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TFT | CHARACTER | UWVD | FSC | SEGMENT | CUSTOM | REPLACEMENT

TFT Display Module

Part Number

E28RA-I-CW384-R

Overview:

- 2.8-inch TFT (50.5x69.7 YY)
- 240È320 LJλÈŜfă
- MCKMyπŌλΰ wD . LyΰŜNTI·ŎŜ
- 8/9/16/18-bit MCU Interface
- 3/4-wire SPI Interface
- All View
- Transmissive, IPS
- Wide Temperature Range
- Resistive Touch Panel
- 384 nits
- TFT IC: ST7789V
- RoHS Compliant

Description

This is a color active matrix TFT (Thin Film Transistor) LCD (Liquid Crystal Display) that uses amorphous silicon TFT as a switching device. This model is composed of a transmissive type TFT LCD Panel, driver circuit, 4-wire resistive touch panel, and a backlight unit. The resolution of the 2.8" TFT LCD contains 240(RGB)x320 pixels and can display up to 262k colors.

TFT Features

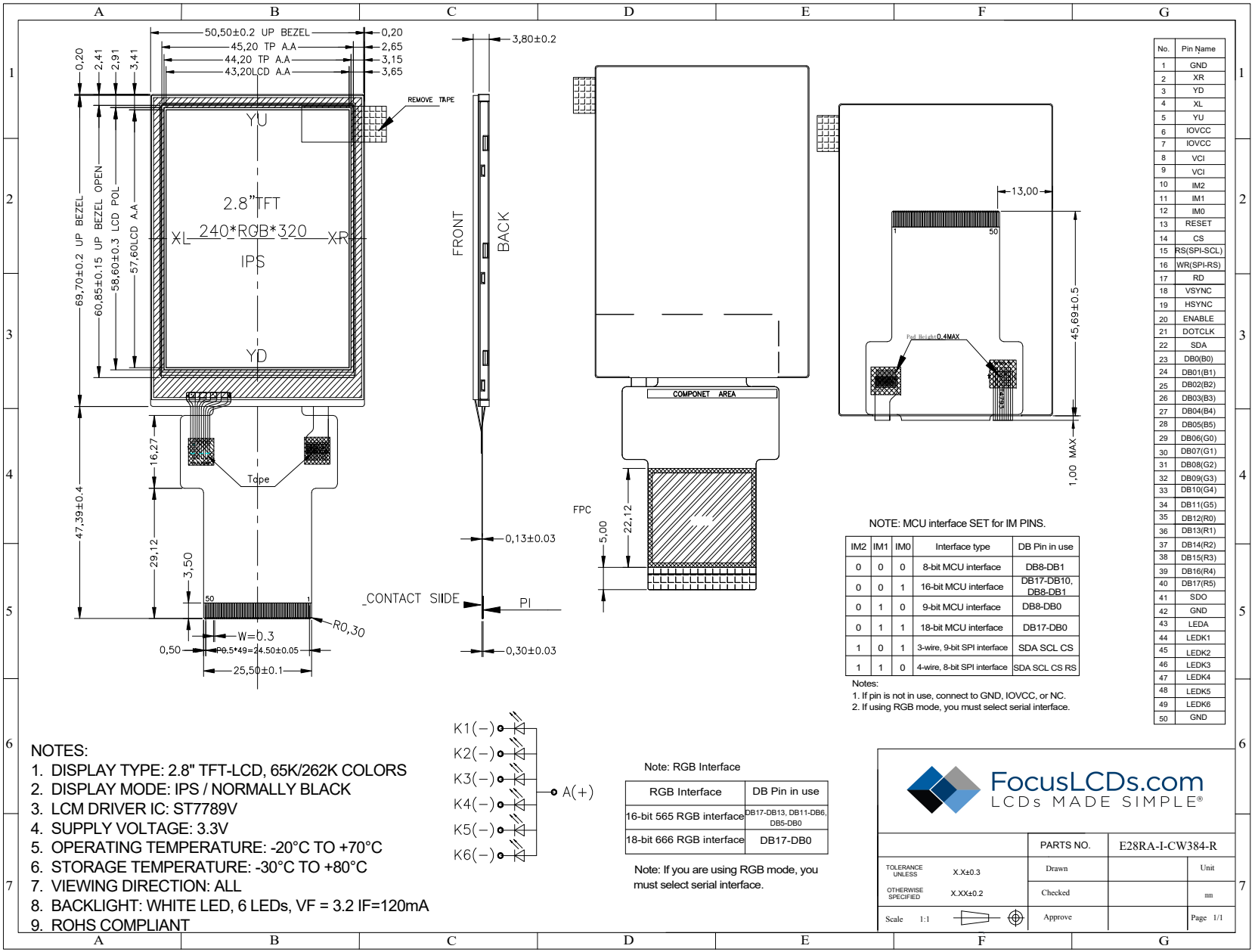
Low Input Voltage: 3.3V
Display Colors: 65k/262k
Interface: 8/9/16/18-bit MCU
3/4SPI+16/18-bit RGB
3/4-wire Serial

General Information Items	Specification	Unit	Note
	Main Panel		
TFT Display area (AA)	43.20(H) x 57.60(V) (2.8 inch)	mm	-
Driver Element	TFT active matrix	-	-
Display Colors	65k/262k	colors	-
Number of pixels	240(RGB)x320	dots	-
TFT Pixel arrangement	RGB vertical stripe	-	-
Pixel Pitch	0.153 (H)x0.153(V)	mm	-
Viewing angle	ALL	o'clock	-
TFT Controller IC	ST7789V	-	-
TFT Interface	MCU, SPI+RGB, SPI	-	-
Display mode	Transmissive/ Normally Black	-	-
Operating temperature	-20～+70	℃	-
Storage temperature	-30～+80	℃	-

Mechanical Information

Item		Min	Typ.	Max	Unit	Note
Module Size	Horizontal (H)		50.50		mm	-
	Vertical (V)		69.70		mm	-
	Depth (D)		3.80		mm	-
	Weight		TBD		g	

1. Outline Dimensions



No.	Pin Name
1	GND
2	XR
3	YD
4	XL
5	YU
6	IOVCC
7	IOVCC
8	VCI
9	VCI
10	IM2
11	IM1
12	IM0
13	RESET
14	CS
15	RS(SPI-SCL)
16	WR(SPI-RS)
17	RD
18	VSYNC
19	HSYNC
20	ENABLE
21	DOTCLK
22	SDA
23	DB0(B0)
24	DB01(B1)
25	DB02(B2)
26	DB03(B3)
27	DB04(B4)
28	DB05(B5)
29	DB06(G0)
30	DB07(G1)
31	DB08(G2)
32	DB09(G3)
33	DB10(G4)
34	DB11(G5)
35	DB12(R0)
36	DB13(R1)
37	DB14(R2)
38	DB15(R3)
39	DB16(R4)
40	DB17(R5)
41	SDO
42	GND
43	LEDA
44	LEDK1
45	LEDK2
46	LEDK3
47	LEDK4
48	LEDK5
49	LEDK6
50	GND

NOTE: MCU interface SET for IM PINS.

