

# TWR-K60F120M Tower Module

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## User's Manual

Rev 1.0

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## Revision History

| Revision | Date         | Changes                                                                                                                |
|----------|--------------|------------------------------------------------------------------------------------------------------------------------|
| 0.1      | Dec 13, 2011 | Initial Release for PWA 700-27167 Rev B                                                                                |
| 1.0      | Nov 20, 2012 | Added information on running EVB at 150MHz<br>Added jumper details for rev C board<br>Added information on using trace |

# 1 TWR-K60F120M and TWR-K60F120M-KIT Overview

The TWR-K60F120M is a development board for the K10, K20 and K60 family 32-bit ARM® Cortex™-M4 MCUs. The TWR-K60F120M is populated with a device rated for 120 MHz operation across the full -40C to 85C temperature range. At room temperatures the board can be over-clocked to 150 MHz to allow for evaluation of the K10, K20, and K60 devices that are rated for 150 MHz operation across the full temperature range.

The TWR-K60F120M is a Tower Controller Module compatible with the Freescale Tower System. It can function as a stand-alone, low-cost platform for the evaluation of the Kinetis K10, K20, and K60 family of microcontroller (MCU) devices. The TWR-K60F120M features the Kinetis K60 low-power microcontroller based on the ARM® Cortex™-M4 architecture with USB 2.0 HS Controller, USB 2.0 full-speed OTG controller and 10/100 Mbps Ethernet MAC.

The TWR-K60F120M is available as a stand-alone product or as a kit (TWR-K60F120M-KIT) with the Tower Elevator Modules (TWR-ELEV) and the Tower Serial Module (TWR-SER). The TWR-K60F120M can also be combined with other Freescale Tower peripheral modules to create development platforms for a wide variety of applications. Figure 1 provides an overview of the Freescale Tower System.

## Controller Module

- Tower MCU/MPU board
- Works stand-alone or in Tower System
- Features integrated debugging interface for easy programming and run-control via standard USB cable

## Secondary Elevator

- Additional and secondary serial and expansion bus signals
- Standardized signal assignments
- Mounting holes and expansion connectors for side-mounting peripheral boards

## Size

- Tower is approx. 3.5" H x 3.5" W x 3.5" D when fully assembled

## Peripheral Module

- Examples include serial interface module, memory expansion module and Wi-Fi®

## Primary Elevator

- Common serial and expansion bus signals
- Two 2x80 connectors on backside for easy signal access and side-mounting board (LCD module)
- Power regulation circuitry
- Standardized signal assignments
- Mounting holes

## Board Connectors

- Four card-edge connectors
- Uses PCI Express® connectors (x16, 90 mm/ 3.5" long, 164 pins)

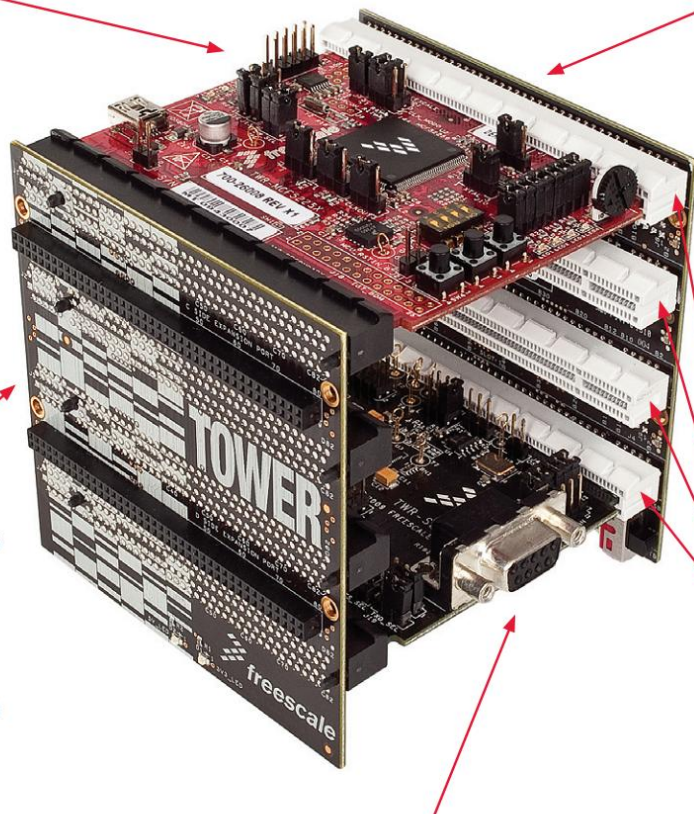


Figure 1. Freescale Tower System Overview

## 1.1 Contents

The TWR-K60F120M contents include:

- TWR-K60F120M board assembly
- 3ft USB cable
- Interactive DVD with software installers and documentation
- Quick Start Guide

The TWR-K60F120M-KIT contains:

- TWR-K60F120M MCU module
- TWR-ELEV – Primary and Secondary Elevator Modules
- TWR-SER – Serial module including USB host/device/OTG, Ethernet, CAN, RS232 and RS485

## 1.2 Features

Figure 2 and Figure 3 show the TWR-K60F120M with some of the key features called out. The following list summarizes the features of the TWR-K60F120M Tower MCU Module:

- Tower compatible microcontroller module
- MK60FN1M0VLQ12: K60FN1M in a 144 LQFP with 120 MHz operation
- Touch Tower Plug-in Socket
- General purpose Tower Plug-in (TWRPI) socket
- On-board JTAG debug circuit (OSJTAG) with virtual serial port
- 2Gb of SLC NAND flash memory
- Three axis accelerometer (MMA8451Q)
- Four (4) user-controllable LEDs
- Four (4) capacitive touch pads
- Two (2) user pushbutton switches
- Potentiometer
- Battery Holder for 20mm lithium battery (e.g. 2032, 2025)
- Micro-SD Card slot





Figure 2. Callouts on front side of the TWR-K60F120M



Figure 3. Callouts on back side of the TWR-K60F120M

## 1.3 Getting Started

Follow the Quick Start Guide found printed in the TWR-K60F120M box or the interactive DVD for the list of recommended steps for getting started. There are also lab walk-through guides available on the tool support page for the TWR-K60F120M: <http://www.freescale.com/TWR-K60F120M>.

## 1.4 Reference Documents

The documents listed below should be referenced for more information on the Kinetis family, Tower System, and MCU Modules. These can be found in the documentation section of [freescale.com/TWR-K60F120M](http://www.freescale.com/TWR-K60F120M) or [freescale.com/kinetis](http://www.freescale.com/kinetis).

- *TWR-K60F120M-QSG: Quick Start Guide*
- *TWR-K60F120M-SCH: Schematics*
- *TWR-K60F120M-PWB: Design Package*
- *K60 Family Product Brief*
- *K60 Family Reference Manual*
- *Tower Configuration Tool*

## 2 Hardware Description

The TWR-K60F120M is a Tower Controller Module featuring the MK60FN1M0VLQ12—an ARM Cortex-M4 based microcontroller with USB 2.0 HS Controller, USB 2.0 full-speed OTG controller and 10/100 Mbps Ethernet MAC in a 144 LQFP package with a maximum core operating frequency of 120MHz. It is intended for use in the Freescale Tower System but can operate stand-alone. An on-board debug circuit, OSJTAG, provides a JTAG debug interface and a power supply input through a single USB mini-AB connector. Figure 4 shows a block diagram of the TWR-K60F120M. The following sections describe the hardware in more detail.

