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TWR-MCF51MM

User Manual

Rev. 1.0

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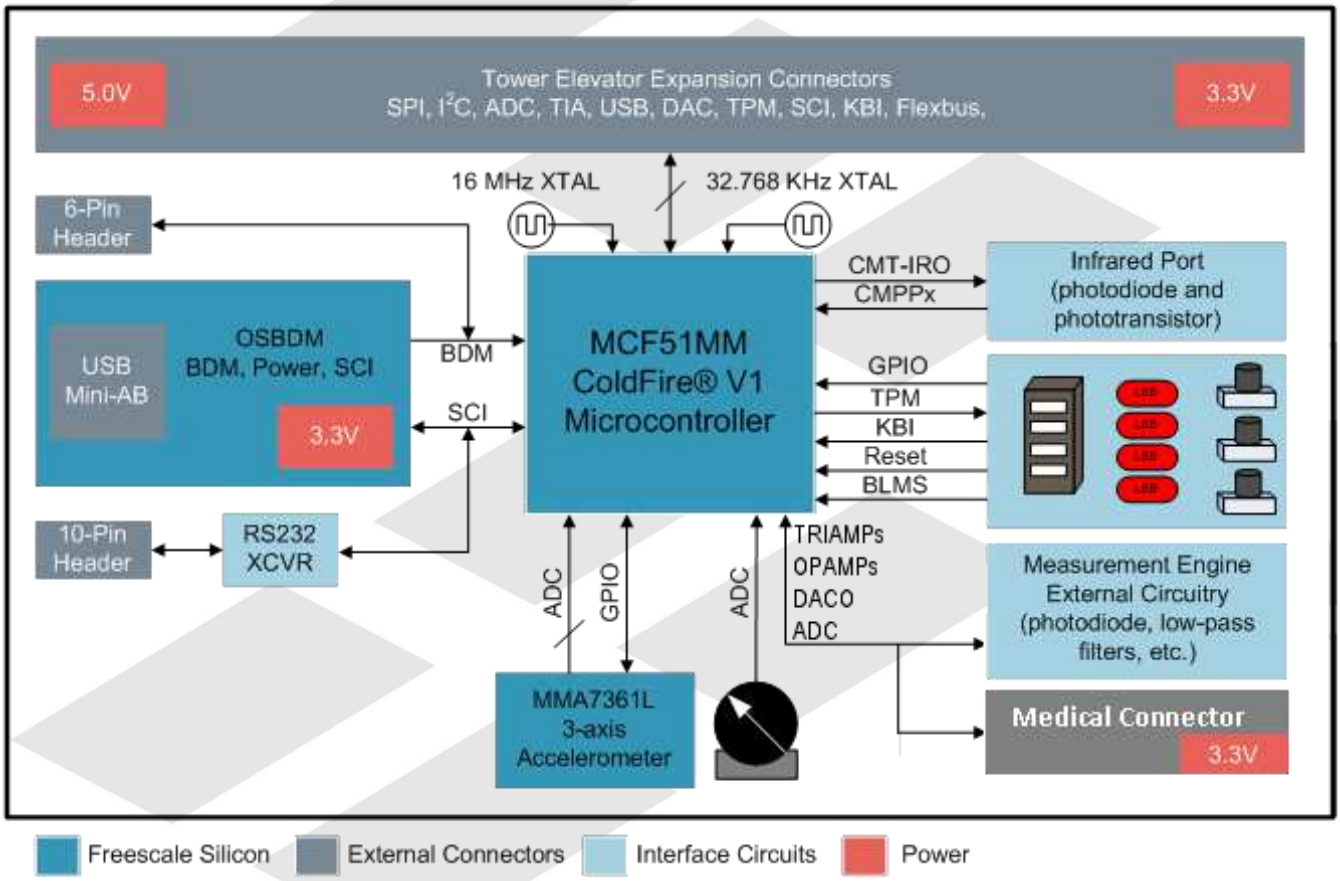
1 Overview

TWR-MCF51MM is a low-cost evaluation, demonstration and development board that features a 32-bit MCF51MM256 microcontroller. The TWR-MCF51MM can operate stand-alone or as the main control board in a Tower System with peripheral modules.

