



TWR-KL25Z Tower Module

User Manual
TWR-KL25Z-UM
Rev. 1.0



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1 TWR-KL25Z

The TWR-KL25Z microcontroller module is designed to work either in standalone 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 www.freescale.com/tower for additional Tower System microcontroller modules and compatible peripherals. For TWR-KL25Z specific information and updates visit www.freescale.com/TWR-KL25Z

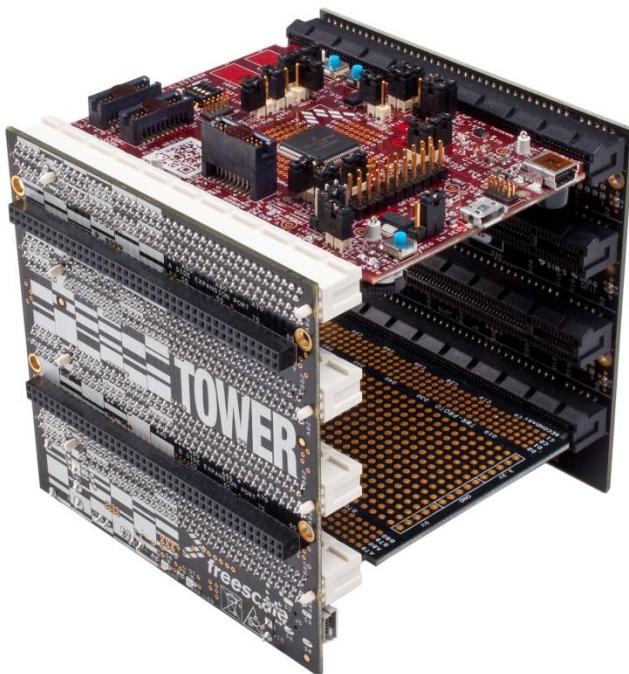


Figure 1 Freescale Tower System Overview

2 Contents

The TWR-KL25Z contents include:

- TWR-KL25Z board assembly
- 3ft A to mini-B USB cable for debug interface and power
- 3ft A to micro-B USB cable for MKL25Z128VLK4 USB interface
- Micro-B to A adapter for MKL25Z128VLK4 USB Host applications
- Quick Start Guide

3 TWR-KL25Z Features

- Tower compatible microcontroller module
- MKL25Z128VLK4 MCU (48 MHz, 128KB Flash, 16 KB RAM, Low power, 80LQFP package)
- Dual role USB interface with Micro-AB USB connector
- Touch Tower Plug-in Socket
- General purpose Tower Plug-in (TWRPI) socket
- On-board debug circuit MK20 openSDA serial debug interface with virtual serial port and mass storage device bootloader
- Three axis accelerometer (MMA8451Q)
- Four (4) user-controllable LEDs
- Two (2) capacitive touch pads
- Two (2) user pushbutton switches
- Infrared transmit and receive
- Potentiometer for ADC measurements
- GPIO header for prototyping

