INNOLUX DISPLAY CORPORATION

LCD MODULE

SPECIFICATION

Customer: _____

Model Name: AT035TN02
SPEC NO: AT035-02-TT-06
Date: Sept.23, 2004
Version: 6.0

☐ Preliminary Specification

■ Final Specification

For Customer's Acceptance

Approved by	Comment

Presented by	Reviewed by	Prepare by
	張正昌 10/8 謝慶東 10/8 劉如晏 10/8 吳錫堯 10/11 徐志揚 10/8 [illegible] 10/8	

Innolux Display Corporation,
2F, No.16, Ke-Tung Road 3, Science-Based Industrial Park, Chu-Nan 350, Mao-Li County, Taiwan
Tel: 886-37-586000 Fax: 886-37-586060

Revisions Section

Revision	Page	Description	Date
1		Initial Release	03/31 04
2	12	Define of viewing angle range & direction	05/31 04
3	17	Add Packing Label sample	06/14 04
4	14	Update Reliability test Items	06/24 04
5	16	Add Handling Precautions	07/05 04
6	15	Update Reliability test Items	09/23 04

Contents:

1. General specifications

No.	Item	Specification	Remark
1	LCD size	3.5 inch	
2	Driver element	a-Si TFT active matrix	
3	Resolution	160 X RGB X 234	
4	Display mode	Normally white, Transmissive with Backlight	
5	Dot pitch	0.15(W) X 0.216(H) mm	
6	Active area	72(W) X 50.544(H) mm	
7	Module size	82.8(W)X 60(H)X6.0(D) mm	Note 1
8	Color configuration	R.G.B delta	
9	Interface	Analog	
10	Weight	37g±3g	
11	Light source	CCFL Type	

Note 1: Refer to Mechanical drawing.

2. Pin assignment

Pin No.	Symbol	IO	Function	Remark
1	STHL	I/O	Start pulse for horizontal scan line	Note 1
2	OEH	I	Output enable control for data driver	
3	Q1H	I	Analog signal rotate input	
4	CPH1	I	Sampling and shifting clock pulse for data driver	
5	CPH2	I	Sampling and shifting clock pulse for data driver	
6	CPH3	I	Sampling and shifting clock pulse for data driver	
7	GND	P	Ground	
8	VB	I	Alternated video signal (Blue)	
9	VG	I	Alternated video signal (Green)	
10	VR	I	Alternated video signal (Red)	
11	NC	-	This pin should be electrical opened during operation	
12	L/R	I	LEFT/RIGHT scan control input	Note 1, 2
13	STHR	I/O	Start pulse for horizontal scan line	Note 1
14	AV_{DD}	P	Supply voltage for analog circuit	
15	VCOM	I	Common electrode driving signal	
16	V_{GH}	P	Positive power for scan driver	
17	DV_{DD}	P	Supply voltage of logic control circuit for driver	
18	STVL	I/O	Start pulse for vertical scan frame	Note 1
19	OEV	I	Output enable control for scan driver	
20	CKV	I	Shift clock input for scan driver	
21	U/D	I	UP/DOWN scan control input	Note 1, 2
22	STVR	I/O	Start pulse for vertical scan frame	Note 1
23	NC	-	This pin should be electrical opened during operation	
24	V_{GL}	P	Negative power for scan driver	

Note:

1. Selection of scanning mode (please refer to the following table)

Setting of scan control input		IN/OUT state for start pulse				Scanning direction
U/D	L/R	STVR	STVL	STHR	STHL	
GND	DV_{DD}	O	I	O	I	Up to Down, Left to Right
DV_{DD}	GND	I	O	I	O	Down to Up, Right to Left
GND	GND	O	I	I	O	Up to Down, Right to Left
DV_{DD}	DV_{DD}	I	O	O	I	Down to Up, Left to Right

I: input, O: output

2. Definition of Scanning Direction.
   Refer to figure as below:

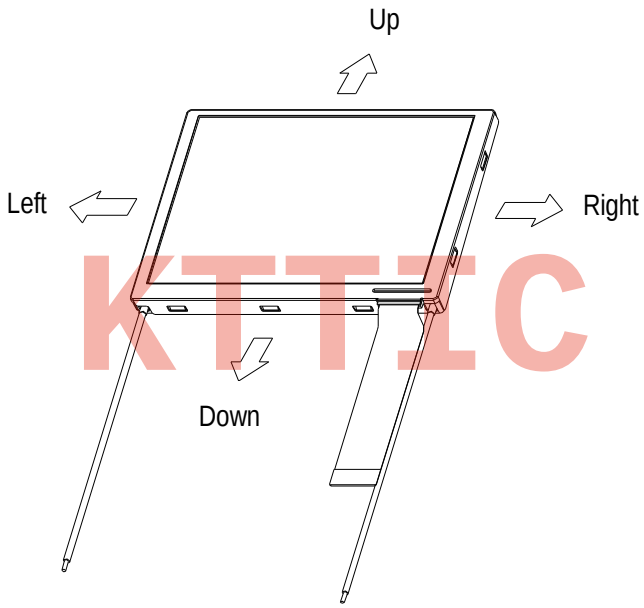


Fig. 2-1 Definition of Scanning Direction

3. Electrical specifications

3.1. Absolute maximum ratings

Item	Symbol	Condition	Values		Unit	Remark
			Min.	Max.		
Power voltage	DV_{DD}	GND=0	-0.3	7	V	
	AV_{DD}	AV_{SS}=0	-0.3	7	V	
	V_{GH}	GND=0	-0.3	18	V	
	V_{GL}		-15	0.3	V	
	V_{GH} -V_{GL}	-	-	33	V	
Input signal voltage	Vi	-	-0.3	AV_{DD}+0.3	V	Note 1
	VI	-	-0.3	DV_{DD}+0.3	V	Note 2
	VCOM	-	-2.9	5.2	V	
Operation Temperature	Top	-	0	60	℃	Ambient
Storage Temperature	Tst	-	-25	80	℃	Ambient

Note:
1. VR, VG, VB.
2. STHL, STHR, OEH, L/R, CPH1~CPH3, STVR, STVL, OEV, CKV, U/D, Q1H

3.2. Electrical characteristics

3.2.1. Typical operating conditions (GND =0V)

Item		Symbol	Values			Unit	Remark
			Min.	Typ.	Max.		
Power supply		DV_{DD}	3	5	5.2	V	
		AV_{DD}	4.8	5	5.2	V	
		V_{GH}	14.3	15	15.7	V	
		V_{GLAC}	3.5	5	6.5	V	AC component of V_{GL} Note1
		V_{GL-H}	-10.5	-10	-9.5	V	High level of V_{GL}
Video signal amplitude (VR, VG, VB)		V_{iAM}	0.4	-	AV_{DD}-0.4	V	Note2
		V_{iAC}	-	3	-	V	AC component
		V_{iDC}	-	AV_{DD}/2	-	V	DC component
VCOM		V_{CAC}	3.5	5	6.5	V	Note3
		V_{CDC}	1.0	1.25	1.5	V	DC component
Input signal Voltage	H level	V_{IH}	0.8 DV_{DD}	-	DV_{DD}	V	Note4
	L level	V_{IL}	0	-	0.2 DV_{DD}	V	

Note:

1. The same phase and amplitude with common electrode driving signal (VCOM)
2. Refer to Fig.3-3(a).
3. The brightness of LCD panel could be changed by adjusting the AC component of VCOM.
4. SRHL, STHR, OEH, L/R, CPH1~CPH3, STVR, STVL, OEV, CKV, U/D, Q1H
5. Be sure to apply GND, DV_{DD}, and V_{GL}, to the LCD first, and then apply V_{GH}
6. V_{CDC} should be provided an optimized voltage, so as to minimize flicker or maximize contrast every each module.