The following list summarizes the features of the MCF51MM Tower MCU boards:

- Tower compatible processor board
- Open Source BDM (OSBDM) circuit
- Analog measurement circuitry
- 4 LEDs
- DIP Switches and push buttons for user input
- Potentiometer
- MMA7361L three-axis accelerometer
- RS232 transceiver and 2x5 pin header

Figure 1. TWR-MCF51MM Block Diagram



2 Reference Documents

The documents listed below are available online. Refer to http://www.freescale.com/tower for the latest revision of all Tower System documentation.

- *TWR-MCF51MM Schematics*
- *TWR-MCF51MM Quick Start Guide*
- *TWR-MCF51MM-KIT Lab Tutorial*
- *MCF51MM256 Reference Manual*
- *MCF51MM256 Data Sheet*
- *AN3561, USB Bootloader for the MC9S08JM60*

3 Hardware Features

This section provides more details about the features and functionality of the TWR-MCF51MM.

3.1 Clocking

Two crystals are provided on the board for clocking the MCF51MM256 device:

1. A 16 MHz crystal connected to XTAL2 and EXTAL2 for system clocking
2. A 32.768kHz crystal connected to XTAL1 and EXTAL1 for TOD usage

3.2 System Power

The TWR-MCF51MM can be powered by the Open Source BDM (OSBDM) circuit via the Mini-B USB connector when stand-alone. When assembled with the Tower System and the TWR-SER is configured to run USB device mode (J16 pin 3 and 4 connected), the Mini-B USB connector is no longer used as a power source and only used for OSBDM debugging purposes. In this case, the power will be supplied from the Mini-B USB from the TWR-SER. Please plug in the Mini-B USB connector from TWE-SER before plugging in the Mini-B USB connector from TWR-MCF51MM.

A standard USB A male to Mini-B male cable (provided) can be used to supply power from a USB host or powered USB hub. Optionally, an AC to DC adapter with a USB A female receptacle (not provided) can be used as the power source.

A jumper, J11, can be used to isolate the 3.3V supply from the microcontroller. This connection can be used to measure the power usage of the MCF51MM256 microcontroller.

3.3 Debug Interface

An on-board, MC9S08JM60 based OSBDM circuit provides a debug interface to the MCF51MM256. A standard USB A male to Mini-B male cable (provided) can be used for debugging via the USB connector, J17. Refer to Section 6 for information on other modes of operation of the OSBDM.

3.4 RS232 Interface

An RS232 transceiver on the TWR-MCF51MM connects to a standard 2x5 pin header (refer to Figure 2). Selection jumpers J15 and J16 allow MCF51MM256 SCI2 signals to be routed to either the RS232 transceiver or the OSBDM circuit. Refer to Figure 5 for more details.

Alternatively, when assembled as a Tower System, the MCF51MM256 SCI1 TX and RX are routed to the SER-TWR. If the SER-TWR jumpers are configured to run in RS-232 mode, the SCI1 TX and the RX signal can be communicated via the RS232 connector from the TWR-SER. Please refer to the TWE-SER user manual (TWRSERUM) from www.freescale.com/tower for more detail.

MCF51MM256 Signal	Pin		MCF51MM256 Signal
Not Connected	1	2	Not Connected
TX2	3	4	Not Connected
RX2	5	6	Not Connected
Not Connected	7	8	Not Connected
GND	9	10	3.3V

Figure 2. RS232 2x5 Pin Header Connections

3.5 Infrared Port

The TWR-MCF51MM implements an infrared transmit and receive port. The transmit circuit is implemented with an infrared diode and the user can choose to drive the diode either with IRO or SCI TX. The receiver is implemented by an infrared transistor and the user can choose to input this signal to the SCI RX or the ACMP input. Jumpers J9, J25 and J26 are used for routing the connections, refer to Section 4 to set the jumpers. Please refer to application note AN4116, searchable from www.freescale.com

3.6 Medical Connector

The TWR-MCF51MM features a 2x10 expansion connector J27 (refer to Figure 3) to MED-EKG for routing the medical engine signals to external medical board so it can use the OPAMP, TRIAMP, ADC and DAC on MCF51MM to implement the requirement signal conditioning for medical applications.

When the DSC MC56F8006 from the MED-EKG is enabled, MCF51MM256 can choose to read the conditioned EKG results output from the DSC via I2C transmission (pin 3 and pin 4). To enable I2C communication, you must assemble the MEG-EKG with the Tower System because the TWR-SER has the pulled up resistors circuit required for I2C transmission.