4 Get to Know the TWR-KL25Z

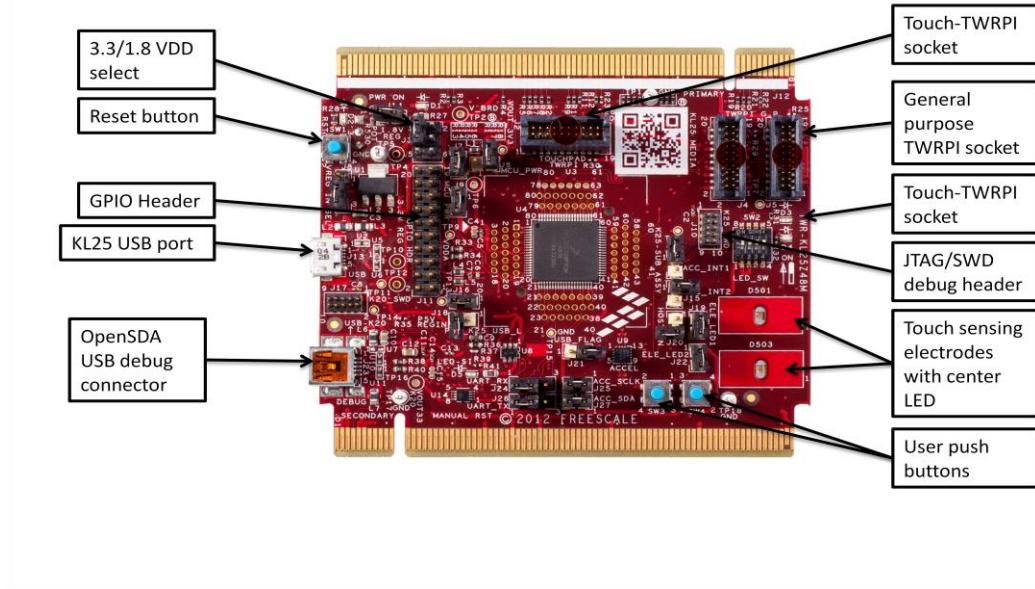


Figure 2 Top side of TWR-KL25Z module

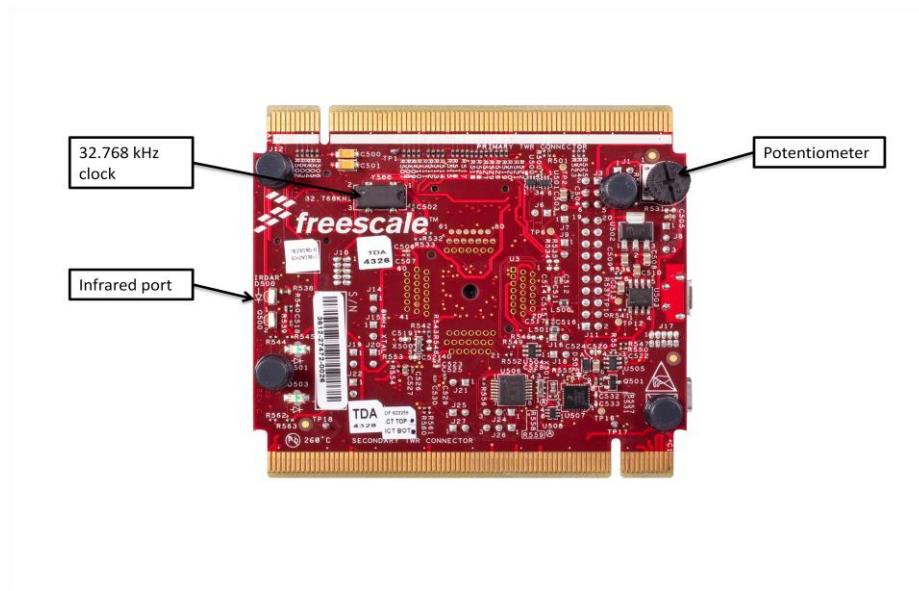


Figure 3 Bottom side of TWR-KL25Z module

5 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 <http://www.freescale.com/TWR-KL25Z> or <http://www.freescale.com/kinetis>

- TWRKL25ZQSG: Quick Start Guide
- TWR-KL25Z-SCH: Schematics
- TWR-KL25Z-PWA: Design Package
- MKL25Z128VLK4 Reference Manual
- Tower Configuration Tool
- Tower Mechanical Drawing

6 Hardware description

The TWR-KL25Z is a Tower MCU Module featuring the MKL25Z128VLK4 —a Kinetis microcontroller with USB 2.0 full-speed OTG controllers in a 80 LQFP package. It is intended for use in the Freescale Tower System but can operate stand-alone. An on-board debug circuit, openSDA, provides a JTAG interface and a power supply input through a single USB mini-AB connector, as well as a serial to USB, CDC class compliant UART interface.

