



上海冠显光电科技有限公司
Shanghai Top Display Optoelectronics Co., LTD

LCD MODULE SPECIFICATION

Customer: _____

Module No.: TL024QVV35-I1249B

Date: 2023-10-13

Version: 2.0

For Customer's Acceptance:

Approved by	Comment

Approved by	Checked by	Prepared by
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Table of Contents

Record of Revision.....	3
1 General Specifications.....	4
2 Pin Assignment.....	5
3 Absolute Maximum Ratings	6
4. Electrical Characteristics	7
5 Timing Chart.....	8
6 Optical Characteristics	15
7 Environmental / Reliability Test	18
8 Mechanical Drawing.....	19
9 Precautions for Use of LCD Modules	20

Record of Revision

Rev.	Date	Description	Editor
1.0	2019-03-31	First release	Zaiping.Yang
2.0	2023-10-13	Update the parameters with the new SPEC.	Zaiping.Yang

1 General Specifications

No.	Item	Specification	Remark
1	LCD Size	2.4 inch (Diagonal)	
2	Driver Element	a-Si TFT active matrix	
3	Resolution	240 (RGB) × 320	
4	Display Mode	Normally White, Transmissive	
5	Pixel Pitch	0.153 (H) × 0.153 (V)	
6	Display Colors	65K/262K	
7	Surface Treatment	/	
8	Color Arrangement	RGB-Stripe	
9	Interface	3/4-line SPI / MCU / SPI+ RGB(Optional)	
10	Viewing Direction	6 O'clock	
11	Gray Scale Inversion Direction	12 O'clock	Note 1
12	Outline Dimension (mm)	42.72(W) × 60.26 (H) × 2.44 (T)	
13	Active Area (mm)	36.72 (W) × 48.96 (H)	
14	Touch Screen	Without CTP	
15	Display Driver IC	ST7789	
16	Touch Driver IC	--	

Note 1: Viewing direction for best image quality is different from TFT definition. There is a 180° shift.

Note 2: RoHS compliant.

2 Pin Assignment

2.1 LCD Pin assignment

Match connector: XF2M-4015-1A (OMRON) or equivalent.

PIN	Symbol	I/O	Description	Remark
1	TE	O	Tearing effect signal is used to synchronize MCU to frame memory writing.	
2~19	DB17~DB0	I	MCU Parallel Data bus; RGB Data bus,R5-0,G5-0,B5-0.	Note1
20	SDA	I	SPI interface input,The data is latched on the rising edge of the SCL signal.	
21	DOTCLK	I	Pixel clock signal in RGB I/F mode.	
22	ENABLE	I	Data enable signal in RGB I/F mode.	
23	HSYNC	I	Line synchronizing signal in RGB I/F mode.	
24	VSYNC	I	Vertical synchronizing signal in RGB I/F mode.	
25	RD	I	MCU Read enable in parallel interface.Not used, please fix this pin at VDDI or DGND.	
26	WR/SPI-RS	I	MCU Write strobe signal input pin; 4-line SPI Data/Instruction select input pin.	
27	DC/SPI-CLK	I	MCU Data or Instruction select input pin /Serial interface clock in 3/4-wire serial data interface	
28	CS	I	LCM Chip selection signal	
29	RESET	I	LCM Reset pin	
30	IM0	I	LCM Interface mode select, IM0	Note1
31	IM1	I	LCM Interface mode select, IM1	Note1
32	IM2	I	LCM Interface mode select, IM2	Note1
33	IM3	I	LCM Interface mode select, IM3	Note1
34	VDD	P	Power Supply for Analog, Digital System and Booster Circuit.	
35	VDDI	P	Power Supply for I/O System.	
36	VSS	P	Power/Ground.	
37	NC	--	Not connect, open pin	
38	NC	--	Not connect, open pin	
39	LEDK	P	LED Cathode.	
40	LEDA	P	LED Anode.	

I---Input, O---Output, P--- Power/Ground

Note1: The LCM supports 8/16/9/18 bit parallel data bus for 8080 series CPU, RGB serial interfaces. Selection of these interfaces are set by IM[3:0] pins as shown below.

IM3	IM2	IM1	IM0	Interface	Read Back Data Bus Selection
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

3 Absolute Maximum Ratings

Ta = 25°C

Item	Symbol	Min.	Max.	Unit	Remark
Power Voltage	VDD	-0.50	4.2	V	
	VDDI	-0.50	3.6	V	
Operating Temperature	Top	-20.0	70.0	°C	
Storage Temperature	T _{st}	-30.0	80.0	°C	
Operating and Storage Humidity	H _{stg}	10%	90%	%(RH)	

4. Electrical Characteristics

4.1 Recommended Operating Condition

VDD=3.3V, GND=0V, Ta = 25°C

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Power supply	VDD	2.8	3.0	3.3	V	
	VDDI	1.65	3.0	3.3	V	
Input Signal Voltage	Low Level	V _{IL}	0	-	0.3 x VDDI	V
	High Level	V _{IH}	0.7 x VDDI	-	VDDI	V
Current of Power supply	I _{DD}	-	20	60	mA	VDD=3.3V, Color bar pattern

4.2 Backlight Unit Driving Condition

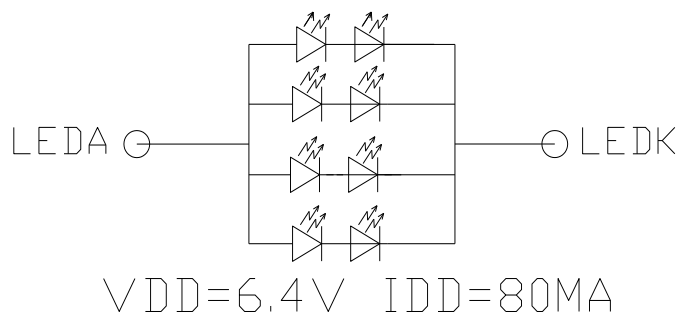
Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Forward Current	I _F	-	80	100	mA	4 Dual-coreLEDs (2 LED Serial, 4 LED Parallel)
Forward Current Voltage	V _F	-	6.4	6.8	V	
Backlight Power Consumption	W _{BL}	-	512	680	mW	
Operating Life Time	--	30000	--	--	hrs	Note 2, Note 3

Note1: The LED driving condition is defined for each module (1 LED Serial, 4 LED Parallel).