In Figure 3, the **bold** text highlights the functions that are used to implement the MED-EKG demonstration. For detail about the MED-EKG, please refer to the MED-EKG user manual, MED-EKG lab and schematic included in the TWR-MCF51MM-KIT or TWR-S08MM128-KIT. All these are also available on Freescale.com/tower

MCF51MM256 Signal	Pin		MCF51MM256 Signal
MOSFET Q6 (pin 3)-Power (3.3V)	1	2	**Ground(GND)**
PTD4/**SDA**/RGPIOP10/TPM1CH2	3	4	PTD5/**SCL**/RGPIOP11/TPM1CH3
DADP0	5	6	**DADM0**
PTC4/KBI1P7/CMPP0/**ADP8**	7	8	**DACO_E**
OUT1	9	10	**OUT2**
INP1-	11	12	**INP2-**
PTA4/**INP1+**	13	14	PTA7/**INP2+**
VINP1	15	16	**VINP2**
VINN1/DADM2	17	18	**VINN2**/DADM3
TRIOUT1/DADP2	19	20	**TRIOUT2**/DADP3

Figure 3. Medical Connector 2x10 Pin Header Connections

3.7 Elevator Connections

The TWR-MCF51MM features two expansion card-edge connectors that interface to elevator boards in a Tower System: the Primary and Secondary Elevator connectors. The Primary Elevator connector, comprised of sides A and B, is utilized by the TWR-MCF51MM, while the Secondary Elevator connector only makes connections to ground (GND). Figure 4 provides the pinout for the Primary Elevator connector. An "X" in the "Used" column indicates that there is a connection from the TWR-MCF51MM to that pin on the elevator connector. An "X" in the "Jmp" column indicates that a jumper is available that can configure or isolate the connection from the elevator connector.

Figure 4. TWR-MCF51MM Primary Elevator Connector Pinout

TWR-MCF51MM Primary Connector									
Pin	Name	Usage	Used	Jmp	Pin	Name	Usage	Used	Jmp
B1	**5V**	**5V Power**	**X**		A1	**5V**	**5V Power**	**X**	
B2	**GND**	**Ground**	**X**		A2	**GND**	**Ground**	**X**	
B3	**3.3V**	**3.3V Power**	**X**		A3	**3.3V**	**3.3V Power**	**X**	
B4	ELE_PS_SENSE	Elevator power sense	**X**		A4	**3.3V**	**3.3V Power**	**X**	
B5	**GND**	**Ground**	**X**		A5	**GND**	**Ground**	**X**	
B6	**GND**	**Ground**	**X**		A6	**GND**	**Ground**	**X**	
B7	SPI1_CLK	SPI1 clock	**X**		A7	SCL0	IIC clock	**X**	
B8	SPI1_CS1				A8	SDA0	IIC data	**X**	
B9	SPI1_CS0	SPI1 chip select	**X**		A9	GPIO9 / OPEN	GPIO PTE4	**X**	
B10	SPI1_MOSI	SPI1 MOSI	**X**		A10	GPIO8 / OPEN	GPIO PTC7	**X**	
B11	SPI1_MISO	SPI1 MISO	**X**		A11	GPIO7 / OPEN	GPIO PTC6	**X**	
B12	ETH_COL				A12	ETH_CRS			
B13	ETH_RXER				A13	ETH_MDC			
B14	ETH_TXCLK				A14	ETH_MDIO			