IM2	IM1	IM0	Interface type	DB Pin in use
0	0	0	8-bit MCU interface	DB8-DB1
0	0	1	16-bit MCU interface	DB17-DB10, DB8-DB1
0	1	0	9-bit MCU interface	DB8-DB0
0	1	1	18-bit MCU interface	DB17-DB0
1	0	1	3-wire, 9-bit SPI interface	SDA SCL CS
1	1	0	4-wire, 8-bit SPI interface	SDA SCL CS RS

Notes:
1. If pin is not in use, connect to GND, IOVCC, or NC.
2. If using RGB mode, you must select serial interface.

NOTES:
1. DISPLAY TYPE: 2.8" TFT-LCD, 65K/262K COLORS
2. DISPLAY MODE: IPS / NORMALLY BLACK
3. LCM DRIVER IC: ST7789V
4. SUPPLY VOLTAGE: 3.3V
5. OPERATING TEMPERATURE: -20°C TO +70°C
6. STORAGE TEMPERATURE: -30°C TO +80°C
7. VIEWING DIRECTION: ALL
8. BACKLIGHT: WHITE LED, 6 LEDs, VF = 3.2 IF=120mA
9. ROHS COMPLIANT

Note: RGB Interface

RGB Interface	DB Pin in use
16-bit 565 RGB interface	DB17-DB13, DB11-DB6, DB5-DB0
18-bit 666 RGB interface	DB17-DB0

Note: If you are using RGB mode, you must select serial interface.

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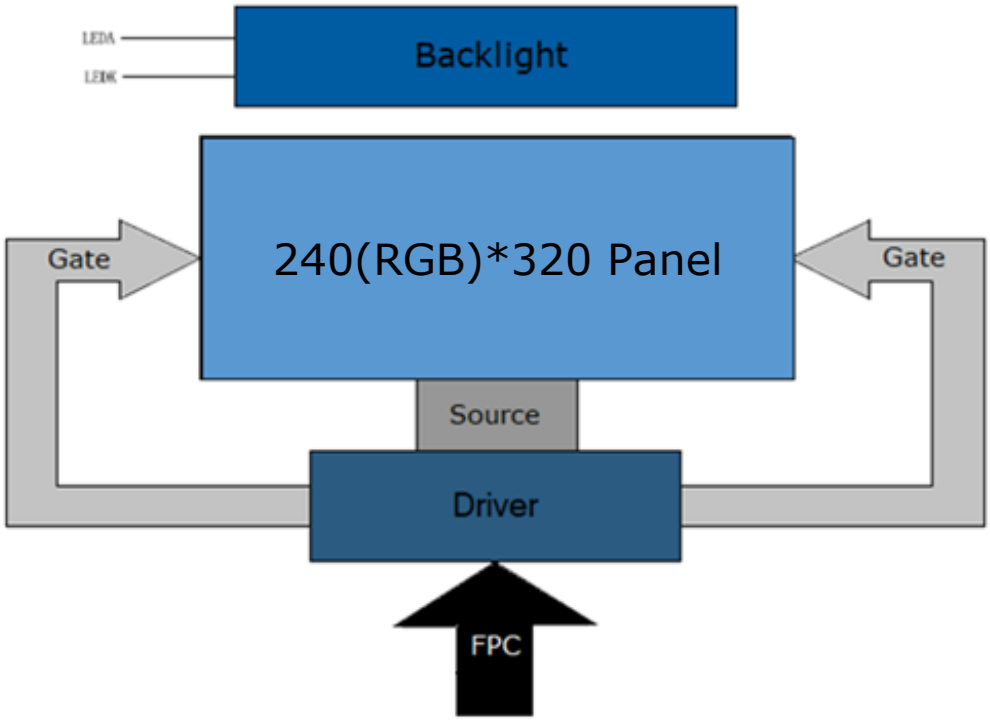
	PARTS NO.	E28RA-I-CW384-R	
TOLERANCE UNLESS OTHERWISE SPECIFIED X.X±0.3 X.XX±0.2	Drawn		Unit
	Checked		mm
Scale 1:1	Approve		Page 1/1

2. Block Diagram



3. Input Terminal Pin Assignment

Recommended TFT Connector: FH12S-50S-0.5SH(55) Recommended RTP Connector: FH33-4S-1SH(10)

<table>
<tr><th>NO.</th><th>Symbol</th><th>Description</th><th>I/O</th></tr>
<tr><td>1</td><td>GND</td><td>Ground.</td><td>P</td></tr>
<tr><td>2</td><td>XR</td><td>Touch panel right glass terminal.</td><td>A/D</td></tr>
<tr><td>3</td><td>YD</td><td>Touch panel bottom film terminal.</td><td>A/D</td></tr>
<tr><td>4</td><td>XL</td><td>Touch panel left glass terminal.</td><td>A/D</td></tr>
<tr><td>5</td><td>YU</td><td>Touch panel top film terminal.</td><td>A/D</td></tr>
<tr><td>6</td><td>IOVCC</td><td>Supply voltage (1.8-3.3V).</td><td>P</td></tr>
<tr><td>7</td><td>IOVCC</td><td>Supply voltage (1.8-3.3V).</td><td>P</td></tr>
<tr><td>8</td><td>VCI</td><td>Supply voltage (3.3V).</td><td>P</td></tr>
<tr><td>9</td><td>VCI</td><td>Supply voltage (3.3V).</td><td>P</td></tr>
<tr><td rowspan="9">10-12</td><td rowspan="9">IM2
IM1
IM0</td><td colspan="5"><table>
<tr><td>Interface selection</td><td>IM2</td><td>IM1</td><td>IM0</td><td>Pins used</td></tr>
<tr><td>DBI 8-bit</td><td>0</td><td>0</td><td>0</td><td>DB8-DB1</td></tr>
<tr><td>DBI 16-bit</td><td>0</td><td>0</td><td>1</td><td>DB17-DB10 DB8-DB1</td></tr>
<tr><td>DBI 9-bit</td><td>0</td><td>1</td><td>0</td><td>DB8-DB0</td></tr>
<tr><td>DBI 18-bit</td><td>0</td><td>1</td><td>1</td><td>DB17-DB0</td></tr>
<tr><td>3-wire, 9-bit SPI</td><td>1</td><td>0</td><td>1</td><td>SDA SCL CS</td></tr>
<tr><td>4-wire, 8-bit SPI</td><td>1</td><td>1</td><td>0</td><td>SDA SCL CS RS</td></tr>
</table></td><td rowspan="9">I</td></tr>
<tr><td colspan="5">Note: If pin is not in use, connect to GND or IOVCC.</td></tr>
<tr><td>13</td><td>RESET</td><td>Reset signal of the device. Must be applied to properly initialize the device. Signal is active low.</td><td>I</td></tr>
<tr><td>14</td><td>CS</td><td>Chip select pin. When not used this pin can be fixed low.</td><td>I</td></tr>
<tr><td>15</td><td>RS(SPI_SCL)</td><td>Data or command signal for the parallel MCU interface. RS=1: data is selected, RS=0: command is selected. The clock for the serial interface. If not used, pin to IOVCC or GND.</td><td>I</td></tr>
<tr><td>16</td><td>WR(SPI_RS)</td><td>Write signal in the parallel MCU interface. Command or parameter select signal for the 4-wire serial interface. If not used, pin to IOVCC or GND.</td><td>I</td></tr>
<tr><td>17</td><td>RD</td><td>Read signal for the MCU parallel interface. If not used, pin to IOVCC or GND.</td><td>I</td></tr>
<tr><td>18</td><td>VSYNC</td><td>Frame synchronizing signal for the RGB interface. If not used, pin to IOVCC or GND.</td><td>I</td></tr>
<tr><td>19</td><td>HSYNC</td><td>Line synchronizing signal for the RGB interface. If not used, pin to IOVCC or GND.</td><td>I</td></tr>
<tr><td>20</td><td>ENABLE</td><td>Data enable signal for the RGB interface. If not used, pin to IOVCC or GND.</td><td>I</td></tr>
<tr><td>21</td><td>DOTCLK</td><td>Dot clock signal for the RGB interface. If not used, pin to IOVCC or GND.</td><td>I</td></tr>
<tr><td>22</td><td>SDA</td><td>Serial input signal. The data is applied at the rising edge of the SCL signal. If not used, pin to IOVCC or GND.</td><td>I</td></tr>
<tr><td>23-40</td><td>DB0-DB17</td><td>18-bit parallel bi-directional data but for the RGB and MCU interfaces. Fix to GND when not used.</td><td>I/O</td></tr>
<tr><td>41</td><td>SDO</td><td>Serial data output for the SPI interface.</td><td>O</td></tr>
<tr><td>42</td><td>GND</td><td>Ground.</td><td>P</td></tr>
<tr><td>43</td><td>LEDA</td><td>Anode pin of the backlight.</td><td>P</td></tr>
<tr><td>44</td><td>LEDK1</td><td>Cathode pin of the backlight.</td><td>P</td></tr>
<tr><td>45</td><td>LEDK2</td><td>Cathode pin of the backlight.</td><td>P</td></tr>
<tr><td>46</td><td>LEDK3</td><td>Cathode pin of the backlight.</td><td>P</td></tr>
<tr><td>47</td><td>LEDK4</td><td>Cathode pin of the backlight.</td><td>P</td></tr>
<tr><td>48</td><td>LEDK5</td><td>Cathode pin of the backlight.</td><td>P</td></tr>
<tr><td>49</td><td>LEDK6</td><td>Cathode pin of the backlight.</td><td>P</td></tr>
<tr><td>50</td><td>GND</td><td>Ground.</td><td>P</td></tr>
</table>