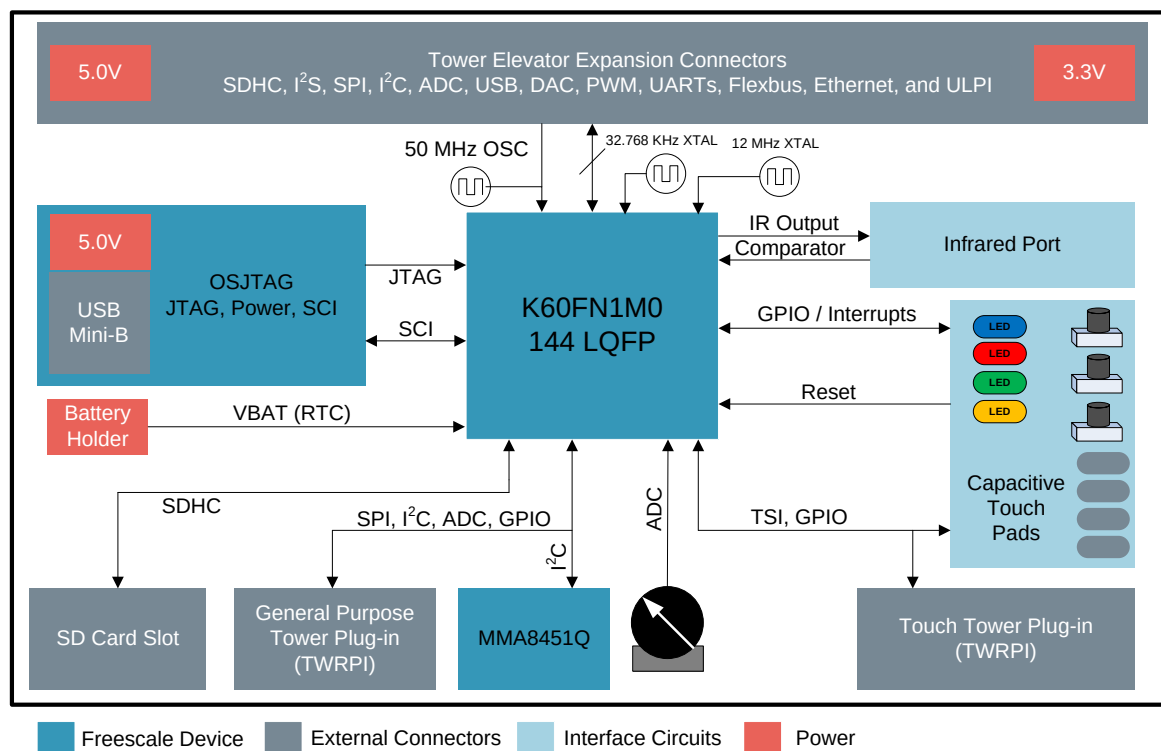


Figure 4. TWR-K60F120M Block Diagram

### 2.1 K60FN1M0 Microcontroller

The TWR-K60F120M module features the MK60FN1M0VLQ12. The K60 microcontroller family is part of the Kinetis portfolio of devices built around an ARM Cortex-M4 core. Refer to the *K60 Family Product Brief* and the *K60 Family Reference Manual* for comprehensive information on the MK60FN1M0VLQ12 device. The key features are listed here:

- 32-bit ARM Cortex-M4 core with DSP instructions
- 120MHz maximum core operating frequency
- 144 LQFP, 20mm x 20 mm, 0.5mm pitch package
- 1.71V – 3.6V operating voltage input range
- 1 Mbyte of program flash, 128 Kbytes of static RAM
- NAND flash controller
- External bus interface
- Power management controller with 10 different power modes
- Multi-purpose clock generator with PLL and FLL operation modes
- 16-bit SAR ADC, 12-bit DAC
- High-speed analog comparator with 6-bit DAC
- Programmable voltage reference
- USB high-speed OTG controller
- USB full-speed/low-speed OTG/Host/Device controller with device charge detect
- 10/100 Mbps Ethernet MAC
- SPI, I<sup>2</sup>C (w/ SMBUS support), UART (w/ ISO7816, CEA709.1-B (LON), and IrDA support), CAN, I<sup>2</sup>S
- SD Host Controller (SDHC)
- GPIO with pin interrupt support, DMA request capability, digital glitch filtering
- Capacitive touch sensing inputs (TSI)
- Debug interfaces: JTAG, cJTAG, SWD
- Trace: TPIO, FPB, DWT, ITM, ETM, ETB

## 2.2 Clocking

The Kinetis MCUs start up from an internal digitally controlled oscillator (DCO). Software can enable one, two, or three external oscillators if desired. Two of the external oscillators provide clocks to the Multipurpose Clock Generator (MCG) module and 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.

The EXTAL0 and EXTAL1 pins of the main external oscillators can also be driven directly from an external clock source. The TWR-K60F120M features a 50 MHz on-board clock oscillator connected to EXTAL0 as seen in sheet 4 of the schematics. However, when the K60 Ethernet MAC is operating in RMII mode, synchronization of the MCU input clock and the 50 MHz RMII transfer clock is important. In this mode, the MCU input clock must be kept in phase with the 50 MHz clock supplied to the external PHY. Therefore, the TWR-K60F120M provides the option (see description for J19 in Table 5) to select the clock input to the MCU from 1) the on-board 50MHz source or 2) an external clock from the CLKIN0 pin on the Primary Connector. When the K60 is operating in Ethernet RMII mode, the Tower peripheral module implementing the RMII PHY device should drive a 50 MHz clock on the CLKIN0 signal that is kept in phase with the clock supplied to the RMII PHY. Refer to section 2.11 “Ethernet” for more information.

The TWR-K60F120M also includes a 12MHz crystal connected to EXTAL1/XTAL1.



## 2.3 System Power

In stand-alone operation, the main power source for the TWR-K60F120M module is derived from the 5.0V input from either the USB mini-B connector, J13, or the debug header, J11, when a shunt is placed on jumper J12. A low-dropout regulator provides a 3.3V supply from the 5.0V input voltage. Refer to sheet 6 of the TWR-K60F120M schematics for more details.

When installed into a Tower System, the TWR-K60F120M can be powered from either an on-board source or from another source in the assembled Tower System. If both the on-board and off-board sources are available, the TWR-K60F120M will default to the off-board source.

The 3.3V power supplied to the MCU is routed through a jumpers, J8. J8 can be supplies VDD to the processor. The jumper shunt can be removed to allow for either 1) alternate MCU supply voltages to be injected or 2) the measurement of power consumed by the MCU.

### 2.3.1 RTC VBAT

The Real Time Clock (RTC) module on the K60 has two modes of operation, system power-up and system power-down. During system power-down, the RTC is powered from the backup power supply, VBAT. The TWR-K60F120M provides a battery holder for a coin cell battery that can be used as the VBAT supply. The holder can accept common 20mm diameter 3V lithium coin cell batteries (e.g. 2032, 2025). Refer to the description J9 in Table 5 “TWR-K60F120M Jumper Table” for more information.

## 2.4 Debug Interface

There are two debug interface options provided: the on-board OSJTAG circuit and an external Cortex Debug+ETM connector.

### 2.4.1 OSJTAG

An on-board MC9S08JM60 based Open Source JTAG (OSJTAG) circuit provides a JTAG debug interface to the K60FN1M0. A standard USB A male to Mini-B male cable (provided) can be used for debugging via the USB connector, J13. The OSJTAG interface also provides a USB to serial bridge. Drivers for the OSJTAG interface are provided in the *P&E Micro Kinetis Tower Toolkit* (available on the included DVD).

### 2.4.2 Cortex Debug+ETM Connector

The Cortex Debug+ETM connector is a 20-pin (0.05") connector providing access to the SWD, SWV, JTAG, cJTAG, EzPort and ETM trace (4-bit) signals available on the K60 device. The pinout and K60 pin connections to the debug connector, J14, is shown in Table 1Table 1.

NOTE: The TRACE\_CLKOUT signal is not connected to the debug connector by default. In order to use trace functionality R137 should be populated and R138 and R11 should be removed.

Table 1. Cortex Debug+ETM Connector Pinout

| Pin | Function    | TWR-K60F120M Connection                           |
|-----|-------------|---------------------------------------------------|
| 1   | VTref       | 3.3V MCU supply (P3V3_MCU)                        |
| 2   | TMS / SWDIO | PTA3/SCIO_RTS_b/FTM0_CH0/JTAG_MS/SWD_DIO          |
| 3   | GND         | GND                                               |
| 4   | TCK / SWCLK | PTA0/SCIO_CTS_b/FTM0_CH5/JTAG_CLK/SWD_CLK/EZP_CLK |

| Pin | Function     | TWR-K60F120M Connection                        |
|-----|--------------|------------------------------------------------|
| 5   | GND          | GND                                            |
| 6   | TDO / SWO    | PTA2/SCI0_TX/FTM0_CH7/JTAG_DO/TRACE_SWO/EZP_DO |
| 7   | Key          | —                                              |
| 8   | TDI          | PTA1/SCI0_RX/FTM0_CH6/JTAG_DI/EZP_DI           |
| 9   | GNDDetect    | PTA4/FTM0_CH1/MS/NMI_b/EZP_CS_b                |
| 10  | nRESET       | RESET_b                                        |
| 11  | Target Power | 5V supply (via J12)                            |
| 12  | TRACECLK     | PTA6/FTM0_CH3/TRACE_CLKOUT                     |
| 13  | Target Power | 5V supply (via J12)                            |
| 14  | TRACEDATA[0] | PTA10/FTM2_CH0/FTM2_QD_PHA/TRACE_D0            |
| 15  | GND          | GND                                            |
| 16  | TRACEDATA[1] | PTA9/FTM1_CH1/FTM1_QD_PHB/TRACE_D1             |
| 17  | GND          | GND                                            |
| 18  | TRACEDATA[2] | PTA8/FTM1_CH0/FTM1_QD_PHA/TRACE_D2             |
| 19  | GND          | GND                                            |
| 20  | TRACEDATA[3] | PTA7/FTM0_CH4/TRACE_D3                         |

**Note:** Many of the trace signals connected to the debug connector are also connected elsewhere on the TWR-K60F120M. Refer to Table 6 “I/O Connectors and Pin Usage Table” and Table 7 “TWR-K60F120M Primary Connector Pinout” for more information.

