TWR-LCD-RGB

User's Guide

Rev. 2

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1 Overview

The Tower LCD RGB Module (TWR-LCD-RGB) adds a side mounting TFT WQVGA Display to the Freescale Tower System. It can be used with Tower Processor Modules featuring an RGB interfacing LCD Controller.

The TWR-LCD-RGB features a 4.3” WQVGA TFT LCD Display with touch sensitive overlay. The LCD interfaces to the Tower System through a 24-bit RGB interface. The 4-wire resistive touch overlay can interface directly with a compatible Tower Processor Module using GPIO enabled ADC lines, or can offload the resistive touch sensing to the on-board Xtrinsic Touch Sensing Platform (CRTouch).

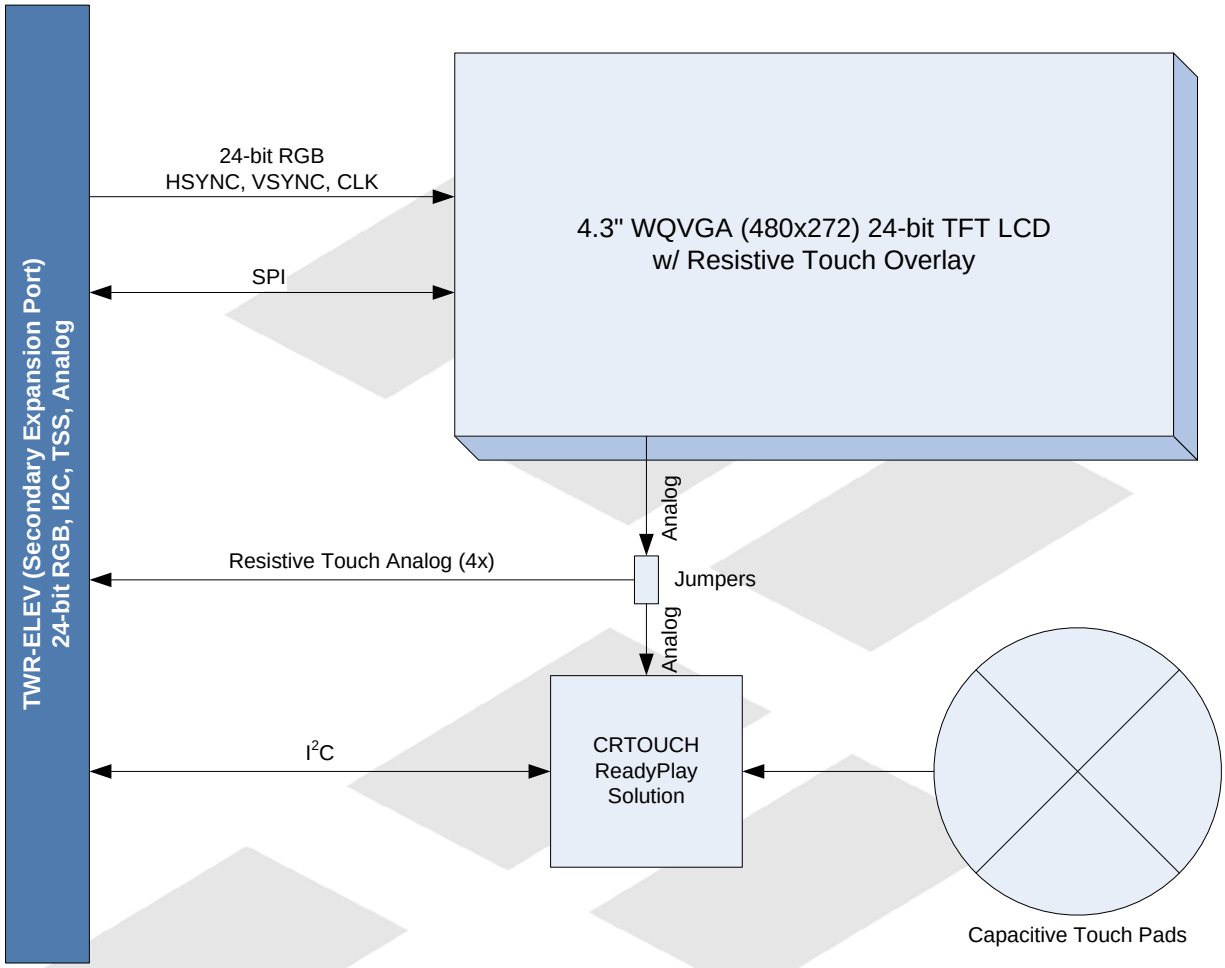


Figure 1 - TWR-LCD-RGB Block Diagram

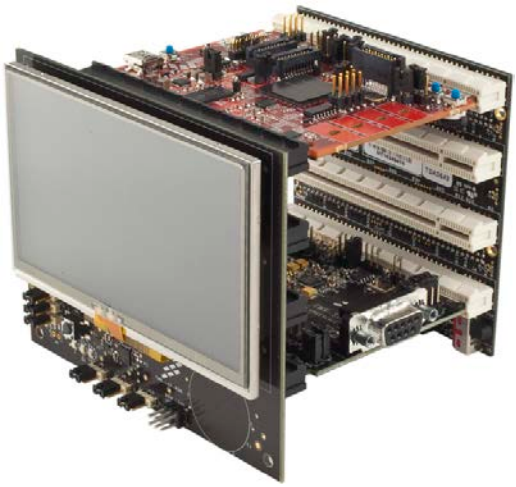


Figure 2 - Tower System with TWR-LCD-RGB

2 Reference Material

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

- *TWR-LCD-RGB Schematics*
- *TWR-LCD-RGB Quick Start Guide*
- *Example Binary Application featuring Swell Software*

For additional software applications supporting the TWR-LCD-RGB refer to:

- http://freescale.com/eGUI
- http://freescale.com/peg
- http://swellsoftware.com

3 Hardware Features

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

3.1 Tower System connection

The TWR-LCD-RGB is designed to interface with the secondary side of the Freescale Tower System. The TWR-LCD-RGB comes pre-attached to an additional TWR-SELE (Secondary Elevator). The LCD module can be detached from the included TWR-SELE, but it is recommended that the modules remain attached to avoid any damage to the LCD glass when attempting to reconnect the modules. For Tower System assemblies that require use of the TWR-LCD-RGB, use the included pre-assembled TWR-LCD-RGB + TWR-SELE.

