LCD MODULE SPECIFICATION

Customer	---
Model Name	3.1nch 800x480 R.G.B. Vertical Stripe
Product Description	HC031IGA2028-F78
Date	2022.12.01
Version	2.0

■ Preliminary Specification	□ Final Specification

For Customer's Acceptance

Approved by	Comment

Approved by	Reviewed by	Prepared by
William	Michael	Dane

Revision History

Version	Section	Revision Items	Name	Date
0.0	All	First Release	Lucy Chen	2021.11.05
1.0	P5	Update pin 1,pin 6,pin 24 Add note1&note2	EE Sun Long	2021.12.17
	P6	Update pin 30 Add note1&note2	EE Sun Long	2021.12.17
	P7	Update Table 5.1.2.2 LVDS DC Characteristics	EE Sun Long	2021.12.17
	P8	Update Note3	EE Sun Long	2021.12.17
	P10	Add 5.3 LCD Module Block Diagram	EE Sun Long	2021.12.17
	P13	Update Figure 6.2.1 Power on Sequence	EE Sun Long	2021.12.17
	P14	Update Figure6.2.2 Power off Sequence	EE Sun Long	2021.12.17
	P17	Add “Ta”, Add Note2，Note7，Note10 delete” Luminance”	OD Chen Qiuan	2021.12.17
	P18	Update test conditions	OD Chen Qiuan	2021.12.17
	P19	Update Note2	OD Chen Qiuan	2021.12.17
	P20	Update Note7,Note9,Note10	OD Chen Qiuan	2021.12.17
	P21	Update the temperature of ”Low Temperature Storage” Add Low Temperature Operation	DQ Lv Yapeng	2021.12.17
	P23	Update Mechanical Drawing	ME Dengyanyu	2022.1.6
	P26	Add Note1~Note4	QE Wang Yujue	2021.12.17
	P27	Update Packing Instruction& Module label information	Package ME Peng Yichang ME Dengyanyu	2021.12.17
1.1	P21 P22	Update High Temperature Storage& High Temperature Operation Add Note7 for High Temperature Operation	OD Chen Qiuan	2022.2.23
1.2	P4	Add Absorption axis angle of Top Polarize Update Weight	OD Chen Qiuan ME Deng Yanyu	2022.5.9
	P23	Update Mechanical Drawing	ME Deng Yanyu	2022.5.9
	P27	Update Packing Instruction	Package ME Peng Yichang	2022.5.9
2.0	P6 & P7	The VFB and UL/DR pin definition functions were migrated from 7.1.1 to 3.Input/ Output Terminals. Add Note3 and Note4	EE Sun Long	2022.8.1

	P9	Update LVDS DC Characteristics parameter	EE Sun Long	2022.8.1
	P15	Revise 6.2 Power on/ Off Sequence d iagram and timing (T2 and T3)	EE Sun Long	2022.8.1
	P27	Update Packing Instruction	Package ME	2022.8.1
	P23	Update the Mechanical Drawing	ME Dengyanyu	2022.12.1
	P24	Update the Light-on condition	ME Dengyanyu	2022.12.1
	P27	Update the Module label information	ME Dengyanyu	2022.12.1

Table of Contents

1. Features

This is a 3.14 inch LTPS module with normal-black technology. It is composed of a TFT-LCD panel, LCD Driver IC and FPC unit. This product is designed for automotive and other high reliability electronic products and complies with *RoHS* Directive.

2. General Specification

Feature	Specification	Remark
Diagonal Size	3.14 inch	
Resolution	800(RGB) x 480	
Active Area(mm)	68.4 x 41.04	
CTP View Area	NA	
Pixel Pitch (mm)	0.0855 x 0.0855	
Pixel Configuration	R.G.B. Vertical Stripe	
Technology Type	LTPS	
Display Mode	Normally Black	
Landscape or Portrait	Landscape	
Surface Treatment (Top Polarizer)/CTP Surface Treatment	Hard coating	
Absorption axis angle of Top Polarizer	90°（Vertical direction)	
Gray Scale Inversion Direction	NA	
Optimal Viewing Direction	NA	
Interface	LVDS(JEIDA)	
Color Depth	16.7 M	
Dimension (H x V x D) (mm)	81 x 56.9 x 2.8(Typ.)	Note1
Weight (g)	21.3±5%	Note2

Table 2.1 General TFT Specifications

Note1: The dimensions do not include the length of FPC、the thickness of protective film and component height etc...
For detail dimension, please refer to the module outline drawing.
Note2: Weight does not include the weight of protective film

3. Input/ Output Terminals

Mating connector type (recommended): FH28D-30S-0.5SH (Hirose)

No	Symbol	I/O	Description	Remark
1	NC	N	Power input for OTP function in Tianma.Must leave it open in the customer.	
2	UL/DR	I	Display flip control input	Note4
3	VFB	O	Fail detection signal output.	Note3
4	SCL	I	SPI serial clock SPI If the serial interface mode is not used, connect to GND.	
5	CSB	I	SPI chip select SPI If the serial interface mode is not used, connect to VDD.	
6	SDI	I	erial data intput If the serial interface mode is not used, connect to GND.	
7	SDO	O	Serial data output If the serial interface mode is not used, open.	
8	GND	P	Ground	Note1
9	R0-	I	Data signal 0-	
10	R0+	I	Data signal 0+	
11	GND	P	Ground	
12	R1-	I	Data signal 1-	
13	R1+	I	Data signal 1+	
14	GND	P	Ground	Note1
15	R2-	I	Data signal 2-	
16	R2+	I	Data signal 2+	
17	GND	P	Ground	Note1
18	CLK-	I	Clock signal-	
19	CLK+	I	Clock signal+	
20	GND	P	Ground	Note1
21	R3-	I	Data signal 3-	
22	R3+	I	Data signal 3+	
23	GND	P	Ground	Note1
24	PWRON	I	Display ON/OFF select PWRON=H : Display ON, PWRON=L : Display OFF	Note2
25	VDD	P	Power supply	Note2
26	VDD	P	Power supply	
27	VDD	P	Power supply	

28	TH	O	Thermistor If thermistor is not used, open.	
29	GND	P	Ground	
30	RES	I	Global reset input (active L)	Note1

I/O definition: I---Input, O---Output, P---Power/Ground, N---No connection
Note1: All of the GND pins should be connected to the system ground.
Note2: All risks from the pin layout will be responsible by customer.nomal
Note3:VFB Output high level when normal,.Any one of the following cases will trigger the fail detect function to set the FAIL_DET to low

1) OTP reload fail
2) PFM abnormal
3) No video
4) Internal source circuit fail
5) GAS function fail
6) LVDS lock fail

Note4: Scan Direction Control Description

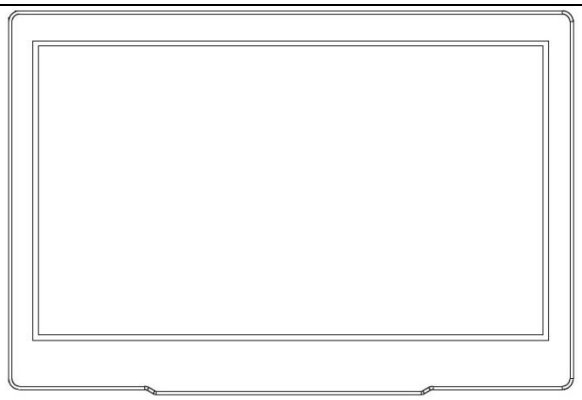
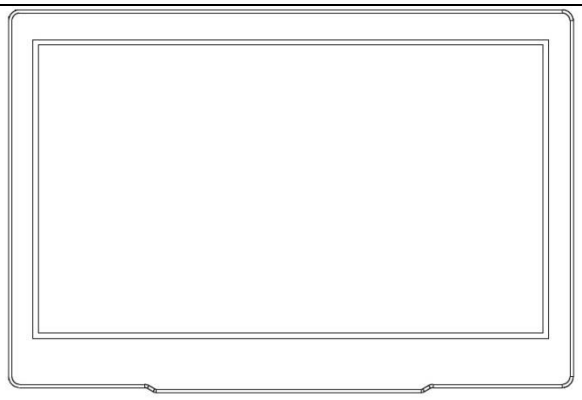
UL/DR =L	UL/DR =H
	

Figure 3.1.1 Description of Scan Direction

4. Absolute Maximum Ratings

GND=0V, Ta = 25℃

Item	Symbol	Min	Max	Unit	Remark
Logic supply voltage	VCC	-0.3	4	V	
LVDS lines voltage	V_{LVDS}	-0.3	VCC+0.3	V	
Control(single ended) lines voltage	V_{SE}	-0.3	VCC+0.3	V	

Operating Temperature	Top	-40	105	℃	Note1/2/3/4
Storage Temperature	Tst	-40	105	℃	Note1

Table 4.1.1 Absolute Maximum Rating

Note1: The temperature is the ambient temperature of IC.
Note2: No Electro-optical specification are guaranteed below -40°C.
Note3: If the voltage exceeds its absolute maximum ratings, the FOG may be damaged. Also, if the FOG is operated with the absolute maximum ratings for a long time, its reliability may drop.

