

Doc. Number :

- ☐ Tentative Specification  
☐ Preliminary Specification  
☒ Approval Specification

**MODEL NO.: G104V1**  
**SUFFIX: T03**

**Customer:**

**APPROVED BY**

**SIGNATURE**

**Name / Title** \_\_\_\_\_

Note

\_\_\_\_\_  
Please return 1 copy for your confirmation with your signature and comments.

Approved By	Checked By	Prepared By

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## REVISION HISTORY

Version	Date	Page	Description
3.3	Apr .29, 2019	P6	1.5 MECHANICAL SPECIFICATIONS Modify Note(1) Module depth 7.8mm =>7.81mm
		P7	2.2.2 LED CONVERTER Add Enable Voltage Min value & Backlight Adjust Min value
		P8	3.1 TFT LCD MODULE Delete Power Supply Current white min value & black min value
		P9	3.2 LED CONVERTER 1.Modify EN Control Level Backlight on Min value(2.0=>2.5) & Backlight off Max value (0.8=>0.3) 2.Modify PWM Control Level PWM High Level Min value(2.0=>2.5) & PWM Low Level Max value(0.8=>0.15) 3.Modify note(2)
		P24	Modify 10.1 INX MODULE LABEL Add NBINX'S FAB ID: COCKN
3.4	Jan 4 ,2021	P18	Modify 7.2 OPTICAL SPECIFICATION Item: Color Chromaticity Gy(Typ) 0.562=>0.582 Wx(Typ) 0.313=>0.308 Wy(Typ) 0.329=>0.316 Item: Response Time T <sub>R</sub> (Typ) 14=>17 T <sub>R</sub> (Max) 19=>22
		P26-P27	Modify 12. MECHANICAL CHARACTERISTICS
3.5	Dec 20,2021	P13	5.2 BACKLIGHT UNIT (CONVERTER CONNECTOR PIN) Note(1) add Connector Part No 2 <sup>nd</sup> source
		P26-27	Modify 12. MECHANICAL CHARACTERISTICS

## 1. GENERAL DESCRIPTION

### 1.1 OVERVIEW

The G104V1-T03 model is a IAV 10.4" TFT-LCD module with white LED Backlight Unit and a 31-pin and 1ch TTL interface. This module supports 640 x 480 VGA mode and display 262,144 colors. The converter for the LED Backlight Unit is built in.

### 1.2 FEATURES

- Wide viewing angle
- High contrast ratio
- VGA (640 x 480 pixels) resolution
- Wide operating temperature
- DE (Data Enable) mode
- CMOS/TTL (Transistor-Transistor Logic) interface
- Reversible-scan direction
- RoHS Compliance
- LED Light Bar Replaceable

### 1.3 APPLICATION

- TFT LCD Monitor
- Industrial Application
- Amusement

### 1.4 GENERAL SPECIFICATIONS

Item	Specification	Unit	Note
Diagonal Size	10.4	inch	(1)
Active Area	211.2(H) x 158.4(V)	mm	
Bezel Opening Area	215.4(H) x 161.8(V)	mm	
Driver Element	a-si TFT active matrix	-	-
Pixel Number	640 x R.G.B. x 480	pixel	-
Pixel Pitch	0.33(H) x 0.33(V)	mm	-
Pixel Arrangement	RGB vertical stripe	-	-
Display Colors	262,144	color	-
Transmissive Mode	Normally black	-	-
Surface Treatment	Hard coating (3H), Anti-glare (Haze 25%)	-	-
Module Power Consumption	7.38	W	Typ.

## 1.5 MECHANICAL SPECIFICATIONS

Item		Min.	Typ.	Max.	Unit	Note
Module Size	Horizontal (H)	225	225.5	226	mm	(1)
	Vertical (V)	175.8	176.3	176.8	mm	
	Depth (D)	8.84(7.31)	9.34(7.81)	9.84(8.31)	mm	
Weight		345	395	445	g	-
I/F connector mounting position		The mounting inclination of the connector makes the screen center within $\pm 0.5\text{mm}$ as the horizontal.			-	(2)

Note (1) Please refer to the attached drawings for more information of front and back outline dimensions.

Module depth 7.81mm does not include TTL connector, with TTL connector is 9.34mm (typical).

Note (2) Connector mounting position



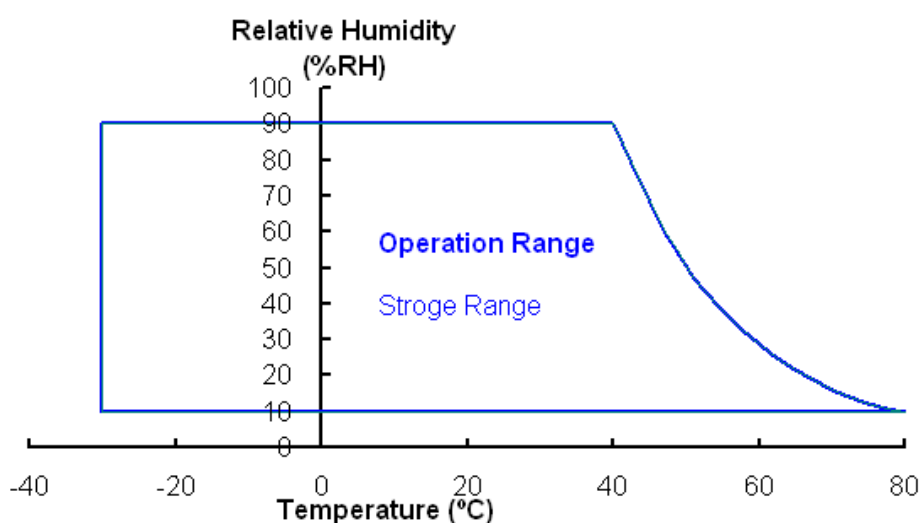
## 2. ABSOLUTE MAXIMUM RATINGS

### 2.1 ABSOLUTE RATINGS OF ENVIRONMENT

Item	Symbol	Value		Unit	Note
		Min.	Max.		
Operating Ambient Temperature	T <sub>OP</sub>	-30	+80	°C	
Storage Temperature	T <sub>ST</sub>	-30	+80	°C	

Note (1) Temperature and relative humidity range is shown in the figure below.

- (a) 90 %RH Max. ( $T_a \leq 40\text{ }^{\circ}\text{C}$ ).
- (b) Wet-bulb temperature should be 39 °C Max. ( $T_a > 40\text{ }^{\circ}\text{C}$ ).
- (c) No condensation.



