Freescale Semiconductor, Inc.
User's Guide

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TWR-KV11Z75M Tower System Module User's Guide

1. Overview

The TWR-KV11Z75M Tower System Module is the entry level member of the Kinetis-based Microcontroller family specifically labeled "Kinetis V-Series". On a single chip, the Module combines the processing power of up to
75 MHz ARM® Cortex®-M0+ CPU with up to 128 KB flash, 16 KB RAM, a motor control timer, and an ADC with capability to capture two inputs simultaneously (two current phase measurements), within a period of 800 nanoseconds (ns) to 1 millisecond (ms). The TWR-KV11Z75M Tower System Module has a full set of programmable peripherals, including two 6 channel PWM timers to drive two 3-phase complementary inverter stages, four 2 channel PWM timers, 2x 16 bit ADCs with two capture and hold circuits and 1 µs conversion speed, two UART, one SPI, I^2C, CRC block, analog comparators with DAC, CAN and on-chip/off-chip clock sources, and a 12b DAC. Each peripheral can be independently shut down to save power. It can work with a power supply voltage range from 1.71 V to 3.6 V.

The TWR-KV11Z75M board is targeted for low dynamic variable speed with dual BLDC 6-step sensorless motor control used in industrial pumps, compressors, fans, and power conversion, as well as other general purpose applications. The Tower board is designed to easily evaluate these modules and help customers build the prototype for development.

The TWR-KV11Z75M Tower System Module has a 64-LQFP chip soldered directly on the PCB. The Module

Contents

works with temperatures ranging between -40 ˚C and
105 ˚C.

The following list summarizes the features of the TWR-KV11Z75M Tower System module:

- 64-LQFP KV11 MCU
- High-speed CAN transceiver TJA1051T/3
- On-board OpenSDA with USB connection used to debug code without an external debug interface
- Header for standard Cortex SWD connector used to debug code on either OpenSDA or KV11 MCU with external debug interface
- Power indication LED
- 10 MHz crystal on board for the microcontroller
- FX0S87000CQ 3-axis digital accelerometer and magnetometer
- Eight LEDs connected with buffers to PWM channels for dimming
- Two push buttons for user input or interrupts to the microcontroller
- Four thermistors for single-ended or differential analog inputs
- Reset push button for KV11 MCU
- Elevator signal supporting TWR-MCLV3PH
- Header to connect to APMOTOR56F800E motor board
- Can be powered by an external supply such as the APMOTOR56F800E motor board and TWR-MCLV3PH
- Headers to connect SCI0 and SCI1 signals to either OpenSDA or an elevator board
- 2-pin jumper for current measurement.

2. Get to know the TWR-KV11Z75M Tower System module

The following figure shows the components of the TWR-KV11Z75M Tower System module.

