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

LCD MODULE SPECIFICATION

Customer: _____

Module No.: TL040HDS31CT-B1623A

Date: 2024-08-15

Version: 1.0

□ **Pre-Specification for parameter checking**

■ **Final-Specification for sample approval**

For Customer's Acceptance:

Approved by	Comment

Approved by	Checked by	Prepared by
Kanglin.Zhong	Xianren.Zhou	Zaiping.Yang

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Record of Revision

Rev.	Date	Description	Editor
1.0	2024-08-15	First release	Zaiping.Yang

1 General Specifications

No.	Item	Specification	Remark
1	LCD Size	4.0 inch (Diagonal)	
2	Driver Element	a-Si TFT active matrix	
3	Resolution	720 (RGB) ×720	
4	Display Mode	Normally Black	
5	Pixel Pitch(mm)	0.0999 (H) × 0.0999 (V)	
6	Display Colors	16.7M	
7	Surface Treatment	AF	
8	Color Arrangement	RGB-Stripe	
9	Interface	MIPI	
10	Viewing Direction	ALL	
11	Gray Scale Inversion Direction	--	Note 1
12	Outline Dimension (mm)	84.0 (W) × 84.0 (H) × 2.59 (T)	
13	Active Area (mm)	71.93 (W) × 71.93 (H)	
14	Touch Screen	With CTP	
15	Display Driver IC	ST7703	
16	Touch Driver IC	FT6336U	

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-3015-1A by OMRON or equivalent

PIN	Symbol	I/O	Description	Remark
1	LEDA	P	LED ANODE	
2	LEDK1	P	LED CATHODE	
3	LEDK2	P	LED CATHODE	
4	VCI	P	LCD analog power supply (3.3V)	
5	IOVCC	P	LCD I/O power supply(1.8V)	
6	RESET	I	Reset Signal ,Active Low(1.8V)	
7	TE	O	Tearing effect(1.8V)， Not Connect	
8	PWM	-	Not Connect	
9	GND	P	Ground	
10	D0P	I/O	MIPI DSI differential data pair (Data lane 0)	
11	D0N	I/O	MIPI DSI differential data pair (Data lane 0)	
12	GND	P	Ground	
13	D1P	I	MIPI DSI differential data pair (Data lane 1)	
14	D1N	I	MIPI DSI differential data pair (Data lane 1)	
15	GND	P	Ground	
16	CLKP	I	MIPI DSI differential clock pair	
17	CLKN	I	MIPI DSI differential clock pair	
18	GND	P	Ground	
19	D2P	I	MIPI DSI differential data pair (Data lane 2)	
20	D2N	I	MIPI DSI differential data pair (Data lane 2)	
21	GND	P	Ground	
22	D3P	I	MIPI DSI differential data pair (Data lane 3)	
23	D3N	I	MIPI DSI differential data pair (Data lane 3)	
24	GND	P	Ground	
25	TP_INT	O	Touch Interrupt(1.8V)	
26	TP_SDA	I/O	Touch IIC Data signal(1.8V)	
27	TP_SCL	I	Touch IIC Clock signal(1.8V)	
28	TP_RESET	I	Touch Reset Signal(1.8V)	
29	TP_VCI	P	Touch IC analog power supply (3.3V)	
30	TP_IOVCC	P	Touch IC I/O power supply(1.8V~3.3V)	

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

NOTES:

When TP_IOVCC = 1.8 V, the TP I/O signal voltage is 1.8 V;

When TP_IOVCC = 2.8 V, the TP I/O signal voltage is 2.8 V.

3 Absolute Maximum Ratings

Ta = 25℃

Item	Symbol	Min.	Max.	Unit	Remark
Power Voltage	VCI	-0.50	4.2	V	
	IOVCC	-0.30	+2.2	V	
	TP_VCI	-0.30	+3.6	V	
	TP_IOVCC	-0.30	+3.6	V	
Operating Temperature	Top	-20.0	70.0	℃	
Storage Temperature	T_{st}	-30.0	80.0	℃	
Operating and Storage Humidity	H_{stg}	10%	90%	%(RH)	

4. Electrical Characteristics

4.1 Recommended Operating Condition

VCI=3.3V， GND=0V， Ta = 25℃

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Analog supply Voltage	VCI	2.8	3.0	3.3	V	
Digital supply Voltage	IOVCC	1.65	1.8	1.95	V	
TP Power	TP_VCI	2.8	3.3	3.3	V	
TP Power	TP_IOVCC	1.8	-	3.3	V	
Input logic high voltage	VIH	0.7 IOVCC	-	IOVCC	V	
Input logic low voltage	VIL	0		0.3 IOVCC	V	
Current of digital supply voltage	I_{IOVCC}	-	10	-	mA	
Current of LCM supply Voltage	I_{VCI}	--	50	--	mA	VCI=3.3V, color bar pattern

