Model name: PT500GT02-8

Date: 18.Jan.2021

(√) Preliminary Specification

(   ) Approval Specification

Any modification is not allowed without HKC's permission

Customer's Approval	**Chuzhou HKC**
Approved by Company(公司): ____________ Title(职称): ____________ Signature(签名): ____________	Approved By Product Director Date Name: Signature:
	Reviewed By PM Manager Date Name: Signature:
Note	Reviewed By Project Leader Date Name: Signature:
	Reviewed By PM Date Name: Signature:

Content

Revision History 3
1. GENERAL DESCRIPTION 4
1.1 General Specifications 4
2. ABSOLUTE MAXIMUM RATINGS 5
2.1 Absolute Maximum Ratings 5
2.2 Absolute Ratings of Environment 5
2.3 Package Storage 6
3. ELECTRICAL SPECIFICATIONS 7
3.1 Electrical Characteristics 7
3.1.1 Power Consumption (Ta = 25 ± 2 ºC) 7
3.1.2 USI-T Characteristic 7
3.1.3 USI-T Eye Diagram 8
3.1.4 VGH VS. Temperature Curve 9
3.2 Interface Connections 9
3.2.1 Block Diagram of Interface 9
3.2.2 Interface Pin Assignment For XL board 10
3.3 USI-T Timing Spec 13
3.4 Power On/Off Sequence 15
3.5 Flicker Adjustment 16
3.6 Driver IC ESD Spec 16
4. OPTICAL CHARACTERISTICS 17
4.1 Measurement Conditions 17
4.2 Optical Specifications 18
5. MECHANICAL CHARACTERISTICS 21
5.1 Mechanical Specification 21
5.2 Packing 22
5.2.1 Packing Specifications 22
5.2.2 Packing material specification 22
6. DEFINITION OF LABELS 23
6.1 Open Cell Label 23
6.2 Carton Label 24
6.3 Pallet Label 25
7. PRECAUTION 26
7.1 Unpacking 26
7.2 Storage test 26
8. GP REQUIREMENT 27

Revision History

Version	Date	Page (New)	Section	Description	Revision by
Rev.P1	2021/1/18	27	ALL	Preliminary Specification was First Issued	ALL

1. GENERAL DESCRIPTION

The specification is applied to 50" model (PT500GT02-8) TFT Liquid Crystal Display open cell and it supports 3840 x 2160 UHD mode with 16.78M (8bit) colors. This product is with data driver ICs and one 96-pins connector with USI-T interface on S-PCB and built in without backlight unit.

1.1 General Specifications

Item	Specification	Unit	Note
Screen Size	50 inch Diagonal		-
Outline Dimension	1105.96(H)x627.91(V) x1.375(D)	mm	D: cell thickness
Active area	1095.84(H)x 616.41(V)	mm	-
Driver Element	a-Si TFT active matrix	-	-
Cell transmittance	5.0%	-	HKC BLU，center point
Pixel Number	3840 x 2160	pixel	-
Sub Pixel Pitch	0.0951(H) x 0.2854(V)	mm	-
Pixel Arrangement	RGB vertical	-	-
Display Colors	16.78M	color	8bit
Display Mode	Normally Black	-	-
Display Orientation	Signal input with "ABC"	-	-
Surface Treatment	Type=AG	-	-
	Haze=3%	-	-
	Top Surface Hardness : 3H	-	--
Weight	2200	g	

Note:

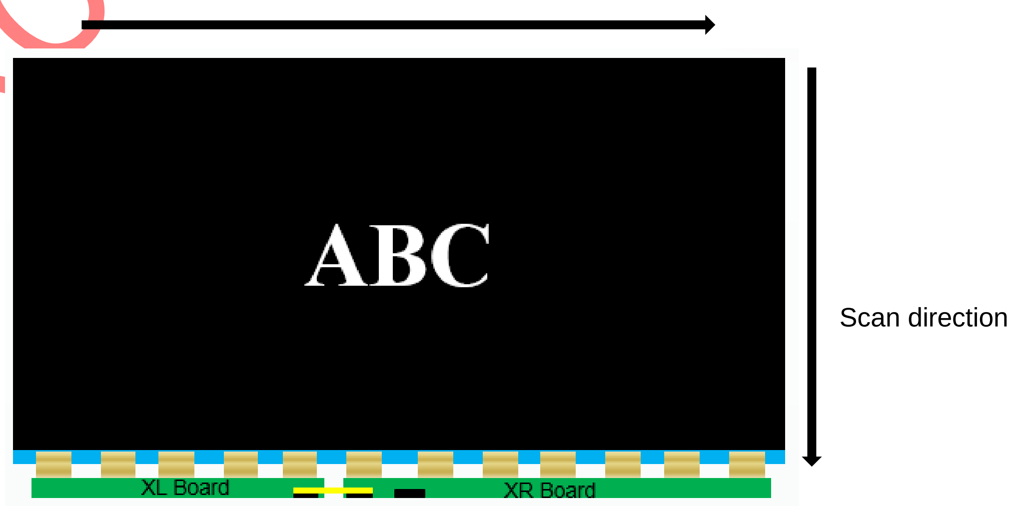


Fig. 1.1 Display Orientation

2. ABSOLUTE MAXIMUM RATINGS

2.1 Absolute Maximum Ratings

The followings are maximum values which, if exceeded, may cause damage to the unit.

Item	Symbol	Value		Unit
		Min.	Max.	
Input Singal Voltage	V_{IN}	-0.3	3.6	V

2.22.2 Absolute Ratings of Environment

Temperature and relative humidity range is shown in the figure below.

Item	Symbol	Value		Unit	Note
		Min.	Max.		
Storage Temperature	TST	-20	60	°C	(1)
Operating Temperature	TOP	0	50	°C	(1), (2)
Panel Surface Temperature of Display Area	PST	-	65	°C	(3)

Note:

(1) a. 90 % RH Max. (Ta ≤ 40 °C).

b. Web-bulb temperature should be 39℃ Max.(Ta>40℃)

c. No condensation

d. Operating condition with a assemble module

(2) Any point on the Driver surface must be less than 120 °C under any condition ,If the surface temperature is out of the spec, thermal solutions should be applied to avoid be damaged.

(3) Surface temperature of display area is measured at 50℃ dry condition.

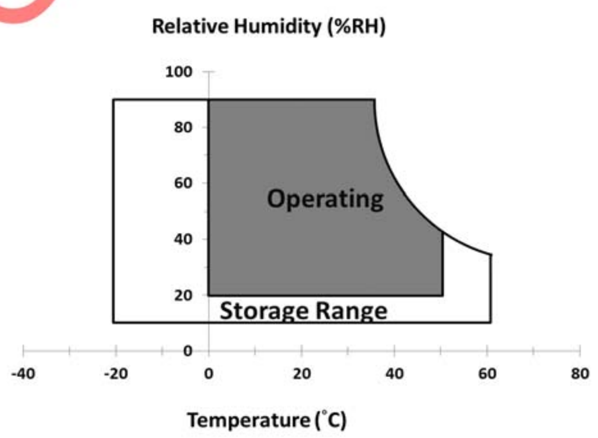


Fig. 2.1 Operating and storage environment

2.3 Package Storage

When storing open cell as spares for a long time, please follow the precaution instructions:

(1) Do not store the open cell in high temperature and high humidity for a long time. It is highly recommended to store the module with temperature from 20ºC to 30ºC in normal humidity (50 ± 10%RH) with shipping package.

(2) The open cell should be keep within one month shelf life.

