



ORIENT DISPLAY

Your Total LCD Solution Provider

Specification for LCD Module

AFY240320A1-2.4INTH

Revision F



A	Orient Display
FY	TFT Type
240320	Resolution 240 x 320
A1	Serial A1
2.4	2.4", Module Dimension 42.72 x 58.50 x 2.15 mm
I	IPS Display
N	Top: -20~+70°C; Tstr: -30~+80°C
T	Transmissive
H	High Brightness, 1000 nits
/	No Touch Panel
/	White Backlight
/	Controller ST7789V Or Compatible
/	RGB/MCU/SPI Interface



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1. GENERAL INFORMATION

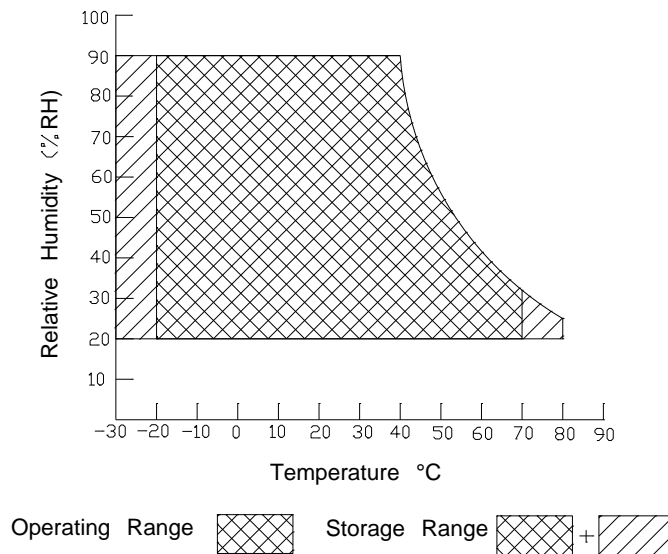
No.	Item	Contents	Unit
1	LCD size	2.4 inch (Diagonal)	/
2	Display mode	Normally black/Transmissive/Anti-glare	/
3	Viewing direction(eye)	FREE	/
4	Gray scale inversion direction	-	/
5	Resolution(H*V)	240 *320 Pixels	/
6	Module size (L*W*H)	42.72*58.50*2.15	mm
7	Active area (L*W)	36.72*48.96	mm
8	Pixel pitch (L*W)	0.153*0.153	mm
9	Interface type	RGB/MCU/SPI interface	/
10	Color Depth	16.7M	/
11	Module power consumption	TBD	W
12	Back light type	LED	/
13	Driver IC	ST7789VI or compatible	/
14	Weight	12.1	g

2. ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit	Note
Power supply input voltage for TFT	VDD	-0.3	4.6	V	
Backlight current (normal temp.)	ILED	-	100	mA	
Operation temperature	Top	-20	+70	°C	Note1
Storage temperature	Tst	-30	+80	°C	Note1
Humidity	RH	-	90%(Max60 °C)	RH	Note1

Note1 :

- 1).The relative humidity and temperature range are as below sketch,90%RH Max.
- 2).The maximum wet bulb temperature $\leq 40^{\circ}\text{C}$ and without dewing.



3. ELECTRICAL CHARACTERISTICS

DC CHARACTERISTICS(at Ta=25°C)

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Power supply input voltage	VCC	2.4	2.8	3.6	V	
I/O logic voltage	VDDIO	-	1.8	-	V	
Input voltage 'H' level	VIH	0.7VDDIO	-	VDDIO	V	
Input voltage 'L' level	VIL	VSS	-	0.3VDDIO	V	
Power supply current	IVDD	-	9	-	mA	

4. BACKLIGHT CHARACTERISTICS

(at Ta=25°C,RH=60%)

Item	Symbol	Min.	Typ.	Max.	Unit	Note
LED forward voltage	VF	5.6	6	6.8	V	
LED forward current	IF	-	80	-	mA	IF=20*4mA
LED power consumption	PLED	-	0.48	-	W	Note1
Number of LED	-		4		PCS	
Connection mode	-		4 parallel		/	
LED life-time	-	-	30000	-	Hrs	Note2

Note1 : Calculator value for reference : $IF \cdot VF = PLED$

Note2 : The LED life-time define as the estimated time to 50% degradation of initial brightness at Ta=25°C and IF =80mA. The LED lifetime could be decreased if operating IF is larger than 80mA.

6. ELECTRO-OPTICAL CHARACTERISTICS

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remark	Note
Response time	Tr+ Tf	-	-	35	45	ms	FIG.1	Note 1
Contrast ratio	Cr		500	750	-	-	FIG.2	Note 2
Surface luminance	Lv	$\theta=0^\circ$	800	1000	-	cd/m ²	FIG.2	Note 3
Luminance uniformity	Yu	$\theta=0^\circ$	75	80	-	%	FIG.2	Note 4
NTSC	-	$\theta=0^\circ$	-	50	-	%	FIG.2	Note 5
Viewing angle	θ	$\varnothing=90^\circ$	70	80	-	deg	FIG.3	Note 6
		$\varnothing=270^\circ$	70	80	-	deg	FIG.3	
		$\varnothing=0^\circ$	70	80	-	deg	FIG.3	
		$\varnothing=180^\circ$	70	80	-	deg	FIG.3	
CIE (x,y) chromaticity	Red x	$\theta=0^\circ$ $\varnothing=0^\circ$ Ta=25°C	Typ -0.04	0.63	Typ +0.04	-	FIG.2 CIE1931	Note 5
	Red y			0.34		-		
	Green x			0.32		-		
	Green y			0.61		-		
	Blue x			0.15		-		
	Blue y			0.05		-		
	White x			0.30		-		
	White y			0.33		-		

