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

TFT Display Module

Part Number

E28RA-I-CW600-C

Overview:

- 2.8-inch TFT (50.5x69.7 ΥΥ)
- 240È320 LJιÈŜfă
- 3/4SPI+MCKMyπōλű wD . LyűŜℕƬI·ŎŜ
- 8/9/16/18-bit MCU Interface
- 3/4-wire SPI Interface
- All View
- Transmissive, IPS
- Wide Temperature
- Capacitive Touch Panel
- 600 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, capacitive 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

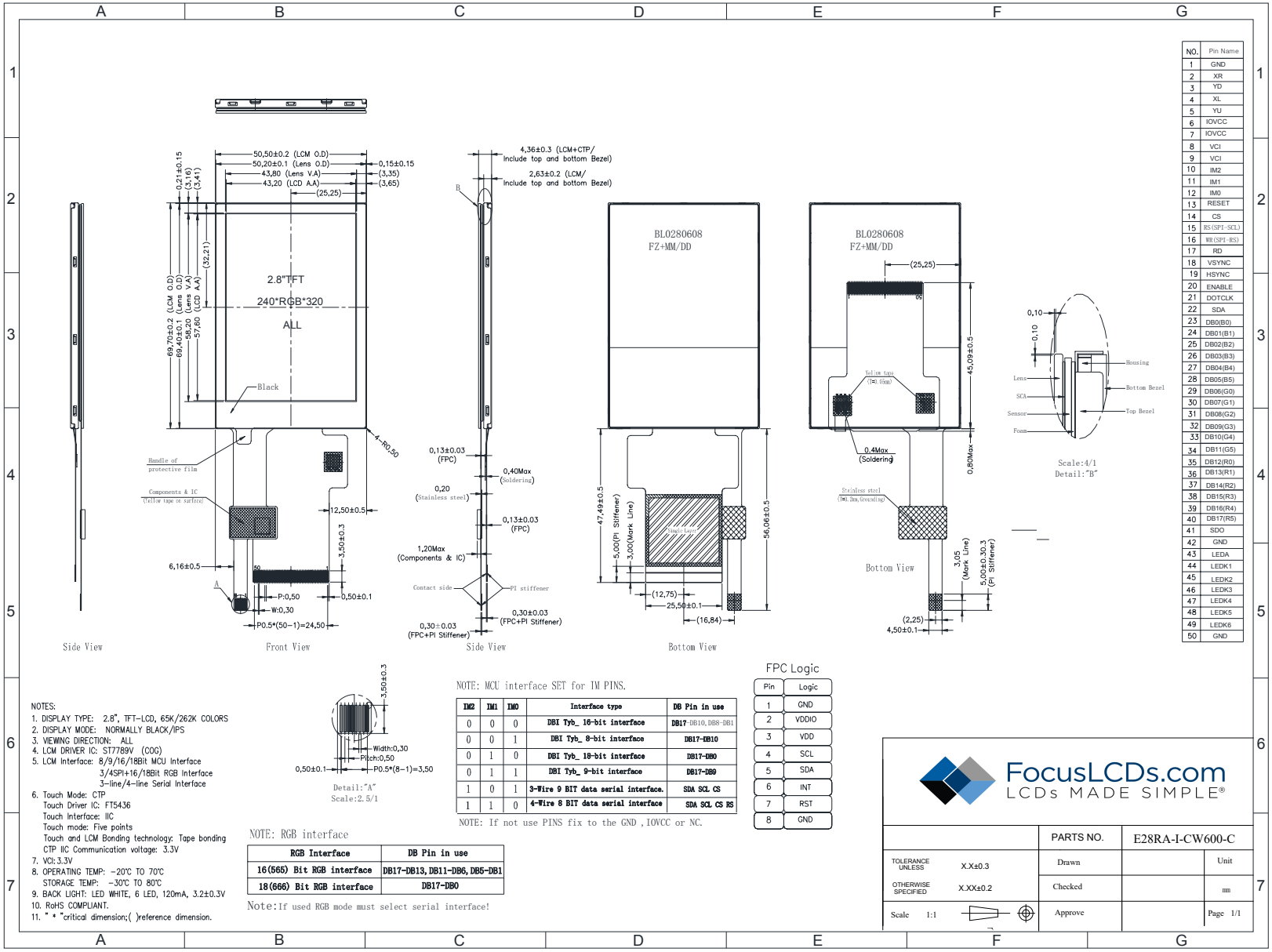
Low Input Voltage: 3.3V
Display Colors: 65k/262k
Interface: 8/9/16/18-bit MCU
3/4SPI+16/18-bitRGB
3/4-wire Serial

General Information Items	Specification Main Panel	Unit	Note
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	0.18(H)x0.18(V)	mm	-
Viewing angle	ALL	o'clock	-
TFT Controller IC	ST7789V	-	-
TFT Interface	MCU, RGB, SPI	-	-
Display mode	Transmissive/ Normally Black	-	-
Operating temperature	-20～+70	℃	-
Storage temperature	-30～+80	℃	-
CTP IC	FT5439	-	-
CTP Interface	I2C	℃	-
Touch Mode	5 points and gestures	℃	-

Mechanical Information

Item		Min	Typ.	Max	Unit	Note
Module Size	Horizontal (H)		50.50		mm	-
	Vertical (V)		69.70		mm	-
	Depth (D)		4.36		mm	-
	Weight		30		g	

3. 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	DB1(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

NOTES:
1. DISPLAY TYPE: 2.8", TFT-LCD, 65K/262K COLORS
2. DISPLAY MODE: NORMALLY BLACK/IPS
3. VIEWING DIRECTION: ALL
4. LCM DRIVER IC: ST7789V (COG)
5. LCM Interface: 8/9/16/18Bit MCU Interface
   3/4SPI+16/18Bit RGB Interface
   3-line/4-line Serial Interface
6. Touch Mode: CTP
   Touch Driver IC: FT5436
   Touch Interface: IIC
   Touch mode: Five points
   Touch and LCM Bonding technology: Tape bonding
   CTP IIC Communication voltage: 3.3V
7. VCI: 3.3V
8. OPERATING TEMP: -20℃ TO 70℃
   STORAGE TEMP: -30℃ TO 80℃
9. BACK LIGHT: LED WHITE, 6 LED, 120mA, 3.2±0.3V
10. RoHS COMPLIANT.
11. " * "critical dimension;( )reference dimension.

NOTE: MCU interface SET for IM PINS.

IM2	IM1	IM0	Interface type	DB Pin in use
0	0	0	DBI Tyb_ 16-bit interface	DB17-DB10, DB8-DB1
0	0	1	DBI Tyb_ 8-bit interface	DB17-DB10
0	1	0	DBI Tyb_ 18-bit interface	DB17-DB0
0	1	1	DBI Tyb_ 9-bit interface	DB17-DB9
1	0	1	3-Wire 9 BIT data serial interface.	SDA SCL CS
1	1	0	4-Wire 8 BIT data serial interface	SDA SCL CS RS

NOTE: If not use PINS fix to the GND , IOVCC or NC.