3.2 Power Supply

The TWR-LCD-RGB is designed to be powered via the Tower System and does not require a direct power source. The Freescale Tower System is capable of being powered directly over USB using the TWR-ELEV, the Processor Module, or specific peripheral modules. Depending on the number of modules in the Tower System and the amount of power required for each module it may be required to use a power source that can supply more than 500mA. Up to 2A may be required depending on the Tower System configuration. This can be accomplished by either a USB wall adapter or a 5V power supply, attached to the screw terminal of the TWR-ELEV.

3.3 LCD Display / Driver

The TWR-LCD features an NEC color LCD module (NL4827HC19-05B), which his composed of an amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT array, touch panel, and backlight. The display panel a 4.3" a-Si TFT active matrix with 16,777,216 colors, 480(H) x 272 (V) pixels, 24-bit RGB (8-bit per signal).

3.3.1 Timing parameters

The following "typical" timing parameters are taken from the NL4827HC19-05B specification, for complete details refer to NEC for the latest data.

Table 1 - NEC TFT Timing Parameters

Parameter	Typical Value	Unit
Clock Frequency	10.87	MHz
HSYNC Cycle	20.7	kHz
HSYNC Display Period	480	CLK
HSYNC Front porch	2	CLK
HSYNC Pulse width	41	CLK
HSYNC Back porch	2	CLK
VSYNC Cycle	75	Hz
VSYNC Display Period	272	CLK
VSYNC Front porch	1	H
VSYNC Pulse width	2	H
VSYNC Back porch	1	H

3.3.2 Communication Mode

The TWR-LCD-RGB is accessible through the 24-bit RGB interface defined on the Secondary Tower Elevator Pin out. The integrated 4-wire resistive touch panel is accessible via the CRTouch using the I2C interface or optionally through the ADC signals.