Note1. Definition of response time

The response time is defined as the LCD optical switching time interval between “White” state and “Black”state.Rise time (T_{ON}) is the time between photo detector output intensity changed from 90% to 10%. And fall time (T_{OFF}) is the time between photo detector output intensity changed from 10% to 90%. For additional information see FIG1.

Note2.Definition of contrast ratio

Contrast ratio(Cr) is defined mathematically by the following formula.
For more information see FIG.2.

Contrast ratio= $\frac{\text{Luminance measured when LCD on the "White" state}}{\text{Luminance measured when LCD on the "Black" state}}$

Measured at the center area of the LCD

Note3.Definition of surface luminance

Surface luminance is the luminance with all pixels displaying white.

For more information see FIG.2.

Lv = Average Surface Luminance with all white pixels(P1,P2,P3,,Pn)

Note4.Definition of luminance uniformity

The luminance uniformity in surface luminance is determined by measuring luminance at each test position 1 through n, and then dividing the maximum luminance of n points luminance by minimum luminance of n points luminance.For more information see FIG.2.

Yu = $\frac{\text{Minimum surface luminance with all white pixels (P1,P2,P3,.....,Pn)}}{\text{Maximum surface luminance with all white pixels (P1,P2,P3,.....,Pn)}}$

Note5. Definition of color chromaticity (CIE1931)

CIE (x,y) chromaticity,The x,y value is determined by screen active area center position P5.For more information see FIG.2.

Note6. Definition of viewing angle

Viewing angle is the angle at which the contrast ratio is greater than 10. angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface.

For more information see FIG.3.

For viewing angle and response time testing, the testing data is base on Autronic-Melchers's ConoScope or DMS series Instruments or compatible. For contrast ratio, Surface Luminance, Luminance uniformity and CIE,the testing data is base on TOPCON's BM-5or BM-7 photo detector or compatible.

FIG.1. The definition of response Time

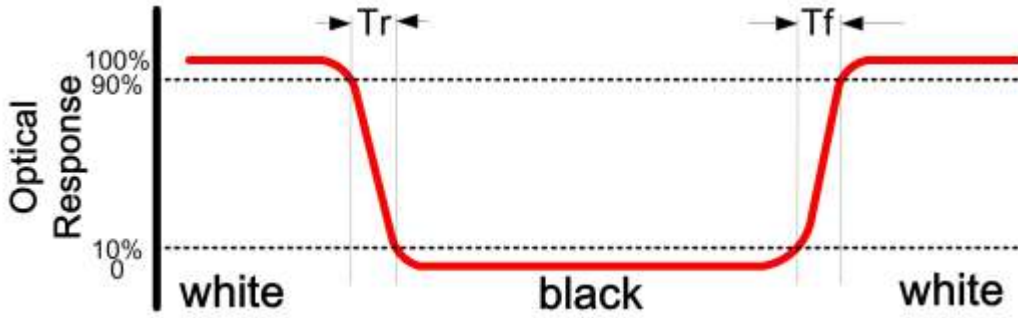


FIG.2. Measuring method for contrast ratio, surface luminance, luminance uniformity, CIE (x,y) chromaticity

H,V : Active area

Light spot size $\varnothing=1.5\text{mm}$ (BM-5) or $\varnothing=7.7\text{mm}$ (BM-7)50cm distance or compatible distance from the LCM surface to detector lens.

Test spot position : see Figure a.

measurement instrument : TOPCON's luminance meter BM-5 or BM-7 or compatible ,see Figure b.