5. Electrical Characteristics

5.1 DC Characteristics

5.1.1 Panel Driving

GND=0V, Ta = 25℃

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Logic supply voltage	VCC	3.0	3.3	3.6	V	Note1
System Ground	GND	-	0	-	V	
Permissible Ripple Voltage of VCC	Vr	-	-	100	mV	
Input / Output High Voltage	V_{IH}/V_{oh}	0.7xVCC	-	VCC	V	Note2
Input / Output Low Voltage	V_{IL}/V_{oh}	0	-	0.3xVCC	V	

Table 5.1.1 Operating Voltages

Note1: Indicate the subsequent version may be updated
Note2: Including VFB,SDA,SCL,CS,HSD,VSD,PWRON,EN,D-ID.

Figure 5.1.1 LVDS waveform

5.1.2 LVDS lines

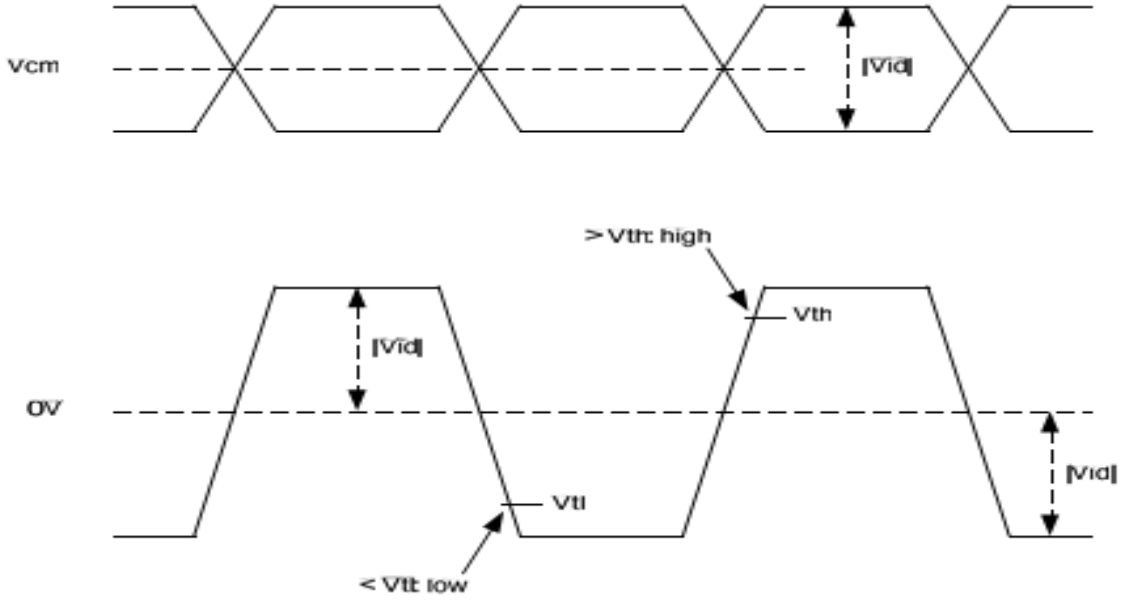


Figure 5.1.2.1LVDS waveform

GND=0V,Ta=25℃

Item	Symbol	Min	Typ.	Max	Unit	Remark
Logic Supply Current	I_{VCC}	-	-	60	mA	Note1 Note2
VCC inrush current	I_{inrush}	-	-	1.5	A	Note3
LVDS differential input high threshold voltage	V_{TH}	-	-	100	mV	
LVDS differential input low threshold voltage	V_{TL}	-100	-	-		
Differential input voltage	$\|V_{ID}\|$	0.1	0.35	0.6	mV	
Differential input common mode voltage	V_{CM}	1	1.2	1.7-|VID|/2	V	
External LVDS termination resistor	R_E	99	100	101	Ω	

Table 5.1.2.2 LVDS DC Characteristics

Note1: Test pattern: Test result is based on 5 samples at white pattern.
Note2: DCLK=25MHz, VCC=3.3V
Note3: VCC rising time>0.5ms.

5.1.3 SPI lines

GND=0V, Ta = 25℃

Item	Symbol	MIN	TYP	MAX	Unit	Remark

Input / Output High Voltage	V_{IH}/V_{oh}	0.7xVCC	-	VCC	V	Note1
Input / Output Low Voltage	V_{IL}/V_{oh}	0	-	0.3xVCC	V	

Table 5.1.3.1 SPI DC Characteristics

Note1: Including SDAI,SCL,CSB

5.2 AC Characteristics

5.2.1 LVDS lines

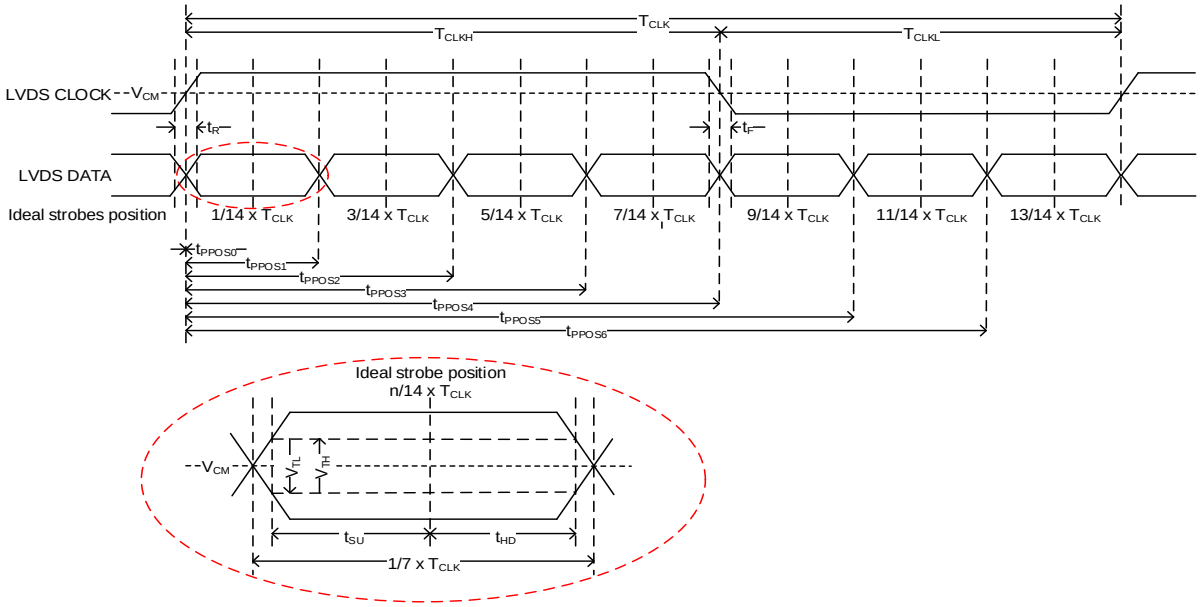


Figure 5.2.1.1 LVDS input timing

Parameter	Symbol	Min	Typ.	Max	Unit	Remarks
Input clock period	t_{CLK}	-	40	-	ns	FCLK=25MHz
Input clock high period	t_{CLKH}	-	4/7	-	T_{CLK}	-
Input clock low period	t_{CLKL}	-	3/7	-	T_{CLK}	-
Input data pulse position	t_{PPOSn}	n/7 x T_{CLK} - t_{SKM}	n/7 x T_{CLK}	n/7 x T_{CLK} + t_{SKM}	ns	n = 0 to 7
Data pulse width	T_P	-	1/7	-	T_{CLK}	-
Skew margin	t_{SKM}	-600	0	600	ps	FCLK=25MHz