### 2.2 ELECTRICAL ABSOLUTE RATINGS

#### 2.2.1 TFT LCD MODULE

Item	Symbol	Value		Unit	Note
		Min.	Max.		
Power Supply Voltage	VCC	-0.3	7	V	(1)

#### 2.2.2 LED CONVERTER

Item	Symbol	Value		Unit	Note
		Min.	Max.		
Converter Voltage	V <sub>i</sub>	-0.3	18	V	(1) , (2)
Enable Voltage	EN	-0.3	5.5	V	
Backlight Adjust	ADJ	-0.3	5.5	V	

Note (1) Permanent damage to the device may occur if maximum values are exceeded. Function operation should be restricted to the conditions described under Normal Operating Conditions.

Note (2) Specified values are for LED (Refer to 3.2 for further information).

### 3. ELECTRICAL SPECIFICATIONS

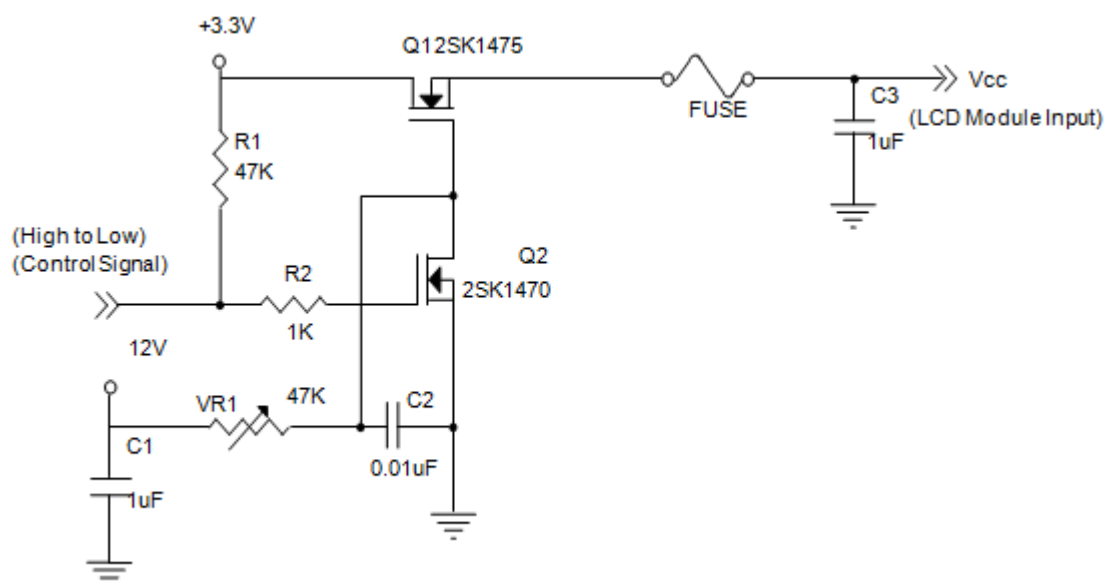
#### 3.1 TFT LCD MODULE

$T_a = 25 \pm 2 \text{ }^{\circ}\text{C}$

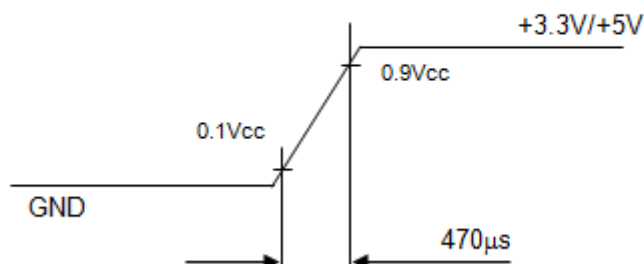
Parameter	Symbol	Value			Unit	Note
		Min.	Typ.	Max.		
Power Supply Voltage	VCC	3.0	3.3	3.6	V	at VCC=3.3V
		4.75	5.0	5.25	V	at VCC=5.0V
Power Supply Current	White	---	490	540	mA	(3)a, at VCC=3.3V, 60Hz
	Black	---	390	440	mA	(3)a, at VCC=5.0V, 60Hz
		---	470	520	mA	(3)b, at VCC=3.3V, 60Hz
		---	380	430	mA	(3)b, at VCC=5.0V, 60Hz
Power Consumption	$P_L$	---	1.617	---	W	VCC=3.3V, 60Hz
Logic input voltage	$V_{IH}$	$0.7V_{CC}$	-	$V_{CC}$	V	
	$V_{IL}$	0	-	$0.3V_{CC}$	V	

Note (1) The module is recommended to operate within specification ranges listed above for normal function.

Note (2) Measurement Conditions:



**Vcc rising time is 470μs**





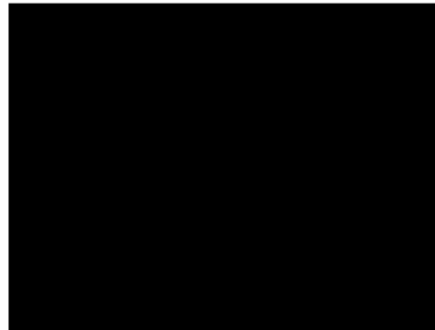
Note (3) The specified power supply current is under the conditions at  $T_a = 25 \pm 2^\circ\text{C}$ ,  $f_v = 60\text{ Hz}$ , where as a power dissipation check pattern below is displayed.