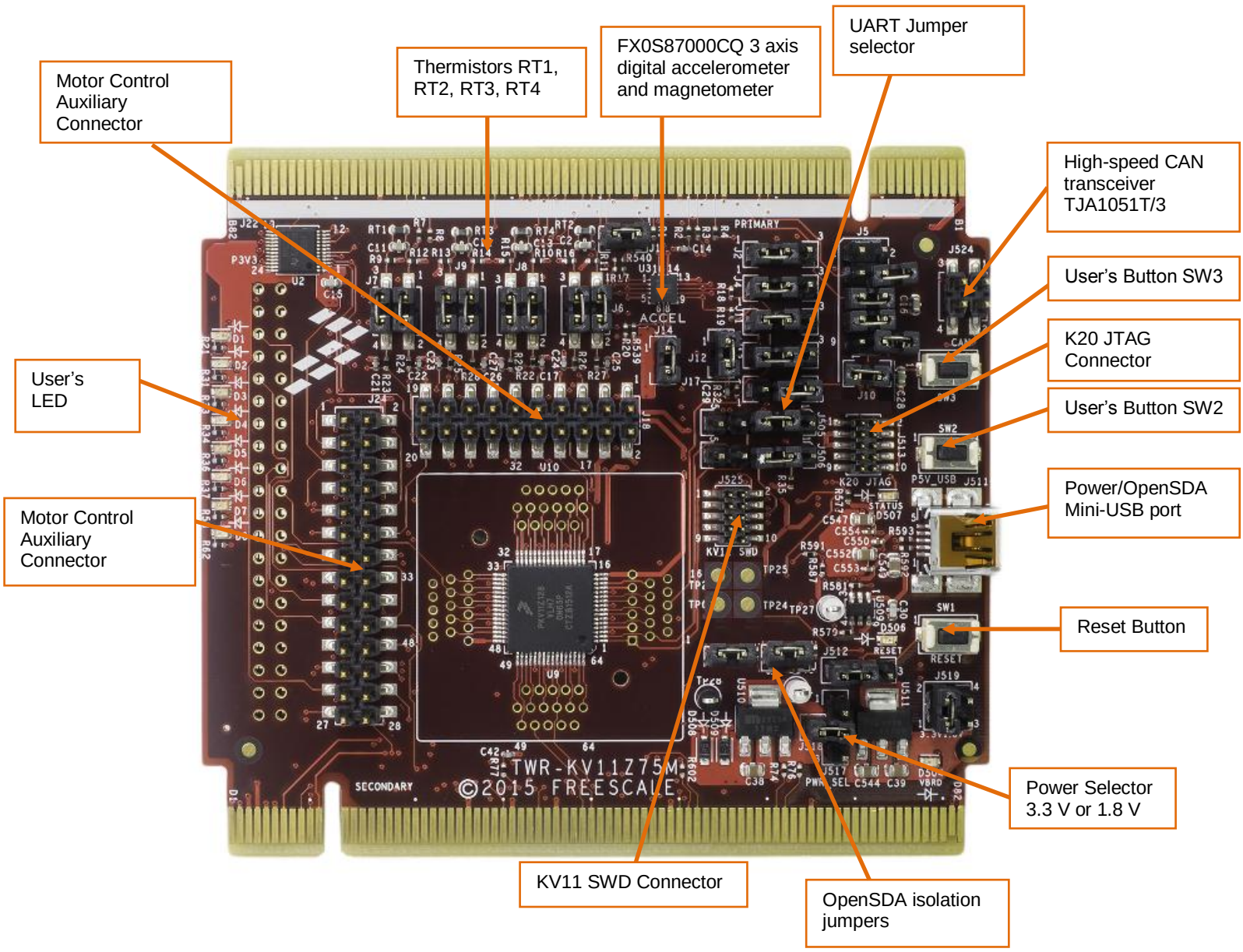

Figure 1. TWR-KV11Z75M Tower System module

3. Hardware description

This section provides specification details for the TWR-KV11Z75M Tower System module.

3.1. Block diagram

A block diagram for the TWR-KV11Z75M platform is shown in the following figure.

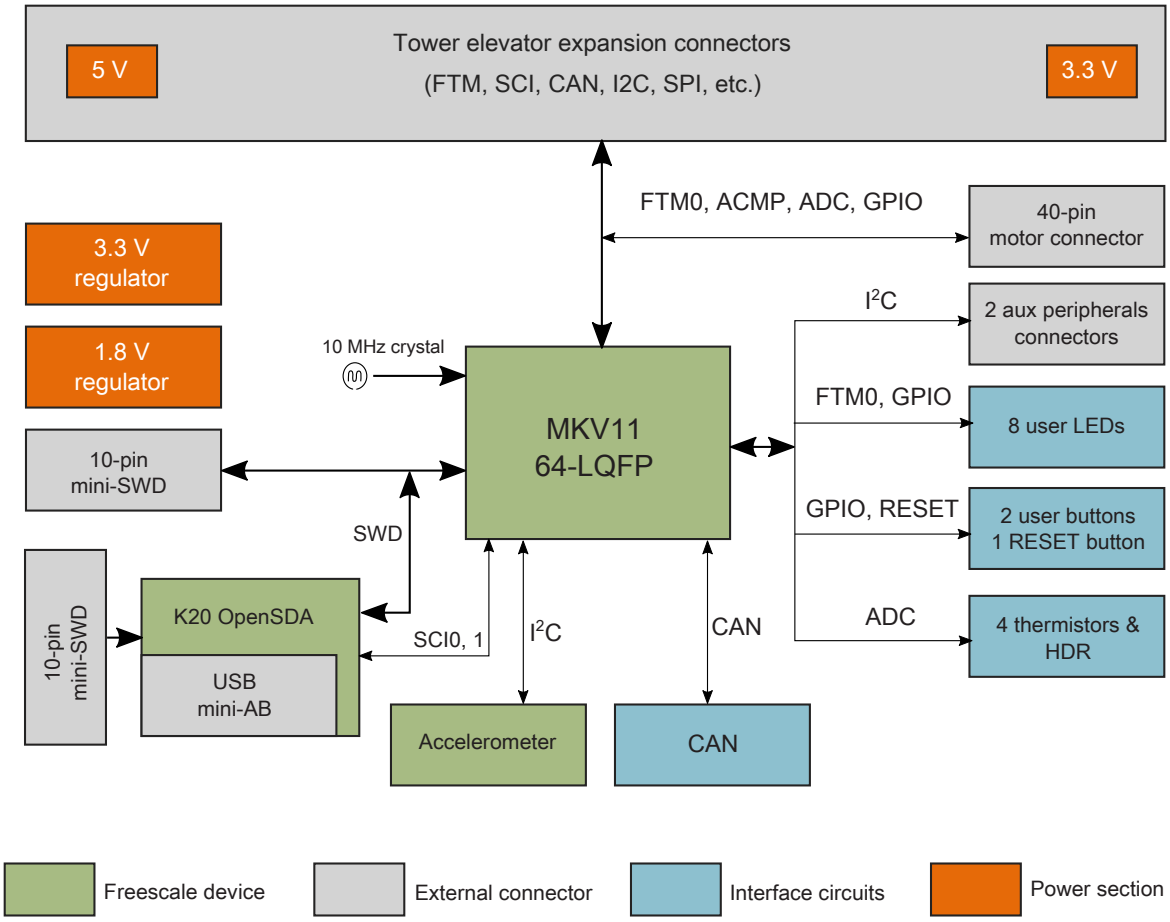

Figure 2. TWR-KV11Z75M Tower System module

3.2. Microcontroller

The KV11 64-LQFP package with MKV11Z128VLH7 is used on this board.

