SPECIFICATION

[ ] Preliminary Specification
[√] Final Specification

Description **6.5” 640xRGBx480 TFT-LCD Module**

Part Number **P0650VGF2MB31**

Customer		Industrial Product Dept, PDBU Tianma Microelectronics Co., Ltd.	
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Comments:			

* This cover page is for your Comments and Signatures back to TIANMA.

REVISION HISTORY

Rev	Date	Page	Revision Items	Editor
1.0	2023/12/19	-	Preliminary Specification Released.	Ao_Chen
1.1	2024/1/31	-	Luminance to 750nits typ, Chromaticity(Wx,Wy) is target value	Ao_Chen
1.2	2024/4/19	-	Change connect 1 MSAK24025P40 to DF9-31P-1V(32)，add packing instruction	Ao_Chen
1.3	2024/7/5	-	Change luminance typ 750nits to 650nits	Ao_Chen
2.0	2024/10/14	-	Final SPEC	Ao_Chen
2.1	2025/2/28	4,15, 20, 4， 4	Update Contrast Ratio min:600→500, add label information， Polarizer pencil-hardness 3H， LED drive board(option) 1560415720→PB065QXGS01	Ao_Chen

CONTENTS

1. Summary

1.1 General Description

This is a 6.5 inch a-Si TFT-LCD module with Normal- black technology. It is composed of a TFT-LCD panel, a driver circuit, PCB, and a LED backlight unit.

1.2 Features

- Ultra-wide viewing angle (Super Fine TFT (SFT))
- 70Khrs Long LED life time
- Interface: RGB 6-bit digital signals
- Without LED driver
- Compliant with the European RoHS Directive (2011/65/EU) and Delegated Directive (2015/863/EU, Amending Annex II of 2011/65/EU)
- Acquisition product for UL62368-1/CSA C22.2 No.62368-1-14 (File number: E333987)

2. General Specifications

Feature		Spec	Unit
Display Spec	Size	6.5 inches	
	Resolution	640(RGB)x480	
	Pixel Pitch	0.207 (H) x 0.207(V)	mm
	TFT Active Area	132.48×99.36	mm
	Technology Type	a-Si	
	Pixel Configuration	R.G.B Vertical Stripe	
	Display Mode	SFT Normally black	
	Surface Treatment	AG	
	Polarizer pencil-hardness	3H	
	Viewing Direction	ALL	
Mechanical Characteristics	LCM (W x H x D)	153W* 118H * 8.2D(typ)	mm
	Weight	135	g
Optical Characteristics	Luminance	650	cd/m2
	Contrast Ratio	800:1	
	NTSC	45	%
	Viewing Angle	88/88/88/88	degree
	Polarizer absorption axis	Vertical	
Electrical Characteristics	Interface	RGB	
	Color Depth	262K	color
	Power Consumption	LCD:379.5typ Backlight: 1800typ	mW
	Recommended LED driver board (Option)	PB065QXGS01	

Table 2.1 General TFT Specifications

3. Input / Output Terminals

3.1 CN1 Pin assignment (LCD Interface)

Connector Information	
LCD Module connector	DF9-31P-1V(32) （Hirose）
Matching connector	DF9-31S-1V(32) （Hirose ） or equivalent

Table 3.1.1 Connector information

No	Symbol	I/O	Description	Comment
1	GND	P	Ground	
2	CLK	I	Dot clock	
3	Hsync	I	Horizontal synchronous signal	
4	Vsync	I	Vertical synchronous signal	
5	GND	P	Ground	
6	R0	I	Red data	
7	R1	I	Red data	
8	R2	I	Red data	
9	R3	I	Red data	
10	R4	I	Red data	
11	R5	I	Red data	
12	GND	P	Ground	
13	G0	I	Green data	
14	G1	I	Green data	
15	G2	I	Green data	
16	G3	I	Green data	
17	G4	I	Green data	
18	G5	I	Green data	
19	GND	P	Ground	
20	B0	I	Blue data	
21	B1	I	Blue data	
22	B2	I	Blue data	
23	B3	I	Blue data	
24	B4	I	Blue data	
25	B5	I	Blue data	
26	GND	P	Ground	
27	DE	I	Data enable	Leave it open in SYNC Mode
28	VCC	P	Power supply	
29	VCC	P	Power supply	
30	MODE	I	Select DE or SYNC mode	High or Open: DE Mode Low: SYNC Mode
31	DPS	I	Selection of scan direction	Low or Open: Normal scan High: Reverse scan

Table 3.1.2 Pin Assignment for LCD Interface

Note1: I/O definition: I---Input, O---Output, P---Power/Ground, N---No connection
Note2: All of the GND pins should be connected to the system ground.

3.2 CN2 Pin assignment (Back Light)

Connector Information	
Back Light connector	MS24011P8RA(STM)
Matching connecter	P24011P8 (STM), SHR-08V-S (JST) or equivalent