FPC Logic

Pin	Logic
1	GND
2	VDDIO
3	VDD
4	SCL
5	SDA
6	INT
7	RST
8	GND

NOTE: RGB interface

RGB Interface	DB Pin in use
16(565) Bit RGB interface	DB17-DB13, DB11-DB6, DB5-DB1
18(666) Bit RGB interface	DB17-DB0

Note: If used RGB mode must select serial interface!

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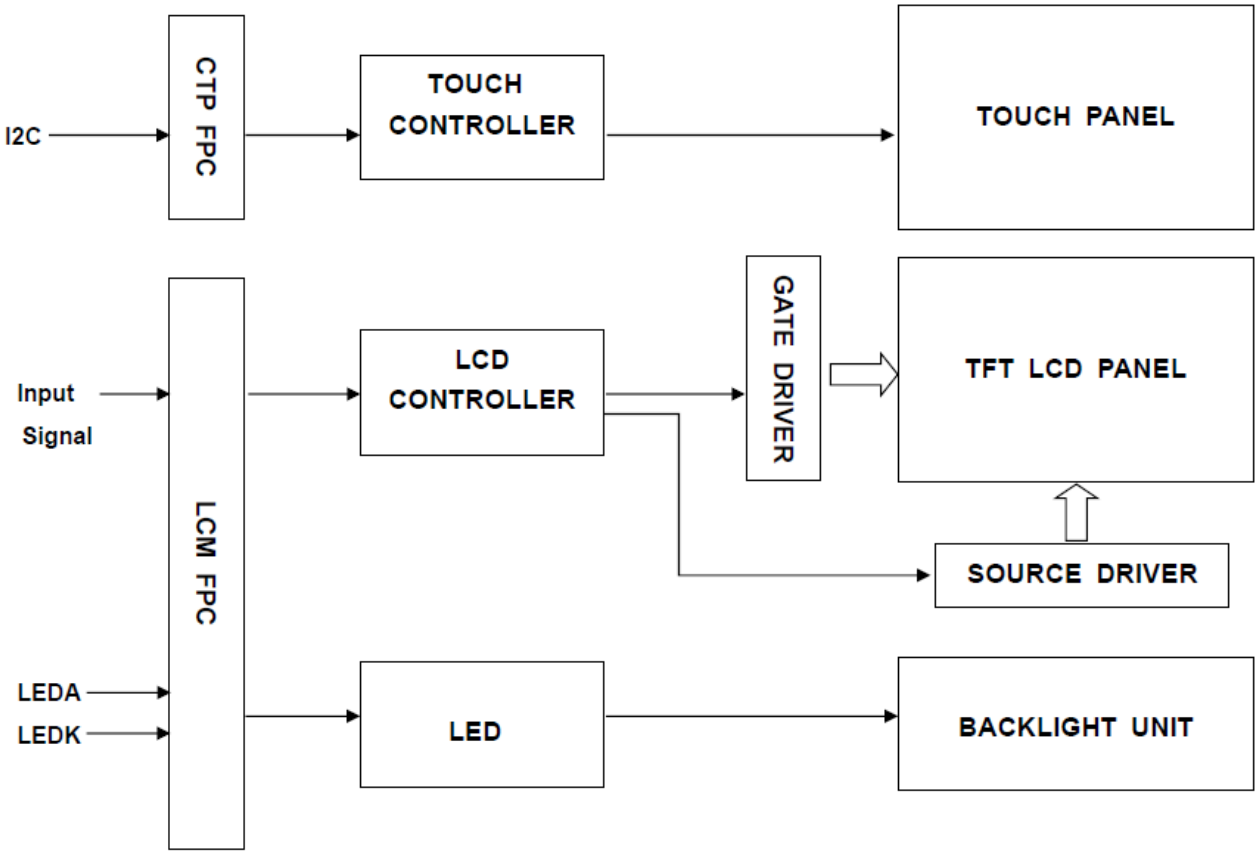
		PARTS NO.	E28RA-I-CW600-C	
TOLERANCE UNLESS OTHERWISE SPECIFIED	X.X±0.3	Drawn		Unit
	X.XX±0.2	Checked		mm
Scale 1:1		Approve		Page 1/1

2. Block Diagram



3. Input Terminal Pin Assignment

3.1 TFT

NO.	Symbol	Description	I/O
1	GND	Ground	P
2	XR (NC)	Touch panel right glass terminal	A/D
3	YD (NC)	Touch panel bottom film terminal	A/D
4	XL (NC)	Touch panel left glass terminal	A/D
5	YU (NC)	Touch panel top film terminal	A/D
6-7	IOVCC	Supply voltage (1.65-3.3V)	P
8-9	VCI	Supply voltage (3.3V)	P
10-12	IM2 IM1 IM0	Interface selection: IM2 IM1 IM0 — Pins used DBI 8-bit: 0 0 0 — DB7-DB0 DBI 16-bit: 0 1 0 — DB15-DB0 DBI 9-bit: 0 0 1 — DB8-DB0 DBI 18-bit: 0 1 1 — DB17-DB0 3-wire, 9-bit SPI: 1 0 1 — SDA SCL CS 4-wire, 8-bit SPI: 1 1 0 — SDA SCL CS RS	I
13	RESET	Reset signal of the device. Must be applied to properly initialize the device.	I
14	CS	Chip select pin. When not used this pin can be fixed low.	I
15	RS(SPI_SCL)	Data or command signal for the parallel MCU interface. RS=1: data selected, RS=0: command selected. The clock for the serial interface. If not used, pin to VCI or GND.	I
16	WR(SPI_RS)	Write signal in the parallel MCU interface. Command or parameter select signal for the 4-wire serial interface. If not used, pin to VCI or GND.	I
17	RD	Read signal for the MCU parallel interface. If not used, pin to VCI or GND.	O
18	VSYNC	Frame synchronizing signal for the RGB interface. If not used, pin to VCI or GND.	I
19	HSYNC	Line synchronizing signal for the RGB interface. If not used, pin to VCI or GND.	I
20	ENABLE	Data enable signal for the RGB interface. If not used, pin to VCI or GND.	I
21	DOTCLK	Dot clock signal for the RGB interface. If not used, pin to VCI or GND.	I
22	SDA	Serial input signal. The data is applied at the rising edge of the SCL signal. If not used, pin to VCI or GND.	I
23-40	DB0-DB17	18-bit parallel bi-directional data but for the RGB and MCU interfaces. Fix to GND when not used.	I/O
41	SDO	Serial data output for the SPI interface.	I
42	GND	Ground	P
43	LEDA	Anode pin of the backlight	P
44-49	LEDK1-K6	Cathode pins of the backlight	P
50	GND	Cathode pin of the backlight	P

I: Input, O: Output, P: Power

3.2 CTP

NO.	Symbol	Description	I/O
1	GND	Ground	P
2	VDDIO	I/O power supply voltage	P
3	VDD	Supply voltage	P
4	SCL	I2C clock input	I
5	SDA	I2C data input and output	I/O
6	INT	External interrupt signal to the host	I
7	RST	External reset, active low	I
8	GND	Ground	O