TWR-MCF51MM Primary Connector									
Pin	Name	Usage	Used	Jmp	Pin	Name	Usage	Used	Jmp
B15	ETH_TXEN				A15	ETH_RXCLK			
B16	ETH_TXER				A16	ETH_RXDV			
B17	ETH_TXD3				A17	ETH_RXD3			
B18	ETH_TXD2				A18	ETH_RXD2			
B19	ETH_TXD1				A19	ETH_RXD1			
B20	ETH_TXD0				A20	ETH_RXD0			
B21	GPIO1 / OPEN	GPIO PTA2	X		A21	SSI_MCLK			
B22	GPIO2 / OPEN	GPIO PTA6	X		A22	SSI_BCLK	TRIAMP1 negative input	X	
B23	GPIO3 / OPEN	GPIO PTB1	X		A23	SSI_FS	TRIAMP2 output	X	
B24	CLKIN0				A24	SSI_RXD	TRIAMP1 output	X	
B25	CLKOUT1				A25	SSI_TXD	OPAMP1 output	X	
B26	**GND**	**Ground**	X		A26	**GND**	**Ground**	X	
B27	AN7	ADC channel 9	X		A27	AN3	ADC differential minus	X	
B28	AN6	ADC channel 8	X		A28	AN2	ADC differential plus	X	
B29	AN5	ADC channel 7	X		A29	AN1	TRIAMP2 positive input	X	
B30	AN4	ADC channel 6	X		A30	AN0	TRIAMP2 negative input	X	
B31	**GND**	**Ground**	X		A31	**GND**	**Ground**	X	
B32	DAC1	VREF output	X		A32	DAC0	DAC output	X	X
B33	TMR3	TPM1 channel 3	X		A33	TMR1	TPM1 channel 1	X	
B34	TMR2	TPM1 channel 2	X		A34	TMR0	TPM1 channel 0	X	
B35	GPIO4	GPIO PTF0	X		A35	GPIO6	GPIO PTF1	X	
B36	**3.3V**	**3.3V Power**	X		A36	**3.3V**	**3.3V Power**	X	
B37	PWM7	TPM1 channel 3	X		A37	PWM3	TPM2 channel 3	X	
B38	PWM6	TPM1 channel 2	X		A38	PWM2	TPM2 channel 2	X	
B39	PWM5	TPM1 channel 1	X		A39	PWM1	TPM2 channel 1	X	
B40	PWM4	TPM1 channel 0	X		A40	PWM0	TPM2 channel 0	X	
B41	CANRX0				A41	RXD0			
B42	CANTX0				A42	TXD0			
B43	CAN				A43	RXD1	SCI1 receive	X	
B44	SPI0_MISO	SPI0 MISO	X		A44	TXD1	SCI1 transmit	X	
B45	SPI0_MOSI	SPI0 MOSI	X		A45	BKGD			
B46	SPI0_CS0	SPI0 Chip Select	X		A46	ALLPST			
B47	SPI0_CS1	SPI1 Chip Select	X		A47	JTAG_EN			
B48	SPI0_CLK	SPI0 clock	X		A48	TRST_b / DSCLK			
B49	**GND**	**Ground**	X		A49	**GND**	**Ground**	X	
B50	SCL1				A50	TCLK / DSCLK			
B51	SDA1				A51	TDI / DSI			
B52	GPIO5 / OPEN	GPIO PTA3	X		A52	TDO / DSO			
B53	USB0_DP_PDOWN				A53	TMS / BKPT_b			
B54	USB0_DM_PDOWN				A54	USB_DM	USB data minus	X	
B55	IRQ_H	KBI2P1	X		A55	USB_DP	USB data plus	X	
B56	IRQ_G	KBI2P2	X		A56	USB_ID			
B57	IRQ_F	KBI2P1	X		A57	USB_VBUS	USB VBUS input	X	
B58	IRQ_E	KBI2P2	X		A58	TMR7	OPAMP2 output	X	