Parameter	Symbol	Min	Typ.	Max	Unit	Remarks
SSC modulation ratio	F_{DEV}		±4		%	Jitter level the pixel clock tolerance means the length of pixel clock,not the quantity of pixel clock number.
SSC modulation frequency	F_{MOD}	-	-	50	KHz	FCLK=25MHz

Table 5.2.1.2 LVDS AC Characteristics

5.2.2 SPI lines

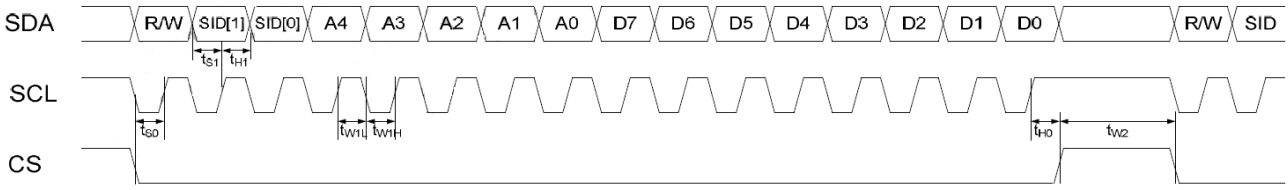


Figure 5.2.2.1 SPI signal timing

Parameter	Symbol	Conditions	Spec.			Unit	Remark
			Min.	Typ.	Max.		
SDA Setup Time	t_{S0}	CS to SCL	60	-	-	ns	Note1, Note2, Note3, Note4, Note5
	t_{S1}	SDA to SCL	60	-	-	ns	
SDA Hold Time	t_{H0}	CS to SCL	60	-	-	ns	
	t_{H1}	SDA to SCL	60	-	-	ns	
Pulse Width	t_{W1L}	SCL pulse width	100	-	-	ns	
	t_{W1H}	SCL pulse width	100	-	-	ns	
	t_{W2}	CS pulse width	1	-	-	us	
Clock duty	-	-	40	50	60	%	

Table 5.2.2.2 SPI AC Characteristics

Note1: The first bit R/W selects read/write mode. Setting R/W to 0 selects write mode, and setting R/W to 1 selects read mode.
Note2: A [4:0] specify the address of the register to be read or written.
Note3: D [7:0] is the 8-bit data of each register.
Note4: The address and data are transferred from the MSB to LSB edge sequentially at SCL rising edge.
Note5: The second and third bits SID[1:0] selects source driver ID . Setting SID[1:0] to 00.