4.2 Backlight Unit Driving Condition

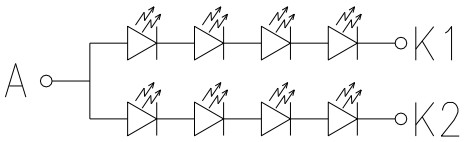
Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Forward Current	I_F	-	40	50	mA	8 LEDs (4 LED Serial, 2 LED Parallel)
Forward Current Voltage	V_F	-	12.8	14	V	
Backlight Power Consumption	W_{BL}	-	512	700	mW	
Operating Life Time	--	30000	--	--	hrs	Note 2, Note 3

Note1: The LED driving condition is defined for each module (4 LED Serial, 2 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℃ 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 DSI Interface Timing Characteristics

High Speed Mode

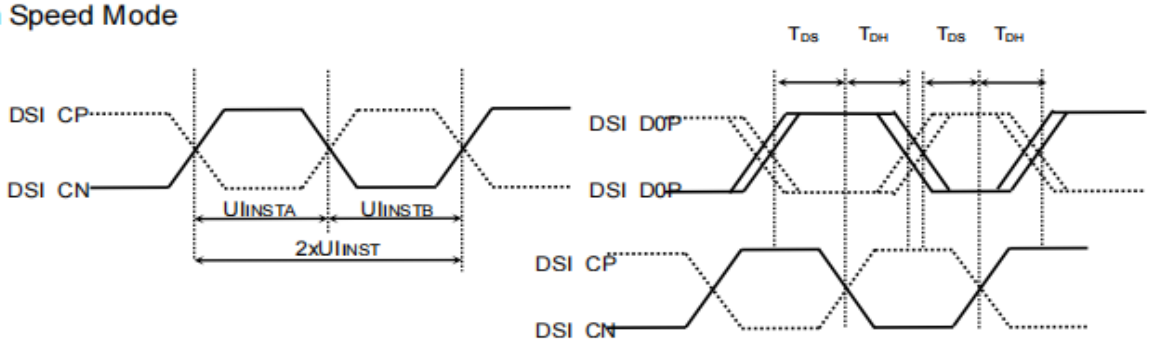
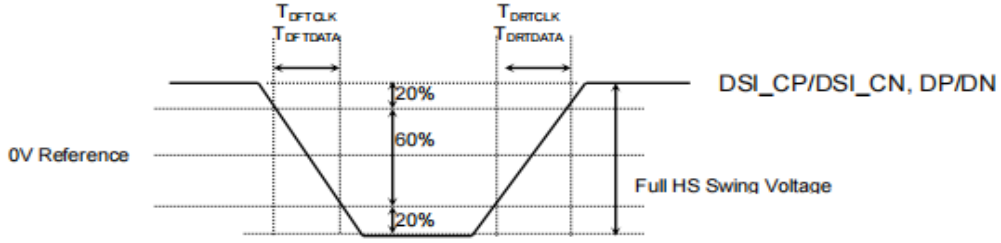


