

# Specification

Tianma Part Number: TM128VDKP01-00

Description: 12.8" FHD

Prepared by	Approve by	Signature
Liu Jia 2019-1-10		



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## 1. Features

This is an 12.8 inch amorphous-TFT-LCD (Thin Film Transistor Liquid Crystal Display) Normally Black technology module, which is composed of a TFT-LCD panel, LCD Driver IC with T-con integrated, FPC and a LED backlight unit. It is designed for Automotive and other high reliability electronic products and complies with the Q/S0002 (including RoHS/REACH/ELV/GADSL) environmental protection directive.

## 2. General Specification

Display Feature	Specification	Remark
Diagonal size	12.8 inch	
Resolution	1920(RGB) x 1080	
Active area(mm)	283.392x159.408	
Pixel pitch (mm)	0.1476x0.1476	
Pixel configuration	R.G.B. Vertical Stripe	
Technology type	a-Si	
Display mode	Normally Black	
Landscape or portrait	Landscape	
Surface treatment	HC	
Interface	2 port LVDS (VESA&DE mode)	
Color depth	16.7M	
Dimension (W x H x D) (mm)	292.69*171.21*7.45	Note1
Weight with CTP(g)	TBD	Note2
EMI	CISPR25 Class4 with TIANMA Test board	Note3

Table 2.1 General TFT Specifications

Note1: The dimensions do not include FPC length & component height

Note2: Without CTP

Note3: The LCM EMI-emission is only related to LCM only with Tianma test jig and 5\*5 chessboard pattern, no guarantee for head unit emission. If the emission deviate in the head unit, Tianma can assist the analysis.

### 3. CN1 Pin Assignment (TFT Interface)

Mating Connector Type: FH28K-60S-0.5SH

No	Symbol	I/O	Description	Remark
1	A4	P	LED Anode 4	
2	A3	P	LED Anode 3	
3	A2	P	LED Anode 2	
4	A1	P	LED Anode 1	
5	NC	/	Not connected	
6	NTC1	/	Thermistor +	
7	NTC2	/	Thermistor -	
8	NC	/	Not connected	
9	K4	P	LED Cathode 4	
10	K3	P	LED Cathode 3	
11	K2	P	LED Cathode 2	
12	K1	P	LED Cathode 1	
13	NC	/	Not connected	
14	VDD_OTP	/	TIANMA test pin. This pin must float;	
15	GND	P	Ground	
16	ELV3P	I	Even LVDS signal 3p	
17	ELV3N	I	Even LVDS signal 3n	
18	GND	P	Ground	
19	ELVCKP	I	Even LVDS clockp	
20	ELVCKN	I	Even LVDS clockn	
21	GND	P	Ground	
22	ELV2P	I	Even LVDS signal 2p	
23	ELV2N	I	Even LVDS signal 2n	
24	GND	P	Ground	
25	ELV1P	I	Even LVDS signal 1p	
26	ELV1N	I	Even LVDS signal 1n	
27	GND	P	Ground	
28	ELV0P	I	Even LVDS signal 0p	
29	ELV0N	I	Even LVDS signal 0n	
30	GND	P	Ground	

31	OLV3P	I	Odd LVDS signal 3p	
32	OLV3N	I	Odd LVDS signal 3n	
33	GND	P	Ground	
34	OLVCKP	I	Odd LVDS clockp	
35	OLVCKN	I	Odd LVDS clockn	
36	GND	P	Ground	
37	OLV2P	I	Odd LVDS signal 2p	
38	OLV2N	I	Odd LVDS signal 2n	
39	GND	P	Ground	
40	OLV1P	I	Odd LVDS signal 1p	
41	OLV1N	I	Odd LVDS signal 1n	
42	GND	P	Ground	
43	OLV0P	I	Odd LVDS signal 0p	
44	OLV0N	I	Odd LVDS signal 0n	
45	GND	P	Ground	
46	NC	/	Not connected	
47	AVDD	P	Power supply for AVDD	
48	AVDD	P	Power supply for AVDD	
49	NC	/	Not connected	
50	VCOM	P	Power supply for VCOM	
51	NC	/	Not connected	
52	VGL	P	Power supply for VGL	
53	NC	/	Not connected	
54	VGH	P	Power supply for VGH	
55	CSB	I	SPI interface enable signal.	
56	VCC	P	Power supply for LCD	
57	VCC	P	Power supply for LCD	
58	SCL	I	Clock signal of SPI	
59	SDA	I	Serial data input/output of SPI	
60	GND	P	Ground	

Table 3.1.1 Pin Assignment for TFT Interface (Pin assignment can be customized)

NOTE: Please strictly refer to the connector specification Operation and Precautions.

## 4. Absolute Maximum Ratings

GND=0V

Item	Symbol	Min	Max	Unit	Remark
Logic supply voltage for LCD	VCC	-0.5	5	V	
Digital I/O Input voltage for panel	V <sub>IO</sub>	-0.5	5	V	Note5
Digital I/O Input voltage for CTP	V <sub>IO-CTP</sub>			V	Note6
Digital power supply for CTP controller	DVDD			V	
Analog power supply for CTP controller	AVDD			V	
Backlight Forward Current	I <sub>BL</sub>	0	480	mA	
Backlight Forward voltage	V <sub>BL</sub>	0	30.6	V	Note5
Operating Temperature	Top	-30	+85	°C	Note1/2/3/4
Storage Temperature	Tst	-40	+95	°C	Note1

Table 4.1.1 Absolute Maximum Rating

Note1: The temperature is the ambient temperature (Ta = 25°C) of module.

Note2: No Electro-optical specification are guaranteed below -30°C.

Note3: LED forward current should follow De-rating curve.

Note4: NTC resistance should not be below TBD

Note5: Include : Reset, STBYB, RL, UD, SDA, SCL, CSB, RGB,DCLK,DE.

