TIANMA
Microelectronics Co.,LTD

SPECIFICATION FOR TFT LCD MODULE

MODEL NO:	**TM240320B9NFWGWC13**
CUSTOMER:	
CUSTOMER P/N.	
VERSION	**V1.0**
CUSTOMER APPROVED	

□ **Preliminary Specification**

■ **Final Specification**

PREPARED	CHECKED	VERIFIED BY QA DEPT	VERIFIED BY R&D DEPT

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REVISION RECORD

Date	Rev.No.	Page	Revision Items	Prepared
2008.7.23 **2009.9.18**	**V0.0** **V1.0**		**The first release(pre-spec)** **Change the Controller（ILI9325 change to ILI9328）in page 5** **Update Outline Drawing in page 6** **Update Circuit Block Diagram in page 7**	**W.D.H** **X.Y.X**

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1.NOTICE

1.1 announce

1.1.1 These specification sheets are the proprietary product of Tianma and include materials protected under copyright of Tianma. Do not reproduce or cause any third party to reproduce them in any form or by any means, electronic or mechanical, for any purpose,in whole or in part,without theexpress written permission of Tianma . Tianma assumes no responsibility for any problems related to any industrial property right of a third party resulting from the use of the device.

1.1.2 Do not use the device for equipment that requires an extreme level of reliability, such as aerospace applications, nuclear power control equipment and medical or other equipment for life support..Tianma assumes no responsibility for any damage resulting from the use of the device whichdoes not comply with the instructions and the precautions specified in these specification sheets.

1.1.3 Contact and consult. with a Tianma sales representative for any questions about this device.

1.2 For handling and system design

1.2.1 Do not scratch the surface of the polarizer film as it is easily damaged.

1.2.2 If the cleaning of the surface of the LCD panel is necessary, wipe it swiftly with cotton or other soft cloth. Do not use organic solvent as it damages polarizer.

1.2.3 Water droplets on polarizer must be wiped off immediatelyas they may cause color changes, or other defects if remained for a long time.

1.2.4 Since this LCD panel is made of glass, dropping the module or banging it against hard objects may cause cracks or fragmentation.

1.2.5 Certain materials such as epoxy resin (amine's hardener)or silicone adhesive agent(de-alcohol or de-oxym) emits gas to which polarizer reacts(color change).Check carefully that gas from materials used in system housing or packing do not hart polarizer.

1.2.6 Liquid crystal material will freeze below specified storage temperature range and it will not get back to normal quality even after temperature comes back within specified temperature range.Liquid crystal material will become isotropic above specified temperature range and may not get back to normal quality. Keep the LCD module always within specified temperature range.

1.2.7 Do not expose LCD module to the direct sunlight, or to strong ultraviolet light for long time.If the LCD driver IC is exposed to light, normal operation may be impeded. It is necessary to design so that the light is shut off when the LCD module is mounted.

1.2 Do not disassemble the LCD module as it may cause permanent damage. Hold LCD very carefully when placing LCD module into the system housing. Do not apply excessive stress or pressure to LCD module.

1.2.9 As this LCD module contains components sensitive to electrostatic discharge, be sure to follow the instructions in below.

①Operators

Operators must wear anti-static wears to prevent electrostatic charge up to and discharge

from human body.

②Equipment and containers

Process equipment such as conveyer, soldering iron, working bench and containers may possibly generate electrostatic charge up and discharge.Equipment must begrounded through 100Mohms resistance. Use ion blower.

③Floor

Floor is an important part to leak static electricity which is generated from human body or equipment. There is a possibility that the static electricity is charged to them without leakage .in case of insulating floor, so the countermeasure(electrostatic earth:1×108Ω) should be made.

④Humidity

Proper umidityof working roommay reduce the isk ofelectrostatic charge up and discharge. Humidity should be kept over 50% all the time.

⑤Transportation/storage

Storage materials must be anti-static to prevent causing electrostatic discharge.

⑥Others

Protective film is attached on the surface of LCD panel to prevent scratches or other damage.When removing this protective film, remove it slowly under proper anti-ESD control such as ion blower.

1.2.10 Do not hold or touch LCD panel to flex interconnection area as it may be damaged.As the binding material between LCD panel and flex connector mentioned in flex area contains an organic material, any type of organic solvents are not allowed to be used. Direct contact by fingers are also prohibited.

1.2.11 When carrying the LCD module, place it on the tray to protect from mechanical damage.

It is recommended to use the conductive trays to protect the CMOS components from electrostatic discharge. When holding the module, hold the Plastic Frame of LCD module so that the panel ,TCP and other electric parts are not damaged. e.g. chart1

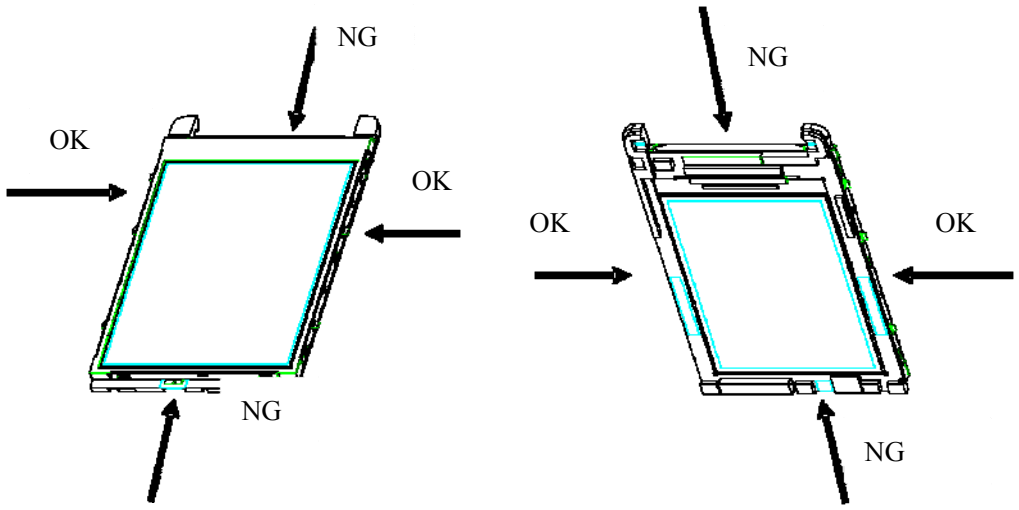


chart1 Note : The LCD module illustration is general module image

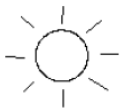
1.2.12 Do not touch the FPC ‘s exposed base film and patterning area, slit part. Otherwise the circuit maybe damaged. Do not touch LSI chips as it may cause a trouble in the inner lead connection.
1.2.13 Place a protective cover on the LCD module to protect the glass panel from mechanical damages.
1.2.14 LCD panel is susceptible to mechanical stress and even the slightest stress will cause a color change
in background.So make sure the LCD panel is placed on flat plane without any continuous twisting, bending or pushing stress.
1.2.15 Protective film is placed onto the surface of LCD panel when it is shipped from factory. Make sure to peel it off before assembling the LCD module into the system. Be very careful not to damage LCD module by electrostatic discharge when peeling off this protective film. Ion blower and ground strap are recommended.
1.2.16 Make sure the mechanical design of the system in which the LCD module will be assembled matches specified viewing angle of this LCD module.

1.3 For operating LCD module

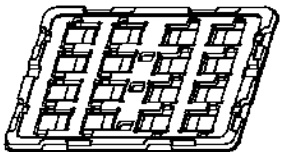
1.3.1 Do not operate or store the LCD module under outside of specified environmental conditions.
1.3.2 As opto-electrical characteristics of LCD will be changed, dependent on the temperature, the confirmation of display quality and characteristics has to be done after temperature is set at 25 °C and it becomes stable.

1.4 Precautions for Storage

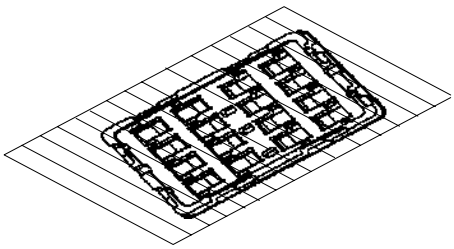
1.4.1 Do not expose the LCD module to direct sunlight or strong ultraviolet light for long periods. Store in a dark place.
1.4.2 The liquid crystal material will solidify if stored below the rated storage temperature and will becomean isotropic liquid if stored above the rated storage temperature, and may not retain its original properties. Only store the module at normal temperature and humidity（25±5℃、60±10% RH）in order to avoid exposing the front polarizer to chronic humidity.
1.4.3 Keeping method



NG



OK



a.Don't keeping under the direct sunlight.

b.Keeping in the tray under the dark place

1.5 Other Notice

1.5.1 Generally, At power on, in order not to apply DC charge directly to LCD panel, supply logic voltage first and initialize LSI logic function including polarity alternation. Then supply voltage for LCD bias. At power off, in order not to apply DC charge directly to LCD panel, execute Power OFF sequence and Discharge command.

1.5.2 Don't touch to PWB surface, exposed IC chip, electric parts and other parts, to any electric, metallic materials.

1.5.3 No bromide specific fire-retardant material is used in this module.

1.5.4 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.

2.General Specifications

TM240320B9NFWGWC13 is a color active matrix LCD module incorporating amorphous silicon TFT (Thin Film Transistor). It is composed of a color TFT-LCD panel, driver IC, FPC, a back light unit and TP (Touch Panel). The 2.83″ display area contains 240 x 320 pixels and can display up to 262K colors. This product accords with RoHS environmental criterion.