Figure 7-4: DSI clock timing Characteristics

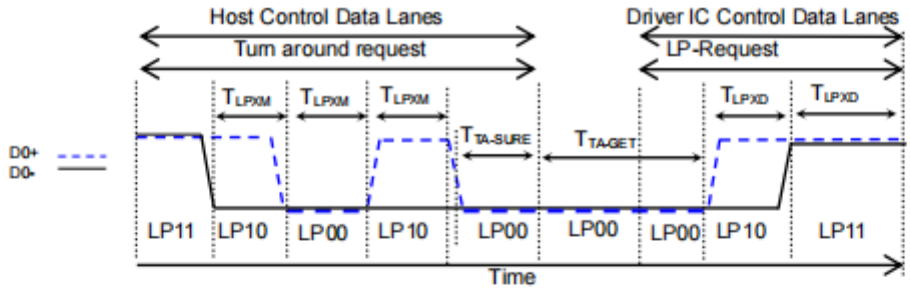


Rising and falling time on clock and data channel

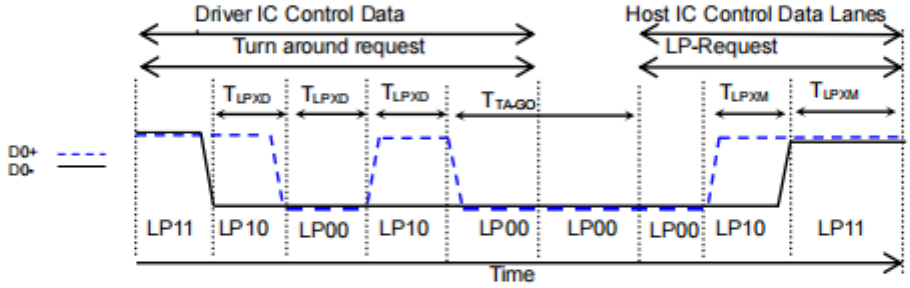
(VSSA=0V, IOVCC=1.65V to 3.3V, VCI=2.5V to 3.3V, T_A = -30 to 70°C)

Signal	Item	Symbol	Spec.			Unit
			Min.	Typ.	Max.	
DSI_CP/ DSI_CN	Double UI instantaneous	2xUINST	4LANE：3.30 3LANE：2.85 @ VDDD=1.8V	-	25	ns
	UI instantaneous	UINSTA UINSTB	4LANE：1.67 3LANE：1.43 @ VDDD=1.8V	-	12.5	ns
DP/DN	Data to clock setup time	TDS	0.15xUI	-	-	ps
	Data to clock hold time	TDH	0.15xUI	-	-	ps
DSI_CP/ DSI_CN	Differential rise time for clock	TDRTCLK	150	-	0.3UI	ps
	Differential fall time for clock	TDFTCLK	150	-	0.3UI	ps
DP/DN	Differential rise time for data	TDRTDATA	150	-	0.3UI	ps
	Differential fall time for data	TDFTDATA	150	-	0.3UI	ps

5.2 Low Power Mode



BTA from HOST to Display Module Timing



BTA from Display Module Timing to HOST

(VSSA=0V, IOVCC=1.65V to 3.3V, VCI=2.3V to 3.3V, T_A = -30 to 70°C)

Signal	Item	Symbol	Spec.			Unit
			Min.	Typ.	Max.	
DSI_D0P/ DSI_D0P	Length of LP-00/LP01/LP10/LP11 Host→ Display module	T_{LPXM}	50	-	-	ns
	Length of LP-00/LP01/LP10/LP11 Display module →Host	T_{LPXD}	50	-	-	ns
	Time-out before the MPU start driver	$T_{TA-SURE}$	T_{LPXD}	-	2xT_{LPXD}	ns
	Time to drive LP-00 by display module	T_{TA-GET}	5xT_{LPXD}	-	-	ns
	Time to drive LP-00 after turnaround request Host	T_{TAGO}	4xT_{LPXD}	-	-	ns

DSI Low Power Mode Characteristics

5.3 Reset input timing

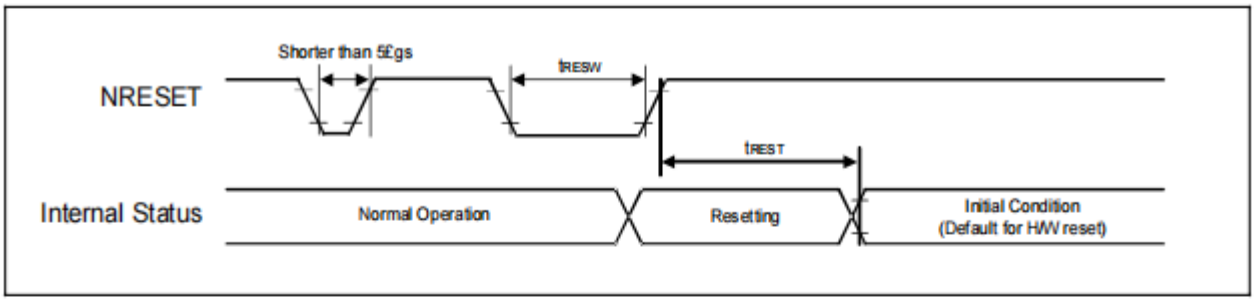


Figure 7-8: Reset input timing

Symbol	Parameter	Related Pins	Spec.			Note	Unit
			Min.	Typ.	Max.		
tRESW	Reset low pulse width(1)	NRESET	10	-	-	-	µs
tREST	Reset complete time(2)	-	15	-	-	When reset applied during SLPIN mode	ms
		-	120	-	-	When reset applied during SLPOUT mode	ms

