

MODEL NO : TM028HDHG59
MODEL VERSION: 01
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- Preliminary Specification
 Final Product Specification

Customer : _____

pp oved by	Notes

TIANMA Confirmed :

Prepared by	Checked by	Approved by
Haiping_luo	Wenkai_wang Junwei_liu Yuming_han	Guangkun_an

This technical specification is subjected to change without notice

Table of Contents

Table of Contents	2
Record of Revision.....	3
1 General Specifications.....	4
2 Input/Output Terminals	5
3 Absolute Maximum Ratings.....	6
4 Electrical Characteristics	7
4.1 Driving TFT LCD Panel.....	7
4.2 Driving Backlight	7
5 Timing Chart.....	8
5.1 Input Clock and Data Timing.....	8
5.2 Reset Timing.....	8
6 Optical Characteristics	10
6.1 Driving the backlight condition.....	10
6.2 Not Driving the backlight condition.....	10
7 Environmental / Reliability Test.....	15
8 Mechanical Drawing.....	15
9 Packing Drawing	15
10 Precautions for Use of LCD Modules.....	20

1 General Specifications

Feature		Spec
Display Spec.	Size	2.80 inch
	Resolution	240(RGB) x 320
	Technology Type	a-Si
	Pixel Configuration	R.G.B Stripe
	Pixel pitch(mm)	0.18(H)x0.18(V)
	Display Mode	TN, Normally white
	Surface Treatment	AG
	Viewing Direction	6.0 o'clock
	Gray Scale Inversion Direction	12 o'clock
Mechanical Characteristics	LCM (W x H x D) (mm)	49.9 x 66.1 x 3.9
	Active Area(mm)	43.20×57.60
	With /Without TSP	Without TSP
	Matching Connection Type	ZIF
	LED Numbers	4-Parallel white LED
	Weight (g)	TBD
Electrical Characteristics	Interface	18 Bit RGB interface / 3-wire SPI
	Color Depth	65K/262K
	Driver IC	ST7789VI

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

Note 2: Requirements on Environmental Protection: Q/S0002

Note 3: LCM weight tolerance: $\pm 5\%$

2 Input/Output Terminals

Pin No.	Symbol	I/O	Function	Remark
1	NC	-	No connect	
2	NC	-	No connect	
3	NC	-	No connect	
4	NC	-	No connect	
5	GND	P	Power Ground	
6	S1	-	Connect together	
7	S1	-		
8	VDD	P	Power	
9	R5	I	Red data input (MSB)	
10	R4	I	Red data input	
11	R3	I	Red data input	
12	R2	I	Red data input	
13	R1	I	Red data input	
14	R0	I	Red data input (LSB)	
15	G5	I	Green data input (MSB)	
16	G4	I	Green data input	
17	G3	I	Green data input	
18	G2	I	Green data input	
19	G1	I	Green data input	
20	G0	I	Green data input (LSB)	
21	B5	I	Blue data input (MSB)	
22	B4	I	Blue data input	
23	B3	I	Blue data input	
24	B2	I	Blue data input	
25	B1	I	Blue data input	
26	B0	I	Blue data input(LSB)	
27	SDI	I	Serial data input pin and output pin(SDA) in serial bus system interface I. Serial data input pin (SDI) in serial bus system interface II. The data is inputted on the rising edge of the SCL signal. If not used, please let it open or connected to VSSD.	

28	Dclk	I	Dot clock signal for RGB interface operation Fix to VCC or VSS level when not in use
29	GND	p	Ground
30	DE(CLAC)	I	Data enable signal for RGB interface operation Fix to VCC or VSS level when not in use
31	HS	I	Line synchronizing signal for RGB interface operation Fix to VCC or VSS level when not in use
32	VS	I	Frame synchronizing signal for RGB interface operation Fix to VCC or VSS level when not in use
33	SCL	I	Input data effective signal
34	CS	I	Chip select signal
35	RESET	I	Reser pin
36	S2	-	Connect together
37	S2	-	
38	LEDK	P	Backlight cathode
39	LEDA	P	Backlight anode

3 Absolute Maximum Ratings

Item	Symbol	MIN	MAX	Unit	Remark
Power Supply Voltage	VDD	-0.3	3.3	V	Note1
Logic Supply Voltage	VCCIO	-0.3	3.3	V	
Logic Input voltage	I/O PINs	-0.3	VCCIO+0.3	V	
Operating Temperature	Top	-20	70	°C	
Storage Temperature	Tst	-30	80	°C	

Table 3 Absolute Maximum Ratings

Note1: Input voltage include R0~R5, G0~G5, B0~B5, Dotclk, Hsync, Vsync, Enable.

Note2: Ta means the ambient temperature.

It is necessary to limit the relative humidity to the specified temperature range.
Condensation on the module is not allowed.

4 Electrical Characteristics

4.1 Driving TFT LCD Panel

GND=0V, Ta=25°C

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Supply voltage for logic	VDD	2.4	2.8	3.3	V	
Input Signal Voltage	High Level	V _{IH}	0.7*IOVCC	-	IOVCC	V
	Low Level	V _{IL}	0	-	0.3*IOVCC	V
Output Voltage	High Level	V _{OH}	0.8VDD	-	VDD	
	Low Level	V _{OL}	V _{ss}	-	0.2VDD	
Current Consumption	ICC1	-	6	9	mA	
	ICC2	-	TBD	-	mA	

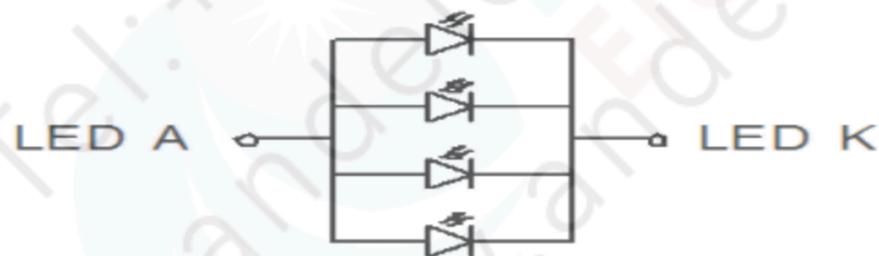
Note1: For different LCM, the value may have a bit of difference.

