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

Document Number: TWRKV46F150MUG
Rev. 0, 01/2015

# TWR-KV46F150M Tower Module User's Guide

## 1 Introduction

The TWR-KV46F150M MCU module is designed to work in a stand-alone mode or as a part of the Freescale Tower system, a modular development platform that enables rapid prototyping and tool reuse 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 MCU modules and compatible peripherals.

**Contents**

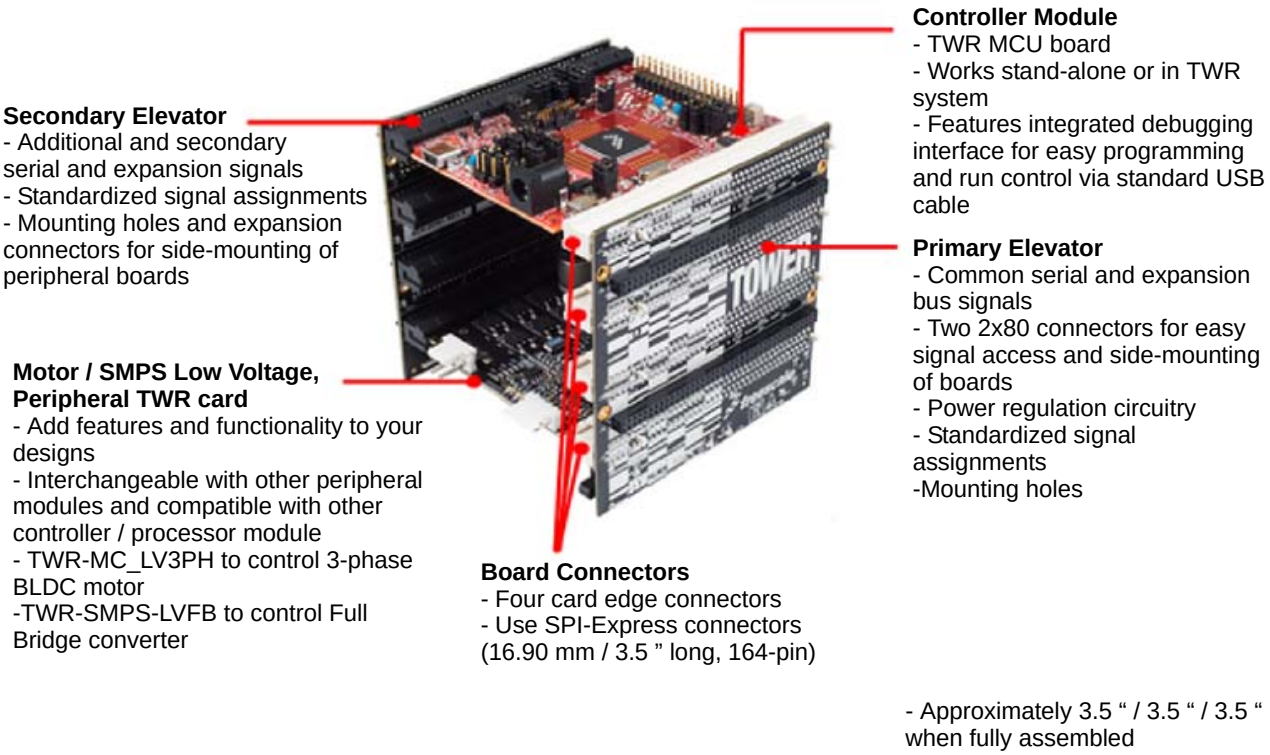


**Figure 1. Freescale Tower system overview**

# 2 Contents

The TWR-KV46F150M contents include:

- TWR-KV46F150M board assembly
- Micro-B USB cable for debug interface and power
- Quick start guide

# 3 TWR-KV46F150M features

- Tower-compatible MCU module
- KV46F256VLL15 MCU (150 MHz, 256 KB Flash, 32 KB RAM, low-power, 100 LQFP package)
- On-board debug circuit K20DX128VFM5 (OpenSDA) with virtual serial port
- Nine user-controllable LEDs plus
- Two user push-button switches for GPIO interrupts
- One user push-button switch for MCU reset
- One potentiometer