3.3. Clocking

A 10 MHz external crystal, which can work between the temperature range of -40 ˚C to +105 ˚C, is used for the external clock source for the KV11 MCU. The clock signal can be isolated when the EXTAL and XTAL pin are used for the other purpose (GPIO, IIC) of depopulating resistors R517 and R520.

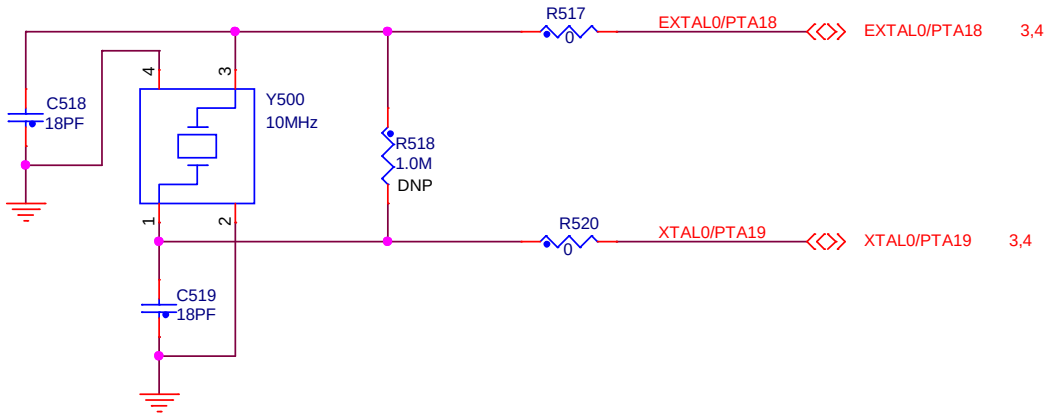

Figure 3. Clock circuit

3.4. System power

The KV11 MCU can be powered by the OpenSDA circuit (via the Micro-AB USB connector), the Tower Elevator power connections, or the motor connection. The KV11 MCU can work with a 3.3 V or 1.8 V power supply, selectable via J519 header. The 3.3 V power supply can be from the Tower System module 3.3 V regulators from a 5 V power rail coming from a USB port, or directly from other Tower modules through Tower System Elevators. It can also come directly from the Motor Connector.

The power supply source selection from either the 3.3 V regulator or the Tower Elevator is supplied automatically. The power supply source selection from the Tower System and the Motor Connector is also completed automatically.

The LED indicators for power, reset, target power, and status are present: D504, D507 indicate the 5 V power is on from the USB port rail and enabled by the OpenSDA; D506 indicates the 3.3 V power supply is on.

VDDA, VREFH and VSSA, and VREFL are the analog power supply pins for the microcontroller. These voltage sources supply power to the ADC module. A 0.1 uF ceramic bypass capacitor is located as close to the microcontroller power pins as possible to suppress high-frequency noise.

A J10 jumper is provided between the system power supply and the power rail to the MCU to allow for current measurements. It also allows external power supply directly to the microcontroller.

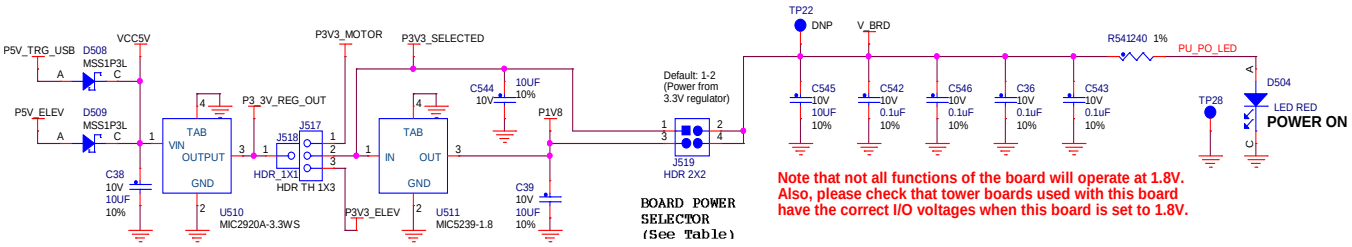

Figure 4. System power

3.5. Debug interface

There are two debug interface options provided: the on-board Open Source SDA (OpenSDA) circuit, and an external ARM JTAG mini-connector (2x5 pins).

3.5.1. OpenSDA

The OpenSDA circuit is MK20-based, and provides an SWD debug interface for the KV11 MCU. A standard USB (male) to micro-B (male) cable can be used for debugging via the USB connection.

This interface also supports the USB virtual serial port. This port can be selected to connect to the SCI0 or SCI1 with option jumpers J505 and J506. The SCI0 pins used in this case are PTB16/RXD0 and PTB17/TXD0, while the SCI1 pins used are PTE1/RXD1 and PTE0/TXD1. The default setting is the J505 pin 2-3 and J506 pin 2-3, which have a shunt installed in each. This ensures that SCI0 RXD0/PTB16 and TXD0/PTB17 are used for the OpenSDA COM port interface. This is shown in the two figures below. To isolate OpenSDA SWD_DIO/CLK signals from an external debugger signals, the jumpers on J523 and J526 must be removed.