3.2.2. Current consumption (GND =0V)

Parameter	Symbol	Condition	Values			Unit	Remark
			Min.	Typ.	Max.		
Current for Driver	I_{GH}	V_{GH}=15V	-	100	300	uA	V_{GH}
	I_{GL}	V_{GL-H}=-10V	-	-100	-300	uA	V_{GL}
	I_{DD}	DV_{DD}=5V	-	1.5	4	mA	DV_{DD}
	I_{AVDD}	AV_{DD}=5V	-	5	10	mA	AV_{DD}

3.2.3. Backlight driving conditions

Parameter	Symbol	Values			Unit	Remark
		Min.	Typ.	Max.		
Lamp voltage	V_L	-	260	290	Vrms	Note 3
Lamp current	I_L	2.5	2.9	3.3	mArms	
Frequency	F_L	55	60	65	kHz	Note 3,4
Lamp starting voltage	V_S	-	-	550	Vrms	Note 1,3,5
		-	-	850	Vrms	Note 2,3,5

Note:

1. Ta = 25℃
2. Ta = 0℃
3. Reference value, correct value is subject to final backlight specification which will be decided in the future.
4. The lamp frequency should be selected as different as possible from display horizontal Synchronous signal to avoid interference.
5. For starting the backlight unit, the output voltage of DC/AC's transformer should be larger than the maximum lamp starting voltage.

3.3. AC timing

3.3.1. Timing conditions (sequential mode)

Item	Symbol	Values			Unit	Remark
		Min.	Typ.	Max.		
Rising time	t_r	-	-	10	ns	Note 1
Falling time	t_f	-	-	10	ns	Note 1
High and low level pulse width	t_{CPH}	299	312	342	ns	CPH1~CPH3
CPH pulse duty	t_{CWH}	40	50	60	%	CPH1~CPH3
CPH pulse delay	t_{C12} t_{C23} t_{C31}	70	$t_{CPH}/3$	$t_{CPH}/2$	ns	CPH1~CPH3
STH setup time	t_{SUH}	35	-	-	ns	STHR, STHL
STH hold time	t_{HDH}	35	-	-	ns	STHR, STHL
STH pulse width	t_{STH}	-	1	-	t_{CPH}	STHR, STHL
STH period	t_H	61.5	63.5	65.5	μs	STHR, STHL
OEH pulse width	t_{OEH}	-	3	-	t_{CPH}	
Sample and hold disable time	t_{DIS1}	-	8.42	--	μs	
OEV pulse width	t_{OEV}	-	13		t_{CPH}	
CKV pulse width	t_{CKV}	16	20	40	t_{CPH}	
Clean enable time	t_{DIS2}	-	10	--	t_{CPH}	
Horizontal display start	t_{SH}	-	0	-	$t_{CPH}/3$	
Horizontal display timing range	t_{DH}	-	480	-	$t_{CPH}/3$	
STV setup time	t_{SUV}	400	-	-	ns	STVL, STVR
STV hold time	t_{HDV}	400	-	-	ns	STVL, STVR
STV pulse width	t_{STV}	-	-	1	t_H	STVL, STVR
Horizontal lines per field	t_V	256	262	268	t_H	Note 2
Vertical display start	t_{SV}		3	-	t_H	
Vertical display timing range	t_{DV}		234	-	t_H	Note 3
VCOM rising time	t_{rCOM}		-	5	μs	
VCOM falling time	t_{fCOM}		-	5	μs	
VCOM delay time	t_{DCOM}		-	3	μs	
RGB delay time	t_{DRGB}		-	1	μs	

Note:

1. For all of the logic signals
2. Please don't use odd horizontal lines to drive LCD panel for both odd and even field simultaneously.
3. Vertical total display lines.