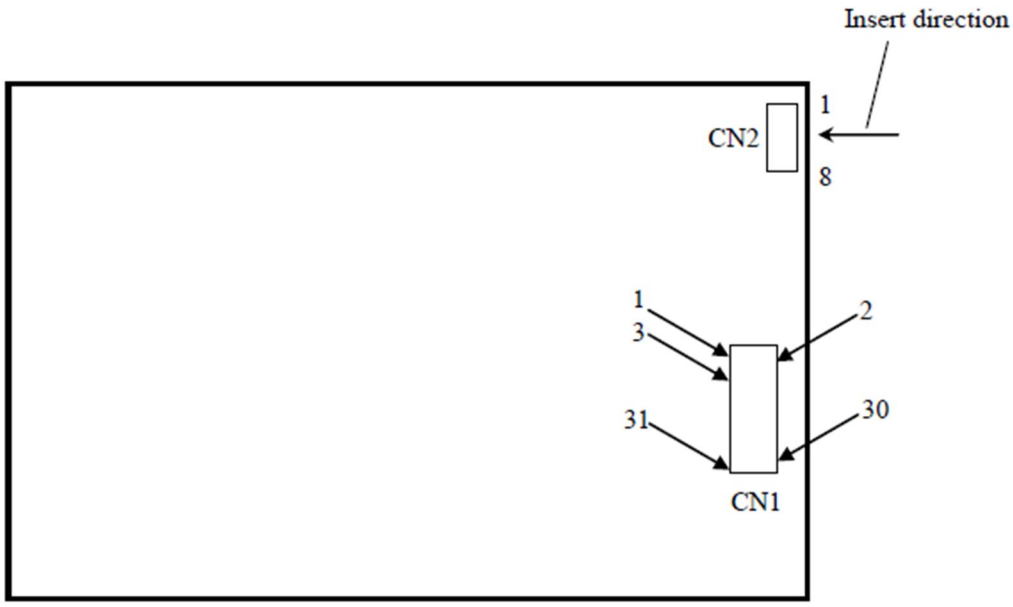
Table 3.2.1 Connector information

No	Symbol	I/O	Description	Comment
1	A1	P	Anode1	
2	K1	P	Cathode1	
3	A2	P	Anode2	
4	K2	P	Cathode2	
5	A3	P	Anode3	
6	K3	P	Cathode3	
7	N. C.	N	-	Keep this pin Open.
8	N. C.	N	-	Keep this pin Open.

Table 3.2.2 Pin Assignment for Back Light Interface

Note1: I/O definition: I---Input, O---Output, P---Power/Ground, N---No connection

3.3 Positions of socket



4. Absolute Maximum Ratings

GND=0V

Item	Symbol	MIN	MAX	Unit	Remark
Power Supply Voltage	VCC	-0.3	5.0	V	Note1
Digital Input Voltage	$V_{I/O}$	-0.3	VCC+0.3	V	
Storage temperature	Tst	-30 to +80		°C	Note2
Operating temperature	TopF	-30 to +80		°C	Note3
	TopR	-30 to +80		°C	Note4
Relative Humidity Note4	RH	--	≤95	%	Ta≤40°C
		--	≤85	%	40°C＜Ta≤50°C
		--	≤55	%	50°C＜Ta≤60°C
		--	≤36	%	60°C＜Ta≤70°C
		--	≤24	%	70°C＜Ta≤80°C
Absolute Humidity Note5	AH	--	≤70 Note5	g/m³	Ta＞80°C

Table 4.1 Absolute Maximum Ratings

Note1: Digital input voltage includes DPS, MODE
Note2: Measured at LCD panel surface (including self-heat)
Note3: Measured at LCD module's rear shield surface (including self-heat)
Note4 No condensation
Note5: Water amount at Ta= 80°C and RH= 24%

5. Electrical Characteristics

5.1 DC Characteristics for Panel Driving

Item		Symbol	MIN	TYP	MAX	Unit	Remark
Power supply Voltage		VCC	3.0	3.3	3.6	V	Include ripple
Power supply current		IVCC	-	115	165	mA	at VCC=3.3V Note1
Power supply ripple		Vp-p	-	-	100	mA	for VCC
Digital input voltage	Low Level	VIL	GND	--	0.3×VCC	V	Note2
	High Level	VIH	0.7*VCC	--	VCC	V	

Table 5.1.1 DC characteristics

Note1: To test the current dissipation, using the “white “testing pattern.
Note2: Digital input voltage includes DPS,MODE

5.2 DC Characteristics for Backlight Driving

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Forward Current	I_F	-	50	-	mA	12 LEDs (4 LED Serial, 3 LED Parallel)
Forward Current Voltage	V_F	-	12.0	13.7	V	
Backlight Power Consumption	W_{BL}	-	1800	-	mW	
Operating Life Time	--	-	70000	-	hrs	Note

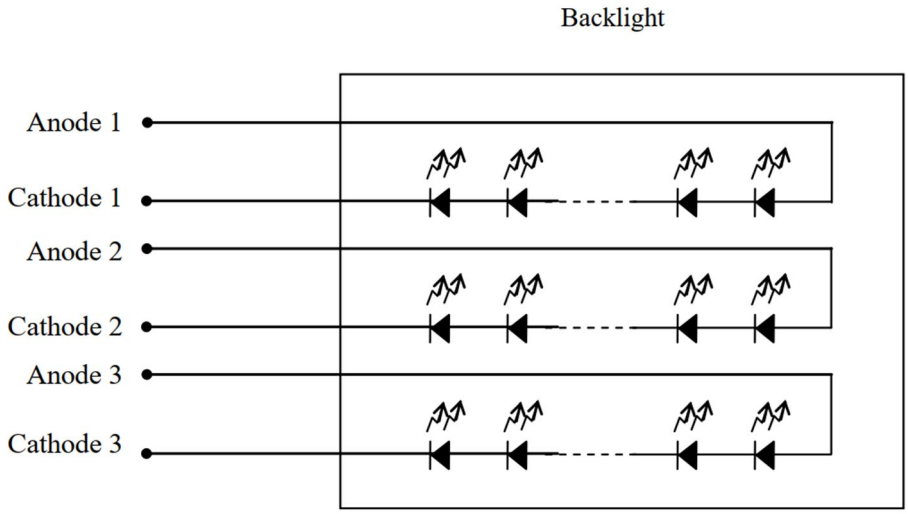
Table 5.2.1 LED Backlight Characteristics

Note1: I_F is defined for Current value of one LED circuit

Note2: Optical performance should be evaluated at Ta=25℃ only.

Note3: If LED is driven by high current, high ambient temperature & humidity condition. The life time of LED will be reduced.

Note4: Operating life means brightness goes down to 50% of initial brightness. Typical operating life time is estimated data.