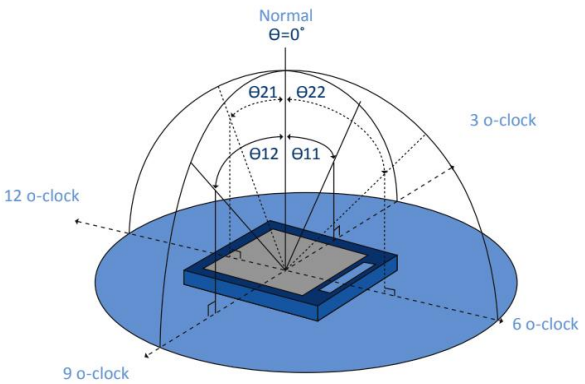
4. LCD Optical Characteristics

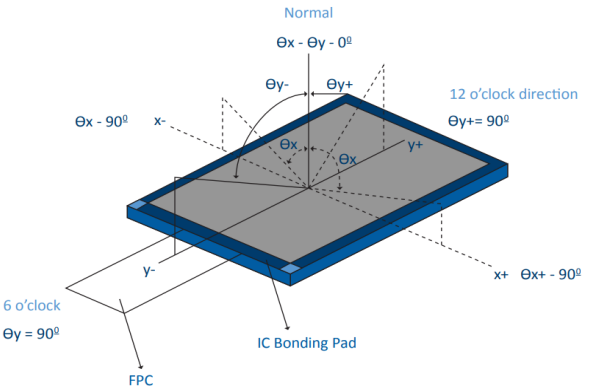
4.1 Optical Specifications

Item		Symbol	Condition	Min	Typ.	Max	Unit	Note
Color Gamut		S%	θ=0 Normal viewing angle	60	65	--	%	(3)
Contrast Ratio		CR		600	800	--	%	(2)
Response Time	Rising	T_R+T_F		--	30	40	ms	(4)
	Falling							
Color Filter Chromaticity	White	W_X		0.237	0.277	0.317		(5)(6)
		W_Y		0.256	0.296	0.336		
	Red	R_X		0.577	0.617	0.657		
		R_Y		0.303	0.343	0.383		
	Green	G_X		0.261	0.301	0.341		
		G_Y		0.545	0.585	0.625		
	Blue	B_X		0.108	0.148	0.188		
		B_Y		0.012	0.052	0.092		
Viewing Angle	Hor.	ΘL	CR≥10	--	80	--	degrees	(1)(6)
		ΘR		--	80	--		
	Ver.	ΘT		--	80	--		
		ΘB		--	80	--		
Option View Direction		ALL						(1)

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.



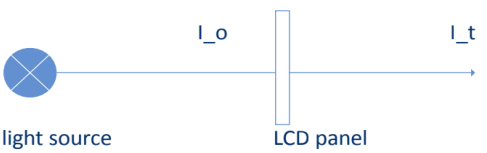


(2) Definition of Contrast Ratio (Cr): measured at the center point of panel. The contrast ratio (Cr) measured on a module, is the ratio between the luminance (Lw) in a full white area (R=G=B=1) and the luminance (Ld) in a dark area (R=G=B=0).

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

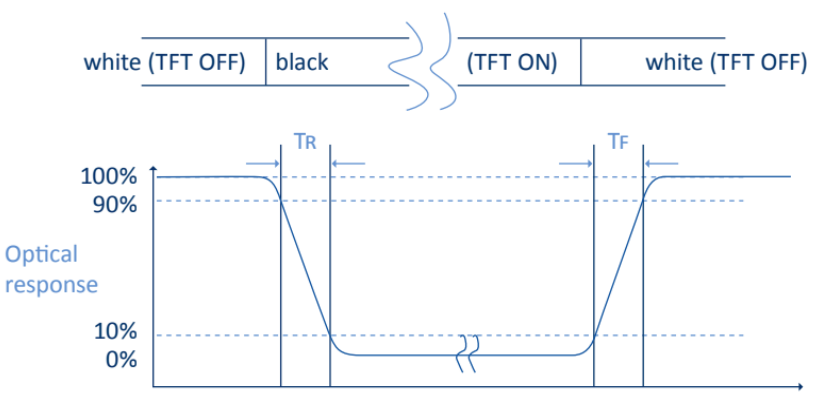
(3) Definition of transmittance (T%): The transmittance of the panel including the polarizers is measured with electrical driving. The equation for transmittance Tr is:

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



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

(4) Definition of Response Time (Tr, Tf): 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.

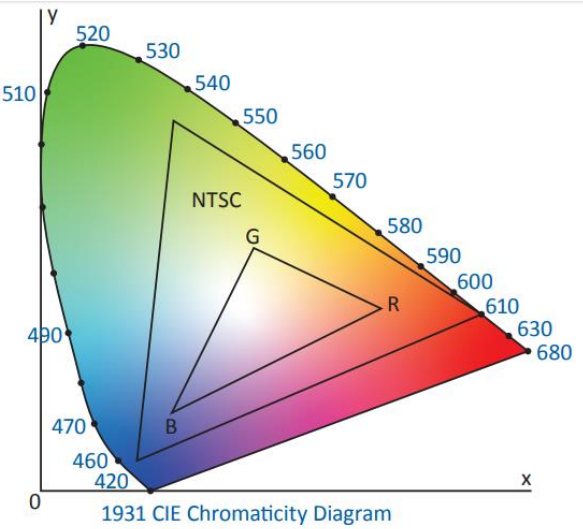
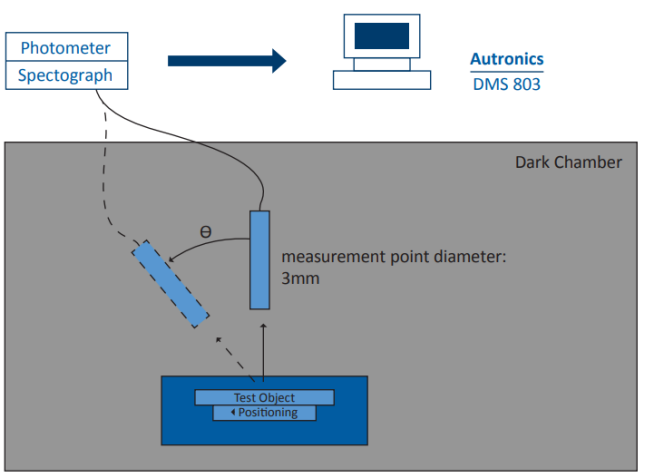