Item	Contents	Unit	Note
LCD Type	TFT	-	
Display Color	65K/262K		1
LCD Duty	1/320	-	
Viewing Direction	6:00	O'Clock	
Active Area(W×H)	43.20×57.60	mm	
Number of Dots	240(RGB)×320	-	
Dot Pitch(W×H)	0.18X0.18	mm	
Controller	ILI9328	-	
V_{DD}	2.7~3.3	V	
V_{DDIO}	1.8/2.8	V	
Outline Dimensions	Refer to outline drawing on next page		
Backlight	4-LEDs(white)	-	
Weight	-	g	
Interface	16 bits parallel bus	-	
Polarizer Mode	Transmissive/Positive	-	

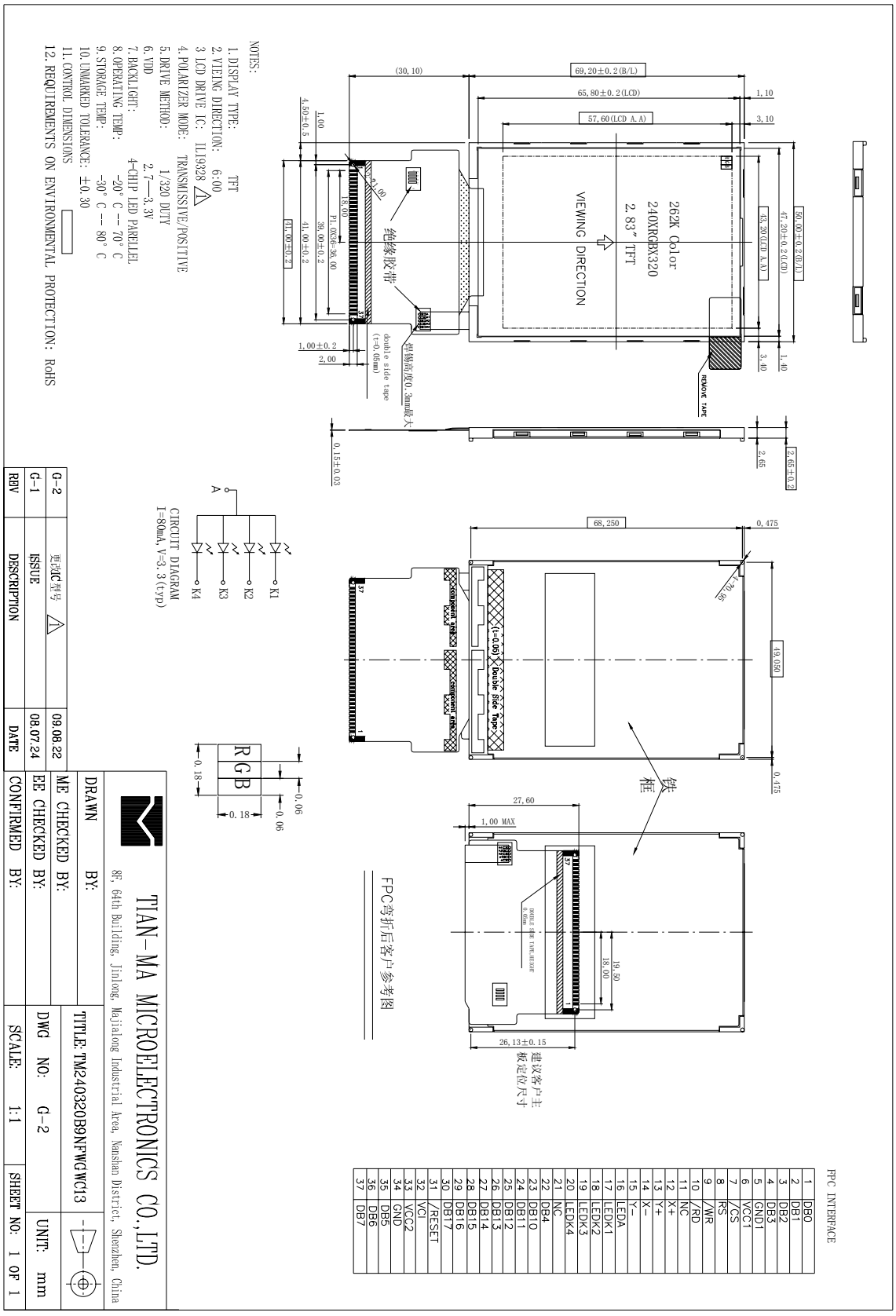
Note 1: Color tune is slightly changed by temperature and driving voltage.

Note 2: Requirements on Environmental Protection:RoHS

Note 3: Customer should do assembly according to our FPC bending sketch in the outline drawing.

Note 4:Please approve our spec before placing mass production order. Otherwise we will regard customer has approved the spec when we receive the first 2Kpcs or above order from customer.

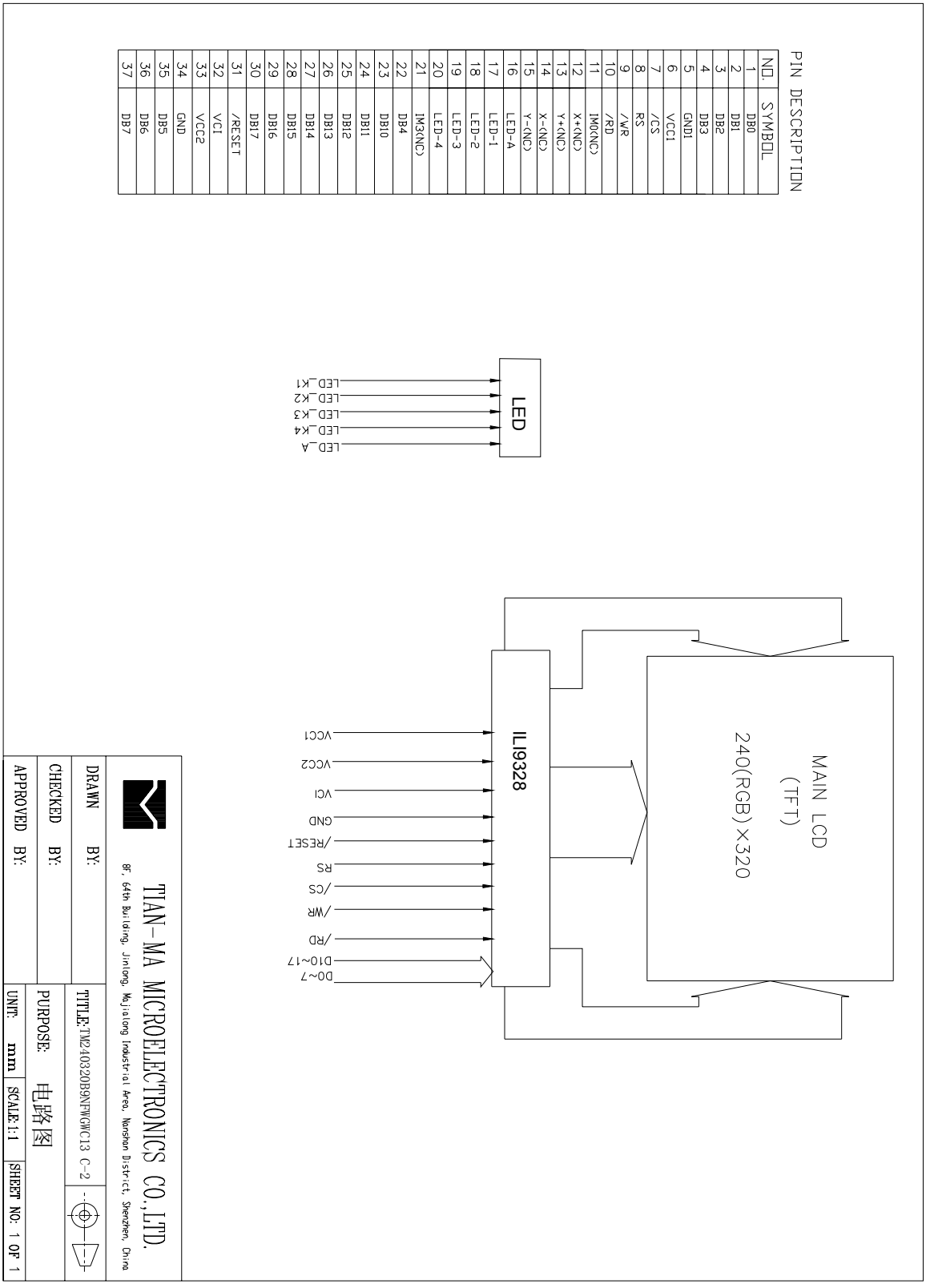
3. Outline Drawing



FPC INTERFACE

1	DB0
2	DB1
3	DB2
4	DB3
5	GND1
6	VCC1
7	/CS
8	RS
9	/WR
10	/RD
11	NC
12	X+
13	Y+
14	X-
15	Y-
16	LEDA
17	LEDK1
18	LEDK2
19	LEDK3
20	LEDK4
21	NC
22	DB4
23	DB10
24	DB11
25	DB12
26	DB13
27	DB14
28	DB15
29	DB16
30	DB17
31	/RESET
32	VCI
33	VCC2
34	GND
35	DB5
36	DB6
37	DB7

4. Circuit Block Diagram



5. Absolute Maximum Ratings(Ta=25℃)

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	V_{DD}	-0.3	3.3	V	1,2,3
Logic Signal Input /Output Voltage	V_{IOVCC}	-0.3	V_{DD}+0.3	V	
Operating Temperature	Top	-20	+70	℃	
Storage Temperature	Tst	-30	+80	℃	

Notes:

1. In case of below 0℃，the response time of liquid crystal (LC)becomes slower and the color
2. Of panel becomes darker than normal one. Level of retardation depends on temperature, because of LC´s characteristics.
3. If the module is above these absolute maximum ratings. It may become permanently damaged. Using the module within the following electrical characteristic conditions are also exceeded, the module will malfunction and cause poor reliability.

