TWR-LCD

User's Manual

Rev. 1.3

Freescale Semiconductor Inc.

Contents

1 Overview

The Tower LCD Module (TWR-LCD) adds a side mounting TFT QVGA Display to the Freescale Tower System. It can be used with a wide variety of Tower Processor Modules through a SPI and/or external bus interface (EBI).

The TWR-LCD features a 3.2” QVGA TFT LCD Display with touch sensitive overlay, 5-way navigation control, MicroSD Card slot, dedicated MCF51JM microcontroller, and a Piezo Buzzer for audible feedback. The LCD Display Controller is accessible to the dedicated MCF51JM microcontroller through the SPI. The LCD Display Controller is also accessible to any capable Tower MCU module utilizing either the SPI or the EBI. A block diagram for the TWR-LCD is shown in the figure below.

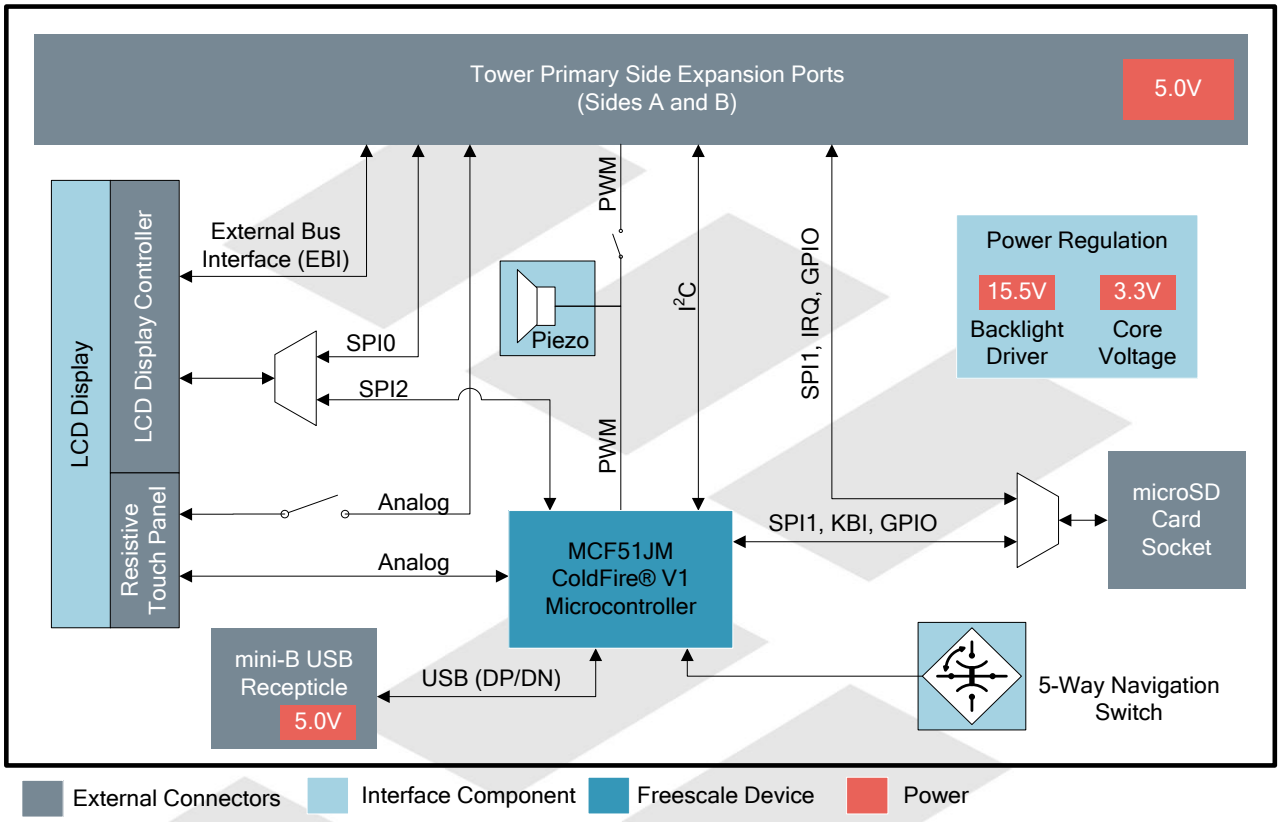


Figure 1 - TWR-LCD Block Diagram

Figure 2 - Tower System with TWR-LCD

2 Reference Documents

The documents listed below should be referenced for more information on the Freescale Tower system and the TWR-LCD. Refer to http://www.freescale.com/tower for the latest revision of all Tower documentation.