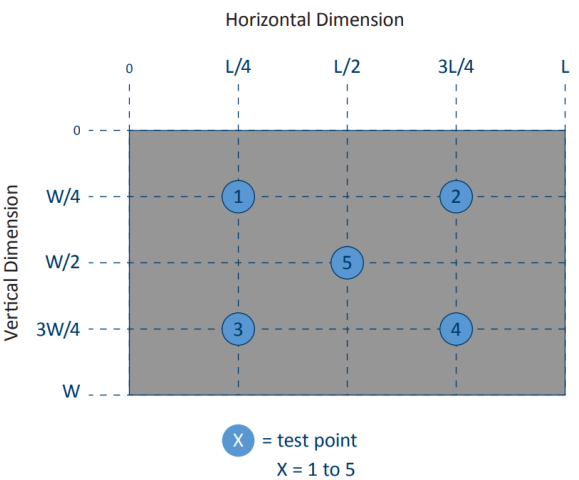
Fig. 1931 CIE chromacity diagram

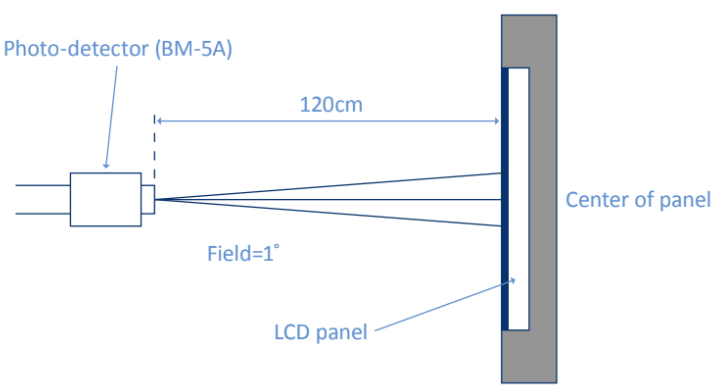
Color gamut: $S = \frac{\text{Area of RGB triangle}}{\text{Area of NTSC triangle}} \times 100\%$

(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	
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	2.5	3.3	3.6	V	
Digital Interface Supply Voltage	IOVCC	1.65	1.8	3.3	V	
Normal Mode Current	IDD	--	8	--	mA	
Level Input Voltage	VIH	0.7IOVCC	--	IOVCC	V	
	VIL	GND	--	0.3IOVCC	V	
Level Output Voltage	VOH	0.8IOVCC	--	IOVCC	V	
	VOL	GND	--	0.2IOVCC	V	

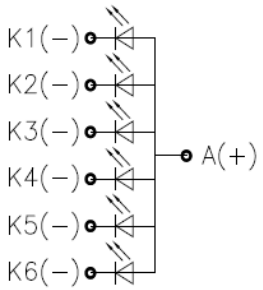
5.3 LED Backlight Characteristics

Item	Symbol	Min	Typ.	Max	Unit	Note
Forward Current	IF	90	120	--	mA	
Forward Voltage	VF	--	3.2	--	V	
LCM Luminance	LV	550	600	--	cd/m2	Note 3
LED lifetime	Hr	--	50000	--	hour	Note1 & 2
Uniformity	AVg	80	--	--	%	Note 3

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

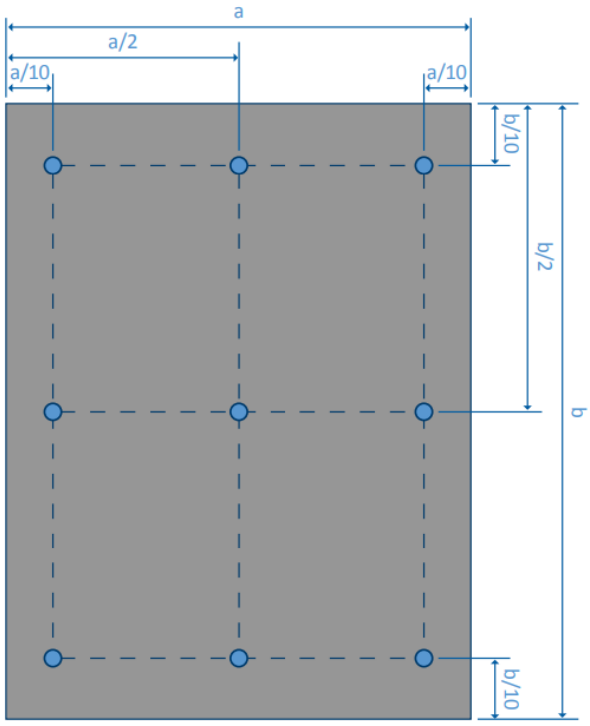
Note 1: LED lifetime (Hr) can be defined as the time in which it continues to operate under the condition: Ta=25±3 °C, typical IL value indicated in the above table until the brightness becomes less than 50%.