3.3.2. Timing diagram

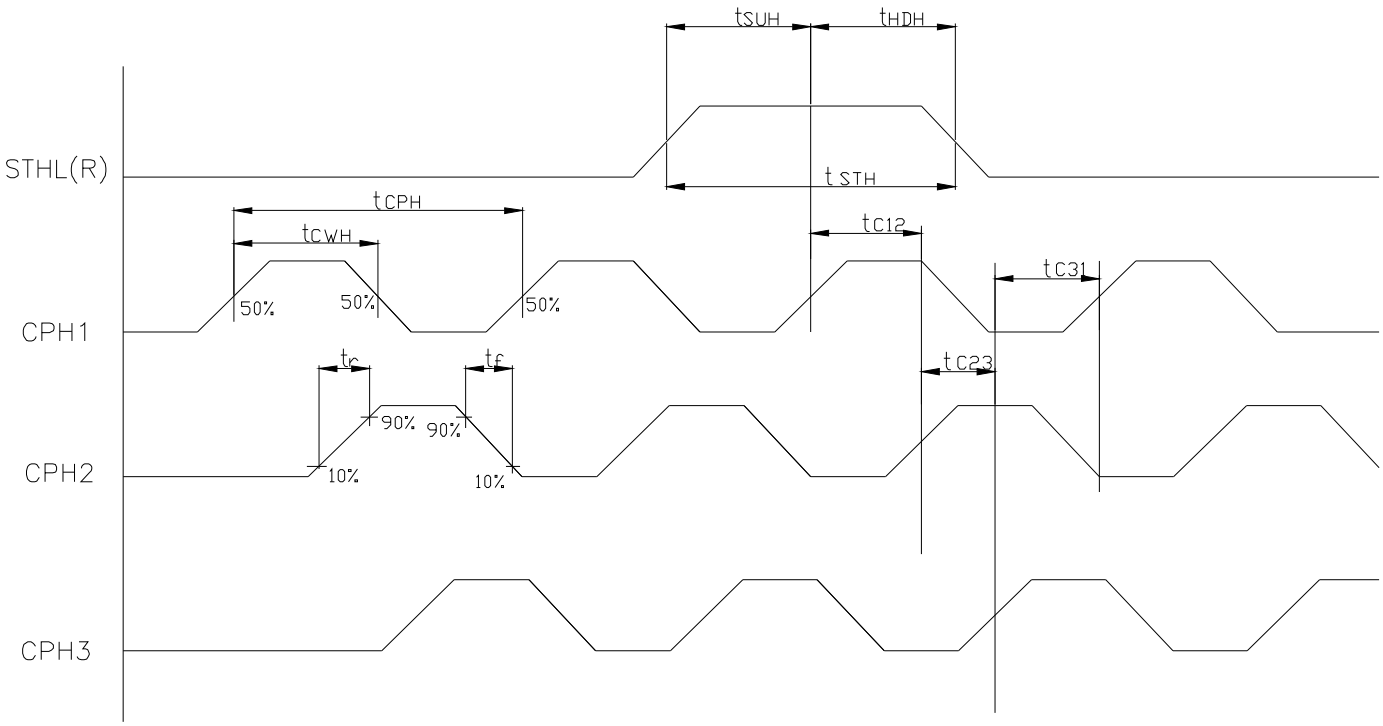


Fig.3-1 Sampling clock timing

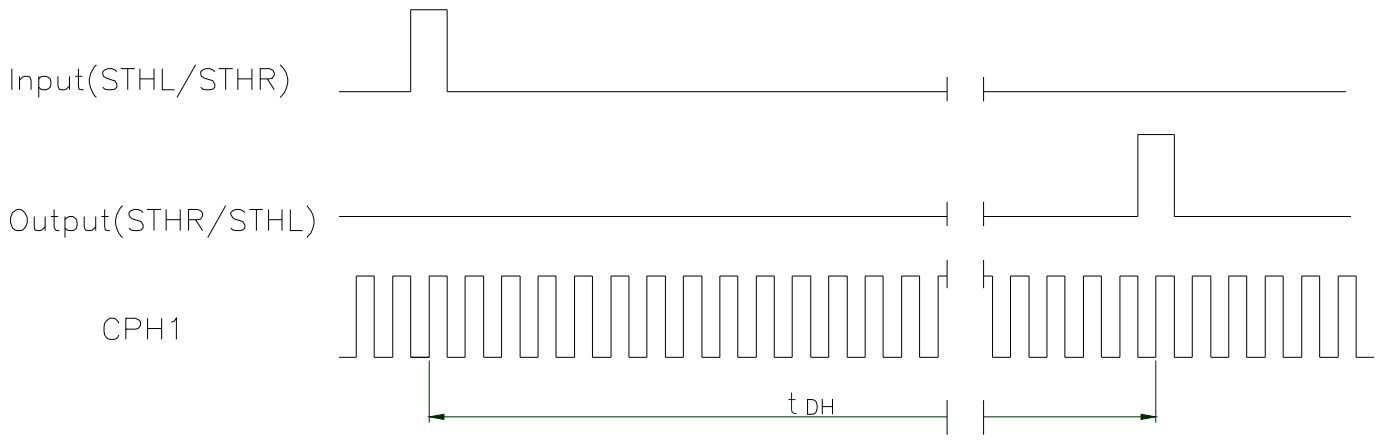


Fig.3-2 Horizontal display timing range