TWR-MCF51MM Primary Connector									
Pin	Name	Usage	Used	Jmp	Pin	Name	Usage	Used	Jmp
B59	IRQ_D	IRQ pin	X		A59	TMR6	OPAMP1 negative input	X	
B60	IRQ_C	IRQ pin	X		A60	TMR5	OPAMP2 negative input	X	
B61	IRQ_B	KBI1P2	X		A61	TMR4	OPAMP1 positive input	X	
B62	IRQ_A	KBI1P1	X		A62	RSTIN_b			
B63	EBI_ALE / EBI_CS1_b	Minibus chip select 1	X		A63	RSTOUT_b			
B64	EBI_CS0_b	Minibus chip select 0	X		A64	CLKOUT0	Clock output on PTC7	X	
B65	**GND**	**Ground**	X		A65	**GND**	**Ground**	X	
B66	EBI_AD15	Minibus address bus	X		A66	EBI_AD14	Minibus address bus	X	
B67	EBI_AD16	Minibus address bus	X		A67	EBI_AD13	Minibus address bus	X	
B68	EBI_AD17	Minibus address bus	X		A68	EBI_AD12	Minibus address bus	X	
B69	EBI_AD18	Minibus address bus	X		A69	EBI_AD11	Minibus address bus	X	
B70	EBI_AD19	Minibus address bus	X		A70	EBI_AD10	Minibus address bus	X	
B71	EBI_R/W_b	Minibus read/write strobe	X	X	A71	EBI_AD9	Minibus address bus	X	
B72	EBI_OE_b	Minibus output enable	X		A72	EBI_AD8	Minibus address bus	X	
B73	EBI_D7	Minibus data bus	X		A73	EBI_AD7	Minibus address bus	X	
B74	EBI_D6	Minibus data bus	X		A74	EBI_AD6	Minibus address bus	X	
B75	EBI_D5	Minibus data bus	X		A75	EBI_AD5	Minibus address bus	X	
B76	EBI_D4	Minibus data bus	X		A76	EBI_AD4	Minibus address bus	X	
B77	EBI_D3	Minibus data bus	X		A77	EBI_AD3	Minibus address bus	X	
B78	EBI_D2	Minibus data bus	X		A78	EBI_AD2	Minibus address bus	X	
B79	EBI_D1	Minibus data bus	X		A79	EBI_AD1	Minibus address bus	X	
B80	EBI_D0	Minibus data bus	X		A80	EBI_AD0	Minibus address bus	X	
B81	**GND**	**Ground**	X		A81	**GND**	**Ground**	X	
B82	**3.3V**	**3.3V Power**	X		A82	**3.3V**	**3.3V Power**	X	

3.8 Mechanical Form Factor

The TWR-MCF51MM is designed for the Freescale Tower System and complies with the electrical and mechanical specification as described in *Freescale Tower Electromechanical Specification*.

4 Jumper Table

There are several jumpers provided for isolation, configuration, and feature selection. Refer to the following table for details. The default installed jumper settings are shown in **bold**.

Figure 5. TWR-MCF51MM Jumper Table

Jumper	Option	Setting	Description of MCF51MM256 signal routing
J1	DADP0 routing selection	**1-2**	Connect DADP0 to medical connector J27 pin 5
J2	DADM0 routing selection	**1-2**	Connect DADM0 to medical connector J27 pin 6
J3	VINP1 routing selection	1-2	VINP1 connect to GND
		2-3	VINP1 optionally connected to DACO
J4	Potentiometer connection	**1-2**	Connection of ADP4 to potentiometer

J5	DACO routing selection	1-2	Connect DACO to VINP1 if pin 2-3 of J3 is connected
		2-3	Connect DACO to a RC low pass filter
J6	DACO routing selection	**1-2**	Connect DACO to medical connector J27 pin 8
J7	TRIAMP routing selection	1-2	Connect TRIOUT1 to TRIOUT_SEL2
		2-3	Connect TRIOUT2 to TRIOUT_SEL2
J8	TRIAMP routing selection	1-2	Connect TRIOUT1 to TRIOUT_SEL1
		2-3	Connect TRIOUT2 to TRIOUT_SEL1
J9	Infrared receive routing	**1-2**	Connect Infrared transistor output to CMPP1
J10	USB3.3V connection	1-2	USB3.3V connects to external 3.3V power supply
		2-3	USB3.3V connects to on-chip USB 3.3V regulator output
J11	MCU IDD measure	**1-2**	For measuring MCF51MM256 current
J12	OSBDM Bootloader mode or debugger mode selection	1-2	OSBDM IC in bootloader mode(For OSBDM firmware reprogramming)
		Open	OSBDM IC in debugger mode .
J13	BDM connector for MCF51MM256	**Open**	BDM connector for MCF51MM256
J14	BDM connector for JM60	**Open**	BDM connector for MC9S08JM60
J15	SCI2 TXD Routing Selection	**1-2**	Connect TX2 to the RS232 transceiver
		2-3	Connect TX2 to the OSBDM debugger interface circuit
J16	SCI2 RXD Routing Selection	**1-2**	Connect RX2 to the RS232 transceiver
		2-3	Connect RX2 to the OSBDM debugger interface circuit
J18	LED & Accelerometer connections	**1-2**	Connects LED4 to pin PTE7/USB_VBUSVLD/TPM2CH3
		3-4	Connects LED3 to pin PTF0/USB_ID/TPM2CH2
		5-6	Connects LED2 to pin PTF1/RX2/USB_DP_DOWN/TPM2CH1
		7-8	Connects LED1 to pin PTF2/TX2/USB_DM_DOWN/TPM2CH0
		9-10	Connects ADP8 to ACCZ
		11-12	Connects ADP7 to ACCY
		13-14	Connects ADP6 to ACCX
J19	Accelerometer mode control	**1-2**	Connects PTA3 to SELF TEST pin of accelerometer
		3-4	Connects PTA6 to $\overline{\text{SLEEP}}$ pin of accelerometer
		5-6	Connects PTA5 to G-SELECT pin of accelerometer
J20	Accelerometer control	1-2	Connects PTB0 to 0G-DETECT pin of accelerometer
J21	RS232 connector	**Open**	2x5 RS232 connector
J24	Infrared filter connection	1-2	Choose whether to filter Infrared output
J25	Infrared transmit routing	1-2	Connects Infrared transistor output to ADP10
		3-4	Connects Infrared transistor output to RX1
		5-6	Connects either IRO or TX1 to Infrared diode base on J26
J26	Infrared transmit routing	1-2	TX1 pin drives Infrared transmit
		2-3	IRO pin drives Infrared transmit
J27	Medical board connector	**Open**	Connects to MED-EKG board