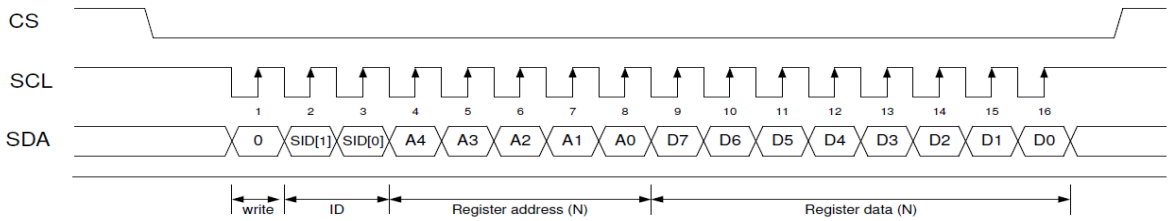


Figure 5.2.2.3 SPI signals, normal write mode

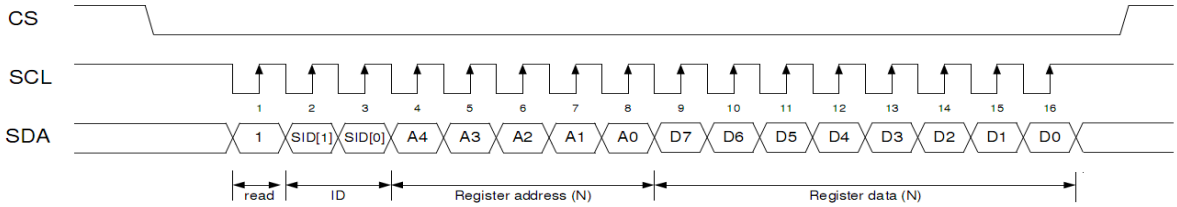


Figure 5.2.2.4 SPI signals, normal read mode

5.3 LCD Module Block Diagram

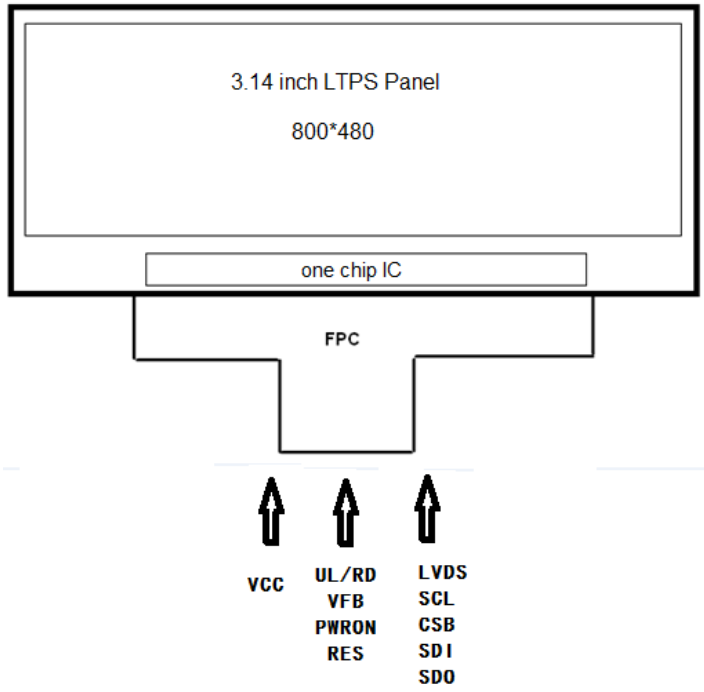


Figure 5.3 LCD Module Block Diagram

6. Timings

6.1 LVDS Interface Timing Characteristics

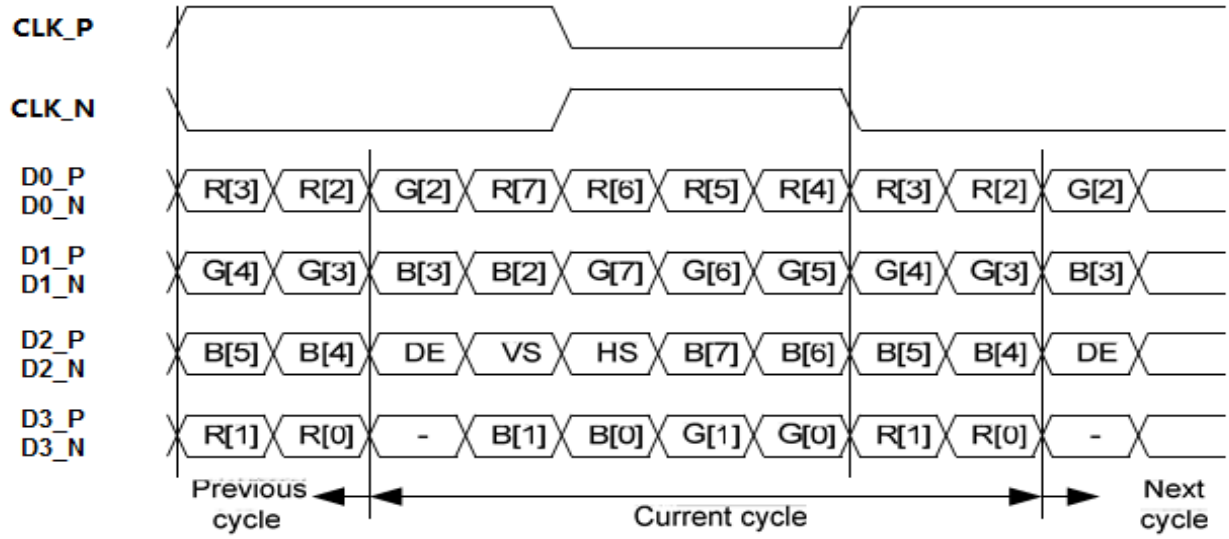


Figure 6.1.1 LVDS JEIDA mode data mapping

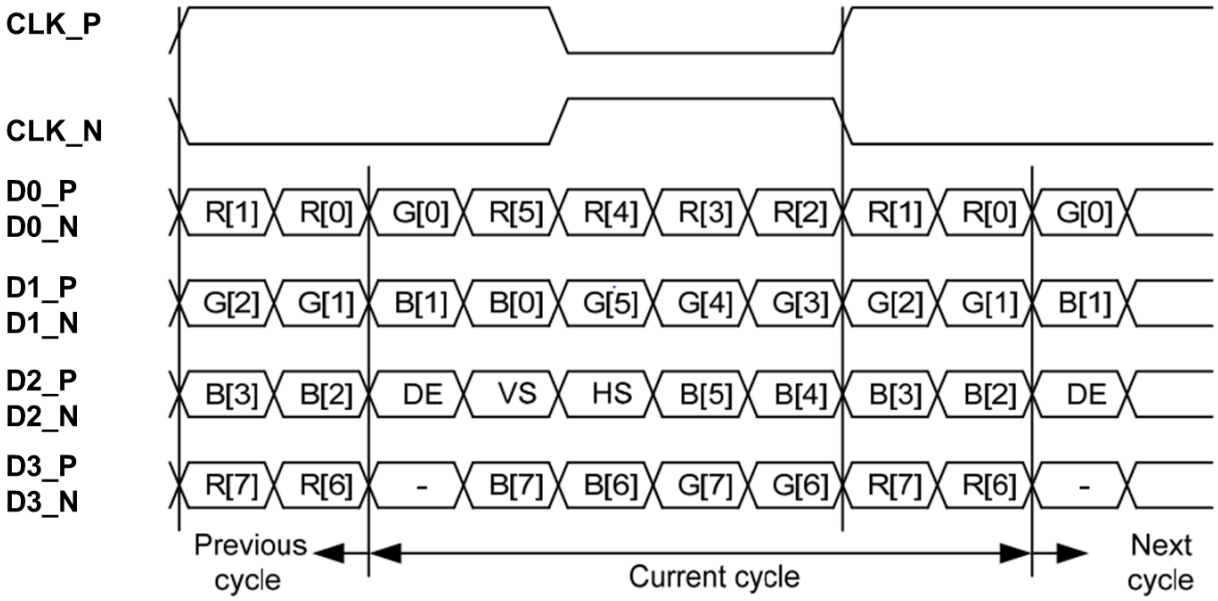


Figure 6.1.2 LVDS VESA mode data mapping

Parameter	Symbol	Min	Typ.	Max	Unit
DCLK frequency	FDCLK	25.005	25.005	29.232	MHz
Horizontal valid data	t_{hd}	800			DCLK
Hsync pulse Width	t_{hpw}	14	14	14	DCLK
Hsync back porch	t_{hbp}	34	34	34	DCLK

Hsync front porch	t_{hfp}	20	20	94	DCLK
1 horizontal line	t_h	854	854	928	H
Vertical valid data	t_{vd}	480			H
Vsync pulse width	t_{vpw}	2	2	2	H
Vsync back porch	t_{vbp}	4	4	4	H
Vsync front porch	t_{vfp}	4	4	41	H
1 vertical field	t_v	488	488	525	H
Frame rate	FR	-	60	-	HZ

Table 6.1.3 Sync MODE

Note1: Typical DCLK frequency is allowed to have +/- 0.02% static tolerance on pixel clock

• Horizontal

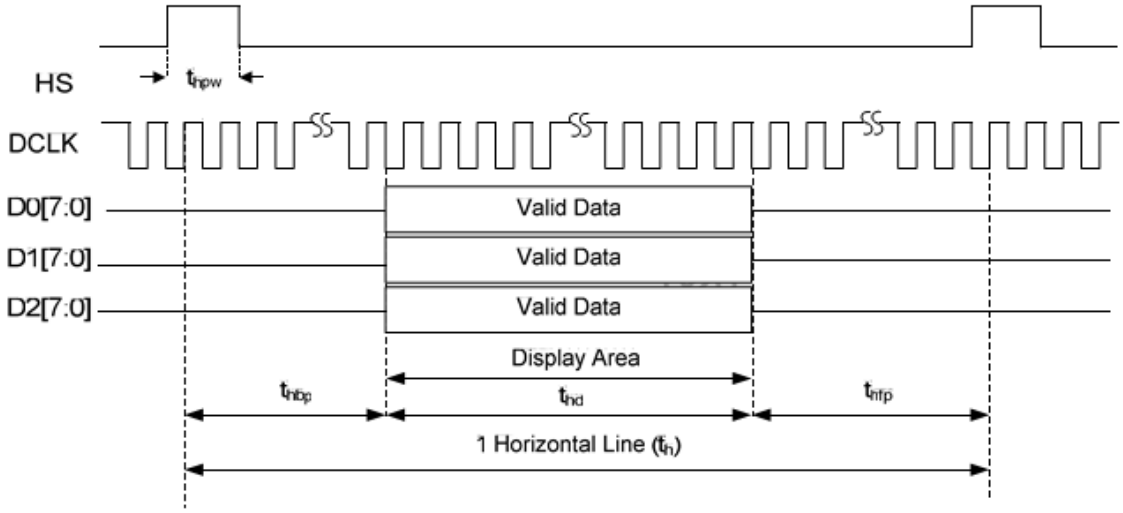


Figure 6.1.4 Horizontal input timing at SYNC only mode

• Vertical

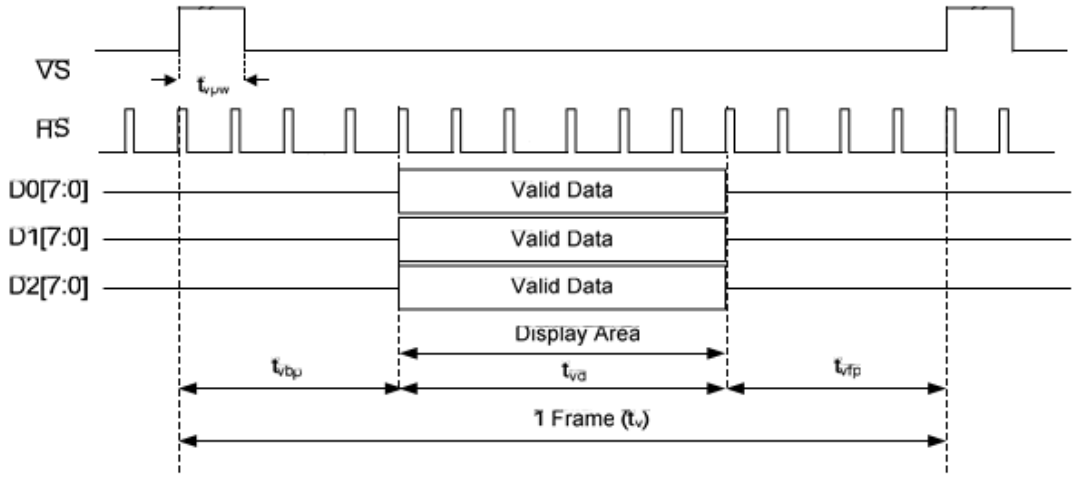
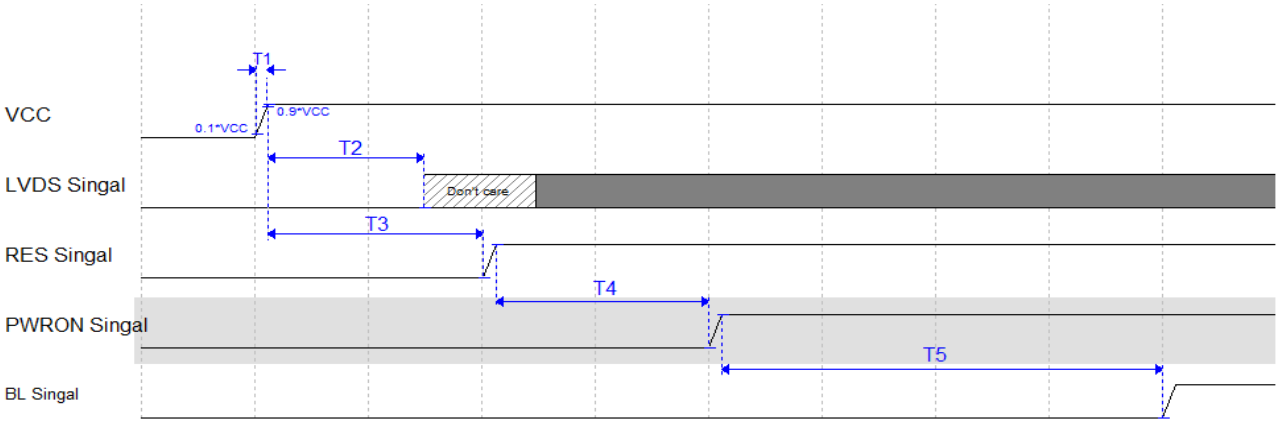