3. ELECTRICAL SPECIFICATIONS

3.1 Electrical Characteristics

3.1.1 Power Consumption (Ta = 25 ± 2 ºC)

Parameter	Symbol	Value			Unit	Note
		Min.	Typ.	Max.		
Analog power supply	VAA	13.9	14.2	14.5	V	
Analog power supply	HVAA	L_H+0.2	-	U_L-0.2	V	
Gamma Voltage	U_H	13.39	13.54	13.69	V	
	U_L	6.84	6.99	7.14	V	
	L_H	6.34	6.49	6.64	V	
	L_L	0.91	1.06	1.21	V	
Digital power supply for source driver	VCCA1.8V	1.62	1.8	1.98	V	
Digital power supply for source driver	VCCA1.9V	1.62	1.9	1.98	V	
Power supply for Gate on output	VGH	29.20	30.00	30.80	V	25℃
Power supply for Gate off output	VGL	-12.24	-11.94	-11.64	V	
Power supply for Common electrode	VCOM	4.67	-	6.72	V	
Digital power supply	VDD33	3.0	3.3	3.6	V	

3.1.2 USI-T Characteristic

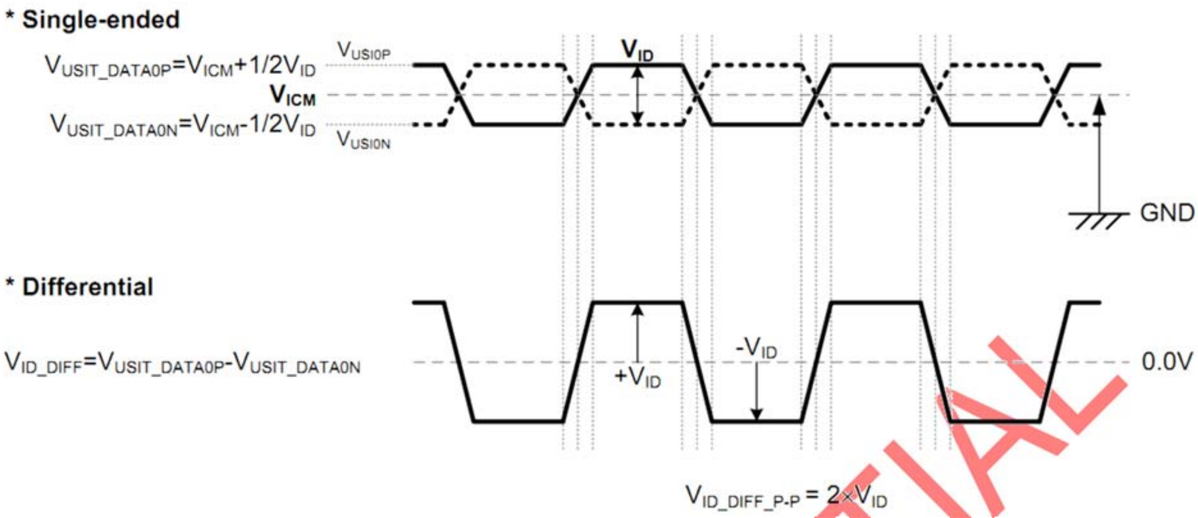
Parameter	Symbol	Condition	Value			Unit	Note
			Min.	Typ.	Max.		
Input offset voltage	V_{ICM}	VDD1A = 1.62 V to 1.98 V	0.3	0.45	0.6	V	
Differential input data voltage	V_{ID}		67.5	-	600	mV	
Differential input data peak-to-peak voltage	$V_{ID\_DIFF\_P-P}$		135	-	1200	mV	
Internal termination resistor	R_T	TC(5)	Typ-20%	100	Typ+20%	Ω	

Note:

(1) VICM voltage is the common mode voltage of the differential input data.

(2) The min/max level of VID includes all the AC fluctuation upon DC level.

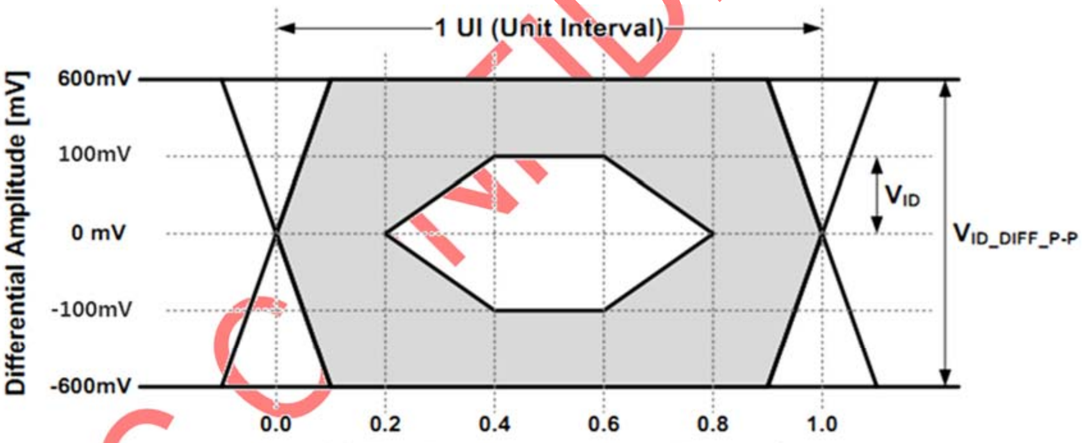
(3) The min level of VID means internal min value of USI-T data and the max level of VID means external max value of the USI-T data in eye diagram, respectively.



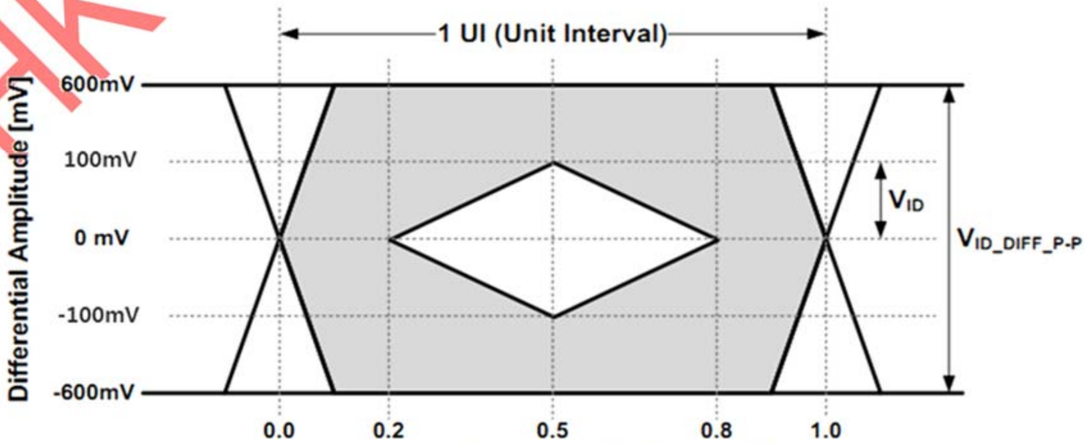
(4) The conditions of measurement for eye diagram are to remove the driver IC and to attach 100Ω termination resistor on the source PCB (Figure 3.1 (a)), and to bond a Driver IC on the source PCB (Figure 3.1 (b)), respectively.

(5) RT is an internal termination resistor (On-Die Termination). Condition is TC,typ (52.5°C).