- *TWR-LCD Schematics*
- *TWR-LCD Quick Start Guide*
- *Truly TFT2N0451-E LCD Module Specification*

3 Hardware Features

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

3.1 Power Supply

The TWR-LCD can be powered as a standalone device from the Mini-B USB connector. The TWR-LCD can also be powered from a source in an assembled Tower System via the 5.0V supply on the TWR-ELEV Side Expansion Port. When attached to a Tower Elevator board, it is required that the board be externally powered from the Elevator board; additionally the USB connector on the TWR-LCD can still be used to communicate over USB to the on-board MCF51JM MCU. On-board power regulation will provide the necessary core voltage (3.3V) and backlight driver voltage (15.5V).

3.2 LCD Display / Controller

The TWR-LCD features a Truly Semiconductor 3.2” TFT LCD with an analog resistive touch overlay.

3.2.1 Communication Mode

The LCD utilizes a 240 RGB x 320 QVGA display controller. The display controller is accessible to the on-board MCF51JM MCU through SPI. The controller is also accessible to any compatible Tower MCU module through SPI or the External Bus Interface (EBI) via the primary Tower Side Expansion Ports.

Use SW1-DIP1 and DIP2 to configure the desired interface mode (SPI or EBI). Refer to Section 4 for more configuration details.

Table 1 - LCD Communication Mode Settings

SW1-DIP1 (PS2)	**SW1-DIP 2** (PS0)	**Description**
OFF	ON	Enables SPI communication mode to the LCD Display; can be driven by SPI0 on the Primary Elevator or by the on-board MCF51JM, selectable by JM/ELE (SW1-DIP3)
ON	OFF	Enables EBI (16b mode) communication to the LCD Display This interface is only accessible from the Tower Elevator MCU
ON	ON	Enables EBI (8b mode) communication to the LCD Display This interface is only accessible from the Tower Elevator MCU

3.2.2 MCU Selection

The LCD can be controlled by either the on-board MCF51JM MCU or a compatible Tower MCU Module.

Use SW1-DIP3 to specify which MCU has access to the display controller. Refer to Section 4 for more configuration details.

Table 2 - Display Driver MCU Selection

JM/ELE (SW1-DIP3)	ON	Enables SPI connection from SPI0 of Primary Elevator Connector
	OFF	Enables SPI connection from on-board MCF51JM MCU

Setting the JM/ELE (SW1-DIP3) configuration switch to the “Off” position will isolate the SPI signals from the Tower MCU allowing a direct connection between the on-board MCF51JM MCU and the LCD display controller.
Setting the JM/ELE configuration switch to the “On” position will cause both the on-board MCF51JM MCU and Tower MCU SPI signals to be simultaneously connected to the LCD display controller. It is required that on-board MCF51JM MCU firmware detect the status of the JM/ELE signal and tri-state the on-board MCF51JM MCU SPI signals.

If utilizing a Tower MCU module to drive the SPI to the LCD display controller, use SW1-DIP5 to specify the desired SPI chip select.

Table 3 - Tower MCU SPI CS Selection

SPI CS SEL (SW1-DIP5)	ON	Select SPI0 CS1 as the chip-select for LCD SPI interface
	OFF	Select SPI0 CS0 as the chip-select for LCD SPI interface

3.2.3 Resistive Touch Overlay

The TWR-LCD display features an integrated analog resistive touch panel. The panel can be access by either the on-board MCF51JM MCU or a compatible Tower MCU module. The selection of which MCU interfaces the Touch Panel is independent of which MCU is driving the LCD display controller (designated by JM/ELE).

Use SW1-DIP6 to specify which MCU has access to the resistive touch panel. Refer to Section 4 for more configuration details.

Table 4 - Resistive Touch MCU Selection

TP SEL (SW1-DIP6)	ON	Disables MCF51JM connection to the LCD Touch Panel Use SW5 to enable ADC connection from Primary Elevator Connector
	OFF	Enables MCF51JM connection to the LCD Touch Panel Ensure that all switches on SW5 DIP are OFF

Setting the TP SEL (SW1-DIP6) configuration switch to the “Off” position will indicate to the on-board MCF51JM MCU that it is the interfacing MCU to the touch panel’s analog signals.
Setting the TP SEL configuration switch to the “On” position will indicate to the on-board MCF51JM MCU that the tower MCU Module is the interfacing MCU to the touch panel’s analog signals. It is required that on-board MCF51JM MCU firmware detect the status of the To SEL signal and tri-state the respective on-board MCF51JM MCU ADC signals.