I: Input, O: Output, P: Power

4. LCD Optical Characteristics

4.1 Optical Specifications

Item		Symbol	Condition	Min	Typ.	Max	Unit	Note
Color Gamut		S%		--	60	--	%	(3)
Contrast Ratio		CR		600	800	--		(2)
Transmittance (with Polarizer)		T (%)		--	(4.63)	--	%	Measuring with polarizer, Reference only.
Transmittance (without polarizer)		T (%)		--	(17.5)	--	%	
Response Time	Rising	T_R+T_F		--	30	40	ms	(4)
	Falling							
Color Filter Chromaticity	White	W_X	θ=0 Normal viewing angle	0.288	0.308	0.328		(5)(6)
		W_Y		0.310	0.330	0.350		
	Red	R_X		0.621	0.641	0.661		
		R_Y		0.317	0.337	0.357		
	Green	G_X		0.254	0.274	0.294		
		G_Y		0.540	0.560	0.580		
	Blue	B_X		0.121	0.141	0.161		
		B_Y		0.093	0.113	0.133		
Viewing Angle	Hor.	ΘL	CR≥10	--	80	--	degrees	(1)(6)
		ΘR		--	80	--		
	Ver.	ΘT		--	80	--		
		ΘB		--	80	--		
Option View Direction		ALL						(1)

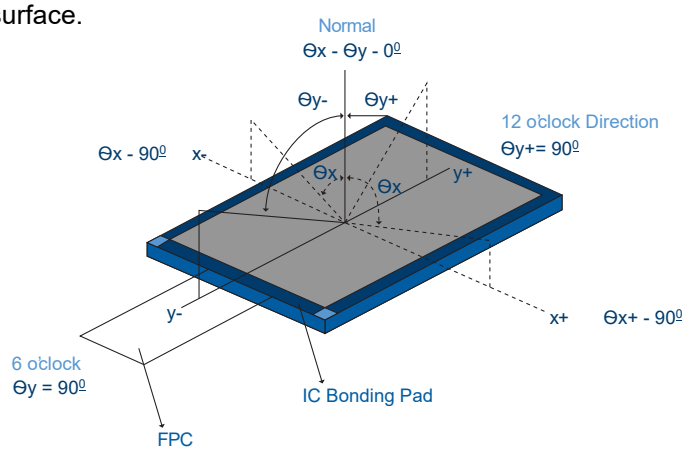
Measuring Conditions:

. Dark Room
. Ambient Temperature of 25±2°C
. 15 Minute Warm up

Optical Specification Reference Notes:

(1) Definition of Viewing Angle:

The viewing angle is the angle at which the contrast ratio is greater than 10. The viewing angles are determined for the horizontal or 3,9 o'clock direction and the vertical or 6,12 o'clock direction with respect to the optical axis which is normal to the LCD surface.



(2) Definition of Contrast Ratio:

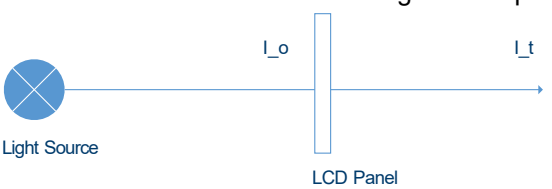
Measured at the center point of panel. The contrast ratio (Cr) measured on a module, is the ratio between the luminance (Lw) in a full white area (R=G=B=1) and the luminance (Ld) in a dark area (R=G=B=0).

$$Cr = \frac{Lw}{Ld}$$

(3) Definition of Transmittance (T%):

The transmittance of the panel including the polarizers is measured with electrical driving. The equation for transmittance Tr is:

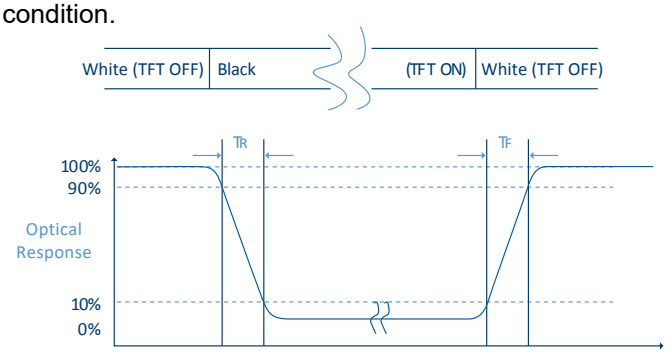
$$Tr = \frac{It}{Io} \times 100\%$$



Io = the brightness of the light source.
It = the brightness after panel transmission

(4) Definition of Response Time (T_R, T_F):

The rise time 'Tr' is defined as the time for luminance to change from 90%to 10% as a result of a change of the electrical condition. The fall time 'Tf' is defined as the time for luminance to change from 10% to 90% as a result of a change of the electrical condition.