## 2.5 NAND Flash

The TWR-K60F120M includes 2Gb of SLC NAND flash memory (MT29F2G15ABAEAWP). The data lines used for the NAND flash are shared between the NAND flash controller and the FlexBus interface. Internal arbitration logic in the processor allows for dynamic sharing between the NAND flash and FlexBus interfaces.

## 2.6 Infrared Port

An infrared transmit and receive interface is implemented on the board. The CMT\_IRO pin directly drives an infrared diode. The receiver uses an infrared phototransistor connected to an on-chip analog comparator through a low-pass filter. Internal to the K60 device, the output of the analog comparator can be routed to a UART module for easier processing of the incoming data stream.

## 2.7 Accelerometer

An MMA8451Q digital accelerometer is connected to the K60 MCU through an I2C interface and a GPIO/IRQ signal. Refer to Table 6 “I/O Connectors and Pin Usage Table” for connection details.

## 2.8 Potentiometer, Pushbuttons, LEDs

The TWR-K60F120M features two pushbutton switches connected to GPIO/interrupt signals, one pushbutton connected to the master reset signal, four capacitive touch pad electrodes, four user-controllable LEDs, and a potentiometer connected to an ADC input signal. Refer to Table 6 “I/O Connectors and Pin Usage Table” for information about which port pins are connected to these features.

## 2.9 General Purpose Tower Plug-in (TWRPI) Socket

The TWR-K60F120M features a socket that can accept a variety of different Tower Plug-in modules featuring sensors, RF transceivers, and more. The General Purpose TWRPI socket provides access to I2C, SPI, IRQs, GPIOs, timers, analog conversion signals, TWRPI ID signals, reset, and voltage supplies. The pinout for the TWRPI Socket is defined in Table 2.

Refer to Table 6 “I/O Connectors and Pin Usage Table” for the specific K60 pin connections to the General Purpose TWRPI socket.

Table 2. General Purpose TWRPI socket pinout

| Left-side 2x10 Connector |                  | Right-side 2x10 Connector |                   |
|--------------------------|------------------|---------------------------|-------------------|
| Pin                      | Description      | Pin                       | Description       |
| 1                        | 5V VCC           | 1                         | GND               |
| 2                        | 3.3 V VCC        | 2                         | GND               |
| 3                        | GND              | 3                         | I2C: SCL          |
| 4                        | 3.3V VDDA        | 4                         | I2C: SDA          |
| 5                        | VSS (Analog GND) | 5                         | GND               |
| 6                        | VSS (Analog GND) | 6                         | GND               |
| 7                        | VSS (Analog GND) | 7                         | GND               |
| 8                        | ADC: Analog 0    | 8                         | GND               |
| 9                        | ADC: Analog 1    | 9                         | SPI: MISO         |
| 10                       | VSS (Analog GND) | 10                        | SPI: MOSI         |
| 11                       | VSS (Analog GND) | 11                        | SPI: SS           |
| 12                       | ADC: Analog 2    | 12                        | SPI: CLK          |
| 13                       | VSS (Analog GND) | 13                        | GND               |
| 14                       | VSS (Analog GND) | 14                        | GND               |
| 15                       | GND              | 15                        | GPIO: GPIO0/IRQ   |
| 16                       | GND              | 16                        | GPIO: GPIO1/IRQ   |
| 17                       | ADC: TWRPI ID 0  | 17                        | GPIO: GPIO2       |
| 18                       | ADC: TWRPI ID 1  | 18                        | GPIO: GPIO3       |
| 19                       | GND              | 19                        | GPIO: GPIO4/Timer |
| 20                       | Reset            | 20                        | GPIO: GPIO5/Timer |

## 2.10 Touch Interface

The touch sensing input (TSI) module of the Kinetis MCUs provides capacitive touch sensing detection with high sensitivity and enhanced robustness. Each TSI pin implements the capacitive measurement of an electrode.

The TWR-K60F120M provides two methods for evaluating the TSI module. There are four individual electrodes on-board the TWR-K60F120M that simulate pushbuttons. Additionally, twelve TSI signals are connected to a Touch Tower Plug-in (TWRPI) socket that can accept Touch TWRPI daughter cards that may feature keypads, rotary dials, sliders, etc.

The pinout for the Touch TWRPI socket is defined in Table 3. Refer to Table 6 “I/O Connectors and Pin Usage Table” for the specific K60 pin connections to the Touch TWRPI socket.

Table 3. Touch TWRPI socket pinout

| Pin | Description      |
|-----|------------------|
| 1   | 5V VCC           |
| 2   | 3.3 V VCC        |
| 3   | Electrode 0      |
| 4   | 3.3V VDDA        |
| 5   | Electrode 1      |
| 6   | VSS (Analog GND) |
| 7   | Electrode 2      |
| 8   | Electrode 3      |
| 9   | Electrode 4      |
| 10  | Electrode 5      |
| 11  | Electrode 6      |
| 12  | Electrode 7      |
| 13  | Electrode 8      |
| 14  | Electrode 9      |
| 15  | Electrode 10     |
| 16  | Electrode 11     |
| 17  | ADC: TWRPI ID 0  |
| 18  | ADC: TWRPI ID 1  |
| 19  | GND              |
| 20  | Reset            |

## 2.11 Ethernet

The K60FN1M0 features a 10/100 Mbps Ethernet MAC with MII and RMII interfaces. The TWR-K60F120M routes the RMII interface signals from the K60 MCU to the Primary Connector, allowing the connection to an external Ethernet PHY device on a Tower peripheral module.

When the K60 Ethernet MAC is operating in RMII mode, synchronization of the MCU clock and the 50 MHz RMII transfer clock is important. The MCU input clock must be kept in phase with the 50 MHz clock supplied to the external PHY. Therefore, the TWR-K60F120M provides the option (see description for J18 in Table 5) to clock the MCU from an external clock from the CLKIN0 pin on the Primary Connector. The Tower peripheral module implementing the RMII PHY device should drive a 50 MHz clock on the CLKIN0 pin that is kept in phase with the clock supplied to the RMII PHY.

The TWR-SER module that comes as part of the TWR-K60F120M-KIT provides a 10/100 Ethernet PHY that can operate in either MII or RMII mode. By default the PHY is boot strapped to operate in MII mode; therefore jumper configuration changes may be required. Table 4 shows the settings for proper interoperability between the Ethernet interface on the TWR-SER and the TWR-K60F120M.

Table 4. Ethernet operation jumper settings

| Tower Module       | Jumper | Setting |
|--------------------|--------|---------|
| TWR-K60F120M(revB) | J18    | OFF     |
| TWR-K60F120M(revC) | J6     | ON      |

|         |     |      |
|---------|-----|------|
| TWR-SER | J2  | 3-4  |
| TWR-SER | J3  | 2-3  |
| TWR-SER | J12 | 9-10 |

## 2.12 USB

The K60FN1M0 features two different USB modules--a USB full-speed/low-speed OTG/Host/Device controller with built-in transceiver and a high-speed OTG/Host/Device controller that requires a external ULPI PHY.

### 2.12.1 FS/LS USB

The TWR-K60F120M routes the USB D+ and D- signals from the K60 MCU to the Primary Connector, allowing the connection to external USB connectors or additional circuitry on a Tower peripheral module.