Note2: When LCM is operated, the stable forward current should be inputted. And forward voltage is for reference only.

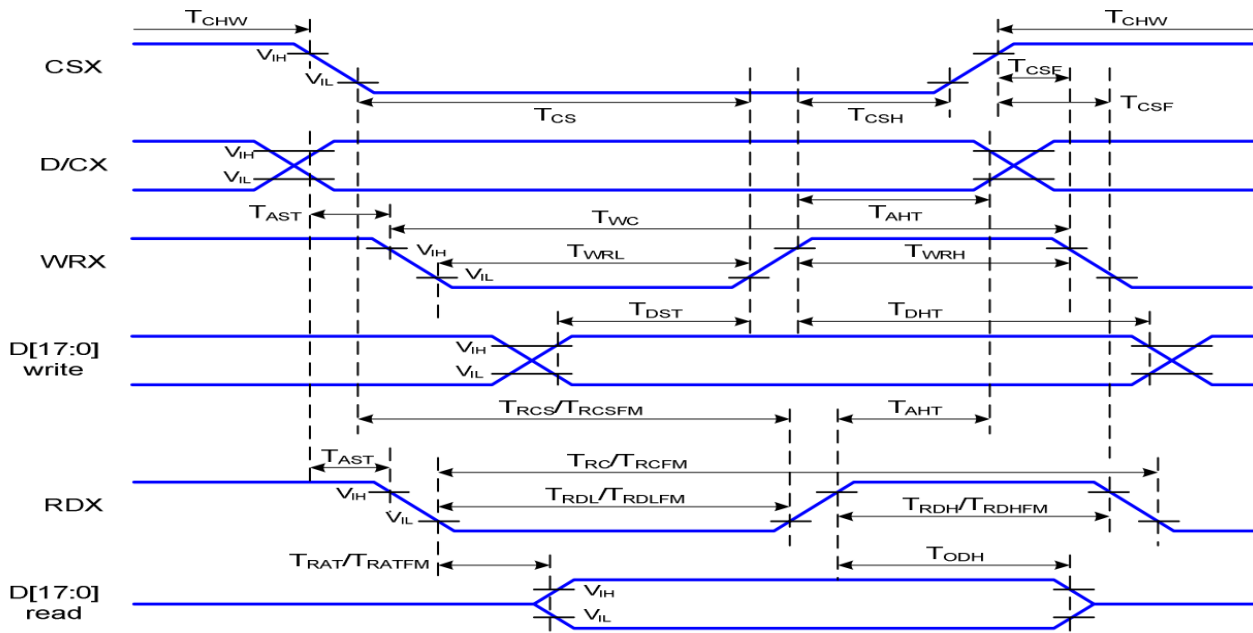
Note3: Optical performance should be evaluated at Ta=25°C When LED is driven at high current, high ambient temperature & humidity condition. The life time of LED will be reduced. Operating life means brightness goes down to 50% initial brightness. Typical operating life time is estimated data.

Note4: The LED driving condition is defined for each LED module.