Note6: Include : INT, RST, TP\_SDA, TP\_SCL .

## 5. Electrical Characteristics

### 5.1 DC Characteristics for Panel Driving

GND=0V

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Logic supply voltage	VCC	3.0	3.3	3.6	V	
Power for analog circuit	AVDD	12.5	13	13.5	V	
Positive power supply for gate	VGH	22.8	23	23.2	V	
Negative power supply for gate	VGL	-7.8	-8	8.2	V	
Input High Voltage	V <sub>IH</sub>	0.7VDD	-	VDD	V	VDD domain Note 1
Input Low Voltage	V <sub>IL</sub>	GND	-	0.3VDD	V	
Output High Voltage	V <sub>OH</sub>	VDD-0.4 V	-	VDD	V	VDD domain

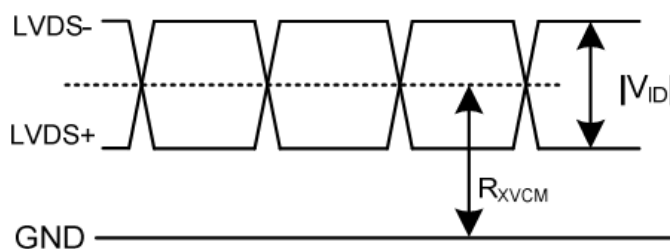
						I <sub>OH</sub> =-1mA A Note 1
Output Low Voltage	V <sub>OL</sub>	GND	-	0.4V	V	VDD domain I <sub>OH</sub> =1mA A Note 1
LVDS differential input high threshold	V <sub>TH</sub>	-	-	100	mV	Note 2
LVDS differential input low threshold	V <sub>TL</sub>	-100	-	-		
Differential input voltage	V <sub>id</sub>	0.1	-	(1.5-R <sub>XVCM</sub> )*2	V	
Differential input common mode voltage	R <sub>XVCM</sub>	1.0	1.2	1.4		

Table 5.1.1 Operating Voltages for Panel

Note1: Including STBYB, RESET.

Note2: Refers to the LVDS waveform below

### Single-end Signal



### Differential Signal

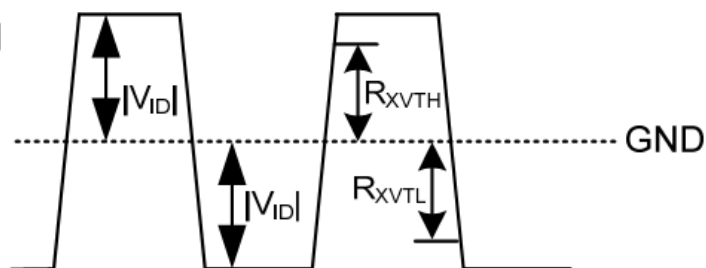


Table 5.1.2 LVDS waveform

## 5.2 DC Characteristics for Backlight Driving

Item	Symbol	Min	Typ	Max	Unit	Remark
Forward current	I <sub>F</sub>	--	105	120	mA	Note1
Forward voltage	V <sub>BL</sub>	25.2	27.45	30.6	V	Note2
Backlight Power Consumption	P <sub>BL</sub>	10.584	11.529	12.852	W	Note2



Lifetime	--	10000	--	--	Hrs	Note2,3
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Table 5.2.1 LED backlight characteristics

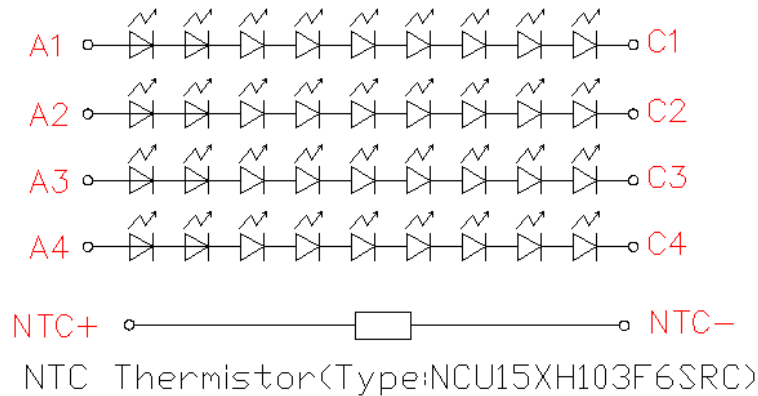


Figure 5.2.2 LED connection of backlight.

Item	Value	Remarks
Type	NCU15XH103F6SRC	Murata
Resistance / Tolerance	10kΩ±1%	Ta=25°C
Permissive Operating Current	0.31mA	Ta=25°C