The signal specification required to drive the display is as follows:

Table 2 – TWR-LCD-RGB TFT Signals

TWR-SELE	Description
LCD_D[23:16]	8-bit Red data signal: LCD_D[23:16] -> R[7:0]
LCD_D[15:8]	8-bit Green data signal: LCD_D[15:8] -> G[7:0]
LCD_D[7:0]	8-bit Blue data signal: LCD_D[7:0] -> B[7:0]
LCD_HSYNC	Horizontal Sync Signal
LCD_VSYNC	Vertical Sync Signal
LCD_CLK	Clock
LCD_DE	Data Enable
GPIO22	Backlight Enable Signal ON/OFF signal, requires jumper **J9** shunted on pins **2-3**
PWM15	Backlight Dimming Control signal, requires jumper **J9** shunted on pins **1-2**

Either GPIO22 or PWM15 must be appropriately driven.

3.3.3 Resistive Touch Overlay

The TWR-LCD-RGB display features an integrated analog resistive touch panel. The panel can be access by either the on-board CRTouch Xtrinsic Touch Sensing Solution or a compatible Tower MCU module. The CRTouch is the preferred interface, allowing the most compatibility within the Freescale Tower System. The CRTouch features gesture detection such as slide, two-point zoom, and two-point rotate.

The signal specification available to interface the 4-wire resistive touch overlay using the on-board CRTouch Xtrinsic Touch Sensing Solution is as follows:

Table 3 – TWR-LCD-RGB 4-Wire Resistive Overlay Digital Signals

TWR-SELE	Description
SDA2	I2C SDA signal from the CRTouch
SCL2	I2C SCL signal from the CRTouch
IRQ_I	Optional Touch Pending Interrupt from CRTouch, Requires jumper **J10** shunted on pins **1-2**
IRQ_M	Optional Touch Pending Interrupt from CRTouch, Requires jumper **J10** shunted on pins **2-3**

The signal specification available to interface the 4-wire resistive touch overlay directly from the MCU using GPIO capable ADC signals is as follows:

Table 4 – TWR-LCD-RGB 4-Wire Resistive Overlay Analog Signals

TWR-SELE	Description
AN11	X-axis right analog signal (XR) direct access to MCU ADC, requires jumper **J8** shunted on pins **2-3**
AN10	Y-axis down analog signal (YD) direct access to MCU ADC, requires jumper **J5** shunted on pins **2-3**
AN9	X-axis left analog signal (XL) direct access to MCU ADC, requires jumper **J3** shunted on pins **2-3**
AN8	Y-axis up analog signal (YU) direct access to MCU ADC, requires jumper **J2** shunted on pins **2-3**

3.4 4-way Navigation Pad

The TWR-LCD-RGB features a 4-way navigation pad implemented using capacitive electrodes. The touch enables electrodes are accessible only through the CRTouch Xtrinsic Touch Sensing Solution. Refer to the CRTouch datasheet for details in reading the capacitive electrode states.

4 Software Features

This section provides more details about the software specific features and enablement of the TWR-LCD-RGB.

4.1 Swell Software - http://swellsoftware.com

Swell Software provides Graphical User Interface (GUI) Solutions for Embedded Devices. Swell's PEG Pro, PEG+ and C/PEG product offering includes a Graphical User Interface (GUI) library for embedded development that works tightly with real-time operating systems. The development tool allows developers to layout user interface screens and controls using the PEG library and external resources to generate C/C++ code. The PEG WindowBuilder automatically generates C++ source code that is ready to be compiled and linked into any application, further accelerating the deployment of the final product.

The TWR-LCD-RGB is supported in PEG Pro and PEG+ versions of the Swell Software GUI development suite. Official support is included PEG v2.3.13 and later.