3. V_{DD} >V_{SS} must be maintained.

6. Electrical Specifications and Instruction Code

6.1 Electrical characteristics(Vss=0V ,Ta=25℃)

Parameter		Symbol	Condition	Min	Typ	Max	Unit	Note
Input voltage	'H'	V_{IH}	V_{DD}=2.8V	0.8V_{DD}	-	V_{DD}	V	
	'L'	V_{IL}	V_{DD}=2.8V	Vss	-	0.2V_{DD}	V	
Output Voltage	'H'	V_{OH}	-	0.8V_{DD}	-	V_{DD}	V	
	'L'	V_{OL}	-	Vss	-	0.2V_{DD}	V	
Current Consumption		I_{CC1}	Normal mode	-	-	-	mA	1,3
		I_{CC2}	Standby mode	-	-	-	mA	2

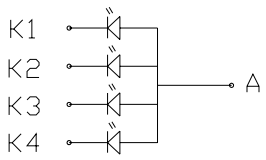
Note:
1: Display full white. Backlight on state.
2: IC on standby mode.
3: the default voltage is 3.2V, for N lights in series, the power is that the current multiply N.

6.2 LED backlight specification(VDD=2.8V,Vss=0V ,Ta=25℃)

Item		Symbol	Condition	Min	Typ	Max	Unit	Note
Supply voltage		V_f	I_f=80mA	-	3.3	-	V	
Reverse voltage		V_r	-	-	-	-	V	
Forward current	Normal	I_{pn}	4-chip Parallel		-	-	mA	
	Dimming	I_{pd}						
Reverse Current		I_r	-	-	-	-	μA	
Uniformity		△Bp	I_f=80mA	80%				
Color coordinate*		X		0.270		0.315	-	
		Y		0.270		0.315	-	

White LED CIRCUIT DIAGRAM:

e.g.



背光电路图,建议定电流驱动
I=4 × 20mA

NOTE:

1 The LED ‘s driver mode needs to be constant current mode.

2 Permanent damage to the device may occur if maximum values are exceeded or reverse voltage is loaded .Functional operation should be restricted to the conditions described under normal operating conditions.

6.3 Interface Signals

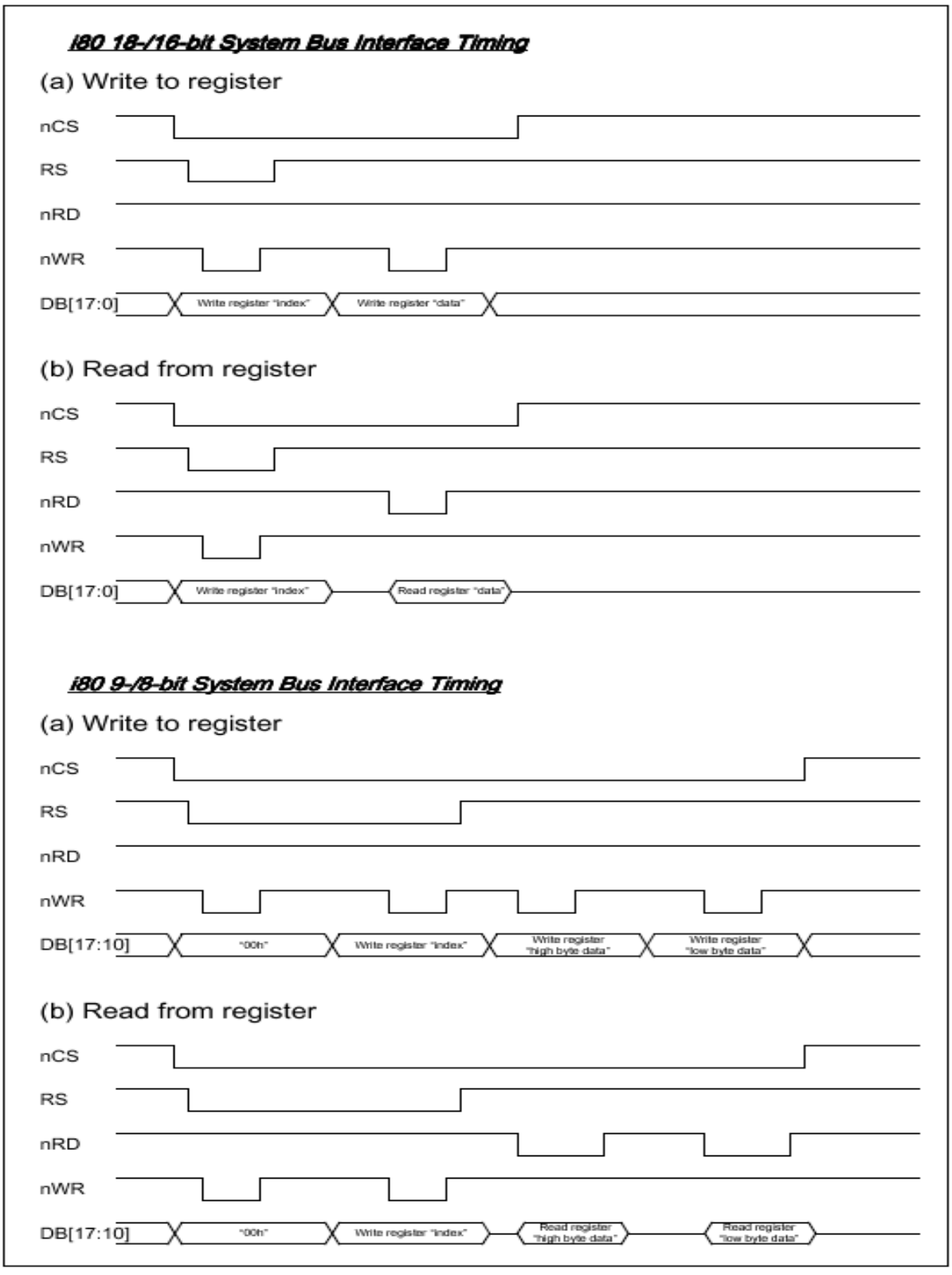
Pin No.	Symbol	I/O	Function
1	DB0	I	Display data input
2	DB1	I	Display data input
3	DB2	I	Display data input
4	DB3	I	Display data input
5	GND1	PG	Power ground
6	VCC1	P	Power Supply for Digital
7	/CS	I	Chip select input pin("low" is enable)
8	RS	I	Display data/command selection pin in MCU interface
9	/WR	I	Write control pin
10	/RD	I	Read control pin
11	NC		Not connect.
12	X+	I	Touch Panel X+
13	Y+	I	Touch Panel Y+
14	X-	I	Touch Panel X-
15	Y-	I	Touch Panel Y-
16	LEDA	I	LED backlight +
17	LEDK1	I	LED backlight -
18	LEDK2	I	LED backlight -
19	LEDK3	I	LED backlight -
20	LEDK4	I	LED backlight -
21	NC		Not connect.
22	DB4	I	Display data input
23	DB10	I	Display data input
24	DB11	I	Display data input
25	DB12	I	Display data input
26	DB13	I	Display data input
27	DB14	I	Display data input
28	DB15	I	Display data input
29	DB16	I	Display data input
30	DB17	I	Display data input
31	/RESET	I	Reset input pin.Signal is active low
32	VCI	P	Power Supply for Analog
33	VCC2	P	Power Supply for Digital
34	GND	PG	Power ground
35	DB5	I	Display data input
36	DB6	I	Display data input
37	DB7	I	Display data input

6.4 Interface Timing Chart

Note: Please refer to ILITEK's ILI9328 data sheet for more details.

ILITEK's 9328 INTERFACE PROTOCOL

Inter 80 system CPU interface



INSTRUCTION DESCRIPTION(ILITEK's 9328)

