

LCM Specification

Preliminary specification

Final Specification

Project No. 项目编号	TFT-H024A7QVIST8N45		
Customer 客户名称			
Module No. 客户型号			
Product type 产品内容	TFT LCD Module 240 x 3RGB x 320 Dots 2.4" TFT LCD		
Signature by customer: 客户确认签章:			
<input type="checkbox"/> Trial production <input type="checkbox"/> Mass production			
编 制	电子审核	结构审核	批 准
Y. L			

深圳市鑫洪泰电子科技有限公司

Shenzhen Hot Display Technology Co., Ltd

1 Document revision history :

DOCUMENT REVISION	DATE	DESCRIPTION	PREPARED BY	APPROVED BY
0	2019-11-1	First Release.	Y.L	
1	2019-11-11	Increase RGB initialization code	Y.L	

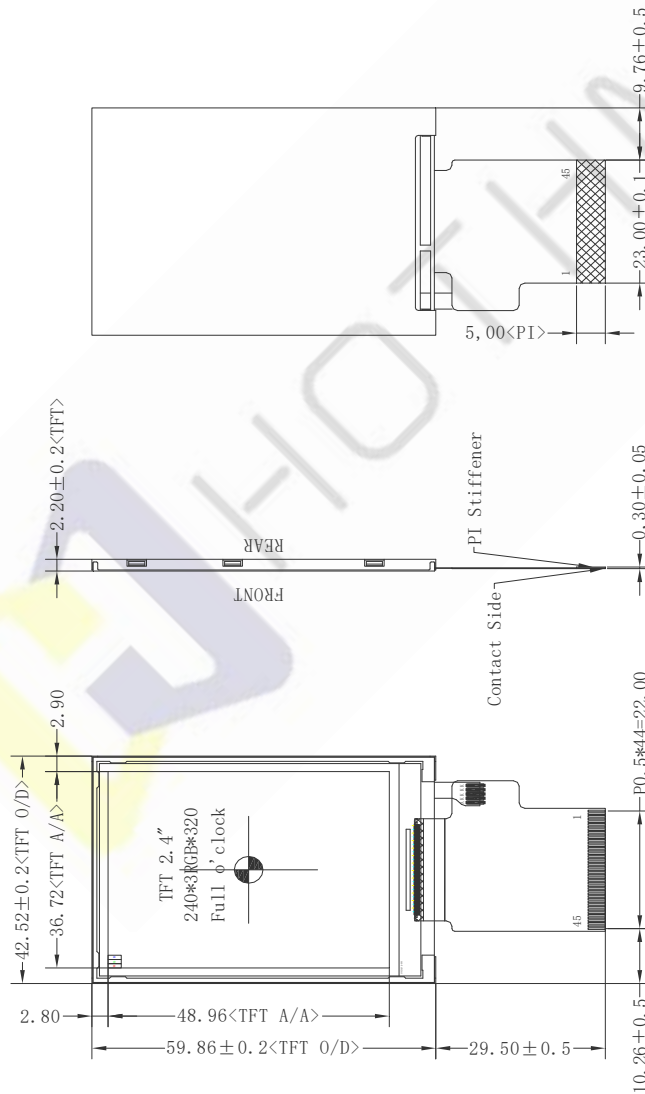
1. General Feature:

Item	Standard Value	Unit
Display Size	2.4"	--
Number of Pixels	240(H)x3(RGB)*320(V)	--
Active Area	36.72(H) *48.96(V)	mm
LCM Outline Dimension	42.32(H) ×59.91× 2.40(V)	mm
Viewing Direction	FULL O'Clock	-
LCM Interface	*Parallel 8080-series MCU Interface (8/9/16/18-bit) *6/16/18 RGB Interface(VSYNC, HSYNC, DOTCLK, ENABLE, DB[17:0]) *Serial Peripheral Interface(3SPI/4SPI)	-
LCM Driver IC	ST7789V	-
LCM Driver Voltage	IOVCC=1.8V,VCI=2.8V (Max 3.3V)	V
Backlight	White LED	-
Touch Panel	Whitout Touch Panel	-
CTP Driver IC	T.B.D	-
CTP Driver Voltage	T.B.D	V
CTP I/O Digital Voltage	T.B.D	V
Operation Temperature	-20~70	°C
Storage Temperature	-30~80	°C

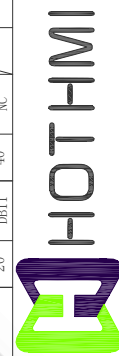
Note1:Initialization via SPI when RGB interface.

2. Outline Dimensions

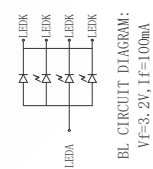
*** Do not display the fixed pattern for a long time when using a normally black panel, as it may cause image sticking due to the LCM structure. If the screen is displayed in fixed mode, use a screen saver. It is recommended to display the fixed mode in less than 2 minutes or less.