Screen drivers featuring the TWR-LCD-RGB are included for the following Tower Controller Modules:

- TWR-K70F120M
- TWR-PXD10
- TWR-PXD20
- TWR-VF65GS10

Selection of the TWR-LCD-RGB specific pre-defined Screen Driver is done using the “Screen Driver Configuration” panel within the Swell Window Builder application. The use of the CRTouch is specified using the appropriate pre-defined Touch Screen driver from the “Input/Output Configuration” panel within the Swell Window Builder application.

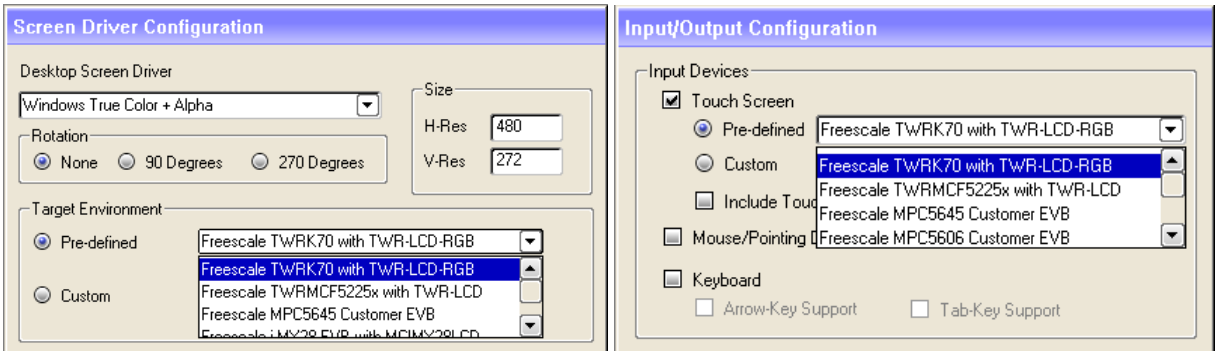


Figure 3 - Window Builder Configuration

Example projects are included with the installation of PEG Pro and PEG+. Additionally example pre-compiled applications are available for download at from the TWR-LCD-RGB webpage located on http://freescale.com/tower

4.2 eGUI Software - http://freescale.com/eGUI

The complimentary Freescale embedded graphical user interface (eGUI) allows single chip microcontroller (MCU) systems to implement a graphical user interface and drive the latest generation of color graphics LCD panels with integrated display RAM and simple serial peripheral interface (SPI) or parallel bus interface.

The TWR-LCD-RGB is officially supported in eGUI 3.0 and later releases.

Selection of a low-level driver that utilizes the TWR-LCD-RGB is done through the **d4d_user_cfg.h** header file included with the installation of eGUI.

As an reference example, below are the defines required to support the TWR-K70F120M with the TWR-LCD-RGB

```
#define D4D_LLD_LCD    d4dlcd_frame_buffer
#define D4D_LLD_LCD_HW d4dlcdhw_k70_lcdc
#define D4D_LLD_TCH    d4dtch_cr_touch
```

4.3 Loading Example Pre-Compiled Applications

Several example applications are posted on the TWR-LCD-RGB webpage. The section below provides details regarding loading these applications on to the Tower System.

These specific instructions detail flashing an example application on the TWR-K70F120M with the TWR-LCD-RGB.

4.3.1 Setup the Tower System

Install the Tower System with the following Tower System modules:

- TWR-ELEV (Primary Elevator)
- Preassembled TWR-LCD-RGB + TWR-SELE (Secondary Elevator)
- TWR-K70F120M
- TWR-SER

Attach the miniUSB connector between the TWR-K70F120M and the host PC. This will enable programming the TWR-K70F120M over the Open Source JTAG interface.

Be aware that the example projects include a large amount of graphical assets that are compiled directly into the application. This results in a fairly large flash file. Using the Open Source JTAG interface can result in approximately a 5 minute flash process.