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

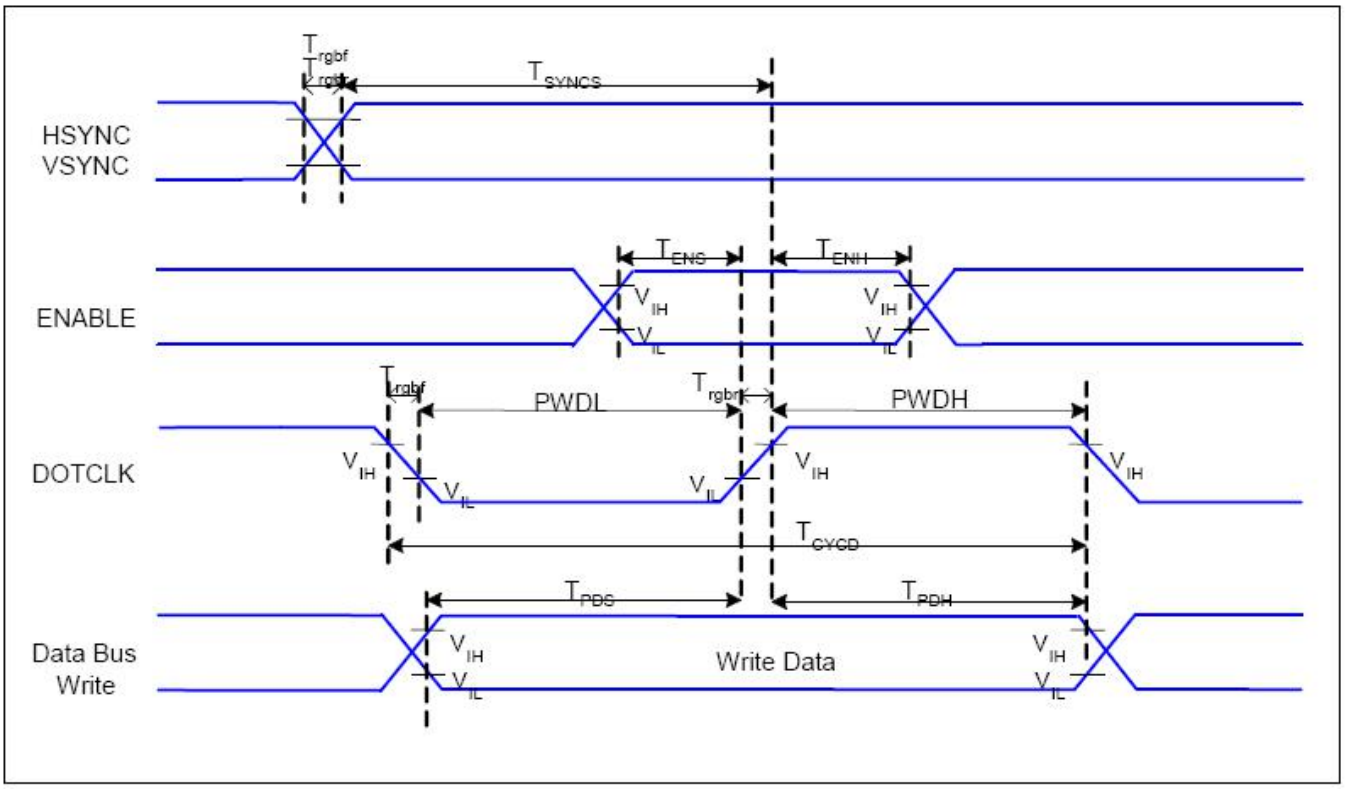


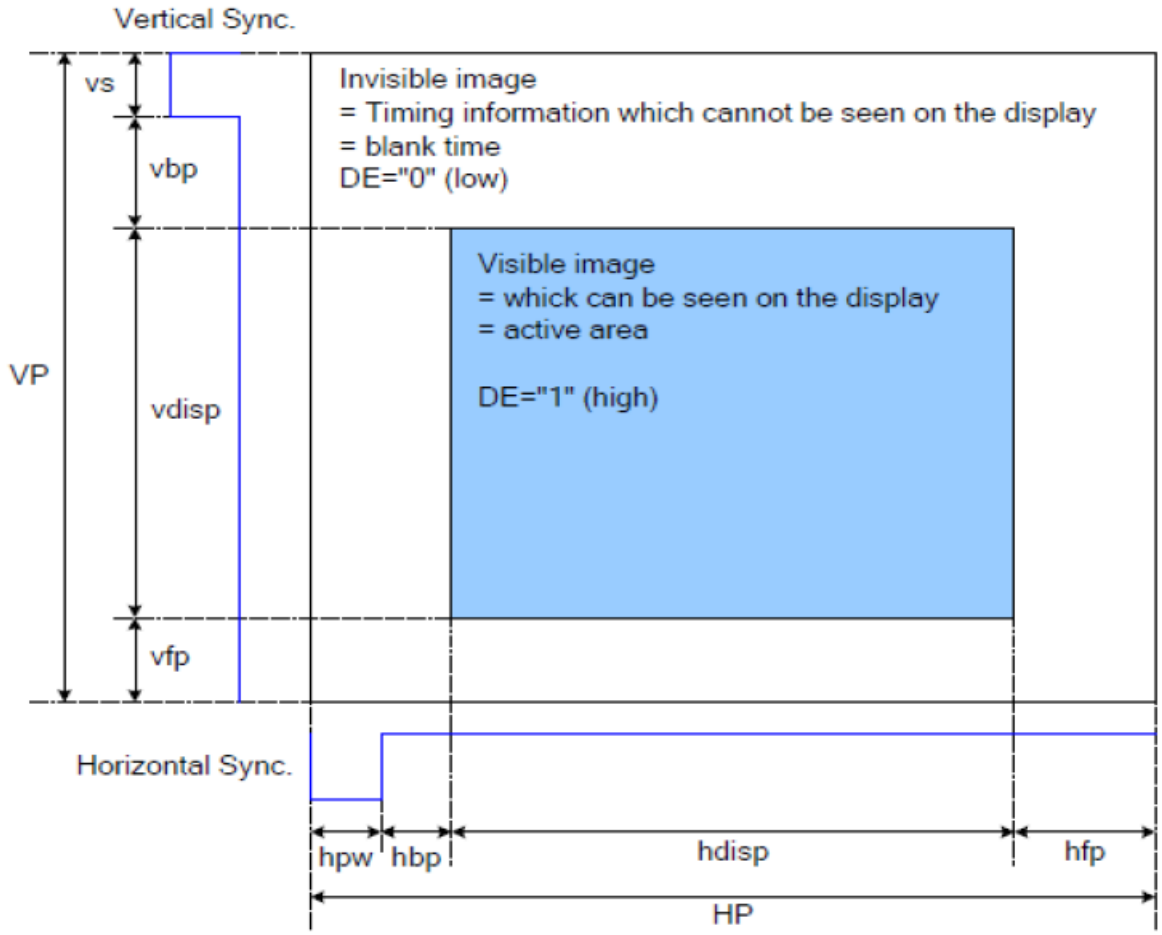
Figure 6.1: Parallel RGB Interface Timing Diagram

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

Table 6.1: Parallel RGB Interface Timing Characteristics

6.2 Timing Tables

The display operation via the RGB interface is synchronized with the VSYNC, HSYNC and DOTCLK signals. The data can be written only within the specified area with low power consumption by using the window address function. The back porch and front porch are used to set the RGB interface timing signals.



Parameter	Symbol	Min	Typ	Max	Unit
DCLK cycle time	dclk	120	-	--	ns
Horizontal sync width	hpw	2	10	16	dclk
Horizontal back porch	hbp	2	20	24	dclk
Horizontal front porch	hfp	2	10	16	dclk
Vertical sync width	vs	1	2	4	Line
Vertical back porch	vbp	1	2	--	Line
Vertical front porch	vfp	3	4	--	Line