5.3 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	F0603HI2000V032T	AEM	2.0A 32V	4.0A	/

5.4 Power ON/OFF Sequence

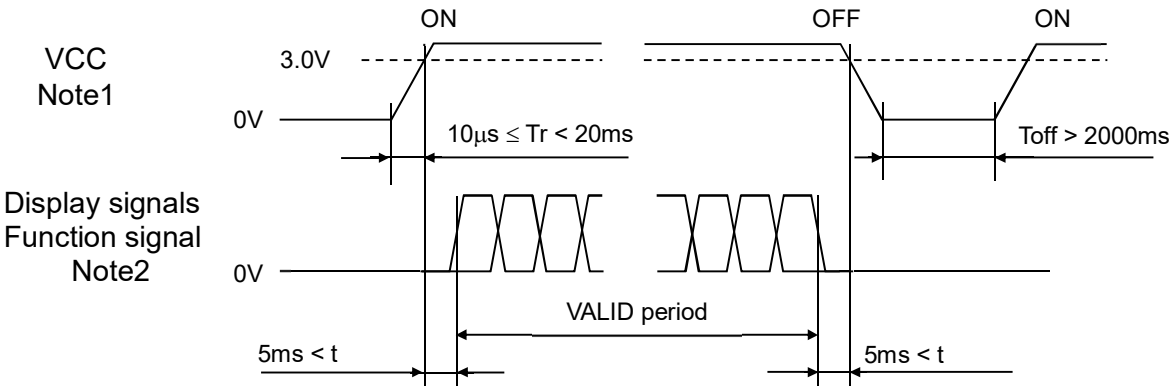


Figure 5.3 Power on/off sequence

Note1: If there is a voltage variation (voltage drop) at the rising edge of VCC below 3.0V , there is a possibility that a product does not work due to a protection circuit.

Note2: Display signals (CLK, Hsync, Vsync, DE, DATA (R0 to R5, G0 to G5, B0 to B5)) and function signal (DPS,MODE) must be set to Low or High-impedance, except the VALID period (See above sequence diagram), in order to avoid the circuitry damage.
If some of display and function signals of this product are cut while this product is working, even if the signal input to it once again, it might not work normally. If a customer stops the display and function signals, VCC also must be shut down.

5.5 LCD Module Block Diagram

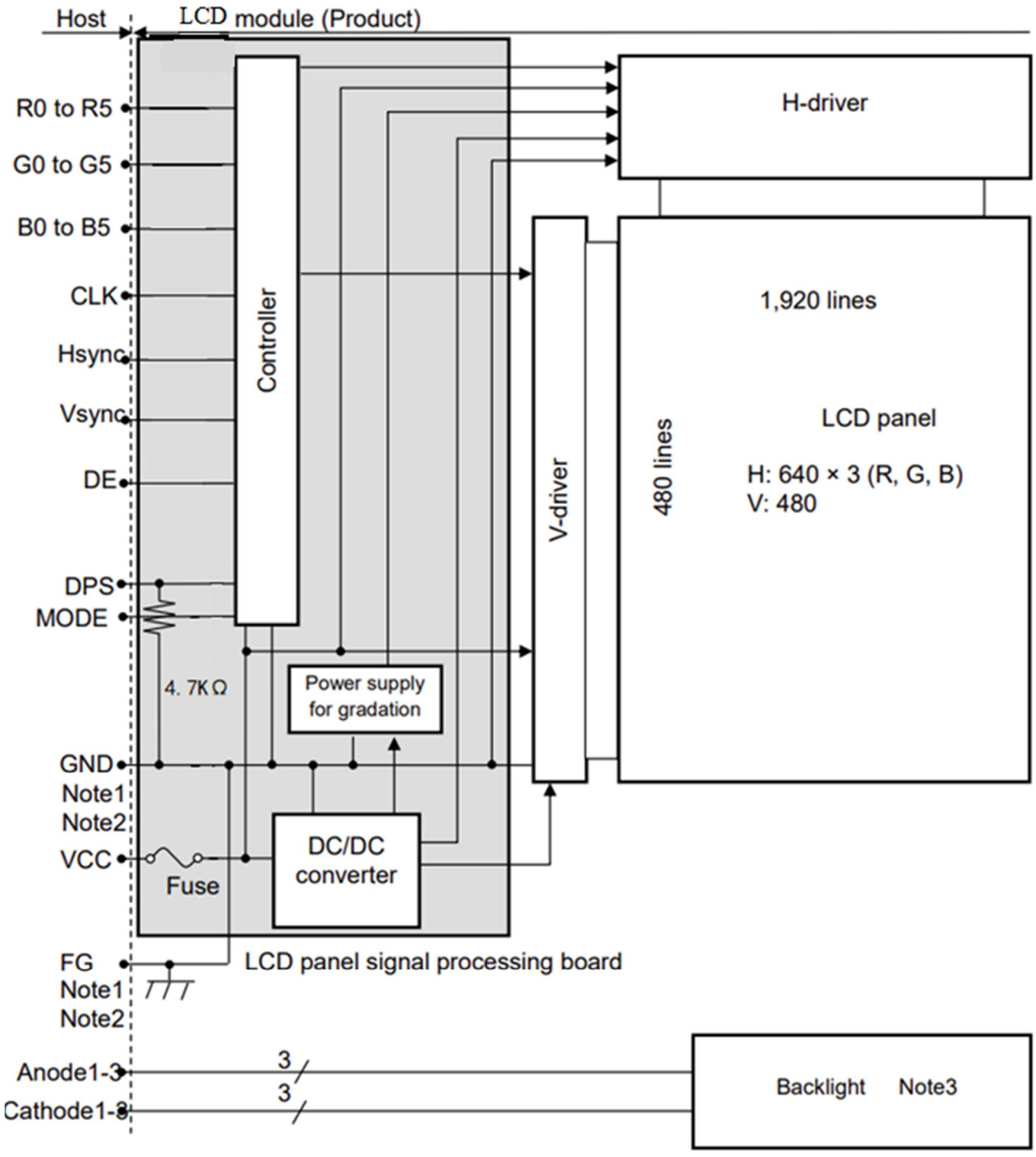


Figure 5.6.1 LCD Module Block Diagram

Note1: Relation between GND (Signal ground) and FG (Frame ground) in the LCD module is as follows.