No.	Registers Name	R/W	RS	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
IR	Index Register	W	0	-	-	-	-	-	-	-	-	ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0
00h	Driver Code Read	RO	1	1	0	0	1	0	0	1	1	0	0	1	0	1	0	0	0
01h	Driver Output Control 1	W	1	0	0	0	0	0	SM	0	SS	0	0	0	0	0	0	0	0
02h	LCD Driving Control	W	1	0	0	0	0	0	0	BC0	EOR	0	0	0	0	0	0	0	0
03h	Entry Mode	W	1	TRI	DFM	0	BGR	0	0	0	0	ORG	0	I/D1	I/D0	AM	0	0	0
04h	Resize Control	W	1	0	0	0	0	0	0	RCV1	RCV0	0	0	RCH1	RCH0	0	0	RSZ1	RSZ0
07h	Display Control 1	W	1	0	0	PTDE1	PTDE0	0	0	0	BASEE	0	0	GON	DTE	CL	0	D1	D0
08h	Display Control 2	W	1	0	0	0	0	FP3	FP2	FP1	FP0	0	0	0	0	BP3	BP2	BP1	BP0
09h	Display Control 3	W	1	0	0	0	0	0	PTS2	PTS1	PTS0	0	0	PTG1	PTG0	ISC3	ISC2	ISC1	ISC0
0Ah	Display Control 4	W	1	0	0	0	0	0	0	0	0	0	0	0	0	FMARKOE	FMI2	FMI1	FMI0
0Ch	RGB Display Interface Control 1	W	1	0	ENC2	ENC1	ENC0	0	0	0	RIM	0	0	DM1	DM0	0	0	RIM1	RIM0
0Dh	Frame Maker Position	W	1	0	0	0	0	0	0	0	FMP8	FMP7	FMP6	FMP5	FMP4	FMP3	FMP2	FMP1	FMP0
0Fh	RGB Display Interface Control 2	W	1	0	0	0	0	0	0	0	0	0	0	0	VSPL	HSPL	0	DPL	EPL
10h	Power Control 1	W	1	0	0	0	SAP	0	BT2	BT1	BT0	APE	AP2	AP1	AP0	0	0	SLP	STB
11h	Power Control 2	W	1	0	0	0	0	0	DC12	DC11	DC10	0	DC02	DC01	DC00	0	VC2	VC1	VC0
12h	Power Control 3	W	1	0	0	0	0	0	0	0	0	VCIRE	0	0	PON	VRH3	VRH2	VRH1	VRH0
13h	Power Control 4	W	1	0	0	0	VDV4	VDV3	VDV2	VDV1	VDV0	0	0	0	0	0	0	0	0
20h	Horizontal GRAM Address Set	W	1	0	0	0	0	0	0	0	0	AD7	AD6	AD5	AD4	AD3	AD2	AD1	AD0
21h	Vertical GRAM Address Set	W	1	0	0	0	0	0	0	0	AD16	AD15	AD14	AD13	AD12	AD11	AD10	AD9	AD8
22h	Write Data to GRAM	W	1	RAM write data (WD17-0) / read data (RD17-0) bits are transferred via different data bus lines according to the selected interfaces.															
29h	Power Control 7	W	1	0	0	0	0	0	0	0	0	0	0	VCM5	VCM4	VCM3	VCM2	VCM1	VCM0
2Bh	Frame Rate and Color Control	W	1	0	0	0	0	0	0	0	0	0	0	0	0	FRS[3]	FRS[2]	FRS[1]	FRS[0]
30h	Gamma Control 1	W	1	0	0	0	0	0	KP1[2]	KP1[1]	KP1[0]	0	0	0	0	0	KP0[2]	KP0[1]	KP0[0]
31h	Gamma Control 2	W	1	0	0	0	0	0	KP3[2]	KP3[1]	KP3[0]	0	0	0	0	0	KP2[2]	KP2[1]	KP2[0]
32h	Gamma Control 3	W	1	0	0	0	0	0	KP5[2]	KP5[1]	KP5[0]	0	0	0	0	0	KP4[2]	KP4[1]	KP4[0]
35h	Gamma Control 4	W	1	0	0	0	0	0	RP1[2]	RP1[1]	RP1[0]	0	0	0	0	0	RP0[2]	RP0[1]	RP0[0]
36h	Gamma Control 5	W	1	0	0	0	VRP1[4]	VRP1[3]	VRP1[2]	VRP1[1]	VRP1[0]	0	0	0	0	VRP0[3]	VRP0[2]	VRP0[1]	VRP0[0]
37h	Gamma Control 6	W	1	0	0	0	0	0	KN1[2]	KN1[1]	KN1[0]	0	0	0	0	0	KN0[2]	KN0[1]	KN0[0]
38h	Gamma Control 7	W	1	0	0	0	0	0	KN3[2]	KN3[1]	KN3[0]	0	0	0	0	0	KN2[2]	KN2[1]	KN2[0]
39h	Gamma Control 8	W	1	0	0	0	0	0	KN5[2]	KN5[1]	KN5[0]	0	0	0	0	0	KN4[2]	KN4[1]	KN4[0]
3Ch	Gamma Control 9	W	1	0	0	0	0	0	RN1[2]	RN1[1]	RN1[0]	0	0	0	0	0	RN0[2]	RN0[1]	RN0[0]
3Dh	Gamma Control 10	W	1	0	0	0	VRN1[4]	VRN1[3]	VRN1[2]	VRN1[1]	VRN1[0]	0	0	0	0	VRN0[3]	VRN0[2]	VRN0[1]	VRN0[0]
50h	Horizontal Address Start Position	W	1	0	0	0	0	0	0	0	0	HSA7	HSA6	HSA5	HSA4	HSA3	HSA2	HSA1	HSA0
51h	Horizontal Address End Position	W	1	0	0	0	0	0	0	0	0	HEA7	HEA6	HEA5	HEA4	HEA3	HEA2	HEA1	HEA0
52h	Vertical Address Start Position	W	1	0	0	0	0	0	0	0	VSA8	VSA7	VSA6	VSA5	VSA4	VSA3	VSA2	VSA1	VSA0
53h	Vertical Address End Position	W	1	0	0	0	0	0	0	0	VEA8	VEA7	VEA6	VEA5	VEA4	VEA3	VEA2	VEA1	VEA0
60h	Driver Output Control 2	W	1	GS	0	NL5	NL4	NL3	NL2	NL1	NL0	0	0	SCN5	SCN4	SCN3	SCN2	SCN1	SCN0
61h	Base Image Display Control	W	1	0	0	0	0	0	0	0	0	0	0	0	0	0	NDL	VLE	REV
6Ah	Vertical Scroll Control	W	1	0	0	0	0	0	0	0	VL8	VL7	VL6	VL5	VL4	VL3	VL2	VL1	VL0
80h	Partial Image 1 Display Position	W	1	0	0	0	0	0	0	0	PTDP08	PTDP07	PTDP06	PTDP05	PTDP04	PTDP03	PTDP02	PTDP01	PTDP00
81h	Partial Image 1 Area (Start Line)	W	1	0	0	0	0	0	0	0	PTSA08	PTSA07	PTSA06	PTSA05	PTSA04	PTSA03	PTSA02	PTSA01	PTSA00
82h	Partial Image 1 Area (End Line)	W	1	0	0	0	0	0	0	0	PTEA08	PTEA07	PTEA06	PTEA05	PTEA04	PTEA03	PTEA02	PTEA01	PTEA00
83h	Partial Image 2 Display Position	W	1	0	0	0	0	0	0	0	PTDP18	PTDP17	PTDP16	PTDP15	PTDP14	PTDP13	PTDP12	PTDP11	PTDP10
84h	Partial Image 2 Area (Start Line)	W	1	0	0	0	0	0	0	0	PTSA18	PTSA17	PTSA16	PTSA15	PTSA14	PTSA13	PTSA12	PTSA11	PTSA10
85h	Partial Image 2 Area (End Line)	W	1	0	0	0	0	0	0	0	PTEA18	PTEA17	PTEA16	PTEA15	PTEA14	PTEA13	PTEA12	PTEA11	PTEA10
90h	Panel Interface Control 1	W	1	0	0	0	0	0	0	DIVI1	DIVI00	0	0	0	0	RTNI3	RTNI2	RTNI1	RTNI0
92h	Panel Interface Control 2	W	1	0	0	0	0	0	NOWI2	NOWI1	NOWI0	0	0	0	0	0	0	0	0
95h	Panel Interface Control 4	W	1	0	0	0	0	0	0	DIVE1	DIVE0	0	0	RTNE5	RTNE4	RTNE3	RTNE2	RTNE1	RTNE0
A1h	OTP VCM Programming Control	W	1	0	0	0	0	OTP_PGM_EN	0	0	0	0	0	VCM_OTP5	VCM_OTP4	VCM_OTP3	VCM_OTP2	VCM_OTP1	VCM_OTP0
A2h	OTP VCM Status and Enable	W	1	PGM_CNT1	PGM_CNT0	VCM_D5	VCM_D4	VCM_D3	VCM_D2	VCM_D1	VCM_D0	0	0	0	0	0	0	0	VCM_EN
A5h	OTP Programming ID Key	W	1	KEY 15	KEY 14	KEY 13	KEY 12	KEY 11	KEY 10	KEY 9	KEY 8	KEY 7	KEY 6	KEY 5	KEY 4	KEY 3	KEY 2	KEY 1	KEY 0

7. Optical Characteristics（VDD=2.8V,Vss=0V ,Ta=25℃）

Item	Symbol		Condition	Min.	Typ.	Max.	Unit	Note
Brightness	Bp		θ=0° Φ=0°	180	-	-	Cd/m^2	1
Uniformity	△Bp			80%	-	-		1,2
Viewing Angle	θ1 (Φ=90° or270°)		Cr≥10	-40～+20			Deg	3
	θ2 (Φ=0° or 180°)			-40～+40				
Contrast Ratio	Cr		θ=0° Φ=0°		300		-	4
Response Time	T_r			-	35	-	ms	5
	T_f						ms	
Color of CIE Coordinate	W	x	θ=0° Φ=0°	-	-	-	-	1,6
		y		-	-	-	-	
	R	x		-	-	-	-	
		y		-	-	-	-	
	G	x		-	-	-	-	
		y		-	-	-	-	
	B	x		-	-	-	-	
		y		-	-	-	-	
NTSC Ratio	S				55%	-		

Note：The parameter is slightly changed by temperature, driving voltage and materiel.

Note 1: The data are measured after LEDs are turned on for 5 minutes. LCM displays full white. The brightness is the average value of 9 measured spots. Measurement equipment

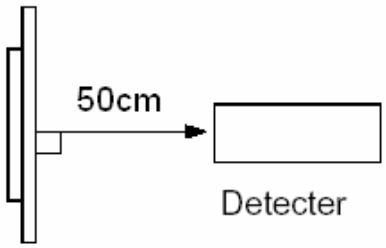
PR-705 (Φ8mm)

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 5 minutes while

backlight turning on.

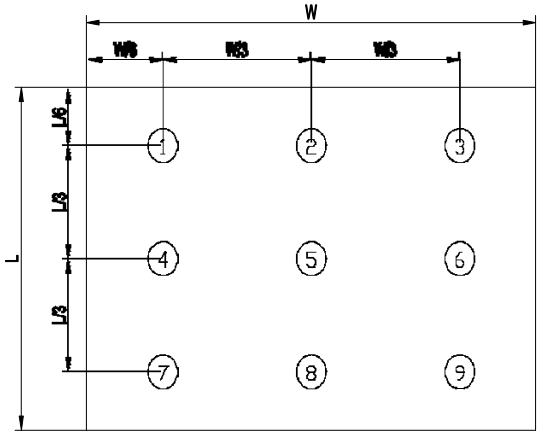


Note 2: The luminance uniformity is calculated by using following formula.