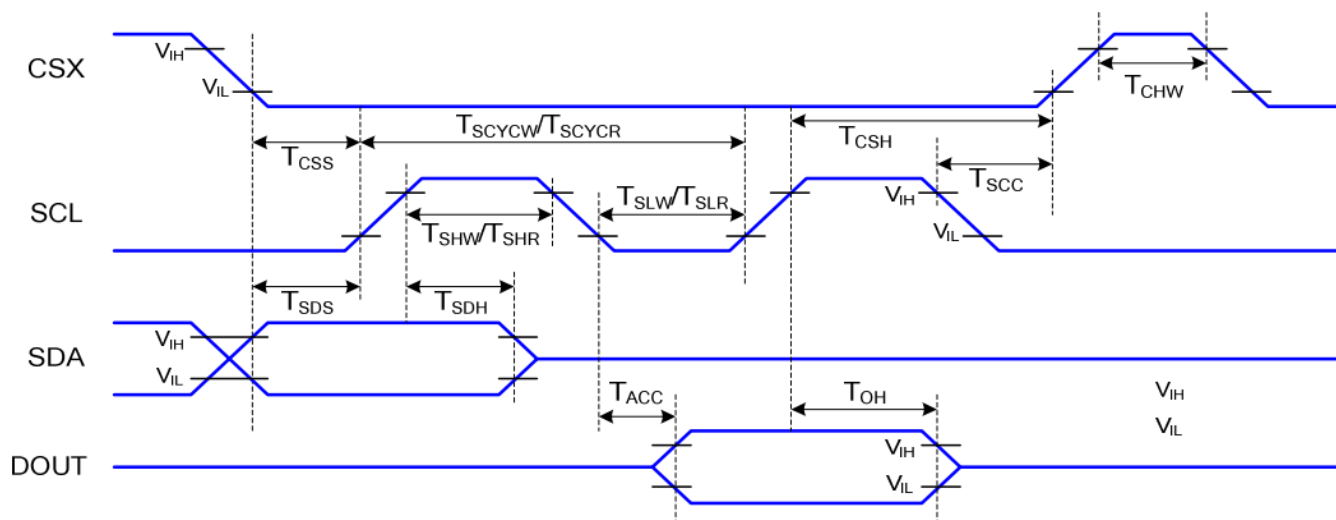
5 Timing Chart

5.1 Parallel 8/9/16/18 bit Interface Characteristics.



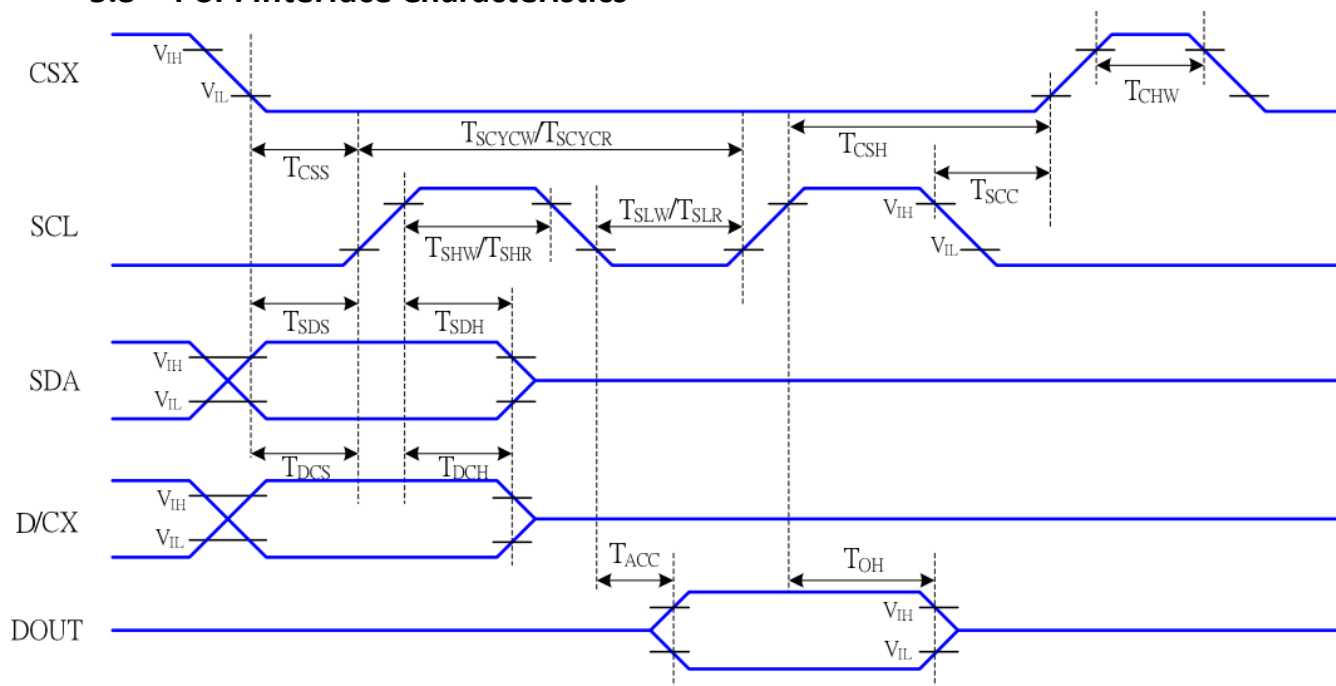
Signal	Symbol	Parameter	Min	Max	Unit	Description
D/CX	T_{AST}	Address setup time	0		ns	-
	T_{AHT}	Address hold time (Write/Read)	10		ns	
CSX	T_{CHW}	Chip select "H" pulse width	0		ns	-
	T_{CS}	Chip select setup time (Write)	15		ns	
	T_{RCS}	Chip select setup time (Read ID)	45		ns	
	T_{RCSFM}	Chip select 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_{RATEFM}	Read access time (FM)		340	ns	
	T_{ODH}	Output disable time	20	80	ns	

5.2 3-SPI Interface Characteristics.



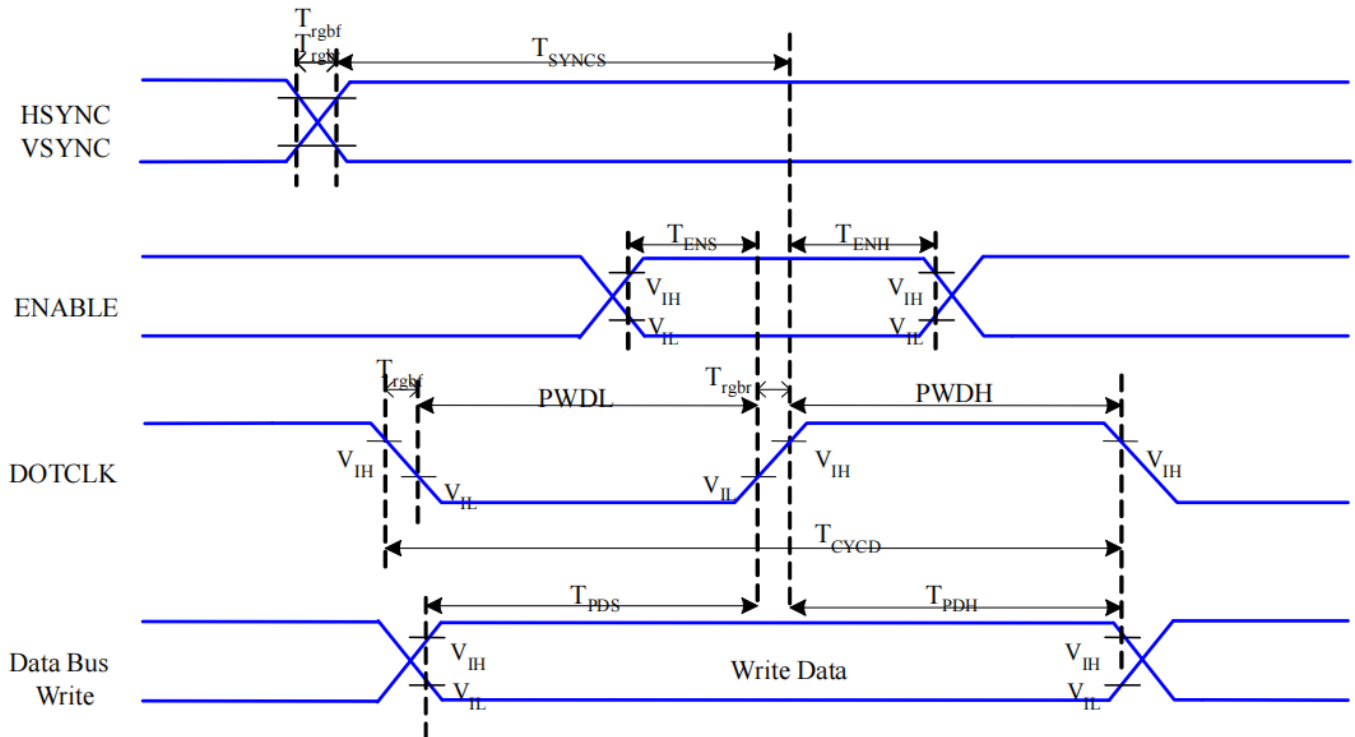
Signal	Symbol	Parameter	Min	Max	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15		ns	
	T_{CSH}	Chip select hold time (write)	15		ns	
	T_{CSS}	Chip select setup time (read)	60		ns	
	T_{SCC}	Chip select hold time (read)	65		ns	
	T_{CHW}	Chip select "H" pulse width	40		ns	
SCL	T_{SCYCW}	Serial 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