GND - FG	Connected

Note2: GND and FG must be connected to customer equipment's ground, and it is recommended that these grounds to be connected together in customer equipment.

Note3: See 5.2 for details

6. Timing Characteristics

6.1 Data Input Timing Parameter Setting

VCC=3.3V, GND=0V, Ta=25℃

(a) Sync mode

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency	1/tc	23.1	25.2	27.1	MHz	Note1
Hsync	Cycle	t_H	744	800	840	CLK	
	Display period	t_{HD}		640		CLK	
	Front-porch	t_{HFP}	80	136	176	CLK	
	Pulse width	t_{HPW}	2	-	5	CLK	
	Back-porch	t_{HBP}	13	-	16	CLK	
	Total of pulse width and back-porch	t_{HPW+} t_{HBP}		18		CLK	
Vsync	Cycle	t_V	517	525	537	H	
	Display period	t_{VD}		480		H	
	Front-porch	t_{VFP}	17	25	37	H	
	Pulse width	t_{VPW}	2	-	5	H	
	Back-porch	t_{VBP}	7	-	10	H	
	Total of pulse width and back-porch	t_{VPW} + t_{VBP}		12			
FR	Frame Rate	FR		60		Hz	

Figure 6.1.1 Input Timing Parameters on Fixed Mode

Note1: Definition of parameters is as follows.
tc= 1CLK, th= 1H

(b) DE mode

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	23.1	25.2	27.1	MHz	Note1
DE	Horizontal	Cycle	t_h	744	800	840	CLK	
		Display period	t_{HD}		640		CLK	Note2
	Vertical (One frame)	Cycle	t_V	517	525	537	H	Note3
		Display period	t_{VD}		480		H	-
FR	Frame Rate		FR		60		Hz	-

Figure 6.1.1 Input Timing Parameters on DE Mode

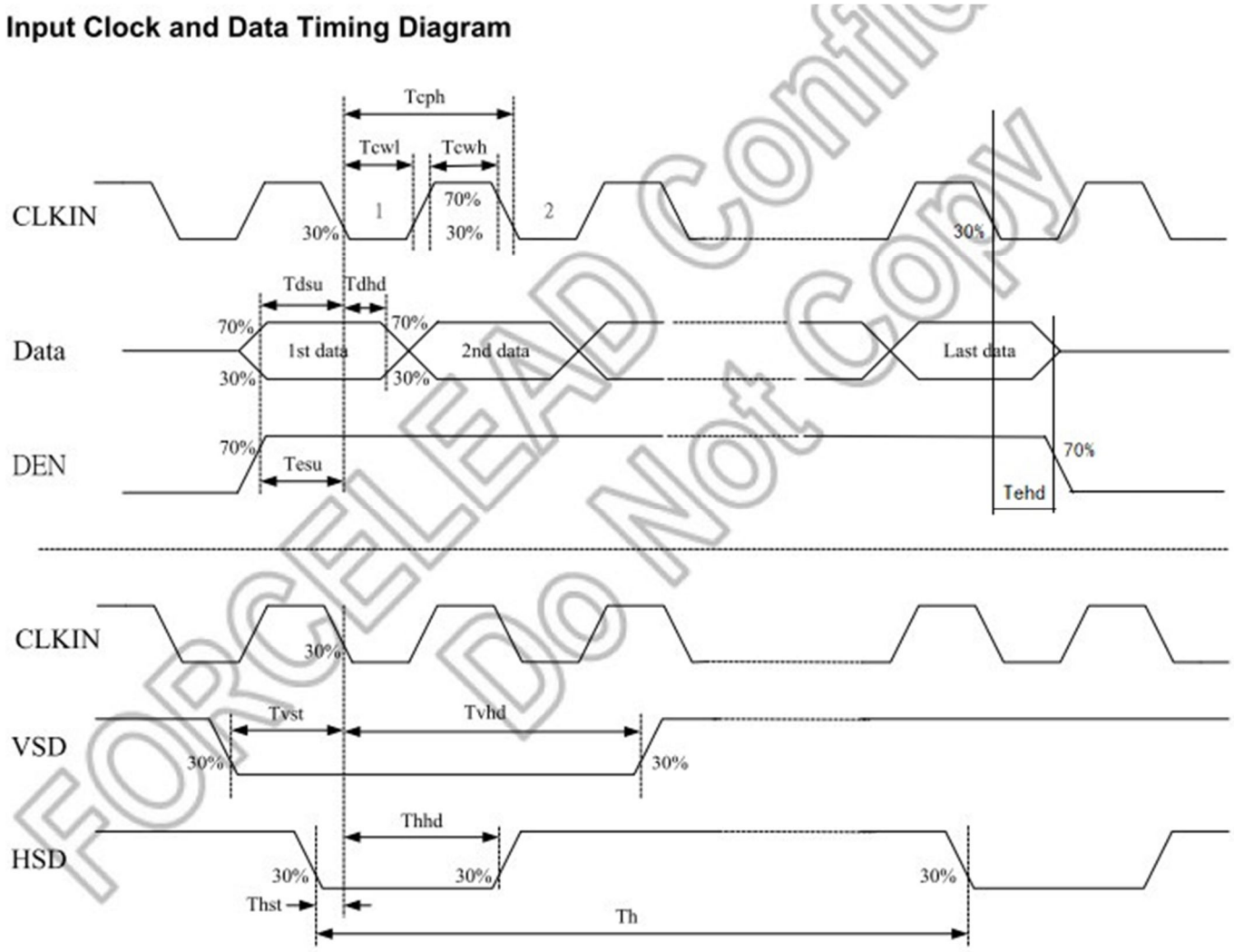
Note1: Definition of parameters is as follows.
tc= 1CLK, th= 1H

Note2: Hsync signal (Pin No.3 of CN1) and Vsync signal (Pin No.4 of CN1) are not used inside the product at DE mode.
Do not keep pin open to avoid noise problem.

Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

Table 6.1.1 Data Input Timing Parameters

6.2 AC Characteristics



Item	Signal	Symbol	Condition	Rating		Unit
				Min.	Max.	
CLK cycle time	CLK	Tcph	-	36.9	43.3	ns
CLK pulse high duty		Tcwh	-	40	60	%
CLK pulse low duty		Tcwl	-	40	60	
Vsync setup time	Vsync	Tvst	-	4	-	ns
Vsync hold time		Tvhd	-	2	-	
Hsync setup time	Hsync	Thst	-	4	-	
Hsync hold time		Thhd	-	2	-	
Data setup time	R[0:5] G[0:5] B[0:5]	Tdsu	-	4	-	
Data hold time		Tdhd	-	2	-	
DE setup time	DE	Tesu	-	4	-	
DE hold time		Tehd	-	2	-	

7. Optical Characteristics

Item		Symbol	Condition	Min	Typ	Max	Unit	Remark
View Angles		θU	CR≧10	70	88	-	Degree	Note 2
		θD		70	88	-		
		θL		70	88	-		
		θR		70	88	-		
Contrast Ratio		CR	θ=0°	500	800	-		Note1 Note3
Response Time		T_{ON}	25℃		25	35	ms	Note1 Note4
		T_{OFF}						
Chromaticity	White	x	Backlight is on	0.254	0.304	0.354		Note1 Note5
		y		0.287	0.337	0.387		
	Red	x		0.541	0.591	0.641		
		y		0.308	0.358	0.408		
	Green	x		0.242	0.292	0.342		
		y		0.501	0.551	0.601		
	Blue	x		0.111	0.161	0.211		
		y		0.100	0.150	0.200		
Uniformity		U		72	80	-	%	Note1 Note6
NTSC				40	45	-	%	Note 5
Luminance(Without TP)		L		570	650	-	cd/m^2	Note1 Note7

Table 7.1 Optical Parameters

Test Conditions:

1. I_F= 50mA, and the ambient temperature is 25℃±2℃,humidity is 65±7%.
2. The test systems refer to Note1 ~Note7.

Note1: Definition of optical measurement system.

The optical characteristics should be measured in dark room. After 5 Minutes operation, the optical characteristics are measured at the center point of the LCD screen.

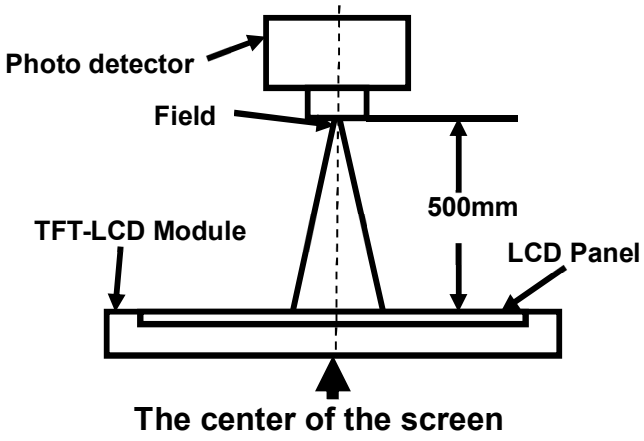


Fig1. Measurement Set Up

Note2: Definition of viewing angle range and measurement system. Viewing angle is measured at the center point of the LCD 。

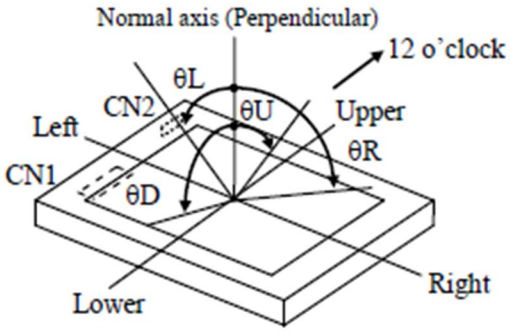


Fig2. Measurement viewing angle

Note3: Definition of contrast ratio

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

Note4: Definition of Response time

For SFT LCM, the response time is defined as the LCD optical switching time interval between “White” state and “Black” state. Rise time (T_r) is the time between photo detector output intensity changed from 10% to 90%. And fall time (T_f) is the time between photo detector output intensity changed from 90% to 10%.

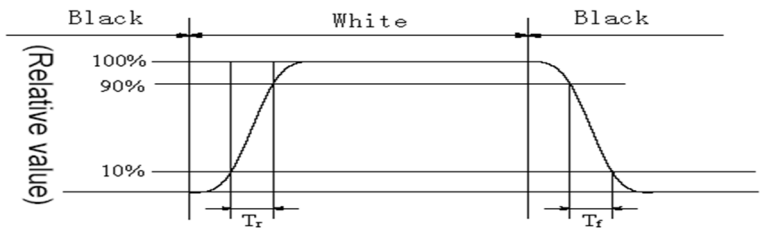


Fig4. Response Time Testing(SFT)

Note5: Definition of color chromaticity (CIE1931)

Color coordinates measured at center point of LCD.

Note6: Definition of Luminance Uniformity

Active area is divided into 9 measuring areas (Refer Fig.5). Every measuring point is placed at the center of each measuring area.

Luminance Uniformity (U) = Lmin/ Lmax

Lmax: The measured Maximum luminance of all measurement position.

Lmin: The measured Minimum luminance of all measurement position.

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

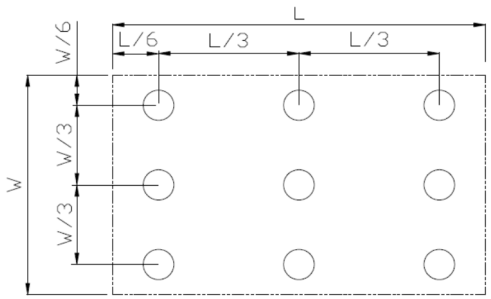


Fig5. Luminance Uniformity Measurement Locations(9 points)

Note7: Definition of Luminance:

Measure the luminance of white state at center point.