△Bp = Bp (Min.) / Bp (Max.)×100 (%)

Bp (Max.) = Maximum brightness in 9 measured spots

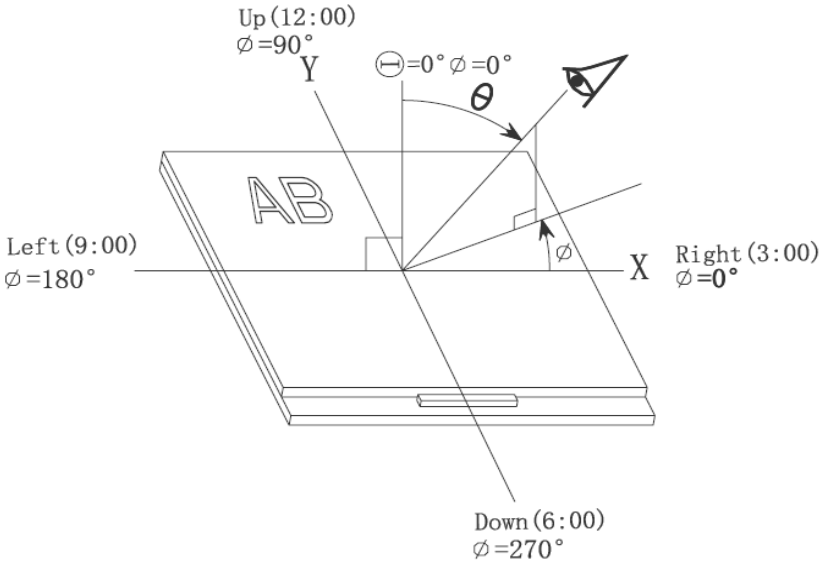
Bp (Min.) = Minimum brightness in 9 measured spots.



Measurement equipment PR-705 (Φ8mm)

Note 3: The definition of viewing angle:

Refer to the graph below marked by θ and Φ



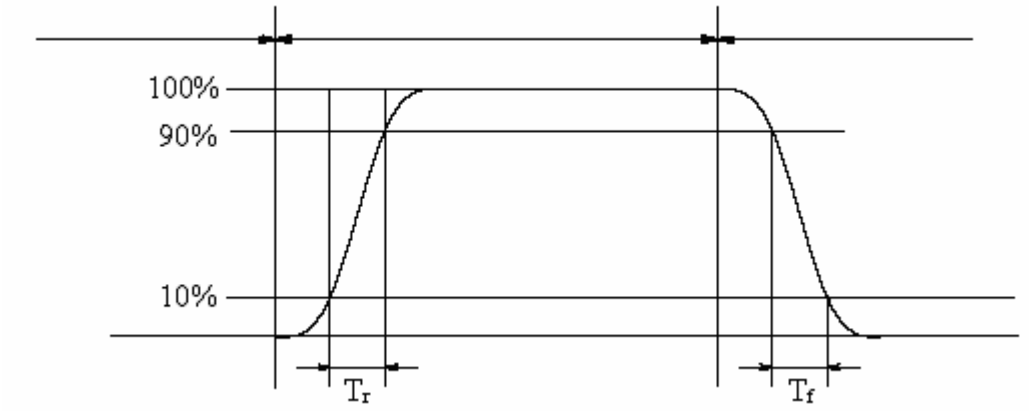
Note 4: The definition of contrast ratio (Test LCM using PR-705):

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

(Contrast Ratio is measured in optimum common electrode voltage)

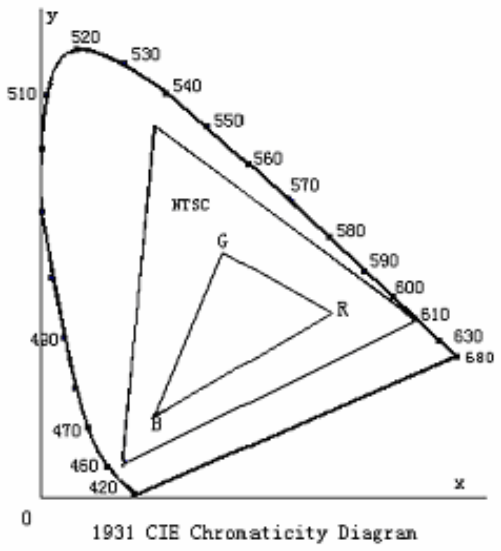
Note 5: Definition of Response time. (Test LCD using DMS501):

The output signals of photo detector are measured when the input signals are changed from “black” to “white”(falling time) and from “white” to “black”(rising time), respectively. The response time is defined as the time interval between the 10% and 90% of amplitudes.Refer to figure as below.



The definition of response time

Note 6: Definition of Color of CIE Coordinate and NTSC Ratio.



1931 CIE Chromaticity Diagran

Color gamut:

$$S = \frac{\text{area of RGB triangle}}{\text{area of NTSC triangle}} \times 100\%$$

8.Initial Code Setting（for example ILI9328）

```
// VCI=2.8V
//************* Reset LCD Driver ****************//
LCD_nRESET = 1;
delayms(1);                                  // Delay 1ms
LCD_nRESET = 0;
delayms(10);                                 // Delay 10ms This delay time is necessary
LCD_nRESET = 1;
delayms(50);                                 // Delay 50 ms
//************* Start Initial Sequence **********//
LCD_CtrlWrite_ILI9328(0x00E3, 0x3008); // Set internal timing
LCD_CtrlWrite_ILI9328(0x00E7, 0x0012); // Set internal timing
LCD_CtrlWrite_ILI9328(0x00EF, 0x1231); // Set internal timing
LCD_CtrlWrite_ILI9328(0x0001, 0x0100); // set SS and SM bit
LCD_CtrlWrite_ILI9328(0x0002, 0x0700); // set 1 line inversion
LCD_CtrlWrite_ILI9328(0x0003, 0x1030); // set GRAM write direction and BGR=1.
LCD_CtrlWrite_ILI9328(0x0004, 0x0000); // Resize register
LCD_CtrlWrite_ILI9328(0x0008, 0x0202); // set the back porch and front porch
LCD_CtrlWrite_ILI9328(0x0009, 0x0000); // set non-display area refresh cycle ISC[3:0]
LCD_CtrlWrite_ILI9328(0x000A, 0x0000); // FMARK function
LCD_CtrlWrite_ILI9328(0x000C, 0x0000); // RGB interface setting
LCD_CtrlWrite_ILI9328(0x000D, 0x0000); // Frame marker Position
LCD_CtrlWrite_ILI9328(0x000F, 0x0000); // RGB interface polarity
//*************Power On sequence ****************//
LCD_CtrlWrite_ILI9328(0x0010, 0x0000); // SAP, BT[3:0], AP, DSTB, SLP, STB
LCD_CtrlWrite_ILI9328(0x0011, 0x0007); // DC1[2:0], DC0[2:0], VC[2:0]
LCD_CtrlWrite_ILI9328(0x0012, 0x0000); // VREG1OUT voltage
LCD_CtrlWrite_ILI9328(0x0013, 0x0000); // VDV[4:0] for VCOM amplitude
delayms(200);                                 // Dis-charge capacitor power voltage
LCD_CtrlWrite_ILI9328(0x0010, 0x1290); // SAP, BT[3:0], AP, DSTB, SLP, STB
LCD_CtrlWrite_ILI9328(0x0011, 0x0227); // R11h=0x0221 at VCI=3.3V, DC1[2:0], DC0[2:0],
VC[2:0]
delayms(50);                                  // Delay 50ms
LCD_CtrlWrite_ILI9328(0x0012, 0x009C); // External reference voltage= Vci
delayms(50);                                  // Delay 50ms
LCD_CtrlWrite_ILI9328(0x0013, 0x1800); // VDV[4:0] for VCOM amplitude
LCD_CtrlWrite_ILI9328(0x0029, 0x0028); // VCM[5:0] for VCOMH
LCD_CtrlWrite_ILI9328(0x002B, 0x000B); // Frame Rate = 51Hz
delayms(50);                                  // Delay 50ms
LCD_CtrlWrite_ILI9328(0x0020, 0x0000); // GRAM horizontal Address
LCD_CtrlWrite_ILI9328(0x0021, 0x0000); // GRAM Vertical Address
// ----------- Adjust the Gamma Curve ----------//
LCD_CtrlWrite_ILI9328(0x0030, 0x0004);
LCD_CtrlWrite_ILI9328(0x0031, 0x0507);
LCD_CtrlWrite_ILI9328(0x0032, 0x0103);
LCD_CtrlWrite_ILI9328(0x0035, 0x0302);
LCD_CtrlWrite_ILI9328(0x0036, 0x0302);
LCD_CtrlWrite_ILI9328(0x0037, 0x0106);
LCD_CtrlWrite_ILI9328(0x0038, 0x0000);
LCD_CtrlWrite_ILI9328(0x0039, 0x0307);
LCD_CtrlWrite_ILI9328(0x003C, 0x0203);
LCD_CtrlWrite_ILI9328(0x003D, 0x0004);
//------------------ Set GRAM area ---------------//
LCD_CtrlWrite_ILI9328(0x0050, 0x0000); // Horizontal GRAM Start Address
LCD_CtrlWrite_ILI9328(0x0051, 0x00EF); // Horizontal GRAM End Address
LCD_CtrlWrite_ILI9328(0x0052, 0x0000); // Vertical GRAM Start Address
LCD_CtrlWrite_ILI9328(0x0053, 0x013F); // Vertical GRAM Start Address
LCD_CtrlWrite_ILI9328(0x0060, 0xA700); // Gate Scan Line
LCD_CtrlWrite_ILI9328(0x0061, 0x0001); // NDL,VLE, REV
LCD_CtrlWrite_ILI9328(0x006A, 0x0000); // set scrolling line
//-------------- Partial Display Control ---------//
LCD_CtrlWrite_ILI9328(0x0080, 0x0000);
LCD_CtrlWrite_ILI9328(0x0081, 0x0000);
LCD_CtrlWrite_ILI9328(0x0082, 0x0000);
LCD_CtrlWrite_ILI9328(0x0083, 0x0000);
LCD_CtrlWrite_ILI9328(0x0084, 0x0000);
LCD_CtrlWrite_ILI9328(0x0085, 0x0000);
//-------------- Panel Control ------------------//
```

```
LCD_CtrlWrite_ILI9328(0x0090, 0x0010);
LCD_CtrlWrite_ILI9328(0x0092, 0x0600);
LCD_CtrlWrite_ILI9328(0x0007, 0x0133); // 262K color and display ON
```