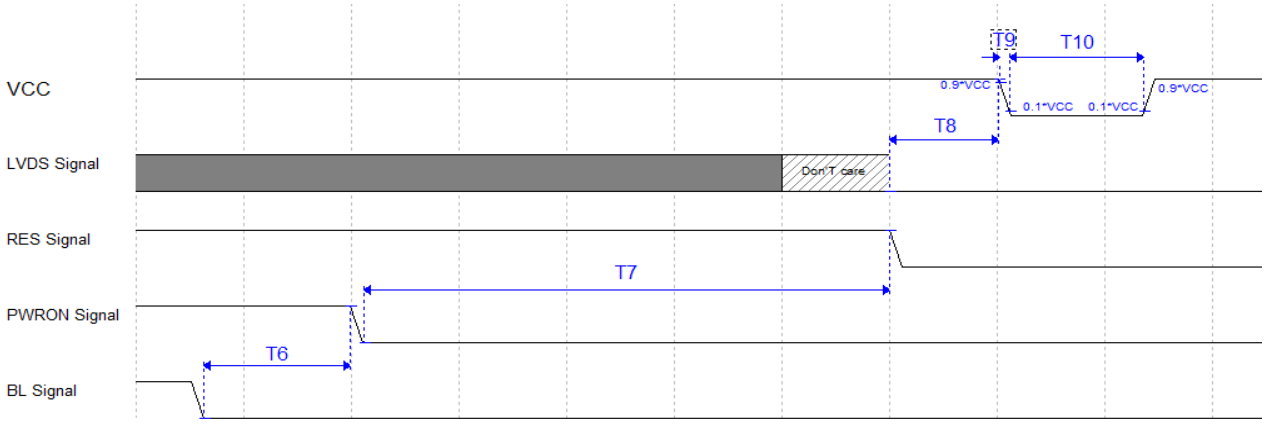
Figure 6.1.5 Vertical input timing at SYNC only mode

6.2 Power on/off Sequence



Symbol	Min	Typ.	Max	Unit	Remark
T1	0.6	-	8	ms	
T2	0.01	-	-	ms	Note3
T3	100	-	-	us	
T4	20	-	-	ms	
T5	10	-	-	frame	Note4

Figure 6.2.1 Power on Sequence



Symbol	Min	Typ.	Max	Unit	Remark
T6	2	-	-	frame	Note5
T7	10	-	-	frame	Note6

T8	0.1	-	-	ms	
T9	0	-	3	ms	
T10	1000	-	-	ms	

Figure6.2.2 Power off Sequence

Note1: The low level of these signals and analog powers are GND level.
Note2: All of the power and signals should be kept at GND level before power on. If there are residual voltages on them, the LCD might not work properly.
Note3: When power off ,if VCC keep high ,T2 should ≥10ms.
Note4: BL is the voltage applied to backlight. Keep it turned off until the display has stabilized. This means that the application needs to ensure minimum 10/FR before relying on the VFB signal and before turning on the BL.
Note5:BL is supposed to turn off before Display Status if Off.
Note6: Power failures in rare conditions, the display can turn on normally as long as power on sequence is respected. But if T7 is not respected, flickering might appear.
Note7: During normal display , it will be supposed to display black pattern if video signal is Off and to normal display if the video signal is On. But it needs a detection time, if LVDS signal is gone (LVDS_CLK:10ms, H-sync : 15ms, V-sync : 77ms)., it needs at least 10ms to enter self-protection mode and display “Black”.

7.Feature Description

7.1 NTC description

A discrete NTC component placed on FPC

Parameter	Symbol	Conditions	Typ.	Min	Max.	Unit	Remarks
Resistance	R_{NTC}	T_A=25°C	10	9.9	10.1	kΩ	Max. used freq.
B-Constant	B_{NTC}	T_A=25/50°C	3380	3345	3413	k	Tol. ±1%
Rated Electric Power	P_{NTC}	T_A=25°C	0.1	0.099	0.101	mW	

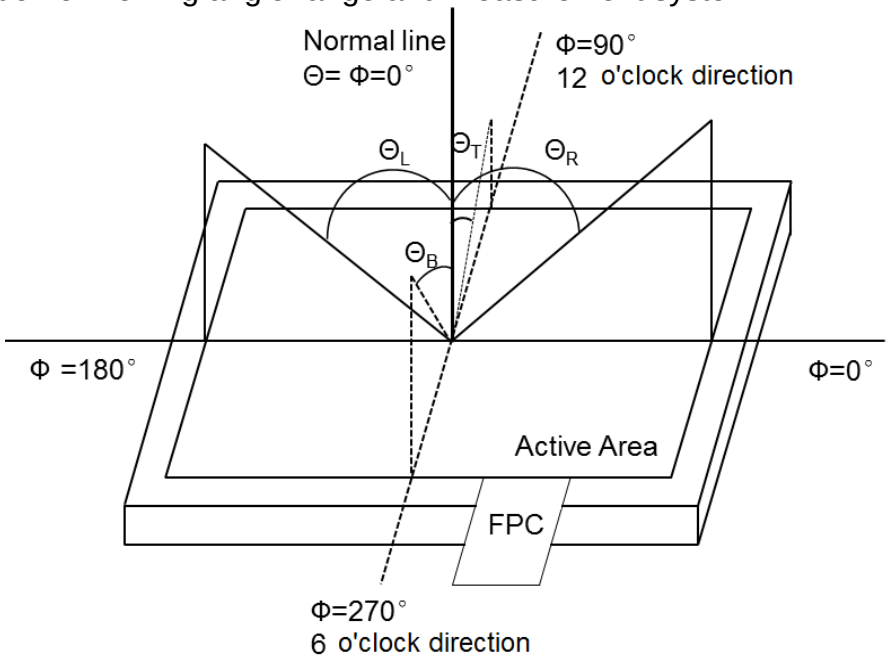
8. Optical Characteristics

Item		Symbol	Condition	Min	Typ.	Max	Unit	Remark
Viewing Angle		θU	CR≧10 Ta=25℃	80	88	--	Degree	Note1
		θD		80	88	--		
		θL		80	88	--		
		θR		80	88	--		
Contrast Ratio		CR	Vertical, Ta=25℃	1000	1200	--		Note2 Note3
Response Time		G2G	Ta=25℃	--	--	50	ms	Note4
		G2G	Ta=-20℃	--	--	375		
		G2G	Ta=-30℃	--	--	875		
Chromaticity	White	x	CIE1931-XYZ C-light Ta=25℃	0.297	0.322	0.347		Note5 Note2
		y		0.367	0.392	0.417		
	Red	x		0.595	0.620	0.645		
		y		0.327	0.352	0.377		
	Green	x		0.272	0.293	0.322		
		y		0.531	0.556	0.581		
	Blue	x		0.118	0.143	0.168		
		y		0.203	0.228	0.253		
NTSC			CIE1931-XYZ , Ta=25℃	40	44	--	%	Note5
Uniformity Black (area scan)		U	Ta=25℃	50	-	--	%	Note2 Note6
Uniformity White (area scan)		U	Ta=25℃	80	-	--	%	Note2 Note6
Transmittance		T	Ta=25℃	6.5	7.0	--	%	Note2 Note7
Flicker			JEITA , Ta=25℃			-30	dB	Note9
Reflectivity (SCI)			Ta=25℃			6.5	%	Note2 Note8
Gamma		γ	Ta=25 ℃,VESA	2.0	2.2	2.4		Note10

Test Conditions:

1. I_F= NAmA (one channel), the ambient temperature is 25℃.
2. The test systems refer to Note 1 and Note 2.
3. All optical tests were based on Tianma 4.2-inch Blu scheme(BEF+DIF).