The OpenSDA firmware is preprogrammed to support debugging for the KV11 MCU.

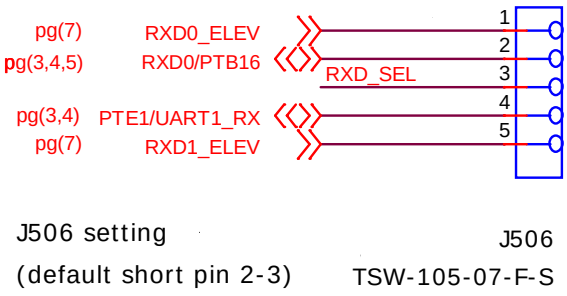

Figure 5. OpenSDA RXD source select

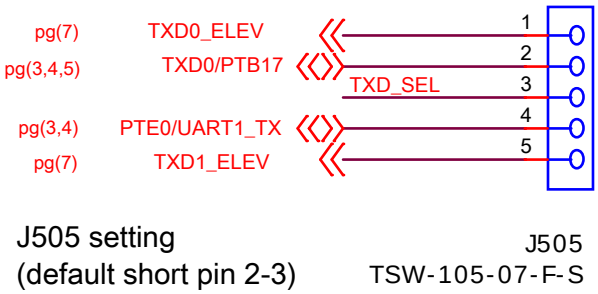

Figure 6. OpenSDA TXD source select

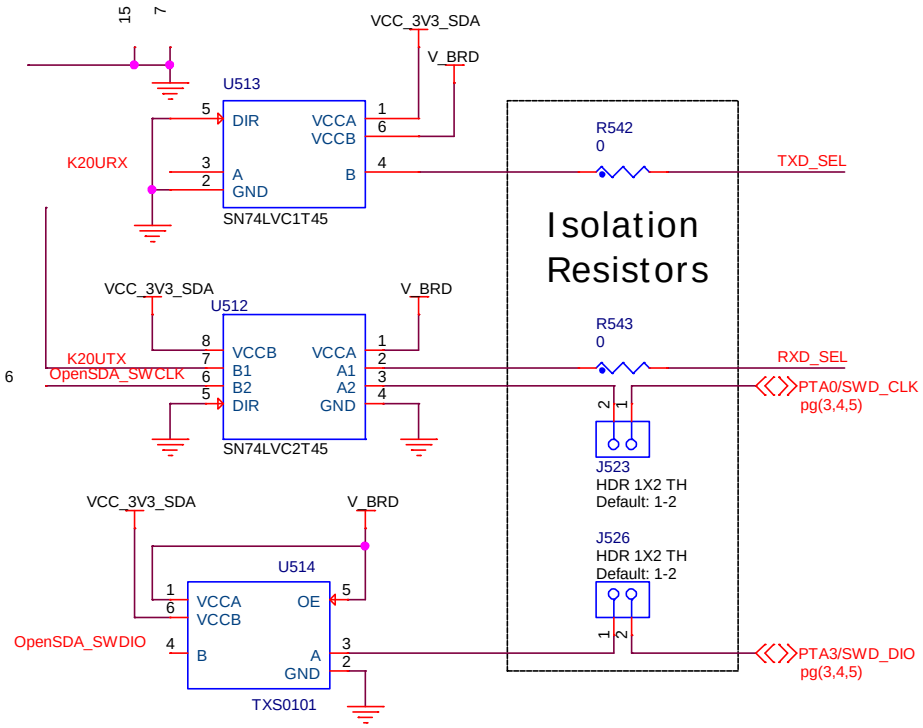

Figure 7. OpenSDA isolation

3.5.2. ARM JTAG/SWD mini-connector

The ARM Cortex-M Debug SWD connectors J513 and J525, are standard 2 x 5-pin (0.05 inch) connectors providing an external debugger cable with access to either the SWD interface of the KV11 MCU or the OpenSDA microcontroller MK20.

Table 1. ARM JTAG/SWD mini-connector J513 description

Pin	Function	Connection to OpenSDA K20
1	Vref	Target MCU power supply
2	SWDIO/TMS	JTAG_TMS
3	GND	GND
4	SWDCLK/TCK	JTAG_TCLK
5	GND	GND
6	SWO/TDO	JTAG_TDO
7	NC	NC
8	TDI	JTAG_TDI
9	NC	NC
10	RESET	K20_RESET

Table 2. ARM JTAG/SWD mini-connector J525 description

Pin	Function	Connection to KV11 MCU
1	Vref	Target MCU power supply
2	SWDIO/TMS	PTA3/SWD_DIO
3	GND	GND
4	SWDCLK/TCK	PTA0/SWD_CLK
5	GND	GND
6	SWO/TDO	NC
7	NC	NC
8	TDI	NC
9	NC	NC
10	RESET	PTA20/RESET_B

3.6. Accelerometer

An FXOS8700CQ digital accelerometer is featured on board to facilitate validation of I^2C of the KV11 MCU.