# 4 Getting to know the TWR-KV46F150M

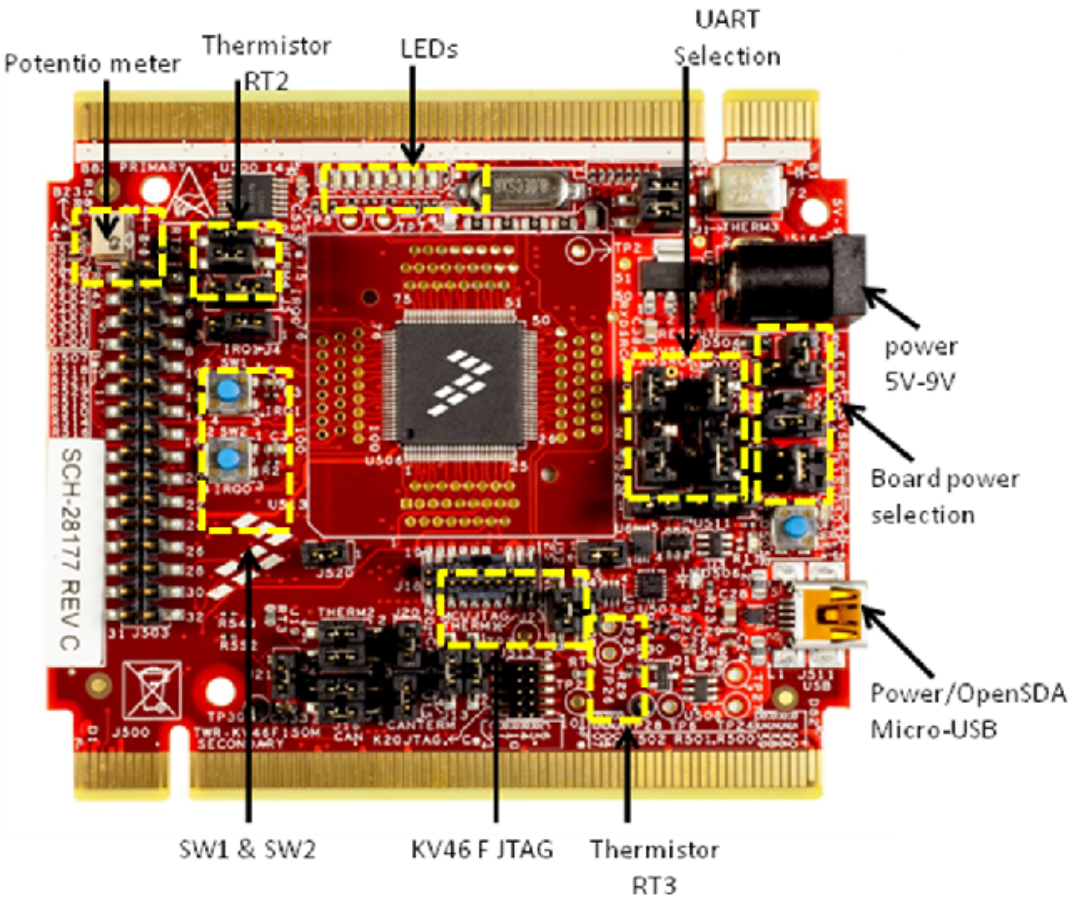


**Figure 2. Front side of the TWR-KV46F150M module**

# 5 Reference documents

The documents listed below should be referenced to for more information on the Kinetis V series, Tower system and MCU modules. These can be found in the documentation section at freescale.com/kinetis.

- TWR-KV46F150M-SCH (schematics)
- Tower configuration tool
- Tower mechanical drawing
- TWR-KV46F150M – QSG (quick start guide)

# 6 Hardware description

The TWR-KV46F150M is a Tower MCU module featuring the KV46F256VLL15 – a Kinetis V Series MCU in a 100 LQFP package with high-speed run mode. It is intended to be used in the Freescale Tower system but can also operate in stand-alone mode. The on-board OpenSDA debug circuit provides a Serial Wire Debug (SWD) interface and a power supply input through a single micro-USB connector.