Note2: To test the current dissipation, use "all Black Pattern".

Table 4.1 LCD module electrical characteristics

4.2 Driving Backlight

Item	Symbol	Min	Typ	Max	Unit	Remark
Forward Current	I _F	-	20	-	mA	For each LED
Forward Voltage	V _F	2.9	3.2	3.4	V	For each LED
Backlight Power Consumption	W _{BL}	-	256	-	mW	4 LEDs
Operating Life Time	-	-	30,000	-	Hrs	For each LED



CIRCUIT DIAGRAM
(I_f=80mA / V_f=3.2V TYP)

Note 1: Optical performance should be evaluated at Ta=25°C only.

Note 2: Under LCM operating, the stable forward current should be inputted. And forward voltage is for reference only.

Note 3: If LED is driven by 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.

5 Timing Chart

5.1 Input Clock and Data Timing

5.1.1 Serial Interface Characteristics (3-line serial):

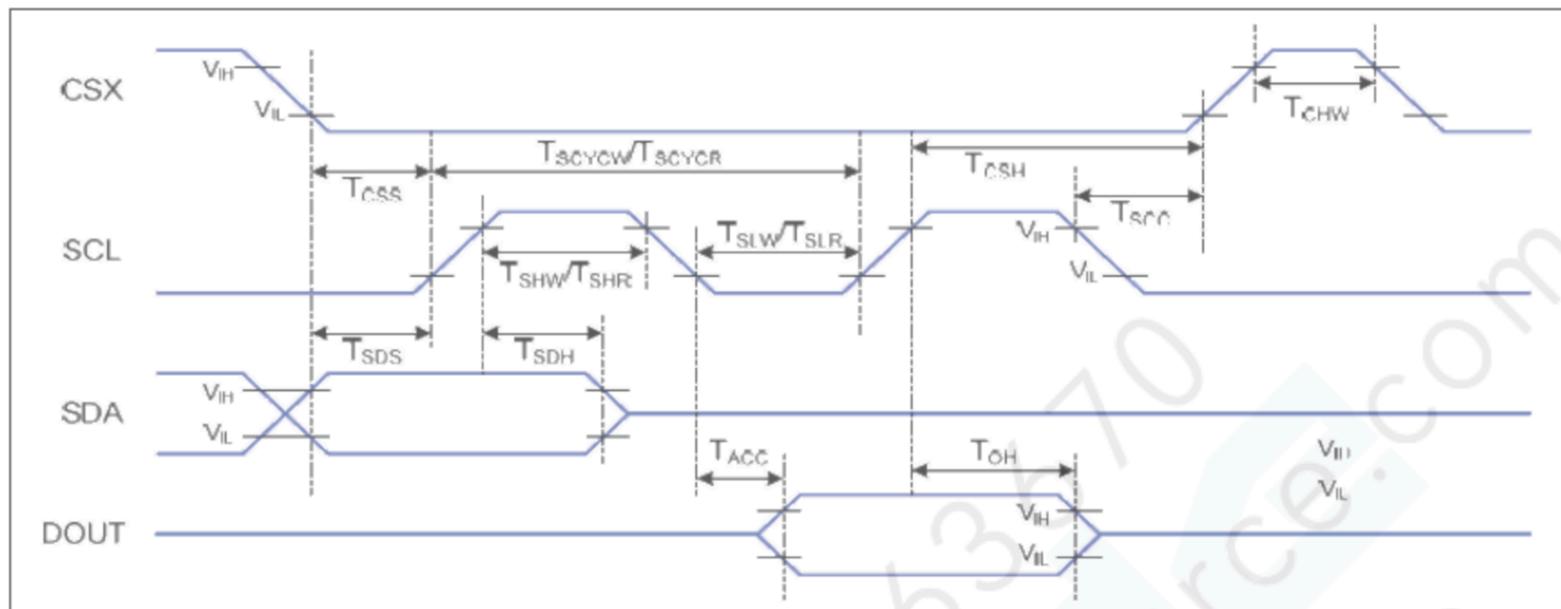


Table 5.1.1 line serial Interface Timing Characteristics

VDDI=1.65 to 3.6V, VDD=2.4 to 3.6V, AGND=DGND=0V, Ta=25 °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)	16		ns	
	T_{SHW}	SCL "H" pulse width (Write)	7		ns	
	T_{SLW}	SCL "L" pulse width (Write)	7		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	7		ns	
	T_{SDH}	Data hold time	7		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