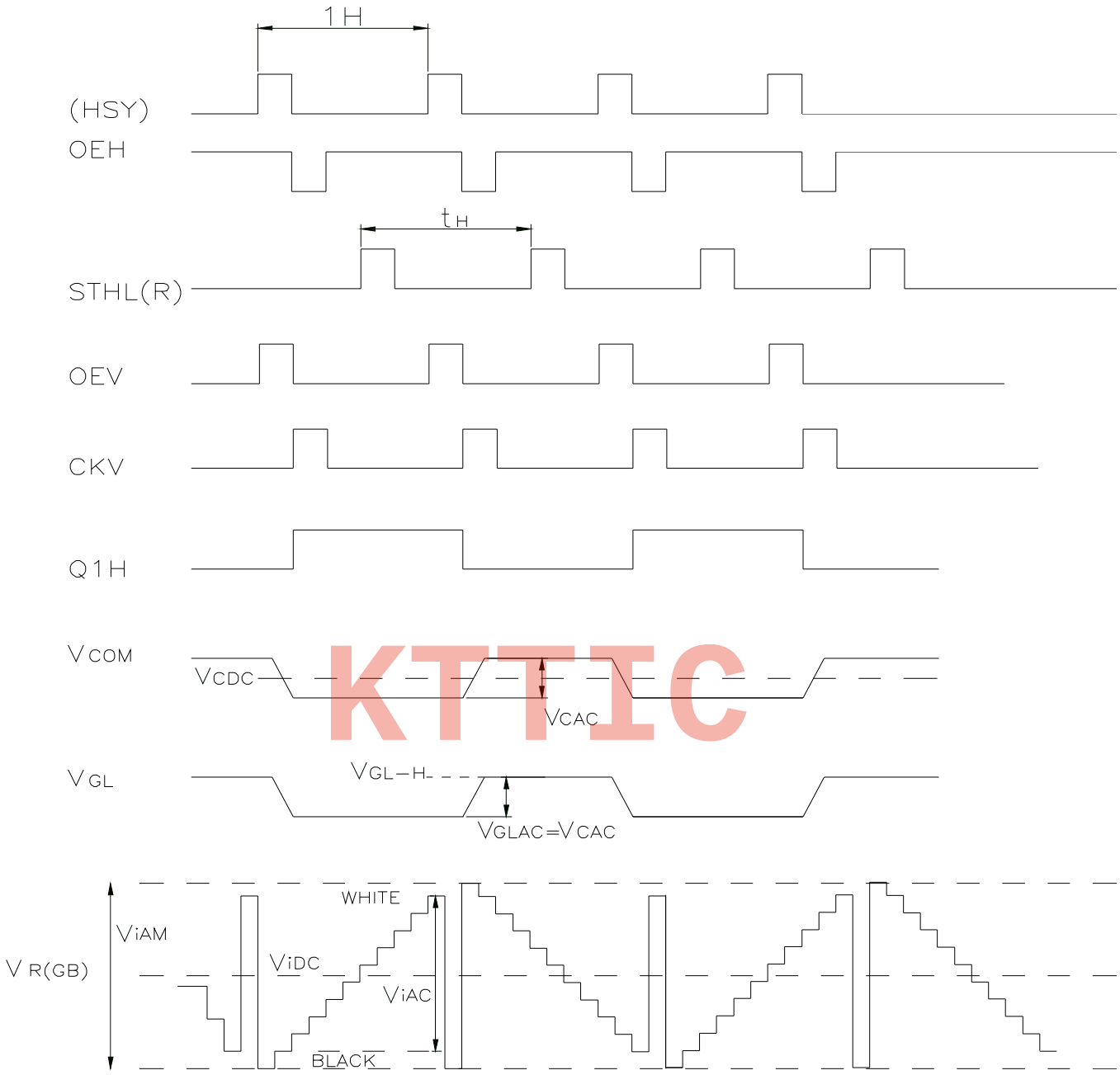
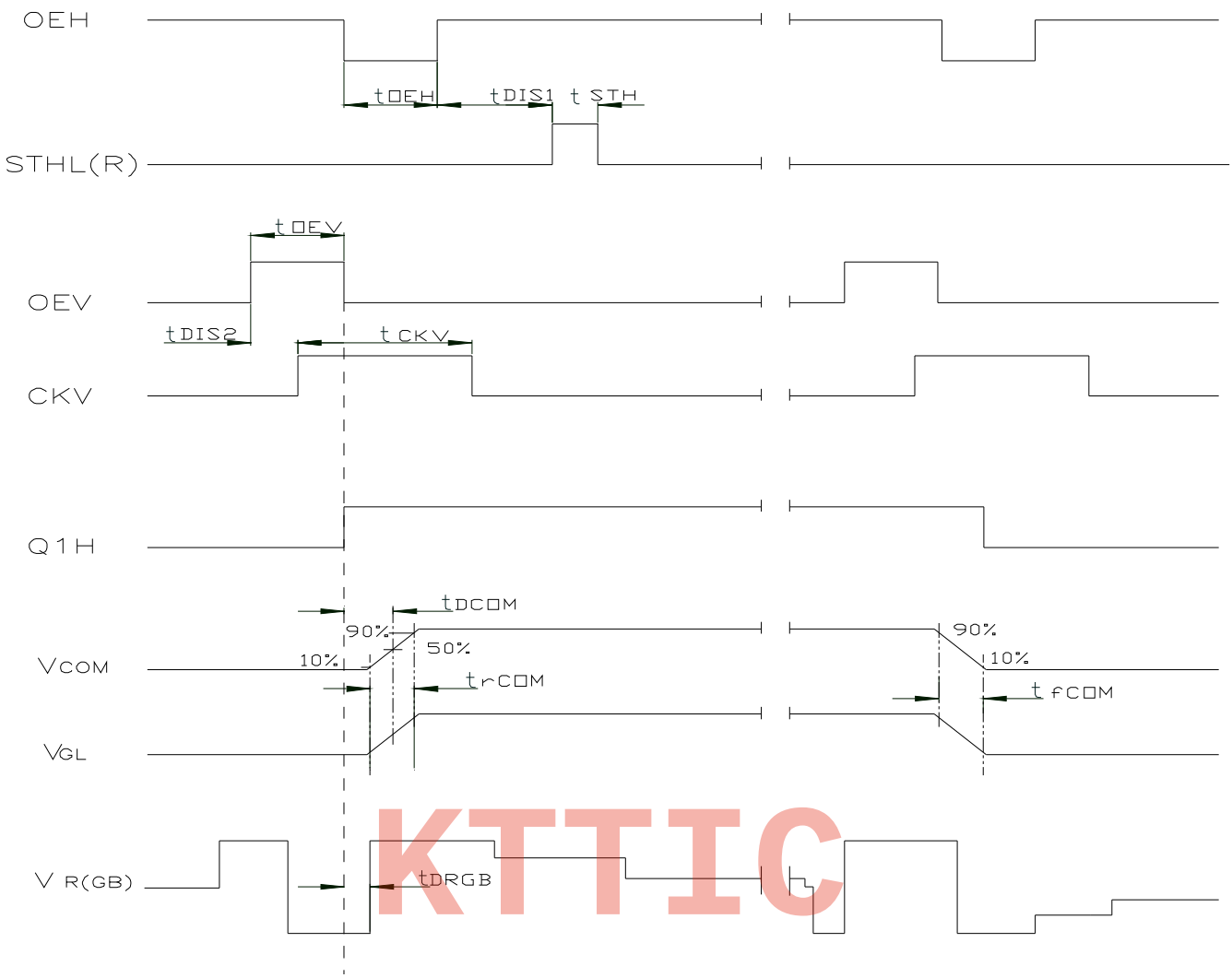


Fig.3-3(a) Horizontal timing



Note: The falling edge of OEV should be synchronized with the falling edge of OEH