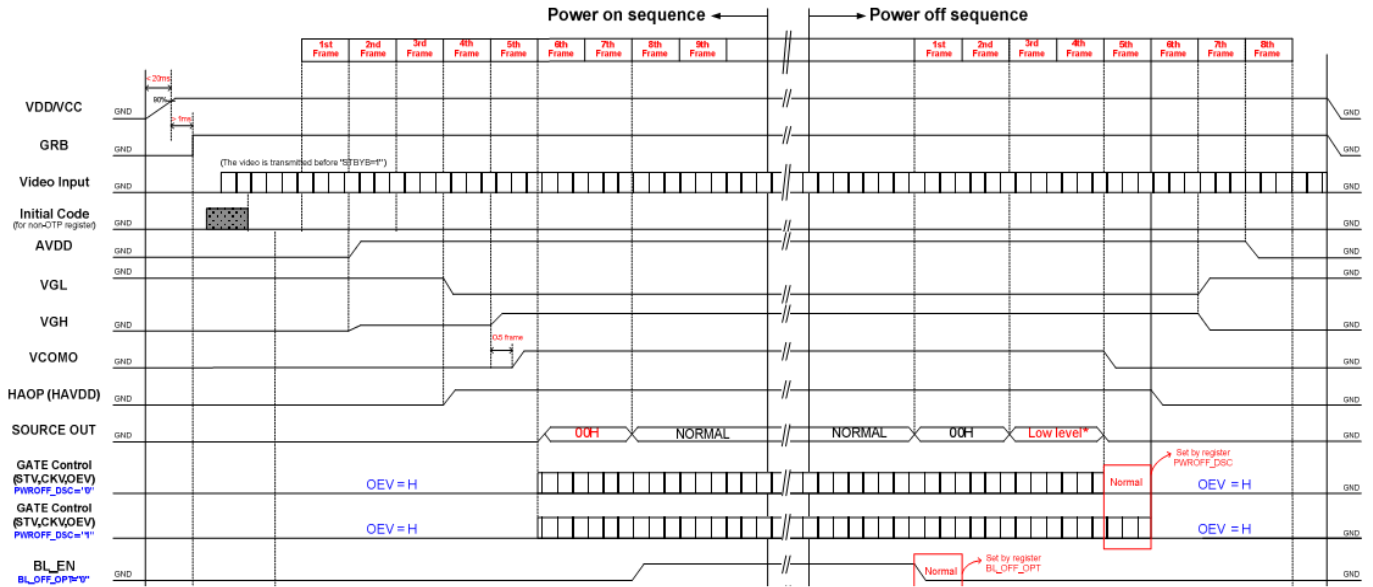
Table 5.2.3 Thermistor description

- Note1: IF is defined for one channel LEDs. There are total four LED channels in backlight unit. While the LCM is operating a stable forward current should be input.
- Note2: IF =105mA per channel.
- Note3: Optical performance should be evaluated at Ta=25°C only. If the LEDs are driven at high current or at high ambient temperature & humidity condition, the lifetime of the LEDs will be reduced. Operating lifetime means the brightness decrease to 50% of the original brightness.
- Note4: NTC thermistor is included in the LED circuit and the part number is NCU15XH103F6SRC. It is used for measuring LED temperature and is located in the LED circuit on the backlight FPC.
- Note5: To reduce the influence of NTC self-heating and improve the measurement accuracy, suggest the operating current of NTC is 0.031mA.
- Note6: When operating at high temperature, NTC resistance should not be below TBD

**TBD**

Figure 5.2.4 PWM vs. Ambient Temperature

### 5.3 Recommended Power ON/OFF Sequence



Note1: The low level of these signals and analog powers are GND level.

Note2: All of power and signals should be kept GND level before power on.

If there are remaining voltages on them, LCD might become abnormal

Note3: Backlight is the voltage applied to backlight, and it will stay low level before display stability; and it need to be turned off before STBYB off, refer to above figure.

## 5.4 LCD Module Block Diagram

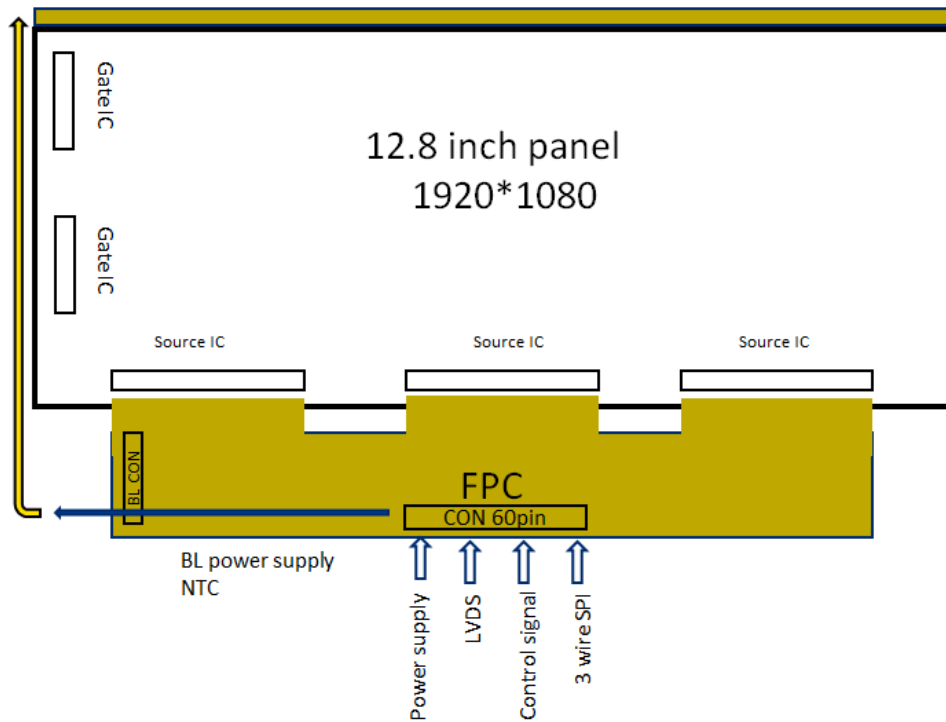


Figure 5.4.1 Block diagram

## 6 Timing Characteristics

### 6.1 LVDS 2 ports input timing

(GND=0V)

Parameter	Symbol	Min.	Typ.	Max.	Unit
CLK frequency	$F_{CLK}$	66.6	66.8	83.4	MHz
Horizontal display area	$T_{HD}$		960		CLK
HS period time	$T_H$	1020	1024	1150	CLK
HS pulse width	$T_{HPW}$	16	-	40	CLK
HS back porch	$T_{HBP}$		48		CLK
HS front porch	$T_{HFP}$	12	16	142	CLK
Vertical display area	$T_{VD}$		1080		H
VS period time	$T_V$	1086	1088	1209	H
VS pulse width	$T_{VPW}$	1	-	20	H
VS back porch	$T_{VBP}$		3		H
VS front porch	$T_{VFP}$	3	5	126	H