5.1.2 RGB Interface Characteristics:

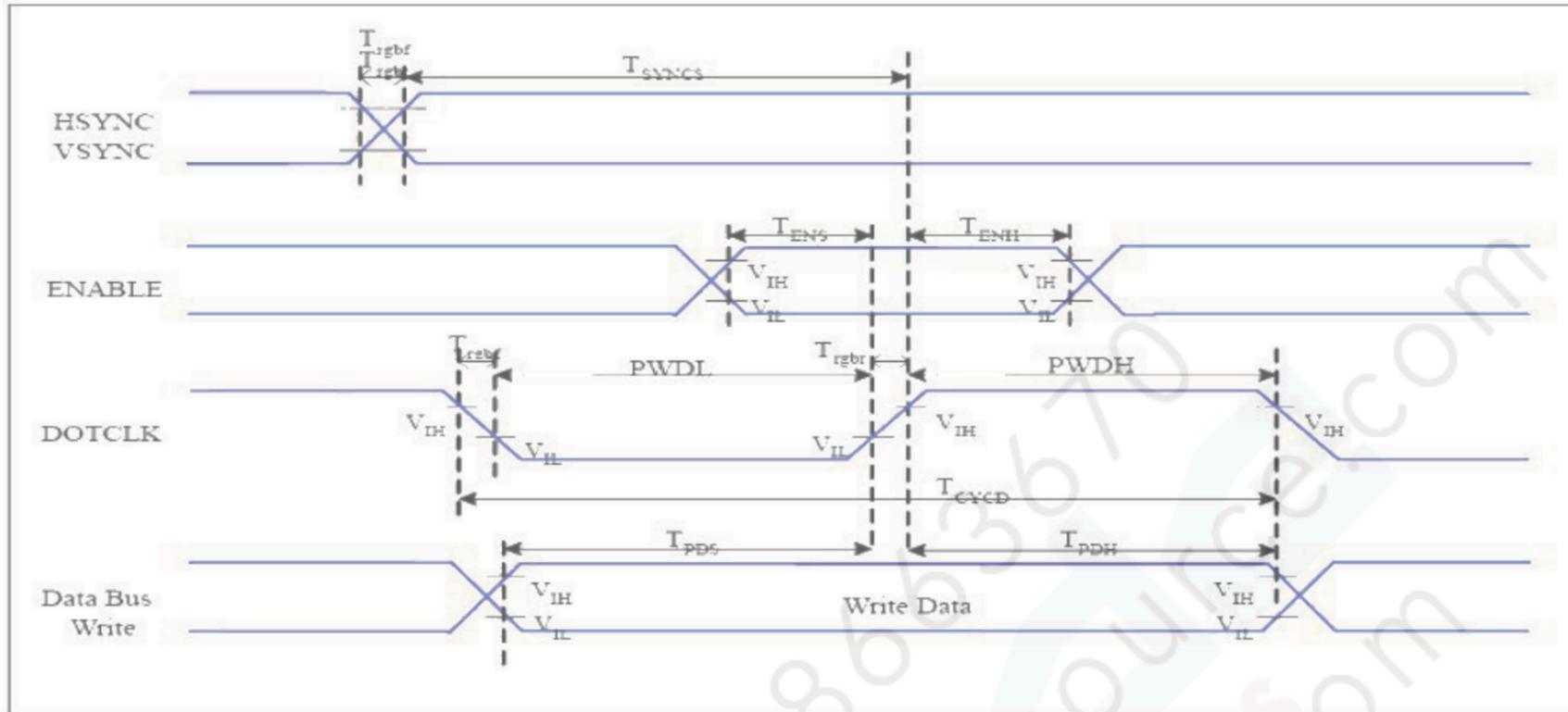


Table 5.1.3 RGB Interface Timing Characteristics

VDDI=1.65 to 3.6V, VDD=2.4 to 3.6V, AGND=DGND=0V, Ta=25 °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	

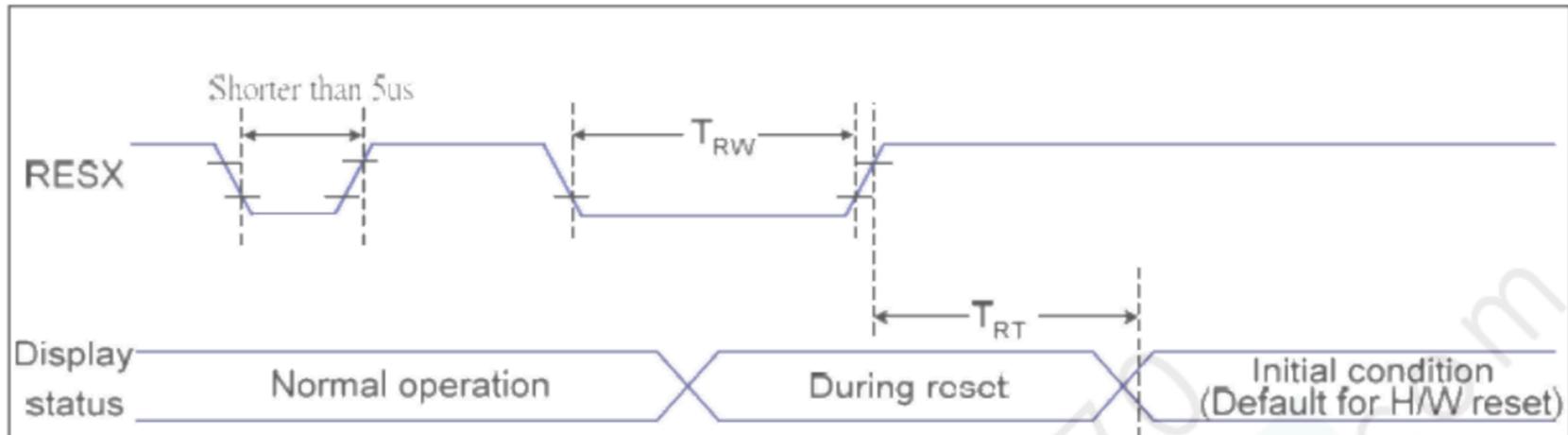
Table 7 18/16 Bits RGB Interface Timing Characteristics

Signal	Symbol	Parameter	MIN	MAX	Unit	Description
HSYNC, VSYNC	T_{SYNCs}	VSYNC, HSYNC Setup Time	25	-	ns	
ENABLE	T_{ENS}	Enable Setup Time	25	-	ns	
DOTCLK	PWDH	DOTCLK High-level Pulse Width	25	-	ns	
	PWDL	DOTCLK Low-level Pulse Width	25	-	ns	
	T_{CYCD}	DOTCLK Cycle Time	55	-	ns	
	Trghr, Trghf	DOTCLK Rise/Fall time	-	10	ns	
DB	T_{PDS}	PD Data Setup Time	25	-	ns	
	T_{PDH}	PD Data Hold Time	25	-	ns	

Table 8 6 Bits RGB Interface Timing Characteristics

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5.2 Reset Timing:



VDDI=1.65 to 3.6V, VDD=2.4 to 3.6V, AGND=DGND=0V, Ta=25

Related Pins	Symbol	Parameter	MIN	MAX	Unit
RESX	TRW	Reset pulse duration	10	-	us
	TRT	Reset cancel	-	5 (Note 1, 5)	ms
				120 (Note 1, 6, 7)	ms

Notes.

1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (tRT) within 5 ms after a rising edge of RESX.

2. Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below.