6.1 Block Diagram

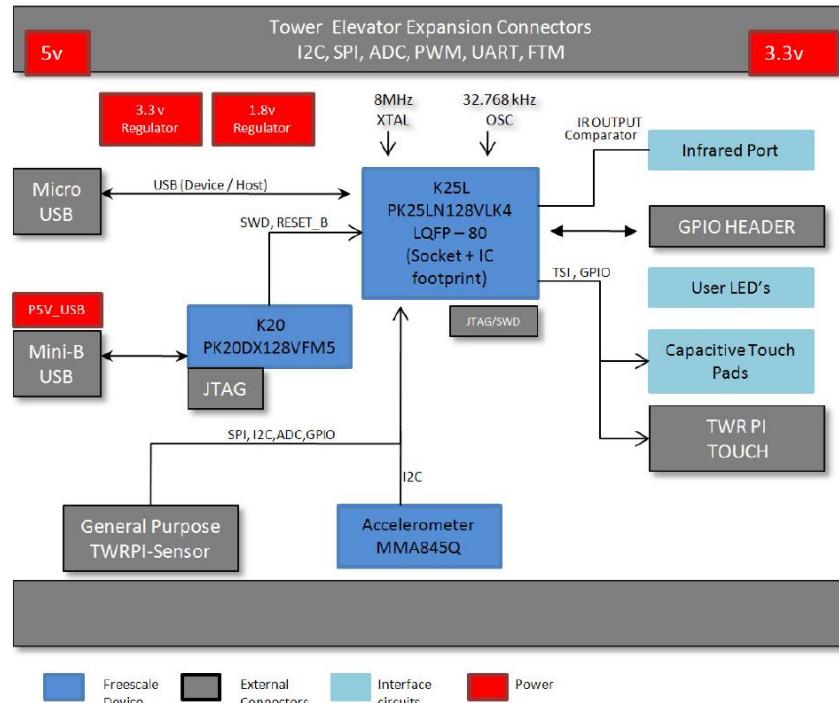


Figure 4 Block Diagram of TWR-KL25Z

6.2 Microcontroller

The TWR-KL25Z features the MKL25Z128VLK4. This 50 MHz microcontroller is part of the Kinetis L series and is available in an 80 LQFP package. The following table notes the features of MKL25Z128VLK4.

Table 1 Features of MKL25Z128VLK4

| Feature | Description |
|----------------------------|---|
| Ultra low power | <ul style="list-style-type: none"> - 10 low-power modes with power and clock gating for optimal peripheral activity and recovery times. Stop currents of <190 nA (VLLS0), run currents of <280 uA/MHz, 4 µs wake-up from Stop mode - Full memory and analog operation down to 1.71V for extended battery life - Low-leakage wake-up unit with up to eight internal modules and sixteen pins as wake-up sources in low-leakage stop (LLS)/very low-leakage stop (VLLS) modes - Low-power timer for continual system operation in reduced power states |
| Flash, SRAM and FlexMemory | <ul style="list-style-type: none"> - 32 KB – 128 KB flash featuring fast access times, high reliability, and four levels of security protection - 16 KB of SRAM - No user or system intervention to complete programming and erase functions and full operation down to 1.71V |
| Mixed-signal capability | <ul style="list-style-type: none"> - High-speed 16-bit ADC with configurable resolution - Single or differential output modes for improved noise rejection - 500 ns conversion time achievable with programmable delay block triggering - Analog comparator with 6-bit DAC reference. - 12-bit independent DAC. |
| Performance | <ul style="list-style-type: none"> - 48 MHz ARM Cortex-M0+ core - Up to four channel DMA for peripheral and memory servicing with reduced CPU loading and faster system throughput - Cross bar switch enables concurrent multi-master bus accesses, increasing bus bandwidth - Independent flash banks allowing concurrent code execution and firmware updating with no performance degradation or complex coding routines - Bit manipulation engine (BME) allows execution of single-instruction atomic bit-modify-write operations on the peripheral address space |