Fig.3-3(b) Detail horizontal

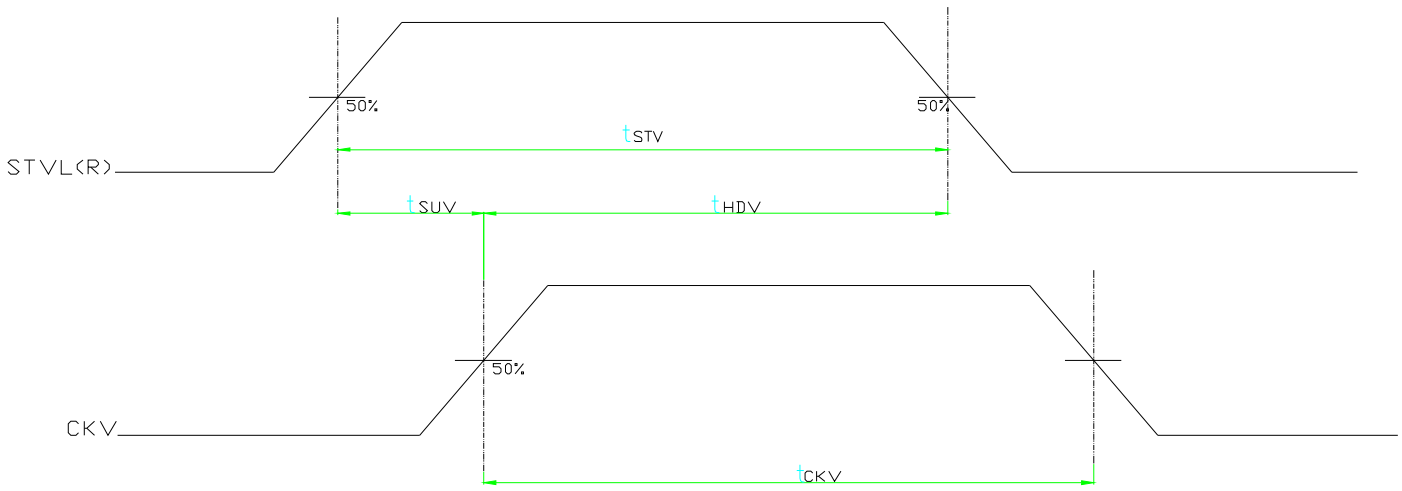


Fig.3-4 Vertical shift clock timing

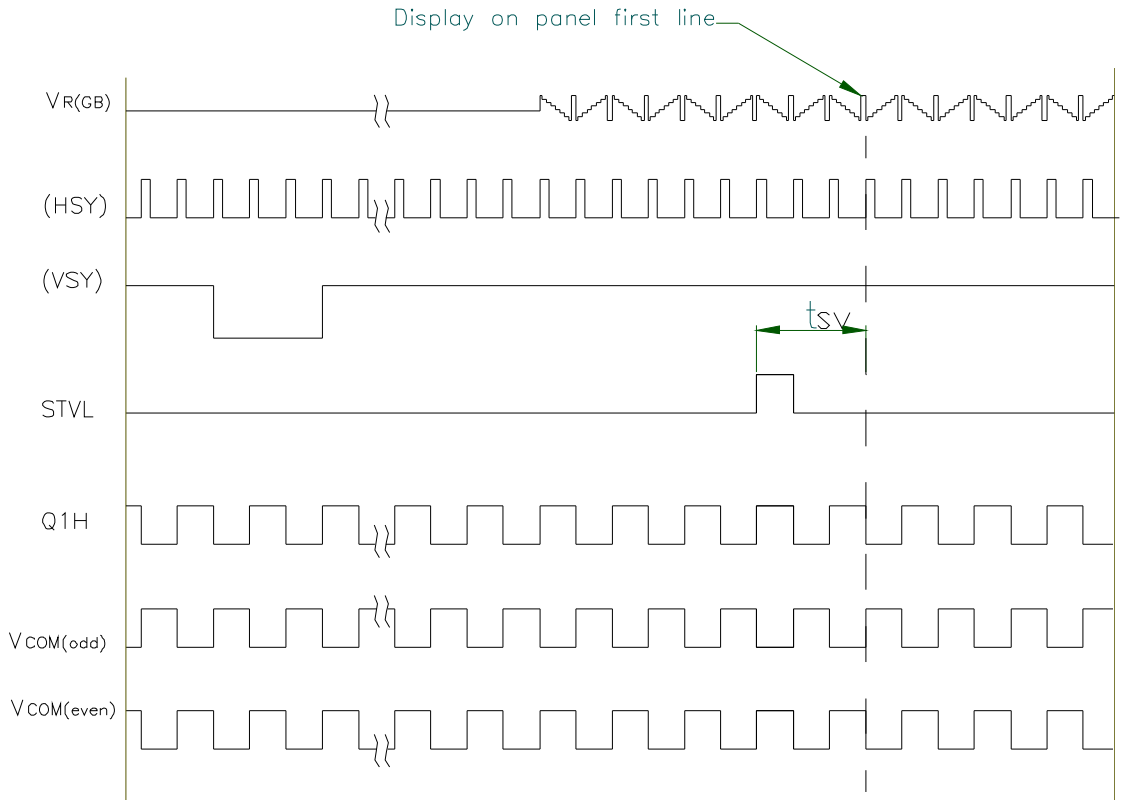


Fig.3-5(a) Vertical timing(from up to down)

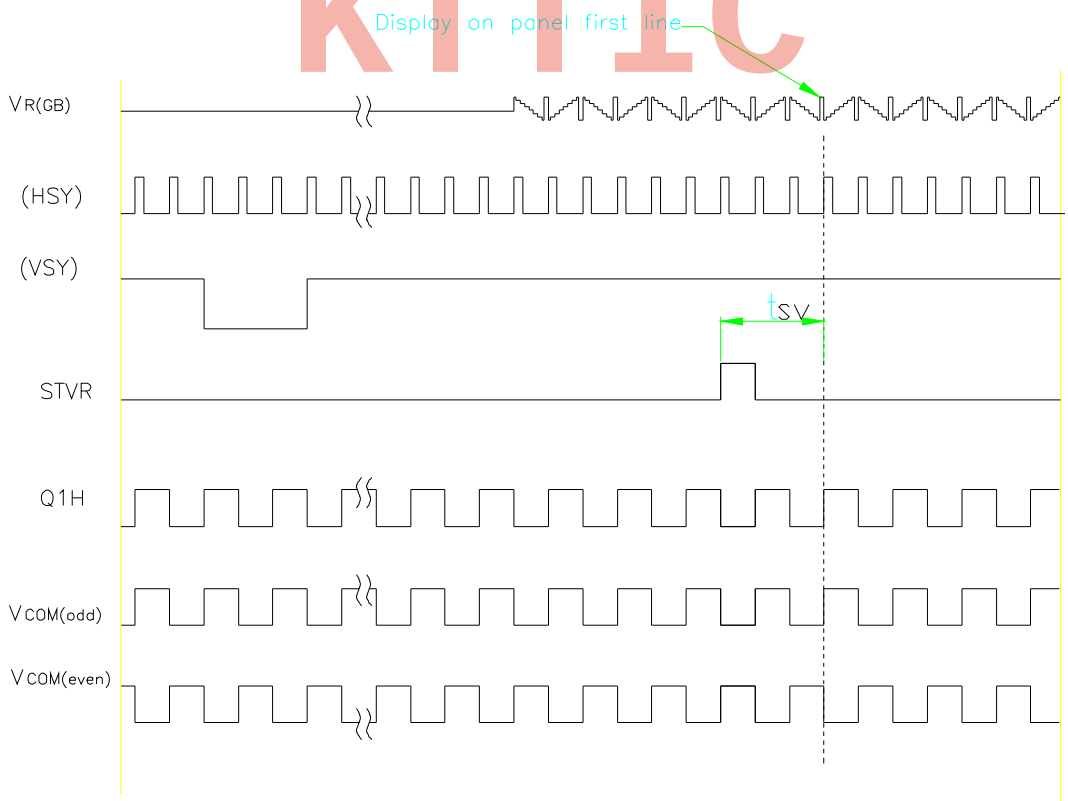


Fig.3-5(b) Vertical timing(from down to up)

3.4. Power sequence

This module adopts high voltage driver IC, so it may be damaged by a large current flow if a wrong power on/off sequence is used! The recommend power sequence is to connect DV_{DD} first, then connect power to driver gate power, V_{GL} and V_{GH}. When shutting off the power, shut off the driver gate power, V_{GL} and V_{GH} , then shut off the logic power, DV_{DD}, or shut off the power simultaneously!