Table 94. DE mode for 1920RGBx1080 (Dual Link LVDS)

Parameter	Symbol	Min.	Typ.	Max.	Unit
CLK frequency	$F_{CLK}$	66.6	66.8	83.4	MHz
Horizontal display area	$T_{HD}$		960		CLK
HS period time	$T_H$	1020	1024	1150	CLK
HS blanking	$T_{HFP} + T_{HBP}$	60	64	190	CLK
Vertical display area	$T_{VD}$		1080		H
VS period time	$T_V$	1086	1088	1209	H
VS blanking	$T_{VBP} + T_{VFP}$	6	8	129	H

Table 6.1.1 LVDS input timing

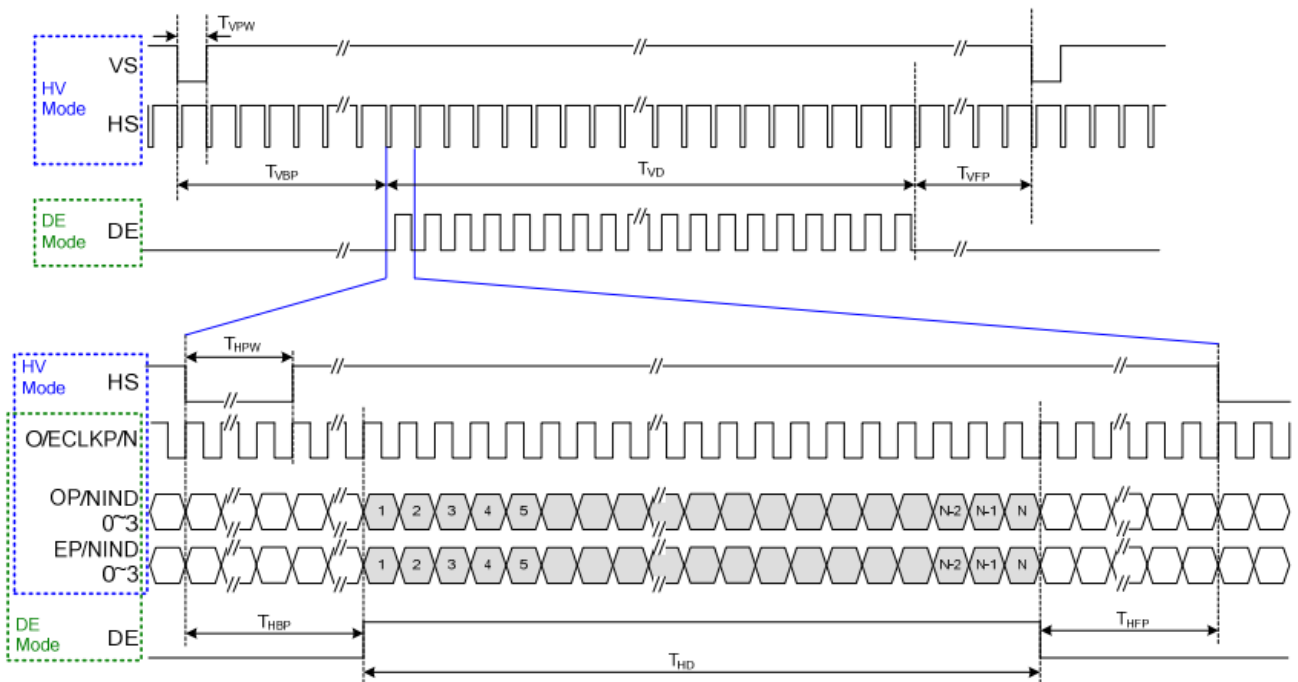


Figure 6.1.2 Dual-link LVDS Input Timing Format

## 7. Optical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit	Remark	
Viewing Angle	$\theta U$	$CR \geq 10$	80	88	--		Note1	
	$\theta D$		80	88	--			
	$\theta L$		80	88	--			
	$\theta R$		80	88	--			
Contrast	Perpendicular	25°C	1100	1400	--	--	Note2	
Contrast @ high temperature	Perpendicular	85°C	550	700	--	--	Note3	
Response Time	Ton+off	25°C	--	--	30	ms	Note4	
	Ton+off	-20°C	--	--	250			
	Ton+off	-30°C	--	--	500			
Chromaticity	White	x		(0.292)		--	Note5	
		y		(0.316)		--	Note2	
	Red	x	CIE1931-XYZ Backlight is on (25°C) perpendicular		(0.632)		--	Note5
		y			( 0.323)		--	
	Green	x			( 0.308)		--	
		y			( 0.628)		--	
	Blue	x			( 0.153)		--	
		y			( 0.056)		--	
Luminance homogeneity white	U	9 points, 25°C		80%	85%			
Luminance homogeneity black	U	9 points, 25°C		60%	65%			
Luminance	Perpendicular	25°C	600	800				
NTSC	--	CIE1931-XYZ	70	74	--	%	Note5	
Reflectivity	Module	SCI	--	--	6	%	Note8	
Gamma	VESA $\gamma$	25°C	2.0	2.2	2.4			
Flicker	Half-grey pattern	db	--	--	-30		Note9	