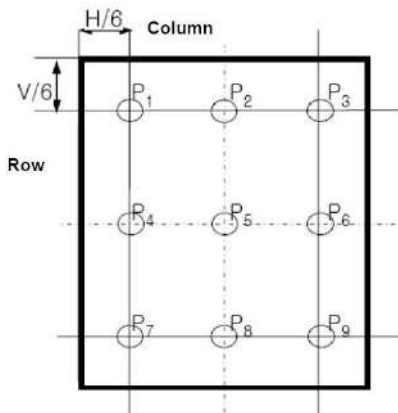


Figure a

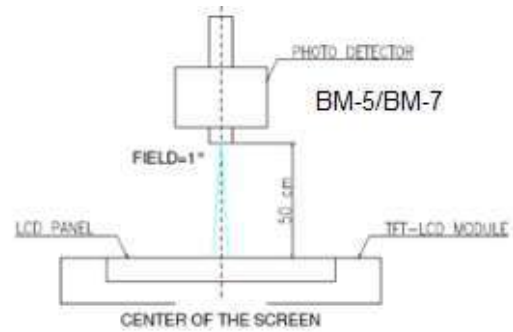
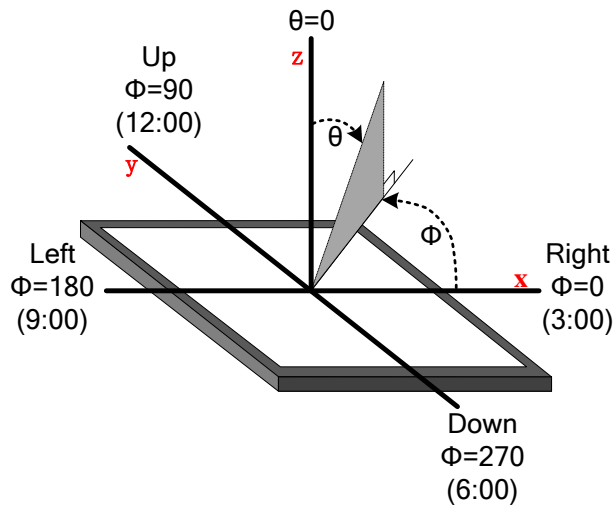


Figure b

FIG.3. The definition of viewing angle



7. INTERFACE DESCRIPTION

Module Interface description

Interface No.	Name	I/O or connect to	Description				
1	LEDK	P	Power for LED backlight(Cathode).				
2	LEDA	P	Power for LED backlight(Anode).				
3	GND	P	Power Ground.				
4	IM0	I	IM2	IM1	IM0	MPU Interface Mode	Data pin
5	IM1	I	0	0	0	80-8bit parallel I/F	DB[7:0]
6	IM2	I	0	0	1	80-16bit parallel I/F	DB[15:0]
			0	1	0	80-9bit parallel I/F	DB[8:0]
			0	1	1	80-18bit parallel I/F	DB[17:0].
			1	0	1	3-line 9bit serial I/F	SDA: in/out
6	IM2	I	1	0	1	2 data lane serial I/F	SDA: in/out WRX: in
						1	1
7	SDA	I/O	SPI interface input pin.				
8	DOTCLK	I	Dot clock.				
9	DE	I	Data enable.				
10	VSYNC	I	Vertical sync input				
11	HSYNC	I	Horizontal sync input				
12	VCC	P	Power supply				
13	RESET	I	Reset signal.				
14	GND	P	Power Ground.				
15-32	DB17--DB0	I/O	Data bus (DB17--DB0).				
33	RD	I	RGB Interface.please fix this pin at VDDI or DGND.				
34	WR	I	RGB Interface.please fix this pin at VDDI or DGND.				
35	RS	I	RGB Interface. serial interface clock.				
36	CS	I	Chip selection pin. Low enable.				
37	XR(NC)	-	NC				
38	YD(NC)	-	NC				
39	XL(NC)	-	NC				
40	YU(NC)	-	NC				

8. AC CHARACTERISTICS

Display Parallel 18/16/9/8-bit Interface Timing Characteristics (8080)