(5) Definition of Color Gamut:

Measuring machine CFT-01. NTSC's Primaries: R(x,y,Y),G(x,y,Y), B(x,y,Y). FPM520 of Westar Display Technologies, INC., which utilized SR-3 for Chromaticity and BM-5A for other optical characteristics.The color chromaticity shall be calculated from the spectral data measured with all pixels first in red, green, blue and white. Measurements shall be made at the center of the panel.

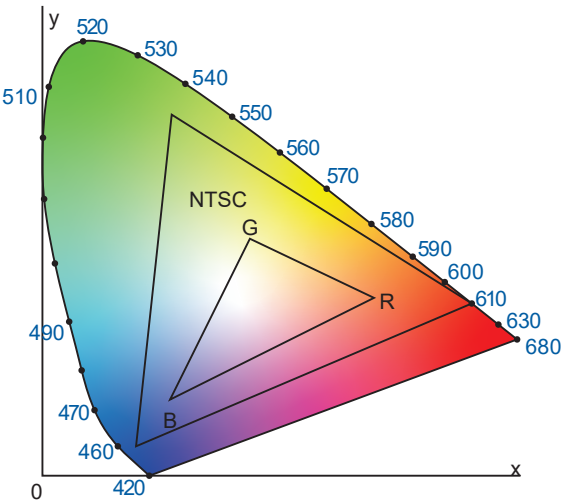
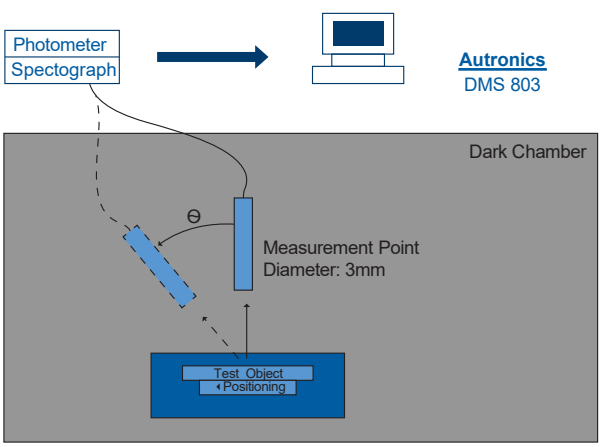


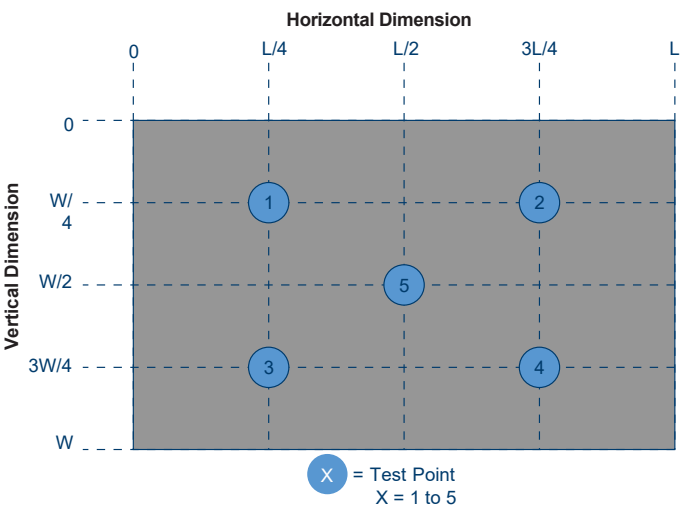
Fig. 1931 CIE Chromacity Diagram

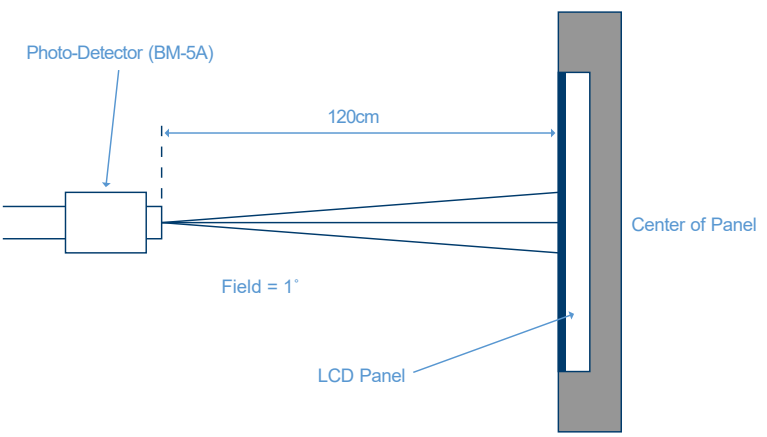
Color Gamut: $S = \frac{\text{Area of RGB Triangle}}{\text{Area of NTSC Triangle}} \times 100\%$

(6) Definition of Optical Measurement Setup:

The LCD module should be stabilized at a given temperature for 20 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting backlight for 20 minutes.







5. TFT Electrical Characteristics

5.1 Absolute Maximum Rating (Ta=25 ˚C, VSS=0V)

Characteristics	Symbol	Min	Max	Unit
Digital Supply Voltage	VDD	-0.3	4.6	V
Digital Interface Supply Voltage	IOVCC	-0.3	4.6	V
Operating Temperature	TOP	-20	+70	℃
Storage Temperature	TST	-30	+80	℃

NOTE: If the absolute maximum rating of the above parameters is exceeded, even momentarily, the quality of the product may be degraded. Absolute maximum ratings specify the values which the product may be physically damaged if exceeded. Be sure to use the product within the range of the absolute maximum ratings.

5.2 DC Electrical Characteristics

Characteristics	Symbol	Min	Typ.	Max	Unit	Note
Digital Supply Voltage	VCI	2.4	3.3	4.2	V	
Digital Interface Supply Voltage	IOVCC	1.65	3.3	4.2	V	
Normal Mode Current	IDD	--	8	--	mA	
Level Input Voltage	VIH	0.7*IOVCC	--	IOVCC	V	
	VIL	GND	--	0.3*IOVCC	V	
Level Output Voltage	VOH	0.8*IOVCC	--	IOVCC	V	
	VOL	GND	--	0.2*IOVCC	V	

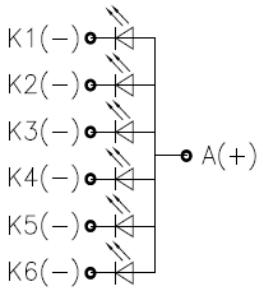
5.3 LED Backlight Characteristics

Item	Symbol	Min	Typ.	Max	Unit	Note
Forward Current	IF	90	120	--	mA	
Forward Voltage	VF	--	3.2	--	V	
LCM Luminance	LV	350	384	--	cd/m2	(3)
LED lifetime	Hr	50000	--	--	hour	(1)(2)
Uniformity	AVg	80	--	--	%	(3)

The back-light system is edge-lighting type with 6 white LEDs.