The block diagram of the TWR-KV46F150M board is shown in Figure 3:

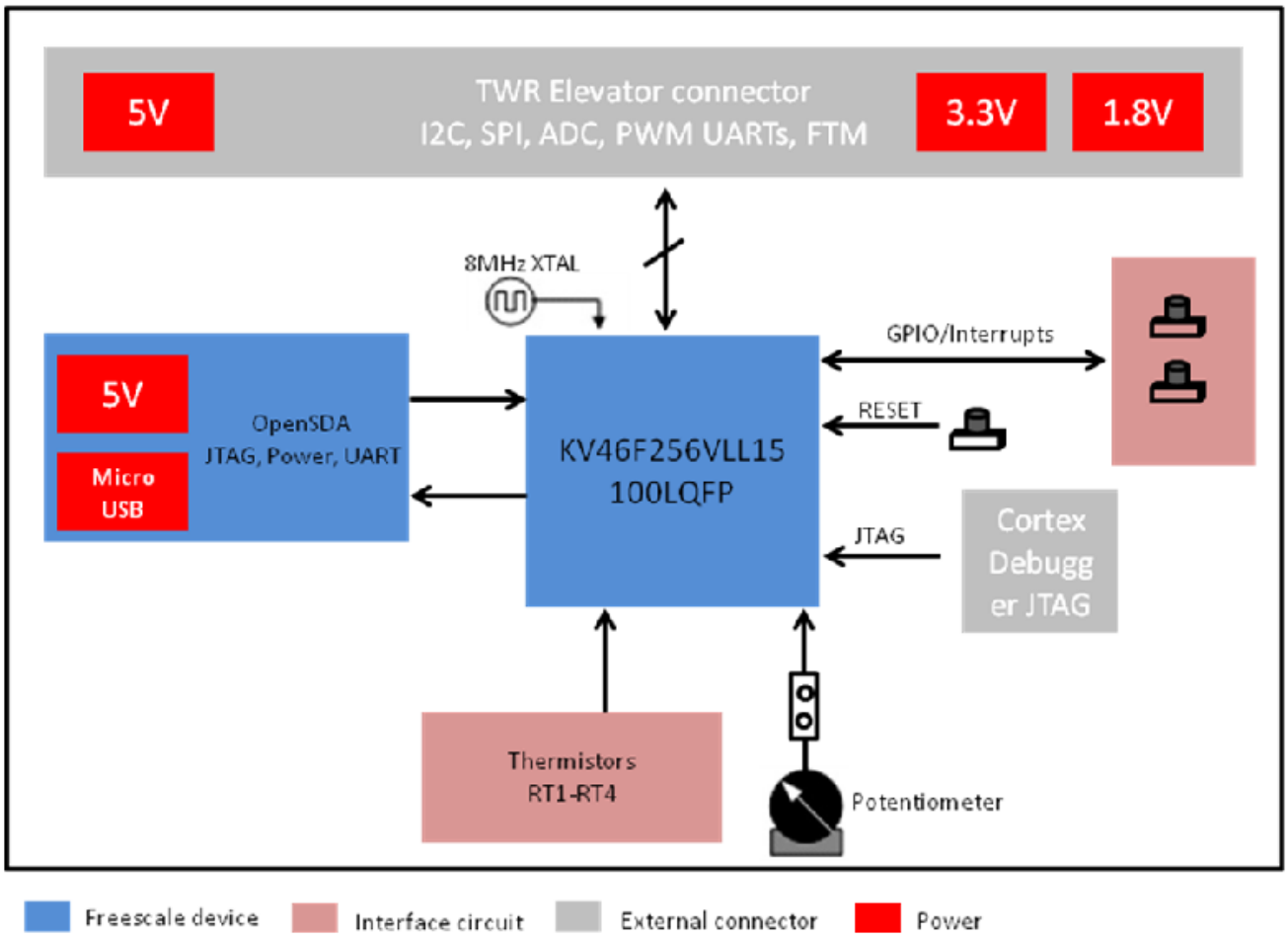


**Figure 3. Block diagram of the TWR-KV46F150M**

## 6.1 MCU

The TWR-KV46F150M features the KV46F256VLL15 MCU. This 150 MHz MCU is part of the Kinetis KV4x family and is implemented in a 100 LQFP package. Table 1 describes some of the features of the KV46F256VLL15 MCU.