a. White Pattern



Active Area

b. Black Pattern



Active Area

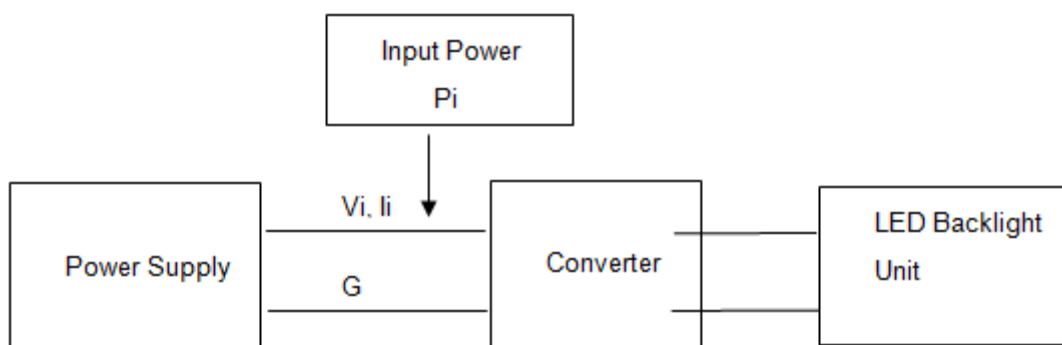
## 3.2 LED CONVERTER

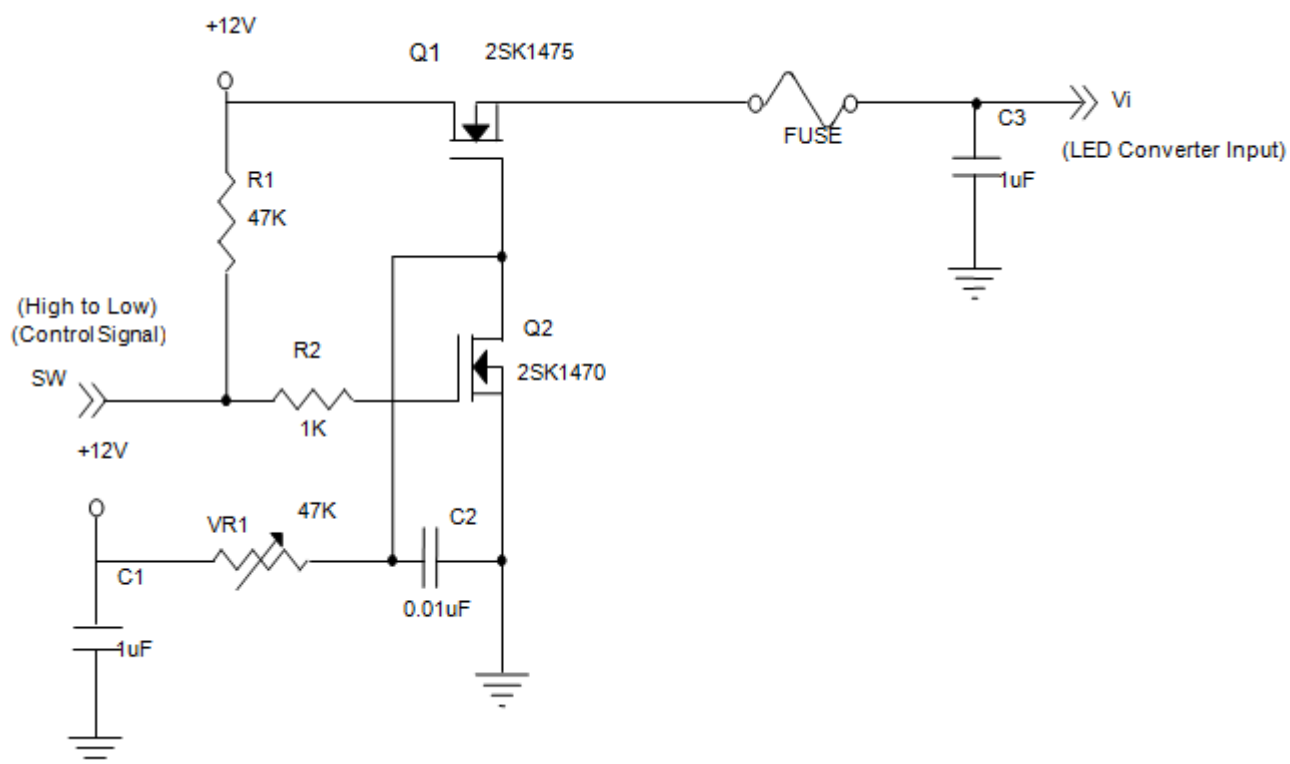
$T_a = 25 \pm 2^\circ\text{C}$

Parameter		Symbol	Value			Unit	Note
			Min.	Typ.	Max.		
Converter Power Supply Voltage		$V_i$	10.8	12.0	12.6	V	(Duty 100%)
Converter Power Supply Current		$I_i$	---	0.48	---	A	(1) $V_i = 12\text{V}$ (Duty 100%)
Converter Power Consumption		$P_i$	---	5.76	---	W	(1) $V_i = 12\text{V}$ (Duty 100%)
EN Control Level	Backlight on		2.5	3.3	5.0	V	
	Backlight off		0	---	0.3	V	
PWM Control Level	PWM High Level		2.5	3.3	5.0	V	
	PWM Low Level		0	---	0.15	V	
PWM Control Duty Ratio			20		100	%	
PWM Control Frequency		$f_{\text{PWM}}$	190	200	20K	Hz	
LED Life Time		$L_L$	50,000			Hrs	(2)

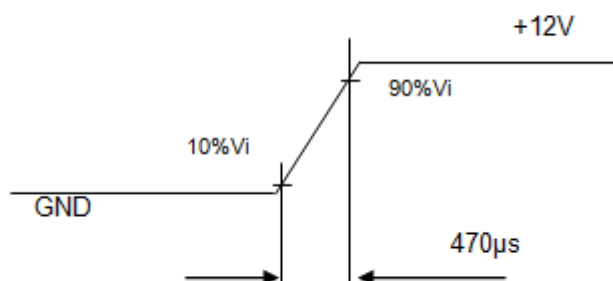
Note (1) LED current is measured by utilizing a high frequency current meter as shown below:

Note (2) The lifetime of LED is estimated data and defined as the time when it continues to operate under the conditions at  $T_a = 25 \pm 2^\circ\text{C}$  and Duty=100% until the brightness becomes  $\leq 50\%$  of its original value. Operating LED under high temperature environment will reduce lifetime and lead to color shift.