| | |
|----------------------------------|---|
| Timing and Control | <ul style="list-style-type: none"> - Low power timers. - Hardware dead-time insertion and quadrature decoding for motor control - Four-channel 32-bit periodic interrupt timer provides time base for RTOS task scheduler or trigger source for ADC conversion |
| Human-Machine Interface | <ul style="list-style-type: none"> - Hardware touch-sensing interface (TSI) with up to 16 inputs - TSI operates in low power modes (minimum current adder when enabled) - TSI hardware implementation avoids software polling methods - High sensitivity level allows use of overlay surfaces up to 5 mm thick. |
| Connectivity and Communications | <ul style="list-style-type: none"> - Full-Speed USB Device/Host/On-The-Go with device charge detect capability - Optimized charging current/time for portable USB devices, enabling longer battery life - USB low-voltage regulator supplies up to 120 mA off chip at 3.3 volts to power external components from 5-volt input - Three UARTs (one UART supports RS232 with flow control, RS485, ISO7816 and IrDA while the other two UARTS support RS232 with flow control and RS485) - One Inter-IC Sound (I2S) serial interface for audio system interfacing - One DSPI module and one I2C module |
| Reliability, Safety and Security | <ul style="list-style-type: none"> - Memory protection unit provides memory protection for all masters on the cross bar switch, increasing software reliability - Independent-clocked computer operating properly (COP) guards against clock skew or code runaway for fail-safe applications such as the IEC 60730 safety standard for household appliances - External watchdog monitor drives output pin to safe state for external components in the event that a watchdog timeout occurs - This product is included in Freescale's product longevity program, with assured supply for a minimum of 10 years after launch |

6.3 Clocking

The Kinetis MCUs start up from an internal digitally controlled oscillator (DCO). Software can enable the main external oscillator (EXTAL0/XTAL0) if desired. The external oscillator/resonator can range from 32.768 KHz up to a 32 MHz. An 8 MHz crystal is the default external source for the MCG oscillator inputs (XTAL/EXTAL). A 32.768 KHz crystal is connected to the RTC oscillator inputs by default.

6.4 System Power

When installed into a Tower System, the TWR-KL25Z can be powered from either an on-board source or from another source in the assembled Tower System.

In stand-alone operation, the main power source (5.0V) for the TWR-KL25Z module is derived from either the openSDA USB mini-B connector or the MKL25Z128VLK4 USB micro-AB connector (J31). Two low-dropout regulators provide 3.3V and 1.8V supplies from the 5.0V input voltage. Additionally, the 3.3V regulator built into the MKL25Z128VLK4 can be selected to power the 3.3V bus. All the user selectable options can be configured using two headers, J3 and J8.

6.5 Real Time Clock (RTC)

Y500 is a 32.768 kHz clock connected to RTC_CLKIN. By enabling the external clock option in the RTC, it can be used as a highly precise time reference.

6.6 Debug Interface

There are two debug interface options provided: the on-board openSDA circuit and an external ARM SWD connector.

6.6.1 OpenSDA

An on-board MK20-OpenSDA circuit provides an SWD debug interface to the KL25Z128. A standard USB A male to mini-B male cable (provided) can be used for debugging via the USB connector, J22. The OpenSDA interface also provides a USB to serial bridge.

6.6.2 Cortex Debug SWD Connector

The Cortex Debug SWD connector is a standard 2x5-pin (0.05") connector providing an external debugger cable with access to the SWD interface of the KL25Z128.