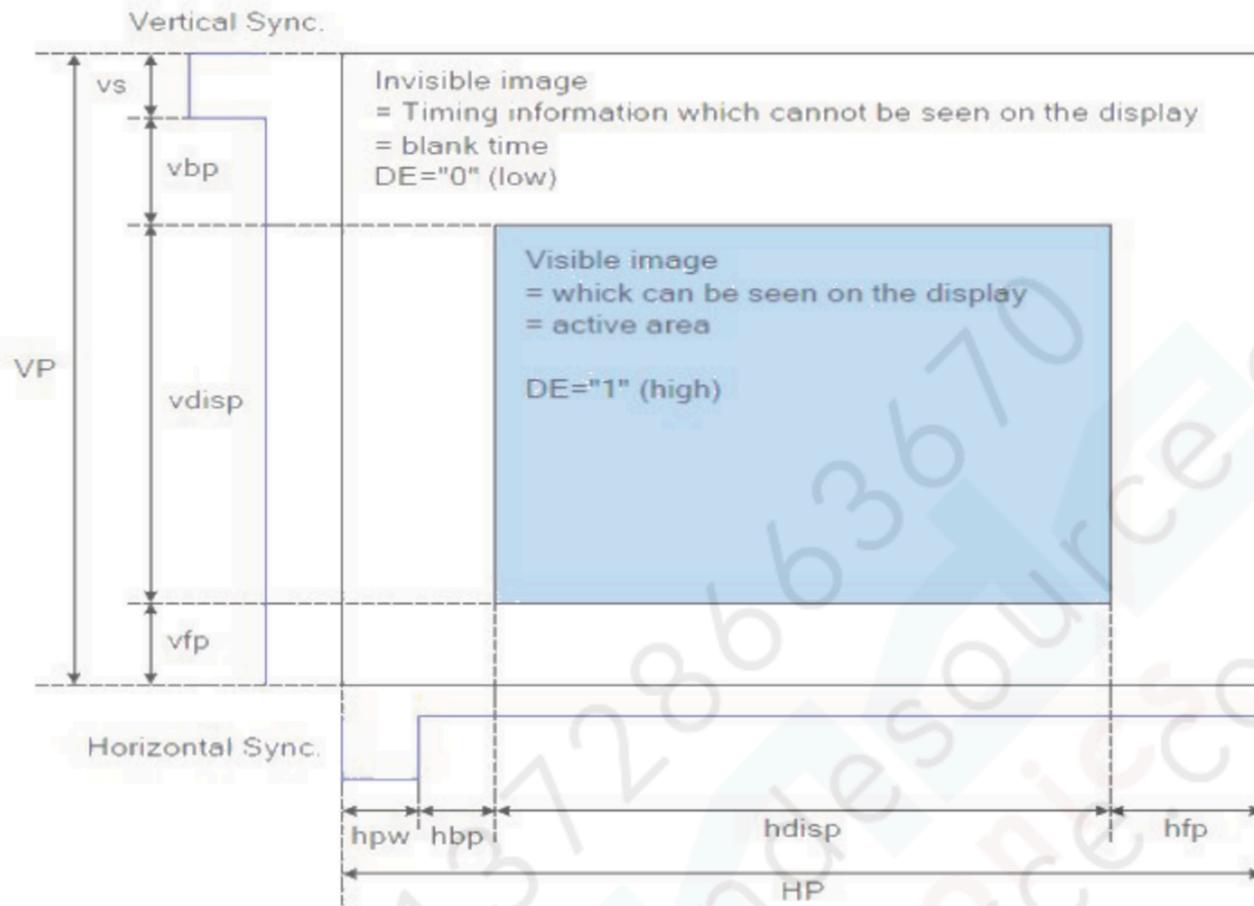
RESX Pulse	Action
Shorter than 5us	Reset Rejected
Longer than 9us	Reset
Between 5us and 9us	Reset starts

3. 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 Hardware Reset.

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

5.3 RGB Interface Definition

The display operation via the RGB interface is synchronized with the VSYNC, HSYNC, and DOTCLK signals. The data can be written only within the specified area with low power consumption by using window address function. The back porch and front porch are used to set the RGB interface timing.



Please refer to the following table for the setting limitation of RGB interface signals.

18bit RGB interface:

Parameter	Symbol	Min.	Typ.	Max.	Unit
Horizontal Sync. Width	hpw	2	10	hpw+hbp=31	Clock
Horizontal Sync. Back Porch	hbp	4	10		Clock
Horizontal Sync. Front Porch	hfp	2	38	-	Clock
Vertical Sync. Width	vs	2	4	vs+vbp=127	Line
Vertical Sync. Back Porch	vbp	2	4		Line
Vertical Sync. Front Porch	vfp	2	8	-	Line

Note:

Typical value are related to the setting of dot clock is 7MHz and frame rate is 70Hz.

If the setting of hpw is 10 dot clocks and hbp is 10 dot clocks, the setting of HBP in command B1h is 20 dot clocks