Table 3. FXOS8700CQ Connection description

Pin	Connection to KV11 MCU
SCL	SCL0/PTC6, with header
SDA	SDA0/PTC7, with header
INT1	PTB3,
INT2	PTA2
SA0	HIGH
SA1	LOW

Table 4. J11 Connector description

Pin	Usage	Description
1	Accelerometer SDA	Pin 1-2 short: KV11 SDA0 to accelerometer (default setting); Pin 2-3 short: KV11 SDA0 to other places
2	KV11 SDA0/PTC7	
3	SDA0/PTC7 to other places than the accelerometer	

Table 5. J13 Connector description

Pin	Usage	Description
1	Accelerometer INT1	Pin 1-2 short: KV11 PTB3 to accelerometer (default setting); Pin 2-3 short: KV11 PTB3 to other places
2	KV11 PTB3	
3	PTB3 to other places than the accelerometer	

Table 6. J4 Connector description

Pin	Usage	Description
1	Accelerometer SCL	Pin 1-2 short: KV11 SCL0 to accelerometer (default setting); Pin 2-3 short: KV11 SCL0 to other places
2	KV11 SCL0/PTC6	
3	SCL0/PTC6 to other places than the accelerometer	

Table 7. J2 Connector description

Pin	Usage	Description
1	Accelerometer INT2	Pin 1-2 short: KV11 PTA2 to accelerometer (default setting); Pin 2-3 short: KV11 PTA2 to other places
2	KV11 PTA2	
3	PTA2 to other places than the accelerometer	

3.7. User interfaces

3.7.1. Push buttons

Two push button switches (SW2 and SW3) are connected to GND and GPIO with LLWU pin interrupt signals (PTA4 and PTE20) to support waking up the KV11 MCU from LLS mode via the LLWU pin interrupt. One push button switch (SW1) is connected to the GND and KV11 MCU/RESET_b pin. The D506 LED lights up when there is a reset.

3.7.2. User LEDs

There are eight LEDs driven directly by FTM0 and GPIO pins of the MCU via buffers. The connection of LEDs to MCU pins are shown below:

Table 8. LED Connection description

LED #	KV11 pin	Description
LED1	PWM0/PTC1	Yellow/green
LED2	PWM1/PTC2	Yellow
LED3	PWM2/PTC3	Yellow/green
LED4	PWM3/PTC4	Yellow
LED5	PWM4/PTD4	Yellow/green
LED6	PWM5/PTD5	Yellow
LED7	ENC_PHASE_B/PTD6	Orange
LED8	ENC_PHASE_C/PTD7	Red