Table 6.2: RGB Interface Timing Table

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

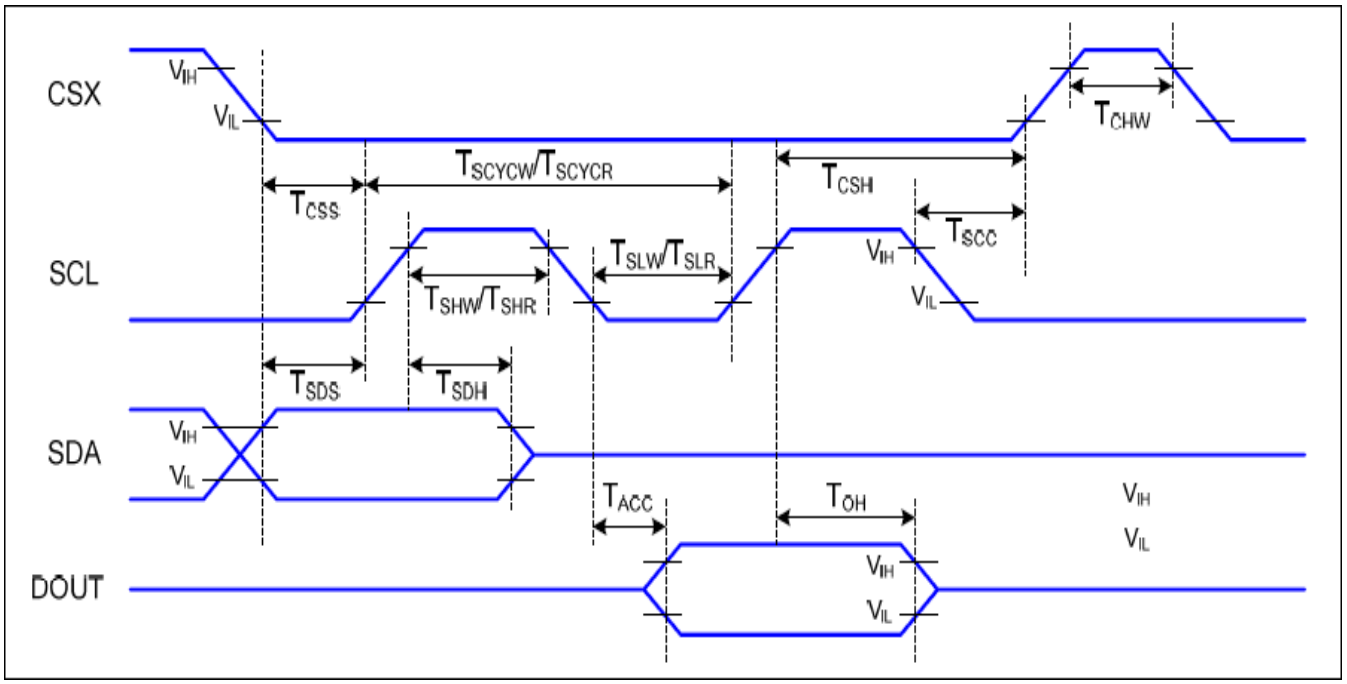


Figure 6.3: Serial Interface **3-SPI Timing Diagram**

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

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” 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	30		ns	
	T_{SDH}	Data hold time	30			
SDA (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)

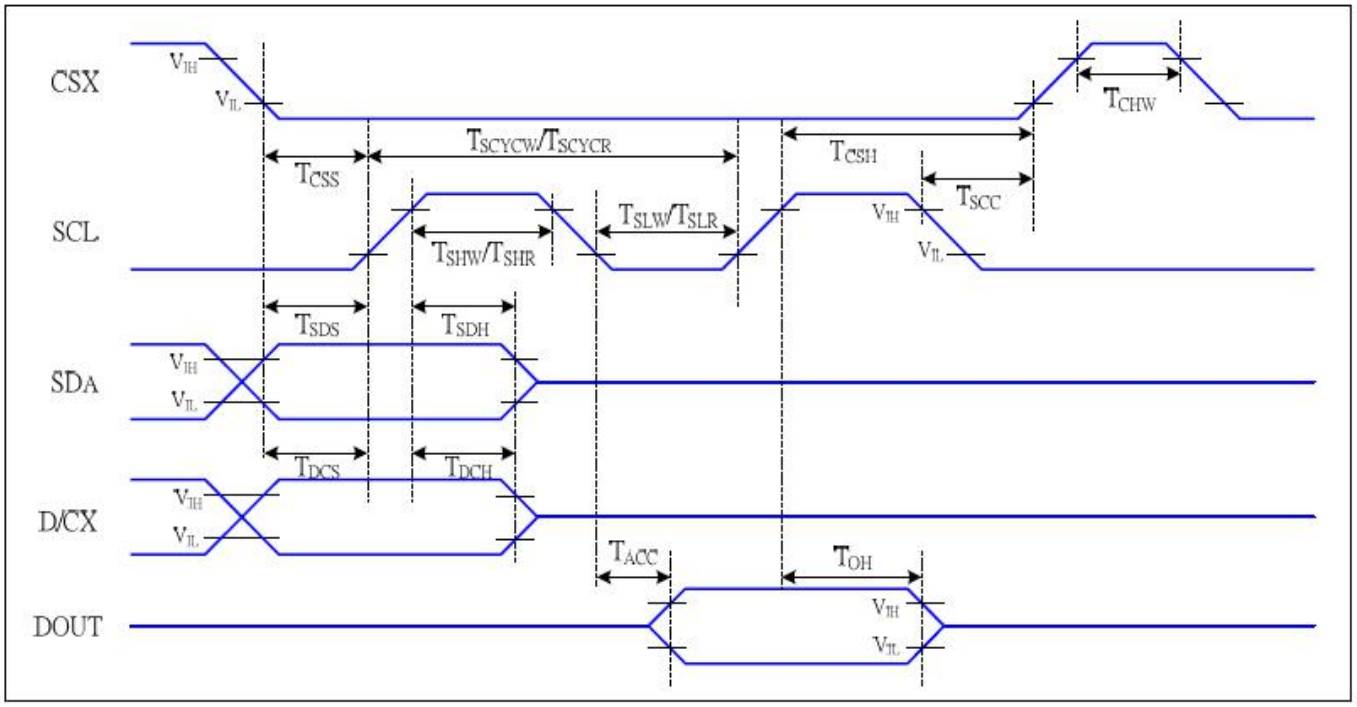


Figure 6.4: Serial Interface **4-SPI Timing Diagram**

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” 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