PIN NO.	SIGNAL	PIX NO.	SIGNAL	PIN NO.	SIGNAL
1	VCI	21	DB10	41	GND
2	GND	22	DB9	42	NC
3	LEDA	23	DB8	43	NC
4	LEBK	24	DB7	44	NC
5	IM0	25	DB6	45	NC
6	IM1	26	DB5		
7	IM2	27	DB4		
8	IM3	28	DB3		
9	TE	29	DB2		
10	VSD	30	DB1		
11	BSD	31	DB0		
12	PCLK	32	RS/SPL_CLK		
13	DEN	33	RD		
14	DB17	34	WR		
15	DB16	35	NC		
16	DB15	36	SPL_CS		
17	DB14	37	SPL_SDI		
18	DB13	38	SPL_SDO		
19	DB12	39	RESET		
20	DB11	40	NC		



Doc Title: **TFT-H024A7QV1ST8N45**
 Scale: 1:1
 Ver: Y0
 Drawn: Liu
 Date: 2019-11-01



*Interface definition by Pin IM0-IM3

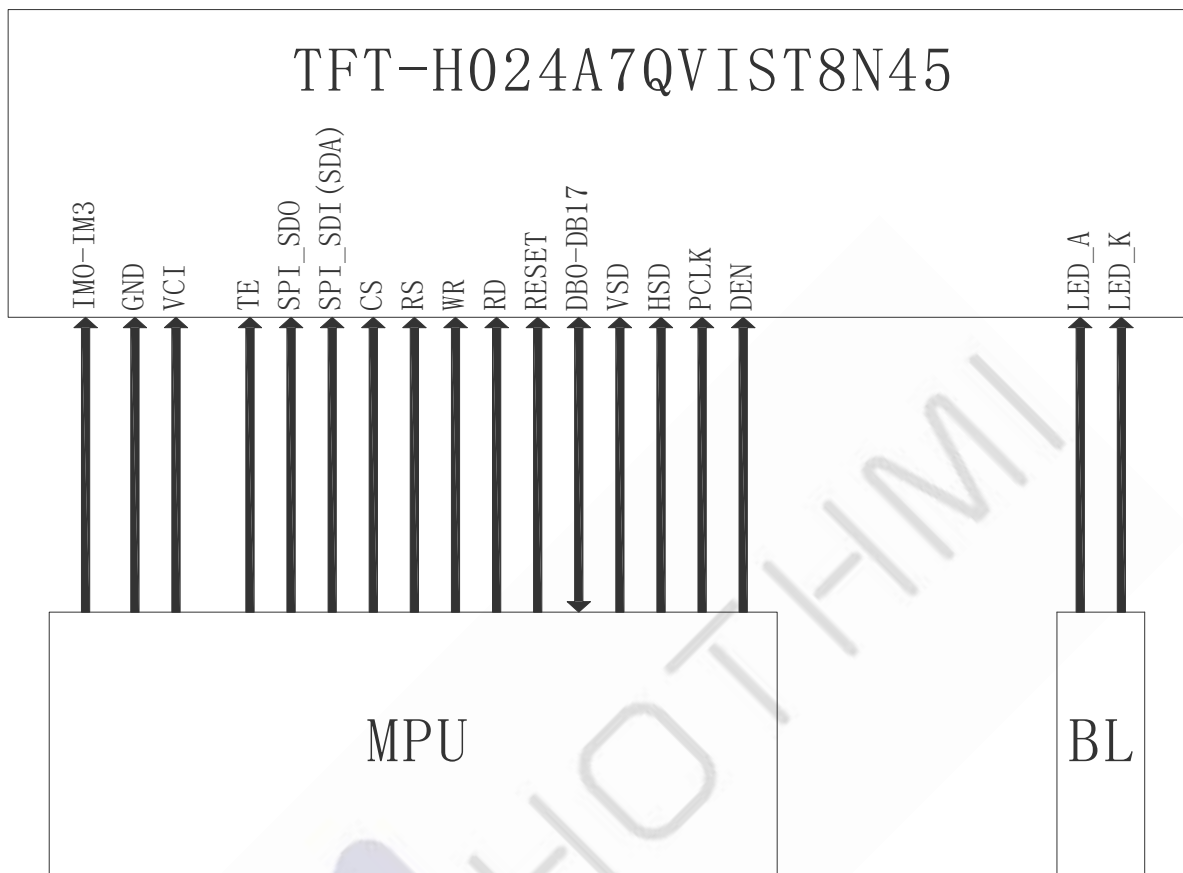
#1. LCD Display Type	TFT, Transmissive, Normally Black
#2. Viewing Direction	Full 0° Clock (080/DB0/L80/R80)
#3. Interface	SPL, RS, WR are fully compatible, free to choose
#4. Operating Voltage	VCI=2.8V, I0VCC=1.8V(Typ)
#5. Operating Temp	-20° C~70° C
#6. Storage Temp	-30° C~80° C
#7. Driver IC	ST7789V(TFT)
#8. Backlight	WHITE Vf=3.2V If=100mA(Typ)
#9. LCM Brightness	800 cd/m ² (Typ)

3. Pin Description

3.1 Pin Description

Pin NO.	Symbol	Description
1	VCI	Analog Power(2.65 ~ 3.3 V)
2	GND	Ground
3	LED_A	LED Anode
4	LED_K	LED Cathode
5-8	IM0-IM3	The MCU interface mode select
9	TE	Tearing effect signal is used to synchronize MCU to frame memory writing. If not used, please let this pin open.
10	VSD	Vertical synchronizing input signal for RGB interface. If not used, please fix this pin at GND.
11	HSD	Horizontal synchronizing input signal for RGB interface. If not used, please fix this pin at GND.
12	PCLK	Dot clock signal for RGB interface. If not used, please fix this pin at GND.
13	DEN	Data enable signal for RGB interface. If not used, please fix this pin at GND.
14-31	DB17-DB0	Data Bus. If not used, please fix this pin at GND.
32	RS/SPI_CLK	◆Display data/command selection pin in parallel IF. ◆This pin is used to be serial interface clock.
33	RD	Read enable in 8080 MCU parallel IF. If not used, please fix this pin at GND.
34	WR/SPI_D/C	◆Write enable in MCU parallel interface ◆Display data/command selection pin in 4-line serial IF. ◆Second Data lane in 2 data lane serial IF.
35	NC	No Connect
36	CS/SPI_CS	Chip select input pin (“Low” enable).
37	SPI_SDI	SPI input/output PIN or input, definition by IM3. If not used, please fix this pin at GND.
38	SPI_SDO	SPI interface output pin. If not used, let this pin open.
39	RESET	LCM Reset Pin.
40	NC	No Connect
41	GND	Ground
42	NC	No Connect
43	NC	No Connect
44	NC	No Connect
45	NC	No Connect