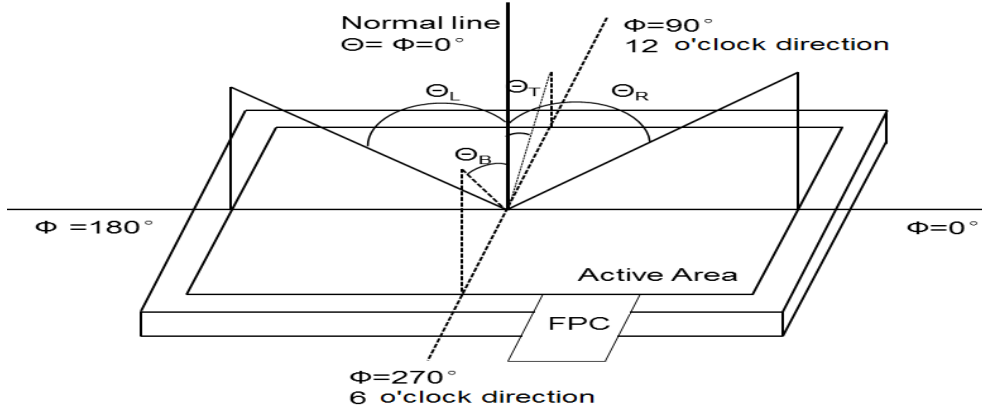
**Test Conditions:**

1.  $I_F = 105$  mA (one channel), the ambient temperature is 25°C.
2. The test systems refer to Note 1 and Note 2.
3. Warm-Up Time before measurement: 5 min Ambient Temp. (if not specified): +25°C. Backlight (if not specified): 100% PWM. All values will be measured perpendicular if there is no viewing angle.

4. All test conditions are ambient temperature except for response time. For response time is panel surface temperature, center of display.

Note1: Definition of viewing angle range and measurement system

Viewing angle is measured at the center point of the LCD by DMS-803/ EZ CONTRAST



Note2: Definition of optical measurement system

Measured at the center of the panel by optical measurement system, refer to Table Optical Measurement System..

Measuring condition:

- Measuring surroundings: Dark room.
- Measuring temperature:  $T_a = +25^\circ\text{C}$ .
- Adjust operating voltage to get optimum contrast at the center of the display.
- Measured value at the center point of LCD panel after 30 minutes while backlight is turned on.

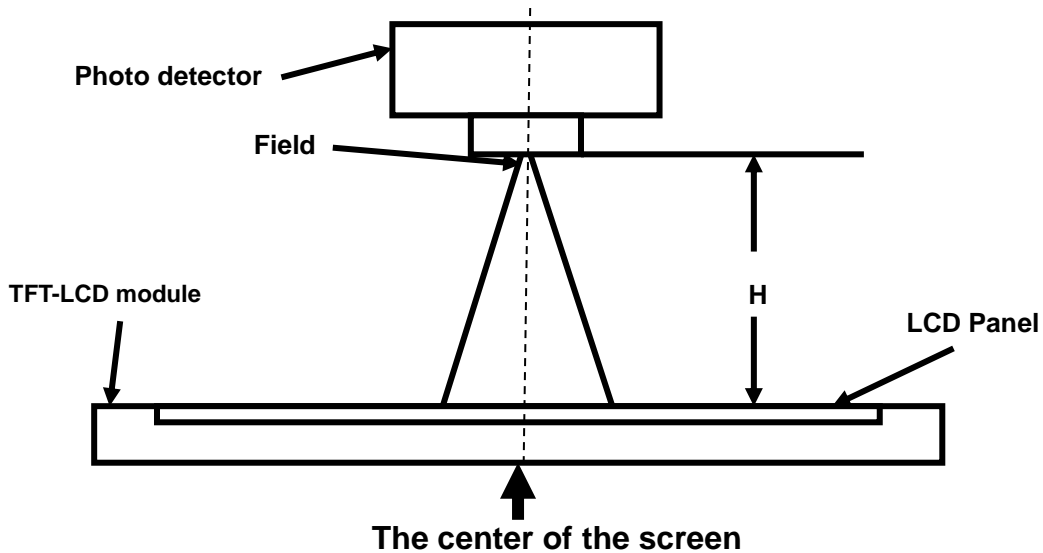


Table: Optical Measurement System

Item	Photo detector	Field	Equipment Suppliers
Contrast Ratio	EZ-Contrast	6mm/3mm	SR-3 & SR-UL1R:TOPCON
Luminance	SR-3A	1°	SR-3 & SR-UL1R:TOPCON
Chromaticity	SR-3A	1°	SR-3 & SR-UL1R:TOPCON
Lum Uniformity	LMK 5-5COLOR/LMK98-4	\	Technoteam
Contrast Plot/	EZ-Contrast	6mm/3mm	EZ CONTRAST XL88RC:ELDIM
Viewing angel	EZ-Contrast		EZ CONTRAST XL88RC:ELDIM
Response Time	DMS803	3mm	DMS803 :Instrument Systems
Reflectivity	CM3600A	8mm/25.4mm	Konica
Flicker	CA310	\	Konica

Note3: Definition of contrast ratio:

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

Contrast Ratio is measured in optimum common electrode voltage

Note4: The response time has to be reached in stable temperature situation (30 min after start-up).

Definition of pixel response times:

Ton=Tblack→white

Toff=Twhite→black

Note5: Definition of color chromaticity (CIE1931)

Color coordinates measured at the center point of the LCD.

Note6: Definition of Luminance Uniformity

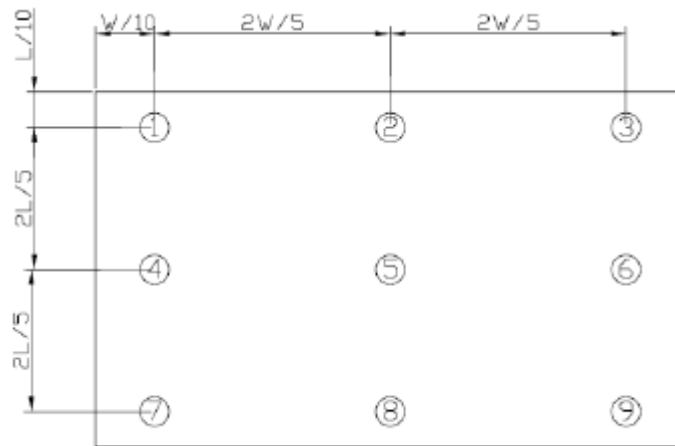
Active area is divided into 9 measuring areas. Every measuring pointed is placed at the center of each measuring area.