NOTE: For more detail, please refer to TWR-MCF51MM schematics available in the TWR-MCF51MM-KIT or on Freescale.com/tower.

5 Input/Output Connectors and Pin Usage Table

The following tables provide details on which MCF51MM256 pins are communicating with the TWR-MCF51MM sensors, LEDs, switches and other I/O interfaces.

Figure 6. I/O Connectors and Pin Usage Table

TWR-MCF51MM		MCF51MM256			
I/O Component	I/O Label	Default	Alt 1	Alt 2	Alt 3
Dip Switch	SW3-1&4	PTA5	-	-	-
	SW3-2&3	PTB1	/BLMS	-	-
Push Button	SW1	PTD1	CMPP2	/RESET	-
	SW2	PTC6	KBI2P1	PRACMPO	ADP10
	SW4	PTE4	CMPP3	TPMCLK	IRQ
LED	LED1 (D9)	PTF2	TX2	USB_DM_DOWN	TPM2CH0
	LED2(D10)	PTF1	RX2	USB_DP_DOWN	TPM2CH1
	LED3(D11)	PTF0	USB_ID	TPM2CH2	-
	LED4(D12)	PTE7	USB_VBUSVLD	TPM2CH3	-
Accelerometer MMA7361L	X_OUT	PTC2	KBI1P5	SPSCK2	ADP6
	Y_OUT	PTC3	KBI1P6	/SS2	ADP7
	Z_OUT	PTC4	KBI1P7	CMPP0	ADP8
Potentiometer	POT	PTA2	KBI1P1	RX1	ADP4
RS232 ICL3232	232_RXD	PTE6	FB_RW	USB_SESSEND	RX2
	232_TXD	PTE5	FB_D7	USB_SESSVLD	TX2

NOTE: LED1 to LED4 are labelled as D9 to D12 on the TWR-MCF51MM silkscreen.

6 OSBDM

An on-board, MC9S08JM60 based OSBDM circuit provides a debug interface to the MCF51MM256. The MC9S08JM60 is a USB-enabled microcontroller with an 8-bit HC9S08 core. The OSBDM circuit provides a USB-to-debug interface that allows run-control and debugging of the MCF51MM256 target device. The USB drivers required to communicate with the OSBDM are provided in development tools such as Freescale CodeWarrior. When TWR-MCF51MM is used stand-alone, this single USB connection can also be used for power.

6.1 Bootloader Mode For MC9S08JM60

The MC9S08JM60 device used in the OSBDM circuit is preprogrammed with OSBDM debugger firmware and a USB Bootloader. The bootloader mode can be used to update the OSBDM debugger firmware if an update becomes available. Jumper J12 determines which application will run following a power-on reset. If the Bootloader Mode is chosen (jumper shunt on J12), the bootloader will be

executed, allowing in-circuit reprogramming of the JM60 flash memory via USB. Refer to Application Note AN3561 on the Freescale website (http://www.freescale.com) for details on the USB Bootloader.