3.2 Wiring Diagram



*Interface definition by Pin IM0-IM3

The MCU interface mode select

IM3	IM2	IM1	IM0	MCU interface mode	Data Pin
0	0	0	0	80-8bit parallel I/F	DB[7:0]
0	0	0	1	80-16bit parallel I/F	DB[15:0]
0	0	1	0	80-9bit parallel I/F	DB[8:0]
0	0	1	1	80-18bit parallel I/F	DB[17:0]
0	1	0	1	3-line 9bit serial I/F	SDA: in/out
				2 data lane serial I/F	SDA: in/out, WRX: in
0	1	1	0	4-line 8bit serial I/F	SDA: in/out
1	0	0	0	80-16bit parallel I/F II	DB[17:10], DB[8:1]
1	0	0	1	80-8bit parallel I/F II	DB[17:10]
1	0	1	0	80-18bit parallel I/F II	DB[17:0]
1	0	1	1	80-9bit parallel I/F II	DB[17:9]
1	1	0	1	3-line 9bit serial I/F II	SDA: in/SDO: out
1	1	1	0	4-line 8bit serial I/F II	SDA: in/SDO: out

4. Electrical Characteristics

4-1 TFT LCD Module Operating Conditions

Item	Symbol	Condition	Min	Type	Max	Unit
Interface logic circuits	IOVCC	-	1.65	1.80	3.30	V
Analog Power supply	VCI	-	2.50	2.80	3.30	V
TFT Gate on voltage	VGH	-	10.0	-	16.0	V
TFT Gate off voltage	VGL	-	-16.0	-	-10.0	V

4-2 LED back light specification (pera chip)

Item	Symbol	Condition	Min	Type	Max	Unit
Forward voltage	Vt	If=20mA	-	3.2	-	V
Forward current	Ipn	/1-chip	-	100	-	mA
Luminance(With LCD)	Lv	If=100mA	-	800	-	cd/m ²
Luminous color	White					

5. OPTICAL SPECIFICATION

4.1 Overview

The test of Optical specifications shall be measured in a dark room (ambient luminance 1lux and temperature = 25 ± 2°C) with the equipment of Luminance meter system (Goniometer system and TOPCON BM-5) and test unit shall be located at an approximate distance 50cm from the LCD surface at a viewing angle of θ and Φ equal to 0°. The center of the measuring spot on the Display surface shall stay fixed. The backlight should be operating for 30 minutes prior to measurement.

4.2 Optical Specifications

Parameter		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Viewing Angle Range	Horizontal	Θ L	CR>10	-	80	-	Deg.	Note 1
		Θ R		-	80	-	Deg.	
	Vertical	Θ U		-	80	-	Deg.	
		Θ D		-	80	-	Deg.	
Contrast ratio		CR	$\Theta = 0^\circ$	-	1500	-		Note2
Color Gamut		CG		-	70	-	%	
White Chromaticity		Wx			0.307			
		Wy			0.334			
Reproduction of color	Red	Rx	$\Theta = 0^\circ$	-0.02	0.652	+0.02		Note4 (Based on C Light)
		Ry			0.322			
	Green	Gx			0.276			
		Gy			0.582			
	Blue	Bx			0.141			
		By			0.091			
Response Time (Rising + Falling)		Tr+Tf	$\Theta = 0^\circ$ Ta= 25°C	-	35	-	ms	Note5
Transmittance		Tr		-	4.65		%	Note3

Note:

1. 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 (see FIGURE 1).

2. Contrast measurements shall be made at viewing angle of $\Theta = 0$ and at the center of the LCD surface. Luminance shall be measured with all pixels in the view field set first to white, then to the dark (black)

state . (see FIGUR 1) Luminance Contrast Ratio (CR) is defined mathematically.

$$CR = \frac{\text{Luminance when displaying a white raster}}{\text{Luminance when displaying a black raster}}$$

3. Transmittance is the Value without APF and without CG.

4. The color chromaticity coordinates specified in the above table 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.

5. The electro-optical response time measurements shall be made as FIGURE 2 by switching the “data” input signal ON and OFF. The times needed for the luminance to change from 10% to 90% is T_r , and 90% to 10% is T_f .

