

Freescale Semiconductor, Inc. User's Guide

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Rev. 0, 01/2015

TWR-KV46F150M Tower Module **User's Guide**

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.

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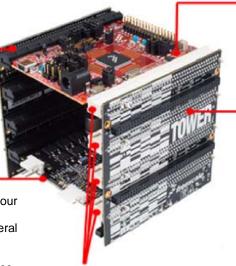
Contents

Secondary Elevator

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

Motor / SMPS Low Voltage, Peripheral TWR card

- Add features and functionality to your designs
- Interchangeable with other peripheral modules and compatible with other controller / processor module
- TWR-MC_LV3PH to control 3-phase BLDC motor
- -TWR-SMPS-LVFB to control Full Bridge converter



Board Connectors

- Four card edge connectors
- Use SPI-Express connectors (16.90 mm / 3.5 " long, 164-pin)

Controller Module

- TWR MCU board
- Works stand-alone or in TWR system
- Features integrated debugging interface for easy programming and run control via standard USB cable

Primary Elevator

- Common serial and expansion bus signals
- Two 2x80 connectors for easy signal access and side-mounting of boards
- Power regulation circuitry
- Standardized signal assignments
- -Mounting holes

- Approximately 3.5 " / 3.5 " / 3.5 " when fully assembled

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

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4 Getting to know the TWR-KV46F150M

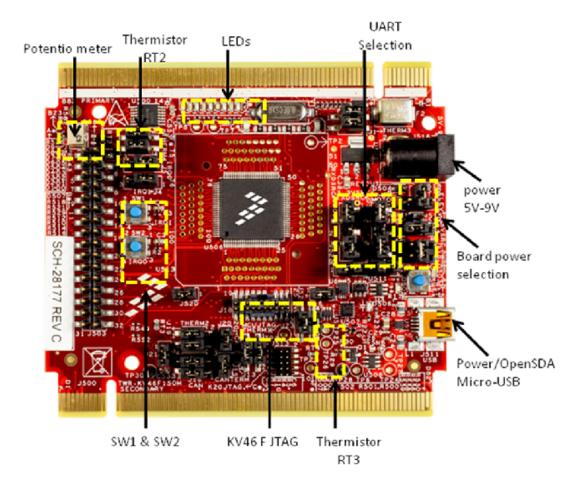


Figure 2. Front side of the TWR-KV46F150M module

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)



Hardware description

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:

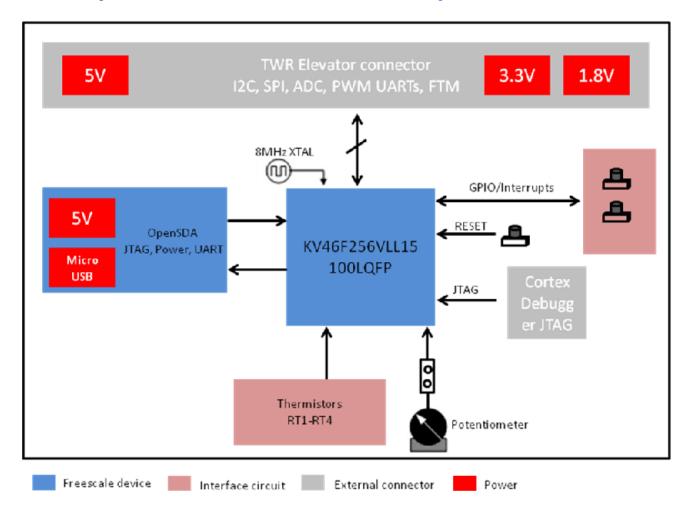


Figure 3. Block diagram of the TWR-KV46F150M

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 Full memory and analog operation down to 1.71 V for extended battery life 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 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 32 KB of SRAM 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 Single or differential output modes for improved noise rejection Four high-speed comparators providing fast and accurate motor over-current protection by driving PWMs to a safe state 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 Up to 16-channel DMA for peripheral and memory servicing with reduced CPU loading and faster system throughput 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 Hardware dead-time insertion and quadrature decoding for motor control 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: UART supporting RS232 hardware flow control (RTS / CTS) UART clocked from fast bus clock MSB / LSB configuration on data One SPI module and one I ² C module			
Reliability, safety, and security	 Cyclic redundancy check (CRC) engine validates memory contents and communication data, increasing system reliability Independently-clocked COP prevents clock skew or code run-away for fail-safe applications such as the IEC 60730 safety standard for household appliances External watchdog monitor drives output pins to a safe state for external components in case the watchdog time-out occurs 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.