SW5 is used to isolate the touch panel’s analog signals from the Tower Elevator Side Expansion Port. This ensures correct isolation of the analog signals when the on-board MCF51JM MCU is used. SW5-DIP[4:1] should all be set to the “Off” position if the on-board MCF51JM MCU is being used to interface the resistive touch panel.

Table 5 - Resistive Touch Analog Isolation Settings

SW5-DIP 1	**Touch Panel Isolation (XPLS)**	ON	Connects AN4 (TWR-ELEV) to XPLS Touch Panel Signal
		OFF	Disconnects AN4 from Touch Panel
SW5-DIP 2	**Touch Panel Isolation (XMNS)**	ON	Connects AN5 (TWR-ELEV) to XMNS Touch Panel Signal
		OFF	Disconnects AN5 from Touch Panel
SW5-DIP 3	**Touch Panel Isolation (YMNS)**	ON	Connects AN6 (TWR-ELEV) to YMNS Touch Panel Signal
		OFF	Disconnects AN6 from Touch Panel
SW5-DIP 4	**Touch Panel Isolation (YPLS)**	ON	Connects AN7 (TWR-ELEV) to YPLS Touch Panel Signal
		OFF	Disconnects AN7 from Touch Panel

3.3 MicroSD Card

The Tower System defines a Secure Digital interface as shown in 0. The SD Card interface is multiplexed over the SPI1 signals and two GPIOs such that the host can communicate with the SD memory card in the SD Card slot using the SPI mode or the one- or four-bit SD mode.
The MicroSD Card slot is accessible to either the on-board MCF51JM MCU or a compatible Tower MCU Module. Use SW1 –DIP4 to select which MCU has access to the MicroSD Card slot. Refer to Section 4 for more configuration details.

Table 6 - MicroSD Card Slot MCU Selection

ELE uSD (SW1-DIP4)	ON	MicroSD is connected to the SPI1 of Primary Elevator Connector
	OFF	MicroSD is connected to the on-board MCF51JM MCU

Setting the EuSD (SW1-DIP4) configuration switch to the “Off” position will isolate the SD signals from the Tower MCU allowing a direct connection between the on-board MCF51JM MCU and the MicroSD Card slot.
Setting the EuSD configuration switch to the “On” position will cause both the on-board MCF51JM MCU and Tower MCU SD signals to be simultaneously connected to the MicroSD Card slot. It is required that on-board MCF51JM MCU firmware detects the status of the EuSD signal and tri-state the on-board MCF51JM MCU SD signals.

Table 7 - Tower System SD Card Interface Pinout

Elevator Pin #	Name	Group	Description	I/O
B7	SDHC_CLK / SPI1_CLK	SDHC / SPI 1	SDHC or SPI Clock	O
B9	SDHC_D3 / SPI1_CS0_b	SDHC / SPI 1	SDHC Chip Select / Data or SPI Chip Select	O
B10	SDHC_CMD / SPI1_MOSI	SDHC / SPI 1	SDHC Command or SPI Master Out / Slave In	O
B11	SDHC_D0 / SPI1_MISO	SDHC / SPI 1	SDHC Data or SPI Master In / Slave Out	I
B22	GPIO2 / SDHC_D1	GPIO / SDHC	General Purpose I/O or SDHC Data	I/O
A10	GPIO8 / SDHC_D2	GPIO / SDHC	General Purpose I/O or SDHC Data	I/O

The SD Card Detect signal is connected to KBI7 on the on-board MCF51JM MCU and, if configured via EuSD (SW1-DIP4), IRQ_H on the Primary Tower Elevator. This will allow the host controller to monitor the presence of an SD memory card. To ensure that he SD Card Detect is handled properly, the MCF51JM must configure the SD Card Detect GPIO/KBI (PTG3 / KBIP7) as an internal pull-up. This is done by setting the appropriate register values for PTEPE (PTGPE3=1) for GPIO and additionally KBI1ES (KBEDG7=0) for KBI functionality. Refer to the MCF51JM128 Reference Manual, Section 9, for additional details. The SD Card Detect signal must be configured as an internal pull-up regardless of which host MCU is accessing the MicroSD Card slot.