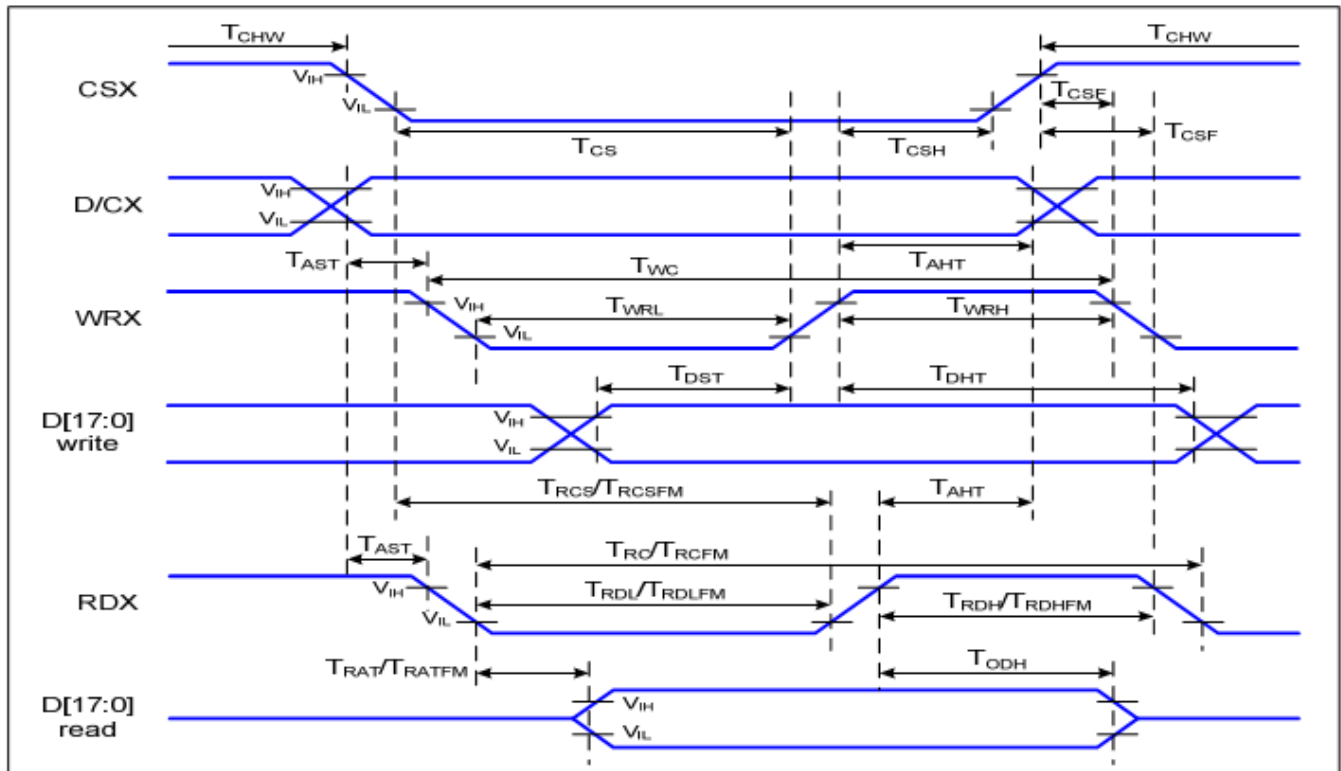


Figure 1 Parallel Interface Timing Characteristics (8080-Series MCU Interface)