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.



Note7: Definition of Luminance

Measure the luminance of white state.  
 Luminance is measured in optimum common electrode voltage  
 White state “: The state is that the LCD should drive when 255 grey scale..  
 The luminance test should follow the De-rating curve.

Note8: SCI&SCE reflective ratio measure method.

Measurement system: CM 3600A fully integral sphere  
 Light source: D65  
 d/8°(ASTM E 1164-09)  
 Observer angle: 10°  
 State: LCD power-off  
 Standard d/8° Integration Sphere Spectroscopic – Reflectometer

Note9: Definition of flicker pattern

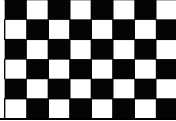

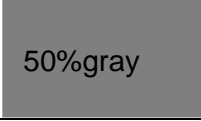
Half-grey pattern

## 8. Reliability Test

No	Test Item	Test condition	Criterion
1	High Temperature Storage	95°C±2°C 500hrs, RH<=45%, Restore 2h at 25. non-operation	Note1, Note2, Note4
2	Low Temperature Storage	-40°C±3°C 500hrs, Restore 2h at 25. non-operation	Note1, Note2, Note4
3	High Temperature Operation	85°C±2°C 500hrs, RH<=45% Restore 2H at 25°C Operation	Note1, Note2, Note4 Note 7
4	Low Temperature Operation	-30°C±3°C 500H Restore 2H at 25°C Operation	Note1, Note2, Note4
5	High Temperature & Humidity Operation (operational)	60°C±2°C, 90±2%RH 500H Restore 2H at 25°C	Note1, Note2, Note4
6	Thermal Shock (non-operational)	-40°C→ change→+85°C 30min 30s 30min	Note1, Note2, Note4



		300cycle non-operation	
7	Vibration Test (non-operational)	Frequency: 8 - 33.3 Hz, Total amplitude: 1.3mm Frequency: 33.3 - 400 Hz, Acceleration: 29.4 m/s <sup>2</sup> sweep time: 15 minutes 2 hours each for X and Z directions, 4 hours for Y direction (total 8 hours) non-operation	Note1, Note2
8	Shock Test (non-operational)	100 x 9.8m/s <sup>2</sup> , t=6ms, XYZ directions, Half sin curve, [non-operating], each directions 2 times	Note1, Note2
9	ESD	Air discharge: C=300pF±10%, R=330Ω±10%, 5 point/panel Air: +/-15KV, 5times Class B With cover	Note1, Note2, Note3
		Air discharge: C=300pF±10%, R=330Ω±10%, 5 point/panel Air: +/-15KV, 5times Class C w/o cover	
		Contact discharge: C=300pF±10%, R=330Ω±10%, 5 point/panel Contact: +/-8KV, 5times Class B With cover	Note1, Note2, Note4
Contact discharge: C=300pF±10%, R=330Ω±10%, 5 point/panel Contact: +/-8KV, 5times Class C w/o cover			
14	Image sticking	Perform at Temperatures: +65°C +/-5°C. 100% Backlighting Display the following image retention test pattern (checkerboard pattern: RGB = 255/255 and 0/255) shown below for 1 hours, then display a 50% gray pattern (RGB = 127/255). After 5min, level2 or less Display the following image	Note3, Note6

		  	
15	EMC Capacity	CISPR25 Class4 with TIANMA Test board	Module (note 8)

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: Image sticking characterization

The maximum brightness difference ( $\Delta LV$ ) of the remaining afterimage has to be evaluated. Following levels are defined:

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


Acceptance Criteria:

The level of remaining afterimage has to be level L2 or less after 5 minutes.

During MP: (1.) 5pcs once per week (2.) After any process and/or material changes.

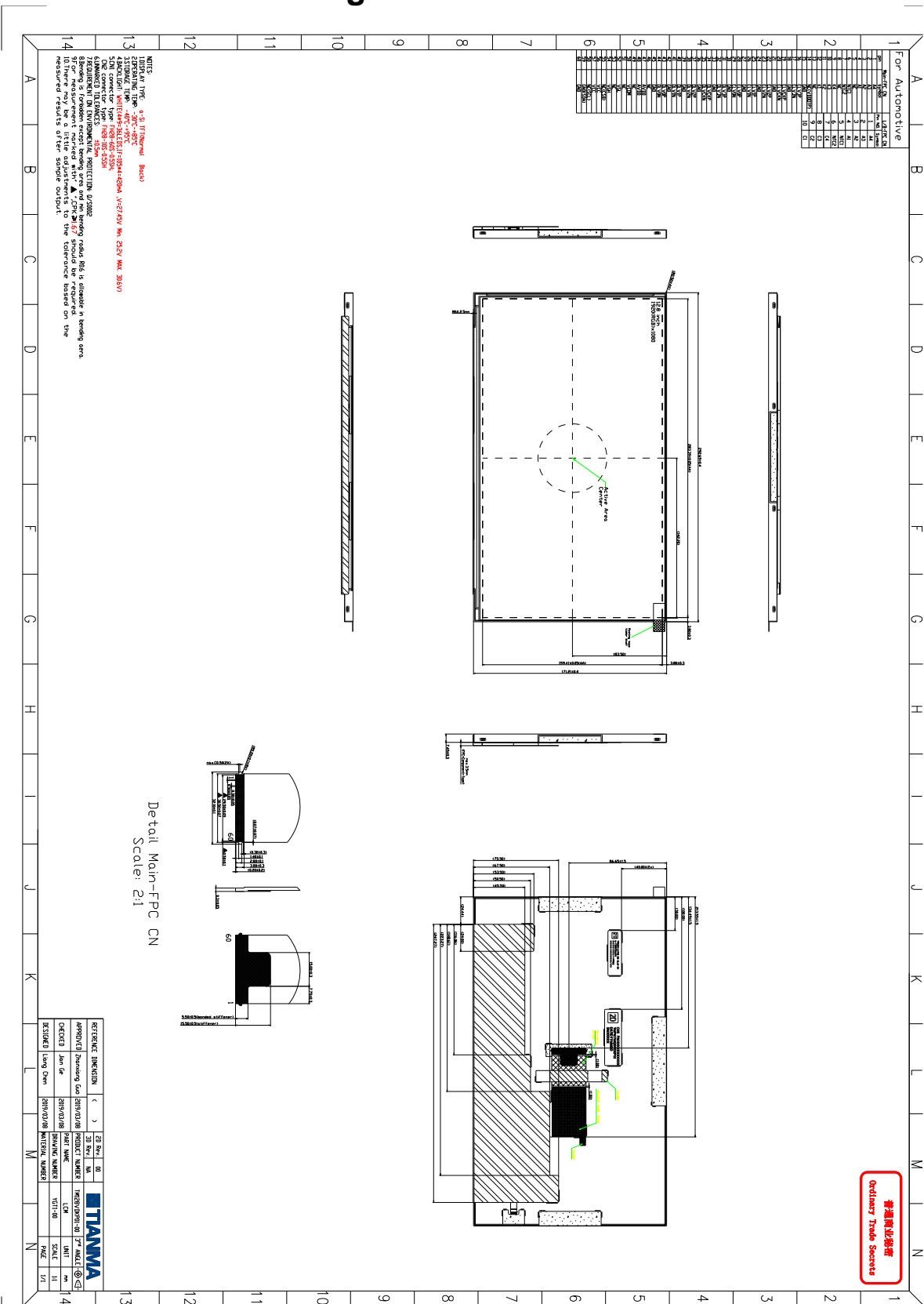
Note7: LED forward current should follow the De-rating curve and the NTC resistance should not be below TBD

