 | — | A27 | AN3 | ADC0_SE6b |
| B28 | AN6 | — | A28 | AN2 | AD0_SE9 |
| B29 | AN5 | — | A29 | AN1 | ADC0_DM0 |
| B30 | AN4 | ADC0_SE7b | A30 | AN0 | ADC0_DP0 |
| B31 | **GND** | **Ground** | A31 | **GND** | **Ground** |
| B32 | DAC1 | — | A32 | DAC0 | DAC0_OUT |
| B33 | TMR3 | — | A33 | TMR1 | PTB19 |
| B34 | TMR2 | — | A34 | TMR0 | PTB18 |
| B35 | GPIO4 | PTD2 | A35 | GPIO6 | — |
| B36 | **3.3 V** | **3.3 V Power** | A36 | **3.3 V** | **3.3 V Power** |
| B37 | PWM7 | PTA1 | A37 | PWM3 | PTB1 |
| B38 | PWM6 | PTA0 | A38 | PWM2 | PTB0 |
| B39 | PWM5 | PTA11 | A39 | PWM1 | PTC2 |
| B40 | PWM4 | PTA10 | A40 | PWM0 | PTC1 |
| B41 | CANRX0 | — | A41 | RXD0 | PTA15 |
| B42 | CANTX0 | — | A42 | TXD0 | PTA14 |
| B43 | 1WIRE | — | A43 | RXD1 | ELEV_UART_RX |
| B44 | SPI0_MISO | PTC7 | A44 | TXD1 | ELEV_UART_TX |
| B45 | SPI0_MOSI | PTC6 | A45 | VSS | VSSA |
| B46 | SPI0_CS0_b | PTD0 | A46 | VDDA | VDDA |
| B47 | SPI0_CS1_b | PTD4 | A47 | CAN1_RX | — |
| B48 | SPI0_CLK | PTD1 | A48 | CAN1_TX | — |
| B49 | **GND** | **Ground** | A49 | **GND** | **Ground** |
| B50 | SCL1 | PTC10 | A50 | GPIO14 | — |
| B51 | SDA1 | PTC11 | A51 | GPIO15 | — |
| B52 | GPIO5 / SPI0_HOLD/IO3 | PTD3 | A52 | GPIO16 | — |
| B53 | USB0_DP_PDOWN | — | A53 | GPIO17 | — |
| B54 | USB0_DM_PDOWN | — | A54 | USB0_DM | ELEV_USB_DN |
| B55 | IRQ_H | — | A55 | USB0_DP | ELEV_USB_DP |
| B56 | IRQ_G | — | A56 | USB0_ID | PTD7 |
| B57 | IRQ_F | PTB10 | A57 | USB0_VBUS | ELEV_USB_VBUS |

**Table 6. TWR-K80F150M Primary Connector Pinout (continued)**

| | | | | | |
|---|---|---|---|---|---|
| B58 | IRQ_E | PTB9 | A58 | I2S0_DIN_BCLK | PTA14 |
| B59 | IRQ_D | PTB5 | A59 | I2S0_DIN_FS | PTA16 |
| B60 | IRQ_C | PTA14 | A60 | I2S0_RXD1 | PTA14 |
| B61 | IRQ_B | PTA13 | A61 | I2S0_TXD1 | PTA16 |
| B62 | IRQ_A | PTA12 | A62 | RSTIN_b | RESET_b |
| B63 | EBI_ALE / EBI_CS1_b | PTD0 | A63 | RSTOUT_b | — |
| B64 | EBI_CS0_b | PTD1 | A64 | CLKOUT0 | PTC3 |
| B65 | **GND** | **Ground** | A65 | **GND** | **Ground** |
| B66 | EBI_AD15 | PTB18 | A66 | EBI_AD14 | PTC0 |
| B67 | EBI_AD16 | PTB17 | A67 | EBI_AD13 | PTC1 |
| B68 | EBI_AD17 | PTB16 | A68 | EBI_AD12 | PTC2 |
| B69 | EBI_AD18 | PTB11 | A69 | EBI_AD11 | PTC4 |
| B70 | EBI_AD19 | PTB10 | A70 | EBI_AD10 | PTC5 |
| B71 | EBI_R/W_b | PTC11 | A71 | EBI_AD9 | PTC6 |
| B72 | EBI_OE_b | PTB19 | A72 | EBI_AD8 | PTC7 |
| B73 | EBI_D7 | PTB20 | A73 | EBI_AD7 | PTC8 |
| B74 | EBI_D6 | PTB21 | A74 | EBI_AD6 | PTC9 |
| B75 | EBI_D5 | PTB22 | A75 | EBI_AD5 | PTC10 |
| B76 | EBI_D4 | PTB23 | A76 | EBI_AD4 | PTD2 |
| B77 | EBI_D3 | PTC12 | A77 | EBI_AD3 | PTD3 |
| B78 | EBI_D2 | PTC13 | A78 | EBI_AD2 | PTD4 |
| B79 | EBI_D1 | PTC14 | A79 | EBI_AD1 | PTD5 |
| B80 | EBI_D0 | PTC15 | A80 | EBI_AD0 | PTD6 |
| B81 | **GND** | **Ground** | A81 | **GND** | **Ground** |
| B82 | **3.3 V** | **3.3 V Power** | A82 | **3.3 V** | **3.3 V Power** |

# 7 References

The list below provides references for more information on the Kinetis family, Tower System and the MCU modules. These can be found in the documentation section of freescale.com/TWR-K80F150M or freescale.com/kinetis.

- *TWR-K80F150M Quick Start Guide* (document TWR-K80F150M-QSG)
- *TWR-K80F150M Schematics* (document TWR-K80F150M-SCH)
- *K80 Family Data Sheet* (document K80P121M150SF5)
- *K80 Family Reference Manual* (document K80P121M150SF5RM)
- *Kinetis Quick Reference User Guide* (document KQRUG)
- *Kinetis Software Development Kit* (http://freescale.com/ksdk)
- *Kinetis Bootloader* (http://freescale.com/kboot)

# 8 Revision history

**Table 7. Revision history**

| Revision Number | Date | Substantive changes |
|---|---|---|
| 0 | 11/2015 | Initial release |

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