The TWR-SER module included as part of the TWR-K60F120M-KIT provides a USB OTG/Host/Device interface with a mini-AB USB connector. There are many configuration options that can be selected to evaluate different USB modes of operation. By default, the TWR-SER is configured for USB Device operation. Please refer to the documentation included with the TWR-SER for more information on the configuration options.

### 2.12.2 HS USB

The TWR-K60F120M routes the ULPI interface signals for the high-speed USB module to the Secondary Connector allowing the connection to an external ULPI PHY or additional circuitry on a Tower peripheral module.

The TWR-SER2 module includes a ULPI PHY that can be used with the TWR-K60F120M in order to evaluate the high-speed USB functionality. The TWR-SER2 is not included as part of the TWR-K60F120M-KIT, but the boards can be ordered individually from Freescale.

## 2.13 Secure Digital Card Slot

A Micro-Secure Digital (SD) card slot is available on the TWR-K60F120M connected to the SD Host Controller (SDHC) signals of the K60 MCU. This slot will accept micro-SD memory cards. Refer to Table 6 "I/O Connectors and Pin Usage Table" for the SDHC signal connection details.

## 2.14 External Bus Interface – FlexBus

The K60 device features a multi-function external bus interface called the FlexBus interface controller capable of interfacing to slave-only devices. The FlexBus interface is not used directly on the TWR-K60F120M. 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 7 "TWR-K60F120M Primary Connector Pinout" and sheet 9 of the TWR-K60F120M schematics for more details.



### 3 Jumper Table

There are several jumpers on the TWR-K60F120M that provide configuration selection and signal isolation. Refer to the following table for details. The default installed jumper settings are shown in bold with asterisks.

Table 5. TWR-K60F120M Jumper Table

| Jumper           | Option                          | Setting      | Description                                                                                                                                                                                                                                                                                         |
|------------------|---------------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| J1               | USB VREGIN Power Connection     | <b>*ON*</b>  | Connect USB0_VBUS from Primary Elevator (A57) to VREGIN                                                                                                                                                                                                                                             |
|                  |                                 | OFF          | Disconnect VREGIN from Primary Elevator                                                                                                                                                                                                                                                             |
| J2               | Infrared Transmitter Connection | ON           | Connect PTD7/CMT_IRO/UART0_TX to IR Transmitter (D1)                                                                                                                                                                                                                                                |
|                  |                                 | <b>*OFF*</b> | Disconnect PTD7/CMT_IRO/UART0_TX from IR Transmitter (D1)                                                                                                                                                                                                                                           |
| J6 (revC board)  | 50 MHz oscillator output enable | ON           | On-board 50MHz oscillator disabled. Off-board clock drives main EXTAL.<br><br>NOTE: This option should be selected whenever a tower module card that provides a clock on primary elevator pin B24 is connected to the CPU module. Otherwise there will be contention between the two clock sources. |
|                  |                                 | <b>*OFF*</b> | On-board 50MHz oscillator enabled. On-board 50 MHz clock drives main EXTAL.                                                                                                                                                                                                                         |
| J8               | MCU Power Connection            | <b>*ON*</b>  | Connect on-board 3.3V supply to MCU                                                                                                                                                                                                                                                                 |
|                  |                                 | OFF          | Isolate MCU from power supply (allows for external supply or power measurements)                                                                                                                                                                                                                    |
| J9               | VBAT Power Selection            | <b>*1-2*</b> | Connect VBAT to on-board 3.3V supply                                                                                                                                                                                                                                                                |
|                  |                                 | 2-3          | Connect VBAT to the higher voltage between on-board 3.3V supply or coin-cell supply                                                                                                                                                                                                                 |
| J10              | OSJTAG Mode Selection           | ON           | OSJTAG bootloader mode (OSJTAG firmware reprogramming)                                                                                                                                                                                                                                              |
|                  |                                 | <b>*OFF*</b> | Debugger mode                                                                                                                                                                                                                                                                                       |
| J12              | JTAG Power Connection           | ON           | Connect on-board 5V supply to JTAG port (supports powering board from external JTAG probe)                                                                                                                                                                                                          |
|                  |                                 | <b>*OFF*</b> | Disconnect on-board 5V supply from JTAG port                                                                                                                                                                                                                                                        |
| J16              | Infrared Receiver Connection    | <b>ON</b>    | Connect PTC6/CMP0_IN0 to IR Receiver                                                                                                                                                                                                                                                                |
|                  |                                 | <b>*OFF*</b> | Disconnect PTC6/CMP0_IN0 to IR Receiver                                                                                                                                                                                                                                                             |
| J18 (revB board) | 50MHz clock disable             | <b>*ON*</b>  | On-board 50MHz oscillator enabled. On-board 50 MHz clock drives main EXTAL.                                                                                                                                                                                                                         |
|                  |                                 | OFF          | On-board 50MHz oscillator disabled. Off-board clock drives main EXTAL.<br><br>NOTE: This option must be selected whenever a tower module card that provides a clock on primary elevator pin                                                                                                         |

|                     |                               |             |                                                                                                       |
|---------------------|-------------------------------|-------------|-------------------------------------------------------------------------------------------------------|
|                     |                               |             | B24 is connected to the CPU module. Otherwise there will be contention between the two clock sources. |
| J18<br>(revC board) | 50 MHz oscillator power       | <b>*ON*</b> | Power supply to 50MHz oscillator enabled.                                                             |
|                     |                               | OFF         | Power supply to 50MHz oscillator disabled.                                                            |
| J19                 | Potentiometer Connection      | <b>*ON*</b> | Connect ADC1_DM1 to the potentiometer                                                                 |
|                     |                               | OFF         | Disconnect ADC1_DM1 from the potentiometer                                                            |
| J21                 | I2S0_TXD0 source              | 1-2         | PTA12 is used as I2S0_TXD0 (Ethernet cannot be used when this option is selected)                     |
|                     |                               | 2-3         | PTC1 is used as I2S0_TXD0 (NFC cannot be used when this option is selected)                           |
| J22                 | I2S0_TX_FS source             | 1-2         | PTA13 is used as I2S0_TX_FS (Ethernet cannot be used when this option is selected)                    |
|                     |                               | 2-3         | PTC2 is used as I2S0_TX_FS (NFC cannot be used when this option is selected)                          |
| J23                 | I2S0_RX_BCLK/I2S0_TXD1 source | 1-2         | PTA14 is used as I2S0_RX_BCLK/I2S0_TXD1 (Ethernet cannot be used when this option is selected)        |
|                     |                               | 2-3         | PTC0 is used as I2S0_RX_BCLK/I2S0_TXD1 (NFC cannot be used when this option is selected)              |
| J24                 | I2S0_RX_FS/I2S0_RXD1 source   | 1-2         | PTA16 is used as I2S0_RX_FS/I2S0_RXD1 (Ethernet cannot be used when this option is selected)          |
|                     |                               | 2-3         | PTC11 is used as I2S0_RX_FS/I2S0_RXD1 (NFC cannot be used when this option is selected)               |

## 4 Input/Output Connectors and Pin Usage Table

The following table provides details on which K60FN1M0 pins are used to communicate with the LEDs, switches, and other I/O interfaces onboard the TWR-K60F120M.

**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. Take care to avoid attempted simultaneous usage of mutually exclusive features.