6 Optical Characteristics

a) Driving the backlight condition

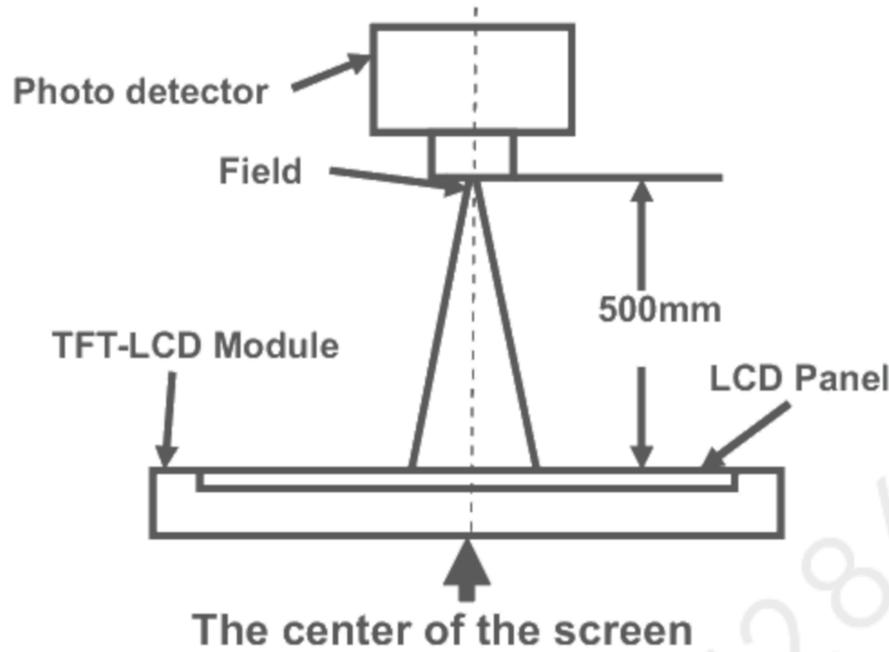
Item	Symbol	Condition	Min	Typ	Max	Unit	Remark
View Angle	θT	$CR \geq 10$	60	70	-	Degree	Note2
	θB		50	60	-		
	θL		60	70	-		
	θR		60	70	-		
Contrast Ratio	CR	$\theta = 0^\circ$	400	500	-		Note3
Response time	T_{on}	$+25^\circ C$	-	20	30	ms	Note4
	T_{off}						
Chromaticity	x	Backlight is on	0.2297	0.2797	0.3297		Note1, 5
	y		0.2553	0.3053	0.3553		
	x		0.5754	0.6254	0.6754		Note1, 5
	y		0.2846	0.3346	0.3846		
	x		0.2698	0.3198	0.3698		Note1, 5
	y		0.5795	0.6295	0.6795		
	x		0.0948	0.1448	0.1948		Note1, 5
	y		0.0131	0.0631	0.1131		
NTSC			60	65	-	%	Note5
Uniformity	U		75	80	-	%	Note6
Luminance	L		250	300	-	cd/m ²	Note7

Test Conditions:

1. $I_F=20mA$ (one LED), and the ambient temperature
2. The test systems refer to Note 1 and Note 2

Note 1: Definition of optical measurement system.

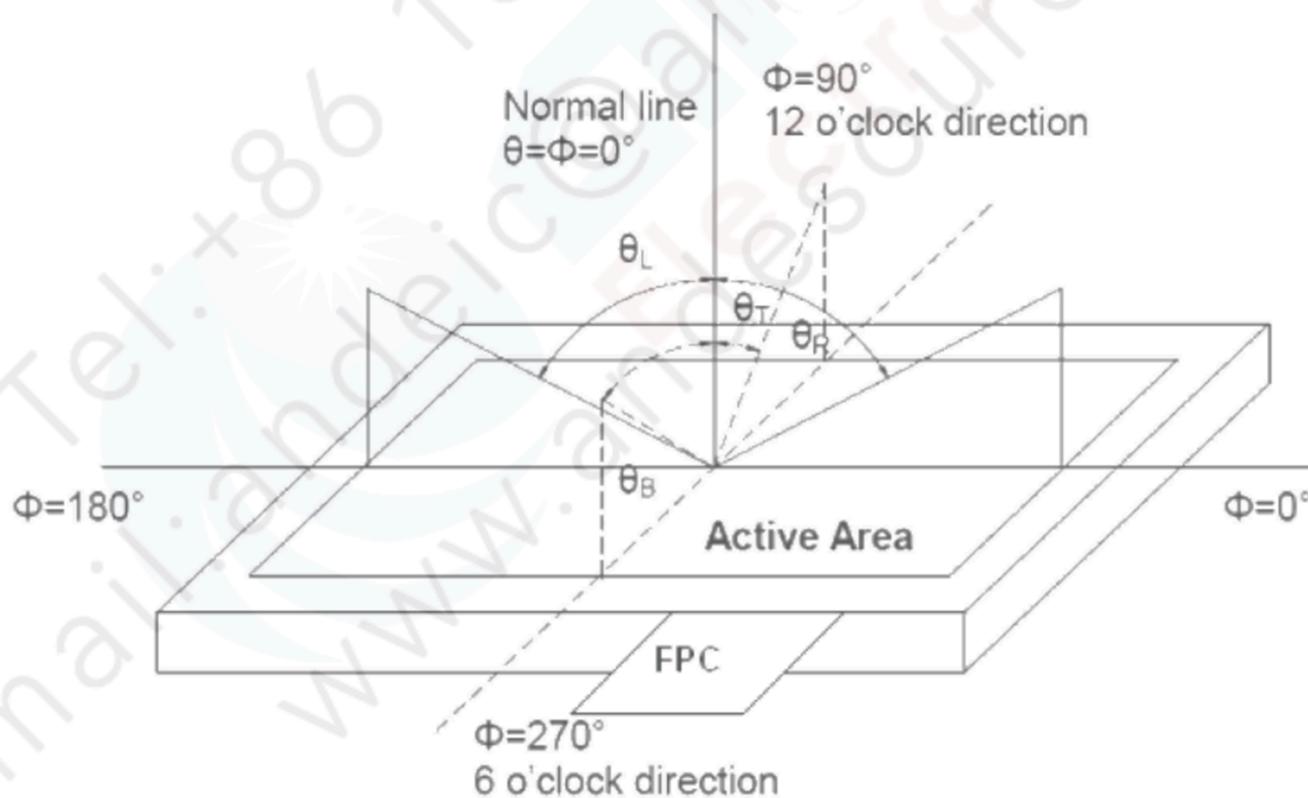
The optical characteristics should be measured in dark room. After 5 Minutes operation, the optical properties are measured at the center point of the LCD screen. All input terminals LCD panel must be ground when measuring the center area of the panel.