Note1: Definition of viewing angle range and measurement system

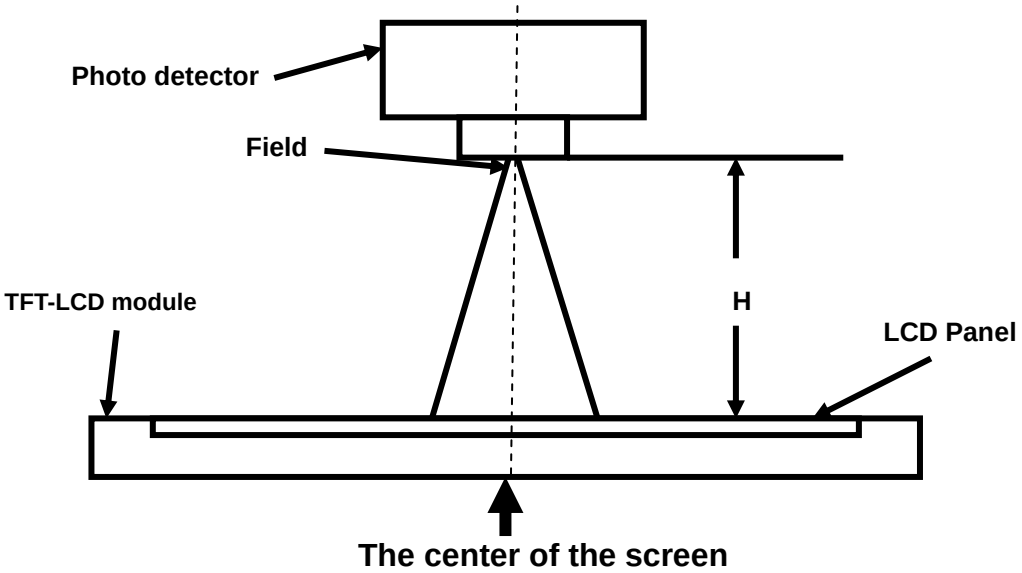


Note2: Definition of optical measurement system

Measured at the center of the panel by SR-3.

Measuring condition:

- Measuring surroundings: Dark room.
- Measuring temperature: Ta=+25℃.
- Adjust operating voltage to get optimum contrast at the center of the display.
- Measured value at the center point of LCD panel after more than 10 minutes while backlight is turned on.



Item	Photo detector	Field	High
Contrast Ratio	SR-3	1°	H=500mm
Transmittance			
Chromaticity			
Transmittance Uniformity	LMK		
Contrast Plot	EZ-Contrast/ DMS	6mm/3mm	H=1mm/H≈80mm
Response Time	LCD5200	3mm	H=200mm
Reflectivity	CM3600A	8mm/25.4mm	H=0mm

Note3: Definition of contrast ratio:

$$\textbf{Contrast Ratio(CR)=}\frac{\textbf{Luminance When LCD is White}}{\textbf{Luminance When LCD is Black}}$$

Contrast Ratio is measured in optimum common electrode voltage

Note4: Definition of response time:

we define 7 grays L1-L7, the grays of L1-L7 were defined as:0, 43, 85, 128, 170, 212, 255. The output signals of photo detector are measured when the input signals are changed from “Lx” to “Ly”, x, y= [1, 7].

n	1	2	3	4	5	6	7
Grey_n	0	43	85	128	170	212	255

The response time is defined as the time interval between the 10% and 90% of amplitudes. The result of the test can be noted as below:

Start:i=1~7

End j=1~7	0	43	85	128	170	212	255
0							
43							
85							
128							
170							
212							
255							

Ton=T1,7=T black→white

Toff=T7,1=Twhite→black

TG2G=Gray to grey response time for all other 40 combinations of i, j (including TR and TF of Gray to Gray)；

Max(TG2G)=Maximum of all 40 TG2G（Maximum of TR or TF of Gray to Gray）

Note5: Definition of color chromaticity (CIE1931)

Color coordinates measured at the center point of the LCD.

Note6: Definition of Uniformity

The measuring condition is area scan.
Transmittance Uniformity (U) = Tr% min/ Tr% max
Tr% max: The measured Maximum Transmittance of all measurement position.
Tr% min: The measured Minimum Transmittance of all measurement position.

Note7: Definition of Transmittance
Measure the Transmittance at white state and backlight at the center point.
Note8: SCI reflective ratio measure method.
Measurement system: CM 3600A fully integral sphere
Light source: D65
d/8° (ASTM E 1164-09)
Observing angle: 10°
State: LCD powered off
Standard d/8° Integration Sphere Spectroscopic – Reflectometer
Note9: The value % base on CR measurement method, dB base on JEITA method.
The test pattern is 128 gray pattern.
Note10: The Gamma calculation is based on the VESA Gamma standard.

9. Reliability Test

No	Test Item	Test condition	Criterion
1	High Temperature Storage	105℃±2℃(panel surface temperature) 500hrs, RH<=45%, Recovery time 2h at room temp. non-operation	Note1, Note2, Note4, Note5 IEC60068-2-1,GB2423.2
2	Low Temperature Storage	-40℃±3℃ 240hrs, Recovery time 2hrs at room temp. non-operation	Note1, Note2, Note4 IEC60068-2-1,GB2423.1
3	High Temperature Operation	105℃±2℃(panel surface temperature) 500H, RH<=45% Restore 2H or more at 25℃ operation.	Note1, Note2, Note4,Note7 IEC60068-2-1,GB2423.2
4	Low Temperature Operation	-40℃±3℃ 240hrs, Recovery time 2hrs at room temp. operation	Note1, Note2, Note4 IEC60068-2-1,GB2423.1
5	High Temperature & Humidity Operation (operational)	60℃±2℃, 90±2%RH 500H Restore 2H or more at 25℃	Note1, Note2, Note4， Note 5 IEC60068-2-78, GB/T2423.3
6	Thermal Shock (non-operational)	-40°C→ change→+85°C 30min 5min 30min 200cycle Restore 2H or more at 25℃	Note1, Note2, Note4 Start with cold temperature End with high temperature, IEC60068-2-14, GB2423.22
7	ESD (operational)	C=150pF±10%,R=330Ω 5 point /panel surface Contact discharge: ±4kV, 5times Air discharge:±8kV, 5times(Environment:15℃~35℃ ,30%~60%, 86Kpa~106Kpa)	Note1, Note2, Note3
8	Image Sticking	Viewing distance: 35cm Ambient illumination: 100 lux Ambient temperature: +65℃ Light source condition: Full Luminance Viewing Angle: 0° Zone: Active area Picture Pattern: 8×6 checker	Note6

		pattern (Black and White) Burn-in time: 1h Judge at 5min @mid gray pattern Criteria: Less level2	

Note1: After completion of the test, the sample shall be free from the following defects:
1) Air bubble in the LCD
2) Seal leak
3) Non-display
4) Missing segments
5) Glass crack

Note2: Use sample for only one reliability test.

Note3: In case of an abnormal display caused by discharge, if it can recover to normal state after reset, it is considered “PASS”. The use of an ionizer (antistatic blower) is recommended during this test. When removing the protection film from LCM panel, do it at a slow speed (preferably more than one second) and blow with ionizer toward the peeling face to minimize ESD which may damage the electrical circuit.

Note4: For duration test in the chamber
a. Keep a small distance between each sample and don’t place the samples close to the wall or the wick. Don’t open the chamber unless absolutely necessary.
b. During the test, avoid moisture condensation on the polarizer.
c. After taking the samples out of the chamber and returning to room temperature and humidity, wait at least two hours before inspecting and measuring data.
d. Perform de-rating during high temp. operation test..