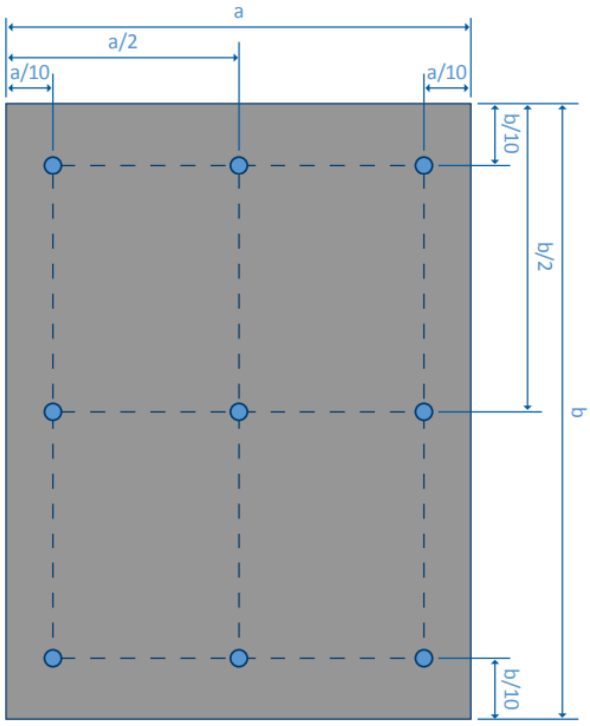
Note 1: LED lifetime (Hr) can be defined as the time in which it continues to operate under the condition: Ta=25±3 °C, typical IL value indicated in the above table until the brightness becomes less than 50%.

Note 2: The "LED lifetime" is defined as the module brightness decrease to 50% original brightness at Ta=25°C and IL=120mA. The LED lifetime could be decreased if operating IL is larger than 120mA. The constant current driving method is suggested.



Backlight LED Circuit

Note 3: Luminance Uniformity of these 9 points is defined as below:



$$\text{Luminance} = \frac{\text{(Total Luminance of 9 points)}}{9}$$

$$\text{Uniformity} = \frac{\text{minimum luminance in 9 points(1-9)}}{\text{maximum luminance in 9 points(1-9)}}$$

6. AC Characteristic

6.1 Parallel RGB Interface Characteristics

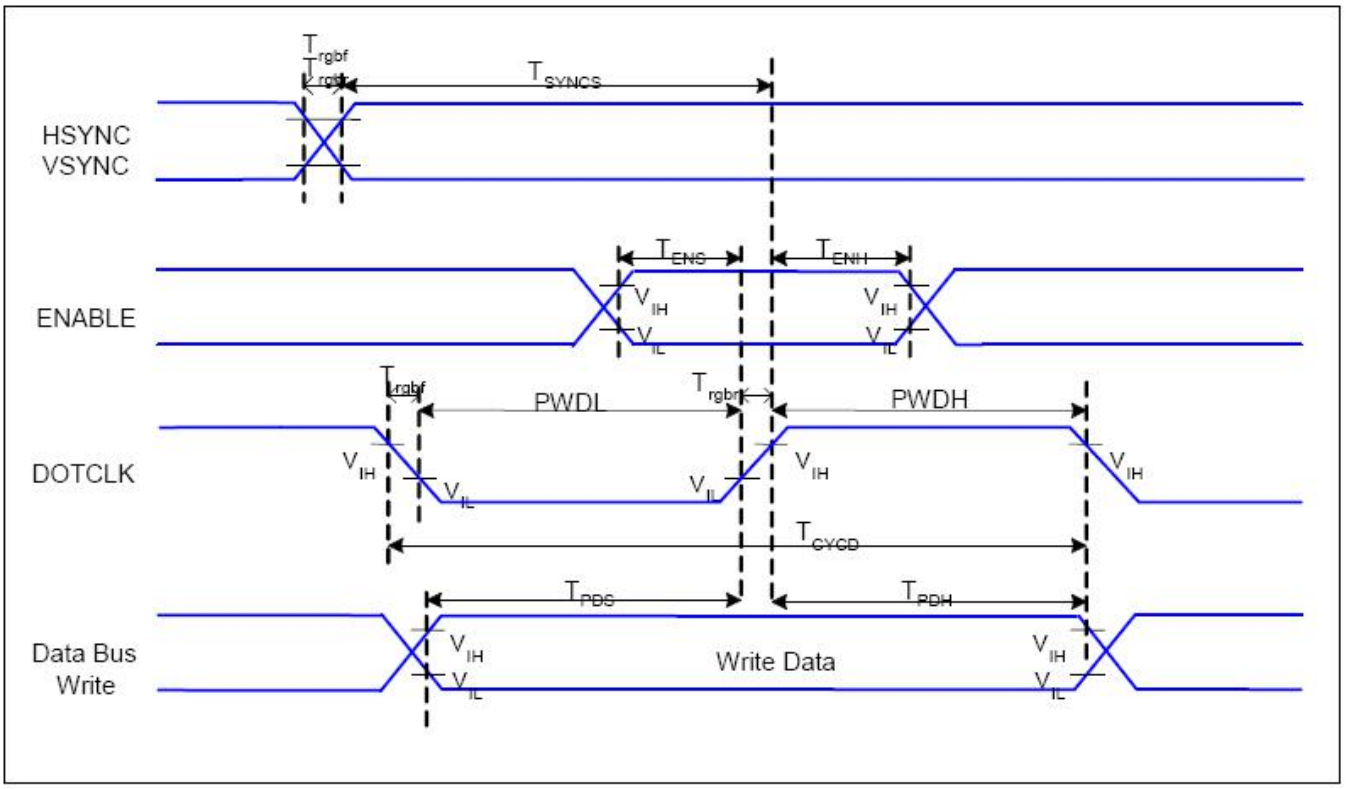


Figure 6.1: Parallel RGB Interface Timing Diagram

Signal	Parameter	Symbol	Min	Max	Unit	Description
HSYNC, VSYNC	VSYNC, HSYNC Setup Time	T_{SYNCS}	30	--	ns	
ENABLE	Enable Setup Time	T_{ENS}	25	--	ns	
	Enable Hold Time	T_{ENH}	25	--	ns	
DOTCLK	DOTCLK High-level Pulse Width	PWDH	60	--	ns	
	DOTCLK Low-level Pulse Width	PWDL	60	--	ns	
	DOTCLK Cycle Time	T_{CYCD}	120	--	ns	
	DOTCLK Rise/Fall Time	T_{RGHR}, T_{RGHF}	--	20	ns	
DB	PD Data Setup Time	T_{PDS}	50	--	ns	
	PD Data Hold Time	T_{PDH}	50	--	ns	

Table 6.1: Parallel RGB Interface Timing Characteristics

6.2 Timing Tables

Parameter	Symbol	Min	Typ	Max	Unit
Horizontal Synchronization	Hsync	2	10	16	DOTCLK
Horizontal Back Porch	HBP	2	20	24	DOTCLK
Horizontal Address	HAdr	--	240	--	DOTCLK
Horizontal Front Porch	HFP	2	10	16	DOTCLK
Vertical Synchronization	VS	1	2	4	Line
Vertical Back Porch	VBP	1	2	--	Line
Vertical Address	VAdr	--	320	--	Line
Vertical front porch	VFP	3	4	--	Line

Table 6.2: RGB Interface Timing Table

Setting Example: To set frame frequency to 70Hz:

Internal Clock

Internal Oscillation Clock: 615KHz

DIV[1:0] = 2'b0 (x 1/1)

RTN[4:0] = 5'h1b (27 clocks)

FP = 7'h2 (2 lines), BP = 7'h2 (2 lines), NL = 6'h27 (320 lines)