3.1.3 USI-T Eye Diagram

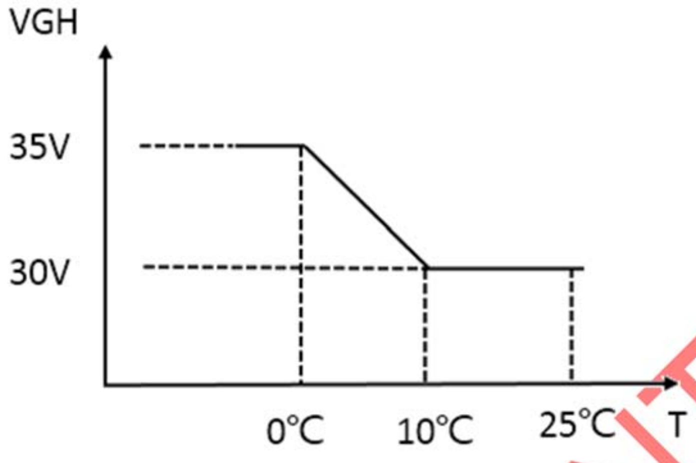


3.1(a) Eye Diagram with a Driver IC



3.1(b) Eye Diagram with a Driver IC

3.1.4 VGH VS. Temperature Curve



3.2 Interface Connections

3.2.1 Block Diagram of Interface

TFT LCD Panel

3.2.2 Interface Pin Assignment For XL board

CN1: COOKR096A (FOOSUNG) or equivalent

Pin No.	Symbol	Description	Note
1	AVDD	Analog power supply	
2	AVDD	Analog power supply	
3	AVDD	Analog power supply	
4	AVDD	Analog power supply	
5	AVDD	Analog power supply	
6	AVDD	Analog power supply	
7	AVDD	Analog power supply	
8	AVDD	Analog power supply	
9	U_H	Gamma Voltage	
10	U_L	Gamma Voltage	
11	HAVDD	Analog power supply	
12	HAVDD	Analog power supply	
13	L_H	Gamma Voltage	
14	L_L	Gamma Voltage	
15	FB_1	Feedback signal	
16	GND	Ground	
17	SFC1	Shared Forward Channel 1	
18	GND	Ground	
19	CH13-	USI-T CH13N	
20	CH13+	USI-T CH13P	
21	GND	Ground	
22	CH12-	USI-T CH12N	
23	CH12+	USI-T CH12P	
24	GND	Ground	
25	CH11-	USI-T CH11N	
26	CH11+	USI-T CH11P	
27	GND	Ground	
28	CH10-	USI-T CH10N	
29	CH10+	USI-T CH10P	
30	GND	Ground	
31	CH9-	USI-T CH9N	
32	CH9+	USI-T CH9P	
33	GND	Ground	

34	CH8-	USI-T CH8N	
35	CH8+	USI-T CH8P	
36	GND	Ground	
37	CH7-	USI-T CH7N	
38	CH7+	USI-T CH7P	
39	GND	Ground	
40	CH6-	USI-T CH6N	
41	CH6+	USI-T CH6P	
42	GND	Ground	
43	CH5-	USI-T CH5N	
44	CH5+	USI-T CH5P	
45	GND	Ground	
46	CH4-	USI-T CH4N	
47	CH4+	USI-T CH4P	
48	GND	Ground	
49	CH3-	USI-T CH3N	
50	CH3+	USI-T CH3P	
51	GND	Ground	
52	CH2-	USI-T CH2N	
53	CH2+	USI-T CH2P	
54	GND	Ground	
55	SRF	Source Driver Ready Feedback	
56	NC	No Connection	
57	VCCB_1.8V	Digital power supply for source driver	
58	VCCB_1.8V	Digital power supply for source driver	
59	VCCA_1.9V	Digital power supply for source driver	
60	VCCA_1.9V	Digital power supply for source driver	
61	HOLD	Demura Flash Hold input	
62	SCK	Demura Flash Serial Clock input	
63	CS	Demura Flash Chip Select input	
64	DI	Demura Flash data input/output	
65	DO	Demura Flash data input/output	
66	WP	Demura Flash Write Protection	
67	VDD3.3	Digital power supply	
68	NC	No Connection	
69	VSS(TFT)	Power supply for Gate off output	

70	VOFF(GOA)	Power supply for Gate off output	
71	VOFF(GOA)	Power supply for Gate off output	
72	LC2	Clock Signal for GDL（100 Frame inversion）	
73	LC1	Clock Signal for GDL（100 Frame inversion）	
74	NC	No Connection	
75	NC	No Connection	
76	NC	No Connection	
77	NC	No Connection	
78	CK8	Clock Signal for GDL	
79	CK7	Clock Signal for GDL	
80	CK6	Clock Signal for GDL	
81	CK5	Clock Signal for GDL	
82	CK4	Clock Signal for GDL	
83	CK3	Clock Signal for GDL	
84	CK2	Clock Signal for GDL	
85	CK1	Clock Signal for GDL	
86	STV	Start pulse for GDL	
87	NC	No Connection	
88	VCOM3	Power supply for Common electrode	
89	VCOM2	Power supply for Common electrode	
90	VCOM2	Power supply for Common electrode	
91	VCOM1(DVR)	Power supply for Common electrode	
92	VCOM1(DVR)	Power supply for Common electrode	
93	NC	No Connection	
94	NC	No Connection	
95	GND	Ground	
96	FB_1	Feedback signal	

(1) The direction of pin assignment is shown as below:

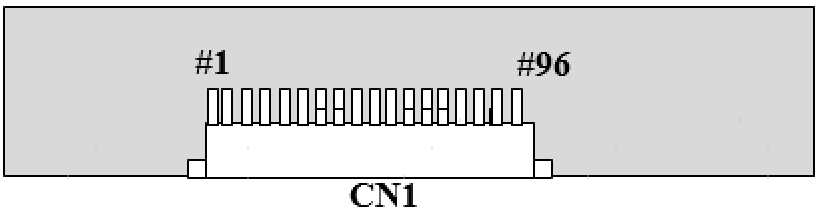


Fig. 3.2 Connector direction sketch map

3.3 USI-T Timing Spec

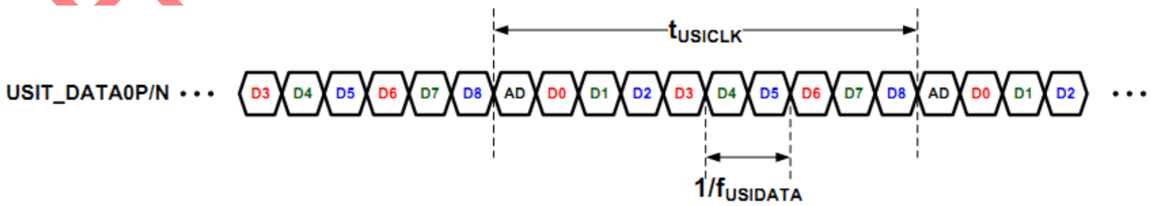
Timing Table

Item	Symbol	Min.	Typ.	Max.	Unit	Note
USI-T data pulse width	tUI	0.333	-	0.833	ns	(1),(3)
USI-T clock period	tUSICLK	3.33	-	8.33	ns	(2)
USI-T data frequency	fUSIDATA	600	-	1500	MHz	(2)
Reference clock phase locking time	tLOCK	4500	-	-	tUSICLK	(4)
Minimum line blank period	tLB	42	-	-	tUSICLK	(5)
CLK1 start time prior to the next line data	tCLK1	1	-	-	tUSICLK	(5)
Power-on slope	t0	-	-	5	ms	(4)
Stand-by time between power-on and 1st data transfer	t1	1	-	-	ms	(4)
Training pattern offset time before SFC=L	t2-1	5	-	-	tUSICLK	(4)
Training pattern offset time after SFC=L	t2-2	5	-	-	tUSICLK	(4)
USI-T SSCG	MR (Modulation Ratio)	- 2	-	+2	%	
USI-T SSCG	MF (Modulation Frequency)	30	-	100	KHz	

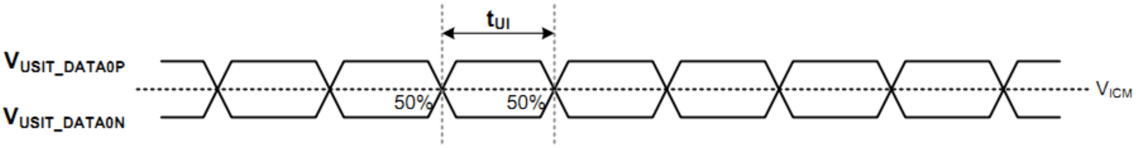
Note:

(1) 1T = 10UI = 1 tUSICLK..