Table 2 Cortex Debug connector

| Pin | Function | TWR-KL25Z Connection |
|-----|----------|---|
| 1 | VTref | 3.3V MCU supply (V_BRD) |
| 2 | SWDIO | PTA3/TSI0_CH4/I2C1_SCL/FTM0_CH0/SWD_DIO |
| 3 | GND | GND |
| 4 | SWCLK | PTA0/TSI0_CH1/FTM0_CH5/SWD_CLK |
| 5 | GND | GND |
| 6 | NC | NC |
| 7 | NC | NC |
| 8 | NC | NC |
| 9 | NC | NC |
| 10 | RESET | RESET_b |

6.7 Infrared Port

An infrared transmit and receive interface is implemented as shown in Figure 55. The UART2_TX pin directly drives an infrared diode. The receiver uses an infrared phototransistor connected to UART2_RX through a low-pass filter. Internal to the K20D50M device, the output of the analog comparator can be routed to a UART module for easier processing of the incoming IrDA data stream.

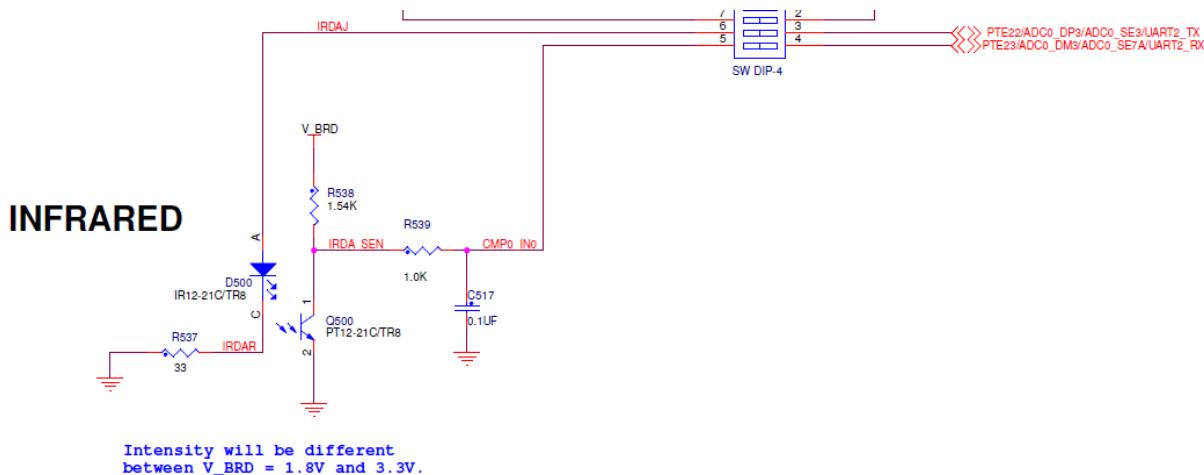


Figure 5 Infrared circuit

6.8 Accelerometer

An MMA8451Q digital accelerometer is connected to the KL25Z128 MCU through I2C module, I2C1, and GPIO/IRQ signals, PTC5 and PTC6. The MMA8451Q is a smart low-power, three-axis capacitive micromachined accelerometer with 14 bits of resolution. The device can be configured to generate inertial wake-up interrupt signals from any combination of the configurable embedded functions allowing the MMA8451Q to monitor events and remain in a low-power mode during periods of inactivity. For more information on the MMA8451Q, please visit the [MMA8451Q Product Summary Page](#).

6.9 General Purpose Tower Plug-in (TWRPI) Socket

The TWR-KL25Z features a socket (J4 and J5) 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 Table 1Table 3

Table 3 General Purpose TWRPI socket pinout

| J4 | | J5 | |
|------------|--------------------|------------|------------------------|
| 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 | UART0_RX / GPIO: GPIO2 |
| 18 | ADC: TWRPI ID 1 | 18 | GPIO: GPIO3 |
| 19 | GND | 19 | GPIO: GPIO4/Timer |
| 20 | Reset | 20 | UART0_TX / GPIO: GPIO5 |

6.10 Potentiometer, Pushbuttons, LEDs

The TWR-KL25Z features two pushbutton switches connected to GPIO/interrupt signals, one pushbutton connected to the master reset signal, two capacitive touch pad electrodes, four user-controllable LEDs, and a potentiometer connected to an ADC input signal. Refer to Table 5 “I/O Connectors and Pin Usage Table” for information about which pins are connected to these features.