Table 6. I/O Connectors and Pin Usage Table

| Feature                     | Connection            | Port Pin | Pin Function |
|-----------------------------|-----------------------|----------|--------------|
| OSJTAG USB-to-serial Bridge | OSJTAG Bridge RX Data | PTE9     | UART5_RX     |
|                             | OSJTAG Bridge TX Data | PTE8     | UART5_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     |
|                             | SD Data3              | PTE4     | SDHC0_D3     |
|                             | SD Card Detect        | PTE28    | PTE28        |
| Infrared Port               | IR Transmit           | PTD7     | CMT_IRO      |
|                             | IR Receive            | PTC6     | CMPO_IN0     |
| Pushbuttons                 | SW1 (IRQ0)            | PTA19    | PTA19        |
|                             | SW2 (IRQ1)            | PTE26    | PTE26        |

|                                            |                            |         |                            |
|--------------------------------------------|----------------------------|---------|----------------------------|
|                                            | SW3 (RESET)                | RESET_b | RESET_b                    |
| Touch Pads                                 | E1 / Touch                 | PTA4    | TSIO_CH5                   |
|                                            | E2 / Touch                 | PTB3    | TSIO_CH8                   |
|                                            | E3 / Touch                 | PTB2    | TSIO_CH7                   |
|                                            | E4 / Touch                 | PTB16   | TSIO_CH9                   |
| LEDs                                       | E1 / Orange LED            | PTA11   | PTA11                      |
|                                            | E2 / Yellow LED            | PTA28   | PTA28                      |
|                                            | E3 / Green LED             | PTA29   | PTA29                      |
|                                            | E4 / Blue LED              | PTA10   | PTA10                      |
| Potentiometer                              | Potentiometer (R52)        | —       | ADC1_DM1                   |
| Accelerometer                              | I2C SDA                    | PTD9    | I2C0_SDA                   |
|                                            | I2C SCL                    | PTD8    | I2C0_SCL                   |
|                                            | INT1                       | PTB4    | PTB4                       |
|                                            | INT2                       | PTB7    | PTB7                       |
| General Purpose<br>TWRPI Socket            | TWRPI AN0 (J4 Pin 8)       | —       | ADC0_DP0/ADC1_DP3          |
|                                            | TWRPI AN1 (J4 Pin 9)       | —       | ADC0_DM0/ADC1_DM3          |
|                                            | TWRPI AN2 (J4 Pin 12)      | —       | ADC1_DP0/ADC0_DP3          |
|                                            | TWRPI ID0 (J4 Pin 17)      | —       | ADC0_DP1/ADC2_DP0/ADC3_DP3 |
|                                            | TWRPI ID1 (J4 Pin 18)      | —       | ADC0_DM1/ADC2_DM0/ADC3_DM3 |
|                                            | TWRPI I2C SCL (J5 Pin 3)   | PTD8    | I2C0_SCL                   |
|                                            | TWRPI I2C SDA (J5 Pin 4)   | PTD9    | I2C0_SDA                   |
|                                            | TWRPI SPI MISO (J5 Pin 9)  | PTD14   | SPI2_SIN                   |
|                                            | TWRPI SPI MOSI (J5 Pin 10) | PTD13   | SPI2_SOUT                  |
|                                            | TWRPI SPI SS (J5 Pin 11)   | PTD15   | SPI2_PCS1                  |
|                                            | TWRPI SPI CLK (J5 Pin 12)  | PTD12   | SPI2_SCK                   |
|                                            | TWRPI GPIO0 (J5 Pin 15)    | PTD10   | PTB4                       |
|                                            | TWRPI GPIO1 (J5 Pin 16)    | PTB8    | PTB8                       |
|                                            | TWRPI GPIO2 (J5 Pin 17)    | PTB9    | PTB9                       |
|                                            | TWRPI GPIO3 (J5 Pin 18)    | PTA19   | PTA19                      |
|                                            | TWRPI GPIO4 (J5 Pin 19)    | PTE26   | PTE26                      |
| Touch Pad /<br>Segment LCD TWRPI<br>Socket | Electrode 0 (J3 Pin 3)     | PTB0    | TSIO_CH0                   |
|                                            | Electrode 1 (J3 Pin 5)     | PTB1    | TSIO_CH6                   |
|                                            | Electrode 2 (J3 Pin 7)     | PTB2    | TSIO_CH7                   |
|                                            | Electrode 3 (J3 Pin 8)     | PTB3    | TSIO_CH8                   |
|                                            | Electrode 4 (J3 Pin 9)     | PTC0    | TSIO_CH13                  |
|                                            | Electrode 5 (J3 Pin 10)    | PTC1    | TSIO_CH14                  |
|                                            | Electrode 6 (J3 Pin 11)    | PTC2    | TSIO_CH15                  |
|                                            | Electrode 7 (J3 Pin 12)    | PTA4    | TSIO_CH5                   |
|                                            | Electrode 8 (J3 Pin 13)    | PTB16   | TSIO_CH9                   |
|                                            | Electrode 9 (J3 Pin 14)    | PTB17   | TSIO_CH10                  |
|                                            | Electrode 10 (J3 Pin 15)   | PTB18   | TSIO_CH11                  |
|                                            | Electrode 11 (J3 Pin 16)   | PTB19   | TSIO_CH12                  |

|  |                       |   |           |
|--|-----------------------|---|-----------|
|  | TWRPI ID0 (J3 Pin 17) | — | ADC1_DP1  |
|  | TWRPI ID1 (J3 Pin 18) | — | ADC1_SE16 |

## 5 Tower Elevator Connections

The TWR-K60F120M features two expansion card-edge connectors that interface to the Primary and Secondary Elevator boards in a Tower system. The Primary Connector (comprised of sides A and B) is utilized by the TWR-K60F120M while the Secondary Connector (comprised of sides C and D) only makes connections to the GND pins. Table 7 provides the pinout for the Primary Connector.

Table 7. TWR-K60F120M Primary Connector Pinout

| TWR-K60F120M Primary Connector |                      |              |                      |       |                   |              |                   |
|--------------------------------|----------------------|--------------|----------------------|-------|-------------------|--------------|-------------------|
| Pin #                          | Side B               |              |                      | Pin # | Side A            |              |                   |
|                                | Name                 | Group        | Usage                |       | Name              | Group        | Usage             |
| B1                             | <b>5V</b>            | <b>Power</b> | <b>5.0V Power</b>    | A1    | <b>5V</b>         | <b>Power</b> | <b>5.0V Power</b> |
| B2                             | <b>GND</b>           | <b>Power</b> | <b>Ground</b>        | A2    | <b>GND</b>        | <b>Power</b> | <b>Ground</b>     |
| B3                             | <b>3.3V</b>          | <b>Power</b> | <b>3.3V Power</b>    | A3    | <b>3.3V</b>       | <b>Power</b> | <b>3.3V Power</b> |
| B4                             | ELE_PS_SENSE         | Power        | Elevator Power Sense | A4    | <b>3.3V</b>       | <b>Power</b> | <b>3.3V Power</b> |
| B5                             | <b>GND</b>           | <b>Power</b> | <b>Ground</b>        | A5    | <b>GND</b>        | <b>Power</b> | <b>Ground</b>     |
| B6                             | <b>GND</b>           | <b>Power</b> | <b>Ground</b>        | A6    | <b>GND</b>        | <b>Power</b> | <b>Ground</b>     |
| B7                             | SDHC_CLK / SPI1_CLK  | SDHC / SPI 1 | PTE2                 | A7    | SCL0              | I2C 0        | PTD8              |
| B8                             | SDHC_D3 / SPI1_CS1_b | SDHC / SPI 1 |                      | A8    | SDA0              | I2C 0        | PTD9              |
| B9                             | SDHC_D3 / SPI1_CS0_b | SDHC / SPI 1 | PTE4                 | A9    | GPIO9 / CTS1      | GPIO / UART  | PTE10             |
| B10                            | SDHC_CMD / SPI1_MOSI | SDHC / SPI 1 | PTE3                 | A10   | GPIO8 / SDHC_D2   | GPIO / SDHC  | PTE5              |
| B11                            | SDHC_D0 / SPI1_MISO  | SDHC / SPI 1 | PTE1                 | A11   | GPIO7 / SD_WP_DET | GPIO / SDHC  | PTE27             |
| B12                            | ETH_COL              | Ethernet     |                      | A12   | ETH_CRS           | Ethernet     |                   |
| B13                            | ETH_RXER             | Ethernet     | PTA5                 | A13   | ETH_MDC           | Ethernet     | PTB1              |
| B14                            | ETH_TXCLK            | Ethernet     |                      | A14   | ETH_MDIO          | Ethernet     | PTB0              |
| B15                            | ETH_TXEN             | Ethernet     | PTA15                | A15   | ETH_RXCLK         | Ethernet     |                   |
| B16                            | ETH_TXER             | Ethernet     |                      | A16   | ETH_RXDV          | Ethernet     | PTA14             |
| B17                            | ETH_TXD3             | Ethernet     |                      | A17   | ETH_RXD3          | Ethernet     |                   |
| B18                            | ETH_TXD2             | Ethernet     |                      | A18   | ETH_RXD2          | Ethernet     |                   |
| B19                            | ETH_TXD1             | Ethernet     | PTA17                | A19   | ETH_RXD1          | Ethernet     | PTA12             |