5.3 4-SPI Interface Characteristics



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

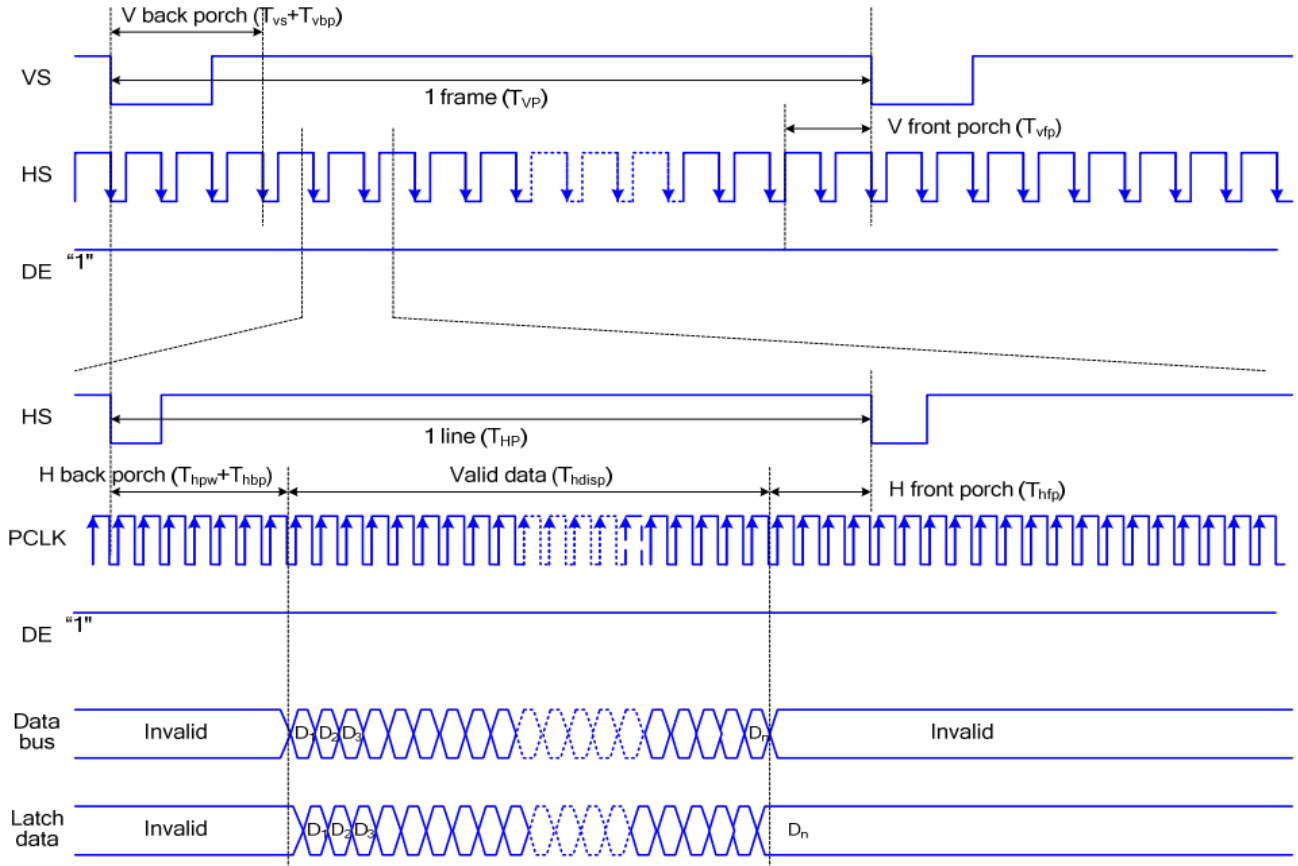
5.4 TFT-LCD Parallel 18/16 bit RGB Interface Characteristics