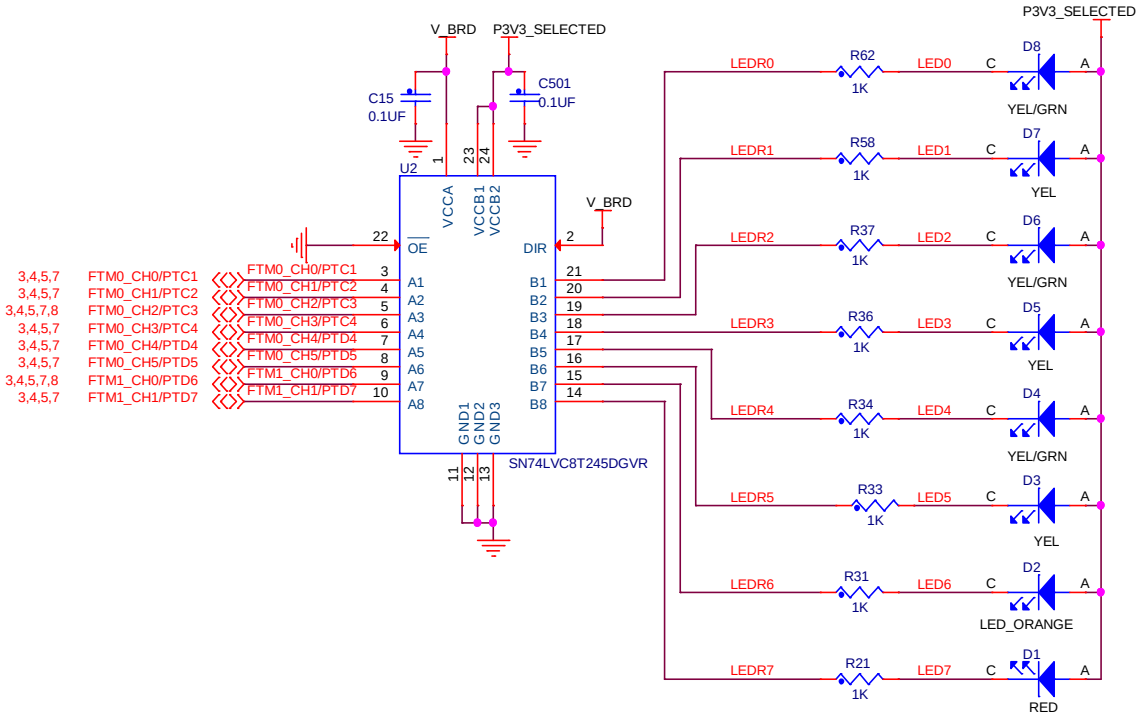

Figure 8. LED connection

3.7.3. Thermistor

There are four thermistors (RT1-4) near each corner of the board that can be used as single-ended or differential analog inputs for the KV11 MCU. In addition to each thermistor, there is a resistor between the thermistor and the 3.3 V system power supply, and another resistor between the thermistor and the ground. The thermistors are all 10 K Ohm parts, but the associated divider chain uses different resistors. This makes the voltage across the thermistor larger or smaller, and provides the ability to try the different gain settings on the analog channels. All four thermistor circuits are designed to provide useable differential inputs ranging between temperatures of 90 ˚C to -20 ˚C. RT2 and RT4 both give a differential voltage of ~1.65 V at 25 ˚C. RT1 gives a differential voltage of ~0.10V, and RT3 gives a differential voltage of ~0.28 V at 25 ˚C. In addition to the thermistor voltage divider chain, each thermistor has a 0.1 uF capacitor in parallel. Each thermistor circuit also has a header (J6 to J9, default settings: pins 1-2 shorted, pins 3-4 shorted on these headers) that allows the thermistor to be disconnected from the analog inputs to the KV11 MCU. If a user wishes to apply an external analog value, these headers may be removed, and the external analog signal attached to the KV11 MCU side of the headers. Each analog input to the KV11 MCU has a 100 Ohm series resistor and a 220 pF capacitor as a low pass filter. This helps protect the KV11 MCU from electrostatic discharges and lowers the impedance of the analog signal so that it can be sampled with less noise.

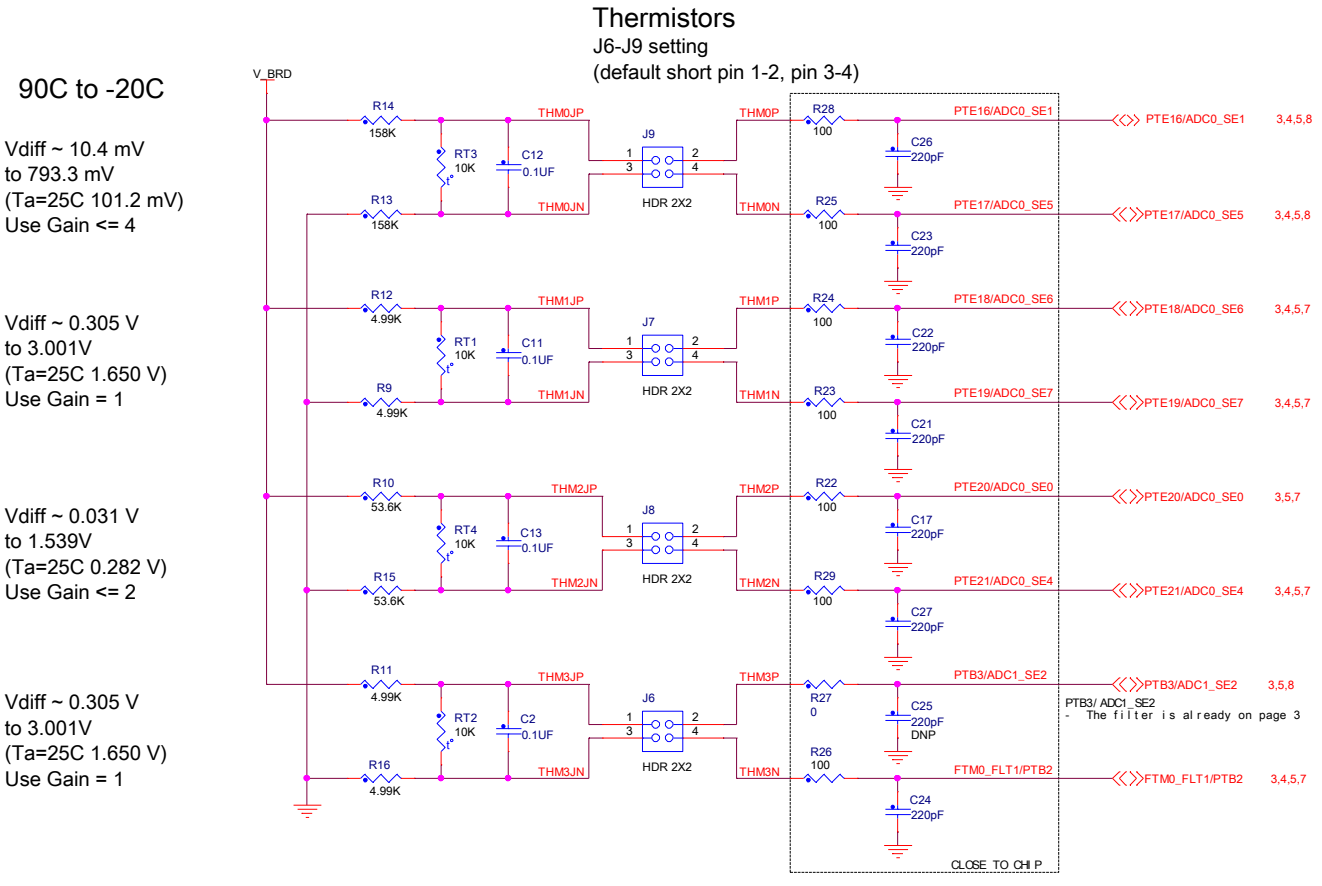

Figure 9. Thermistor inputs

3.8. Interface connectors

3.8.1. Motor connector

The KV11 MCU board can be connected to a motor control board such as APMOTOR56F8000E. The motor control connector (female) is located on the bottom of the board.