|         |                 |              |                   |         |             |              |                                   |
|---------|-----------------|--------------|-------------------|---------|-------------|--------------|-----------------------------------|
| B2<br>0 | ETH_TXD0        | Ethernet     | PTA16             | A2<br>0 | ETH_RXD0    | Ethernet     | PTA13                             |
| B2<br>1 | GPIO1 / RTS1    | GPIO / UART  | PTE11             | A2<br>1 | SSI_MCLK    | SSI          | PTE6                              |
| B2<br>2 | GPIO2 / SDHC_D1 | GPIO / SDHC  | PTE0              | A2<br>2 | SSI_BCLK    | SSI          | PTE12                             |
| B2<br>3 | GPIO3           | GPIO         | PTE28             | A2<br>3 | SSI_FS      | SSI          | PTA13/PTC2<br>(determined by J22) |
| B2<br>4 | CLKIN0          | Clock        | PTA18             | A2<br>4 | SSI_RXD     | SSI          | PTE7                              |
| B2<br>5 | CLKOUT1         | Clock        | PTE26             | A2<br>5 | SSI_TXD     | SSI          | PTA12/PTC1<br>(determined by J21) |
| B2<br>6 | <b>GND</b>      | <b>Power</b> | <b>Ground</b>     | A2<br>6 | <b>GND</b>  | <b>Power</b> | <b>Ground</b>                     |
| B2<br>7 | AN7             | ADC          | PTB7              | A2<br>7 | AN3         | ADC          | PGA0_DP/ADC0_DP0/ADC1_DP3         |
| B2<br>8 | AN6             | ADC          | PTB6              | A2<br>8 | AN2         | ADC          | PGA0_DM/ADC0_DM0/ADC1_DM3         |
| B2<br>9 | AN5             | ADC          | PTB5              | A2<br>9 | AN1         | ADC          | PGA1_DP/ADC1_DP0/ADC0_DP3         |
| B3<br>0 | AN4             | ADC          | PTB4              | A3<br>0 | AN0         | ADC          | PGA1_DM/ADC1_DM0/ADC0_DM3         |
| B3<br>1 | <b>GND</b>      | <b>Power</b> | <b>Ground</b>     | A3<br>1 | <b>GND</b>  | <b>Power</b> | <b>Ground</b>                     |
| B3<br>2 | DAC1            | DAC          | DAC1_OUT          | A3<br>2 | DAC0        | DAC          | DAC0_OUT                          |
| B3<br>3 | TMR3            | Timer        |                   | A3<br>3 | TMR1        | Timer        | PTA9                              |
| B3<br>4 | TMR2            | Timer        | PTD6              | A3<br>4 | TMR0        | Timer        | PTA8                              |
| B3<br>5 | GPIO4           | GPIO         | PTB8              | A3<br>5 | GPIO6       | GPIO         | PTB9                              |
| B3<br>6 | <b>3.3V</b>     | <b>Power</b> | <b>3.3V Power</b> | A3<br>6 | <b>3.3V</b> | <b>Power</b> | <b>3.3V Power</b>                 |
| B3<br>7 | PWM7            | PWM          | PTA2              | A3<br>7 | PWM3        | PWM          | PTA6                              |
| B3<br>8 | PWM6            | PWM          | PTA1              | A3<br>8 | PWM2        | PWM          | PTC3                              |
| B3<br>9 | PWM5            | PWM          | PTD5              | A3<br>9 | PWM1        | PWM          | PTC2                              |
| B4<br>0 | PWM4            | PWM          | PTA7              | A4<br>0 | PWM0        | PWM          | PTC1                              |
| B4<br>1 | CANRX0          | CAN 0        | PTC16             | A4<br>1 | RXD0        | UART 0       | PTA1                              |
| B4<br>2 | CANTX0          | CAN 0        | PTC17             | A4<br>2 | TXD0        | UART 0       | PTA2                              |
| B4<br>3 | 1WIRE           | 1-Wire       |                   | A4<br>3 | RXD1        | UART 1       | PTE9                              |
| B4<br>4 | SPI0_MISO       | SPI 0        | PTD14             | A4<br>4 | TXD1        | UART 1       | PTE8                              |
| B4<br>5 | SPI0_MOSI       | SPI 0        | PTD13             | A4<br>5 | VSS         | Analog Vref  | VSSA                              |
| B4<br>6 | SPI0_CS0_b      | SPI 0        | PTD11             | A4<br>6 | VDDA        | Analog Vref  | VDDA                              |

|         |                        |                |               |         |                  |              |                                    |
|---------|------------------------|----------------|---------------|---------|------------------|--------------|------------------------------------|
| B4<br>7 | SPI0_CS1_b             | SPI 0          | PTD15         | A4<br>7 | CANRX1           | CAN 1        |                                    |
| B4<br>8 | SPI0_CLK               | SPI 0          | PTD12         | A4<br>8 | CANTX1           | CAN 1        |                                    |
| B4<br>9 | <b>GND</b>             | <b>Power</b>   | <b>Ground</b> | A4<br>9 | GND              | Power        | Ground                             |
| B5<br>0 | SCL1                   | I2C 1          | PTD8          | A5<br>0 | GPIO14           | GPIO         |                                    |
| B5<br>1 | SDA1                   | I2C 1          | PTD9          | A5<br>1 | GPIO15           | GPIO         |                                    |
| B5<br>2 | GPIO5 /<br>SD_CARD_DET | GPIO /<br>SDHC | PTE28         | A5<br>2 | GPIO16           | GPIO         |                                    |
| B5<br>3 | RSRV_B53               | USB 0          |               | A5<br>3 | GPIO17           | GPIO         |                                    |
| B5<br>4 | RSRV_B54               | USB 0          |               | A5<br>4 | USB0_DM          | USB 0        | USB0_DM                            |
| B5<br>5 | IRQ_H                  | Interrupt      | PTB4          | A5<br>5 | USB0_DP          | USB 0        | USB0_DP                            |
| B5<br>6 | IRQ_G                  | Interrupt      | PTB4          | A5<br>6 | USB0_ID          | USB 0        |                                    |
| B5<br>7 | IRQ_F                  | Interrupt      | PTB5          | A5<br>7 | USB0_VBUS        | USB 0        | VREGIN                             |
| B5<br>8 | IRQ_E                  | Interrupt      | PTB5          | A5<br>8 | I2S0_DIN_SC<br>K | I2S          | PTA14/PTC0<br>(determined by J23)  |
| B5<br>9 | IRQ_D                  | Interrupt      | PTB6          | A5<br>9 | I2S0_DIN_WS      | I2S          | PTA16/PTC11<br>(determined by J24) |
| B6<br>0 | IRQ_C                  | Interrupt      | PTB6          | A6<br>0 | I2S0_DIN1        | I2S          | PTA16/PTC11<br>(determined by J24) |
| B6<br>1 | IRQ_B                  | Interrupt      | PTB7          | A6<br>1 | I2S0_DOUT1       | I2S          | PTA14/PTC0<br>(determined by J23)  |
| B6<br>2 | IRQ_A                  | Interrupt      | PTB7          | A6<br>2 | RSTIN_b          | Reset        | RESET_b                            |
| B6<br>3 | EBI_ALE /<br>EBI_CS1_b | EBI            | PTD0          | A6<br>3 | RSTOUT_b         | Reset        | PTB8                               |
| B6<br>4 | EBI_CS0_b              | EBI            | PTD1          | A6<br>4 | CLKOUT0          | Clock        | PTC3                               |
| B6<br>5 | <b>GND</b>             | <b>Power</b>   | <b>Ground</b> | A6<br>5 | <b>GND</b>       | <b>Power</b> | <b>Ground</b>                      |
| B6<br>6 | EBI_AD15               | EBI            | PTB18         | A6<br>6 | EBI_AD14         | EBI          | PTC0                               |
| B6<br>7 | EBI_AD16               | EBI            | PTB17         | A6<br>7 | EBI_AD13         | EBI          | PTC1                               |
| B6<br>8 | EBI_AD17               | EBI            | PTB16         | A6<br>8 | EBI_AD12         | EBI          | PTC2                               |
| B6<br>9 | EBI_AD18               | EBI            | PTB11         | A6<br>9 | EBI_AD11         | EBI          | PTC4                               |
| B7<br>0 | EBI_AD19               | EBI            | PTB10         | A7<br>0 | EBI_AD10         | EBI          | PTC5                               |
| B7<br>1 | EBI_R/W_b              | EBI            | PTC11         | A7<br>1 | EBI_AD9          | EBI          | PTC6                               |
| B7<br>2 | EBI_OE_b               | EBI            | PTB19         | A7<br>2 | EBI_AD8          | EBI          | PTC7                               |
| B7<br>3 | EBI_D7                 | EBI            | PTB20         | A7<br>3 | EBI_AD7          | EBI          | PTC8                               |