4.3.2 Create a New Project for Flashing the TWR-K70F120M

Using CodeWarrior for MCU version 10.x

1. Open CodeWarrior for MCU v10.x
2. If required specify the desired workspace
3. Create a new project: **File -> New -> Bareboard Project**
4. Project a Project name, select **Next**
5. Select the following device: **Kinetis -> K70 Family -> K70 (120 MHz) Family -> MK70FN1M0**, select **Finish**
6. Right-click the newly created project and select **Run -> Run Configuration**
7. From the CodeWarrior Download section, select the ***<project_name>*_MK70FN1M0_INTERNAL_FLASH_PnE U-Multilink** option
8. From the C/C++ application section, select the **Browse** option associates with the **Application** field
9. Navigate to the location of the downloaded **.out** file and select **Open**
10. Select **Run**

Using IAR Embedded Workbench

1. Open IAR Embedded Workbench for ARM 6.40
2. Create a new workspace: **File -> New -> Workspace**
3. Create a new project within blank workspace: **Project -> Create New Workspace**
4. Tool chain: **ARM**, Project Template: **Externally built executable**
5. Save the resulting project (.ewp) to a desired location
6. Right-click the project and select **Options**
   - General Options: Under Processor variant select **Device** and choose **Freescale -> K70 -> Freescale MK70FN1M0xxx12**
   - Debugger: Under the Setup tab, Select the **PE Micro** Driver
   - Debugger: Under the Download tab, check the **Use flash loader(s)** option.
7. Add the **.out** file to the project: **Project -> Add Files**, navigate to the location of the **.out** file and select **Open** (make sure the File Filter is set to **All Files (*.*)**
8. Save the resulting workspace (.eww) to a desired location using **File -> Save Workspace As**
9. Flash the project using **Project -> Download and Debug**
10. Run the resulting application using **Debug -> Go**

5 Elevator Connections

The TWR-LCD features two 80-pin connectors that interface to the Side Expansion Ports on the Secondary Elevator board in a Tower System. The Secondary Elevator Side Expansion Port connectors, comprised of sides C and D, are utilized by the TWR-LCD-RGB. The table below provides the pinout for the Secondary Elevator Connector. An "X" in the "Used" column indicated that there is a connection from the TWR-LCD-RGB 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 5 - TWR-LCD-RGB Secondary Elevator Expansion Pinout

TWR-LCD-RGB Secondary Connector									
Pin	Name	Usage	Used	Jmp	Pin	Name	Usage	Used	Jmp
D1	**5V**	**5.0V Power**	**X**		C1	**5V**	**5.0V Power**	**X**	
D2	**GND**	**Ground**	**X**		C2	**GND**	**Ground**	**X**	
D3	**3.3V**	**3.3V Power**	**X**		C3	**3.3V**	**3.3V Power**	**X**	
D4	ELE_PS_SENSE	Elevator Power Sense			C4	**3.3V**	**3.3V Power**	**X**	
D5	**GND**	**Ground**	**X**		C5	**GND**	**Ground**	**X**	
D6	**GND**	**Ground**	**X**		C6	**GND**	**Ground**	**X**	
D7	SPI2_CLK				C7	SCL2	CRTOUCH SCL	**X**	
D8	SPI2_CS1_b				C8	SDA2	CRTOUCH SDA	**X**	
D9	SPI2_CS0_b				C9	GPIO25	RESET_IN_B	**X**	**X**
D10	SPI2_MOSI				C10	ULPI_STOP			
D11	SPI2_MISO				C11	C11			
D12	ETH_COL				C12	GPIO26			
D13	ETH_RXER				C13	ETH_MDC			