9. Reliability Test Items and Criteria

No	Test Item	Test condition	Criterion
1	High Temperature Storage	80℃±2℃ 96H Restore 2H at 25℃ Power off	The test result shall be evaluated after the sample has been left at room temperature and humidity for 2 hours without load. No condensation shall be accepted. The sample shall be free from defects: 1.Air bubble in the LCD; 2.Sealleak; 3.Non-display; 4.missing segments; 5.Glass crack;
2	Low Temperature Storage	-30℃±2℃ 96H Restore 2H at 25℃ Power off	
3	High Temperature Operation	70℃±2℃ 96H Restore 2H at 25℃ Power on	
4	Low Temperature Operation	-20℃±2℃ 96H Restore 4H at 25℃ Power on	
5	High Temperature & Humidity Operation	60℃±2℃ 90%RH 96H Power on	
6	Temperature Cycle	−30℃ → 25℃ → 80℃ 30min 5 min 30min after 10cycle, Restore 2H at 25℃ Power off	
7	Vibration Test	10Hz~150Hz, 100m/s^2, 120min	
8	Shock Test	Half-sine wave,300m/s^2,11ms	
9	Drop Test(package state)	800mm, concrete floor,1corner, 3edges, 6 sides each time	
10	ESD Sensitivity test	Contact ±4KV，150PF/330，20times Air ±8KV,150PF/330，20times	

NOTE:
1.The test samples should be applied to only one test item.
2.Sample size for each test item is 5~10pcs.
3.For Damp Proof Test, Pure water(Resistance＞10MΩ) should be used.
4.In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judge as a good part. Using ionizer(an antistatic blower)

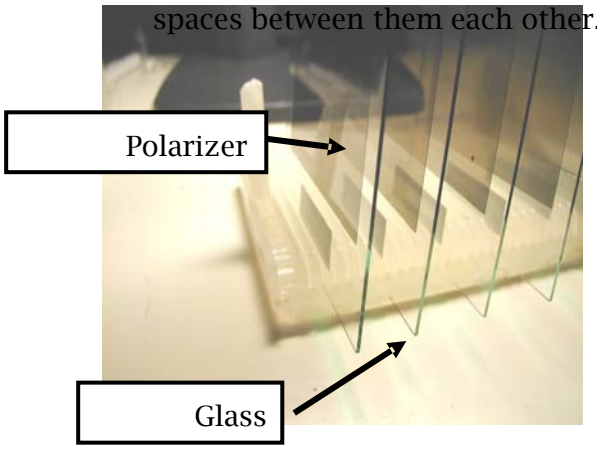
is recommended at working area in order to reduce electro-static voltage. When removing protection film from LCM panel, peel off the tag slowly(recommended more than one second) while blowing with ionizer toward the peeling face to minimize ESD which may damage electrical circuit.

5. EL evaluation should be excepted from reliability test with humidity and temperature: Some defects such as black spot/blemish can happen by natural chemical reaction with humidity and Fluorescence EL has.

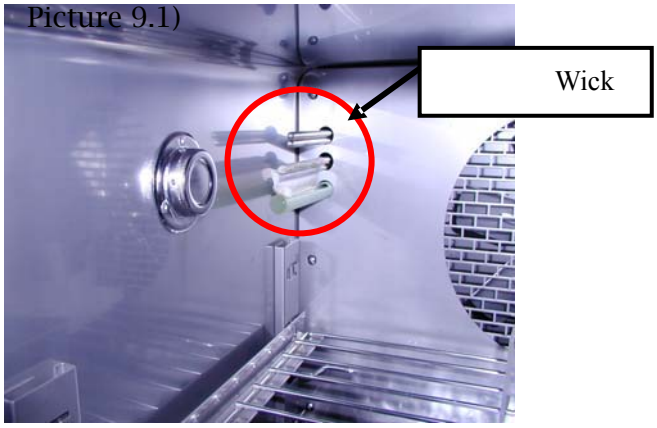
6. Polarizer test criteria

a. when testing avoid samples take out then return, It can cause water coagulation in Polarizer. Increase the distance of samples , And put samples before the wind.

b. When the samples are put into the test, put them upright so that the glasses keep spaces between them each other. (Picture 9.1)



Picture 9.1



Picture 9.2

c. Put samples into testing machine as small as possible so that it is drafty.

d. Do not put samples under wick because water will fall.(Picture 9.2)

e. Do not open testing machine except for taking them out in order to prevent moisture condensation.

7.Please use automatic switch menu(or roll menu) testing mode when test operating mode

8.The inspection terms after reliability test, as below

ITEM	Inspection standard
Contrast	CR>50%
IDD	IDD<200%
Brightness	Brightness>60%
Color Tone	Color Tone+/-0.05

10 Quality level

10.1 Classification of defects

Major defects (MA): A major defect refers to a defect that may substantially degrade usability for product applications, including all functional defects(such as no display,abnormaldisplay, open or missin segment,short circuit,missing component), outline dimension beyond the drawing, progressive defects and those affecting reliability.

Minor defects (MI): A minor defect refers to a defect which is not considered to be able to substantially degrade the product application or a defect that deviates from existing standards almost unrelated to the effective use of the product or its operation, such as black spot, white spot, bright spot, pinhole, black line, white line, contrast variation, glass defect, polarizer defect, etc.

10.2 Definition of inspection range

For dot defect of TFT LCD which is not smaller than 3 inches, dividing three areas to make a judgment (according to figure 1).

A area : center of viewing area

B area : periphery of viewing area

C area : Outside viewing area

For other defects, dividing two areas to make a judgment (according figure 2).

A zone : Inside Viewing area

B zone : Outside Viewing area

X1(A.A~V.A): 0mm X2(A.A~V.A): 0mm

Y1(A.A~V.A): 0mm Y2(A.A~V.A): 0mm

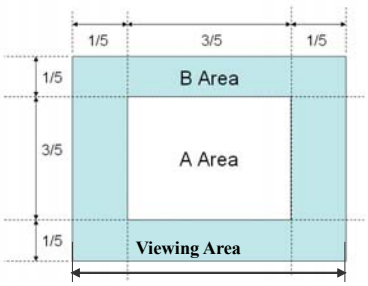


Figure 1

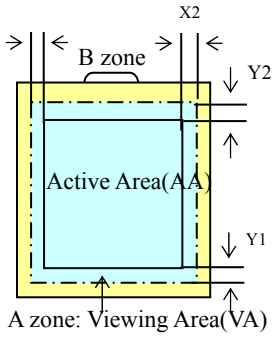


Figure 2

10.3 Inspection items and general notes

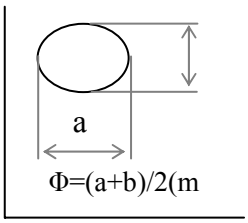
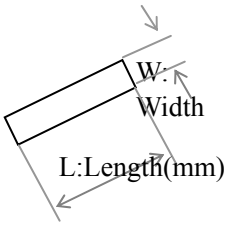
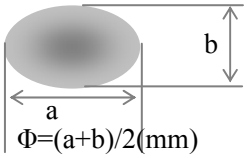
General notes	①Should any defects which are not specified in this standard happen, additional standard shall be determined by mutual agreement between customer and TIANMA. ②Viewing area should be the area which TIANMA guarantees. ③Limit sample should be prior to this Inspection standard. ④Viewing judgment should be under static pattern. ⑤Inspection conditions Inspection distance: 250 mm (from the sample) Temperature : 25±5 ºC Inspection angle : 45 degrees in 6 o'clock direction (all defects in viewing area should be inspected from this direction)	
Inspection items	Pinhole, Bright spot, Black spot, White spot, Black line, White Line, Foreign particle, Bubble	The color of a small area is different from the remainder. The phenomenon doesn't change with voltage
	Contrast variation	The color of a small area is different from the remainder. The phenomenon changes with voltage
	Polarizer defect	Scratch, Dirt, Particle, Bubble on polarizer or between polarizer and glass
	Dot defect (TFT LCD)	The pixel appears bright or dark abnormally when display

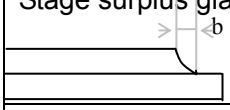
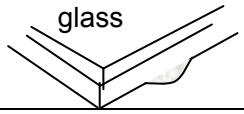
	Functional defect	No display, Abnormal display, Open or missing segment, Short circuit, False viewing direction
	Glass defect	Glass crack, Shaved corner of glass, Surplus glass
	PCB defect	Components assembly defect

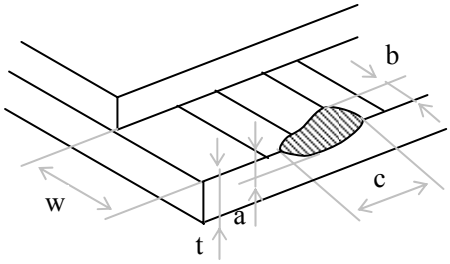
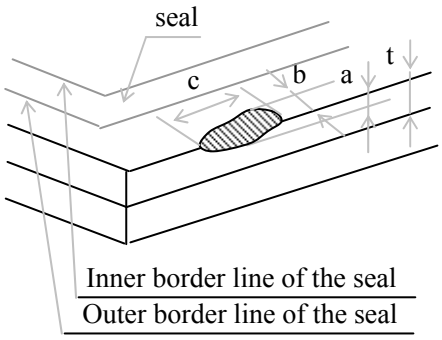
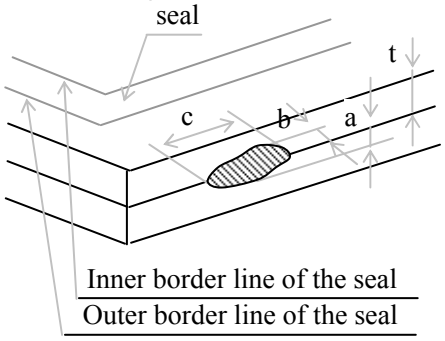
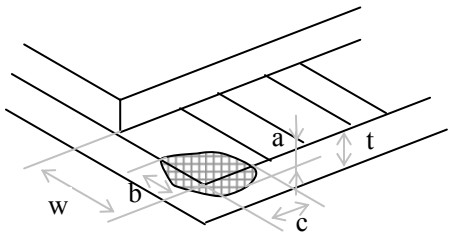
10.4 Outgoing Inspection level