Item	Photo detector	Field
Contrast Ratio	SR-3A	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

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

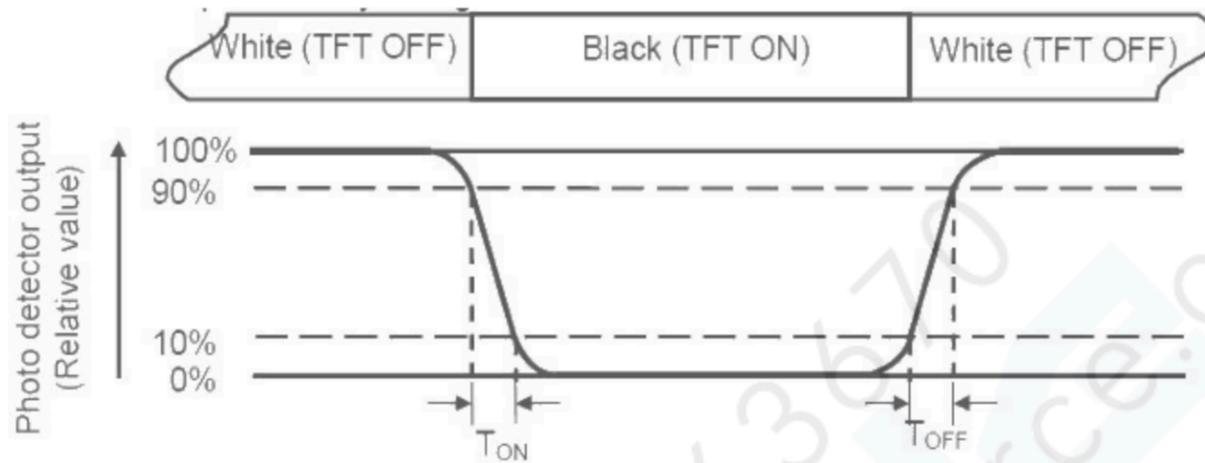
“White state “: The state is that the LCD should drive by Vwhite.

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

V_{white}: To be determined V_{black}: 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)

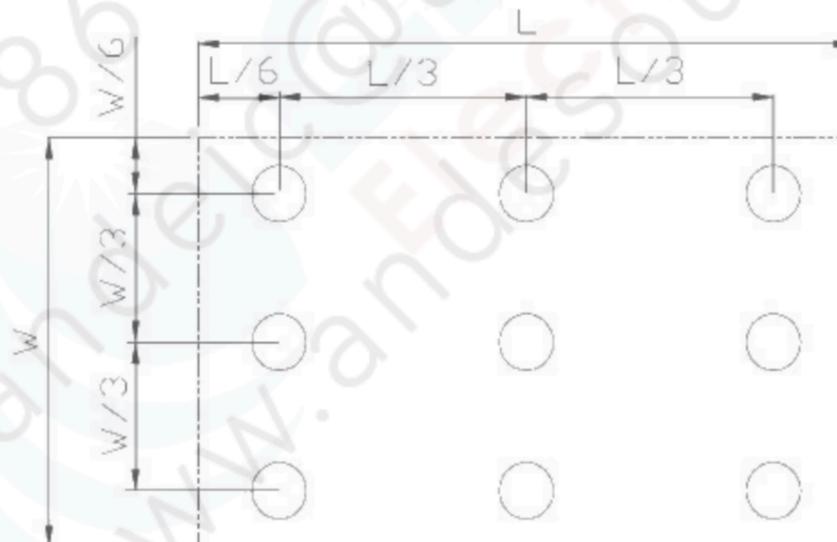
Color coordinates measured at center point of LCD.

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	T _s =+70°C±2°C, 96hrs	IEC60068-2-1:2007 GB2423.2-2008
2	Low Temperature Operation	T _a =-20°C±2°C, 96hrs	IEC60068-2-1:2007 GB2423.1-2008
3	High Temperature Storage	T _a =+80°C±2°C, 96hrs	IEC60068-2-1:2007 GB2423.2-2008
4	Low Temperature Storage	T _a =-30°C±2°C, 96hrs	IEC60068-2-1:2007 GB2423.1-2008
5	Storage at High Temperature and Humidity	T _a =+60°C, 90% RH, 96hrs	IEC60068-2-78 :2001 GB/T2423.3—2006
6	Thermal Shock (non-operation)	30°C←→25°C←→80°C 30min 5min 30min after 10cycle, Restore 2H at 25°C Power off	Start with cold temperature, End with high temperature, IEC60068-2-14:1984,G B2423.22-2002
7	Electro Static Discharge (operation)	Contact ±4KV , 150PF/330 , 12times Air ±6KV,150PF/330 , 12times	IEC61000-4-2:2001 GB/T17626.2-2006
8	Vibration Test	10Hz~150Hz, 100m/s ² , 120min	IEC60068-2-6:1982 GB/T2423.10—1995
9	Mechanical Shock (Non OP)	Half-sine wave,300m/s ² , 11ms	IEC60068-2-27:1987 GB/T2423.5—1995
10	Package Drop Test	800mm, concrete floor,1corner, 3edges, 6 sides each time	IEC60068-2-32:1990 GB/T2423.8—1995