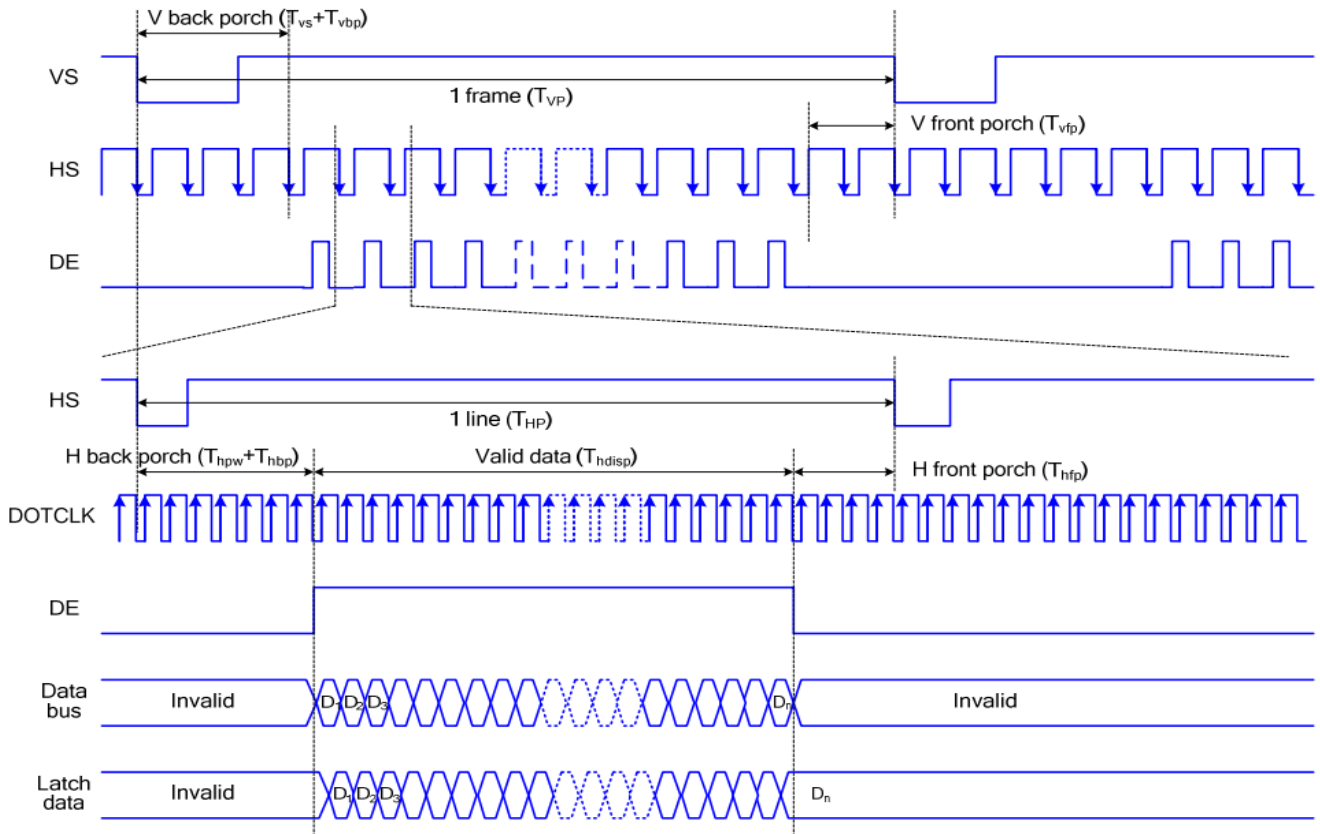
Signal	Symbol	Parameter	MIN	MAX	Unit	Description
HSYNC, VSNC	T_{SYNC}	VSNC, HSYNC Setup Time	30	-	ns	
ENABLE	T_{ENS}	Enable Setup Time	25	-	ns	
	T_{ENH}	Enable Hold Time	25	-	ns	
DOTCLK	PWDH	DOTCLK High-level Pulse Width	60	-	ns	
	PWDL	DOTCLK Low-level Pulse Width	60	-	ns	
	T_{CYCD}	DOTCLK Cycle Time	120	-	ns	
	$T_{\text{rghr}}, T_{\text{rghf}}$	DOTCLK Rise/Fall time	-	20	ns	
DB	T_{PDS}	PD Data Setup Time	50	-	ns	
	T_{PDH}	PD Data Hold Time	50	-	ns	

5.5 TFT-LCD Parallel 18/16 bit RGB Interface Timing

5.5.1 RGB HV Mode



5.5.2 RGB SYNC-DE Mode



5.5.3 Recommended Timing Setting of TCON

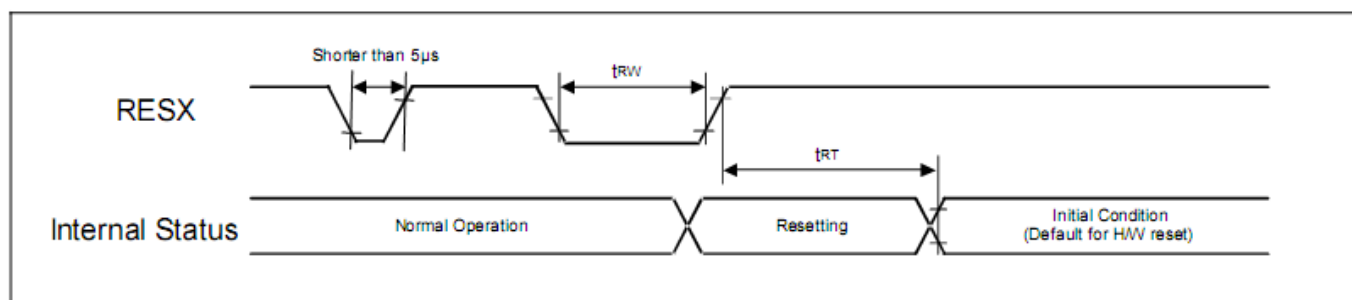
TCON (Embedded in Source IC) Input Timing (DCLK, HS, VS, DE)

VDD=3.3V, GND=0V, Ta=25°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
DCLK	Fclk	-	7	-	MHz	
	tclk	-	142	-	ns	
HSD	thd	240	240	240	tclk	
	thpw	2	10	-	tclk	
	thb	4	10	-	tclk	
	thfp	2	38	-	tclk	
VSD	tvd	320	320	320	th	
	tvpw	1	4	-	th	
	tvb	1	4	-	th	
	tvfp	1	8	-	th	