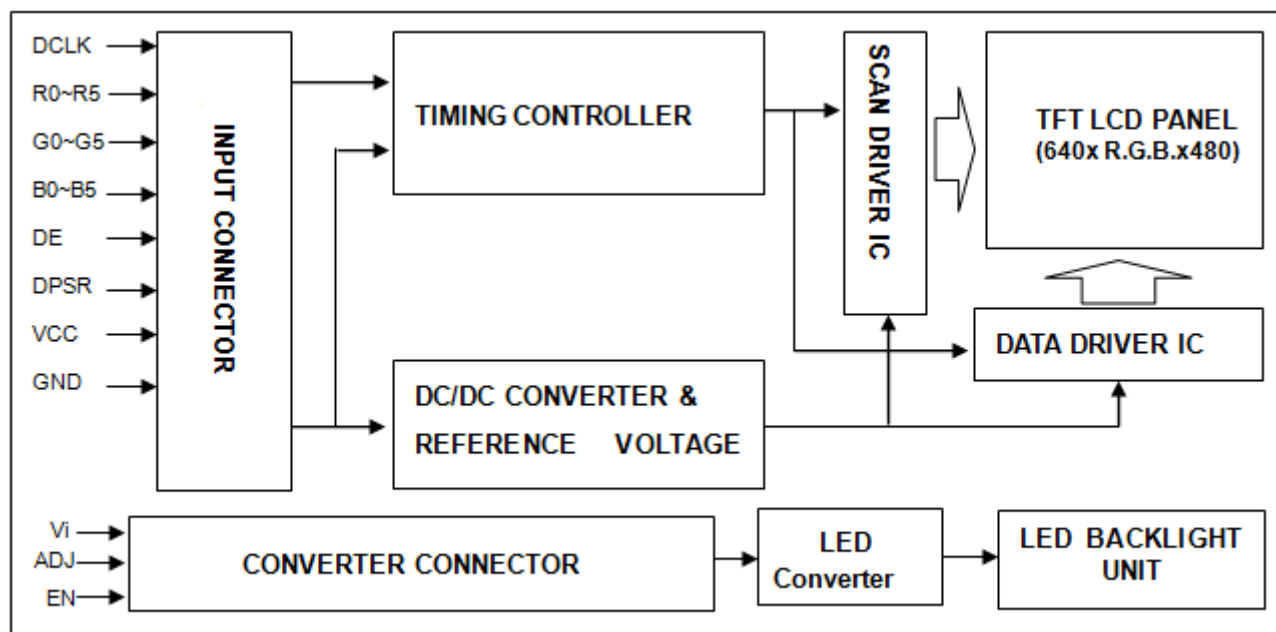


**Vi rising time is 470us**



## 4. BLOCK DIAGRAM

### 4.1 TFT LCD MODULE



## 5. INPUT TERMINAL PIN ASSIGNMENT

### 5.1 TFT LCD MODULE

Pin	Name	Description
1	GND	Ground
2	DCLK	Dot clock
3	N.C.	N.C.
4	N.C.	N.C.
5	GND	Ground
6	R0	Red data (LSB)
7	R1	Red data
8	R2	Red data
9	R3	Red data
10	R4	Red data
11	R5	Red data (MSB)
12	GND	Ground
13	G0	Green data (LSB)
14	G1	Green data
15	G2	Green data
16	G3	Green data
17	G4	Green data
18	G5	Green data (MSB)
19	GND	Ground
20	B0	Blue data (LSB)
21	B1	Blue data
22	B2	Blue data
23	B3	Blue data
24	B4	Blue data
25	B5	Blue data (MSB)
26	GND	Ground
27	DE	Data enable signal
28	VCC	Power supply
29	VCC	Power supply
30	N.C.	Reserved, please keep it floating.
31	DPSR	Selection of scan direction

Note (1) Connector Part No.: DF 9C-31P-1V or equivalent.

## 5.2 BACKLIGHT UNIT (CONVERTER CONNECTOR PIN)

Pin	Symbol	Description	Remark
1	$V_i$	Converter input voltage	12V
2	$V_{GND}$	Converter ground	Ground
3	EN	Enable pin	
4	ADJ	Backlight Adjust	PWM Dimming
5	NC	Not Connect	

Note (1) Connector Part No.: 3823K-F05N-00L (Entery) or CI4205M2HRD-NH1(CviLux) or 50277-00501-001(ACES) or equivalent

Note (2) User's connector Part No.: H208K-P05N-02B (Entery) or equivalent

## 5.3 COLOR DATA INPUT ASSIGNMENT

The brightness of each primary color (red, green and blue) is based on the 6-bit gray scale data input for the color. The higher the binary input, the brighter the color. The table below provides the assignment of color versus data input.

Color		Data Signal																	
		Red						Green						Blue					
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Gray Scale Of Red	Red(0)/Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(1)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Red(2)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
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	Red(61)	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Red(62)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Red(63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
Gray Scale Of Green	Green(0)/Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green(1)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Green(2)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
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	Green(61)	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0
	Green(62)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
Green(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	
Gray Scale Of Blue	Blue(0)/Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Blue(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
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	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Blue(61)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1
	Blue(62)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
Blue(63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	

Note (1) 0: Low Level Voltage, 1: High Level Voltage

## 6. INTERFACE TIMING

### 6.1 INPUT SIGNAL TIMING SPECIFICATIONS

The input signal timing specifications are shown as the following table and timing diagram.

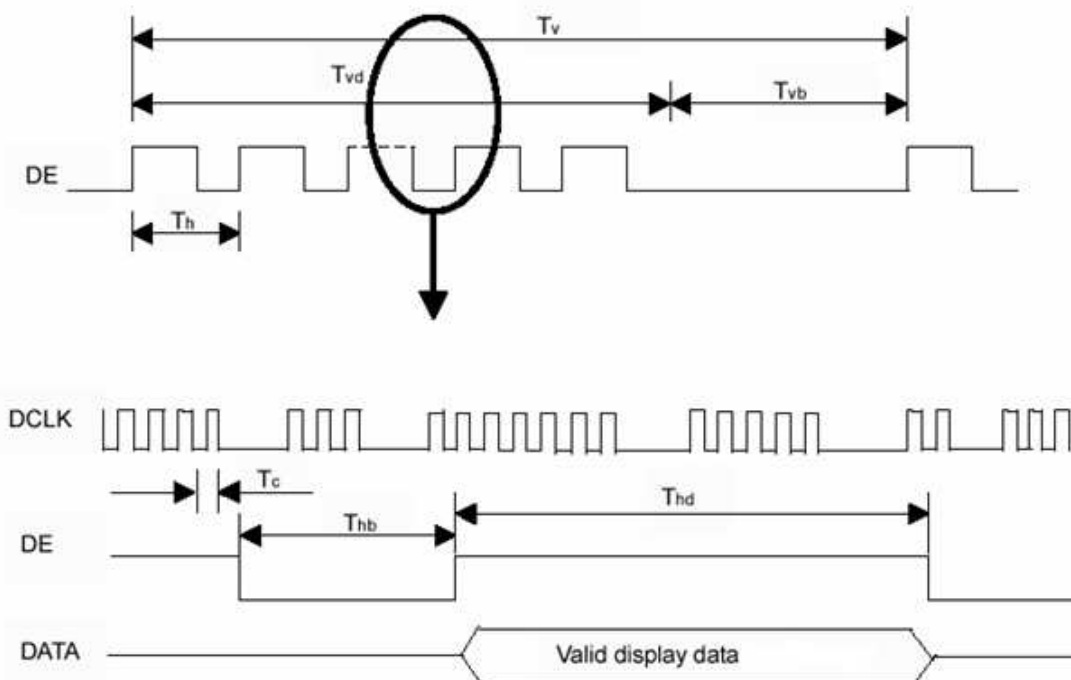
Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
Dot Clock	Frequency	Fc	21	25.175	29	MHz	-
	Period	Tc	34.48	39.72	47.62	ns	
	High Time	TCIH	0.35 Tc	0.5 Tc	0.65 Tc	ns	
	Low Time	TCIL	0.35 Tc	0.5 Tc	0.65 Tc	ns	
Dot Data	Setup Time	Tlvs	8	-	-	ns	(4)
	Hold Time	Tlvh	12	-	-	ns	(4)
DE	Setup Time	TSTC	8	-	-	ns	(5)
	Hold Time	THTC	12	-	-	ns	(5)
Horizontal Active Display Term	Frame Rate	Fr	-	60	-	Hz	
	Total	Th	730	800	900	Th	Th=Thd+Thb
	Display	Thd	-	640	-	Th	-
	Blank	Thb	90	160	260	Th	-
Vertical Active Display Term	Total	Tv	485	525	576	Tc	Tv=Tvd+Tvb
	Display	Tvd	-	480	-	Tc	-
	Blank	Tvb	5	45	96	Tc	-