**Table 1. KV46F256VLL15 features**

| Feature | Description |
|---|---|
| Ultra low-power | • Seven low-power modes with power and clock gating for optimal peripheral activity and recovery times<br>• Full memory and analog operation down to 1.71 V for extended battery life<br>• Low-leakage wake-up unit with up to three internal modules and eight pins used as wake-up sources in low-leakage stop (LLS) and very low-leakage stop (VLLS) modes<br>• Low-power timer for continual system operation in reduced power states |
| Flash and SRAM | • 256 KB of flash featuring fast access times, high reliability and four levels of security protection<br>• 32 KB of SRAM<br>• No user or system intervention needed to complete programming and erase functions, and full operation down to 1.71 V |
| Mixed-signal capability | • Two 12-bit high-speed ADCs with 240 ns conversion time<br>• Single or differential output modes for improved noise rejection<br>• Four high-speed comparators providing fast and accurate motor over-current protection by driving PWMs to a safe state<br>• Optional analog voltage reference provides an accurate reference to analog blocks and replaces external voltage references to reduce system cost |
| Performance | • 150 MHz ARM® Cortex®-M4+ core with DSP and FPU instruction sets, single-cycle MAC, and single instruction multiple data (SIMD) extensions<br>• Up to 16-channel DMA for peripheral and memory servicing with reduced CPU loading and faster system throughput<br>• Crossbar switch enables concurrent multi-master bus accesses, increasing bus bandwidth |
| Timing and control | • Up to three FlexTimer modules (FTM) with a total of 18 channels<br>• Hardware dead-time insertion and quadrature decoding for motor control<br>• Four-channel 32-bit periodic interrupt timer (PIT) provides a time base for the RTOS task scheduler, or a trigger source for the ADC conversion and programmable delay block |
| Connectivity and communications | • Two UARTs:<br>– UART supporting RS232 hardware flow control (RTS / CTS)<br>– UART clocked from fast bus clock<br>• MSB / LSB configuration on data<br>• One SPI module and one $I^2C$ module |
| Reliability, safety, and security | • Cyclic redundancy check (CRC) engine validates memory contents and communication data, increasing system reliability<br>• Independently-clocked COP prevents clock skew or code run-away for fail-safe applications such as the IEC 60730 safety standard for household appliances<br>• External watchdog monitor drives output pins to a safe state for external components in case the watchdog time-out occurs<br>• Included in Freescale's product longevity program, with assured supply for a minimum of 10 years after launch |

## 6.2 Clocking

The Kinetis V Series MCUs start up from an internal digitally-controlled oscillator (DCO). The main external oscillator (EXTAL0 / XTAL0) can be enabled by software if desired. The external oscillator / resonator can range from 31.25 KHz up to 39.0635 KHz. An 8 MHz crystal is the default external source for the MCG oscillator inputs (XTAL / EXTAL). Resistors R4 and R10 enable other external clock sources for the KV46F256VLL15, which can be provided through the TWR-ELEV module or pin 8 and pin 10 of the J502 connector.

## 6.3 System power

When installed into the Tower system, the TWR-KV46F150M 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 (5.0 V) for the TWR-KV46F150M module can be derived from the OpenSDA USB micro-B connector (J511) or from power jack connector (J516). Two low-dropout regulators provide 3.3 V and 1.8 V supplies from the 5.0 V input voltage. All of the user-selectable options can be configured using headers J114, J515, J517, J518, and J519. Refer to page number seven of the TWR-KV46F150M schematics for more details.

## 6.4 Debug interface

There are two debug interface options provided: the on-board OpenSDA circuit and the external ARM Cortex JTAG connector. The ARM Cortex JTAG connector (J18) is a standard 2×10-pin connector that provides an external debugger cable access to the JTAG interface of the KV46F256VLL15. Alternatively, the on-board OpenSDA debug interface can be used to access the debug interface of the KV46F256VLL15.

### 6.4.1 OpenSDA

The on-board K20DX128VFM5-based OpenSDA circuit provides a SWD debug interface to the KV46F256VLL15. A standard USB A male to micro-B male cable (provided) can be used for debugging via the USB connector (J21).

The OpenSDA interface also provides a USB-to-serial bridge. The drivers for the OpenSDA interface are provided in the P&E Micro OpenSDA Tower Toolkit. These drivers and more utilities can be found online at www.pemicro.com/opensda.