Figure1 Measurement Set Up

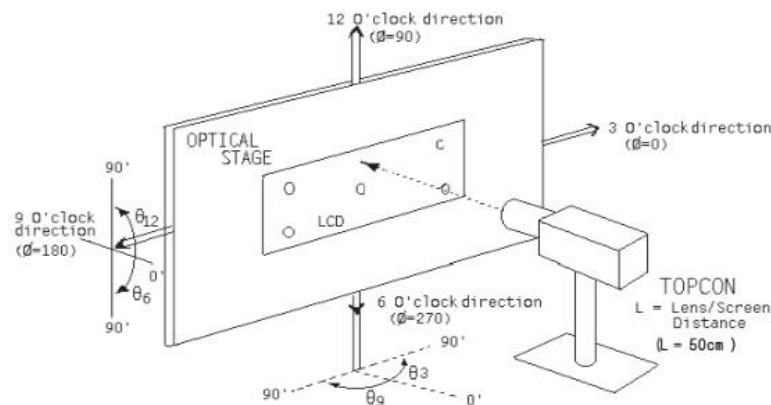
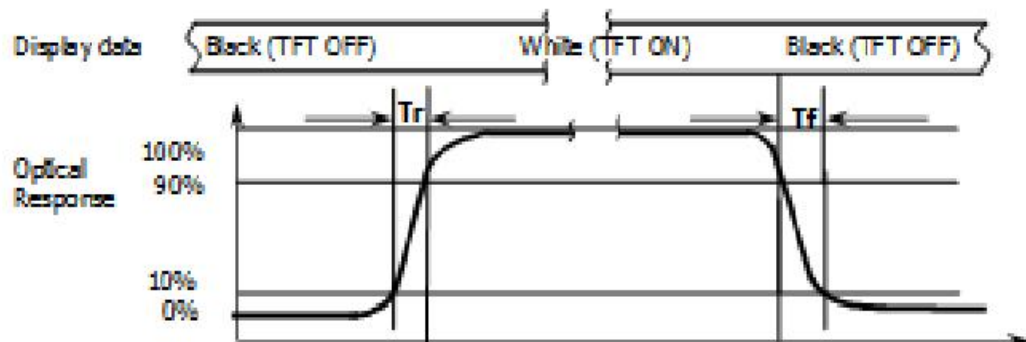
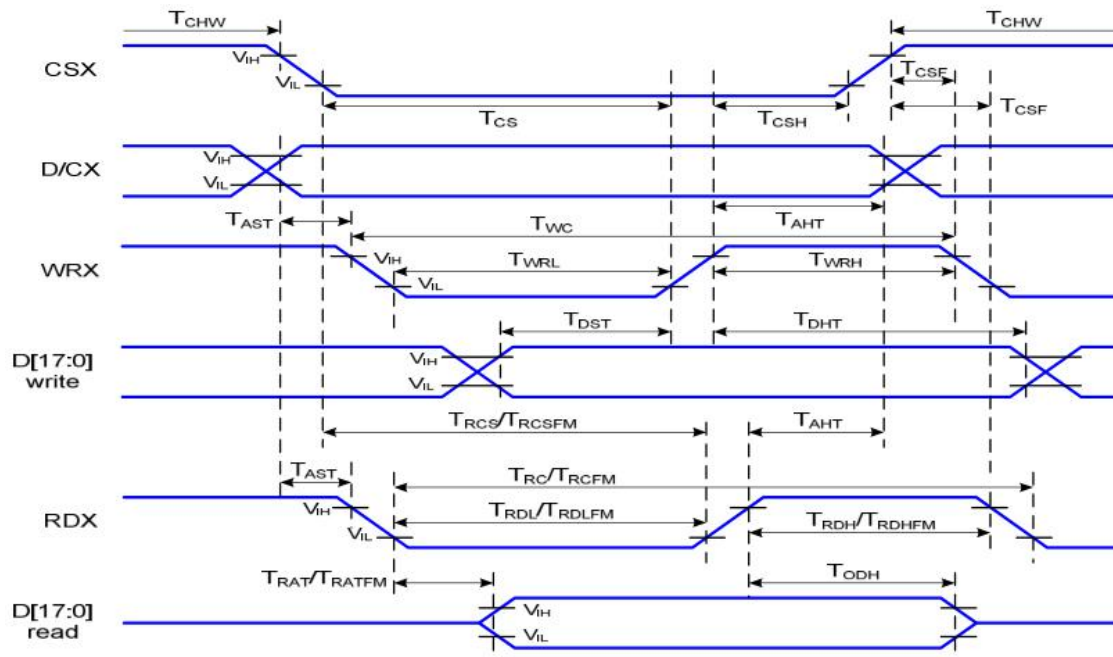


Figure2 Response Time Testing



6. Timing Characteristics of Input Signals

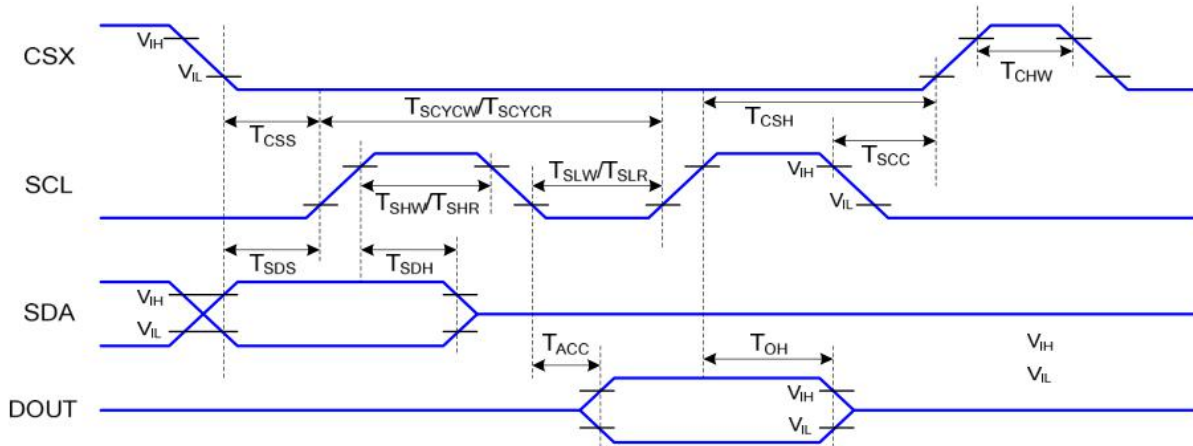
6-1 LCM 8080 Series MCU Parallel Interface Characteristics: 18/16/9/8-bit Bus



VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25°C

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	When read ID data
	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	When read from frame memory
	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 CL=30pF
	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	

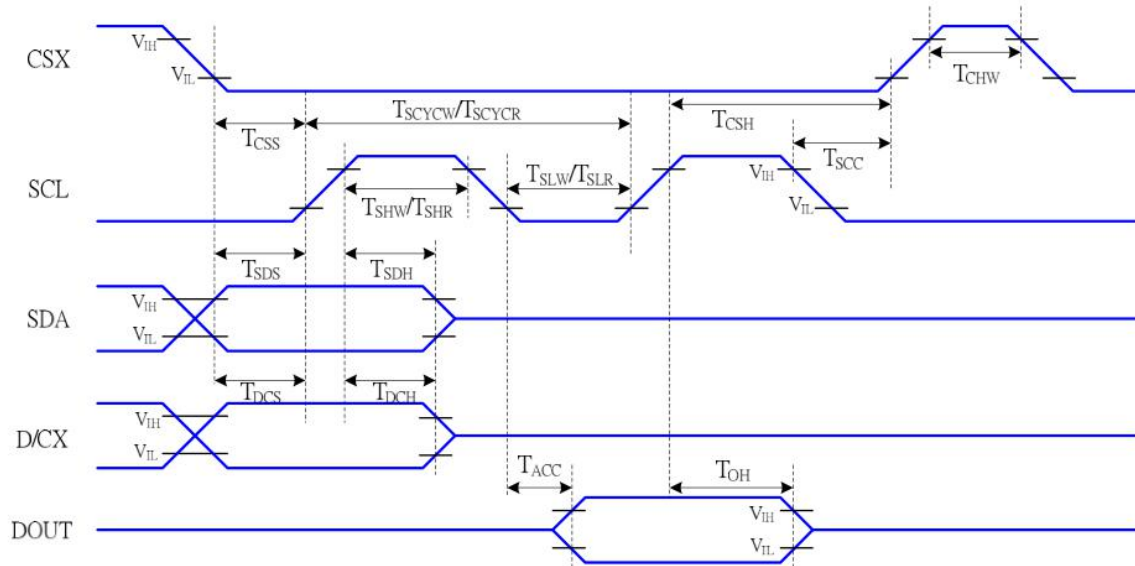
6-2 LCM Serial Interface Characteristics (3-line serial)



$V_{DDI}=1.65$ to $3.3V$, $V_{DD}=2.4$ to $3.3V$, $AGND=DGND=0V$, $T_a=25^{\circ}C$

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		ns	
DOUT	T_{ACC}	Access time	10	50	ns	For maximum $CL=30pF$
	T_{OH}	Output disable time	15	50	ns	For minimum $CL=8pF$

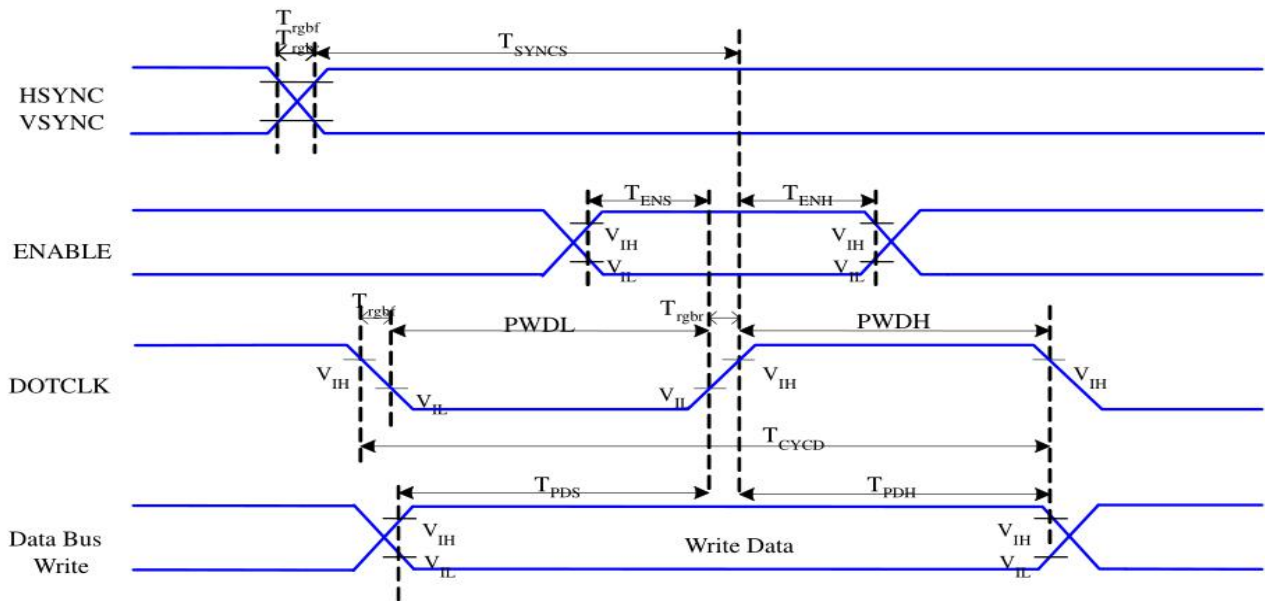
6-3 LCM Serial Interface Characteristics (4-line serial)



VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25°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	-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 maximum CL=30pF
	T _{OH}	Output disable time	15	50	ns	For minimum CL=8pF

6-4 LCM RGB Interface Characteristics



VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25°C

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	
	Trghr, Trghf	DOTCLK Rise/Fall time	-	20	ns	
DB	T_{PDS}	PD Data Setup Time	50	-	ns	
	T_{PDH}	PD Data Hold Time	50	-	ns	

18/16 Bits RGB Interface Timing Characteristics

Signal	Symbol	Parameter	MIN	MAX	Unit	Description
HSYNC, VSYNC	T_{SYNCS}	VSYNC, HSYNC Setup Time	25	-	ns	
ENABLE	T_{ENS}	Enable Setup Time	25	-	ns	

DOTCLK	T_{ENH}	Enable Hold Time	25	-	ns	
	PWDH	DOTCLK High-level Pulse Width	25	-	ns	
	PWDL	DOTCLK Low-level Pulse Width	25	-	ns	
	T_{CYCD}	DOTCLK Cycle Time	55	-	ns	
	Trghr, Trghf	DOTCLK Rise/Fall time	-	10	ns	
DB	T_{PDS}	PD Data Setup Time	25	-	ns	
	T_{PDH}	PD Data Hold Time	25	-	ns	

6 Bits RGB Interface Timing Characteristics

6-4-1: Please refer to the following table for the setting limitation of RGB interface signals.

6-4-1-1: 16/18bit RGB interface:

Parameter	Symbol	Min.	Typ.	Max.	Unit
Horizontal Sync. Width	hpw	2	10	hpw+hbp=31	Clock
Horizontal Sync. Back Porch	hbp	4	10		Clock
Horizontal Sync. Front Porch	hfp	2	38	-	Clock
Vertical Sync. Width	vs	1	4	vs+vbp=127	Line
Vertical Sync. Back Porch	vbp	1	4		Line
Vertical Sync. Front Porch	vfp	1	8	-	Line

Note1: Typical value are related to the setting of dot clock is 7MHz and frame rate is 70Hz.

Note2: If the setting of hpw is 10 dot clocks and hbp is 10 dot clocks, the setting of HBP in command B1h is 20 dot clocks.

Note3: In with ram mode, $hpw+hbp+hfp \geq 22$, In without ram mode, $hpw+hbp \geq 20$

6-4-1-2: 6bit RGB interface:

Parameter	Symbol	Min.	Typ.	Max.	Unit
Horizontal Sync. Width	hpw	6	30	hpw+hbp=93	Clock
Horizontal Sync. Back Porch	hbp	12	30		Clock
Horizontal Sync. Front Porch	hfp	6	60	-	Clock
Vertical Sync. Width	vs	1	4	vs+vbp=127	Line
Vertical Sync. Back Porch	vbp	1	4		Line
Vertical Sync. Front Porch	vfp	1	8	-	Line

Note1: Typical value are related to the setting of dot clock is 17MHz and frame rate is 60Hz.

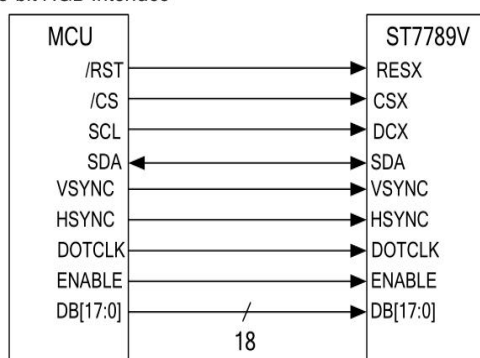
Note2: In with ram mode, $hpw+hbp+hfp \geq 66$, In without ram mode, $hpw+hbp \geq 60$.

Examples

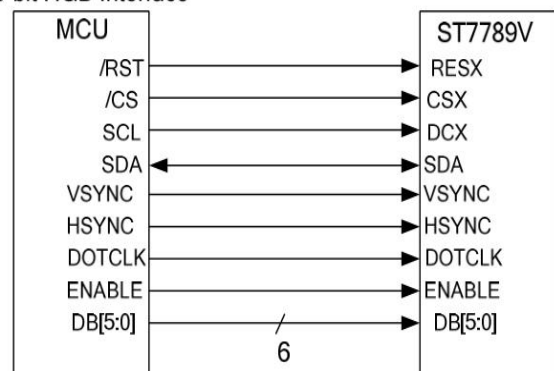
18-bit RGB interface hardware suggestion, IM[3:0]=0101.

6-bit RGB interface hardware suggestion, IM[3:0]=0101.