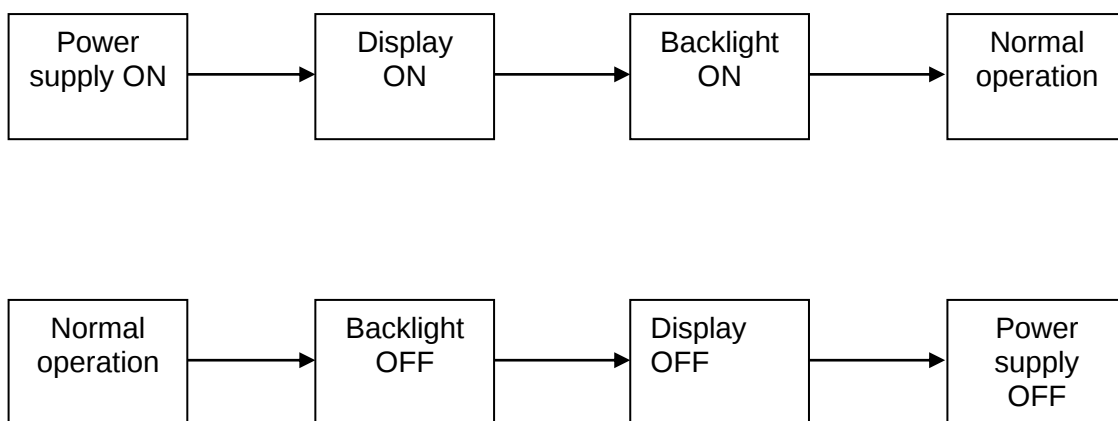
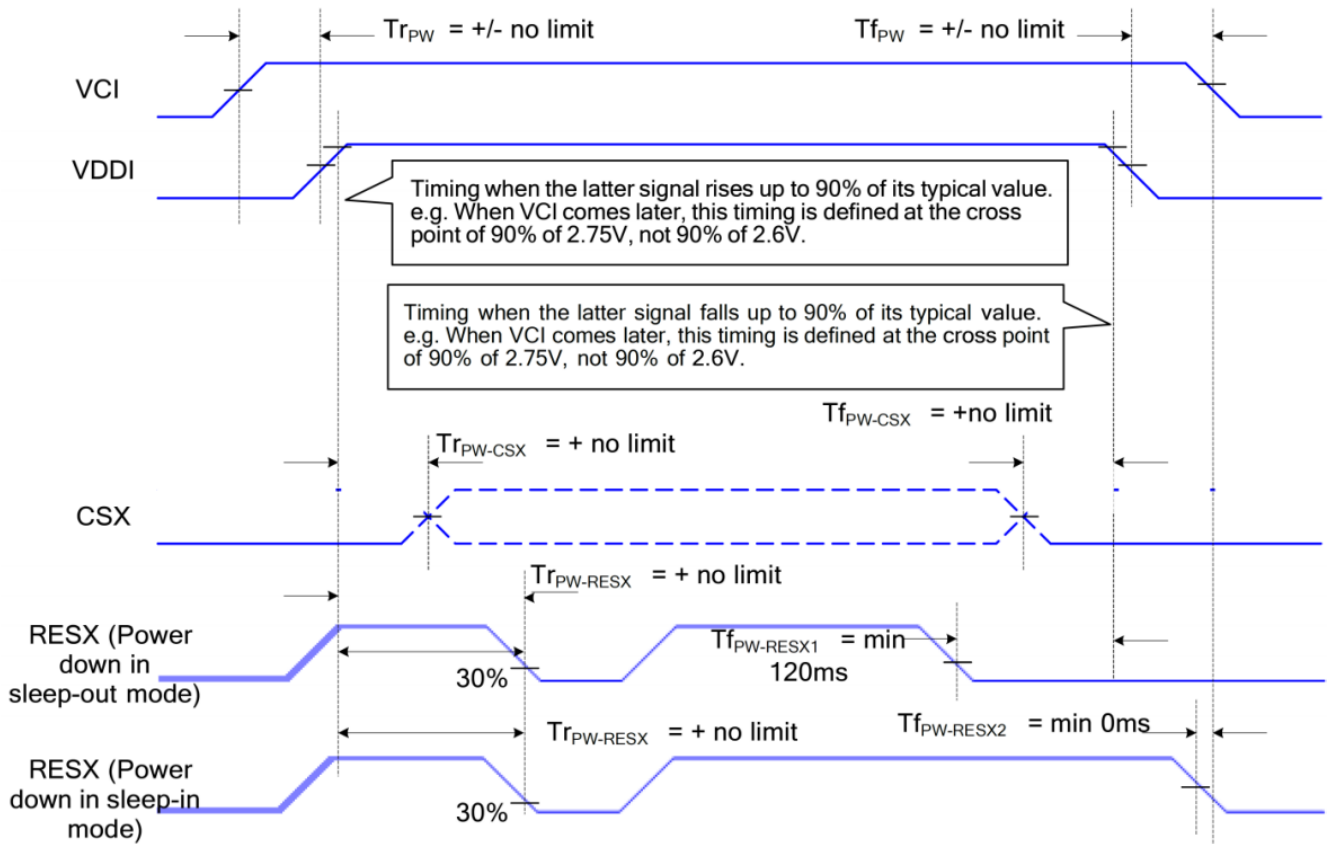
Note: For reference only, it needs to be adjusted according to the actual display effect.

5.6 Reset timing



Symbol	Parameter	Related pins	Min.	Max.	Unit
t _{RW}	Reset pulse width ⁽²⁾	RESX	10	-	µs
t _{RT}	Reset complete time ⁽³⁾	-	-	5	ms
		-	-	120	ms

5.7 Power ON/OFF Timing (VCI=VDD)



6 Optical Characteristics

Ta=25℃

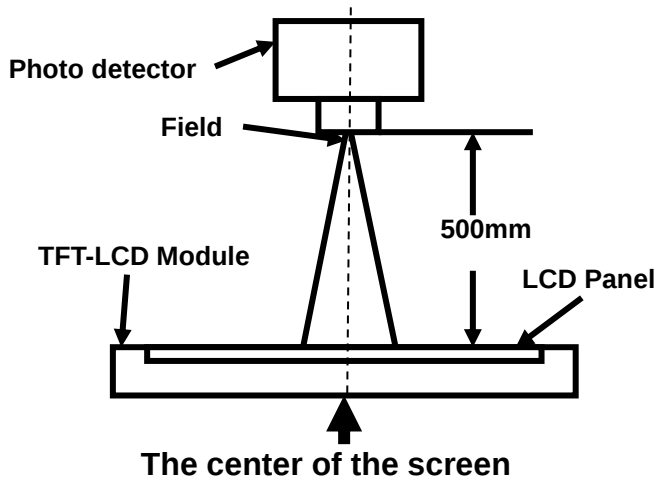
Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
View Angles		θT	CR ≧ 10	-	60	-	Degree	Note 2
		θB		-	55	-		
		θL		-	60	-		
		θR		-	60	-		
Contrast Ratio		CR	θ=0°	-	500	-		Note1 Note3
Response Time		T _{ON}	25℃	-	30	-	ms	Note1 Note4
		T _{OFF}						
Chromaticity	White	x	Backlight is on	0.239	0.269	0.299		Note1 Note5
		y		0.236	0.266	0.296		
	Red	x		0.566	0.596	0.626		
		y		0.317	0.347	0.377		
	Green	x		0.281	0.311	0.341		
		y		0.527	0.557	0.587		
	Blue	x		0.124	0.154	0.184		
		y		0.038	0.068	0.098		
Uniformity		U		80	85	-	%	Note1 Note6
NTSC				-	55	-	%	Note 5
Luminance		L		-	900	-	cd/m²	Note1 Note7

Test Conditions:

1. $I_F = 80 \text{ mA}$, $V_F = 6.4 \text{ V}$ and the ambient temperature is $25 \pm 2^\circ\text{C}$. humidity is $65 \pm 7\%$
2. The test systems refer to Note 1 and Note 2.