### 6.4.2 Cortex debug connector

The Cortex debug connector is a 20-pin (0.05") connector providing access to the SWD, JTAG and cJTAG on the KV46 device. The pin-out and KV46 pin connections to the debug connector (J18) are listed in Table 2.

**Table 2. Cortex debug connector**

| Pin | Function | TWR-KV46F150M connection |
|---|---|---|
| 1 | VDD | 3.3 V MCU supply (MCU_PWR) |
| 2 | TMS / SWDIO | PTA3 / JTAG_TMS / SWD_DIO / UART0_RTS / FTM0_CH0 / XBARIN9 |
| 3 | GND | GND |
| 4 | TCK / SWCLK | PTA0 / JTAG_TCLK / SWD_CLK / UART0_CTS / UART0_COL |
| 5 | GND | GND |
| 6 | TDO/SWO | PTA2 / JTAG_TDO / NOETM_TRACE_SWO / UART0_TX / FTM0_CH7 |
| 7 | Key | – |

**Table 2. Cortex debug connector (continued)**

| Pin | Function | TWR-KV46F150M connection |
|---|---|---|
| 8 | TDI | PTA1 / JTAG_TDI / UART0_RX / FTM0_CH6 / CMP0_OUT |
| 9 | GNDDetect | PTA4 / LLWU_P3 / NMI / FTM0_CH1 / XBARIN10 / FTM0_FLT3 / FLEXPWM_B0 |
| 10 | nRESET | CPU_RESET_B |
| 11 | Target Power | 5 V supply (via jumper J21) |
| 12 | – | NC |
| 13 | Target Power | 5 V supply (via jumper J21) |
| 14 | – | NC |
| 15 | GND | GND |
| 16 | – | NC |
| 17 | GND | GND |
| 18 | – | NC |
| 19 | GND | GND |
| 20 | – | NC |

## 6.5 Thermistors and analog input

The TWR-KV46F150M board provides four thermistors (RT1- RT4) near the corners of the board that can be used as single-ended or differential analog inputs to the KV46F256VLL15 as shown on sheet number six of the schematic. All the thermistors are 10 kΩ. All four thermistor circuits are designed to provide usable differential inputs over the temperature range of 90$^{o}$C to –20$^{o}$C.

## 6.6 Potentiometer, push-buttons and LEDs

The TWR-KV46F150M also features:

- One potentiometer connected to ADC channel ADCB_CH6A and ADCA_CH5 to ADC input signal
- Three pushbutton switches SW1, SW2 and SW3
- SW1 and SW2 for IRQ (interrupt request) and SW5 for RESET.
- Nine user-controllable LEDs connected to the FlexPWM / GPIO signals
- LED RED D503 for power on indication

# 7 TWR-KV46F150M jumper options and headers

There are several headers provided for isolation, configuration and feature selection. Refer to Table 3 for details. The default jumpers positions are represented in **bold**.

**Table 3. TWR-KV46F150M jumper table**

| Jumper | Function | Shunts | Description |
|---|---|---|---|
| J1 | Thermistor RT1 Connect | **1-2, 3-4** | **Connect RT1 circuit to the KV46F256VLL15** |
| | | none | Disconnect RT1 circuit from the KV46F256VLL15 |
| J2 | Thermistor RT2 Connect | **1-2, 3-4** | **Connect RT2 circuit to the KV46F256VLL15** |
| | | none | Disconnect RT2 circuit from the KV46F256VLL15 |
| J4 | IRQ1 Select | **1-2** | **Connect SW1 to KV46F256VLL15 pin PTC7 / CMP3_IN4 / CMP0_IN1 / SPI0_SIN** |
| | | 2-3 | Connect SW1 to KV46F256VLL15 pin GPIOB23 / PWM_X3 |
| | | none | Disconnect SW1 from the KV46F256VLL15 |
| J5 | IRQ0 Select | **1-2** | **Connect SW2 to KV46F256VLL15 pin PTE6 / LLWU_P16 / FTM3_CH1** |
| | | 2-3 | Connect SW2 to KV46F256VLL15 pin GPIOE5 / FTM3_CH0 |
| | | none | Disconnect SW2 from the KV46F256VLL15 |
| J15 | CAN Termination Enable | **1-2** | **Connect the 120 Ω CAN termination resistor** |
| | | Open | No CAN termination |
| J16 | CAN Enable | **1-2, 3-4** | **Connect the CAN transceiver TXD and RXD to:<br>•KV46F256VLL15 pins<br>•GPIOA12/CAN0_TX<br>•GPIOA13/CAN0_RX** |
| | | Open | Disconnect the CAN transceiver |
| J19 | Thermistor RT3 Connect | **1-2, 3-4** | **Connect RT3 circuit to the KV46F256VLL15** |
| | | none | Disconnect RT3 circuit from the KV46F256VLL15 |
| J21 | Debug Target Power | **1-2** | **Connect P5V_TRG_USB to target power** |
| | | Open | Disconnect P5V_TRG_USB to target power |
| J23 | Thermistor RT4 Connect | **1-2, 3-4** | **Connect RT4 circuit to the KV46F256VLL15** |
| | | none | Disconnect RT4 circuit from the KV46F256VLL15 |