Table 7-8: Reset Input Timing

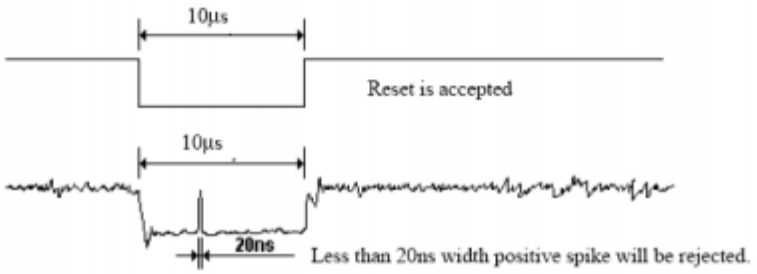
Note: (1) Spike due to an electrostatic discharge on NRESET line does not cause irregular system reset according to the following table.

NRESET Pulse	Action
Shorter than 5 µs	Reset Rejected
Longer than 10 µs	Reset
Between 5 µs and 10 µs	Reset Start

(2) During the resetting period, the display will be blanked (The display is entering blanking sequence, which Maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In –mode) and then return to Default condition for H/W reset.

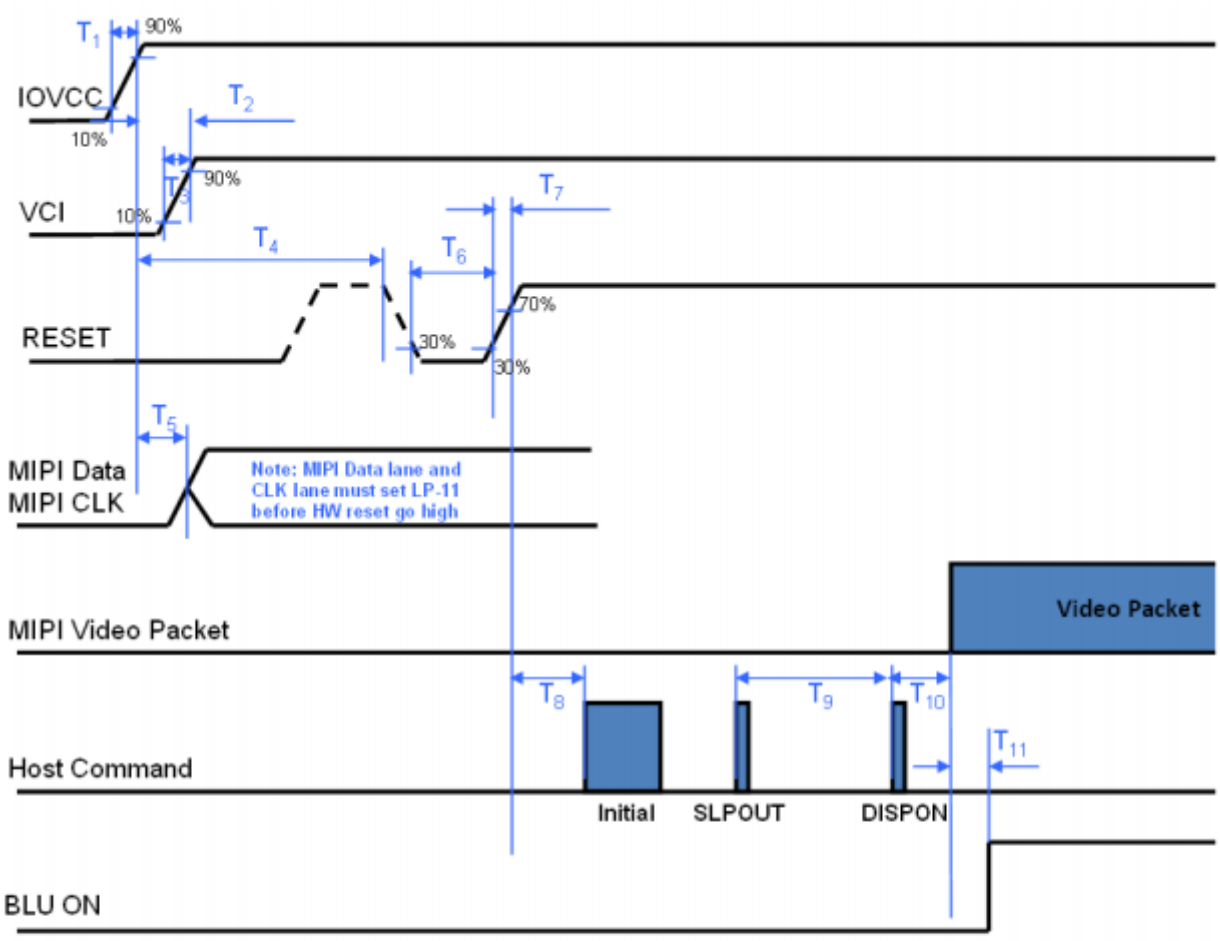
(3) During Reset Complete Time, ID and VCOM value in OTP will be latched to internal register during this period. This loading is done every time when there is H/W reset complete time (tREST) within 15ms after a rising edge of NRESET.