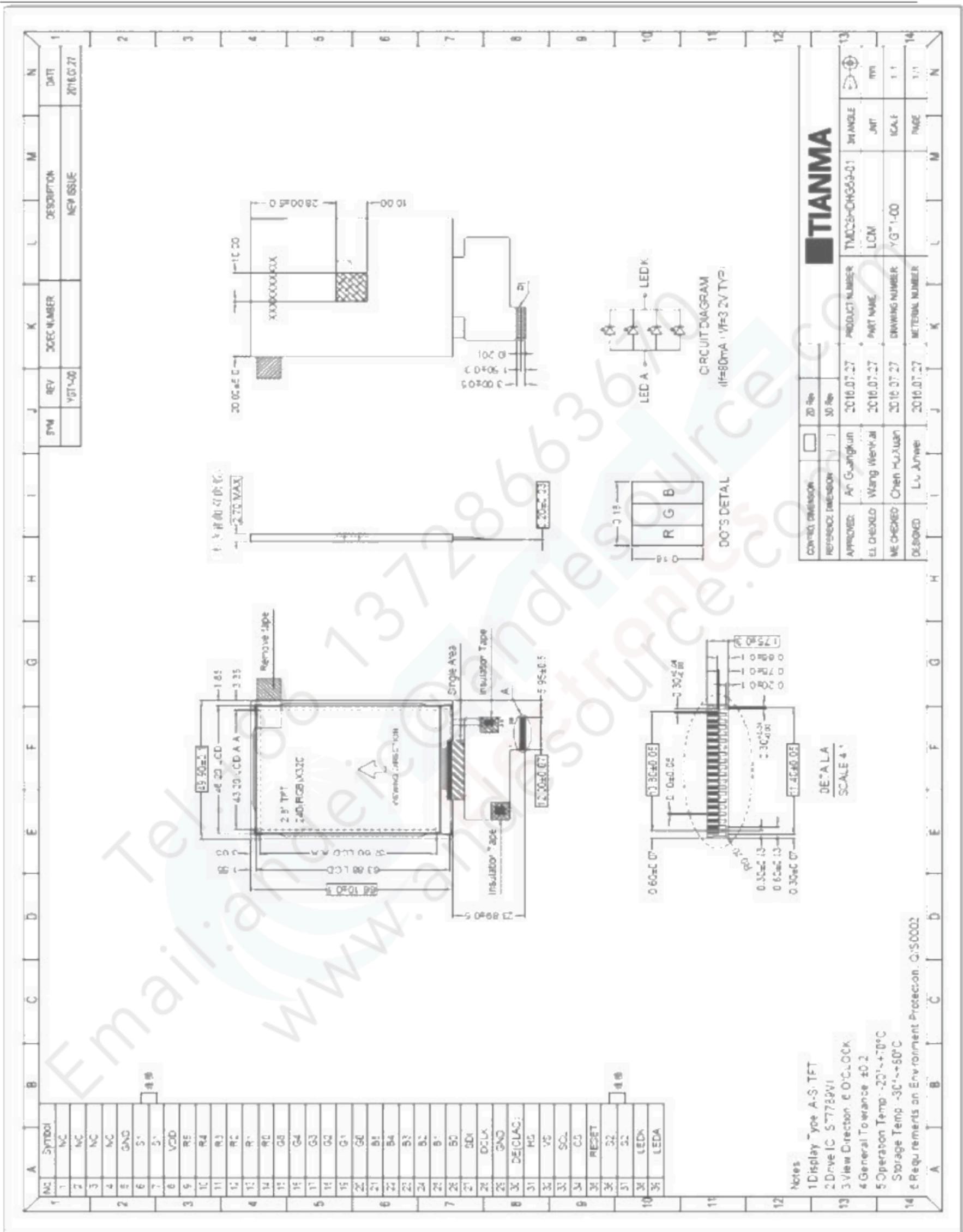
Note1: T_s is the temperature of panel's surface.

Note2: T_a is the ambient temperature of sample.

Note3: Before cosmetic and function test, the product must have enough recovery time, at least 2 hours at room temperature.

Note 4: In the standard condition, there shall be no practical problem that may affect the display function. After the reliability test, the product only guarantees operation, but don't guarantee all of the cosmetic specification.