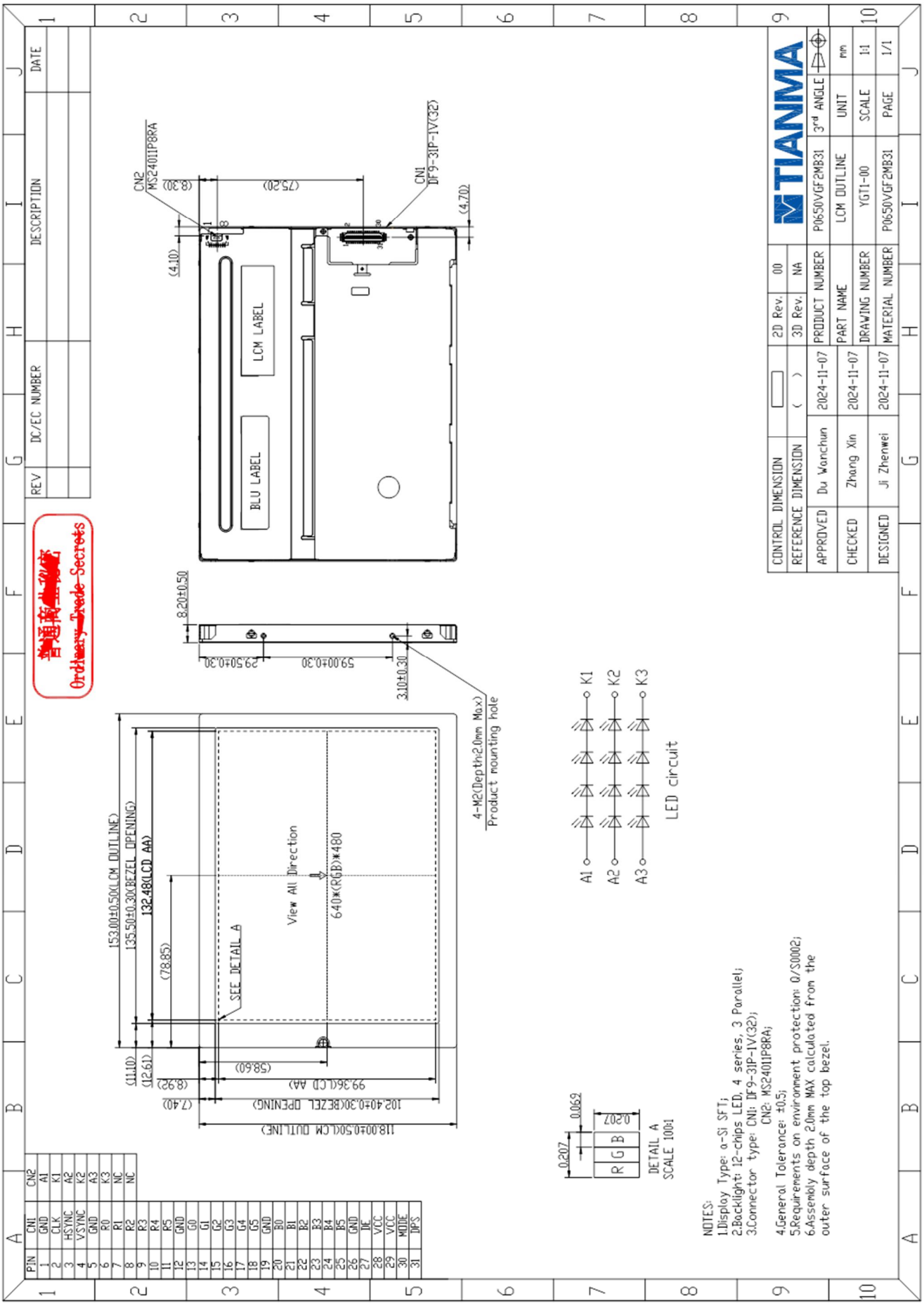
8. Reliability Test

No	Test Item	Condition	Remarks
1	High Temperature Operation	Ta = +80℃, 240 hours	IEC60068-2-2:2007 GB2423.2-2008
2	Low Temperature Operation	Ta = -30℃, 240 hours	IEC60068-2-1:2007 GB2423.1-2008
3	High Temperature Storage	Ta = +80℃, 240hours	IEC60068-2-2:2007 GB2423.2-2008
4	Low Temperature Storage	Ta = -30℃, 240 hours	IEC60068-2-1:2007 GB2423.1-2008
5	High Temperature and Humidity Operation	Ta = +60℃, 90% RH max,240hours	IEC60068-2-78 :2012 GB/T2423.3—2016
6	Thermal Shock (non-operation)	-30℃ 30 min~+80℃ 30 min, Change time:5min, 100 Cycle	Start with cold temperature, End with high temperature, IEC60068-2-14:2009,GB2423.22-2012
7	ESD	C=150pF,R=150Ω,9point/panel Contact:±10Kv,10times;	IEC61000-4-2:2008 GB/T17626.2-2018
8	Vibration Test (non-operation)	5~100HZ，19.60m/s2 1min/cycle 120times Per X\Y\Z	IEC60068-2-6:2007 GB/T2423.10—2019
9	Shock Test (non-operation)	539m/s2, 11ms 5times ±X、±Y、±Z	GB/T 2423.5-1995
10	Package Drop Test	Height:60cm, 1corner,3edges,6surfaces	GB/T 4857.5-1995
11	Package Vibration	Frequency：5-20-200HZ，PSD： 0.01-0.01-0.001 Total:0.781g2/HZ, x/y/z axis per 30min)	GB/T 4857.23-2021

Table 8.1 RA test condition

Note1: Temperature is the ambient temperature of sample
Note2: Before cosmetic and function test, the product must have enough recovery time, at least 24 hours at room temperature.
Note3: In the standard condition, there shall be no practical problem that may affect the display function. After the reliability test, the product's function only be guaranteed, but not for all of the cosmetic specification.