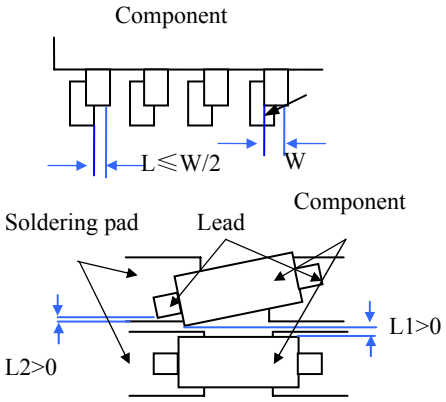
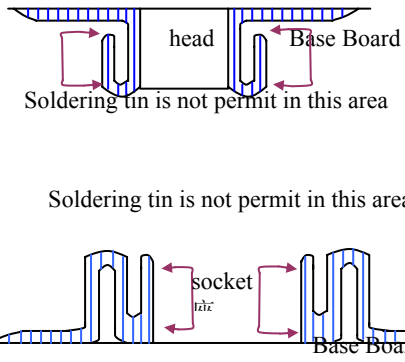
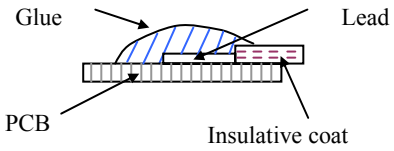
Outgoing Inspection standard	Inspection conditions	Inspection				
		Min.	Max.	Unit	IL	AQL
Major Defects	See 8.3 general notes	See 8.5			II	0.65
Minor Defects	See 8.3 general notes	See 8.5			II	1.5
Note：Sampling standard conforms to GB2828						

10.5 Inspection Items and Criteria

Inspection items			Judgment standard			
			Category		Acceptable number	
					A zone	B zone
1	Black spot, White spot, Bright Spot, Pinhole, Foreign Particle, Particle in or on glass, Scratch on glass		A	Φ≦0.10	Neglected	Neglected
			B	0.10<Φ≦0.15	2	
			C	0.15<Φ≦0.20	1	
			D	0.20<Φ	0	
			Total defective point(B,C)		3	
2	Black line, White line, and Particle Between Polarizer and glass, Scratch on glass		A	W≦0.01	Neglected	Neglected
			B	0.01<W≦0.03 L≦3.0	2	
			C	0.03<W≦0.05 L≦3.0	1	
			D	0.05<W	0	
			Total defective point(B,C)		3	
3	Contrast Variation		A	Φ≦0.2	Neglected	Neglected
			B	0.2<Φ≦0.3	2	
			C	0.3<Φ≦0.4	1	
			D	0.4<Φ	0	
			Total defective point(B,C)		3	

<table>
<tr><td rowspan="6">4</td><td rowspan="6">Dot defect (if TFT LCD is used)</td><td rowspan="3">TFT LCD is smaller than 3 inches</td><td>LCD Class</td><td>Defect</td><td colspan="2">A area</td><td>B area</td></tr>
<tr><td rowspan="3">B</td><td>Bright dot</td><td colspan="2">2</td><td rowspan="3">Neglected</td></tr>
<tr><td>Dark dot</td><td colspan="2">3</td></tr>
<tr><td>Total</td><td colspan="2">4</td></tr>
<tr><td rowspan="3">TFT LCD between 3~10.4 inches</td><td>LCD Class</td><td>Defect</td><td>A area</td><td>B area</td><td>C area</td></tr>
<tr><td rowspan="3">B</td><td>Bright dot</td><td>2</td><td>2</td><td rowspan="3">Neglected</td></tr>
<tr><td>Dark dot</td><td>2</td><td>3</td></tr>
<tr><td>Total</td><td colspan="2">6</td></tr>
<tr><td colspan="7">Notes:
Bright dot: in R、G、B or dark display figure, the pixel appears bright.
Dark dot: in R、G、B or white display figure, the pixel appears dark.
Defect area must be less than an half size of the dot.</td></tr>
<tr><td>5</td><td colspan="2">Bubble inside cell</td><td colspan="2">any size</td><td>none</td><td>none</td></tr>
<tr><td rowspan="4">6</td><td rowspan="4">Polarizer defect (if Polarizer is used)</td><td>Scratch ,damage on polarizer, Particle on polarizer or between polarizer and glass.</td><td colspan="4">Refer to item 1 and item 2.</td></tr>
<tr><td rowspan="3">Bubble, dent and convex</td><td>A</td><td>Φ≦0.3</td><td>Neglected</td><td rowspan="3">Neglected</td></tr>
<tr><td>B</td><td>0.3<Φ≦0.7</td><td>2</td></tr>
<tr><td>C</td><td>0.7<Φ</td><td>0</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Surplus Glass</td><td>Stage surplus glass
  </td><td colspan="4">b≦0.3mm</td></tr>
<tr><td>Surrounding surplus glass
  </td><td colspan="4">Should not influence outline dimension and assembling.</td></tr>
<tr><td>8</td><td colspan="2">Open segment or open common</td><td colspan="4">Not permitted</td></tr>
<tr><td>9</td><td colspan="2">Short circuit</td><td colspan="4">Not permitted</td></tr>
<tr><td>10</td><td colspan="2">False viewing direction</td><td colspan="4">Not permitted</td></tr>
<tr><td>11</td><td colspan="2">Contrast ratio uneven</td><td colspan="4">According to the limit specimen</td></tr>
<tr><td>12</td><td colspan="2">Crosstalk</td><td colspan="4">According to the limit specimen</td></tr>
<tr><td>13</td><td colspan="2">Black /White spot(display)</td><td colspan="4">Refer to item 1</td></tr>
<tr><td>14</td><td colspan="2">Black /White line(display)</td><td colspan="4">Refer to item 2</td></tr>
</table>

Inspection items			Judgment standard		
			Category(application: B zone)		Acceptable number
15	Glass defect crack	①The front of lead terminals 	A	a≤ t, b≤1/5W, c≤3mm	Max.3 defects allowed
			B	Crack at two sides of lead terminals should not cover patterns and alignment mark	
		②Surrounding crack—non-contact side 	b < Inner borderline of the seal		
		③ Surrounding crack— contact side 	b < Outer borderline of the seal		
		④Corner 	A	a ≦ t, b ≦ 3.0, c ≦ 3.0	
			B	Glass crack should not cover patterns u and alignment mark and patterns.	

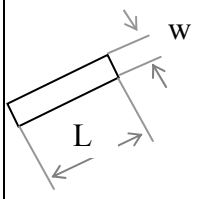
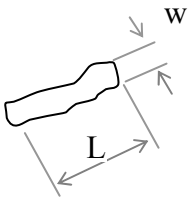
Inspection items			Judgment standard Category(application: B zone)
16	PCB defect	Component soldering: No cold soldering、short、open circuit、burr、tin ball The flat encapsulation component position deviation must be less than 1/3 width of the pin (Pic.1); the sheet component deviation: Pin deviates from the pad and contact with the near components is not permitted（Pic.2）	
		lead defect: The lead lack must be less than 1/3 of its width; The lead burr must be less than 1/3 of the seam; Impurities connect with the near leads is not permitted	
		Connector soldering: Soldering tin is at contact position of the plug and socket is not permitted No foundation is scald Serious cave distortion on plug and socket contact pin is not permitted	
		Glue on root of the speaker receiver and motor lead: The insulative coat of the lead must join into the PCB; the protected glue must envelop to the insulative coat.	

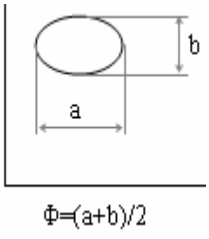
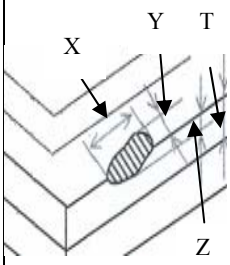
11. TP Module Inspection Standard

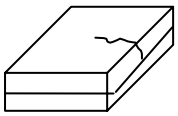
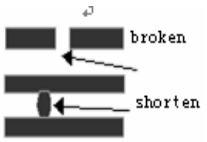
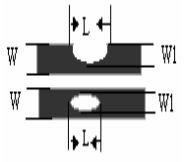
11.1 Scope:

The standard is applied to all customers owning license tag. When there is special requirement by the customer (the customer signed the standard agreement with our company) ,please reference to the customer agreement first.