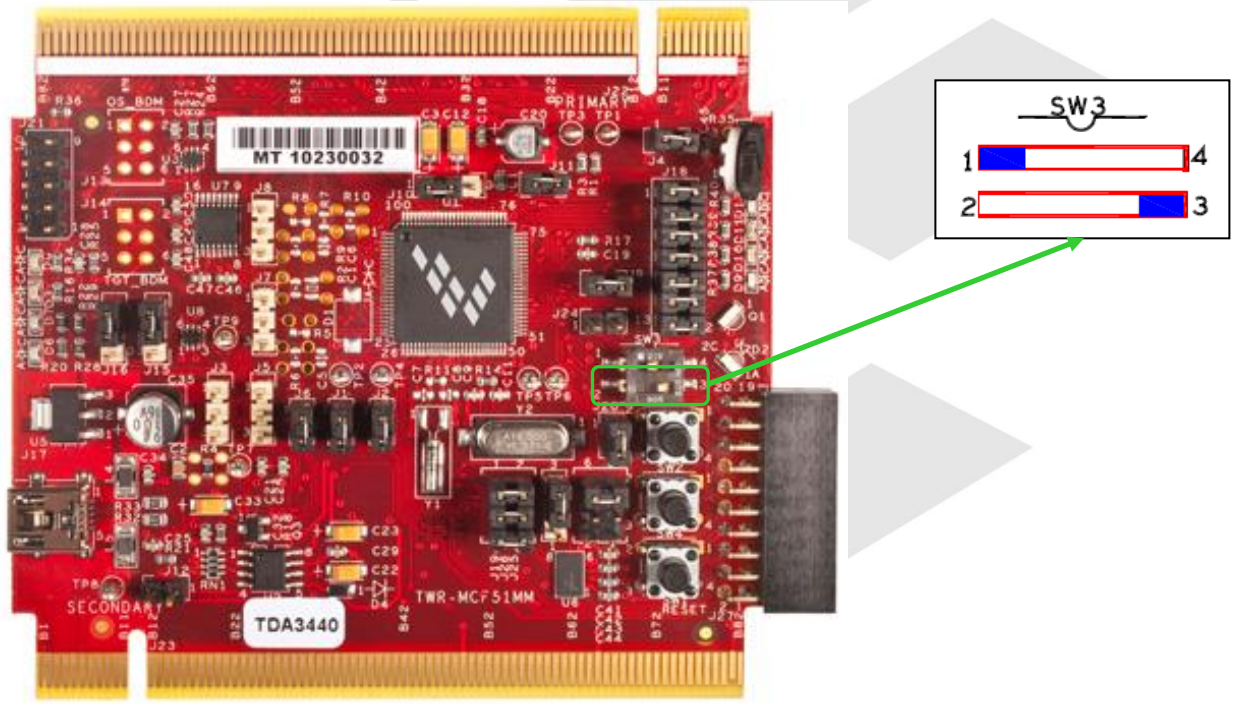
The USB Bootloader communicates with a GUI application running on a host PC. The GUI application can be found on the Freescale website; search keyword "JM60 GUI." Refer to section 2.5 and 3.3 of AN3561 for details on installing and running the application.

Note:
The JM60 GUI Installer should be run before connecting the OSBDM in Bootloader Mode to a host USB port. Otherwise, the JM60 USB device will not be recognized and the proper drivers will not be loaded.

7 Bootloader Mode For MCF51MM256

Unlike MC9S08JM60, MCF51MM256 has an on-chip ROM based USB bootloader that allows the MCF51MM256 for mass erase and programming via its USB interface. This on-chip bootloader does not consume user flash space. To enable USB bootloader mode for MCF51MM256, on the TWR-MCF51MM module, set SW3 DIP switch 2 and 3 to position 3, as indicated in Figure 7. NOTE: Under normal development you will need to set SW3 DIP switch 2 and 3 to position 2.

Figure 7. Setting SW3 for MCF51MM256 USB bootloader mode



8 BDM inteface (Optional)

Both MCF51MM256 and MC9S08JM60 have an on-chip background debug module. The user can choose to bypass the USB OSBDM interface and use the BDM interface for debugging and programming the corresponding chip instead. The BDM interface for MCF51MM256 is at J13 header and MC9S08JM60 is at J14 from the TWR-MCF51MM module. The user needs a P&E USB BDM MULTILINK in order to use this interface. This is a repeat function of the OSBDM and is not required.

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