|         |             |              |                   |         |             |              |                   |
|---------|-------------|--------------|-------------------|---------|-------------|--------------|-------------------|
| B7<br>4 | EBI_D6      | EBI          | PTB21             | A7<br>4 | EBI_AD6     | EBI          | PTC9              |
| B7<br>5 | EBI_D5      | EBI          | PTB22             | A7<br>5 | EBI_AD5     | EBI          | PTC10             |
| B7<br>6 | EBI_D4      | EBI          | PTB23             | A7<br>6 | EBI_AD4     | EBI          | PTD2              |
| B7<br>7 | EBI_D3      | EBI          | PTC12             | A7<br>7 | EBI_AD3     | EBI          | PTD3              |
| B7<br>8 | EBI_D2      | EBI          | PTC13             | A7<br>8 | EBI_AD2     | EBI          | PTD4              |
| B7<br>9 | EBI_D1      | EBI          | PTC14             | A7<br>9 | EBI_AD1     | EBI          | PTD5              |
| B8<br>0 | EBI_D0      | EBI          | PTC15             | A8<br>0 | EBI_AD0     | EBI          | PTD6              |
| B8<br>1 | <b>GND</b>  | <b>Power</b> | <b>Ground</b>     | A8<br>1 | <b>GND</b>  | <b>Power</b> | <b>Ground</b>     |
| B8<br>2 | <b>3.3V</b> | <b>Power</b> | <b>3.3V Power</b> | A8<br>2 | <b>3.3V</b> | <b>Power</b> | <b>3.3V Power</b> |

Table 8. TWR-K60F120M Secondary Connector Pinout

| <b>TWR-K60F120M Secondary Connector</b> |              |              |                      |              |             |              |                   |
|-----------------------------------------|--------------|--------------|----------------------|--------------|-------------|--------------|-------------------|
| Pi<br>n<br>#                            | Side D       |              |                      | Pi<br>n<br># | Side C      |              |                   |
|                                         | Name         | Group        | Usage                |              | Name        | Group        | Usage             |
| D1                                      | <b>5V</b>    | <b>Power</b> | <b>5.0V Power</b>    | C1           | <b>5V</b>   | <b>Power</b> | <b>5.0V Power</b> |
| D2                                      | <b>GND</b>   | <b>Power</b> | <b>Ground</b>        | C2           | <b>GND</b>  | <b>Power</b> | <b>Ground</b>     |
| D3                                      | <b>3.3V</b>  | <b>Power</b> | <b>3.3V Power</b>    | C3           | <b>3.3V</b> | <b>Power</b> | <b>3.3V Power</b> |
| D4                                      | ELE_PS_SENSE | Power        | Elevator Power Sense | C4           | <b>3.3V</b> | <b>Power</b> | <b>3.3V Power</b> |
| D5                                      | <b>GND</b>   | <b>Power</b> | <b>Ground</b>        | C5           | <b>GND</b>  | <b>Power</b> | <b>Ground</b>     |
| D6                                      | <b>GND</b>   | <b>Power</b> | <b>Ground</b>        | C6           | <b>GND</b>  | <b>Power</b> | <b>Ground</b>     |
| D7                                      | SPI2_CLK     | SPI 2        |                      | C7           | SCL2        | I2C 2        |                   |
| D8                                      | SPI2_CS1_b   | SPI 2        |                      | C8           | SDA2        | I2C 2        |                   |
| D9                                      | SPI2_CS0_b   | SPI 2        |                      | C9           | GPIO25      | GPIO         |                   |
| D1<br>0                                 | SPI2_MOSI    | SPI 2        |                      | C1<br>0      | ULPI_STOP   | ULPI         | PTA9              |
| D1<br>1                                 | SPI2_MISO    | SPI 2        |                      | C1<br>1      | ULPI_CLK    | ULPI         | PTA6              |
| D1<br>2                                 | ETH_COL      | Ethernet     |                      | C1<br>2      | GPIO26      | GPIO         |                   |
| D1<br>3                                 | ETH_RXER     | Ethernet     |                      | C1<br>3      | ETH_MDC     | Ethernet     |                   |
| D1<br>4                                 | ETH_TXCLK    | Ethernet     |                      | C1<br>4      | ETH_MDIO    | Ethernet     |                   |
| D1<br>5                                 | ETH_TXEN     | Ethernet     |                      | C1<br>5      | ETH_RXCLK   | Ethernet     |                   |
| D1<br>6                                 | GPIO18       | GPIO         |                      | C1<br>6      | ETH_RXDV    | Ethernet     |                   |

|         |                         |                 |                   |         |                         |                 |                   |
|---------|-------------------------|-----------------|-------------------|---------|-------------------------|-----------------|-------------------|
| D1<br>7 | GPIO19 / SDHC_D4        | GPIO /<br>SDHC  |                   | C1<br>7 | GPIO27 / SDHC_D6        | GPIO /<br>SDHC  |                   |
| D1<br>8 | GPIO20 / SDHC_D5        | GPIO /<br>SDHC  |                   | C1<br>8 | GPIO28 / SDHC_D7        | GPIO /<br>SDHC  |                   |
| D1<br>9 | ETH_TXD1                | Ethernet        |                   | C1<br>9 | ETH_RXD1                | Ethernet        |                   |
| D2<br>0 | ETH_TXD0                | Ethernet        |                   | C2<br>0 | ETH_RXD0                | Ethernet        |                   |
| D2<br>1 | ULPI_NEXT /<br>USB1_DM  | ULPI / USB<br>1 | PTA8              | C2<br>1 | ULPI_DATA0 /<br>USB3_DM | ULPI /<br>USB 3 | PTA10             |
| D2<br>2 | ULPI_DIR /<br>USB1_DP   | ULPI / USB<br>1 | PTA7              | C2<br>2 | ULPI_DATA1 /<br>USB3_DP | ULPI /<br>USB 3 | PTA11             |
| D2<br>3 | UPLI_DATA5 /<br>USB2_DM | ULPI / USB<br>2 | PTA27             | C2<br>3 | ULPI_DATA2 /<br>USB4_DM | ULPI /<br>USB 4 | PTA24             |
| D2<br>4 | ULPI_DATA6 /<br>USB2_DP | ULPI / USB<br>2 | PTA28             | C2<br>4 | ULPI_DATA3 /<br>USB4_DP | ULPI /<br>USB 4 | PTA25             |
| D2<br>5 | ULPI_DATA7              | ULPI            | PTA29             | C2<br>5 | ULPI_DATA4              | ULPI            | PTA26             |
| D2<br>6 | <b>GND</b>              | <b>Power</b>    | <b>Ground</b>     | C2<br>6 | <b>GND</b>              | <b>Power</b>    | <b>Ground</b>     |
| D2<br>7 | LCD_HSYNC /<br>LCD_P24  | Display         |                   | C2<br>7 | AN11                    | ADC             |                   |
| D2<br>8 | LCD_VSYNC /<br>LCD_P25  | Display         |                   | C2<br>8 | AN10                    | ADC             |                   |
| D2<br>9 | AN13                    | ADC             |                   | C2<br>9 | AN9                     | ADC             |                   |
| D3<br>0 | AN12                    | ADC             |                   | C3<br>0 | AN8                     | ADC             |                   |
| D3<br>1 | <b>GND</b>              | <b>Power</b>    | <b>Ground</b>     | C3<br>1 | <b>GND</b>              | <b>Power</b>    | <b>Ground</b>     |
| D3<br>2 | LCD_CLK /<br>LCD_P26    | Display         |                   | C3<br>2 | GPIO29                  | GPIO            |                   |
| D3<br>3 | TMR11                   | Timer           |                   | C3<br>3 | TMR9                    | Timer           |                   |
| D3<br>4 | TMR10                   | Timer           |                   | C3<br>4 | TMR8                    | Timer           |                   |
| D3<br>5 | GPIO21                  | GPIO            |                   | C3<br>5 | GPIO30                  | GPIO            |                   |
| D3<br>6 | <b>3.3V</b>             | <b>Power</b>    | <b>3.3V Power</b> | C3<br>6 | <b>3.3V</b>             | <b>Power</b>    | <b>3.3V Power</b> |
| D3<br>7 | PWM15                   | PWM             |                   | C3<br>7 | PWM11                   | PWM             |                   |
| D3<br>8 | PWM14                   | PWM             |                   | C3<br>8 | PWM10                   | PWM             |                   |
| D3<br>9 | PWM13                   | PWM             |                   | C3<br>9 | PWM9                    | PWM             |                   |
| D4<br>0 | PWM12                   | PWM             |                   | C4<br>0 | PWM8                    | PWM             |                   |
| D4<br>1 | CANRX1                  | CAN 1           |                   | C4<br>1 | RXD2 / TSI0             | UART 2 /<br>TSI |                   |
| D4<br>2 | CANTX1                  | CAN 1           |                   | C4<br>2 | TXD2 / TSI1             | UART 2 /<br>TSI |                   |
| D4<br>3 | LCD_CONTRAST            | Display         |                   | C4<br>3 | RTS2 / TSI2             | UART 2 /<br>TSI |                   |