Note(1) This module is operated by DE only mode

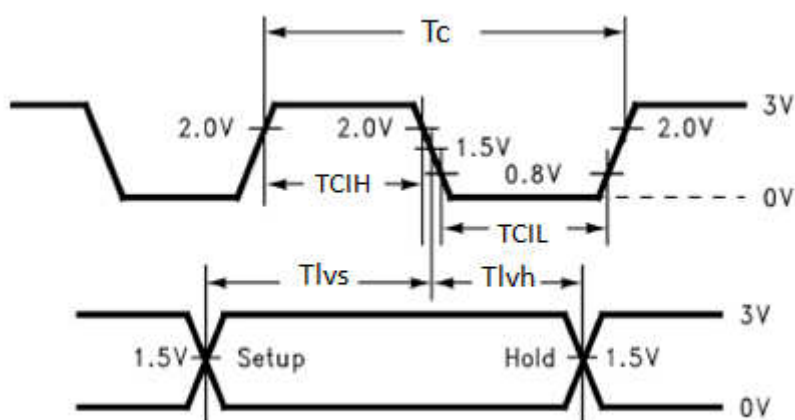
Note (2) Frame rate is 60Hz

Note (3) The Tv(Tvd+Tvb) must be integer, otherwise, this module would operate abnormally.

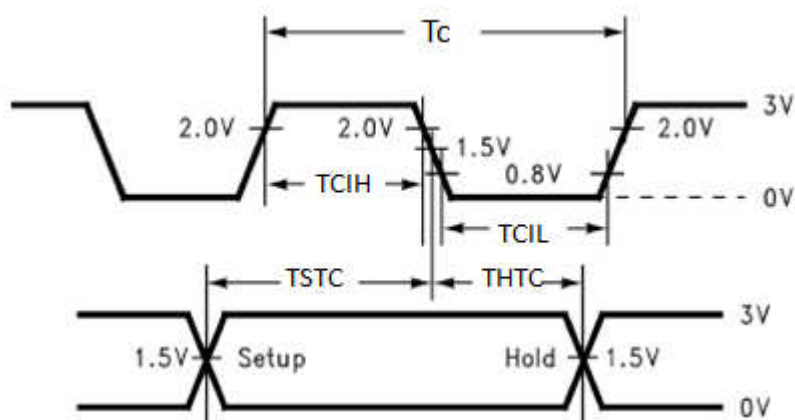
**INPUT SIGNAL TIMING DIAGRAM**



Note (4) Clock and data setup/hold and high/low time input waveforms.

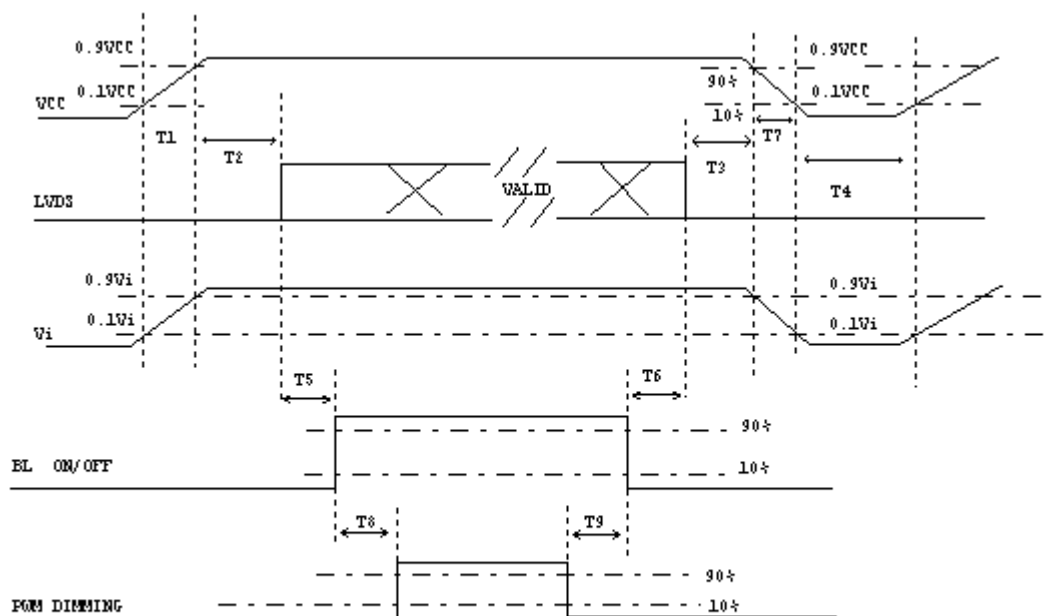


Note (5) Clock and DE setup/hold and high/low time input waveforms.



## 6.2 POWER ON/OFF SEQUENCE

To prevent a latch-up or DC operation of LCD module, the power on/off sequence should follow the conditions shown in the following diagram.



**Power ON/OFF sequence**

Note (1) Please avoid floating state of interface signal at invalid period.

Note (2) When the interface signal is invalid, be sure to pull down the power supply of LCD VCC to 0 V.

Note (3) The Backlight converter power must be turned on after the power supply for the logic and the interface signal is valid. The Backlight converter power must be turned off before the power supply for the logic and the interface signal is invalid.

Parameter	Value			Units
	Min	Typ	Max	
T1	0.5	-	10	ms
T2	0	-	50	ms
T3	0	-	50	ms
T4	500	-	-	ms
T5	200	-	-	ms
T6	20	-	-	ms
T7	5	-	300	ms
T8	10	-	-	ms
T9	10	-	-	ms



### 6.3 SCANNING DIRECTION

The following figures show the image seen from the front view. The arrow indicates the direction of scan.