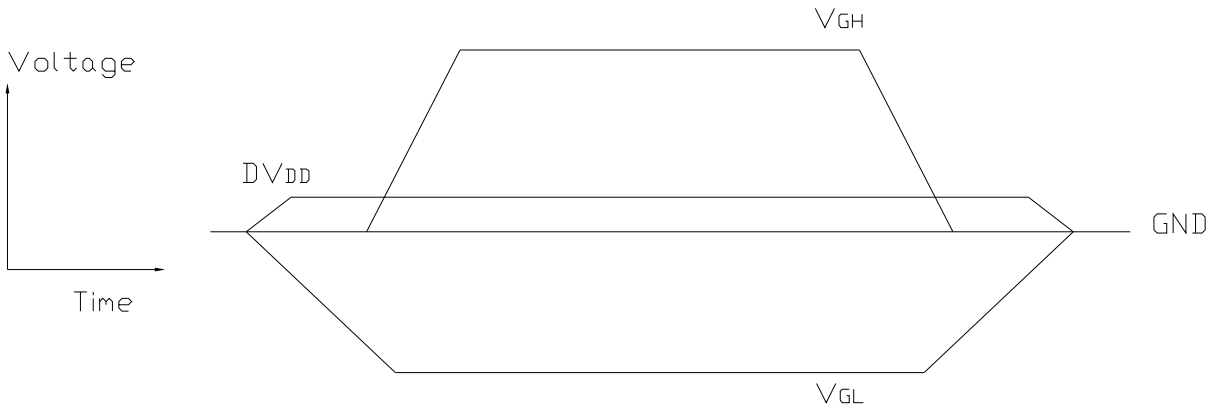


Fig.3-6 Power sequence

4. Optical specifications

Note 1, Note 2 Ta=25℃, I_L=2.9mArms

Parameter		Symbol	Condition	Values			Unit	Remarks
				Min	Typ	Max		
Response time		T_{ON}	Normal θ=Φ=0˚	-	20	30	ms	Note 3, 5
		T_{OFF}		-	30	40		
Contrast ratio		CR	At optimized viewing angle	150	200	-		Note 4, 5
Luminance		L	Normal θ=Φ=0˚	200	250	-	cd/m^2	Note 7
Color chromaticity (CIE1931)	White	W_x	Normal θ=Φ=0˚	0.26	0.31	0.36		Note 6, 7
		W_y		0.28	0.33	0.38		
Viewing angle range (CR≧10)		θ_L		40	45	-	Degree	Note 5
		θ_R		40	45	-		
		θ_T		10	15	-		
		θ_B		30	35	-		

Note 1: Definition of viewing angle range

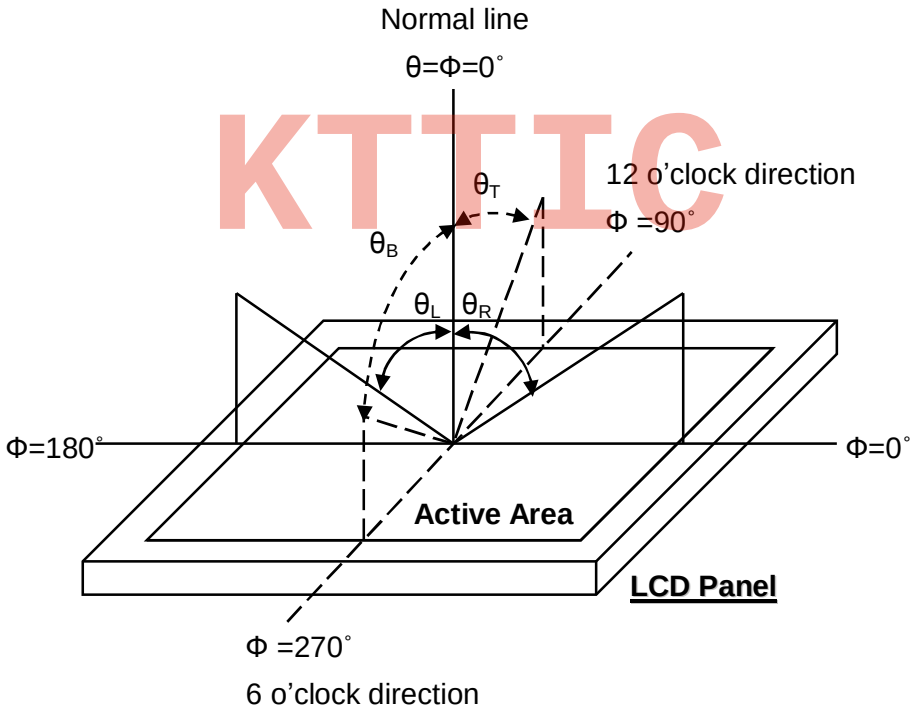


Fig. 4-1(a) Definition of viewing angle

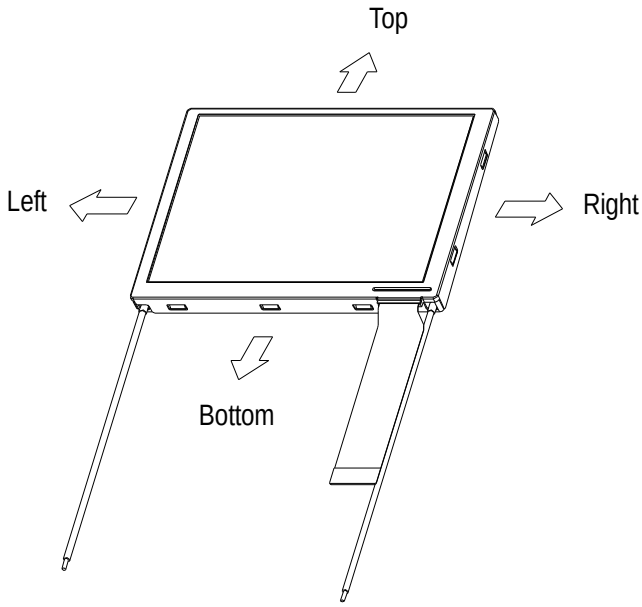


Fig. 4-1(b) Definition of viewing angle

Note 2: Definition of optical measurement system

The optical characteristics should be measured in dark room and with ambient temperature Ta=25℃. After 30 minutes operation, the optical properties are measured at the center point of the LCD screen.

Equipment: Photo detector TOPCON BM-5A /Field of view: 1˚ /Height: 500mm.