18-bit RGB Interface



6-bit RGB Interface



7. RELIABILITY TEST

7-1 Temperature and Humidity

TEST ITEMS	CONDITIONS	NOTE
High temperature storage test	Ta = 80 °C, 240 hrs	
Low temperature storage test	Ta = -30 °C, 240 hrs	
High temperature & high humidity (operation test)	Ta = 60 °C, 90%RH, 240hrs	
Low temperature operation test	Ta = -20 °C, 240hrs	
High temperature operation test	Ta = 70 °C, 240hrs	
Thermal Shock Test	Ta = -40 °C ~ 85°C, 1h/Cycle, 100Cycles	

7-2 Shock and Vibration

ITEMS	CONDITIONS
Packing Shock (Non-Operation)	<ul style="list-style-type: none"> ● Shock level:980m/s² ● Waveform:1/2 Sine wave,6msec ● ±X, ±Y ±Z,each axis 1 times
Packing Vibration (Non-Operation)	<ul style="list-style-type: none"> ● Frequency range:8-33.3HZ ● Stoke:1.0mm ● Sweep: 10Hz-50Hz ● x,y,z 2 hours for each direction

7-3 Electrostatic Discharge

TEST ITEM	CONDITIONS
ESD (Non-operation)	150pF,330 Ω , Contact±4KV,Air :±8KV.Note 1
	200pF,0 Ω , ±200V Contact test.Note 2

Note:Measure Point:

- 1.LCD glass and metal bezel
- 2.IF connector pins

8. HANDLING & CAUTIONS

8-1 Caution For Operation

◆Since the LCM is made of glass, do not apply strong mechanical impact or static load onto it. Handling with care since shock, vibration, and careless handling may seriously affect the product. If it falls from a high place or receives a strong shock, the glass may be broken.

◆It is indispensable to drive the LCM within the specified voltage limit since the higher voltage than the limit causes LCM's life shorter. An electro-chemical reaction due to DC causes undesirable deterioration of the LCM so that the use of DC drive should be avoided.

◆Do not connect or disconnect the LCM to or from the system when power is on.

◆Never use the LCM under abnormal conditions of high temperature and high humidity.

◆When exposed to drastic fluctuation of temperature (hot to cold or cold to hot), the LCM may be affected; specifically, drastic temperature fluctuation from cold to hot, produces dew on the LCM's surface which may affect the operation of the polarizer on the LCM.

◆Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand LCM may turn black at temperature above its operational range. However those phenomena do not mean malfunction or out of order with the LCM. The LCM will revert to normal operation once the temperature returns to the recommended temperature range for normal operation.

◆Do not display the fixed pattern for a long time when using a normally black panel, as it may cause image sticking due to the LCM structure. If the screen is displayed in fixed mode, use a screen saver. It is recommended to display the fixed mode in less than 2 minutes or less.

◆Do not disassemble and/or re-assemble LCM module

7-2 Caution Against Static Charge

◆The LCM uses C-MOS LSI drivers, so customers are recommended that any unused input terminal would be connected to V_{DD} or V_{SS}, do not input any signals before power is turned on, and ground your body, work/assembly area, assembly equipments to protect against static electricity.

◆Remove the protective film slowly, keeping the removing direction approximate 30-degree not vertical from panel surface, if possible, under ESD control device like ion blower, and the humidity of working room should be kept over 50%RH to reduce the risk of static charge.

◆Avoid the use of work clothing made of synthetic fibers. We recommend cotton clothing or other conductivity-treated fibers.

◆In handling the LCM, wear non-charged material gloves. And the conducting wrist to the earth and the conducting shoes to the earth are necessary

9. LCD display initialization code

```

Void Panel_Initial_code1(void) //Mcu Interface
{
    //-----Reset sequence-----//
    LCD_RESET=1;
    Delays(1); //Delay 1ms
    LCD_RESET=0;
    Delays(10); //Delay 10ms
    LCD_RESET=1;
    Delays(120); //Delay 120ms
    //-----//
    WriteComm(0x11);
    Delay(120); //Delay 120ms
    //-----Display Setting-----//
    WriteComm(0x21);
    WriteComm(0x36); //Adjust the display orientation
    WriteData(0x00);
    WriteComm(0x3a);
    WriteData(0x05);
    //-----Frame rate setting-----//
    WriteComm(0xb2);
    WriteData(0x0c);
    WriteData(0x0c);
    WriteData(0x00);
    WriteData(0x33);
    WriteData(0x33);
    WriteComm(0xb7);
    WriteData(0x35);
    //-----Power setting-----//
    WriteComm(0xbb);
    WriteData(0x21); //20
    WriteComm(0xc0);
    WriteData(0x2c);
    WriteComm(0xc2);
    WriteData(0x01);
    WriteComm(0xc3);
    WriteData(0x0b);
    WriteComm(0xc4);
    
```

```

WriteData(0x20);
WriteComm(0xc6);
WriteData(0x0f);
WriteComm(0xd0);
WriteData(0xa4);
WriteData(0xa1);
//-----gamma setting-----//
WriteComm(0xe0);
WriteData(0xD0);
WriteData(0x06);
WriteData(0x0B);
WriteData(0x09);
WriteData(0x08);
WriteData(0x30);
WriteData(0x30);
WriteData(0x5B);
WriteData(0x4B);
WriteData(0x18);
WriteData(0x14);
WriteData(0x14);
WriteData(0x2C);
WriteData(0x32);
WriteComm(0xe1);
WriteData(0xD0);
WriteData(0x05);
WriteData(0x0A);
WriteData(0x0A);
WriteData(0x07);
WriteData(0x28);
WriteData(0x32);
WriteData(0x2C);
WriteData(0x49);
WriteData(0x18);
WriteData(0x13);
WriteData(0x13);
WriteData(0x2C);
WriteData(0x33);
WriteComm(0x29);
Delays (120);
    
```