Figure1.Normal scan (DPSR : Low or Open )



Figure 2. Reverse scan (DPSR : High )

## 7. OPTICAL CHARACTERISTICS

### 7.1 TEST CONDITION

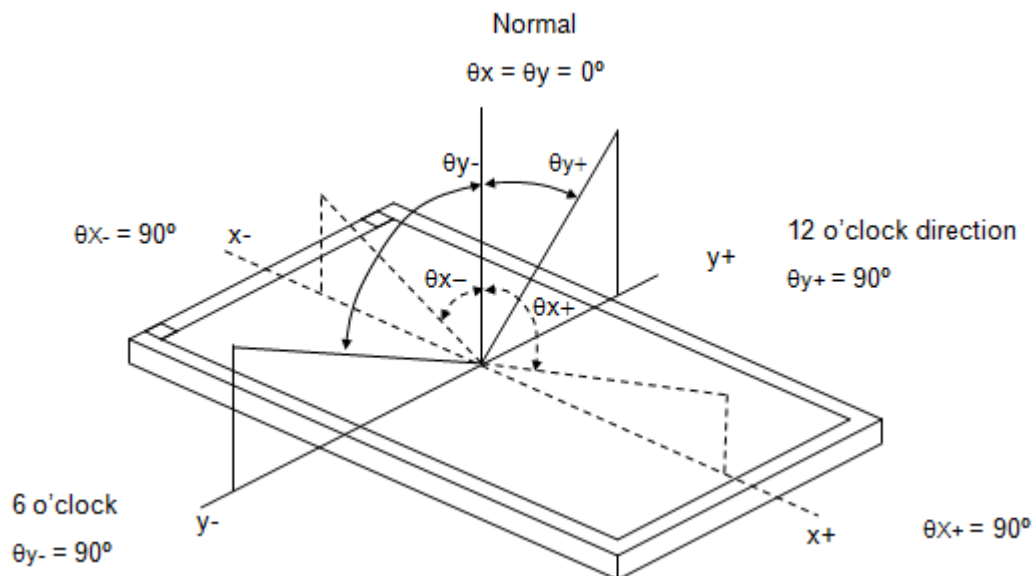
Item	Value	Unit
Ambient Temperature (Ta)	25±2	°C
Ambient Humidity (Ha)	50±10	%RH
Supply Voltage	According to typical value in "ELECTRICAL CHARACTERISTICS"	
Input Signal		
LED Light Bar Input Current Per Input Pin		

### 7.2 OPTICAL SPECIFICATION

The relative measurement methods of optical characteristics are shown in 7.2 and all items are measured at the center point of screen except white variation. The following items should be measured under the test conditions described in 7.1 and stable environment shown in Note (5).

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note				
Color Chromaticity	Red	R <sub>x</sub>	$\theta_x=0^\circ, \theta_Y=0^\circ$ CS-1000	Typ - 0.05	0.619	Typ + 0.05	-	(1), (5)				
		R <sub>y</sub>			0.357		-					
	Green	G <sub>x</sub>			0.333		-					
		G <sub>y</sub>			0.582		-					
	Blue	B <sub>x</sub>			0.145		-					
		B <sub>y</sub>			0.092		-					
	White	W <sub>x</sub>			0.308		-					
		W <sub>y</sub>			0.316		-					
	Center Luminance of White				L <sub>C</sub>		450		500	-	-	(4), (5)
	Contrast Ratio				CR		1000		1500	-	-	(2), (5)
Response Time		T <sub>R</sub>	$\theta_x=0^\circ, \theta_Y=0^\circ$	-	17	22	ms	(3)				
		T <sub>F</sub>		-	9	14	ms					
White Variation		δW	$\theta_x=0^\circ, \theta_Y=0^\circ$	-	-	1.4	-	(5), (6)				
Viewing Angle	Horizontal	θ <sub>x+</sub>	CR≥10	80	88	-	Deg.	(1), (5)				
		θ <sub>x-</sub>		80	88	-						
	Vertical	θ <sub>y+</sub>		80	88	-						
		θ <sub>y-</sub>		80	88	-						

Note (1) Definition of Viewing Angle ( $\theta_x$ ,  $\theta_y$ ):



Note (2) Definition of Contrast Ratio, (CR):

The contrast ratio can be calculated by the following expression.

Contrast Ratio,  $CR = L_{63} / L_0$

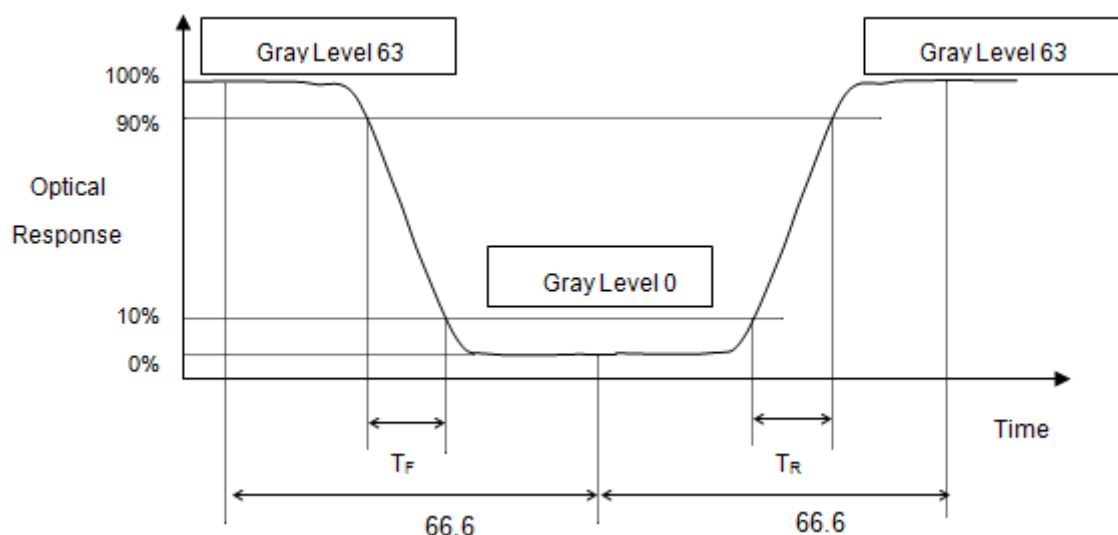
$L_{63}$ : Luminance of gray level 63

$L_0$ : Luminance of gray level 0

$CR = CR(5)$

$CR(X)$  is corresponding to the Contrast Ratio of the point X at Figure in Note (6).