6.11 Touch Interface

The touch sensing input (TSI) module of the KL25Z128 MCU provides capacitive touch sensing detection with high sensitivity and enhanced robustness. Each TSI pin implements the capacitive measurement of an electrode. The TWR-KL25Z provides two methods for evaluating the TSI module. There are two electrodes on-board. Additionally, 12 TSI signals are connected to a Touch Tower Plug-in (TWRPI) socket (J2) that can accept Touch TWRPI daughter cards that may feature keypads, rotary dials, sliders, etc.

Table 4 Touch TWRPI socket pinout

| Pin | Description |
|-----|------------------|
| 1 | P5V_TRG_USB |
| 2 | V_BRD |
| 3 | TSIO_CH9 |
| 4 | 3.3V VDDA |
| 5 | TSIO_CH10 |
| 6 | VSS (Analog GND) |
| 7 | TSIO_CH11 |
| 8 | TSIO_CH12 |
| 9 | TSIO_CH13 |
| 10 | TSIO_CH0 |
| 11 | TSIO_CH6 |
| 12 | TSIO_CH7 |
| 13 | TSIO_CH8 |
| 14 | TSIO_CH1 |
| 15 | TSIO_CH4 |
| 16 | TSIO_CH3 |
| 17 | ADC: TWRPI ID 0 |
| 18 | ADC: TWRPI ID 1 |
| 19 | GND |
| 20 | Reset |

6.12 USB

The KL25Z128 features a full-speed/low-speed USB module with OTG/Host/Device capability and built-in transceiver. The TWR-KL25Z routes the USB D+ and D- signals from the KL25Z128 MCU directly to the on-board USB connector (J13)

A power supply switch with an enable input signal and over-current flag output signal is used to supply power to the USB connector when the KL25Z128 is operating in host mode.

7 TWR-KL25Z Jumper options

The following is a list of all the jumper options. The default installed jumper settings are shown in bold.

Note: Default Configuration, Board powered by OpenSDA USB, RTC powered by V_BRD

| Jumper | Jumper designator | Signal | Jumper Option |
|------------------------------|-------------------|-----------------------|---|
| V_BRD | J7 | V_BRD | DEF: 1-2 VBRD to MCU_PWR |
| | J9 | VDDA_HDR | DEF: 1-2 VDDA to MCU_PWR |
| VREG IN SELECTOR | J8 | VREG IN SELECTOR | DEF: 1-2 Regulator powered by OpenSDA USB 2-3 Regulator powered by tower elevator power |
| BOARD POWER SELECTION | J3 | BOARD POWER SELECTION | DEF: 1-3 P3.3V_REG powers V_BRD(MCU_PWR) 3-5 1.8V powers VBRD(MCU & Interface circuit input power) |