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



(5) It is necessary to wait 15msec after releasing NRESET before sending commands. Also Sleep Out command cannot be sent for 120msec.

5.4 Power On Timing

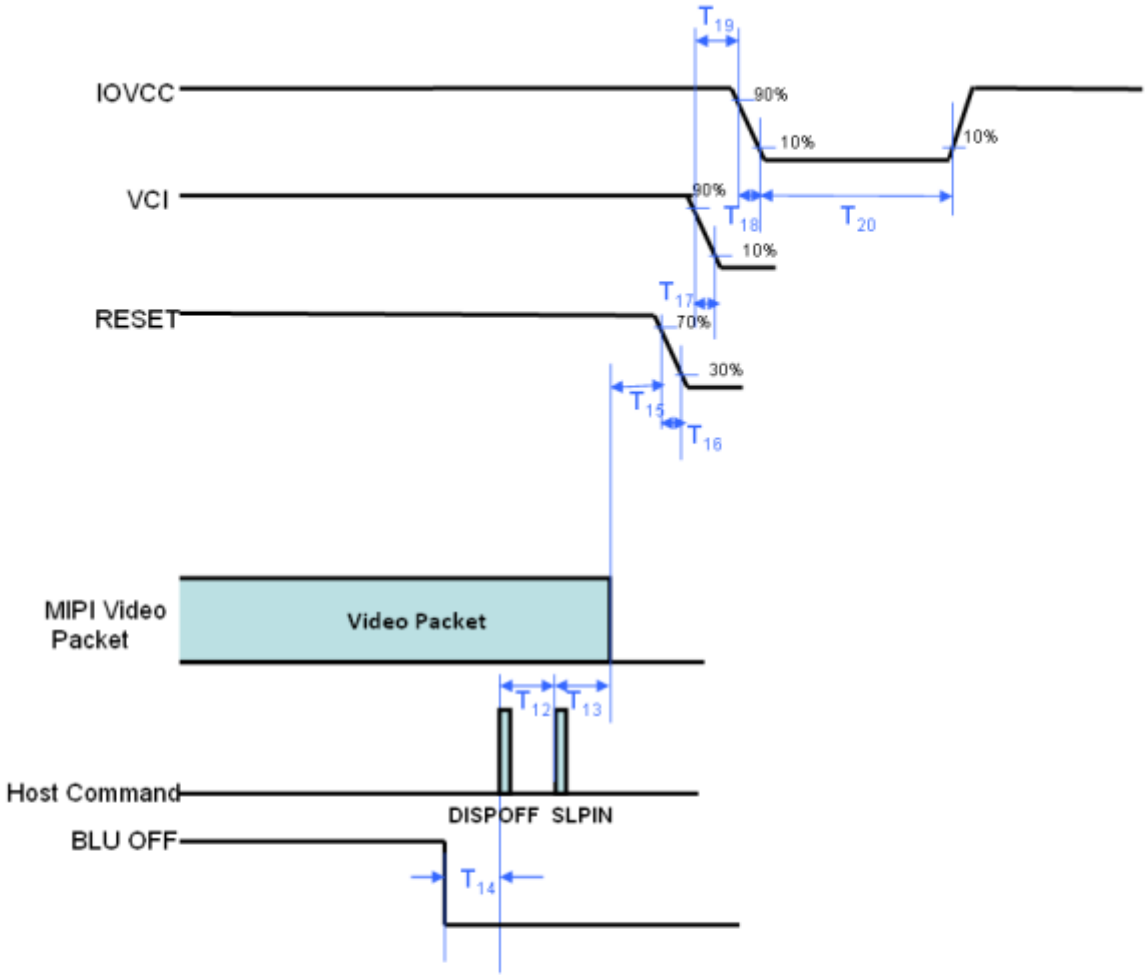


DSI Power On Sequence

	Min.	Typ.	Max.	Unit
T1	0.01	-	10	ms
T2		No Limit		ms
T3	0.01	-	10	ms
T4	1	-	-	ms
T5	1	-	-	ms
T6	10	-	-	us
T7		No Limit		ns
T8	15	-	-	ms
T9	120	-	-	ms
T10		No Limit		ms
T11	100	150	-	ms