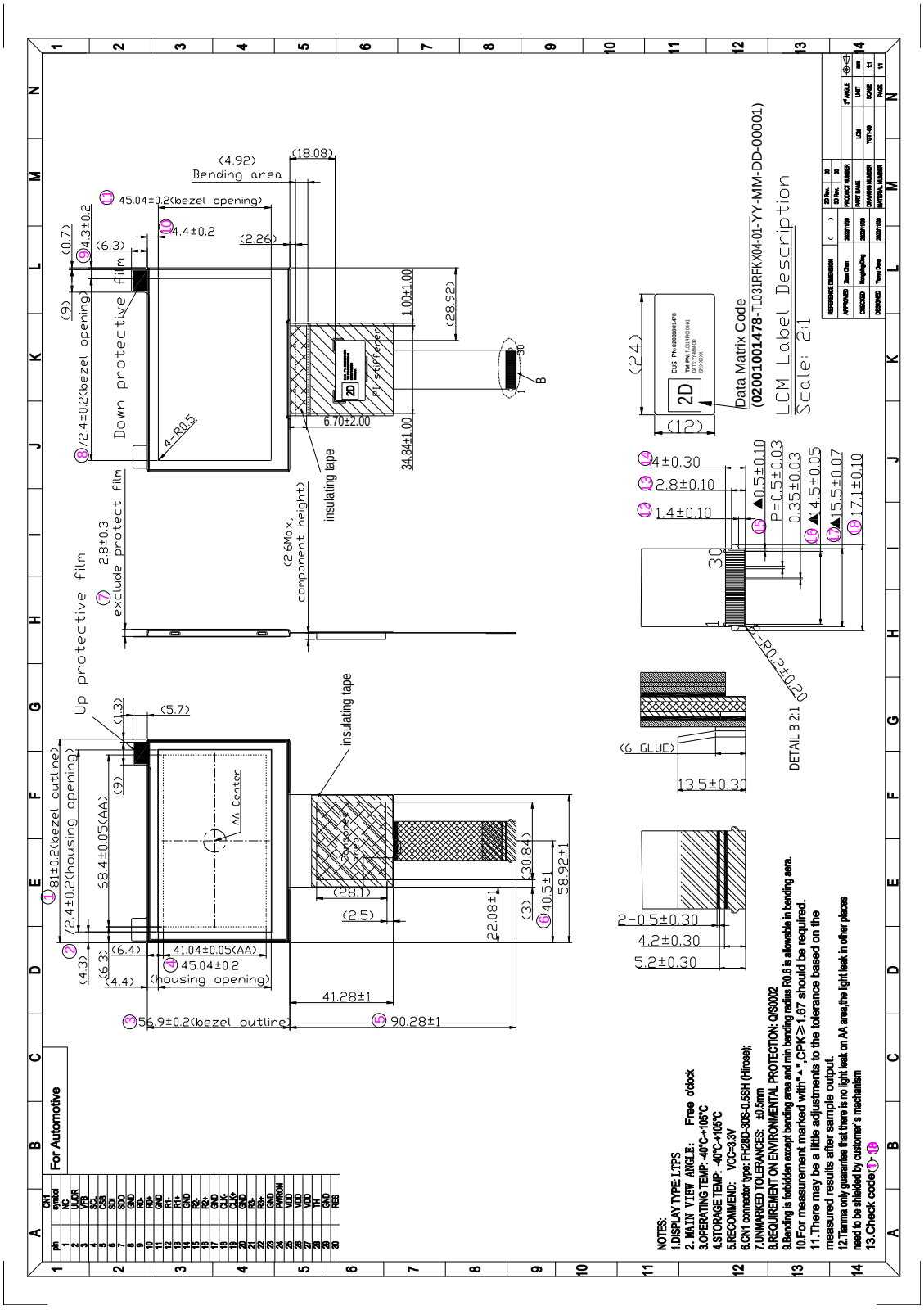
Note5: Polarizer color change (Such as yellowish) will judge pass if the optical test data is within spec. requirement.

Note6: Level Definition:

Level	Description	Remark
L0	Completely invisible	For all distance and viewing angle
L1	Invisible from perpendicular viewing direction	For all distance
L2	Visible by a closer look	Invisible by 60cm distance and viewing angle
L3	Slightly Visible	60cm distance and viewing angle
L4	Prominent	60cm distance and viewing angle

Note7: For High Temperature Operation，deterioration of the polarizer is ignored.

10. Mechanical Drawing



11. Product Inspection Criteria

11.1 Inspection Conditions

11.1.1 Ambient conditions:

a. Temperature: Room temperature 25±5℃

b. Humidity: (60±10) ％RH

c. Illumination:

Display backlight unit on, illumination on the display: <200lux

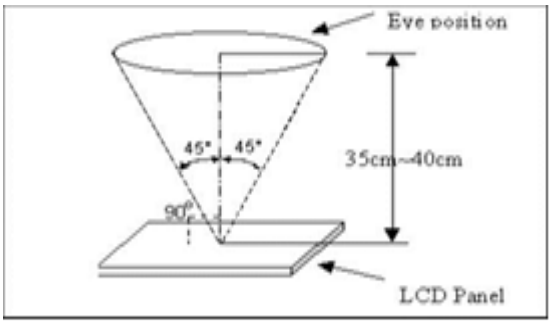
Display backlight unit off, illumination on the display light-off: 800-1200lux

11.1.2 Viewing distance

The distance between the LCD and the inspector's eyes shall be 35cm or more (35 cm to 50 cm max. for scratches, dents 35 cm for dot defects).

11.1.3 Viewing Angle

U/D: 45º/45º, L/R: 45º/45º



11.1.4 Light-on condition

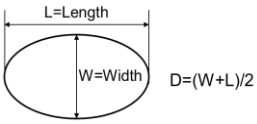
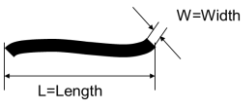
The luminance of the module should refer to the recommended value in this specification. (CQR: Min. 10000 cd/m^2 for operating conditions)

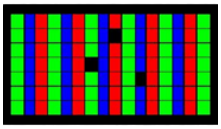
11.2 Major defect

No	Inspection Items	Inspection Standard
1	Function defect Abnormal operation including distinct RGB line defects and white line defect. Vertical stripes Horizontal stripes Flickering RGB Timing Wrong Color Less Brightness / Un-uniformity COG-Mura Color shift Image sticking Afterimage (disappears within 3sec no malfunction)	Not allowed

	Light leakage Pattern overlap Yellow border Blinking dots Current Consumption out of specified values Rotated picture content Mechanical dimensions out of specified values (refer to drawing) Broken glass	