Note (3) Definition of Response Time ( $T_R$ ,  $T_F$ ) and measurement method:



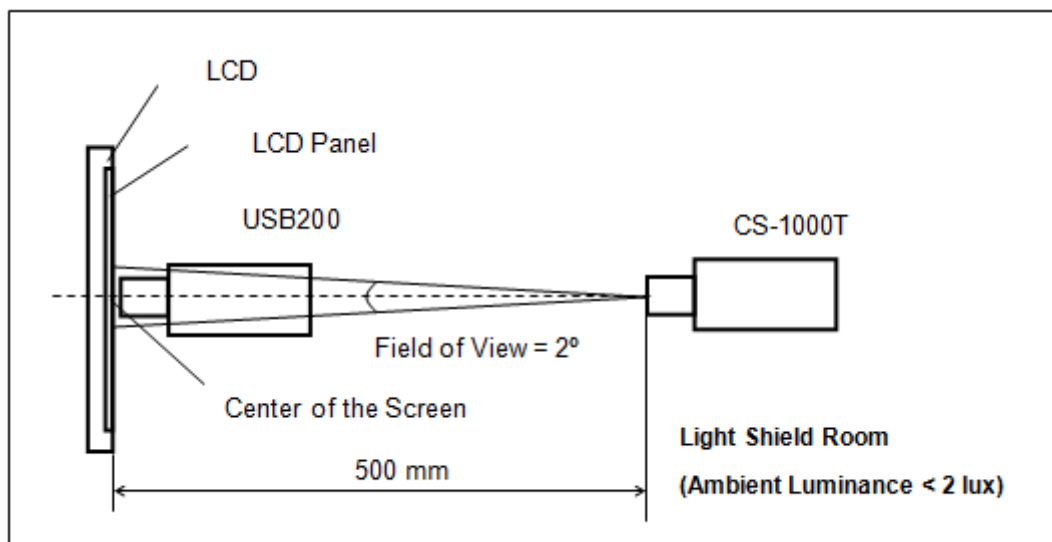
Note (4) Definition of Luminance of White ( $L_c$ ):

Measure the luminance of gray level 63 at center point and 5 points

$L_c = L(5)$ , where  $L(X)$  is corresponding to the luminance of the point X at the figure in Note (6).

Note (5) Measurement Setup:

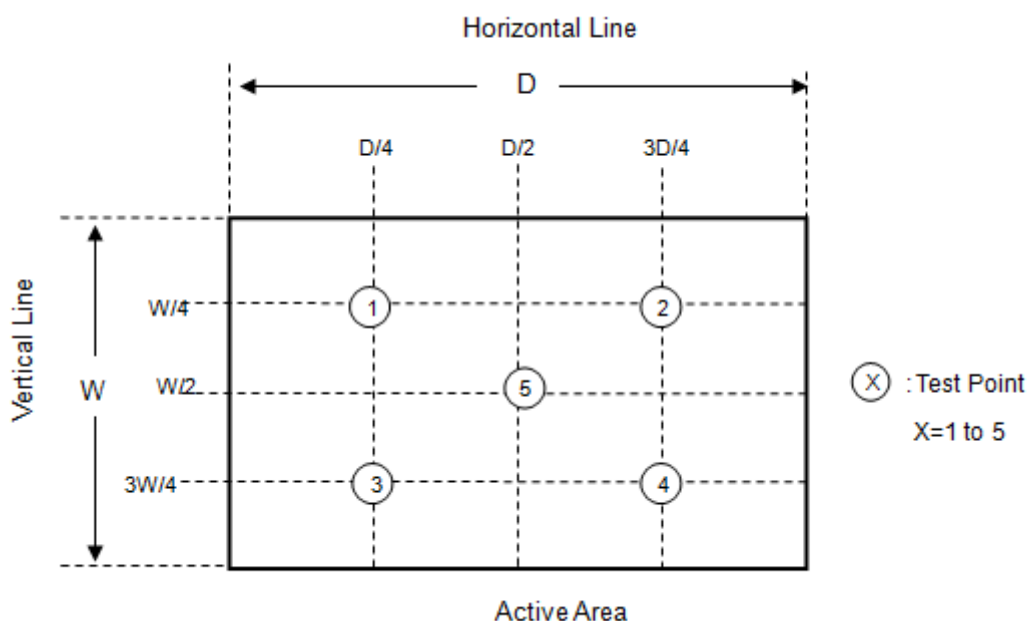
The LCD assembly should be stabilized at given temperature for 30 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting Backlight for 30 minutes in a windless room.



Note (6) Definition of White Variation ( $\delta W$ ):

Measure the luminance of gray level 63 at 5 points

$\delta W = \text{Maximum} [L(1), L(2), L(3), L(4), L(5)] / \text{Minimum} [L(1), L(2), L(3), L(4), L(5)]$



## 8. RELIABILITY TEST CRITERION

Test Item	Test Condition	Note
High Temperature Storage Test	80°C, 240 hours	(1) (2) (4) (5)
Low Temperature Storage Test	-30°C, 240 hours	
Thermal Shock Storage Test	-30°C, 0.5hour←→80°C, 0.5hour; 100cycles, 1hour/cycle	
High Temperature Operation Test	80°C, 240 hours	
Low Temperature Operation Test	-30°C, 240 hours	
High Temperature & High Humidity Operation Test	60°C, 90%RH, 240hours	(1) (2) (4) (6)
Shock (Non-Operating)	200G, 2ms, half sine wave, 1 time for ± X, ± Y, ± Z.	(3) (4)
Vibration (Non-Operating)	1.5G, 10 ~ 300 Hz, 10min/cycle, 3 cycles each X, Y, Z	(3) (4)

Note (1) There should be no condensation on the surface of panel during test.

Note (2) Temperature of panel display surface area should be 85 °C Max.

Note (3) At testing Vibration and Shock, the fixture in holding the module has to be hard and rigid enough so that the module would not be twisted or bent by the fixture.

Note (4) In the standard conditions, there is no function failure issue occurred. All the cosmetic specification is judged before reliability test.

Note (5) Before cosmetic and function test, the product must have enough recovery time, at least 2 hours at room temperature.