Note 1: Definition of optical measurement system.

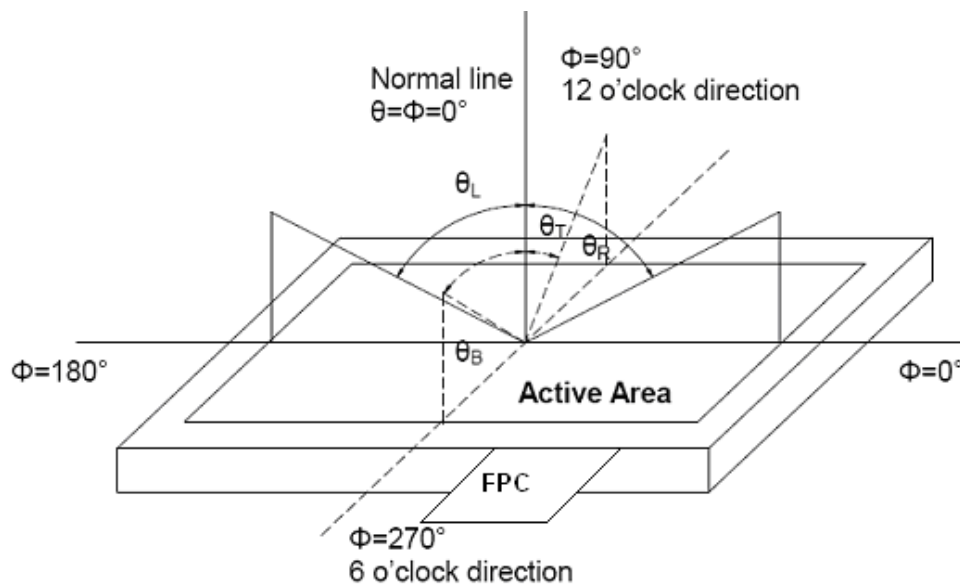
Properties are measured at the center point of the LCD screen. All input terminals LCD panel must be ground when measuring the center area of the panel.



Item	Photo detector	Field
Contrast Ratio	SR-3A or similar equipment	1°
Luminance		
Chromaticity		
Lum Uniformity		
Response Time	BM-7A	2°

Note 2: Definition of viewing angle range and measurement system.

Viewing angle is measured at the center point of the LCD by CONOSCOPE(ergo-80).



Note 3: Definition of contrast ratio

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

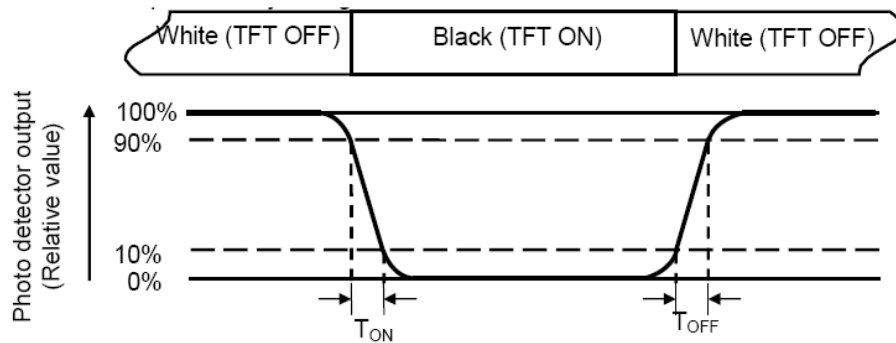
"White state ": The state is that the LCD should drive by Vwhite.

"Black state": The state is that the LCD should drive by Vblack.

Vwhite: To be determined Vblack: To be determined.

Note 4: 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%.



Note 5: Definition of color chromaticity (CIE1931)

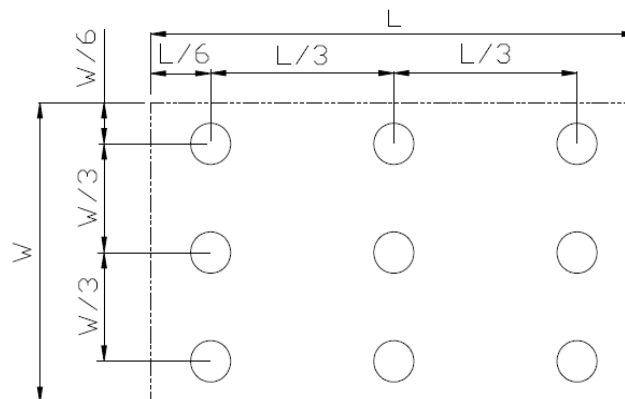
Color coordinates measured at center point of LCD.

Note 6: Definition of luminance uniformity

Active area is divided into 9 measuring areas (Refer Fig. 2). Every measuring point is placed at the center of each measuring area.

$$\text{Luminance Uniformity (U)} = L_{\min} / L_{\max}$$

L-----Active area length W----- Active area width



$L_{\max}$: The measured Maximum luminance of all measurement position.

$L_{\min}$: The measured Minimum luminance of all measurement position.

Note 7: Definition of luminance:

Measure the luminance of white state at center point.