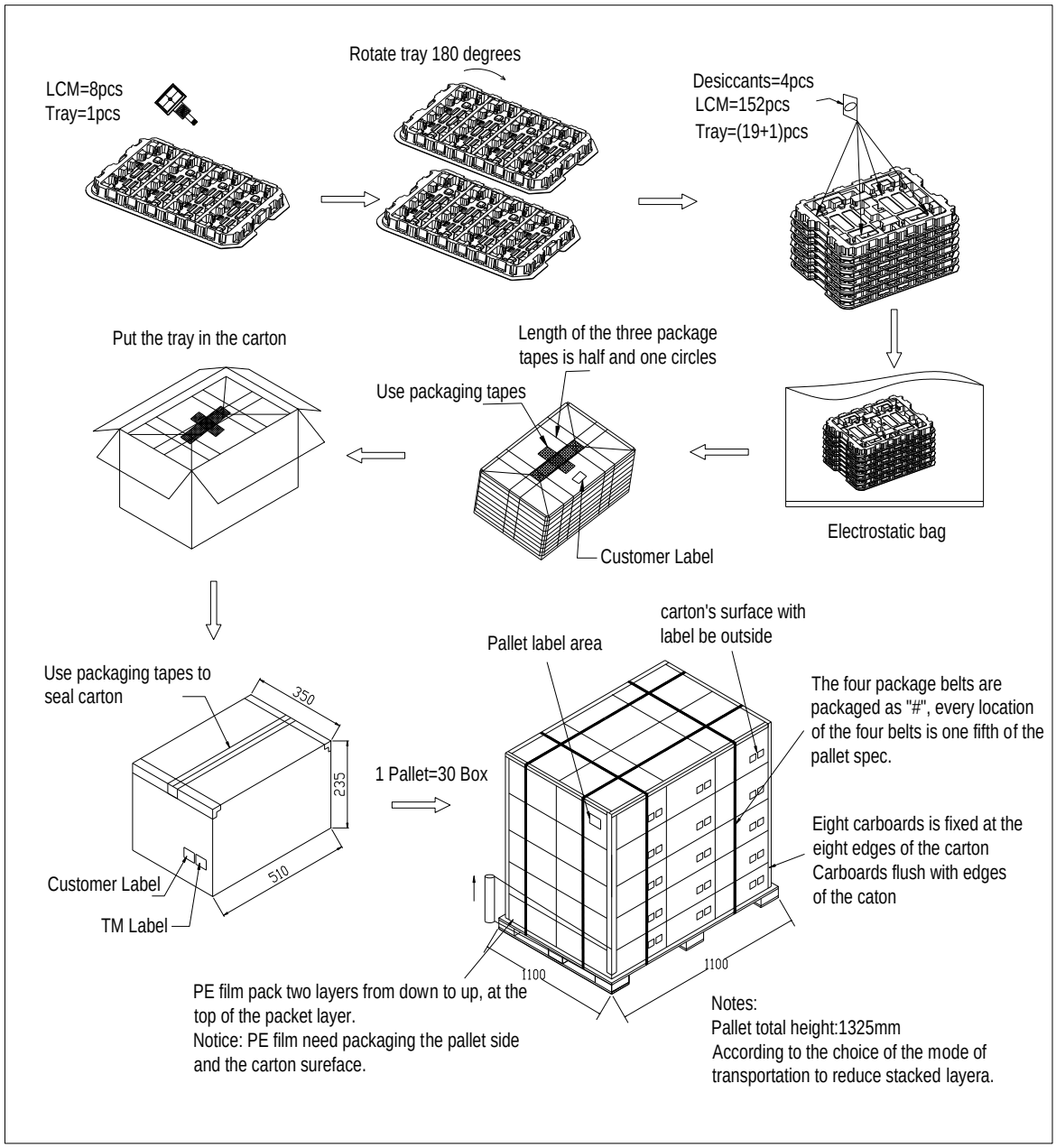
11.3 Minor defect

No.	Inspection Item	Inspection Standards	Acceptable Qty.	Inspection Mode	Note
1	Bright spots	Φ＜0.15	1	Light-on	
		Φ＞0.15	None		
2	Dark spots	D≤0.15	Ignore	Light-on	 D=(W+L)/2
		0.15＜ D ≤ 0.2	1		
		0.20＜ D	0		
3	Dent\Bubble	D≤0.15	Ignore	Light-on Light-off	
		0.15<D≤0.2	2 (Distance≥ 3mm)		
		0.2<D≤0.3	1		
		Φ＞0.3	0		
4	Scratches	W≤0.05 and L≤1	Ignore	Light-on Light-off	
		W≤0.05 and 1<L≤3	2 (Distance≥ 3mm)		
		L>3 or W > 0.05	None		

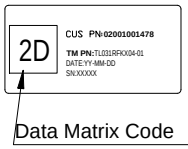
5	Lints	0.04≤W≤ 0.05and L≤1	2 (Distance≥ 3mm)	Light-on Light-off	
		L>1.0 or W > 0.05	None		
6	Electrical Dot Defect	Inspection pattern: Full white、Full black、Red、green and blue screens		Light-on	
		Black dot defect （1/2dot≤Φ≤ 1dot）	RGB pattern allow 2 dot,total≤4		
		Bright dot defect	0		
7	Mura	Black uniformity	Visible through ND3% at full black pattern	Light-on	

Note1: When the size of a specific dot defect is bigger than 50% of the total dot, it is considered as a dot defect.
Note2: Polarizer bubble is defined as the bubble appears on active display area.
The defect of polarizer bubble shall be ignored if the polarizer bubble appears on the outside of active display area.
Note3: If any problems or doubts arise with the LCD, the customer and supplier will cooperate and make efforts to solve it with mutual confidence and respect.
Issues which are not defined in these criteria shall be discussed with parties, customer and supplier, for a better solution.
Note4: Mura is checked via ND3%. Tianma will update this value based on actual measurement during sample phase.

12. Packing Instruction



Module label information



13. Appendix

13.1 The relationship of temperature and resistance for NTC:

TEMP (deg.C)	Resistance (kohm)	TEMP (deg.C)	Resistance (kohm)	TEMP (deg.C)	Resistance (kohm)	TEMP (deg.C)	Resistance (kohm)
-40.000	195.652	2.000	24.988	44.000	5.086	86.000	1.413
-39.000	184.917	3.000	23.951	45.000	4.917	87.000	1.375
-38.000	174.845	4.000	22.963	46.000	4.754	88.000	1.338
-37.000	165.391	5.000	22.021	47.000	4.597	89.000	1.303
-36.000	156.513	6.000	21.123	48.000	4.446	90.000	1.268
-35.000	148.171	7.000	20.267	49.000	4.301	91.000	1.234
-34.000	140.330	8.000	19.450	50.000	4.161	92.000	1.202
-33.000	132.958	9.000	18.670	51.000	4.026	93.000	1.170
-32.000	126.022	10.000	17.926	52.000	3.896	94.000	1.139
-31.000	119.494	11.000	17.214	53.000	3.771	95.000	1.110
-30.000	113.347	12.000	16.534	54.000	3.651	96.000	1.081
-29.000	107.565	13.000	15.886	55.000	3.535	97.000	1.053
-28.000	102.116	14.000	15.266	56.000	3.423	98.000	1.026
-27.000	96.978	15.000	14.674	57.000	3.315	99.000	0.999
-26.000	92.132	16.000	14.108	58.000	3.211	100.000	0.974
-25.000	87.559	17.000	13.566	59.000	3.111	101.000	0.949
-24.000	83.242	18.000	13.049	60.000	3.014	102.000	0.925
-23.000	79.166	19.000	12.554	61.000	2.922	103.000	0.902
-22.000	75.316	20.000	12.081	62.000	2.834	104.000	0.880
-21.000	71.677	21.000	11.628	63.000	2.748	105.000	0.858
-20.000	68.237	22.000	11.195	64.000	2.666	106.000	0.837
-19.000	64.991	23.000	10.780	65.000	2.586	107.000	0.816
-18.000	61.919	24.000	10.382	66.000	2.509	108.000	0.796
-17.000	59.011	25.000	10.000	67.000	2.435	109.000	0.777
-16.000	56.258	26.000	9.634	68.000	2.364	110.000	0.758
-15.000	53.650	27.000	9.284	69.000	2.294	111.000	0.740
-14.000	51.178	28.000	8.947	70.000	2.228	112.000	0.722
-13.000	48.835	29.000	8.624	71.000	2.163	113.000	0.705
-12.000	46.613	30.000	8.315	72.000	2.100	114.000	0.688
-11.000	44.506	31.000	8.018	73.000	2.040	115.000	0.672
-10.000	42.506	32.000	7.734	74.000	1.981	116.000	0.656
-9.000	40.600	33.000	7.461	75.000	1.925	117.000	0.640
-8.000	38.791	34.000	7.199	76.000	1.870	118.000	0.625
-7.000	37.073	35.000	6.948	77.000	1.817	119.000	0.611
-6.000	35.442	36.000	6.707	78.000	1.766	120.000	0.596
-5.000	33.892	37.000	6.475	79.000	1.716	121.000	0.583
-4.000	32.420	38.000	6.253	80.000	1.669	122.000	0.569
-3.000	31.020	39.000	6.039	81.000	1.622	123.000	0.556
-2.000	29.689	40.000	5.834	82.000	1.578	124.000	0.544

-1.000	28.423	41.000	5.636	83.000	1.535	125.000	0.531
0.000	27.219	42.000	5.445	84.000	1.493		
1.000	26.076	43.000	5.262	85.000	1.452		

14. Precautions for Use of LCD Module

14.1 Handling Precautions

13.1.1 The display panel is made of glass. Do not subject it to mechanical shock by dropping it, etc.

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

13.1.3 Do not apply excessive force to the display surface or the bezel since this may cause the color tone to vary.

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

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

- Isopropyl alcohol
- Ethyl alcohol

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

- Water
- Ketone
- Aromatic solvents

13.1.6 Do not attempt to disassemble the LCD Module.

13.1.7 If the logic circuitry is powered off, do not apply the input signals.

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

13.1.8.1 Be sure to ground your body when handling the LCD Modules.

13.1.8.2 Tools used for assembly, such as soldering irons, must be properly grounded.

13.1.8.3 To reduce the amount of static electricity generated, do not conduct assembly or other work under very low humidity conditions.

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

14.2 Storage precautions

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

13.1.10 The LCD modules should be stored within the rated storage temperature range. If the LCD modules will be stored for a long time, the recommend condition is:
Temperature: 15 ~ 35 degree C (or at least Temp. 10 ~ 40 degree C / Humidity 25% ~ 75%), for National Std. recommendation

13.1.11 The LCD modules should be stored in a room without acid, alkali or other harmful gases.

14.3 Transportation Precautions

The LCD modules should not be dropped or subject to violent mechanical shock during transportation. Also they should avoid excessive pressure, water, high humidity and direct sunlight.