3.4 5-way Navigation Switch

The TWR-LCD features a 5-way Navigation Switch. This switch will allow user interaction with the TWR-LCD providing a method to indicate Up (North), Down (South), Right (East), Left (West), and Select (Center). The corresponding directional signals are connected to the on-board MCF51JM MCU. It is intended that the on-board MCF51JM MCU firmware either respond directly to the Navigation Switch or relay the signal detection to the Tower MCU module through the I2C interface.

It is possible to connect the 5-way Navigation Switch directly to the Tower Elevator by making a hardware modification to the TWR-LCD.
The following resister will should to be populated to create a direct connection to the Tower Elevator: R19, R22, R23, R24, R26, R28, R29, R32, R41, R44

The resisters are intentionally unpopulated in the final design to ensure maximum compatibility with additional Freescale Tower MCU and Peripheral Modules.

Populating these resisters will enable to following connections:

Navigation Direction	Tower Elevator Connection
Up (North)	GPIO7 (Pin A11)
Down (South)	GPIO8 (Pin A10)
Right (East)	GPIO5 (Pin B52)
Left (West)	GPIO1 (Pin B21)
Select (Center)	GPIO9 (Pin A9)

Refer to the “Optional Nav Switch Connections to Elevator” section within the TWR-LCD schematics for additional details.

3.5 Mini-B USB Connection

The TWR-LCD features a Mini-B USB connection on the lower right corner of the module. The USB connector is used to provide power to the TWR-LCD module when operating in stand-alone mode (not

connected to the tower system). The USB data signals are connected to the on-board MCF51JM MCU allow a connection to exist between a host device and the TWR-LCD.
In Boot Loader mode, if the USB cable is connected to a host PC, the TWR-LCD will enumerate as a Mass Storage Device. If an appropriate compiled binary (.s19) file is placed in the root directory of the enumerated storage drive, the TWR-LCD will parse the binary file and reprogram the main application running on the TWR-LCD. Refer to Section 3.6 for more details.

3.6 Bootloader

The TWR-LCD includes a USB bootloader that allows simple “drag and drop” reprogramming. This section will describe how to use the bootloader.

3.6.1 Obtaining the S19 file

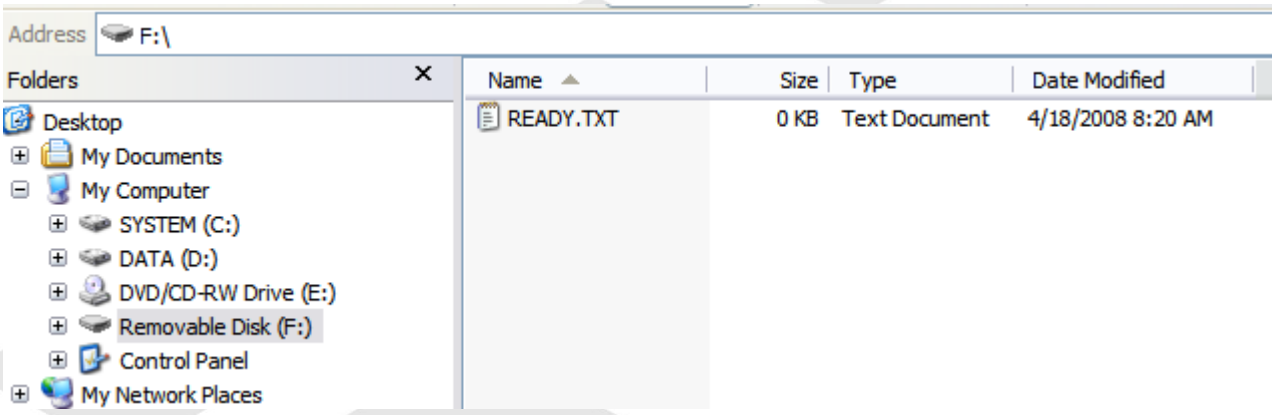
The bootloader accepts srecord or S19 files that it uses to program the board. In the example projects this file can be found in the <project directory>/bin/ folder and will end in an “.s19” file extension. This file will get overwritten every time the project is compiled.

To create an S19 file, click on the “Standard Settings…” button on your project, and look for the Linker category. Select “ColdFire Linker” and make sure that the “Generate S-Record File” option is checked. Also make sure that the “Max S-Record Length” field is set to 32.