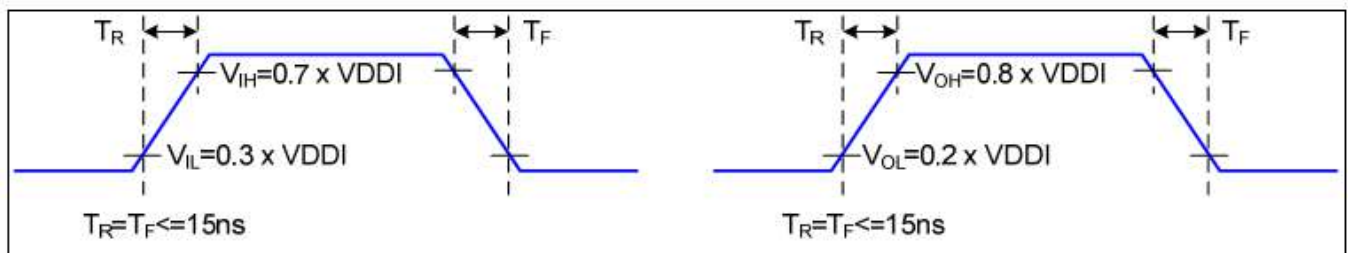


Figure 2 Rising and Falling Timing for I/O Signal

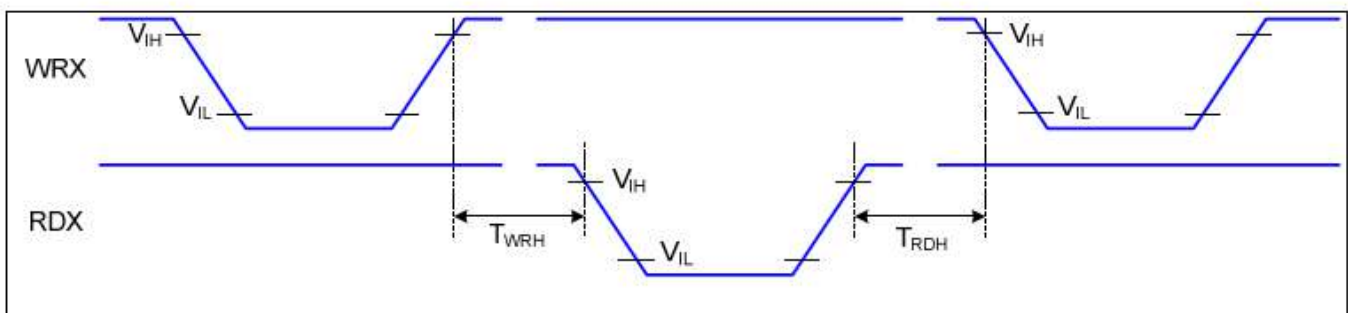


Figure 3 Write-to-Read and Read-to-Write Timing

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	

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

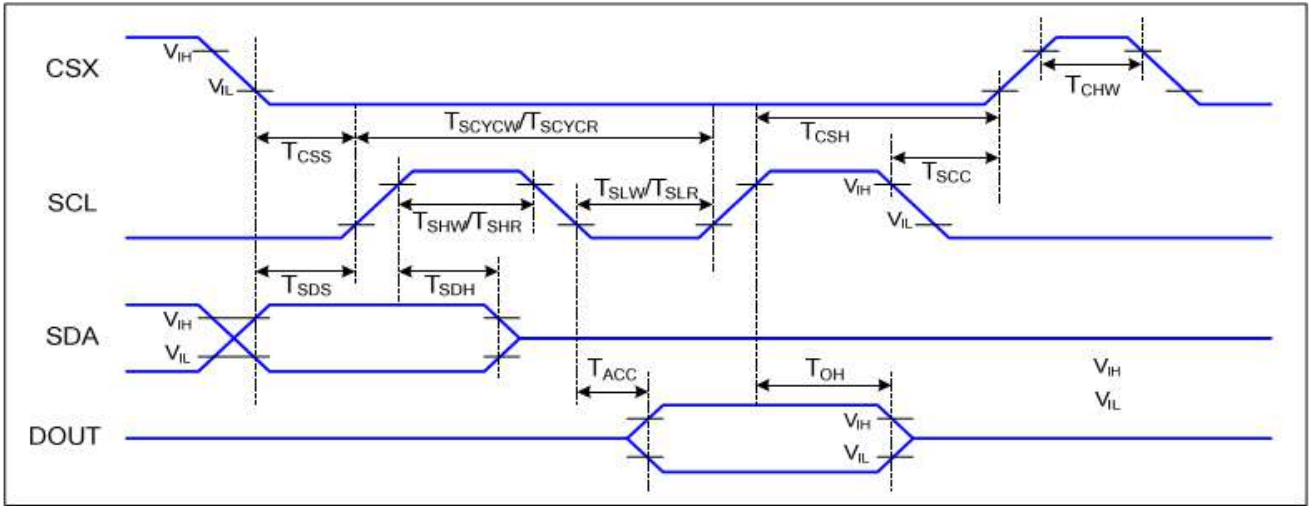


Figure 4 3-line serial Interface Timing Characteristics

VDDI=1.65 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		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

Display Serial Interface Timing Characteristics (4-line SPI system)

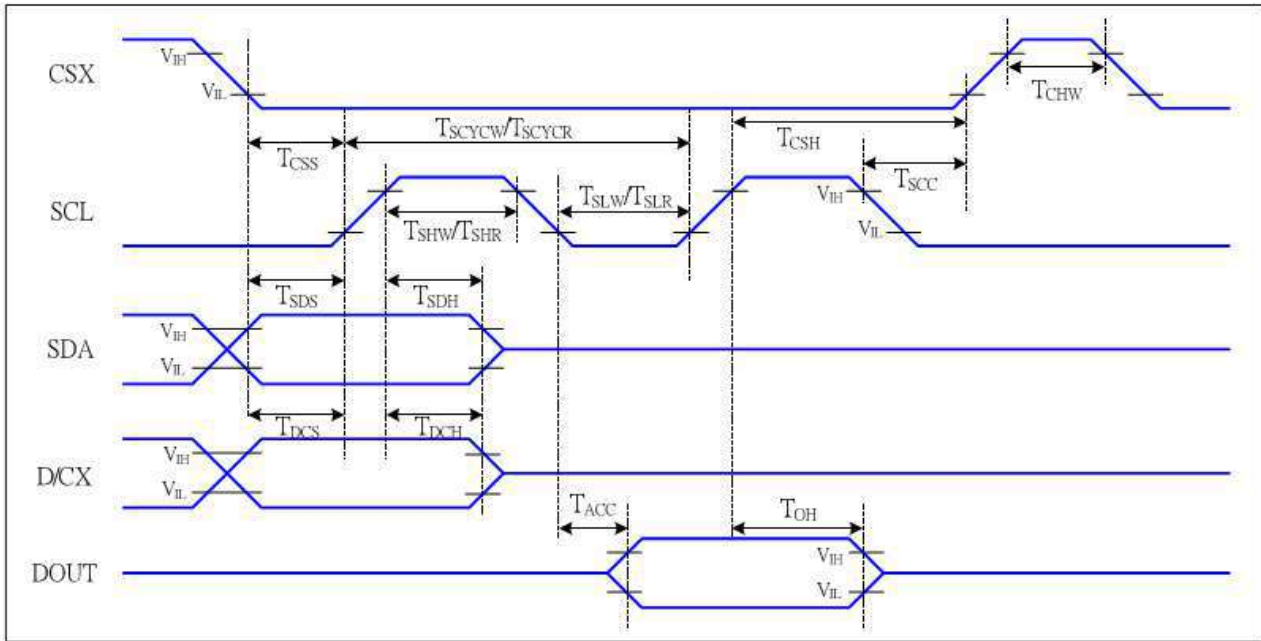


Figure 5 4-line serial Interface Timing Characteristics

$V_{DDI}=1.65$ to $3.3V$, $V_{DD}=2.4$ to $3.3V$, $AGND=DGND=0V$, $T_a=-30$ 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	-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 $CL=8pF$