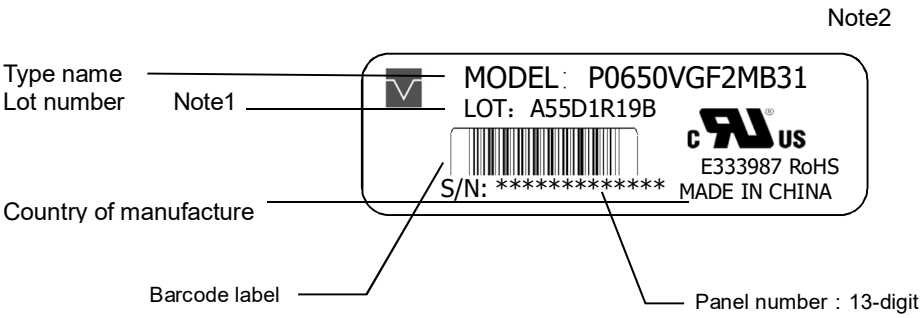
9. Mechanical Drawing



10. Markings

The marking is attached to this product.

10.1 Nameplate label



Note1: The meaning of lot number

- Example: A55D1R19B

A	5	5	D1R19B
Revision 1 letter (Alphabet)	**Manufacturing year** 1 figure of the A.D. end numbers (e.g.: A.D 2025 is 5)	**Manufacturing month** 1 letter Jan. to Sep.: Number of month October: A November: B December: C	**Production number** Multi-letter

Note2: Do not attach anything like another label on the name plate label! In case of replacing the product, Tianma needs the contents of nameplate such as the lot number, inspection date and so on, to identify the warranty period with individual product. If Tianma cannot decipher the contents of nameplate, replacing shall be charged. Tianma also may give a new lot number to replaced products.

11. Packing Instruction

No	Item	Model (Material)	Dimensions(mm)	Unit Weight(Kg)	Quantity	Remark
1	LCM	P0650VGF2MB31	153.0×118.0×8.2	0.135	24	
2	Tray	PET	356×256×19.7	0.125	15	
3	Dust-proof Bag	PE	680×520	0.042	1	
4	EPE 1	EPE	336×246×6	0.01	6	
5	EPE 2	EPE	375×275×10	0.014	4	
6	EPE 3	EPE	250×280×12	0.015	2	
7	Carton	CORRUGATED PAPER	398×290×315	0.58	1	
8	Lable	tagboard	100×52	0.002	1	
9	Total weight	5.885 Kg				

Table 10.1 Packing Instruction

Packaging Specification and Quantity)

(1) LCM quantity per tray:2
(2) Total LCM quantity per group:8(4 trays+1 tray)
(3) Total LCM quantity in Carton: Number of PET trays 12× quantity per tray 2= 24