TWR-LCD-RGB Secondary Connector									
Pin	Name	Usage	Used	Jmp	Pin	Name	Usage	Used	Jmp
D14	ETH_TXCLK				C14	ETH_MDIO			
D15	ETH_TXEN				C15	ETH_RXCLK			
D16	GPIO18				C16	ETH_RXDV			
D17	GPIO19 / SDHC_D4				C17	GPIO27 / SDHC_D6			
D18	GPIO20 / SDHC_D5				C18	GPIO28 / SDHC_D7			
D19	ETH_TXD1				C19	ETH_RXD1			
D20	ETH_TXD0				C20	ETH_RXD0			
D21	ULPI_NEXT / USB1_DM				C21	ULPI_DATA0 / USB3_DM			
D22	ULPI_DIR / USB1_DP				C22	ULPI_DATA1 / USB3_DP			
D23	UPLI_DATA5 / USB2_DM				C23	ULPI_DATA2 / USB4_DM			
D24	ULPI_DATA6 / USB2_DP				C24	ULPI_DATA3 / USB4_DP			
D25	ULPI_DATA7				C25	ULPI_DATA4			
D26	**GND**	**Ground**	X		C26	**GND**	**Ground**	X	
D27	LCD_HSYNC / LCD_P24	RGB_Hsync	X		C27	AN11	Resistive Touch XR	X	X
D28	LCD_VSYNC / LCD_P25	RGB_Vsync	X		C28	AN10	Resistive Touch YD	X	X
D29	AN13				C29	AN9	Resistive Touch XL	X	X
D30	AN12				C30	AN8	Resistive Touch YU	X	X
D31	**GND**	**Ground**	X		C31	**GND**	**Ground**	X	
D32	LCD_CLK / LCD_P26	RGB_CLK	X		C32	GPIO29			
D33	TMR11				C33	TMR9			
D34	TMR10				C34	TMR8			
D35	GPIO21				C35	GPIO30			
D36	**3.3V**	**3.3V Power**	X		C36	**3.3V**	**3.3V Power**	X	
D37	PWM15	LED_PWM	X	X	C37	PWM11			
D38	PWM14				C38	PWM10			
D39	PWM13				C39	PWM9			
D40	PWM12				C40	PWM8			
D41	CANRX1				C41	RXD2 / TSI0			
D42	CANTX1				C42	TXD2 / TSI1			
D43	GPIO22 / Backlight	LCD_ENABLE	X	X	C43	RTS2 / TSI2			
D44	LCD_OE / LCD_P27	RGB_DE	X		C44	CTS2 / TSI3			
D45	LCD_D0 / LCD_P0	BLUE Data Signal B0 (LSB)	X		C45	RXD3 / TSI4			
D46	LCD_D1 / LCD_P1	BLUE Data Signal B1	X		C46	TXD3 / TSI5			
D47	LCD_D2 / LCD_P2	BLUE Data Signal B2	X		C47	RTS3 / TSI6			
D48	LCD_D3 / LCD_P3	BLUE Data Signal B3	X		C48	CTS3 / TSI7			
D49	**GND**	**Ground**	X		C49	**GND**	**Ground**	X	
D50	GPIO23				C50	LCD_D4 / LCD_P4	BLUE Data Signal B4	X	
D51	GPIO24				C51	LCD_D5 / LCD_P5	BLUE Data Signal B5	X	
D52	LCD_D12 / LCD_P12	GREEN Data Signal G4	X		C52	LCD_D6 / LCD_P6	BLUE Data Signal B6	X	
D53	LCD_D13 / LCD_P13	GREEN Data Signal G5	X		C53	LCD_D7 / LCD_P7	BLUE Data Signal B7 (MSB)	X	
D54	LCD_D14 / LCD_P14	GREEN Data Signal G6	X		C54	LCD_D8 / LCD_P8	GREEN Data Signal G0 (LSB)	X	