(2) tUSICLK and fUSIDATA .

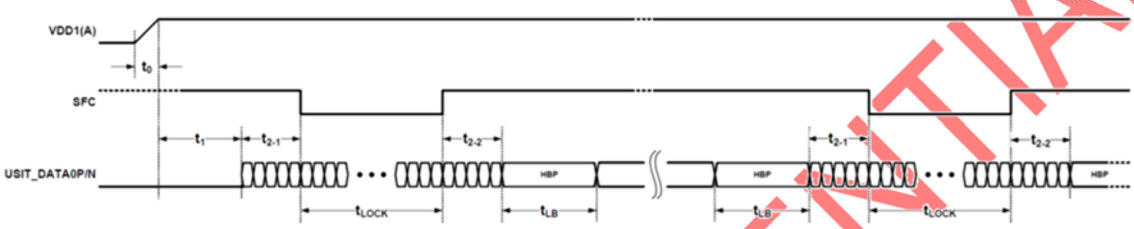


（3）AC timing parameters, tUI.

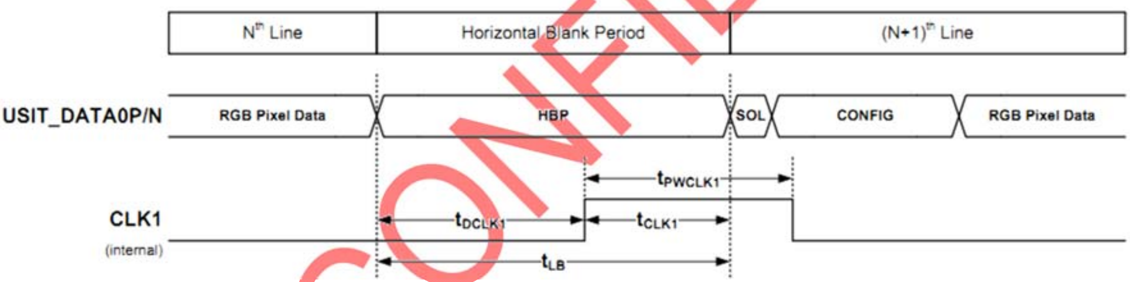


（4）AC timing parameters, t0, t1, t2-1, t2-2, tLB and tLOCK.

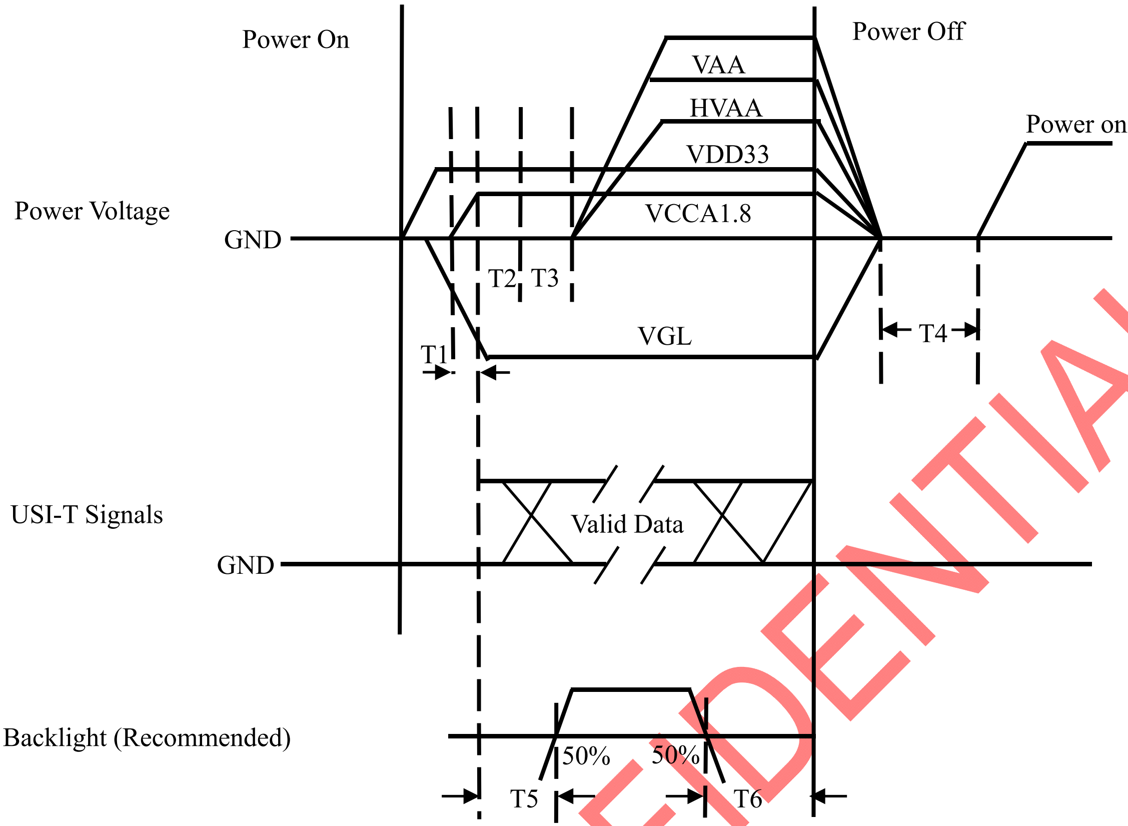
t2-1, t2-2 timing is included in the tSTART and tEND, and in this period, USIT_DATA0P/N is the clock training pattern.



（5）AC timing parameter, tLB , tCLK1



3.4 Power On/Off Sequence



Parameter	Values			Unit
	Min.	Typ.	Max.	
T1	0	-	5	ms
T2	0.04	-	40	ms
T3	8	-	-	ms
T4	1000	-	-	ms
T5	500	-	-	ms
T6	100	-	-	ms

Note:

1, T1 is VCCA1.8V/1.9V settling time

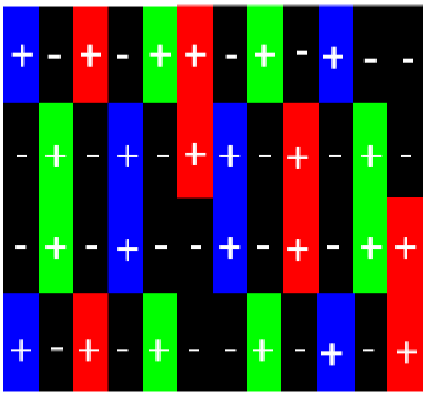
2, T2 is USI-T initialization period

3, T3 is Delay time from the end of USI-T initialization period to the start of VAA

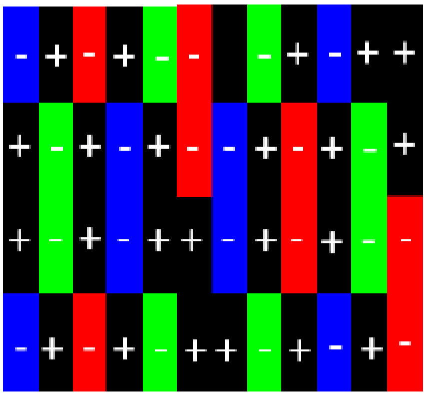
3.5 Flicker Adjustment

The Flicker adjustment pattern suggested as below.