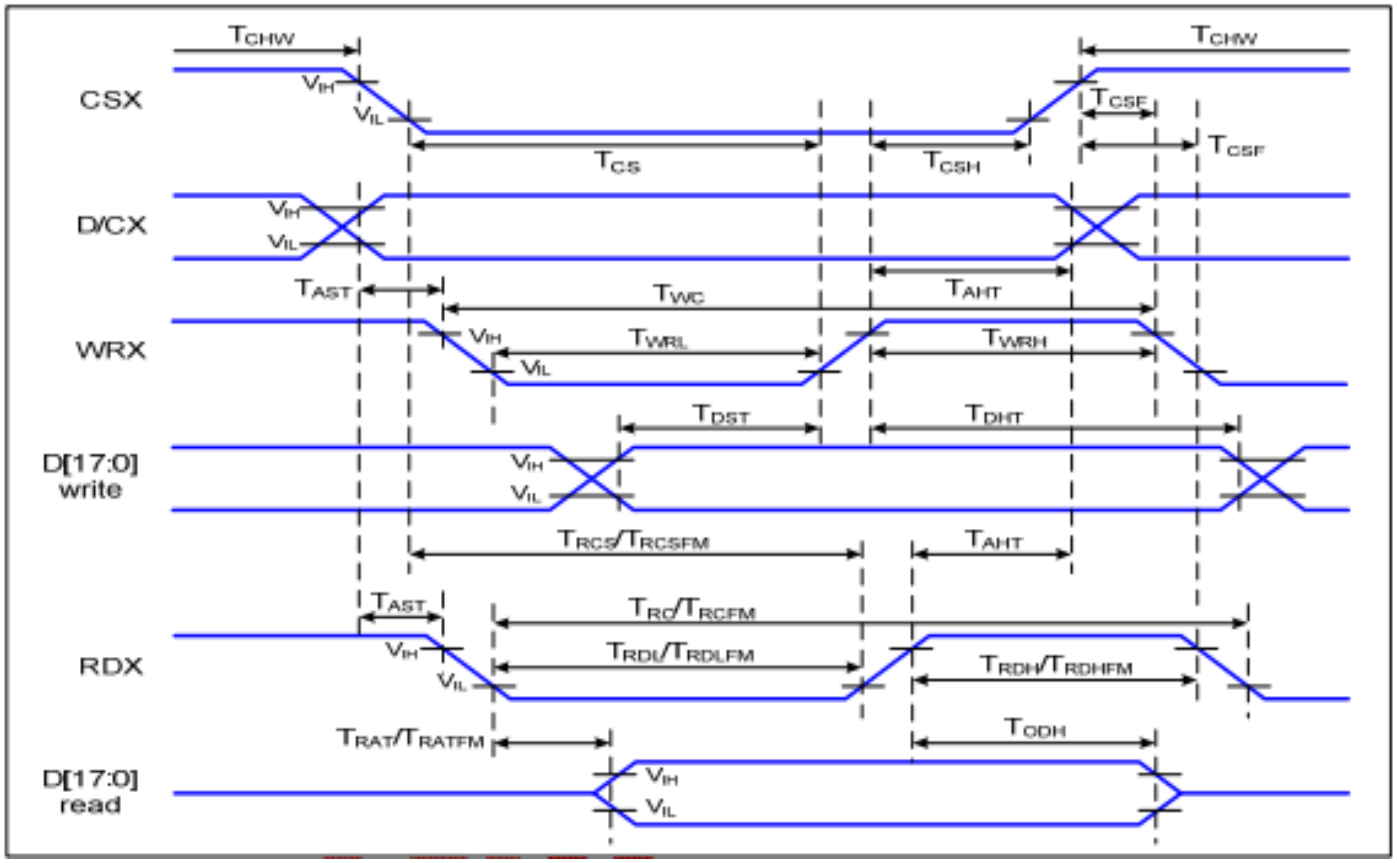


Figure 6.5: Parallel Interface Timing Characteristics (8080-Series MCU Interface)

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	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] D[15:0], D[8:0], D[7:0]	T_{DST}	Write data setup time	10	-	ns	
	T_{DHT}	Write data hold time	10	-	ns	For max CL=30pF
	T_{RAT}	Read access time (ID)	-	40	ns	
	T_{RATFM}	Read access time (FM)	-	340	ns	For min CL=8pF
	T_{ROD}	Output disable time	20	80	ns	

Table 6.5: 8080 Series MCU Parallel Timing Characteristics

6.3 Reset Timing

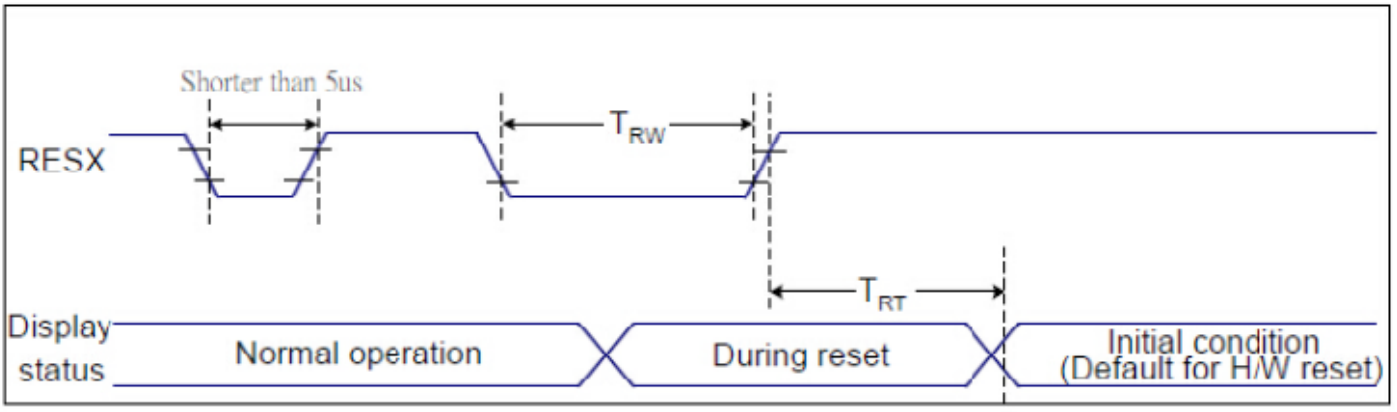


Figure 6.6: Reset Timing Diagram

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:

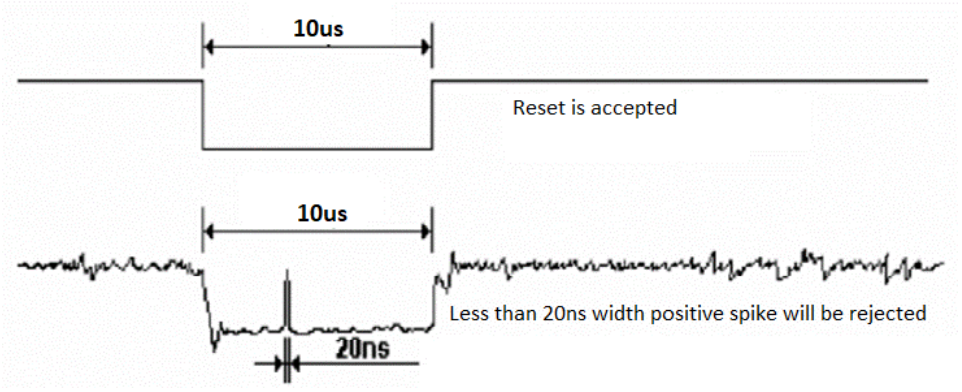
1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (tRT) within 5ms after a rising edge of RESX.

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. CTP Electrical Characteristics

7.1 Absolute Maximum Rating

Item	Symbol	Min	Max	Unit	Note
Power Supply Voltage	VDD	2.7	3.6	V	1
I/O Digital Voltage	VDDIO	1.8	3.6	V	1
Operating Temperature	T_{OP}	-30	+85	℃	-
Storage Temperature	T_{ST}	-30	+85	℃	-

Note: If used beyond the absolute maximum ratings, FT5436 may permanently damage. It is strongly recommended that the device be used within the electrical characteristics in normal operations. If exposed to the condition not within the electrical characteristics, it may affect the reliability of the device.