3.6.2 Using the Bootloader

Connect the on-board USB connector to a Windows computer using the included mini-B to A USB cable and press reset while holding down the BTLD push button.

The badge board will then enumerate as a Mass Storage Device. Inside the newly added storage device, there will be an empty file named “READY.TXT”.



Copy and paste the S19 file into the enumerated drive. Upon successful programming, you will hear two beeps from the board and the S19 file will appear on the removable drive.

Reset or power cycle to TWR-LCD to execute the new application.

For additional information regarding using and creating the TWR-LCD Bootloader refer to the TWR-LCD Lab Guide Document.

3.7 Elevator Connections

The TWR-LCD features two 80-pin connectors that interface to the Side Expansion Ports on the Primary Elevator board in a Tower System. The Primary Elevator Side Expansion Port connectors, comprised of sides A and B, are utilized by the TWR-LCD. The table below provides the pinout for the Primary Elevator Connector. An "X" in the "Used" column indicated that there is a connection from the TWR-LCD 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.

Table 8 - TWR-LCD Primary Elevator Expansion Pinout

TWR-LCD 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**				A3	**3.3V**			
B4	ELE_PS_SENSE				A4	**3.3V**			
B5	**GND**	**Ground**	**X**		A5	**GND**	**Ground**	**X**	
B6	**GND**	**Ground**	**X**		A6	**GND**	**Ground**	**X**	
B7	SDHC_CLK / SPI1_CLK	uSD Clock	X	X	A7	SCL0		X	
B8	SDHC_D3 / SPI1_CS1_b				A8	SDA0		X	
B9	SDHC_D3 / SPI1_CS0_b	uSD Chip Select / Data3	X	X	A9	GPIO9 / CTS1			
B10	SDHC_CMD / SPI1_MOSI	uSD MOSI / Command	X	X	A10	GPIO8 / SDHC_D2	uSD Data2	X	X
B11	SDHC_D0 / SPI1_MISO	uSD MISO / Data0	X	X	A11	GPIO7 / SD_WP_DET			
B12	ETH_COL				A12	ETH_CRS			
B13	ETH_RXER				A13	ETH_MDC			
B14	ETH_TXCLK				A14	ETH_MDIO			
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 / RTS1				A21	SSI_MCLK			
B22	GPIO2 / SDHC_D1	SD Data1	X	X	A22	SSI_BCLK			
B23	GPIO3				A23	SSI_FS			
B24	CLKIN0				A24	SSI_RXD			
B25	CLKOUT1				A25	SSI_TXD			
B26	**GND**	**Ground**	**X**		A26	**GND**			
B27	AN7	Touch Panel YPLS	X	X	A27	AN3			

TWR-LCD Primary Connector									
Pin	Name	Usage	Used	Jmp	Pin	Name	Usage	Used	Jmp
B28	AN6	Touch Panel XMNS	X	X	A28	AN2			
B29	AN5	Touch Panel YMNS	X	X	A29	AN1			
B30	AN4	Touch Panel XPLS	X	X	A30	AN0			
B31	**GND**	**Ground**	**X**		A31	**GND**	**Ground**	**X**	
B32	DAC1				A32	DAC0			
B33	TMR3				A33	TMR1			
B34	TMR2				A34	TMR0			
B35	GPIO4				A35	GPIO6			
B36	**3.3V**				A36	**3.3V**			
B37	PWM7				A37	PWM3			
B38	PWM6				A38	PWM2			
B39	PWM5				A39	PWM1			
B40	PWM4				A40	PWM0	Piezo Buzzer	X	X
B41	CANRX0				A41	RXD0			
B42	CANTX0				A42	TXD0			
B43	1WIRE				A43	RXD1			
B44	SPI0_MISO	LCD SPI MISO	X	X	A44	TXD1			
B45	SPI0_MOSI	LCD SPI MOSI	X	X	A45	Analog VDD			
B46	SPI0_CS0_b	LCD SPI Chip Select	X	X	A46	Analog VSS			
B47	SPI0_CS1_b	LCD SPI Chip Select	X	X	A47	Analog Vref			
B48	SPI0_CLK	LCD SPI Clock	X	X	A48	Analog Vref			
B49	**GND**	**Ground**	X		A49	**GND**			
B50	SCL1				A50	GPIO14			
B51	SDA1				A51	GPIO15			
B52	GPIO5 / SD_CARD_DET				A52	GPIO16			
B53	USB0_DP_PDOWN				A53	GPIO17			
B54	USB0_DM_PDOWN				A54	USB0_DM			
B55	IRQ_H	SD Detect	X	X	A55	USB0_DP			
B56	IRQ_G				A56	USB0_ID			
B57	IRQ_F				A57	USB0_VBUS			
B58	IRQ_E				A58	TMR7			
B59	IRQ_D				A59	TMR6			
B60	IRQ_C				A60	TMR5			
B61	IRQ_B				A61	TMR4			
B62	IRQ_A				A62	RSTIN_b			
B63	EBI_ALE / EBI_CS1_b				A63	RSTOUT_b	Reset	X	
B64	EBI_CS0_b	LCD EBI Chip Select	X	X	A64	CLKOUT0			
B65	**GND**	**Ground**	**X**		A65	**GND**	**Ground**	**X**	
B66	EBI_AD15	LCD EBI	X		A66	EBI_AD14	LCD EBI	X	
B67	EBI_AD16	LCD EBI	X		A67	EBI_AD13	LCD EBI	X	
B68	EBI_AD17				A68	EBI_AD12	LCD EBI	X	
B69	EBI_AD18				A69	EBI_AD11	LCD EBI	X	
B70	EBI_AD19				A70	EBI_AD10	LCD EBI	X	
B71	EBI_R/W_b	LCD EBI R/W_b	X		A71	EBI_AD9	LCD EBI	X	
B72	EBI_OE_b				A72	EBI_AD8	LCD EBI	X	