|         |                       |                      |               |         |                             |                  |               |
|---------|-----------------------|----------------------|---------------|---------|-----------------------------|------------------|---------------|
| D4<br>4 | LCD_OE / LCD_P27      | Display              |               | C4<br>4 | CTS2 / TSI3                 | UART 2 /<br>TSI  |               |
| D4<br>5 | LCD_D0 / LCD_P0       | Display              |               | C4<br>5 | RXD3 / TSI4                 | UART 3 /<br>TSI  |               |
| D4<br>6 | LCD_D1 / LCD_P1       | Display              |               | C4<br>6 | TXD3 / TSI5                 | UART 3 /<br>TSI  |               |
| D4<br>7 | LCD_D2 / LCD_P2       | Display              |               | C4<br>7 | RTS3 / TSI6                 | UART 3 /<br>TSI  |               |
| D4<br>8 | LCD_D3 / LCD_P3       | Display              |               | C4<br>8 | CTS3 / TSI7                 | UART 3 /<br>TSI  |               |
| D4<br>9 | <b>GND</b>            | <b>Power</b>         | <b>Ground</b> | C4<br>9 | <b>GND</b>                  | <b>Power</b>     | <b>Ground</b> |
| D5<br>0 | GPIO23                | GPIO                 |               | C5<br>0 | LCD_D4 / LCD_P4             | Display          |               |
| D5<br>1 | GPIO24                | GPIO                 |               | C5<br>1 | LCD_D5 / LCD_P5             | Display          |               |
| D5<br>2 | LCD_D12 /<br>LCD_P12  | Display              |               | C5<br>2 | LCD_D6 / LCD_P6             | Display          |               |
| D5<br>3 | LCD_D13 /<br>LCD_P13  | Display              |               | C5<br>3 | LCD_D7 / LCD_P7             | Display          |               |
| D5<br>4 | LCD_D14 /<br>LCD_P14  | Display              |               | C5<br>4 | LCD_D8 / LCD_P8             | Display          |               |
| D5<br>5 | IRQ_P /<br>SPI2_CS2_b | Interrupt /<br>SPI 2 | PTB4          | C5<br>5 | LCD_D9 / LCD_P9             | Display          |               |
| D5<br>6 | IRQ_O /<br>SPI2_CS3_b | Interrupt /<br>SPI 2 | PTB4          | C5<br>6 | LCD_D10 / LCD_P10           | Display          |               |
| D5<br>7 | IRQ_N                 | Interrupt            | PTB5          | C5<br>7 | LCD_D11 / LCD_P11           | Display          |               |
| D5<br>8 | IRQ_M                 | Interrupt            | PTB5          | C5<br>8 | TMR16                       | Timer            |               |
| D5<br>9 | IRQ_L                 | Interrupt            | PTB6          | C5<br>9 | TMR15                       | Timer            |               |
| D6<br>0 | IRQ_K                 | Interrupt            | PTB6          | C6<br>0 | TMR14                       | Timer            |               |
| D6<br>1 | IRQ_J                 | Interrupt            | PTB7          | C6<br>1 | TMR13                       | Timer            |               |
| D6<br>2 | IRQ_I                 | Interrupt            | PTB7          | C6<br>2 | LCD_D15 / LCD_P15           | Display          |               |
| D6<br>3 | LCD_D18 /<br>LCD_P18  | Display              |               | C6<br>3 | LCD_D16 / LCD_P16           | Display          |               |
| D6<br>4 | LCD_D19 /<br>LCD_P19  | Display              |               | C6<br>4 | LCD_D17 / LCD_P17           | Display          |               |
| D6<br>5 | <b>GND</b>            | <b>Power</b>         | <b>Ground</b> | C6<br>5 | <b>GND</b>                  | <b>Power</b>     | <b>Ground</b> |
| D6<br>6 | EBI_AD20 /<br>LCD_P42 | EBI /<br>Display     |               | C6<br>6 | EBI_BE_32_24_b /<br>LCD_P28 | EBI /<br>Display |               |
| D6<br>7 | EBI_AD21 /<br>LCD_P43 | EBI /<br>Display     |               | C6<br>7 | EBI_BE_23_16_b /<br>LCD_P29 | EBI /<br>Display |               |
| D6<br>8 | EBI_AD22 /<br>LCD_P44 | EBI /<br>Display     |               | C6<br>8 | EBI_BE_15_8_b /<br>LCD_P30  | EBI /<br>Display |               |
| D6<br>9 | EBI_AD23 /<br>LCD_P45 | EBI /<br>Display     |               | C6<br>9 | EBI_BE_7_0_b /<br>LCD_P31   | EBI /<br>Display |               |
| D7<br>0 | EBI_AD24 /<br>LCD_P46 | EBI /<br>Display     |               | C7<br>0 | EBI_TSIZE0 /<br>LCD_P32     | EBI /<br>Display |               |

|         |                       |                  |                   |         |                         |                  |                   |
|---------|-----------------------|------------------|-------------------|---------|-------------------------|------------------|-------------------|
| D7<br>1 | EBI_AD25 /<br>LCD_P47 | EBI /<br>Display |                   | C7<br>1 | EBI_TSIZE1 /<br>LCD_P33 | EBI /<br>Display |                   |
| D7<br>2 | EBI_AD26 /<br>LCD_P48 | EBI /<br>Display |                   | C7<br>2 | EBI_TS_b / LCD_P34      | EBI /<br>Display |                   |
| D7<br>3 | EBI_AD27 /<br>LCD_P49 | EBI /<br>Display |                   | C7<br>3 | EBI_TBST_b /<br>LCD_P35 | EBI /<br>Display |                   |
| D7<br>4 | EBI_AD28 /<br>LCD_P50 | EBI /<br>Display |                   | C7<br>4 | EBI_TA_b / LCD_P36      | EBI /<br>Display |                   |
| D7<br>5 | EBI_AD29 /<br>LCD_P51 | EBI /<br>Display |                   | C7<br>5 | EBI_CS4_b /<br>LCD_P37  | EBI /<br>Display |                   |
| D7<br>6 | EBI_AD30 /<br>LCD_P52 | EBI /<br>Display |                   | C7<br>6 | EBI_CS3_b /<br>LCD_P38  | EBI /<br>Display |                   |
| D7<br>7 | EBI_AD31 /<br>LCD_P53 | EBI /<br>Display |                   | C7<br>7 | EBI_CS2_b /<br>LCD_P39  | EBI /<br>Display |                   |
| D7<br>8 | LCD_D20 /<br>LCD_P20  | Display          |                   | C7<br>8 | EBI_CS1_b /<br>LCD_P40  | EBI /<br>Display |                   |
| D7<br>9 | LCD_D21 /<br>LCD_P21  | Display          |                   | C7<br>9 | GPIO31 / LCD_P41        | GPIO             |                   |
| D8<br>0 | LCD_D22 /<br>LCD_P22  | Display          |                   | C8<br>0 | LCD_D23 / LCD_P23       | Display          |                   |
| D8<br>1 | <b>GND</b>            | <b>Power</b>     | <b>Ground</b>     | C8<br>1 | <b>GND</b>              | <b>Power</b>     | <b>Ground</b>     |
| D8<br>2 | <b>3.3V</b>           | <b>Power</b>     | <b>3.3V Power</b> | C8<br>2 | <b>3.3V</b>             | <b>Power</b>     | <b>3.3V Power</b> |