RGB Interface Characteristics

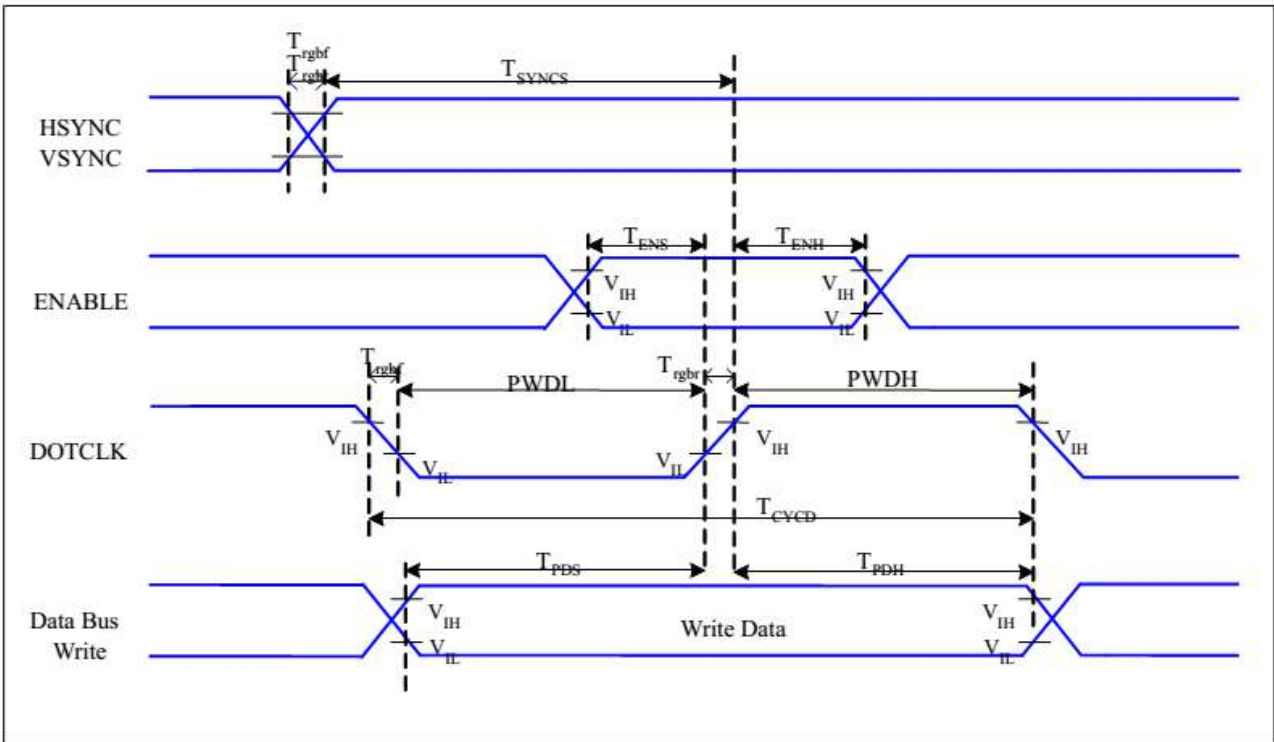


Figure 6 RGB Interface Timing Characteristics

$V_{DDI}=1.65$ to $3.3V$, $V_{DD}=2.4$ to $3.3V$, $AGND=DGND=0V$, $T_a=-30 \sim 70 \text{ }^\circ\text{C}$

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	

9. POWER SEQUENCE

VDDI and VDD can be applied in any order.

VDD and VDDI can be power down in any order.

During power off, if LCD is in the Sleep Out mode, VDD and VDDI must be powered down minimum 120msec after RESX has been released.

During power off, if LCD is in the Sleep In mode, VDDI or VDD can be powered down minimum 0msec after RESX has been released.

CSX can be applied at any timing or can be permanently grounded. RESX has priority over CSX.

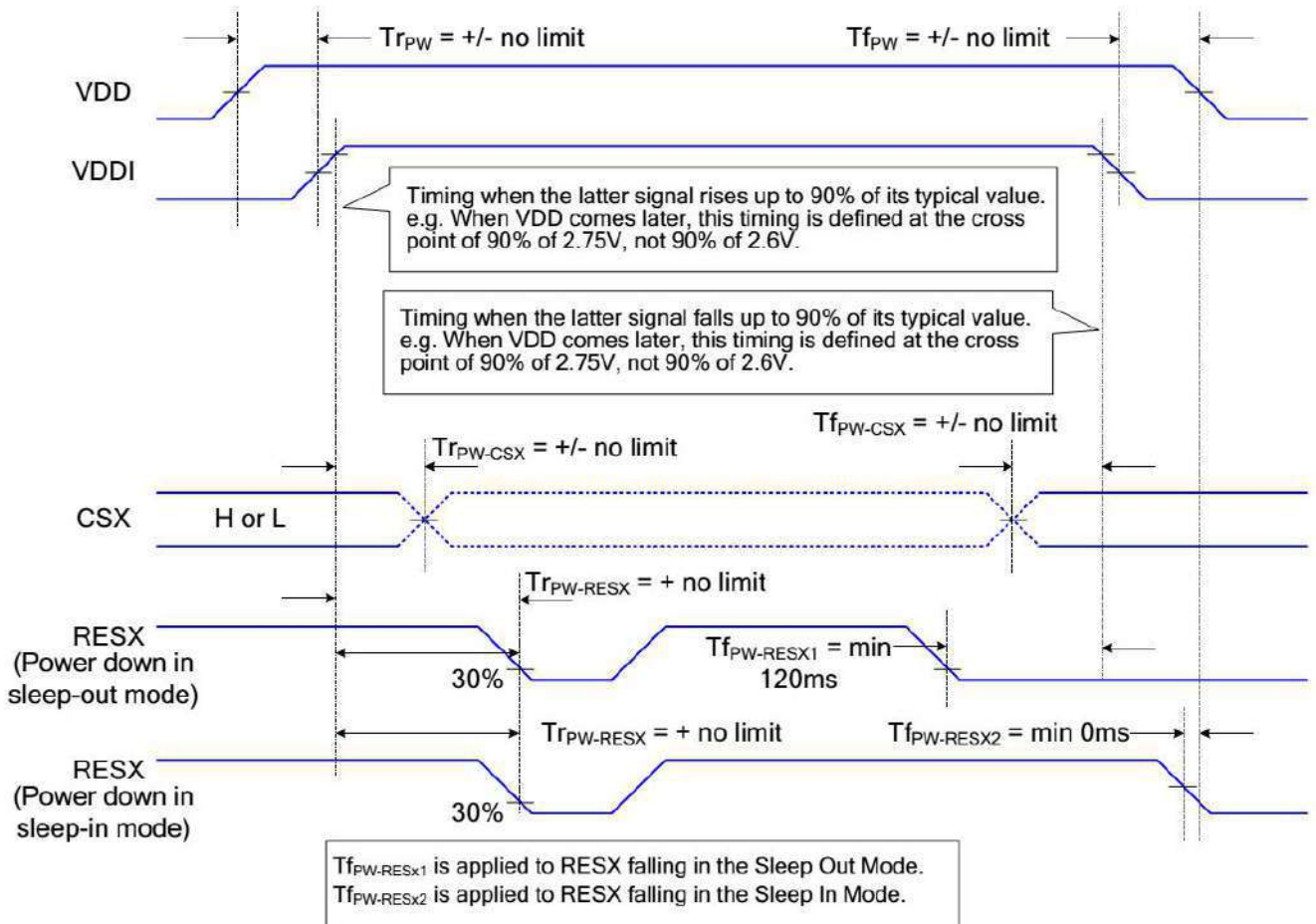
Note 1: There will be no damage to the display module if the power sequences are not met.