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Hardware description

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.

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



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 $10 \text{ k}\Omega$. All four thermistor circuits are designed to provide usable differential inputs over the temperature range of 90°C to -20°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
14	The americate at DT4 Commont	1-2, 3-4	Connect RT1 circuit to the KV46F256VLL15
J1	Thermistor RT1 Connect	none	Disconnect RT1 circuit from the KV46F256VLL15
J2	The americate at DTO Commont	1-2, 3-4	Connect RT2 circuit to the KV46F256VLL15
JZ	Thermistor RT2 Connect	none	Disconnect RT2 circuit from the KV46F256VLL15
	IRQ1 Select	1-2	Connect SW1 to KV46F256VLL15 pin PTC7 / CMP3_IN4 / CMP0_IN1 / SPI0_SIN
J4		2-3	Connect SW1 to KV46F256VLL15 pin GPIOB23 / PWM_X3
		none	Disconnect SW1 from the KV46F256VLL15
		1-2	Connect SW2 to KV46F256VLL15 pin PTE6 / LLWU_P16 / FTM3_CH1
J5	IRQ0 Select	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
315		Open	No CAN termination
J16 CAN Enable		1-2, 3-4	Connect the CAN transceiver TXD and RXD to: •KV46F256VLL15 pins •GPIOA12/CAN0_TX •GPIOA13/CAN0_RX
		Open	Disconnect the CAN transceiver
J19	Thermister PT2 Connect	1-2, 3-4	Connect RT3 circuit to the KV46F256VLL15
319	Thermistor RT3 Connect	none	Disconnect RT3 circuit from the KV46F256VLL15
J21	Debug Target Power	1-2	Connect P5V_TRG_USB to target power
JZ I	Debug larger Fower	Open	Disconnect P5V_TRG_USB to target power
J23	Thermistor RT4 Connect	1-2, 3-4	Connect RT4 circuit to the KV46F256VLL15
JZS		none	Disconnect RT4 circuit from the KV46F256VLL15



Table 3. TWR-KV46F150M jumper table (continued)

Jumper	Function	Shunts	Description
	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
J505		Pin 2 open	Disconnect KV46F256VLL15 pin PTD7 / UART0_TX
J505		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
		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
J506	RXD Source Select (note that	Pin 2 open	Disconnect KV46F256VLL15 pin PTD6 / UART0_RX
3300	only one connection can be made to pin 3 at a time)	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
	VREG_IN Select	J514-1 to J514-2	Connect P5V_TRG_USB voltage to VREG_IN
J514 & J515		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
		J517-1 to J517-2	Connect P3_3V_MOTOR voltage to P3V3_SELECTED
J517 & J518	1.8V (P1V8) Source Select	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
	VBRD Select	1-2	SDA_VOUT33 becomes VBRD power supply for the board
J519		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 &	OpenSDA isolation connector	1-2	OpenSDA use to program and debug KV46F256VLL15
J522		Open	External debugger use to program and debug KV46F256VLL15 using

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Useful links

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

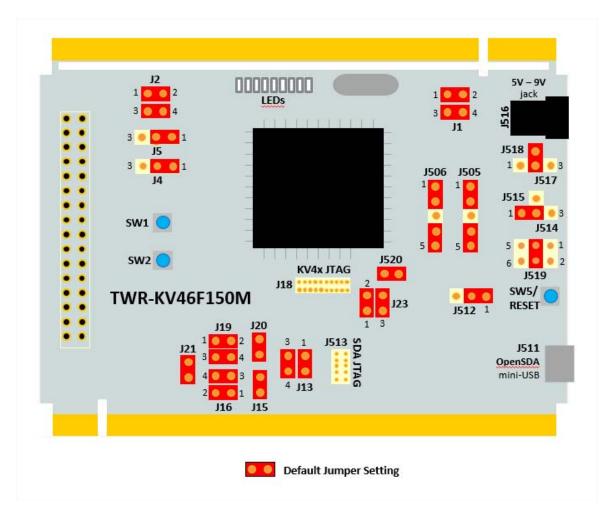


Figure 4. Default jumper position

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



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Web Support:

freescale.com/support

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