Frame Rate → 70.30Hz

DOTCLK

HSYNC = 10 CLK

HBP = 20 CLK

HFP=10 CLK

70Hz x (2 + 320 + 2) lines x (10 + 20 + 240 + 10) clocks = 6.35MHz

DOTCLK frequency = 6.35MHz

6.35 MHz / 615KHz = 10.32 □ Set PCDIV so that PCLK is divided by 10.

external fosc = 6.35 MHz / 10 = 635KHz

PCDIV = [6.35MHz / 635KHz) / 2] - 1 = 4

PCDIV[5:0] = 6'h04 (10 DOTCLK)

6.3 Display Serial Interface Characteristics (3-line SPI system)

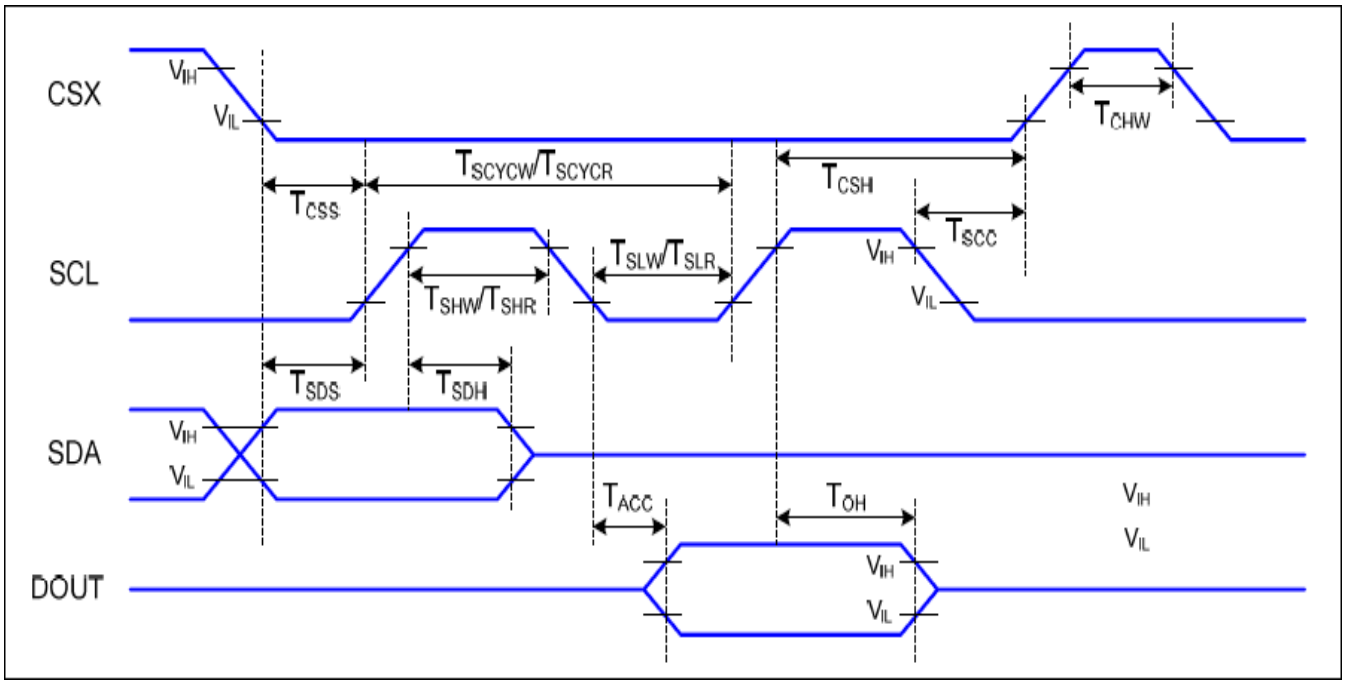


Figure 6.3: Serial Interface **3-SPI Timing Diagram**

VDDI = 1.64 to 3.3V, VDD = 2.4 to 3.3V, AGND=DGND=0V, Ta=-30 to 70 C°

Signal	Symbol	Parameter	Min	Max	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15	--	ns	
	T_{CSH}	Chip select hold time (write)	15	--	ns	
	T_{CSS}	Chip select setup time (read)	60	--	ns	
	T_{SCC}	Chip select hold time (read)	65	--	ns	
	T_{CHW}	Chip select “H” pulse width	40	--	ns	
SCL	T_{SCYCW}	Serial clock cycle (write)	66	--	ns	
	T_{SHW}	SCL “H” pulse width (write)	15	--	ns	
	T_{SLW}	SCL “L” pulse width (write)	15	--	ns	
	T_{SCYCR}	Serial clock cycle (read)	150	--	ns	
	T_{SHR}	SCL “H” pulse width (read)	60	--	ns	
	T_{SLR}	SCL “L” pulse width (read)	60	--	ns	
SDA (DIN)	T_{SDS}	Data setup time	10	--	ns	
	T_{SDH}	Data hold time	10	--		
DOUT	T_{ACC}	Access time	10	50	ns	For max CL=30pF For min CL=8pF
	T_{OH}	Output disable time	15	50		

Table 6.3: 3-line Serial Interface Timing Characteristics

Note: The rising time and falling time (Tr, Tf) of input signal are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for Input signals