DSI Power On Timing

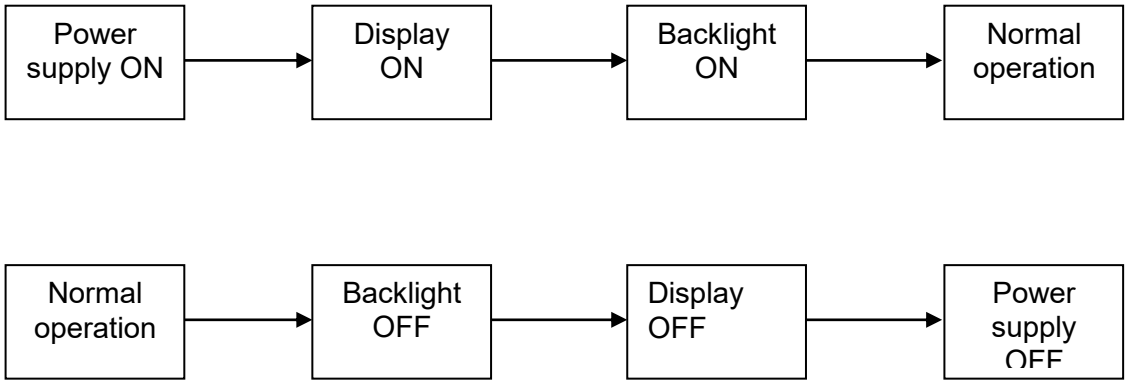
5.5 Power Off Timing



DSI Power Off Sequence

	Min.	Typ.	Max.	Unit
T12	2	-	-	Frame
T13	2	-	-	Frame
T14	40	100	-	ms
T15	10	-	-	ms
T16	No Limit			ms
T17	No Limit			ms
T18	No Limit			ms
T19	No Limit			ms
T20	100			ms

DSI Power Off Timing



5.6 Recommended Timing Setting of TCON

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

VCI=3.3V, GND=0V, Ta=25℃

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
DCLK	Fclk	-	35	-	MHz	
	tclk	-	28	-	ns	
HSD	thd	-	720	-	tclk	
	thpw	-	2	-	tclk	
	thb	-	46	-	tclk	
	thfp	-	44	-	tclk	
VSD	tvd	-	720	-	th	
	tvpw	-	2	-	th	
	tvb	-	18	-	th	
	tvfp	-	16	-	th	

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

6 Optical Characteristics

Ta=25℃

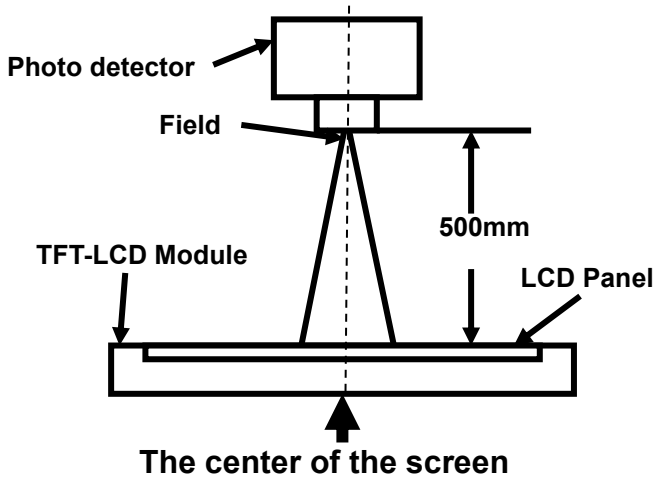
Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
View Angles		θT	CR≧10	80	85	-	Degree	Note 2
		θB		80	85	-		
		θL		80	85	-		
		θR		80	85	-		
Contrast Ratio		CR	θ=0°	800	1000	-		Note1 Note3
Response Time		T_{ON}	25℃	25	35	-	ms	Note1 Note4
		T_{OFF}						
Chromaticity	White	x	Backlight is on	0.261	0.291	0.321		Note1 Note5
		y		0.262	0.292	0.322		
	Red	x		0.635	0.650	0.665		
		y		0.303	0.318	0.333		
	Green	x		0.248	0.263	0.278		
		y		0.550	0.565	0.580		
	Blue	x		0.125	0.140	0.155		
		y		0.071	0.086	0.101		
Uniformity		U		80	85	--	%	Note1 Note6
NTSC				63	68	--	%	Note 5
Luminance		L		--	320	--	cd/m^2	Note1 Note7

Test Conditions:

1. I_F= 40 mA, V_F=12.8 V and the ambient temperature is 25±2℃.humidity is 65±7%
2. The test systems refer to Note 1 and Note 2.