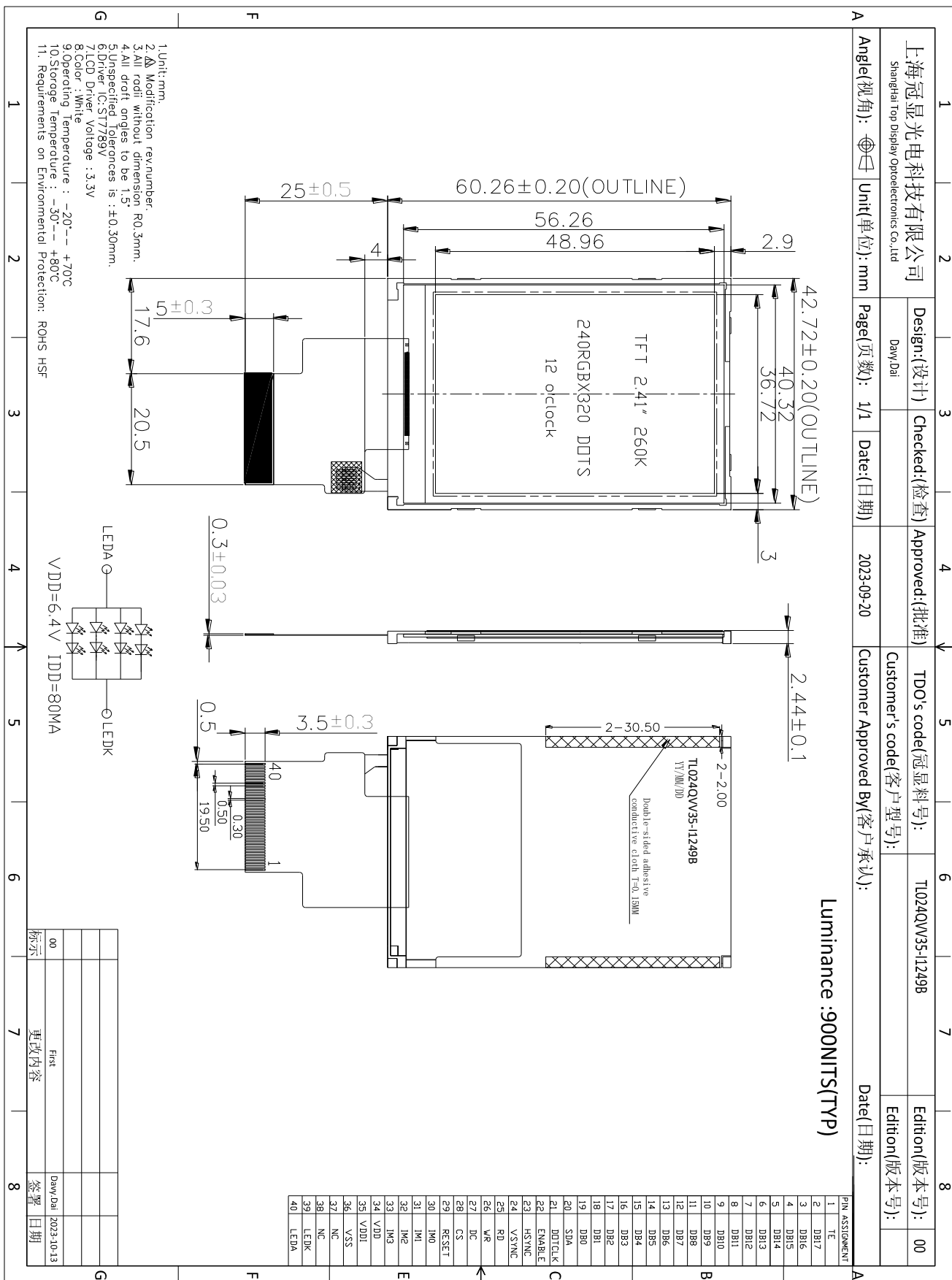
7 Environmental / Reliability Test

No	Test Item	Condition	Remarks
1	High Temperature Operation	Ts = +70℃, 240 hours	No abnormalities in functions
2	Low Temperature Operation	Ta = -20℃, 240 hours	No abnormalities in functions
3	High Temperature Storage	Ta = +80℃, 240 hours	No abnormalities in functions
4	Low Temperature Storage	Ta = -30℃, 240 hours	No abnormalities in functions
5	Storage at High Temperature and Humidity	Ta = +60℃, 90% RH max, 240 hours	No abnormalities in functions
6	Thermal Shock (non-operating)	-30℃ 30 min ~ +70℃ 30 min, Change time: 0.5 hour ← 5 min → 0.5 hour. 10 Cycle	Start with cold temperature, End with high temperature,
7	ESD	C=150pF, R=330Ω, 5 point/panel Air: ±8Kv, 5 times; Contact: ±4Kv, 5 times (Environment: 15℃~35℃, 30%~60% RH, 86Kpa~106Kpa)	No abnormalities in functions

Note1: Ts is the temperature of panel's surface.

Note2: Ta is the ambient temperature of samples.

8 Mechanical Drawing



9 Precautions for Use of LCD Modules

Handling Precautions

9.1.1 The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.

9.1.2 If the display panel is damaged and the liquid crystal substance inside it leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes, promptly wash it off using soap and water.

9.1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

9.1.4 The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

9.1.5 If the display surface is contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If still not completely clear, moisten cloth with one of the following solvents:

- Isopropyl alcohol
- Ethyl alcohol

Solvents other than those mentioned above may damage the polarizer. Especially, do not use the following:

- Water
- Ketone
- Aromatic solvents

9.1.6 Do not attempt to disassemble the LCD Module.

9.1.7 If the logic circuit power is off, do not apply the input signals.

9.1.8 To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

9.1.8.1 Be sure to ground the body when handling the LCD Modules.

9.1.8.2 Tools required for assembly, such as soldering irons, must be properly ground.

9.1.8.3 To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.

9.1.8.4 The LCD Module is coated with a film to protect the display surface. Be care when peeling off this protective film since static electricity may be generated.

Storage Precautions

9.2.1 When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.

9.2.2 The LCD modules should be stored under the storage temperature range. If the LCD modules will be stored for a long time, the recommend condition is: Temperature : 0°C ~ 40°C Relatively humidity: ≤80%

9.2.3 The LCD modules should be stored in the room without acid, alkali and harmful gas.

Transportation Precautions

9.3.1 The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.