6.4 Display Serial Interface Characteristics (4-line SPI serial)

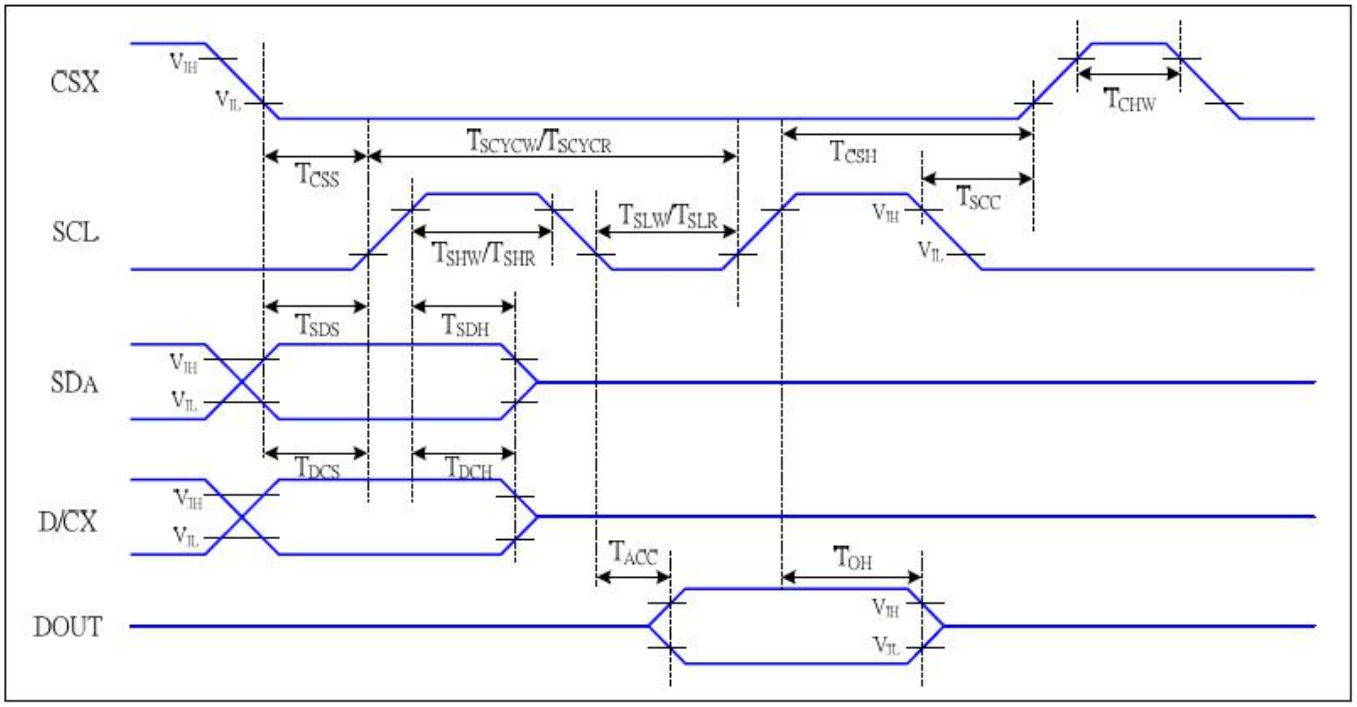


Figure 6.4: Serial Interface **4-SPI Timing Diagram**

Signal	Symbol	Parameter	Min	Max	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15		ns	
	T_{CSH}	Chip select hold time (write)	15		ns	
	T_{CSS}	Chip select setup time (read)	60		ns	
	T_{SCC}	Chip select hold time (read)	65		ns	
	T_{CHW}	Chip select “H” pulse width	40		ns	
SCL	T_{SCYCW}	Serial clock cycle (write)	66		ns	Write command & data ram
	T_{SHW}	SCL “H” pulse width (write)	15		ns	
	T_{SLW}	SCL “L” pulse width (write)	15		ns	
	T_{SCYCR}	Serial clock cycle (read)	150		ns	Read command & data ram
	T_{SHR}	SCL “H” pulse width (read)	60		ns	
	T_{SLR}	SCL “L” pulse width (read)	60		ns	
D/CX	T_{DCS}	D/CX setup time	10		ns	
	T_{DCH}	D/CX hold time	10		ns	
SDA (DIN)	T_{SDS}	Data setup time	10		ns	
	T_{SDH}	Data hold time	10		ns	
DOUT	T_{ACC}	Access time	10	50	ns	For max CL=30pF For min CL=8pF
	T_{OH}	Output disable time	15	50	ns	

Table 6.5: 4-line Serial Interface Timing Characteristics

Note: The rising time and falling time (Tr, Tf) of input signal are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

6.5 8080 Series MCU Parallel Interface Characteristics: 18/16/9/8-bit Bus

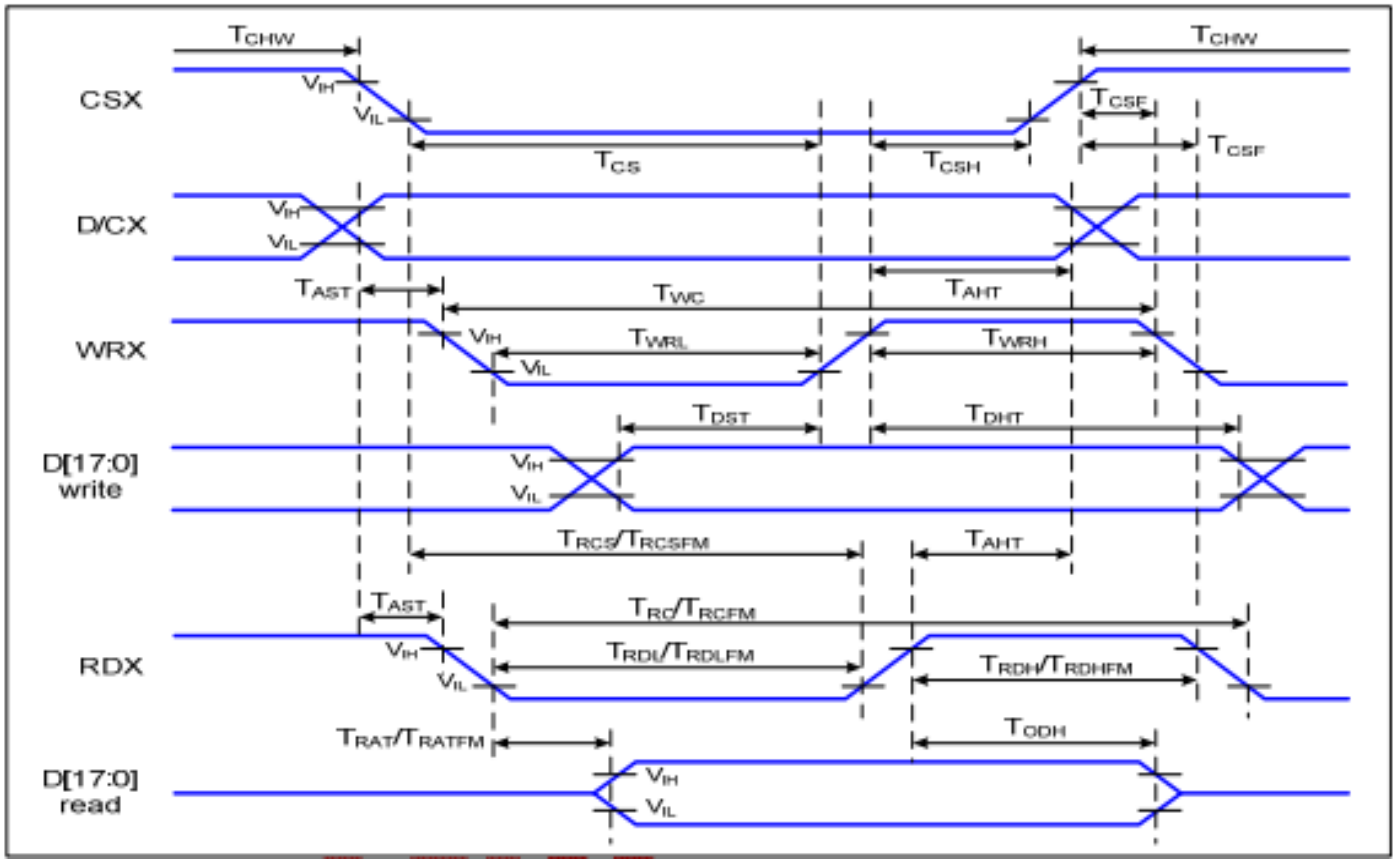


Figure 6.5: Parallel Interface Timing Characteristics (8080-Series MCU Interface)