11.2 Appearance defects inspection item and limit criteria (unit:mm):

Inspection item	Detail content	criteria			remark
Outline dimension	Length, Width, Thickness	Outline should meet the drawing			Vernier caliper ruler
LOGO inclined, color, icon, grounding		LOGO inclined :not allowed			Eyeballing
Surface scratch		(1) W≤0.03 mm，allowed (2)0.03 mm＜W≤0.05，L≤3 mm， defects space 20mm at least, 2 defects are allowed; L＞3mm，not allowed (3)W＞0.05 mm，not allowed			Eyeballing
Linear foreign matter		TP product under 3.5”	A	W≤0.02mm，L≤3mm	Neglected
			B	0.02mm＜W≤0.05mm， L≤3mm，	2
			C	L＞3mm or W＞0.05mm	0
			Total defects（B）		2
			Distance: D≥10mm,out of V,A is neglected		
		TP product between 3.5” and 4.3”	A	W≤0.02mm，L≤3mm	Neglected
			B	0.02mm＜W≤0.03mm，L≤3mm，	3
			C	0.03mm＜W≤0.05mm，L≤3mm，	2
			D	L＞3mm or W＞0.05mm	0
			Total defects(B,C)		2
			Distance: D≥15mm,out of V,A is neglected		
		TP product over 4.3”	A	W≤0.02mm，L≤3mm	Neglected
			B	0.02mm＜W≤0.03mm，L≤3mm，	3
			C	0.03mm＜W≤0.05mm，L≤3mm，	2
			D	L＞3mm or W＞0.05mm	0
			Total defects(B,C)		3
			Distance: D≥20mm,out of V,A is neglected		

Inspection item	Detail content	criteria				remark
Bright spot, Black spot, White spot, Pinhole, Black line, White Line, Foreign matter, air bubble		TP product under 3.5”	A	Φ≤0.15	Neglected	Eyeballing
			B	0.15＜Φ≤0.20	2	
			C	0.20＜Φ≤0.25	1	
			D	Φ＞0.25	0	
			Total defects(B,C)		2	
			distance	D≥10mm	Out of V,A is neglected	
		TP product between 3.5” and 4.3”	A	Φ≤0.15	Neglected	
			B	0.15＜Φ≤0.35	2	
			C	0.35＜Φ≤0.40	1	
			D	Φ＞0.40	0	
			Total defects(B,C)		2	
			distance	D≥15mm	Out of V,A is neglected	
		TP product over 4.3”	A	Φ≤0.15	Neglected	
			B	0.15＜Φ≤0.35	3	
			C	0.35＜Φ≤0.50	1	
			D	Φ＞0.50	0	
			Total defects(B,C)		3	
			distance	D≥20mm	Out of V,A is neglected	
Glass chip and crack		Side: x(length)≥2mm z(deepness) =T: not allowed y(width)≥2 mm z(deepness) =T: not allowed Corner: x、y≥2 mm or z=T: not allowed （T: glass thickness）				Eyeballing
Newton ring		Film+ glass: Newton ring area(S)≤1/2（T/P area Film+ Film：Newton ring area (S)≤1/3 (T/P area)				Eyeballing with the lamplight
Rainbow		Check in the range of viewing angle or press the TP LOGO by the finger, the rainbow is not allowed.				Eyeballing

Inspection item	Detail content	criteria	remark
TP white border		The insulation tape meet the LOGO is not allowed	Eyeballing
Glass crack		Not allowed	Eyeballing
TP surface dirty matter		Cleaned before shipment	Eyeballing
TP pressing mark	The mark btween the TP and LCD	in the V,A(see limited sample):not allowed	Eyeballing
FPC brim teared, shorten, broken, trace mended		Not allowed	Eyeballing with the lamplight
FPC damage		(1)W1＜1/3 trace width W，2 lines are allowed (2)W1≥1/3 routing line width W， the damage length L≥ W，not allowed	Eyeballing with the lamplight
FPC pressing mark /folding mark		(1)hot pressing side and connecting side: not allowed(make the limited sample if necessary) (2)around the hole: not allowed (3)routing line: mark width≤1/3trace width, The mark length ≤1mm is allowed (4)big ground area: neglected (5)no see base material because of the mark.	Eyeballing with the lamplight
FPC trace reveal copper, Electrode oxidated, scratch		Revealing copper is not allowed; Palm oxidation is allowed; black oxidation is allowed; protect cover is forbad scratched and damaged	Eyeballing with the lamplight
TP inclined		Obvious incline is not allowed. No affect the machine assembly first.	eyeballing
Bezel defect		Scratch: length ≤10mm，width≤0.4mm and 3 defects at most; rust and distortion is not allowed	eyeballing
Spray Code defect		According to the content specified by the customer font illegible and wrong position is not allowed	eyeballing
Note: other appearance inspection standards which not mentioned in it ,please refer to《LCM raw material inspection standard》（Q/DDG212-2005）			

11.3 TP function inspection

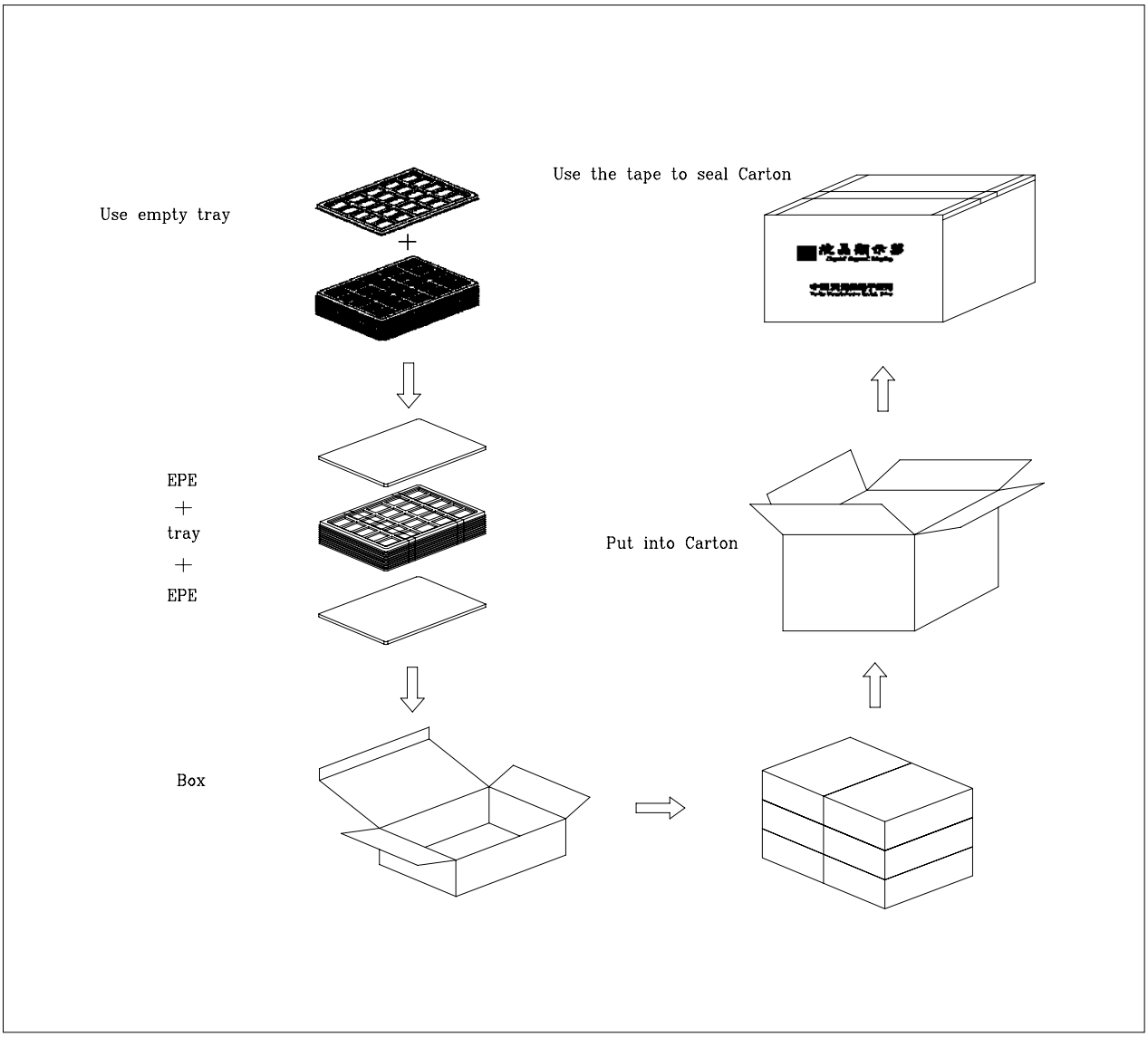
Inspection item	Detail content	Limit criteria
Linearity defect (including distortion and drawing back)	x,y axial linearity＞1.5% : not allowed	Special test jig +computer
Line broken	Exceed 4mm : not allowed	
Terminal resistance	The resistance between X1 and X2 or Y1 and Y2 exceed the design value: not allowed	Test it when it is required during Designing the drawing
Insulation resistance	Resistance between X1 and Y1:not allowed	

11.4 Display defects inspection item and limit criteria

About display defects inspection item and limit criteria ,please refer to the content of 《LCM-TFT liquid display module》（Q/DDG199-2007）and 《liquid display module display defects inspection standard》（Q/DDG439-1999）。

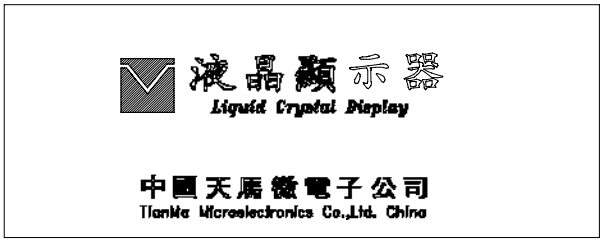
12. Package Method

模块出货包装示意图：

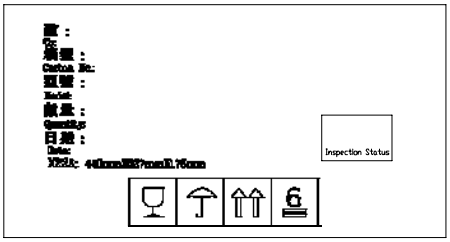


其中卡通箱的正面背面及侧面印刷如下：

卡通箱正面和背面的印刷如下：



卡通箱两个侧面的印刷如下：



注：卡通箱堆叠高度需小于 1.5m