Note 1: Definition of optical measurement system.

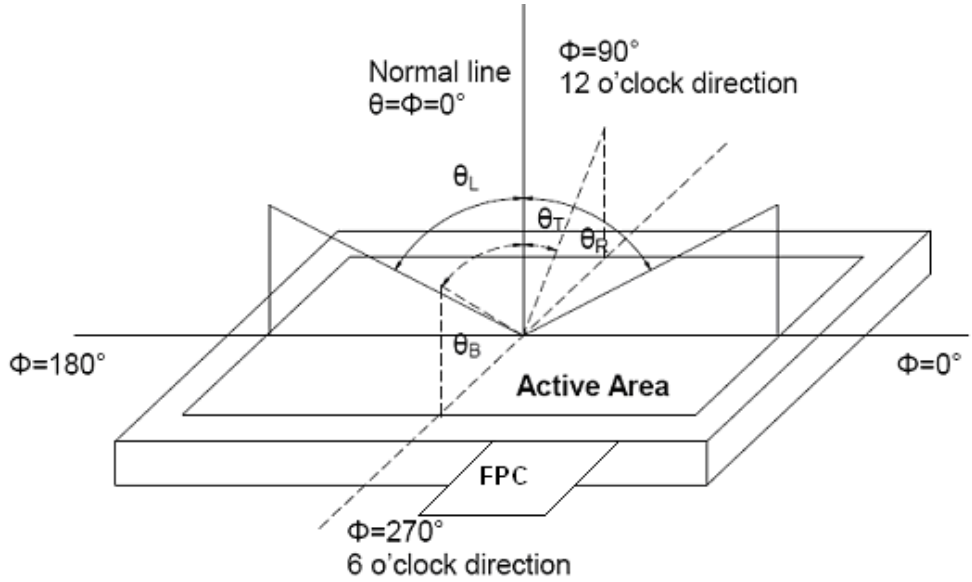
Properties are measured at the center point of the LCD screen. All input terminals LCD panel must be ground when measuring the center area of the panel.



Item	Photo detector	Field
Contrast Ratio	BM-7A 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

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

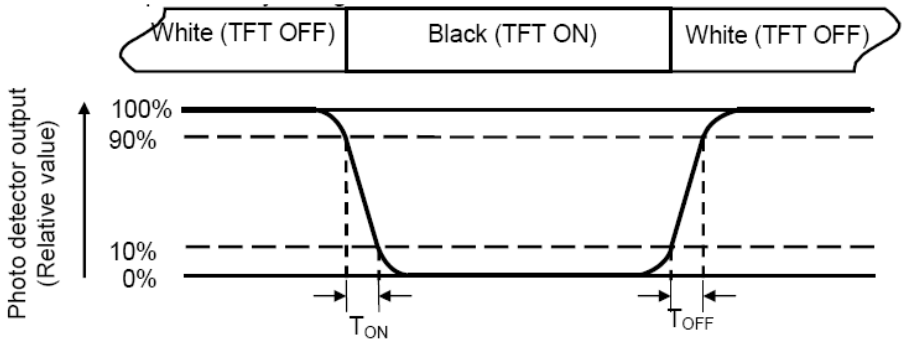
“White state “: The state is that the LCD should drive by Vwhite.

“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)

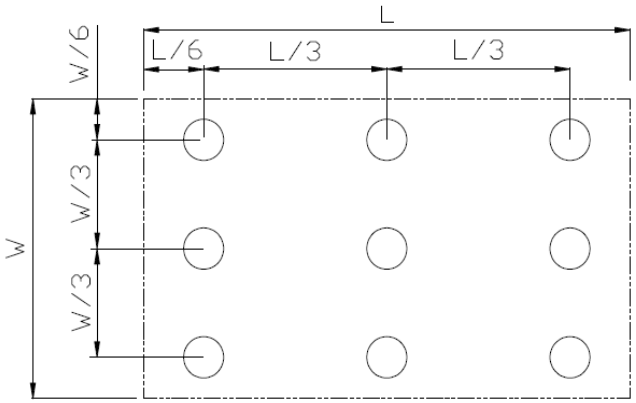
Color coordinates measured at center point of LCD.