Frame N



Frame N+1



3.3 Bright sub-pixel=G127(50% grayscale); dark sub-pixel=G0（0%grayscale）

3.6 Driver IC ESD Spec

If the LCD module is designed with the Plastic Bezel, we suggest ESD protection solutions should be applied to avoid IC damaged, as shown in Fig.3.5

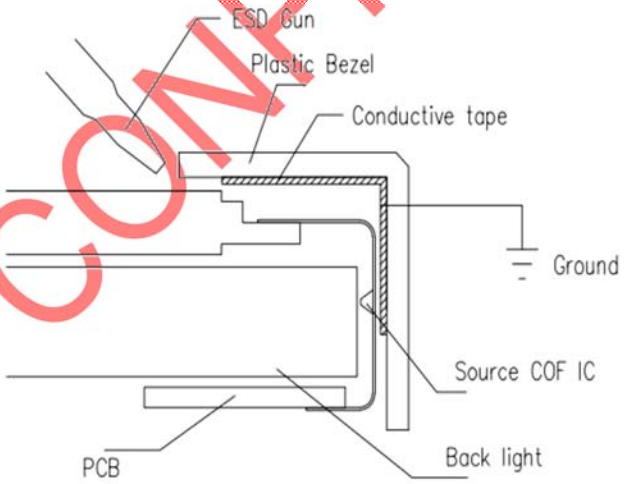


Fig.3.5 Source COF IC ESD Protection

4. OPTICAL CHARACTERISTICS

4.1 Measurement Conditions

The table below is the test condition of optical measurement.

Item	Symbol	Value	Unit
Ambient Temperature	T_A	25±2	ºC
Ambient Humidity	H_A	50±10	% RH
Supply Voltage	V_{CC}	12	V
Driving Signal	Refer to the typical value in Chapter 3: Electrical Specification		
Vertical Refresh Rate	F_v	60	Hz
Light source	HKC module White LED Backlight Module/ Film structure		
Warm up time	Twarm	>30 min	min
Dark room	ED	1lux>	lux

To avoid abrupt temperature change during optical measurement, the measurement should be executed in a stable, windless, in dark room after lighting the light source.

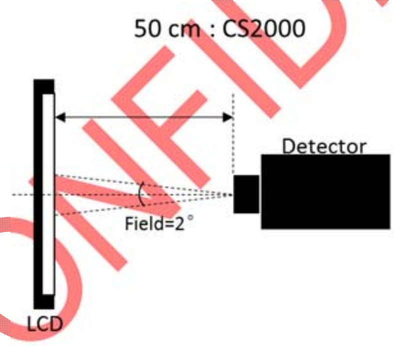


Fig 4.1 Measurement equipment.

4. 2 Optical Specifications

The relative measurement methods of optical characteristics are shown in 4.2. The following items should be measured under the test conditions described in 4.1 and stable environment shown in 4.1.

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Color Chromaticity (CIE1931)	Red	Rx	$\theta_x=0°,\theta_y=0°$ Viewing Angle at Normal Direction at center point of panel, Light source is HKC BLU	Typ. - 0.03	(0.636)	Typ. + 0.03	-	(1)
		Ry			(0.330)			
	Green	Gx			(0.309)			
		Gy			(0.614)			
	Blue	Bx			(0.155)			
		By			(0.045)			
	White	Wx			(0.278)			
		Wy			(0.297)			
Color Gamut		CG		-	72	-	%	(2)
Transmittance		T%		-	5.0	-	%	(3)
Contrast Ratio		CR	$\theta_x=0°,\theta_y=0°$ With HKC BLU	4000	5000	-	-	(4)
Response Time		T_g		-	9.5	19	ms	(5)
Viewing Angle	Horizontal	θ_x+	CR≧10 $\theta_x=0°,\theta_y=0°$	-	89	-	Deg.	(6)
		θ_x-		-	89	-		
	Vertical	θ_y+		-	89	-		
		θ_y-		-	89	-		
Gamma		γ		-	2.2	-	-	(8)

Note:

Light source here is the backlight of HKC Module, and film structure is two diffuser sheets.

(1) Each chromaticity coordinates (x, y) are measured in CIE1931 color space when full-screen displaying (Red, Green, Blue, White) and light source is defined by HKC Backlight, measurements shall be made at the center of the panel, and setup of measurement is shown in Fig 4.1.

(2) The color gamut is defined as the fraction in percent of the area of the triangle bounded by R, G, B coordinates and the area is defined by NTSC 1931 color standard in the CIE color space. Chromaticity coordinates are measured by CS2000 and the standard setup of measurement is shown in Fig 4.1.

(3) Definition of Transmittance (T%):

The transmittance is measured with full white pattern (L_{max}) at the center of the LCD panel.

$$\text{Transmittance (T\%)} = \frac{\text{Luminance of LCD module}}{\text{Luminance of backlight}}$$

(4) Definition of Contrast Ratio (CR):

The contrast ratio can be calculated by the following expression,

Contrast Ratio (CR): $CR = \frac{CR_w}{CR_D}$

CR_W : Luminance of LCD module with full screen white pattern (255,255, 255) at center point.

CR_D : Luminance of LCD module with full screen Dark pattern (0, 0, 0) at center point.

Where the measure point of to the Contrast Ratio is the center of the panel

(5) Definition of Response time (Tg):

Average of gray to gray response time (T_g) means the average switching time of luminance ratios among 0%,25%,50%,75%,and 100% to each other and is optimized on frame rate =60Hz.

Measured Response time		To				
		0%	25%	50%	75%	100%
From	0%		$T_{0\%to25\%}$	$T_{0\% \text{ to } 50\%}$	$T_{0\% \text{ to } 75\%}$	$T_{0\% \text{ to } 100\%}$
	25%	$T_{25\% \text{ to } 0\%}$		$T_{25\% \text{ to } 50\%}$	$T_{25\% \text{ to } 75\%}$	$T_{25\% \text{ to } 100\%}$
	50%	$T_{50\% \text{ to } 0\%}$	$T_{50\% \text{ to } 25\%}$		$T_{50\% \text{ to } 75\%}$	$T_{50\% \text{ to } 100\%}$
	75%	$T_{75\% \text{ to } 0\%}$	$T_{75\% \text{ to } 25\%}$	$T_{75\% \text{ to } 50\%}$		$T_{75\% \text{ to } 100\%}$
	100%	$T_{100\% \text{ to } 0\%}$	$T_{100\% \text{ to } 0\%}$	$T_{100\% \text{ to } 50\%}$	$T_{100\% \text{ to } 75\%}$	

Table 4.2 Switching time of luminance ratios matrix

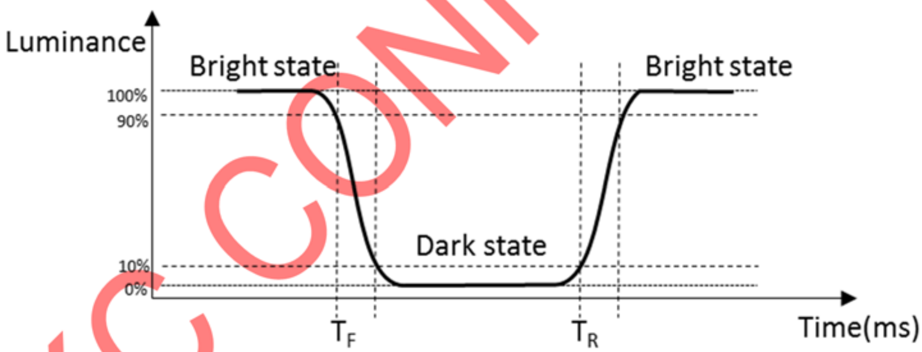


Fig 4.3 The definition of TR and TF

Measured response time is determined by 10% to 90% brightness difference of rising (T_R) or falling (T_F) time.