Note8: The LCM EMI-emission is only related to LCM only with Tianma test jig and 5\*5

 <b>TIANMA</b>	<input checked="" type="checkbox"/> Preliminary Specification <input type="checkbox"/> Product Specification	
	Confidential	Part Number: TM128VDKP01-00    Version: 1.1

chessboard pattern, no guarantee for head unit emission. If the emission deviate in the head unit, Tianma can assist the analysis.

# 9. Mechanical Drawing



普通商业标准  
Ordinary Trade Standard

## 10. Product Inspection Criteria

### 10.1 Inspection Conditions

#### 10.1.1 Ambient conditions:

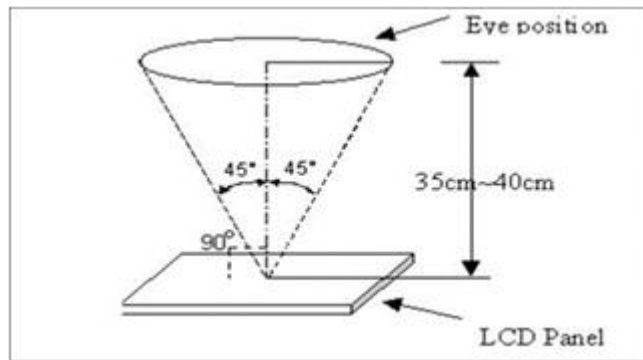
- a. Temperature: Room temperature  $25 \pm 5^\circ\text{C}$
- b. Humidity:  $(60 \pm 10) \%RH$
- c. Illumination: 100-300 Lux  
Appearance test: 800-1200 Lux

#### 10.1.2 Viewing distance

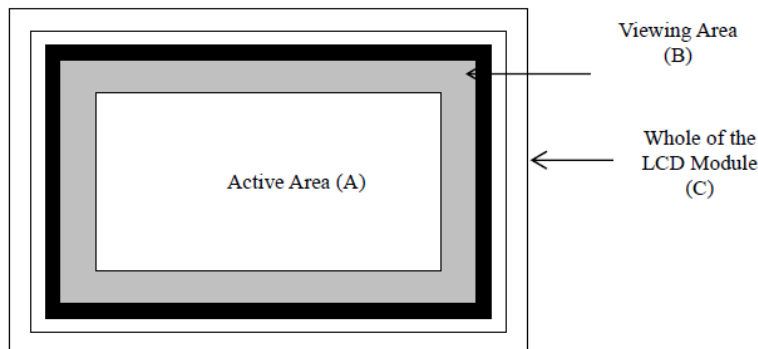
The distance between the LCD and the inspector's eyes shall be 35~40 cm.

#### 10.1.3 Viewing Angle

U/D:  $45^\circ/45^\circ$ , L/R:  $45^\circ/45^\circ$



### 10.2 Definition of LCD zone



A-zone: The inside of the Active Area (as defined on the product drawing)

B-zone: The inside of the Viewing Area which is between A-zone and the metal frame. (Including CTP Black painting area)

C-zone: Whole of the LCD Module except the zone A and B. (Including FPC & Metal Frame & backside of the LCD Module)

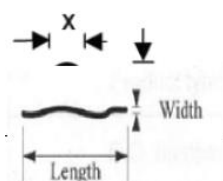

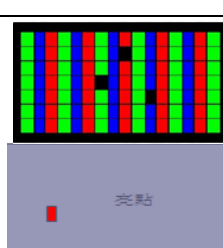
### 10.3 Dot and Line defect Criteria

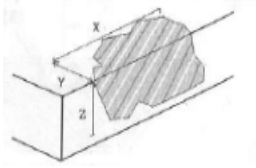
Defects are classified as major defects and minor defects according to the degree of defectiveness defined herein

## 10.4 Major defects

No	Inspection Items	Inspection Standard
1	All functional defects	1) No display 2) Abnormal display 3) Short circuit 4) Line defect
2	Missing	Missing function component
3	Crack	Glass crack