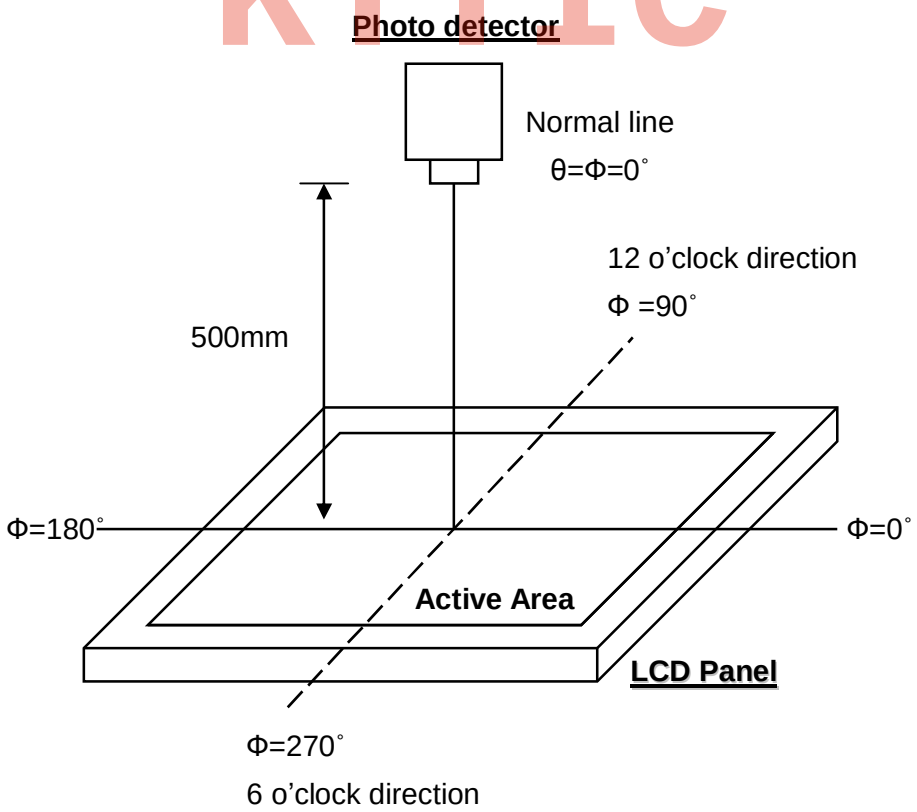


Fig. 4-2 Optical measurement system setup

Note 3: Definition of Response time

The response time is defined as the LCD optical switching time interval between "White" state and "Black" state. Rise time, T_{ON} , is the time between photo detector output intensity changed from 90% to 10%. And fall time, T_{OFF}, is the time between photo detector output intensity changed from 10% to 90%.

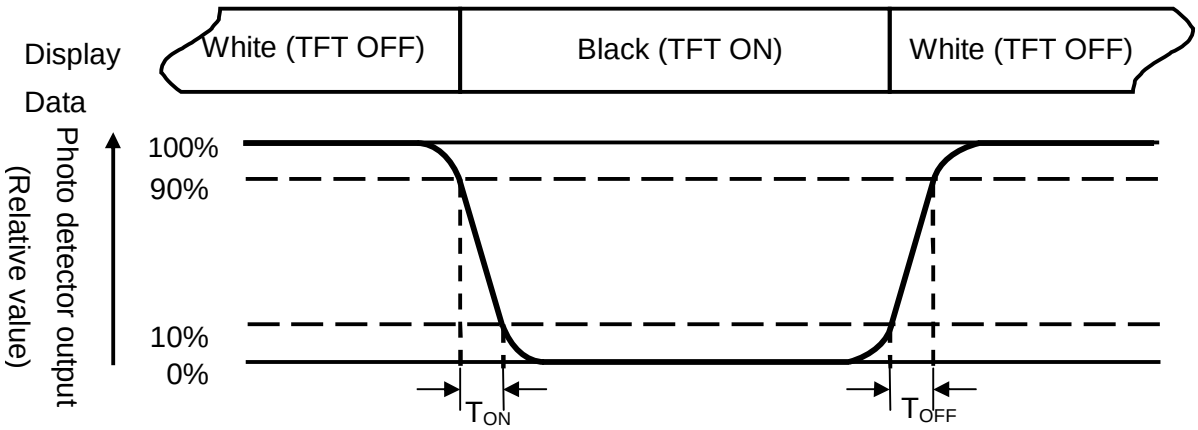


Fig. 4-3 Definition of response time

Note 4: Definition of contrast ratio

The contrast ratio is defined as the following expression.

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

Note 5: For analog signal driving condition

White Vi = V_{i50} ▬ 1.5V

Black Vi = V_{i50} ± 2.0V

"±" means that the analog input signal swings in phase with VCOM signal.

"▬" means that the analog input signal swings out of phase with VCOM signal.

V_{i50}: The analog input voltage when transmission of LCD panel is 50%.

The 100% transmission is defined as the transmission of LCD panel when all the input terminals of module are electrically opened.

Note 6: Definition of color chromaticity (CIE1931)

Color coordinates measured at the center point of LCD.

Note 7: Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

5. Reliability test items

Test Items	Test Conditions	Remark
High temperature storage	+80℃±3℃ for 240 hours	
Low temperature storage	-25℃±3℃ for 240 hours	
High temperature operation	+60℃±3℃for 240 hours	
Low temperature operation	0℃±3℃ for 240 hours	
Operation at high temperature and humidity	+60℃±3℃,90%±3%RH max. for 240 hours	Note 3
Thermal shock	-25℃/1h ~ +80℃/1h for a total 50 cycles, Start with cold temp and end with high temp	Non Operation
Vibration test	Frequency range:10~55Hz Stoke:1.5mm Sweep:10Hz~55Hz~10Hz 2 hours for each direction of X. Y. Z. (6 hours for total)	JIS C7021 A10 Condition A
Mechanical Shock	100G 6ms,±X, ±Y, ±Z 3 times for each direction	JIS C7021 A7 Condition C
Package Vibration Test	Random Vibration : 0.015G*G/Hz from 5-200HZ, -6dB/Octave from 200-500HZ	IEC 68-34
Package Drop Test	Height:60 cm 1 corner, 3 edges, 6 surfaces	JIS Z0202
Pressure Test of panel surface	8KGf, 1min, Φ5mm in center and four corners of panel	
Electro-static discharge	±2KV, Human Body Mode, 100pF/1500Ω	EIA/JESD22-A114

Note:

1: At high temp storage & High temp/High humidity operation, the polarizer is out of subject.

2: Before function check, the test sample requires 2 hours stored at room temperature.

3: The display at the operation tests should be in the autorun mode.

4: The display test under normal operation there shall be no change which might affect practical function.

6. Handling precautions

6.1. Safety

The liquid crystal in the LCD is poisonous. **DO NOT** put it in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and water.

6.2. Handling

(a). The LCD panel is plate glass. **DO NOT** subject the panel to mechanical shock or to excessive force on its surface.
(b). The polarizer attached to the display is very easy to damage, handle it with careful attention.
(c). To avoid contamination on the display surface, **DO NOT** touch the display surface with bare hands.
(d). Provide a space so that the LCD panel does not come into contact with other components.
(e). To protect the LCD panel from external pressure, put covering glass (acrylic board or similar board) keeping appropriate gap between them.
(f). Transparent electrodes may be disconnected if you use the LCD panel under environmental conditions where dew condensation occurs.
(g). Property of semiconductor devices may be affected when they are exposed to light, possibly resulting in malfunctioning of the ICs.
(h). To prevent such malfunctioning of the ICs, your design and mounting layout done are so that the IC is not exposed to light in actual use.

6.3. Static electricity

(a). Ground soldering iron tips, tools and testers when they operate.
(b). Ground your body when handling the products.
(c). **DO NOT** apply voltage to the input terminal without applying power supply.
(d). **DO NOT** apply voltage which exceeds the absolute maximum rating.
(e). Store the products in an anti-electrostatic container.