7.2 DC Electrical Characteristics (Ta=25℃)

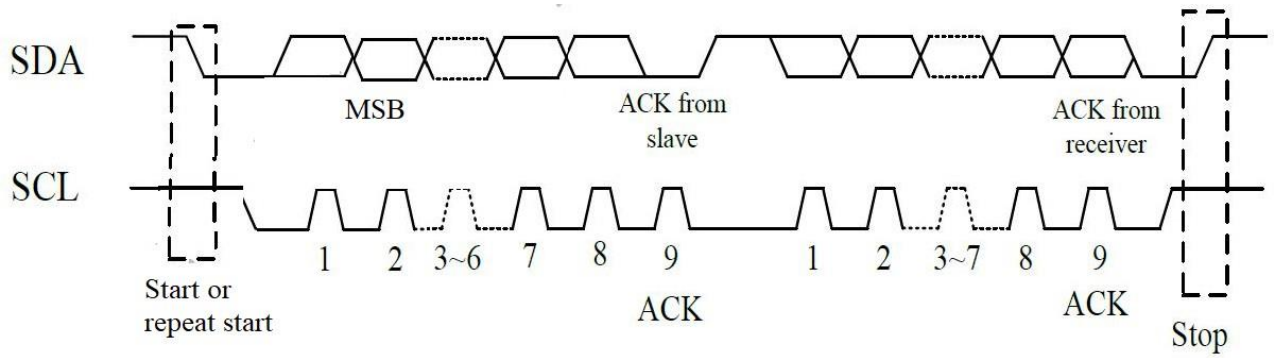
Item	Symbol	Condition	Min	Typ.	Max	Unit	Note
Digital supply voltage	VDD		2.7	3.3	3.47	V	
I/O Digital supply voltage	VDDIO		1.8	--	3.6	V	
Normal operation mode current consumption	I_{OPr}	VDD=2.7V Ta=25℃ MCLK=17.5M Hz		11		mA	
Monitor mode current consumption	I_{mon}			0.43		mA	
Sleep mode current consumption	I_{sip}			42		uA	
Level input voltage	V_{IH}		0.7VDDIO		VDDIO	V	
	V_{IL}		-0.3		0.3VDDIO	V	
Level output voltage	V_{OH}	I_{OH}=-0.1mA	0.7VDDIO			V	
	V_{OL}	I_{OL}=0.1mA			0.3VDIOD	V	

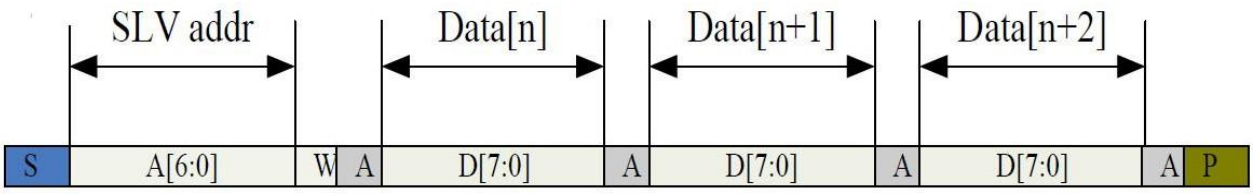
7.3 AC Characteristics

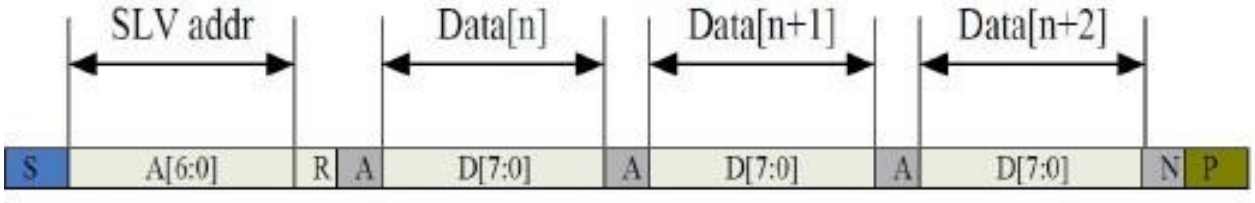
Item	Symbol	Test Condition	Min	Typ.	Max	Unit	Note
OSC clock 1	fosc1	VDDA=2.7V; Ta=25℃	49	50	51	MHz	
Sensor acceptable clock	ftx	VDDA=2.8V; Ta=25℃	50	150	400	kHz	
Sensor output rise time	Ttxr	VDDA=2.8V; Ta=25℃	-	210	-	ns	
Sensor output fall time	Ttxf	VDDA=2.8V; Ta=25℃	-	210	-	ns	
Sensor input voltage	Trxi	VDDA=2.8V; Ta=25℃	1.2	-	1.6	V	

7.4 I2C Interface

The I2C is always configured in the slave mode. The data transfer format is shown below.







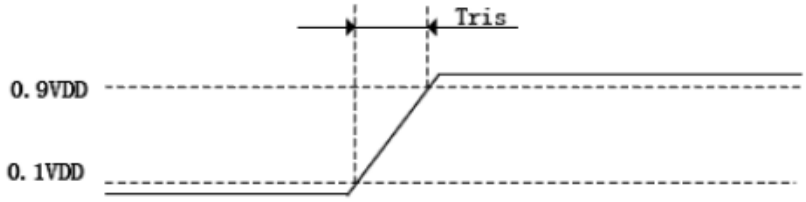
The following table lists the meanings of the mnemonics used in the above figures.

Mnemonics	Description
S	I2C start or I2C restart
A [6:0]	Slave address
R/W	Read/Write bit, '1' for read, '0' for write
A(N)	ACK(NACK)
P	Stop: the indication of the end of a packet (if this bit is missing, S will indicate the end of the current packet and the beginning of the next packet)

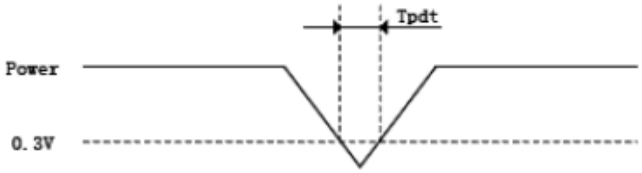
I2C Interface Timing Characteristics

Parameter	Min	Max	Unit
SCL frequency	0	400	kHz
Bus free time between a stop and start condition	1.3	-	us
Hold time (repeated) start condition	0.6	-	us
Data setup time	100	-	us
Setup time for a repeated start condition	0.6	-	us
Setup time for stop condition	0.6	-	us

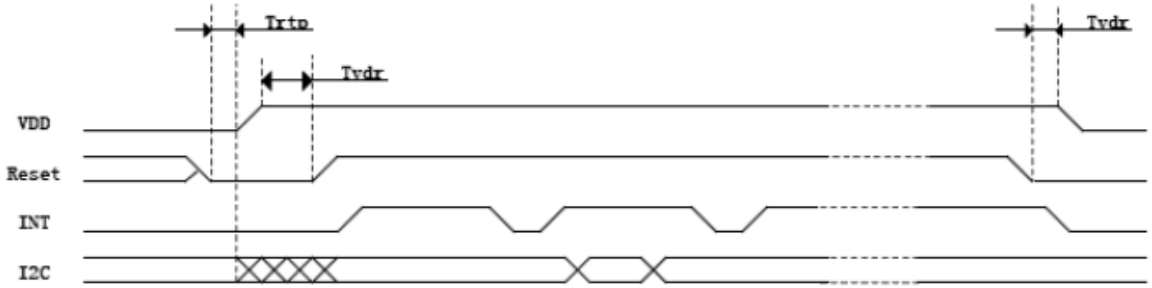
7.5 Power ON/Reset Sequence



Power On Time



Power Cycle Requirement



Power on Sequence

Parameter	Description	Min	Max	Units
Tris	Rise time from 0.1VDD to 0.9VDD	--	5	ms
Tpdt	Time of voltage being below 0.3V	5	--	ms
Trtp	Time of resetting low before powering on	100	--	us
Tvdr	Reset time	1	--	ms
Trsi	Time of starting to report point after resetting	--	200	ms

8. Cautions and Handling Precautions

8.1 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.

8.2 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.