Note 2: There will be no abnormal visible effects on the display panel during the Power On/Off Sequences.

Note 3: There will be no abnormal visible effects on the display between end of Power On Sequence and before receiving Sleep Out command. Also between receiving Sleep In command and Power Off Sequence.

Note 4: If RESX line is not held stable by host during Power On Sequence as defined in the sequence below, then it will be necessary to apply a Hardware Reset (RESX) after Host Power On Sequence is complete to ensure correct operation. Otherwise function is not guaranteed.

The power on/off sequence is illustrated below



10. RELIABILITY TEST CONDITIONS

No.	Test item	Test condition	Inspection after test	
10.1	High temperature storage test	+80°C/240 hours	Inspection after 2~4hours storage at room temperature, the sample shall be free from defects : 1.Current changing value before test and after test is 50% larger; 2. Function defect : Non-display,abnormal-d isplay,missing lines, Short lines,I/O corrosion; 3.Visual defect : Air bubble in the LCD,Seal leak,Glass crack.	
10.2	Low temperature storage test	-30°C/240 hours		
10.3	High temperature operating test	+70°C/120 hours		
10.4	Low temperature operating test	-20°C/120 hours		
10.5	Temperature cycle storage test	-30°C ~ 25°C ~ +80°C/10cycles (30min.) (10min.) (30min.)		
10.6	High temperature high humidity test	+50°C*90% RH/120 hours		
10.7	Vibration test	Frequency : 250 r/min Amplitude : 1 inch Time: 45min		
10.8	Drop test	Drop direction: 1 corner/3 edges/6 sides 10 time		
		Packing weight(kg)		Drop height(cm)
		<11		80±1.6
		11≤G<21	60±1.2	
		21≤G<31	50±1.0	
		31≤G<40	40±0.8	
10.9	ESD test	Air discharge: ±8KV, 10time Contact discharge: ±4KV, 10time		
Remark : 1.The test samples should be applied to only one test item. 2.Sample size for each test item is 3~5pcs. 3.For High temperature high humidity test, Pure water(Resistance>10MΩ) should be used. 4.In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judged as a good part. 5.B/L evaluation should be excepted from reliability test with humidity and temperature: Some defects such as black spot/blemish can happen by natural chemical reaction with humidity and Fluorescence B/L has. 6.Failure judgment criterion: Basic specification, Electrical characteristic, Mechanical characteristic, Optical characteristic. 7.After the reliability test, the product only guarantees operation, but don't guarantee all of the cosmetic specification.				

11. INSPECTION CRITERION

00-QA-007-2.3 《Inspection Criterion for TFT Products-To customer》

12. HANDLING PRECAUTIONS

12.1 Mounting method

The LCD module consists of two thin glass plates with polarizers which easily be damaged. And since the module is so constructed as to be fixed by utilizing fitting holes in the printed circuit board.

Extreme care should be needed when handling the LCD modules.

12.2 Caution of LCD handling and cleaning

When cleaning the display surface, Use soft cloth with solvent [recommended below] and wipe lightly :

- .Isopropyl alcohol
- .Ethyl alcohol

Do not wipe the display surface with dry or hard materials that will damage the polarizer surface.

Do not use the following solvent :

- .Water
- .Aromatics

Do not wipe ITO pad area with the dry or hard materials that will damage the ITO patterns

Do not use the following solvent on the pad or prevent it from being contaminated :

- .Soldering flux
- .Chlorine (Cl) , Sulfur (S)

If goods were sent without being silicon coated on the pad, ITO patterns could be damaged due to the corrosion as time goes on.