8 Mechanical Drawing



9 Packing Drawing

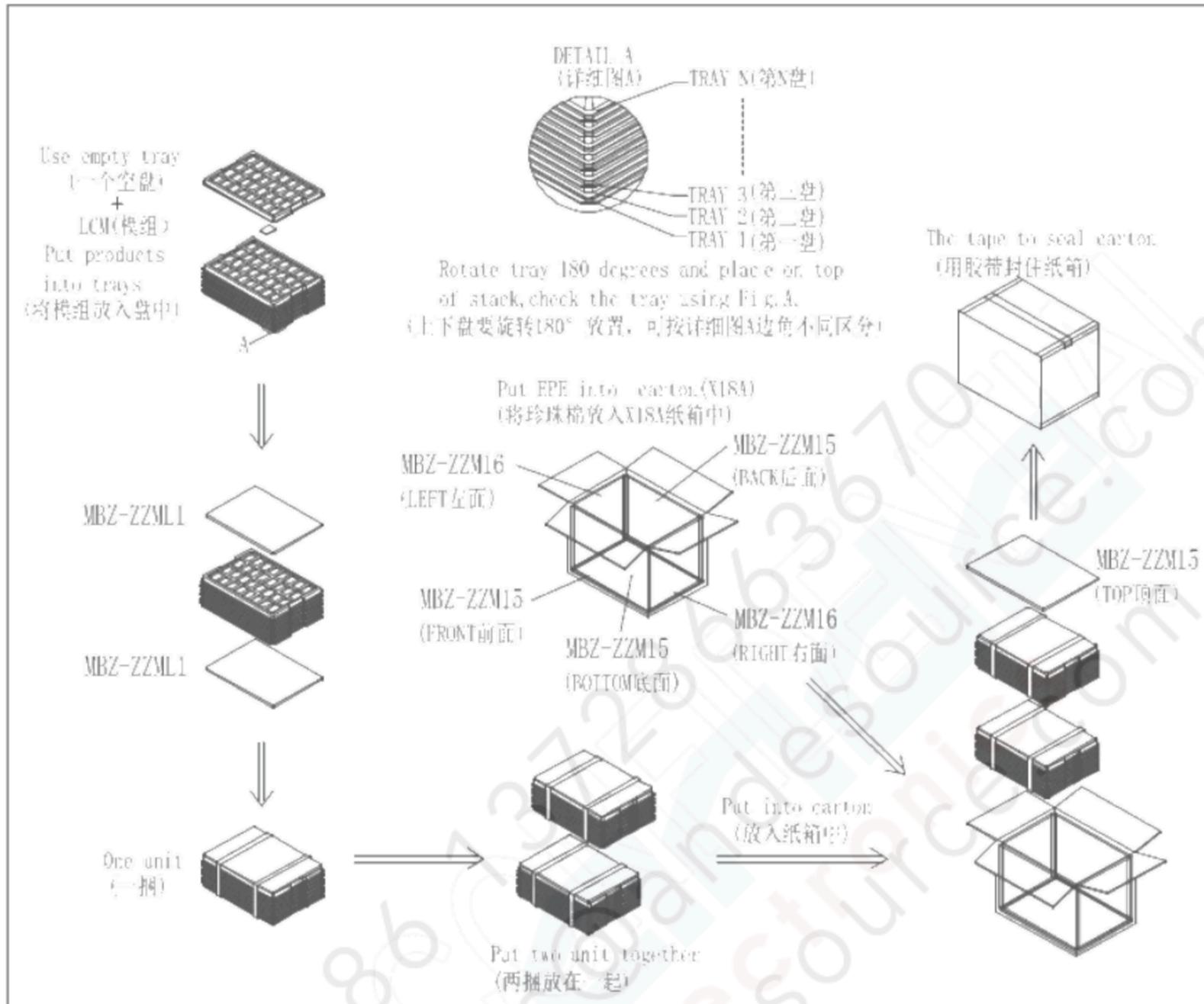
9.1 Per Carton

No	Item	Model (Materiel)	Dimensions(mm)	Unit Weight(Kg)	Quantity	Remark
1	LCM module	TM028HDHG59-01	49.90×66.10×2.70	TBD	168	
2	Tray	TM028HDHG59-01 YBZ1-00	356x256x12.30	TBD	30	
3	EPE(珍珠棉1)	MBZ-ZZML1	336×246×6mm	TBD	4	
4	EPE(珍珠棉2)	MBZ-ZZM15	375×275×10mm	TBD	4	
5	EPE(珍珠棉3)	MBZ-ZZM16	250×280×12mm	TBD	2	
6	Carton(纸箱)	X18A	395×290×315mm	TBD	1	
7	Total weight	TBD				

9.2 Packaging Specification and Quantity

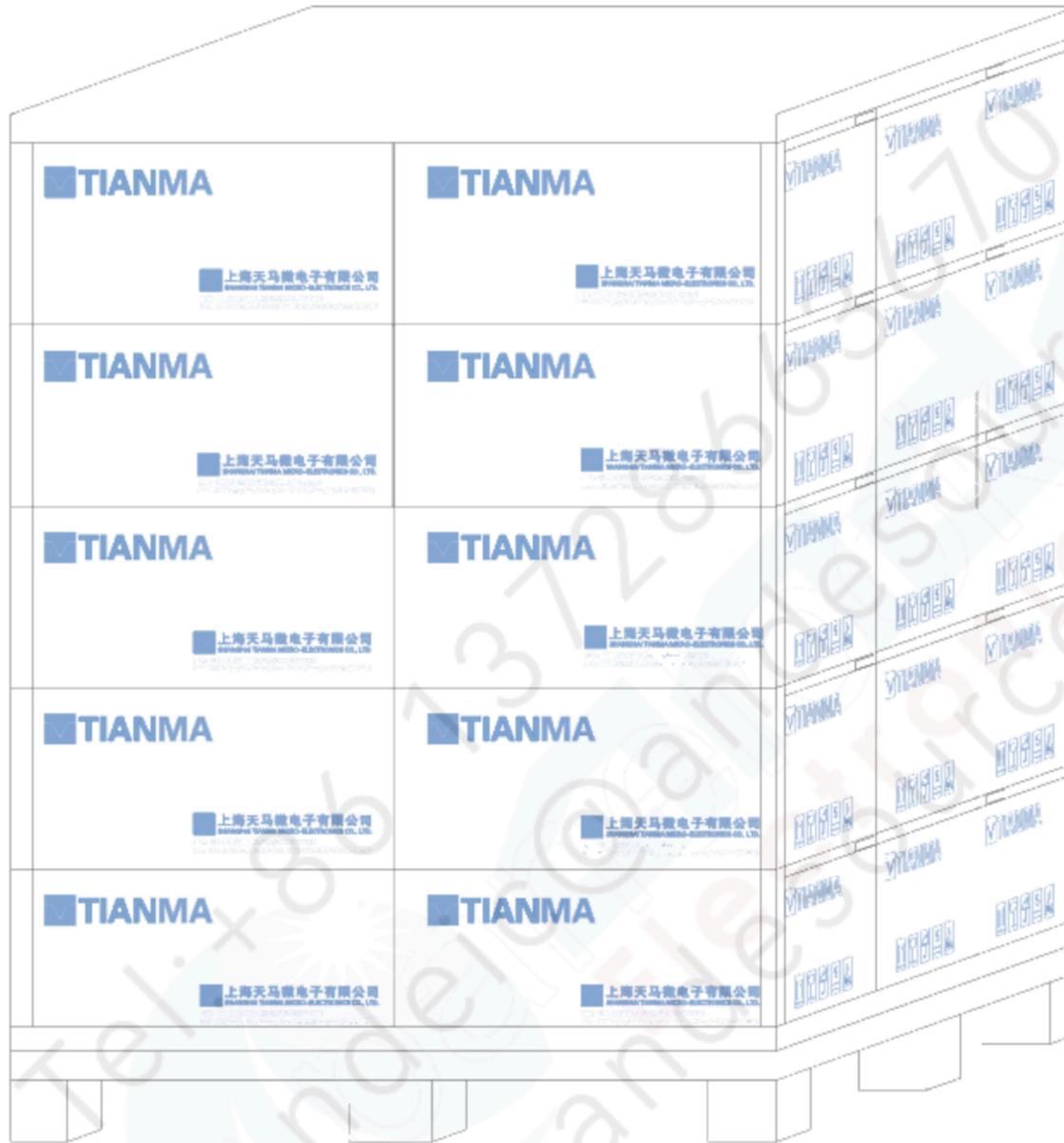
(1) LCM quantity per tray (每盘模组数量) : 6 pcs
(2) Total LCM quantity per group (每组模组总数量) : 84 pcs (14Tray盘+1 Empty tray空盘)
(3) Total LCM quantity per Carton (每箱模组总数量) : quantity per group (每组模组总数量) 84 pcs×group quantity per Carton (每箱组数量) 2= 168 pcs

9.3 Packing Form



9.4 Shipping Package of Palletizing Sequence

The number of cartons stacked by 2 * 3/ total of 5 layers



10 Precautions for Use of LCD Modules

10.1 Handling Precautions

- 10.1.1 The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.
- 10.1.2 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.
- 10.1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.
- 10.1.4 The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.
- 10.1.5 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

10.1.6 Do not attempt to disassemble the LCD Module.

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

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

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

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

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

10.1.8.4 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.

10.2 Storage precautions

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

10.2.2 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%

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

10.3 Transportation Precautions

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