Some KV11 pins are connected to the motor control connector. Those pins, associated with analog inputs, have 100 Ohm resistors in series to provide some ESD protection for the analog inputs of the KV11 MCU. The pins, providing analog signals from the motor control board, have 220 pF caps with the resistors to provide a low pass filter. The connector pin out is shown in Aux peripheral connector 2 J18 description.

Table 9. 40-Pin motor connector J500 description

Pin#	Signal Connection	Function	Pin#	Signal Connection	Function
1	+3.3 V power supply from motor board	External Power supply	2	PTE16/ADC0_SE1/ADC1_SE0	ADC
3	GND	GND	4	RESET_B/PTA20	RESET
5	TXD0/PTB17	TXD	6	PTC0/ADC1_SE11	ADC
7	RXD0/PTB16	RXD	8	GND	GND
9	FTM0_CH0/PTC1	PWM0	10	ADC0_SE5/PTE17	ANA0, DC Bus voltage
11	FTM0_CH1/PTE25	PWM1	12	ADC0_SE4/PTE21	ANA1, DC Bus current
13	FTM1_CH0/PTD6	T0, Phase A Zero crossing/Hall effect	14	PTA4/NMI	GPIO, LED6 on motor board, GREEN
15	FTM1_CH1/PTD7	T1, Phase B Zero crossing/Hall effect	16	GND	GND
17	FTM2_CH0/PTA1	T3	18	ADC0_SE6/PTE18	ANB0, Phase A BEMF
19	FTM2_CH1/PTA2	T2, Phase C Zero crossing/Hall effect	20	ADC0_SE9/PTB1	ANB1, Phase B BEMF
21	PTC7/SDA0	GPIO	22	ADC0_SE7/PTE19	ANB2, Phase C BEMF
23	PTC6/SCL0	GPIO	24	GND	
25	SWD_DIO/PTA3	TDI/GPIO	26	PTE24	GPIO, LED3, YELLOW on motor board

Table 9. 40-Pin motor connector J500 description (continued)

27	SWD_DIO/PTA3	TDO/GPIO	28	PTE30	GPIO, LED2, RED on motor board
29	SWD_CLK/PTA0	TCK/GPIO	30	FTM0_CH2/PTC3	PWM2
31	PTC5	GPIO	32	FTM0_CH3/PTC4	PWM3
33	PTC0/ PDB0_EXTRG	GPIO,LED5,RED on motor board	34	FTM0_CH4/PTD4	PWM4
35	PTE20/ ADC0_SE0	ADC	36	FTM0_CH5/PTD5	PWM5
37	PTB2/ADC0_SE1	ADC	38	PTB0/ ADC0_SE8	ADC
39	PTB3/ADC0_SE10	ADC	40	PTD1/ADC0_SE2	ADC

3.8.2. Aux peripheral connector

The aux peripheral connector 1 is designed to facilitate the evaluation of digital functions.

Table 10. Aux peripheral connector 1 J24 description

Pin#	Signal Connection	Pin#	Signal Connection
2	VDD	1	VSS
4	PTA1	3	PTA0
6	PTA3	5	PTA2
8	VSS	7	PTA4
10	PTB17	9	PTB16
12	PTB3	11	PTB2
14	PTE25	13	PTE24
16	PTC3	15	PTC2
18	PTC5	17	PTC4
20	PTC7	19	PTC6
22	PTD1	21	PTD0
24	PTD3	23	PTD2
26	PTD5	25	PTD4
28	PTD7	27	PTD6

The aux peripheral connector 2 is designed to facilitate the evaluation of analog functions.

Table 11. Aux peripheral connector 2 J18 description

Pin#	Signal Connection	Pin#	Signal Connection
2	VDDA	1	VSSA
4	VREFH	3	VREFL
6	PTE17/ADC0_SE5/ADC1_SE5	5	PTE16/ADC0_SE1
8	PTE19/ADC0_SE7/ADC1_SE7	7	PTE18/ADC0_SE6
10	PTE21/ADC0_SE4	9	PTE20/ADC0_SE0
12	PTE29/ CMP0_IN5/CMP1_IN5	11	PTE30/ADC1_SE4
14	PTC1/ADC1_SE3	13	PTC0/ ADC1_SE11
16	PTC3/CMP1_IN1	15	PTC2/ADC0_SE11
18	PTB1/ ADC1_SE9	17	PTB0/ ADC0_SE8
20	PTB3/ADC1_SE2	19	PTB2/ADC0_SE10