(6) Definition of Viewing angle:

As Note (4) the static contrast ratio definition, the viewing angles are defined at the angle that the contrast ratio is larger than 10 at four directions relative to the perpendicular direction of the HKC's module (two vertical angles: up θ_y+ and down θ_y-; and two horizontal angles: right θ_x+ and left θ_x-). The standard setup of measurement is shown in Fig 4.1 & 4.4

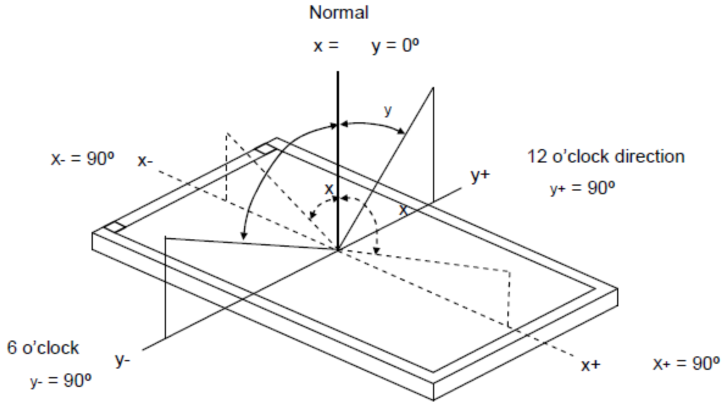


Fig 4.4 Definition of Viewing angle

(7) Definition of Crosstalk (2D)

Crosstalk of one area of the LCD surface by another shall be measured by comparing the luminance (A), with all display pixels set to a gray level, to the luminance (B) of that same area when any adjacent area is driven full white pattern which shown in Fig. 4.5. The gray level of background is set to 25% full gray pattern.

$\text{Crosstalk}(\%) = \text{Max.}\left(\frac{|L_B(X)-L_A(X)|}{L_A(X)} \times 100\%\right)$, Where the X is point 1 to 4 shown in Fig.4.5

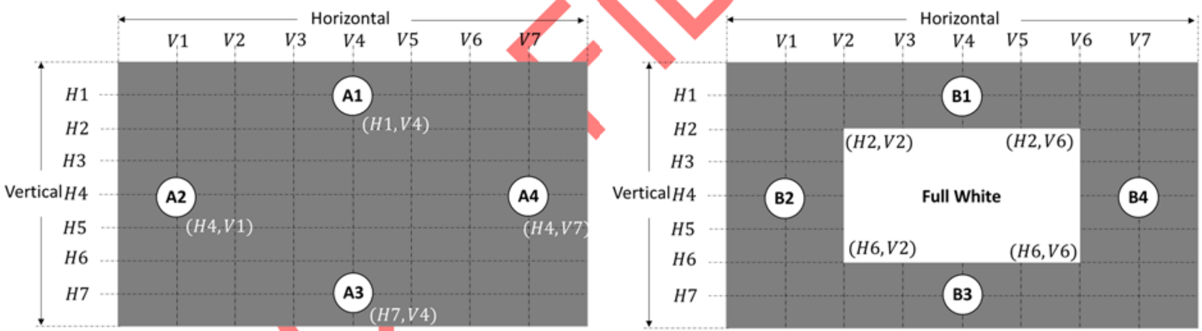


Fig 4.5 Definition of Crosstalk (2D)

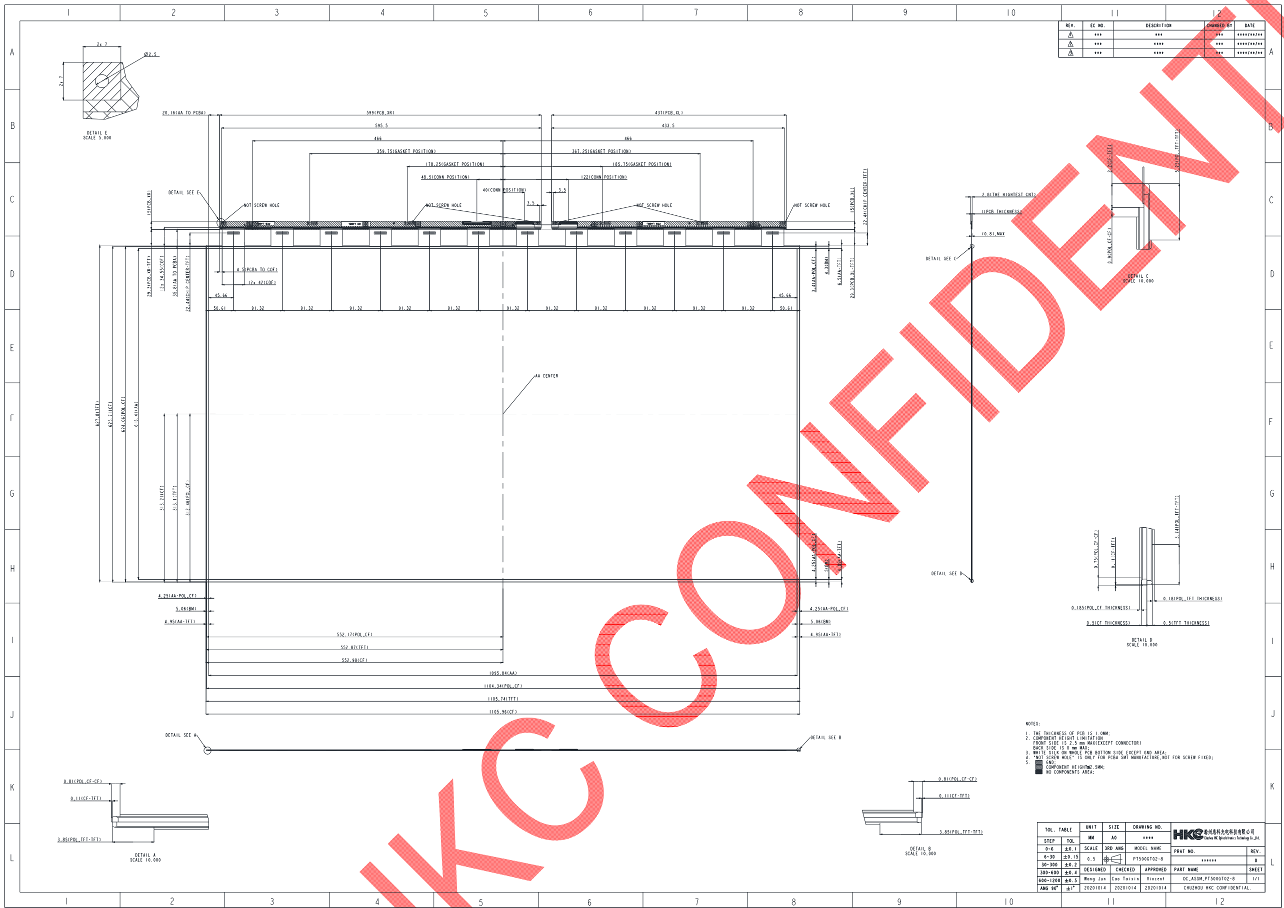
(8) The gamma scale is calculated with below equation

Gamma Scale = Each center gamma value of gray level (G.L) between 50 and 128.

$$\text{local gamma(G. L.)} = Log_{\frac{G.L.}{255}}\left(\frac{Luminance(G.L.)}{Luminance(L255)}\right)$$