TWR-LCD-RGB Secondary Connector									
Pin	Name	Usage	Used	Jmp	Pin	Name	Usage	Used	Jmp
D55	IRQ_P / SPI2_CS2_b				C55	LCD_D9 / LCD_P9	GREEN Data Signal G1	X	
D56	IRQ_O / SPI2_CS3_b				C56	LCD_D10 / LCD_P10	GREEN Data Signal G2	X	
D57	IRQ_N				C57	LCD_D11 / LCD_P11	GREEN Data Signal G3	X	
D58	IRQ_M				C58	TMR16			
D59	IRQ_L				C59	TMR15			
D60	IRQ_K	IRQ_B	X	X	C60	TMR14			
D61	IRQ_J				C61	TMR13			
D62	IRQ_I	IRQ_A	X	X	C62	LCD_D15 / LCD_P15	GREEN Data Signal G7 (MSB)	X	
D63	LCD_D18 / LCD_P18	RED Data Signal R2	X		C63	LCD_D16 / LCD_P16	RED Data Signal R0 (LSB)	X	
D64	LCD_D19 / LCD_P19	RED Data Signal R3	X		C64	LCD_D17 / LCD_P17	RED Data Signal R1	X	
D65	**GND**	**Ground**	X		C65	**GND**	**Ground**	X	
D66	EBI_AD20 / LCD_P42				C66	EBI_BE_32_24_b / LCD_P28			
D67	EBI_AD21 / LCD_P43				C67	EBI_BE_23_16_b / LCD_P29			
D68	EBI_AD22 / LCD_P44				C68	EBI_BE_15_8_b / LCD_P30			
D69	EBI_AD23 / LCD_P45				C69	EBI_BE_7_0_b / LCD_P31			
D70	EBI_AD24 / LCD_P46				C70	EBI_TSIZE0 / LCD_P32			
D71	EBI_AD25 / LCD_P47				C71	EBI_TSIZE1 / LCD_P33			
D72	EBI_AD26 / LCD_P48				C72	EBI_TS_b / LCD_P34			
D73	EBI_AD27 / LCD_P49				C73	EBI_TBST_b / LCD_P35			
D74	EBI_AD28 / LCD_P50				C74	EBI_TA_b / LCD_P36			
D75	EBI_AD29 / LCD_P51				C75	EBI_CS4_b / LCD_P37			
D76	EBI_AD30 / LCD_P52				C76	EBI_CS3_b / LCD_P38			
D77	EBI_AD31 / LCD_P53				C77	EBI_CS2_b / LCD_P39			
D78	LCD_D20 / LCD_P20	RED Data Signal R4	X		C78	EBI_CS1_b / LCD_P40			
D79	LCD_D21 / LCD_P21	RED Data Signal R5	X		C79	GPIO31 / LCD_P41			
D80	LCD_D22 / LCD_P22	RED Data Signal R6	X		C80	LCD_D23 / LCD_P23	RED Data Signal R7 (MSB)	X	

6 Jumper Table

The following 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 6 - TWR-LCD-RGB Configuration Table

Jumper	Option	Setting	Description
J2	Y+ Selection	**1-2**	Use the onboard CRTouch
		2-3	Routes the Y+ signal to the AN8 (ELEV C30)
J3	X- Selection	**1-2**	Use the onboard CRTouch
		2-3	Routes the X- signal to the AN9 (ELEV C29)
J5	Y- Selection	**1-2**	Use the onboard CRTouch
		2-3	Routes the Y- signal to the AN10 (ELEV C28)
J8	X+ Selection	**1-2**	Use the onboard CRTouch
		2-3	Routes the X+ signal to the AN11 (ELEV C27)
J9	LED DIM Control	**1-2**	Uses PWM15 (ELEV D37) to control the LED brightness
		2-3	Uses GPIO22 (ELEV D43) to control the LED on/off state
J10	IRQ Selection	**1-2**	CRTouch IRQ is connected to IRQ_I (ELEV D62)
		2-3	CRTouch IRQ is connected to IRQ_K (ELEV D64)

6.1 Mechanical Form Factor

The TWR-LCD-RGB is designed for the Freescale Tower System as a side mounting peripheral and complies with the electrical and mechanical specification as described in *Freescale Tower Electromechanical Specification*. The TWR-LCD-RGB is intended for use on the secondary side only and come pre-assembled to the TWR-SELE.

7 Revision History

Revision Number	Date	Substantive changes
1	10/2011	Initial release
2	11/2014	Updated to correct Tower Elevator connections

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