If ITO corrosion happens by miss-handling or using some materials such as Chlorine (Cl), Sulfur (S) from customer, Responsibility is on customer.

12.3 Caution against static charge

The LCD module uses C-MOS LSI drivers, so we recommend that you :

Connect any unused input terminal to Vdd or Vss, do not input any signals before power is turned on, and ground your body, work/assembly areas, assembly equipment to protect against static electricity.

12.4 Packing

Modules employ LCD elements and must be treated as such.

- .Avoid intense shock and falls from a height.
- .To prevent modules from degradation, do not operate or store them exposed direct to sunshine or high temperature/humidity.

12.5 Caution for operation

- .It is an indispensable condition to drive LCD's within the specified voltage limit since the higher voltage than the limit causes the shorter LCD life.
- .An electrochemical reaction due to direct current causes LCD's undesirable deterioration, so that the use of direct current drive should be avoided.
- .Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD's show dark color in them. However those phenomena do not mean malfunction or out of order with LCD's, which will come back in the specified operation temperature.
- .If the display area is pushed hard during operation, some font will be abnormally displayed but it resumes normal condition after turning off once.
- .A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit.
- .Usage under the maximum operating temperature, 50%Rh or less is required.
- .When fixed patterns are displayed for a long time, remnant image is likely to occur.

12.6 Storage

In the case of storing for a long period of time for instance, for years for the purpose or replacement use, the following ways are recommended.

- .Storing in an ambient temperature 10°C to 30°C, and in a relative humidity of 45% to 75%. Don't expose to sunlight or fluorescent light.
- .Storing in a polyethylene bag with the opening sealed so as not to enter fresh air outside in it . And with no desiccant.
- .Placing in a dark place where neither exposure to direct sunlight nor light's keeping the storage temperature range.

- .Storing with no touch on polarizer surface by the anything else.

It is recommended to store them as they have been contained in the inner container at the time of delivery from us.

12.7 Safety

- .It is recommendable to crash damaged or unnecessary LCD's into pieces and wash off liquid crystal by either of solvents such as acetone and ethanol, which should be burned up later.
- .When any liquid leaked out of a damaged glass cell comes in contact with your hands, please wash it off well with soap and water.

13. PRECAUTION FOR USE

13.1 A limit sample should be provided by the both parties on an occasion when the both parties agreed its necessity. Judgment by a limit sample shall take effect after the limit sample has been established and confirmed by the both parties.

13.2 On the following occasions, the handing of problem should be decided through discussion and agreement between responsible of the both parties.

- .When a question is arisen in this specification.
- .When a new problem is arisen which is not specified in this specifications.
- .When an inspection specifications change or operating condition change in customer is reported to ODNA, and some problem is arisen in this specification due to the change.
- .When a new problem is arisen at the customer's operating set for sample evaluation in the customer site.

14. PACKING SPECIFICATION

Please consult our technical department for detail information.

15. INITIALIZATION CODE

```
WriteComm(0x11);
Delay(120); //Delay 120ms
//-----Display Setting-----//
WriteComm(0x36);
WriteData(0x00);
WriteComm(0x3a);
WriteData(0x66);
WriteComm(0x21);
//-----ST7789V Frame rate setting-----//
WriteComm(0xb2);
WriteData(0x0c);
WriteData(0x0c);
WriteData(0x00);
WriteData(0x33);
WriteData(0x33);
WriteComm(0xb7);
WriteData(0x75);
//-----ST7789V Power setting-----//
WriteComm(0xb0);
WriteData(0x11);
WriteComm(0xbb);
WriteData(0x13);
WriteComm(0xc0);
WriteData(0x2c);
WriteComm(0xc2);
WriteData(0x01);
WriteComm(0xc3);
WriteData(0x13);
WriteComm(0xc4);
WriteData(0x20);
WriteComm(0xc6);
WriteData(0x0f);
WriteComm(0xd0);
WriteData(0xa4);
WriteData(0xa1);
//-----ST7789V gamma setting-----//
WriteComm(0xE0);
WriteData(0x70);
WriteData(0x08);
WriteData(0x10);
WriteData(0x0D);
WriteData(0x0C);
WriteData(0x07);
WriteData(0x37);
WriteData(0x53);
WriteData(0x4C);
WriteData(0x39);
WriteData(0x15);
WriteData(0x15);
WriteData(0x2A);
WriteData(0x2D);

WriteComm(0xE1);
WriteData(0x70);
WriteData(0x0D);
WriteData(0x12);
WriteData(0x08);
WriteData(0x08);
WriteData(0x15);
WriteData(0x34);
```

WriteData(0x34);
WriteData(0x4A);
WriteData(0x36);
WriteData(0x12);
WriteData(0x13);
WriteData(0x2B);
WriteData(0x2F);
Delay(120);
WriteComm(0x29);
Delay(120);

16. HSF COMPLIANCE

•.This products complies with ROHS 2011/65/EU and 2015/863/EU、REACH 1907/2006/EC requirements, and the packaging complies with 94-62-EC.