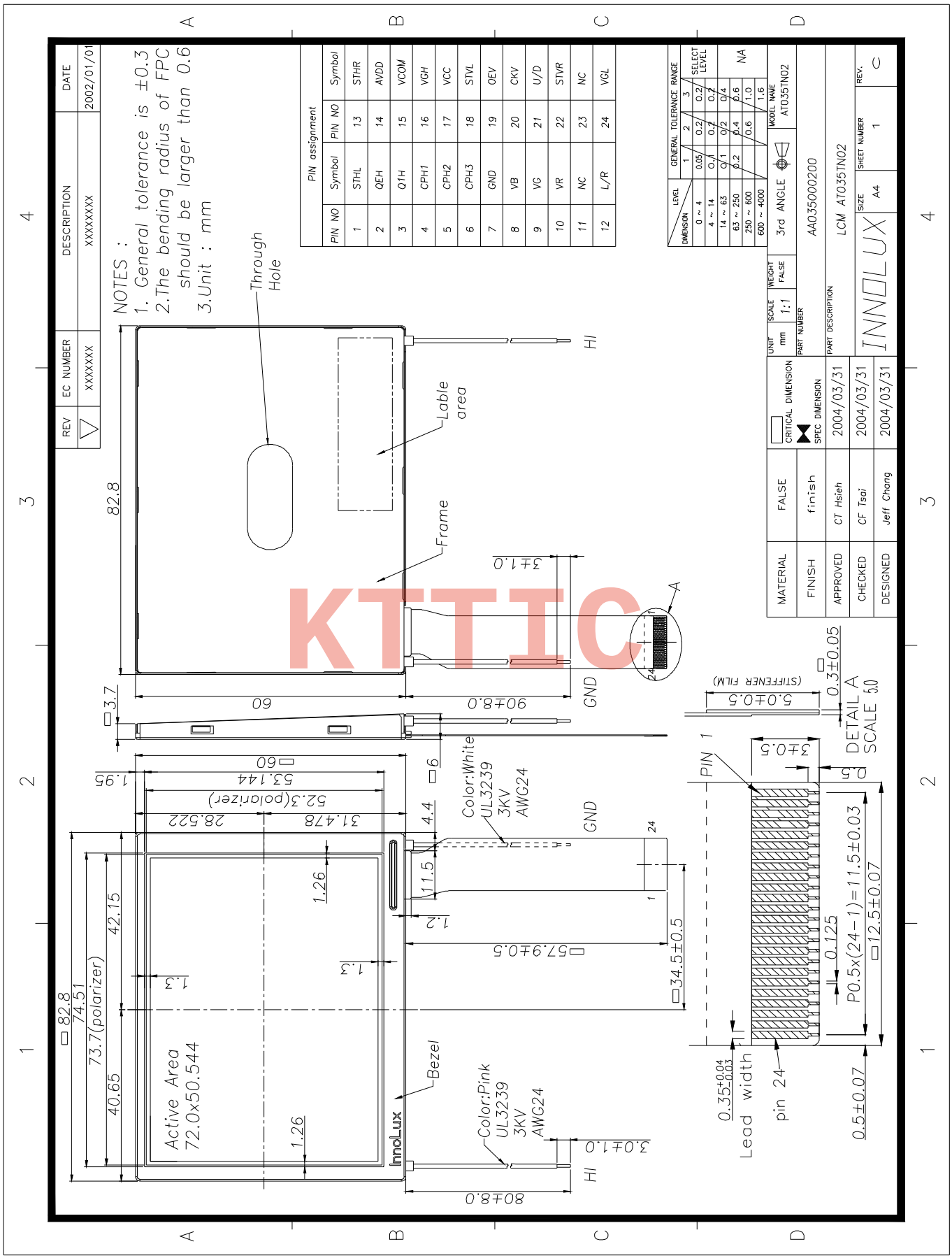
6.4. Storage

(a). Store the products in a dark place at +25℃±10℃, low humidity (65%RH or less).
(b). **DO NOT** store the products in an atmosphere containing organic solvents or corrosive gases.

6.5. Cleaning

(a). **DO NOT** wipe the polarizer with dry cloth, as it might cause scratch.
(b). Wipe the polarizer with a soft cloth soaked with petroleum IPA, other chemical might damage.

7. Mechanical drawing



8. Packing specifications

8.1. Packaging material table

Per carton

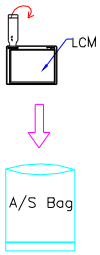
No.	Item	Model (Material)	Dimensions(mm)	Unit Weight(Kg)	Quantity	Remark
1	LCM module	AT035TN02	82.8×60×6.0	0.037	240	
2	EPP tray	EPP	516x384x6.5	0.142	3	Anti-static
3	Cover tray	EPE	493×326×10	0.024	1	Anti-static
4	Anti-Static Bag	PE	100×80×0.05	0.001	240	Anti-static
5	Carton	Carton	530x355x255	1.1	1	
6	Total weight	11 Kg ± 0.6Kg				

8.2. Packaging quantity

(1) LCM quantity per tray: no. of the row 2 row x 28column ＋1row x 24column =80
(2) Total LCM quantity in Carton: no. of EPP trays 3 x quantity per tray 80= 240

8.3. Packing Drawing

Step A.



Put LCM in the A/S bag

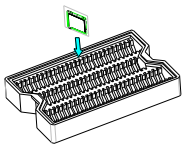
Step B.

Turn the upwards A/S bag back

Step C.

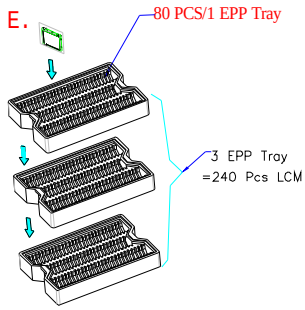
Seal the A/S bag

Step D.



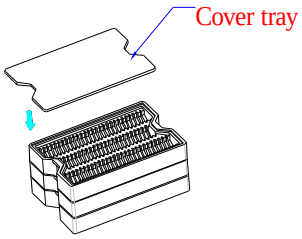
Put LCM in the EPP tray
80pcs per EPP tray

Step E.



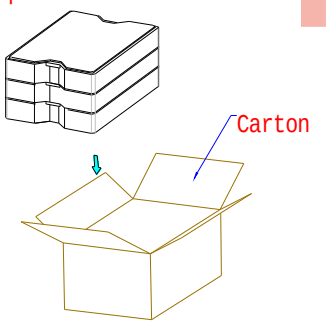
Stack 3 EPP trays
Total numbers :240pcs

Step F.



Put 1 cover tray on the top of
of every 3 stacked trays

Step G.

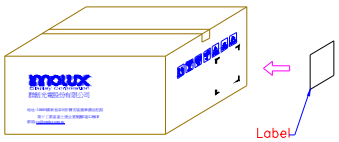


Put stacked trays in outer carton

Step H.

Seal outer carton

Step I.



Paste the label on outer caton

Label

INNOLUX DISPLAY

Customer Name :

Customer P/N :

Box ID :

Model No :

Quantity :

MFG Date :

QC :

INNOLUX QA DISPLAY
OQC
DATE
Pass