5. MECHANICAL CHARACTERISTICS

5.1 Mechanical Specification

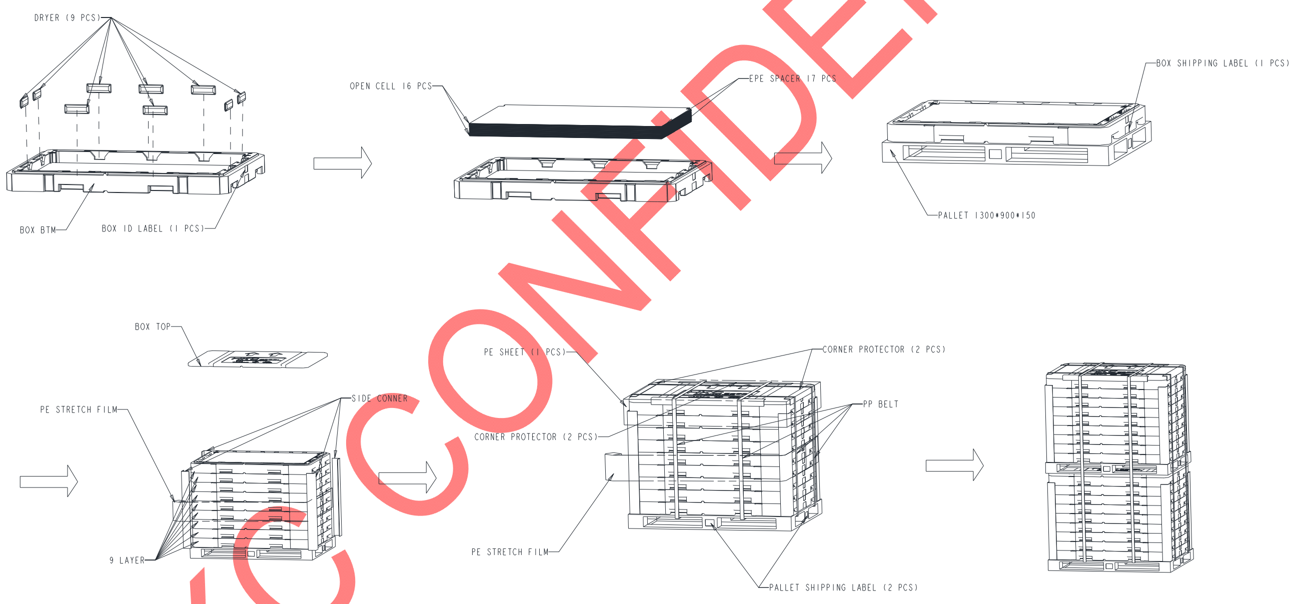


5.2 Packing

5.2.1 Packing Specifications

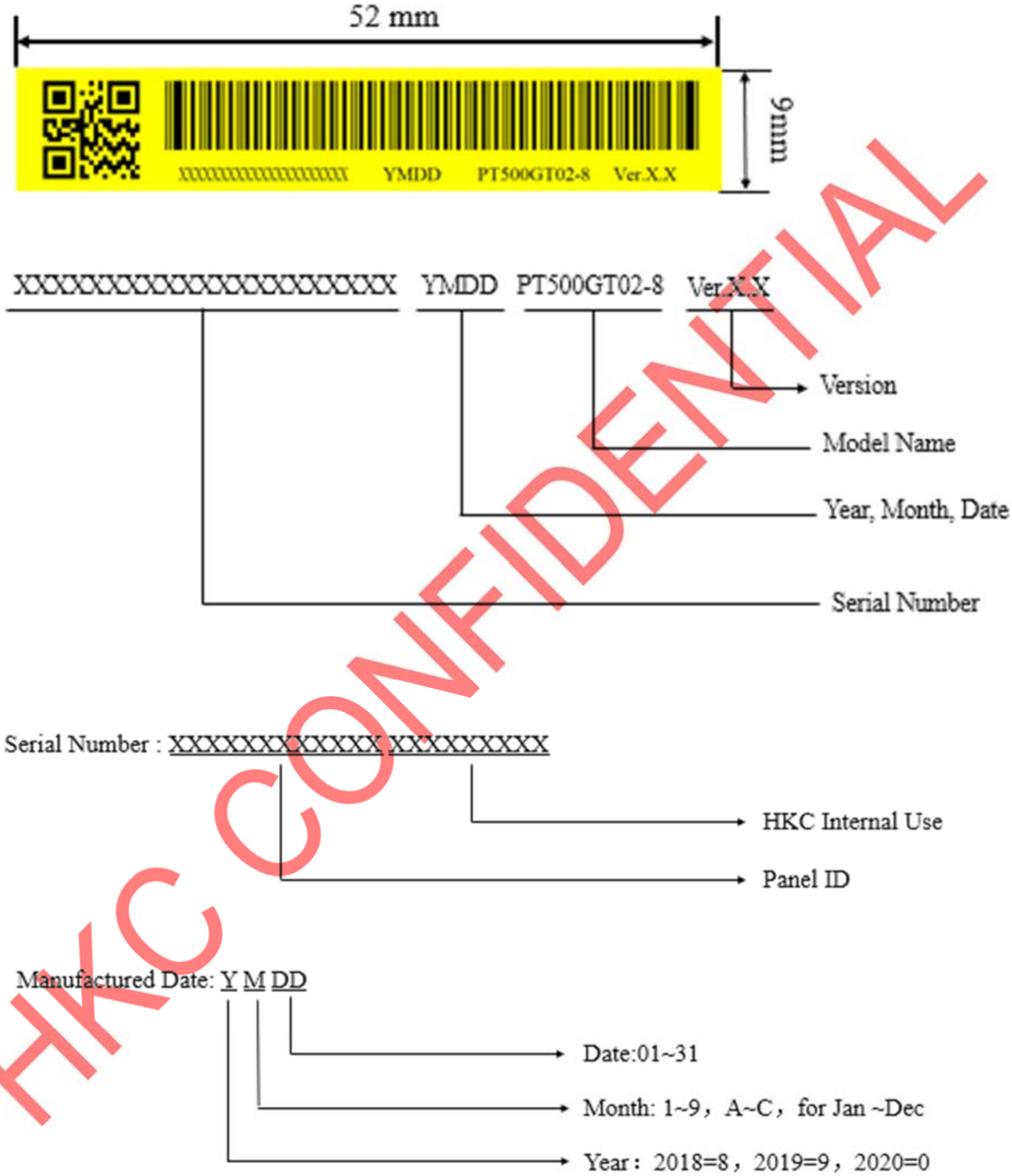
Item	Specification		
	Quantity	**Dimension(mm)**	**Weight(kg)**
Packing Box	16 pcs/box	1275(L) x 840(W) x 107.5(H)	Net Weight: 35.2kg Gross Weight: 39kg
Pallet	1	1300(L) x 900(W) x 150 (H)	Net Weight: 17Kg
Stack Layer	9		
Boxes per Pallet	9		
Pallet after Packing	144pcs/pallet	1300(L) x 900(W) x 1050 (H)	Gross Weight: 370kg