**Table 3. TWR-KV46F150M jumper table (continued)**

| Jumper | Function | Shunts | Description |
|---|---|---|---|
| J505 | TXD Source Select (note that only one connection can be made to pin 3 at a time) | **1-2** | **Connect ELEV_TXD0 from the Tower connector to KV46F256VLL15 pin PTD7 / UART0_TX** |
| | | 2-3 | Connect TXD_SEL from the USB Serial Bridge to KV46F256VLL15 pin PTD7 / UART0_TX |
| | | Pin 2 open | Disconnect KV46F256VLL15 pin PTD7 / UART0_TX |
| | | 3-4 | Connect TXD_SEL from the USB Serial Bridge to KV46F256VLL15 pin PTE0 / UART1_TX |
| | | **4-5** | **Connect ELEV_TXD1 from the Tower connector to KV46F256VLL15 pin PTE0 / UART1_TX** |
| | | Pin 4 open | Disconnect KV46F256VLL15 pin PTE0/UART1_TX |
| J506 | RXD Source Select (note that only one connection can be made to pin 3 at a time) | **1-2** | **Connect ELEV_RXD0 from the Tower connector to KV46F256VLL15 pin PTD6 / UART0_RX** |
| | | 2-3 | Connect RXD_SEL from the USB Serial Bridge to KV46F256VLL15 pin PTD6 / UART0_RX |
| | | Pin 2 open | Disconnect KV46F256VLL15 pin PTD6 / UART0_RX |
| | | 3-4 | Connect RXD_SEL from the USB Serial Bridge to KV46F256VLL15 pin PTE1 / UART1_RX |
| | | **4-5** | **Connect ELEV_RXD1 from the Tower connector to KV46F256VLL15 pin PTE1 / UART1_RX** |
| | | Pin 4 open | Disconnect KV46F256VLL15 pin PTE1 / UART1_RX |
| J514 & J515 | VREG_IN Select | **J514-1 to J514-2** | **Connect P5V_TRG_USB voltage to VREG_IN** |
| | | J515-1 to J514-2 | Connect the PWR_IN voltage to VREG_IN |
| | | J514-2 to J514-3 | Connect P5V_ELEV voltage to VREG_IN |
| J517 & J518 | 1.8V (P1V8) Source Select | J517-1 to J517-2 | Connect P3_3V_MOTOR voltage to P3V3_SELECTED |
| | | **J518-1 to J517-2** | **Connect the P3_3V_REG_OUT voltage to P3V3_SELECTED** |
| | | J517-2 to J517-3 | Connect the P3_3V_ELEV voltage to P3V3_SELECTED |
| J519 | VBRD Select | 1-2 | SDA_VOUT33 becomes VBRD power supply for the board |
| | | **3-4** | **P3V3_SELECTED becomes VBRD power supply for the board** |
| | | 5-6 | P1V8 becomes VBRD power supply for the board |
| J520 | MCU VDD | **1-2** | **Connect MCU_VDD to VBRD** |
| J521 & J522 | OpenSDA isolation connector | **1-2** | **OpenSDA use to program and debug KV46F256VLL15** |
| | | Open | External debugger use to program and debug KV46F256VLL15 using |

Figure 4 shows the default jumper position on the TWR-KV46F256VLL15.