Signal	Symbol	Parameter	Min	Max	Unit	Description
D/CX	T_{AST}	Address setup time	0	-	ns	
	T_{AHT}	Address hold time (Write/Read)	10	-	ns	
CSX	T_{CHW}	Chip select "H" pulse width	0	-	ns	
	T_{CS}	Chip select setup time (Write)	15	-	ns	
	T_{RCS}	Chip select setup time (Read ID)	45	-	ns	
	T_{RCSFM}	Chip select setup time (Read FM)	355	-	ns	
	T_{CSF}	Chip select wait time (Write/Read)	10	-	ns	
	T_{CSH}	Chip select hold time	10	-	ns	
WRX	T_{WC}	Write cycle	66	-	ns	
	T_{WRH}	Control pulse "H" duration	15	-	ns	
	T_{WRL}	Control pulse "L" duration	15		ns	
RDX (ID)	T_{RC}	Read cycle (ID)	160	-	ns	
	T_{RDH}	Control pulse "H" duration (ID)	90	-	ns	
	T_{RDL}	Control pulse "L" duration (ID)	45	-	ns	
RDX (FM)	T_{RCFM}	Read cycle (FM)	450	-	ns	
	T_{RDHFM}	Control pulse "H" duration (FM)	90	-	ns	
	T_{RDLFM}	Control pulse "L" duration (FM)	355	-	ns	
D[17:0]	T_{DST}	Data setup time	10	-	ns	For max CL=30pF For min CL=8pF
	T_{DHT}	Data hold time	10	-	ns	
	T_{RAT}	Read access time (ID)	-	40	ns	
	T_{RATFM}	Read access time (FM)	-	340	ns	
	T_{ODH}	Output disable time	20	80	ns	

Table 6.5: 8080 Series MCU Parallel Timing Characteristics

6.3 Reset Timing

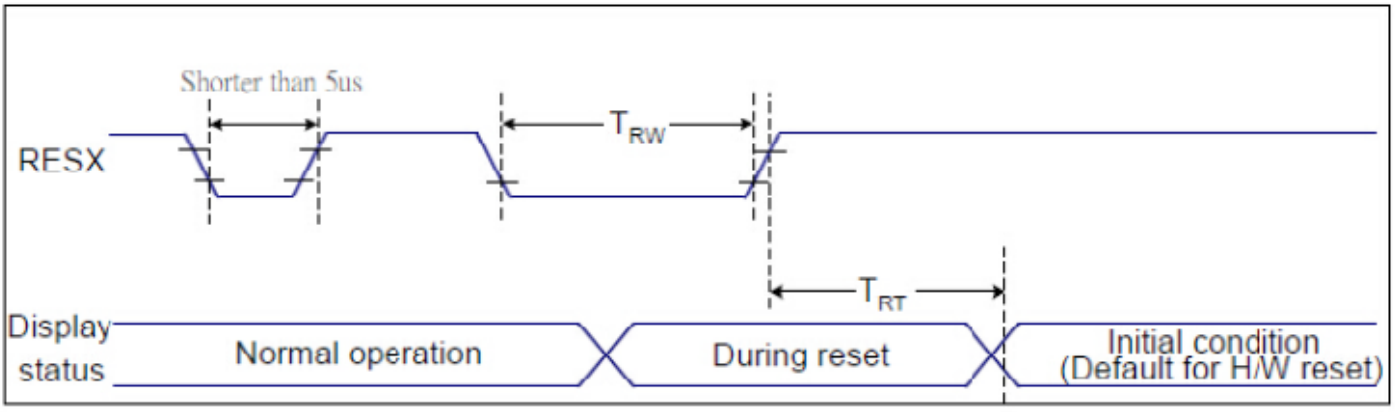


Figure 6.6: Reset Timing Diagram

Related Pins	Symbol	Parameter	Min	Max	Unit
RESX	TRW	Reset pulse duration	10	-	us
	TRT	Reset cancel	-	5 (Note 1,5)	ms
				120 (Note 1, 6, 7)	ms

Notes:

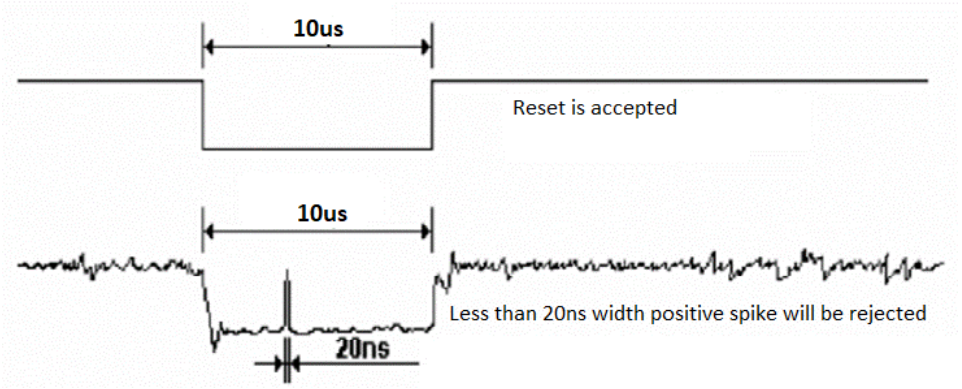
1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (tRT) within 5ms after a rising edge of RESX.

2. Spike due to an electrostatic discharge on RESX line does not because irregular system reset according to the table below:

RESX Pulse	Action
Shorter than 5us	Reset Rejected
Longer than 9us	Reset
Between 5us and 9 us	Reset starts

3. During the resetting period, the display will be blanked (the display is entering blanking sequence, which maximum time is 120ms, when reset starts in Sleep Out mode. The display remains the blank state in Sleep In mode) and then return to Default condition for Hardware Reset.

4. Spike Rejection also applies during a valid reset pulse as shown below:



5. When Reset applied during Sleep In Mode.
6. When Reset applied during Sleep Out Mode.
7. It is necessary to wait 5ms after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120ms.

7. Cautions and Handling Precautions

7.1 Handling and Operating the Module

1. When the module is assembled, it should be attached to the system firmly. Do not warp or twist the module during assembly work.
2. Protect the module from physical shock or any force. In addition to damage, this may cause improper operation or damage to the module and back-light unit.
3. Note that polarizer is very fragile and could be easily damaged. Do not press or scratch the surface.
4. Do not allow drops of water or chemicals to remain on the display surface. If you have the droplets for a long time, staining and discoloration may occur.
5. If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.
6. The desirable cleaners are water, IPA (Isopropyl Alcohol) or Hexane. Do not use ketene type materials (ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.
7. If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contact with hands, legs, or clothes, it must be washed away thoroughly with soap.
8. Protect the module from static; it may cause damage to the CMOS ICs.
9. Use fingerstalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
10. Do not disassemble the module.
11. Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.
12. Pins of I/F connector shall not be touched directly with bare hands.
13. Do not connect, disconnect the module in the “Power ON” condition.
14. Power supply should always be turned on/off by the item Power On Sequence & Power Off Sequence.

7.2 Storage and Transportation

1. Do not leave the panel in high temperature, and high humidity for a long time. It is highly recommended to store the module with temperature from 0 to 35 °C and relative humidity of less than 70%
2. Do not store the TFT-LCD module in direct sunlight.
3. The module shall be stored in a dark place. When storing the modules for a long time, be sure to adopt effective measures for protecting the modules from strong ultraviolet radiation, sunlight, or fluorescent light.
4. It is recommended that the modules should be stored under a condition where no condensation is allowed. Formation of dewdrops may cause an abnormal operation or a failure of the module. In particular, the greatest possible care should be taken to prevent any module from being operated where condensation has occurred inside.
5. This panel has its circuitry FPC on the bottom side and should be handled carefully in order not to be stressed.