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.

Luminance Uniformity (U) = Lmin/ Lmax

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



Lmax: The measured Maximum luminance of all measurement position.

Lmin: The measured Minimum luminance of all measurement position.

Note 7: Definition of luminance:

Measure the luminance of white state at center point.

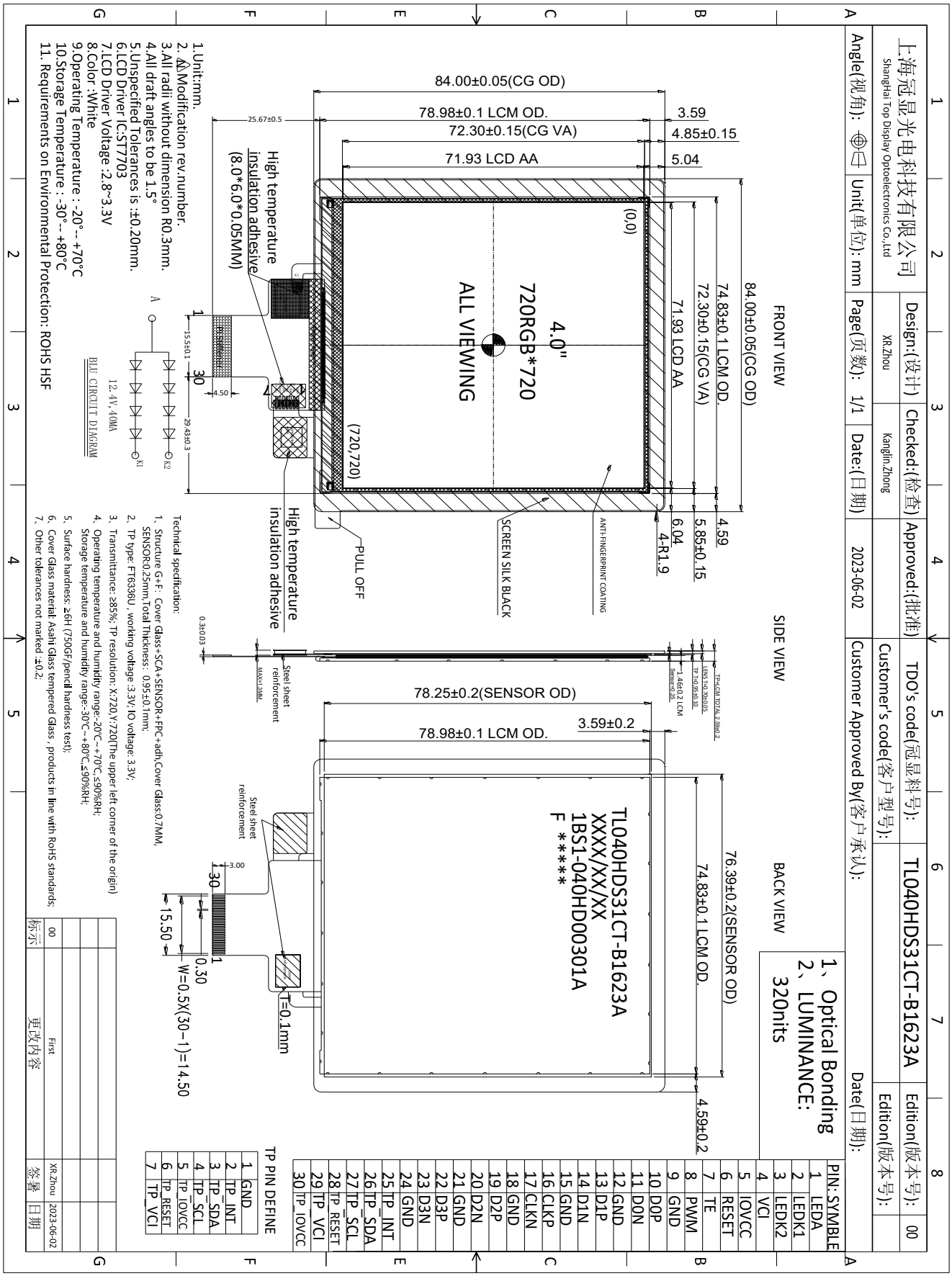
7 Environmental / Reliability Test

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,240hours	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,5point/panel Air: ±8Kv, 5times; Contact:±4Kv,5times (Environment:15℃~35℃, 30%~60%.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℃ ～ 40℃ 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.