}

```

Void Panel_Initial_code2(void) //RGB Interface
{
    SPI_CS=0;
    SPI_RES=1;
    Delay(10);
    SPI_RES=0;
    Delay(800);
    SPI_RES=1;
    Delay(2000);
    //-----//
    SPI_WriteComm(0x11);
    Delay(120); //Delay 120ms
    //-----Display Setting-----//
    //SPI_WriteComm(0x21); //Color inverse
    SPI_WriteComm(0x36);
    SPI_WriteData(0x00);
    SPI_WriteComm(0x3a);
    SPI_WriteData(0x66);
    //=====RGB Interface Setting=====//
    SPI_WriteComm(0xB0);
    SPI_WriteData(0x11); //RGB interface
    SPI_WriteData(0xf0); //Specify RGB interface bus width

    SPI_WriteComm(0xB1);
    SPI_WriteData(0x40); //DE Or HV mode
    //-----Frame rate setting-----//
    SPI_WriteComm(0xb2);
    SPI_WriteData(0x0c);
    SPI_WriteData(0x0c);
    SPI_WriteData(0x00);
    SPI_WriteData(0x33);
    SPI_WriteData(0x33);
    SPI_WriteComm(0xb7);
    SPI_WriteData(0x35);
    //-----Power setting-----//
    SPI_WriteComm(0xbb);
    SPI_WriteData(0x21); //20
    SPI_WriteComm(0xc0);
    SPI_WriteData(0x2c);
    SPI_WriteComm(0xc2);
    
```

```
SPI_WriteData(0x01);
SPI_WriteComm(0xc3);
SPI_WriteData(0x0b);
SPI_WriteComm(0xc4);

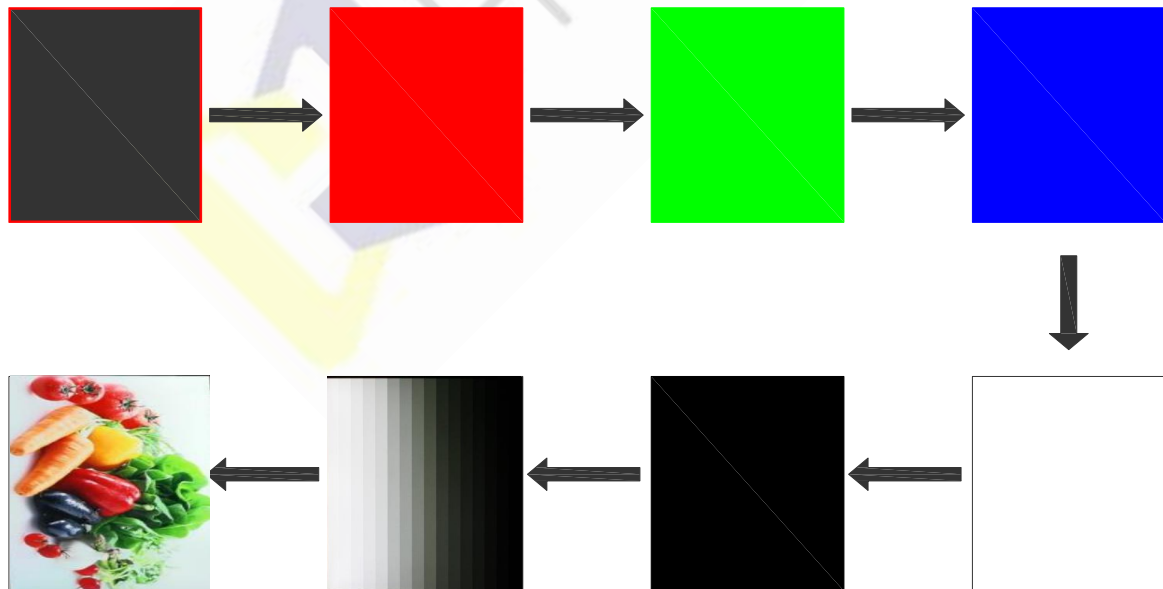
SPI_WriteData(0x20);
SPI_WriteComm(0xc6);
SPI_WriteData(0x0f);
SPI_WriteComm(0xd0);
SPI_WriteData(0xa4);
SPI_WriteData(0xa1);
//-----gamma setting-----//
SPI_WriteComm(0xe0);
SPI_WriteData(0xD0);
SPI_WriteData(0x06);
SPI_WriteData(0x0B);
SPI_WriteData(0x09);
SPI_WriteData(0x08);
SPI_WriteData(0x30);
SPI_WriteData(0x30);
SPI_WriteData(0x5B);
SPI_WriteData(0x4B);
SPI_WriteData(0x18);
SPI_WriteData(0x14);
SPI_WriteData(0x14);
SPI_WriteData(0x2C);
SPI_WriteData(0x32);
SPI_WriteComm(0xe1);
SPI_WriteData(0xD0);
SPI_WriteData(0x05);
SPI_WriteData(0x0A);
SPI_WriteData(0x0A);
SPI_WriteData(0x07);
SPI_WriteData(0x28);
SPI_WriteData(0x32);
SPI_WriteData(0x2C);
SPI_WriteData(0x49);
SPI_WriteData(0x18);
SPI_WriteData(0x13);
SPI_WriteData(0x13);
```

```

SPI_WriteData(0x2C);
SPI_WriteData(0x33);

SPI_WriteComm(0x29);
Delays (120);
}
Void Panel_SleepIn_Mode (void)
{
Write command 0x28);
Delays (120);
Write command 0x10);
Delays (120);
}
Void Panel_SleepOut_Mode (void)
{
Write command 0x11);
Delays (120);
Write command 0x29);
Delays (120);
}
    
```

10. LCD Test Pattern (In the same glass, IC test conditions)



Pattern	Red frame	Red	Green	Blue	White	Black	Gray scale	Image
Current (mA)	3.45	3.97	4.05	3.97	5.33	3.44	3.80	4.40