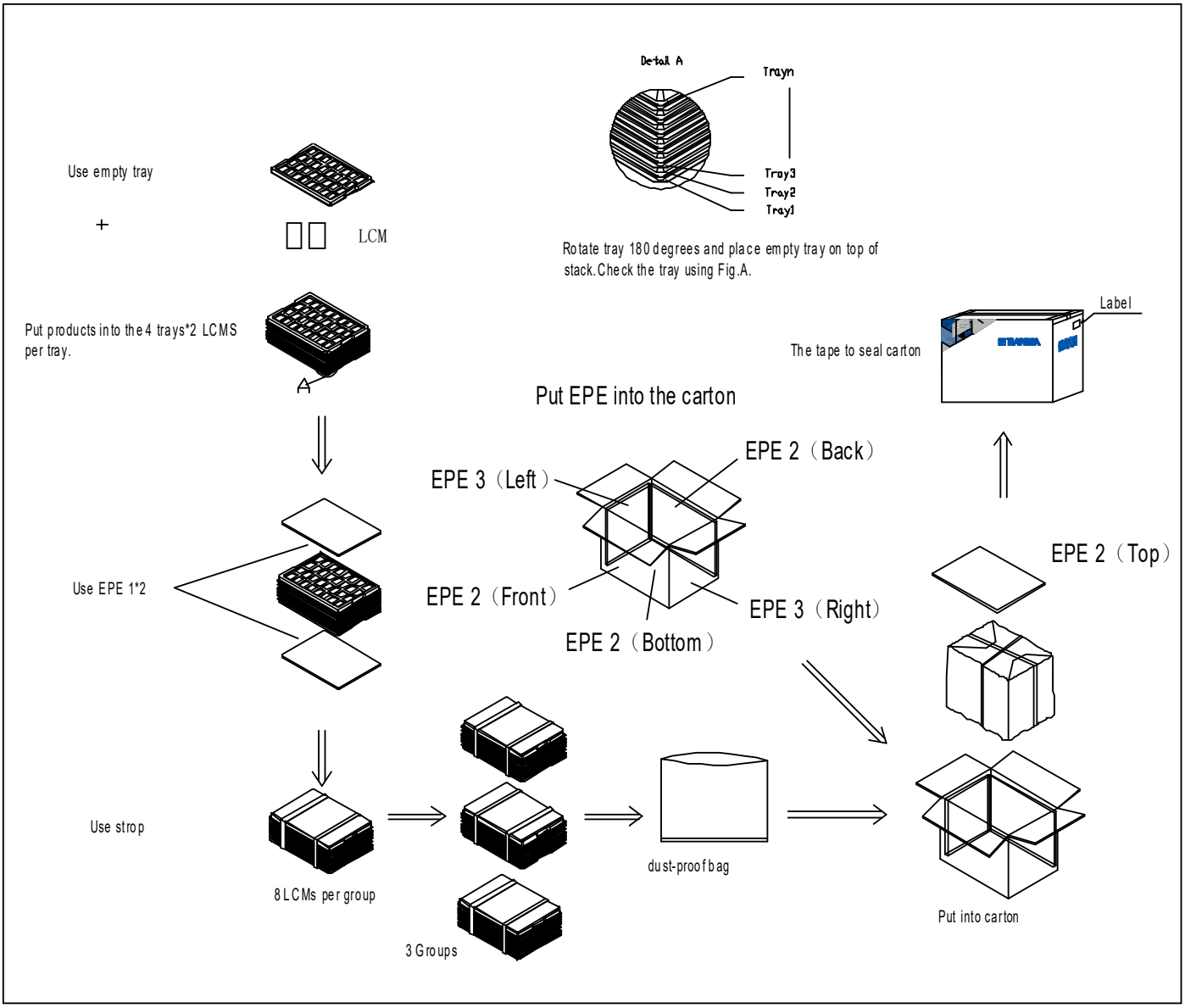
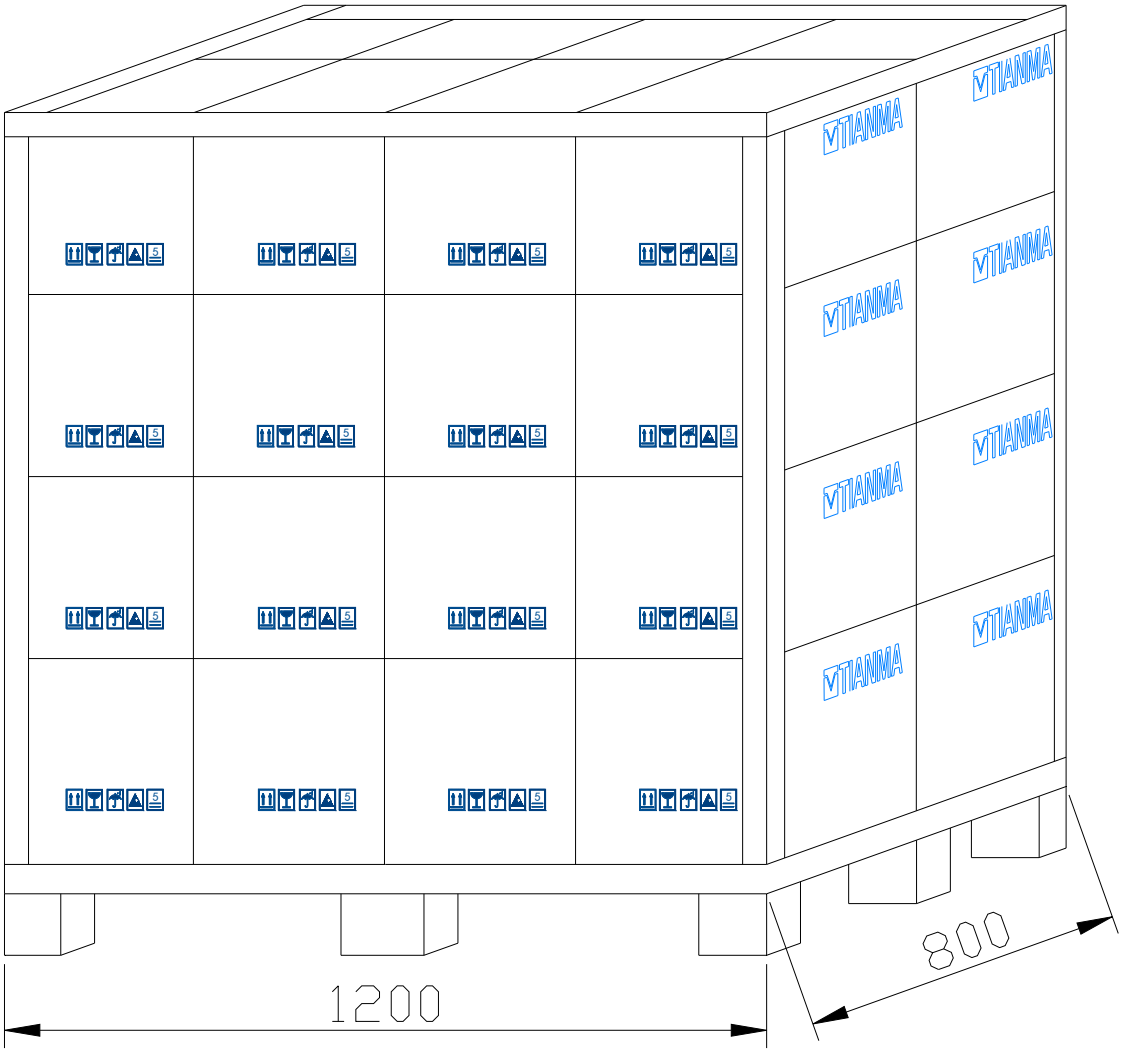


Figure 10.1 Packing Instruction

Stack placement

The number of cartons stacked is 2 x 4/ each layer x 4 layers in total

Below dimensions unit: mm



12. Precautions for Use of LCD Modules

12.1 Handling Precautions

(1) The display panel is made of glass. Do not subject it to mechanical shock by dropping it, etc.
(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.
(3) Do not apply excessive force to the display surface or the bezel since this may cause the color tone to vary.
(4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle the polarizer carefully.
(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
(6) Do not disassemble the LCD Module.
(7) If powered off, do not apply the input signals.
(8) To prevent destruction of the module by static electricity, be careful to maintain an optimum work environment.
(9) Be sure to ground your body when handling the LCD Modules.
(10) Tools used for assembly, must be properly grounded.
(11) To reduce the amount of static electricity generated, do not conduct assembly or other work under very low humidity conditions.
(12) The LCD Module is covered with a film to protect the display surface, remove film slowly under the ionizer.

12.2 Storage precautions

(1) When storing the LCD modules avoid exposure to direct sunlight or to the light of fluorescent lamps.
(2) The LCD modules should be stored within the rated storage temperature range. The recommend condition is: Temperature: 0 ~ 35 ℃ at normal humidity.
(3) The LCD modules should be stored in a room without acid, alkali or other harmful gas.

12.3 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.

12.4 Screen saver Precautions

Not display the fixed pattern for a long time. Use a screen saver, if the fixed pattern is displayed on the screen

12.5 Safety Precautions

(1) When you waste damaged or unnecessary LCDs, it is recommended to crush LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned
(2) Be sure to turn off the power supply when inserting or disconnecting the LED backlight cable.
(3) LED driver should be designed to limit or stop its function when over current is detected on the LED.