Table 5 Connectors and Pin Usage

| Module | Board Designator | Name | Options | Signal |
|----------------------|------------------|---------------------------------------|-----------|-----------------------------------|
| USB | J6 | KL25 VOUT33 | DEF: OPEN | MCU_PWR |
| | J18 | KL25 USB VREGIN | DEF: OPEN | P5V_VREGIN_K25 |
| | J20 | KL25 USB ENA | DEF: OPEN | PTB11/SPI1_SCK |
| | J21 | KL25 USB FLGA | DEF: OPEN | PTE31/FTM0_CH4 |
| IRDA | SW1 6-3 | IRDAJ | OPEN | PTE22/ADC0_DP3/ADC0_SE3/UART2_TX |
| | SW1 5-4 | CMP0_IN0 | OPEN | PTE23/ADC0_DM3/ADC0_SE7A/UART2_RX |
| Potentiometer | J1 | POT 5K | DEF: 1-2 | PTE29/ADC0_SE4B |
| Accelerometer | J24 | SDA Accelerometer Enable | DEF: 1-2 | PTC11/I2C1_SDA |
| | J23 | SCL Accelerometer Enable | DEF: 1-2 | PTC10/I2C1_SCL |
| | J14 | ACCELEROMETER INT1 | DEF: OPEN | PTC5/LLWU_P9/SPI0_SCK/CMP0_OUT |
| | J15 | ACCELEROMETER INT2 | DEF: OPEN | PTC6/LLWU_P10/EXTRG_IN/SPI0_MISO |
| GPIO Header | J11-1 | PTE20/ADC0_DP0/ADC0_SE0 | | |
| | J11-2 | PTE21/ADC0_DM0/ADC0_SE4A | | |
| | J11-3 | PTA1/TSI0_CH2/UART0_RX | | |
| | J11-4 | GND | | |
| | J11-5 | SWD_DIO_TGTMCU | | |
| | J11-6 | PTE31/FTM0_CH4 | | |
| | J11-7 | PTB9 | | |
| | J11-8 | PTA2/TSI0_CH3/UART0_TX | | |
| | J11-9 | PTB11/SPI1_SCK | | |
| | J11-11 | PTB10/SPI1_PCS0 | | |
| | J11-12 | GND | | |
| | J11-13 | PTC4/LLWU_P8/UART1_RX/FTM0_CH3 | | |
| | J11-14 | PTC3/LLWU_P7/UART1_RX/FTM0_CH2/CLKOUT | | |
| | J11-15 | PTC12/FTM_CLKIN0 | | |

| Module | Board Designator | Name | Options | Signal |
|----------------|------------------|------------------------------------|-----------|---------------------------------------|
| | J11-16 | PTC6/LLWU_P10/EXTRG_IN/SPI0_MISO | | |
| | J11-17 | PTC16 | | |
| | J11-18 | PTC13/FTM_CLKIN1 | | |
| | J11-19 | GND | | |
| | J11-20 | PTC17 | | |
| LEDs | J19 | LED orange Enable | DEF: 1-2 | PTA5/FTM0_CH2 |
| | J22 | LED Yellow Enable | DEF: 1-2 | PTA16 |
| | SW1 8-1 | LED Green Enable | OPEN | PTA17 |
| | SW1 7-2 | LED Red Enable | OPEN | PTB8/EXTRG_IN |
| Push Buttons | SW3 | SW3 | PTA4 | PTA4 |
| | SW4 | SW4 | PTC3 | PTC3/LLWU_P7/UART1_RX/FTM0_CH2/CLKOUT |
| TSI Electrodes | Elec1 | Electrode1 | TSI0_CH9 | PTB16/TSI0_CH9/UART0_RX |
| | Elec2 | Electrode2 | TSI0_CH10 | PTB17/TSI0_CH10 |
| UART | J24 | KL25 UART RX (OpenSDA or Elevator) | DEF: 2-3 | UART1_RX_TGTMCU |
| | J26 | KL25 UART TX (OpenSDA or Elevator) | DEF: 2-3 | UART1_TX_TGTMCU |

8 Useful links

- ▶ <http://www.freescale.com/TWR-KL25Z>
- ▶ www.freescale.com
- ▶ www.iar.com/freescale
- ▶ www.pemicro.com
- ▶ www.freescale.com/codewarrior
 - CodeWarrior MCUs v10.3 and above
- ▶ www.segger.com
 - <http://www.segger.com/jlink-flash-download.htm>

Revision History

| Revision | Date | Description |
|----------|----------------|--|
| 1.0 | July, 2012 | First draft |
| 1.0.1 | September,2012 | First version. Updated to board rev C. |

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