5.2.2 Packing material specification



6. DEFINITION OF LABELS

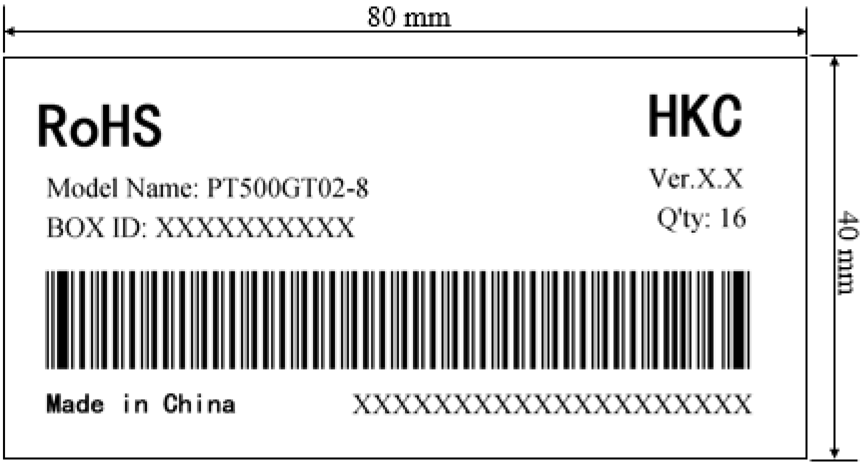
6.1 Open Cell Label

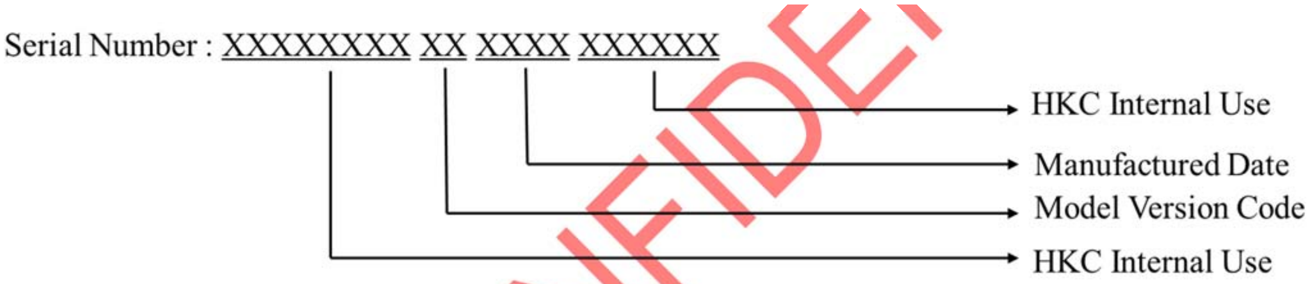


Model Name：PT500GT02-8

Model Version Code：Ver.X.X.，for example：0.0,0.1…，1.0,1.1…，2.0,2.1……

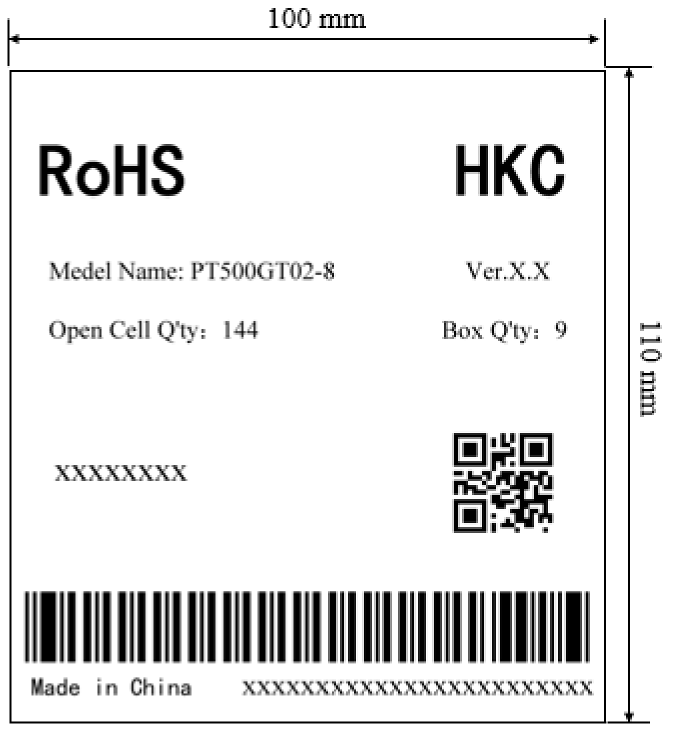
6.2 Carton Label

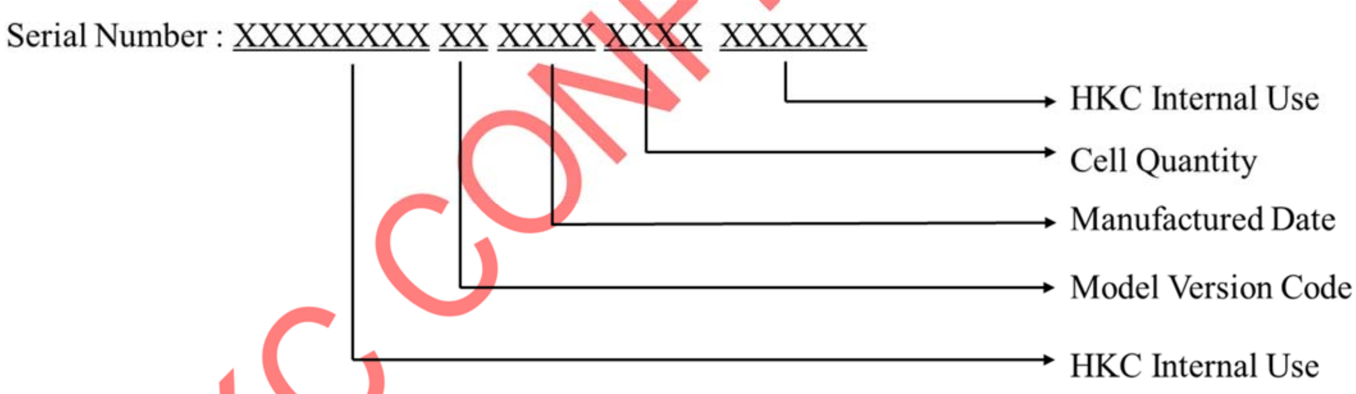




Model Version Code：Ver.X.X.，for example：0.0,0.1…，1.0,1.1…，2.0,2.1……

6.3 Pallet Label





7. PRECAUTION

Please pay attention to the followings when a TFT-LCD cell is used, handled and mounted.

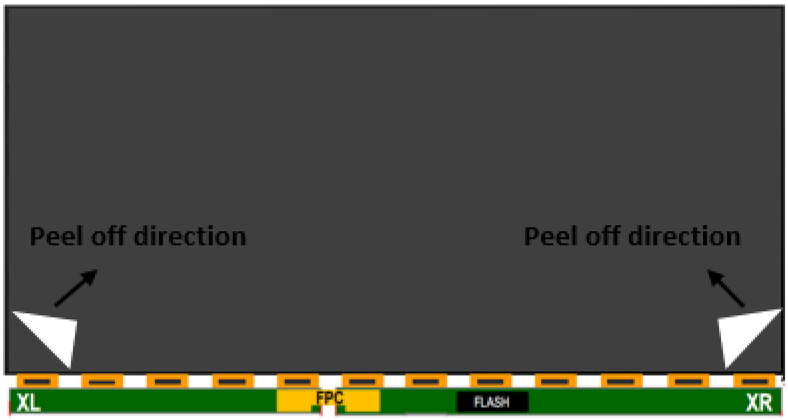
7.1 Unpacking

Should use immediately after unpacking TFT -LCD cell to prevent the terminal corrosion.

Protection film for a polarizer on a TFT open cell should be slowly peeled off so that the electrostatic charge can be minimized.

Source PCB should be connected to the ground when peel off the protection film.

The protection film should not be contacted to the driver during peeling off.



7.2 Storage test

Any attachment on polarizer of open-cell,such as tape,is forbidden and not recommend,especially under the high temperature and high humidity environment.

8. GP REQUIREMENT

a) RoHS, Directive 2011/65/EU of the European Parliament and council of 1 July 2011

b) RoHS, Directive (EU) 2015/863 of the European Parliament and council of 31 March 2015

c) PPW