## 10.5 Dot defects

No.	Inspection Item	Inspection Standards	Acceptable Qty.	Applied Zone	Inspection Mode	Note
1	Bright Spots/Dark Spots	$\varphi \leq 0.2$ $0.2 < \varphi \leq 0.4$ $0.4 < \varphi$	Ignore 4(distance > 10 mm) None	A/B	Light-on Light-off	$\varphi = (x+y) / 2$ 
2	Lines defect including black line	$W \leq 0.03$ and $L \leq 3$ $0.03 < W \leq 0.05$ and $L \leq 3.0$ $0.05 < W$ or $L > 3.0$	Ignore 2(distance > 10mm) None	A/B	Light-on Light-off	The same as 1
3	Polarizer Dent/Bubble	$\varphi \leq 0.2$ $0.2 < \varphi \leq 0.4$ $0.4 < \varphi$	Ignore 3(distance > 10mm) None	A/B	Light-on Light-off	$\varphi = (x+y) / 2$ 
4	Dirty/Dust	Those wiped out easily are acceptable				
5	Sub-pixel Defect	Inspection pattern: Full white, Full black, Red, green and blue screens, and use 5% ND filter Black dot defect Bright dot defect	3(distance > 10mm) None	A	Light-on	
6	Glass Defect	$X \leq 5$ mm	Ignore	B	Light-off	

		$Y \leq 0.3$ mm(Do not enter AA area)	T: Glass thickness			
		$Z \leq T$	X: Length Y: Width Z: thickness			
7	Mura/yellow border(vibration of film thickness from bonding), inhomogeneous color of the background inside viewing area (rainbow coloring)	Can not be found through 5%ND filter	Allowed	A	Light-on Light-off	Notes: 1.inspection pattern: Full white, Full black and use 5%ND filter 2.inspection environment illumination 100-300lux

Note1: Dot defect is defined as the defective area of the dot area is larger than 50% of the dot area.

Note2: Polarizer bubble is defined as the bubble appears on active display area.

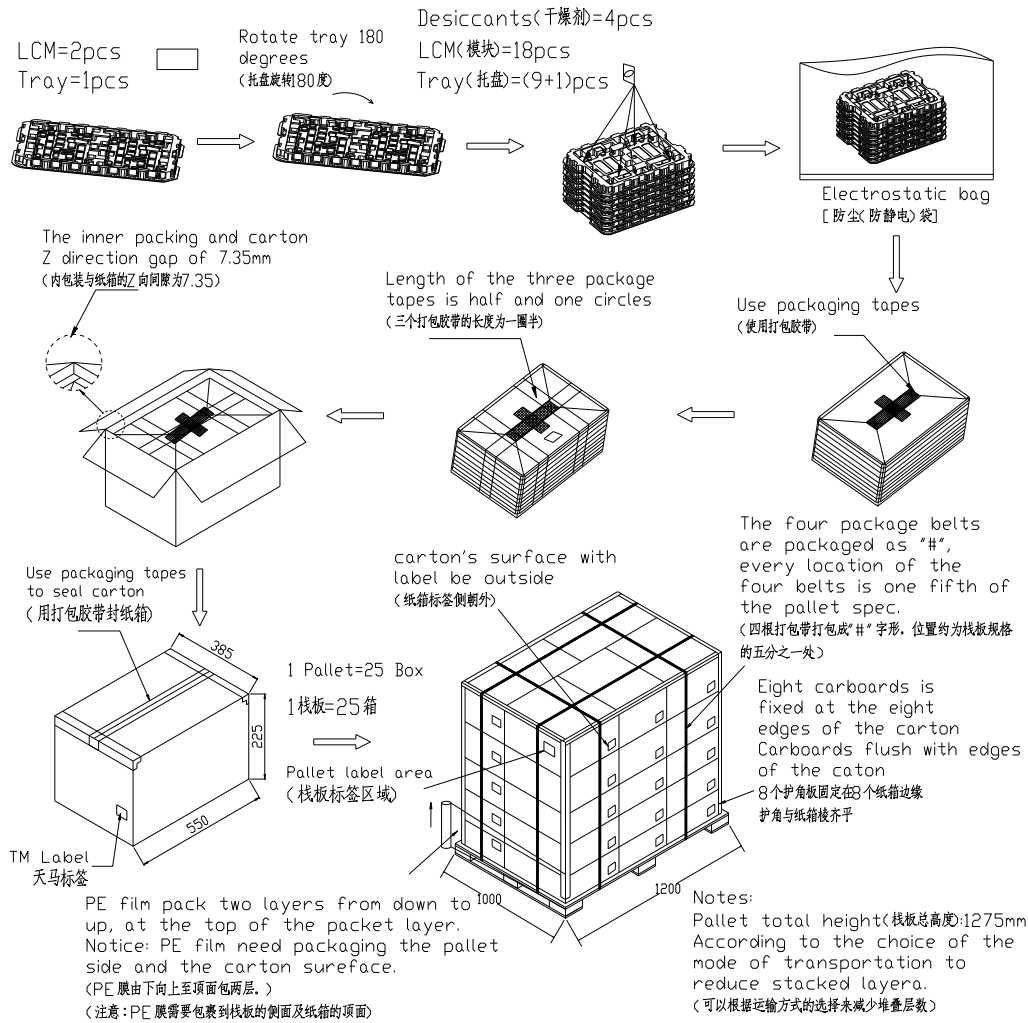
The defect of polarizer bubble shall be ignored if the polarizer bubble appears on the outside of active display area.

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 both parties, customer and supplier, for a better solution.

Note4: The distance between black dot defects should be more than 5mm.

## 11. Packing Instruction



## 12. Appendix

### 12.1 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		

### 13. Precautions for Use of LCD Modules

#### 13.1 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.

## 13.2 Storage Precautions

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

13.2.2 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

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

## 13.3 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.