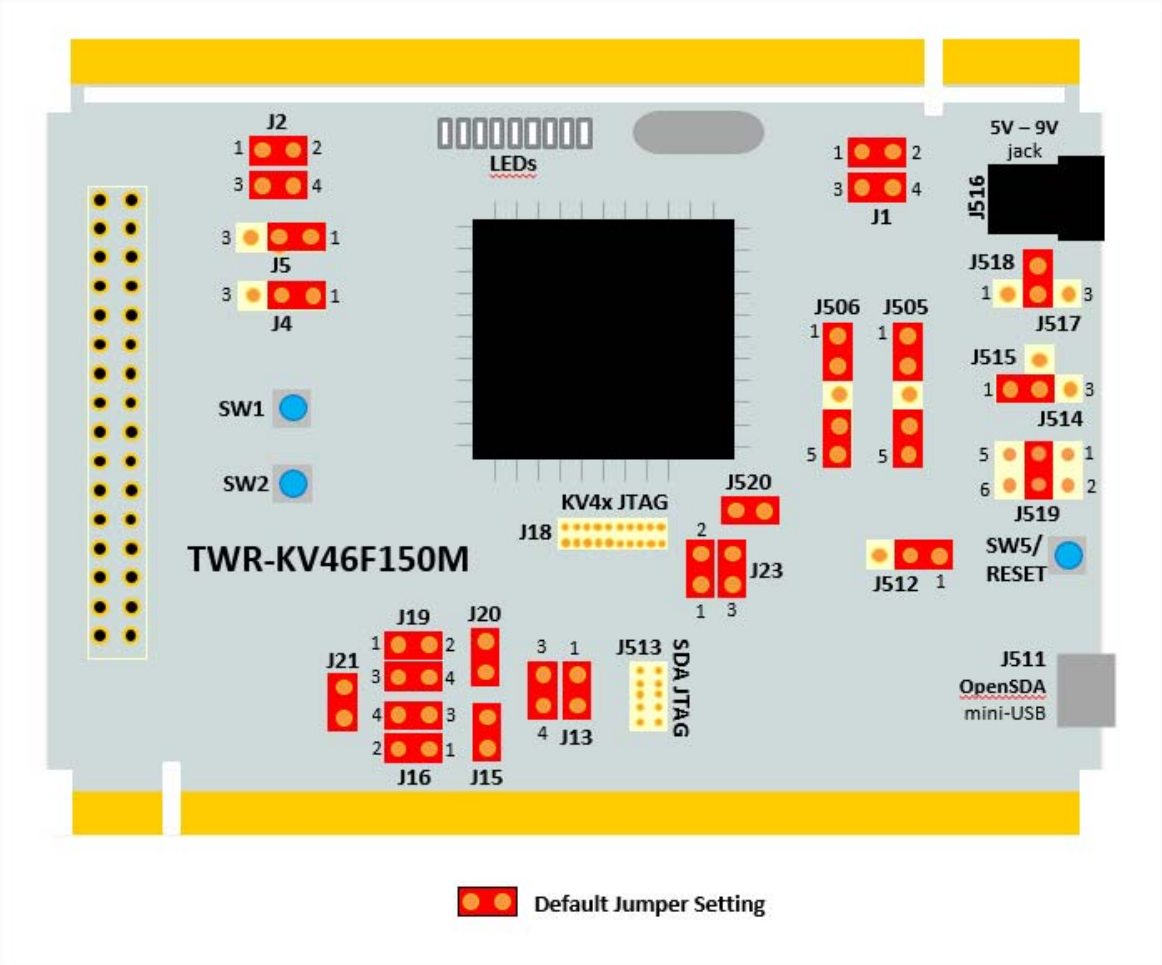


**Figure 4. Default jumper position**

# 8 Useful links

- freescale.com
  - freescale.com/Kinetis
- www.iar.com/freescale
- www.pemicro.com
  - http://www.pemicro.com/opensda
- www.segger.com
  - http://www.segger.com/jlink-flash-download.html

# 9 Revision history

**Table 4. Revision history**

| Revision number | Date | Substantial changes |
|---|---|---|
| 0 | 01/2015 | Initial release |

***How to Reach Us:***

**Home Page:**
freescale.com

**Web Support:**
freescale.com/support



Document Number: TWRKV46F150MUG
Rev. 0
01/2015