4. TWR-KV11Z75M Options and headers

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

Table 12. TWR-KV11Z75M Jumper table

Jumper	Option	Setting	Description
J1	PTC3 select	**ON**	Connect PTC3 to J24 A38 and B47pin
		OFF	Connect PTC3 to J24 B47 pin only
J2	PTA2 selection	**1-2**	Connect PTA2 to FXOS87000CQ
		2-3	Connect PTA2 to elevator J24 and auxiliary connector J6
J4	I2C0 SCL0(PTC6) selection	**1-2**	Connect SCL0 to elevator J24 A7 pin and J6
		2-3	Connect this pin to accelerometer(U6)
J5	CAN signal selector	1-2	Enable pull-down to CAN - C_SLEEP signal
		3-4	Connect PTA13 toCAN - C_SLEEP signa
		5-6	Connect PTE25 to C_RXD signal
		7-8	Connect PTE24 to C_TXD signal
		9-10	Enable 120 ohm resistor load between CANL-CANH signals
J6	RT4 connection with KV11 PTB3	**1-2**	Connect one terminal of RT4 to KV11 PTB3 pin
		OPEN	Connect one terminal of RT3 to KV11 PTB3 pin
	RT4 connection with KV11 PTB2	**3-4**	Connect one terminal of RT3 to KV11 PTB2 pin
		Open	Connect one terminal of RT3 to KV11 PTB2 pin

Table 12. TWR-KV11Z75M Jumper cable (continued)

J7	RT2 connection with KV11 PTE18	**1-2**	Connect one terminal of RT2 to KV11 PTE18 pin
		OPEN	Isolate one terminal of RT2 to KV11 PTE18 pin
	RT2 connection with KV11 PTE19	**3-4**	Connect one terminal of RT2 to KV11 PTE19 pin
		Open	Isolate one terminal of RT2 to KV11 PTE19 pin
J8	RT3 connection with KV11 PTE20	**1-2**	Connect one terminal of RT3 to KV11 PTE20 pin
		OPEN	Isolate one terminal of RT3 to KV11 PTE20 pin
	RT3 connection with KV11 PTE21	**3-4**	Connect one terminal of RT3 to KV11 PTE21 pin
		Open	Isolate one terminal of RT3 to KV11 PTE21 pin
J9	RT1 connection with KV11 PTE16	**1-2**	Connect one terminal of RT1 to KV11 PTE16 pin
		OPEN	Isolate one terminal of RT1 to KV11 PTE16 pin
	RT1 connection with KV11 PTE17	**3-4**	Connect one terminal of RT1 to KV11 PTE17 pin
		Open	Isolate one terminal of RT1 to KV11 PTE17 pin
J10	KV11 power connection	**ON**	Connect power supply to KV11
		OFF	Isolate KV11 from power (connect an ammeter to measure current)
J11	I2C0 SDA0(PTC7) selection	**1-2**	Connect SDA0 to elevator J24 A8 pin and J6
		2-3	Connect this pin to accelerometer(U6)
J12	FSOS8700CQ address option	**ON**	SA1 -> 1
		OFF	SA1 -> 0
J13	PTB3 selection	**1-2**	Connect PTB3 to FXOS87000CQ
		2-3	Connect PTB3 to elevator J24 and auxiliary connector J6
J14	FSOS8700CQ address option	**ON**	SA0 -> 0
		OFF	SA0 -> 1
J17	PTE20 select	1-2	Connect PTE20 to elevator
		2-3	Connect PTE20 to SW1
J18	MC Auxiliary Connector	**OPEN**	No jumper on the connector by default
J24	MC Auxiliary Connector	**OPEN**	No jumper on the connector by default
J505	TXD source selection	1-2	Connect KV11 PTB17 pin to elevator J24 A42 pin
		2-3	Connect KV11 PTB17 pin to OpenSDA TXD
		3-4	Connect KV11 PTD1 pin to OpenSDA TXD
		4-5	Connect KV11 PTD1 pin to elevator J24 A44 pin
J506	RXD source selection	1-2	Connect KV11 PTB16 pin to elevator J24 A41 pin
		2-3	Connect KV11 PTB16 pin to OpenSDA RXD
		3-4	Connect KV11 PTD0 pin to OpenSDA RXD
		4-5	Connect KV11 PTD0 pin to elevator J24 A43 pin
J512	RESET selector	**1-2**	RESET_B connected to SW1/PTA20
		2-3	When OpenSDA MCU is not powered, RESET button can be used.

Table 12. TWR-KV11Z75M Jumper cable (continued)

J519	KV11 power supply select	**1-2**	+3.3 V power supply
		2-3	+1.8 V power supply
J524	CAN output signals	OPEN	CANL on the pin1, CANH on the pin2, GND on the pin3
J523, J526	OpenSDA signals **SWD_DIO and SWD_CLK** configuration	**ON**	OpenSDA debugging is enabled.
		OFF	

5. References

- The OpenSDA User's Guide, available here, is a guide for users of the OpenSDA embedded circuit.

6. Useful links

- www.freescale.com
- www.iar.com/freescale
- https://developer.mbed.org/handbook/Windows-serial-configuration
- www.segger.com
  - http://www.segger.com/jlink-flash-download.html

7. Revision History

This table provides a revision history of the document.

Table 13. Revision history

Revision number	Date	Substantive changes
0	06/2015	Initial release
1	09/2015	• OpenSDA chapter updated • Table12 updated – J523, J526 added • TWR-KV11Z75M images updated

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