TWR-LCD Primary Connector									
Pin	Name	Usage	Used	Jmp	Pin	Name	Usage	Used	Jmp
B73	EBI_D7				A73	EBI_AD7	LCD EBI	X	
B74	EBI_D6				A74	EBI_AD6	LCD EBI	X	
B75	EBI_D5				A75	EBI_AD5	LCD EBI	X	
B76	EBI_D4				A76	EBI_AD4	LCD EBI	X	
B77	EBI_D3				A77	EBI_AD3	LCD EBI	X	
B78	EBI_D2				A78	EBI_AD2	LCD EBI	X	
B79	EBI_D1				A79	EBI_AD1	LCD EBI	X	
B80	EBI_D0				A80	EBI_AD0	LCD EBI	X	

4 Jumper Table

There are several configuration switches provided for isolation, configuration, and feature selection. Refer to the following table for details. The default installed dip switch settings are shown in *__bold__*.

Table 9 - TWR-LCD Configuration Table

Configuration Settings		Option	Setting		Description
SW1	DIP 1 / DIP 2	PS2 / PS0	**DIP 1** (PS2)	**DIP 2** (PS0)	
			OFF	OFF	Not a valid setting
			OFF	***ON***	Enables SPI communication mode to the LCD Display; can be driven by SPI0 on the Primary Elevator or by the on-board MCF51JM, selectable by JM/ELE (SW1-DIP3)
			ON	OFF	Enables EBI (16b mode) communication to the LCD Display This interface is only accessible from the Tower Elevator MCU
			ON	ON	Enables EBI (8b mode) communication to the LCD Display This interface is only accessible from the Tower Elevator MCU
	DIP 3	**JM/ELE**	ON		Enables SPI connection from SPI0 of Primary Elevator Connector
			OFF		Enables SPI connection from on-board MCF51JM MCU
	DIP 4	**ELE uSD**	ON		MicroSD is connected to the SPI1 of Primary Elevator Connector
			OFF		MicroSD is connected to the on-board MCF51JM MCU
	DIP 5	**SPI CS SEL**	ON		Select SPI0 CS1 as the chip-select for LCD SPI interface
			OFF		Select SPI0 CS0 as the chip-select for LCD SPI interface
	DIP 6	**TP SEL**	ON		Disables MCF51JM connection to the LCD Touch Panel Use SW5 to enable ADC connection from Primary Elevator Connector
			OFF		Enables MCF51JM connection to the LCD Touch Panel Ensure that SW5 DIP[4:1] are OFF
	DIP 7	**LCD BL**	**ON**		Enables LCD Backlight
			OFF		Disables LCD Backlight
	DIP 8	**ELE PWM0**	ON		Piezo Buzzer is controlled by PWM0 of Primary Elevator Connector and on-board MCF51JM
			OFF		Piezo Buzzer is controlled by on-board MCF51JM only