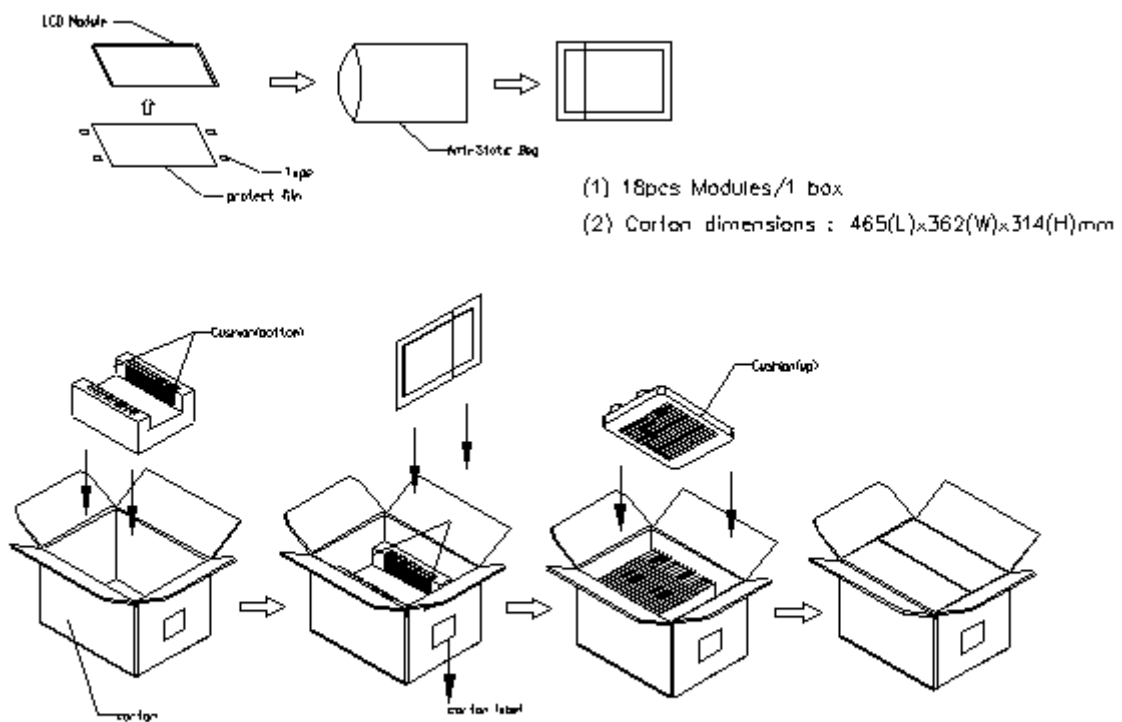
Note (6) Before cosmetic and function test, the product must have enough recovery time, at least 24 hours at room temperature.

## 9. PACKING

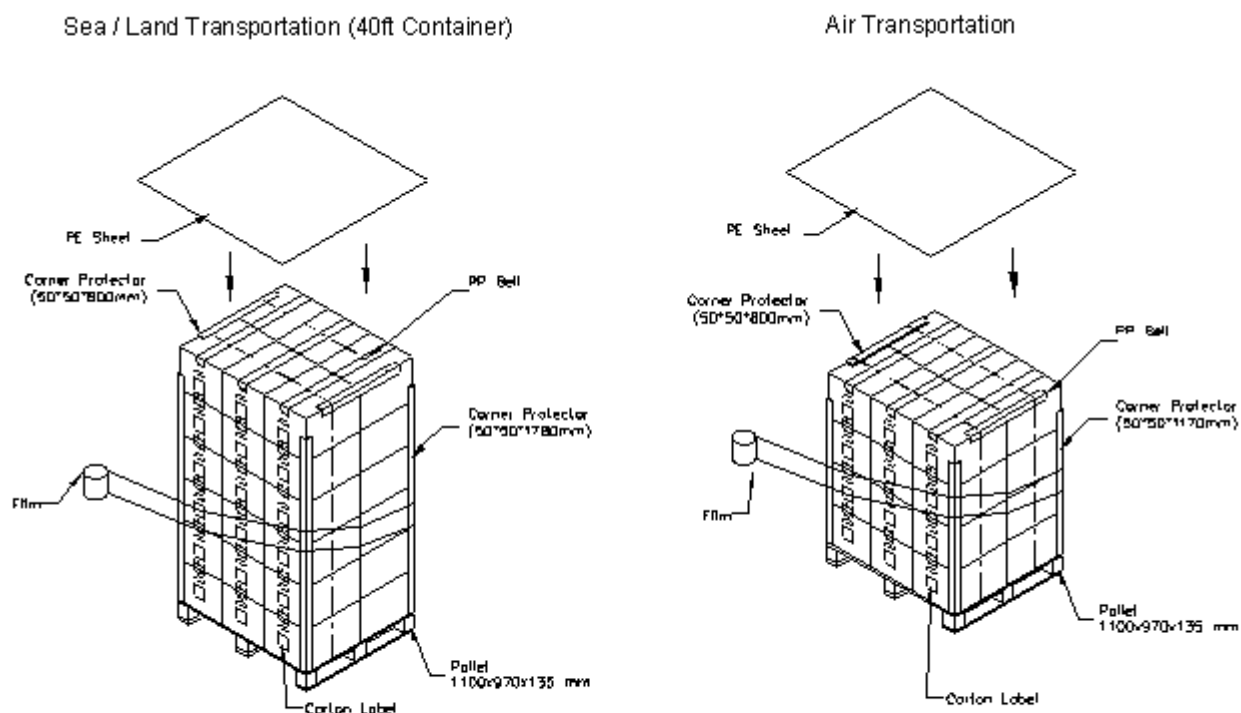
### 9.1 PACKING SPECIFICATIONS

- (1) 18pcs LCD modules / 1 Box
- (2) Box dimensions: 465 (L) X 362 (W) X 314 (H) mm
- (3) Weight: approximately 11.23Kg (18 modules per box)

### 9.2 PACKING METHOD

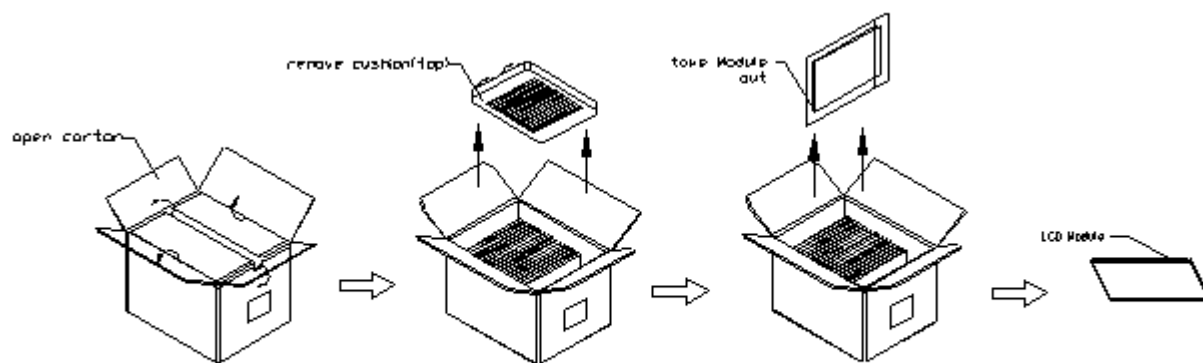


**Figure. 9-1 Packing method**



**Figure. 9-2 Packing method**

### 9.3 UN-PACKING METHOD

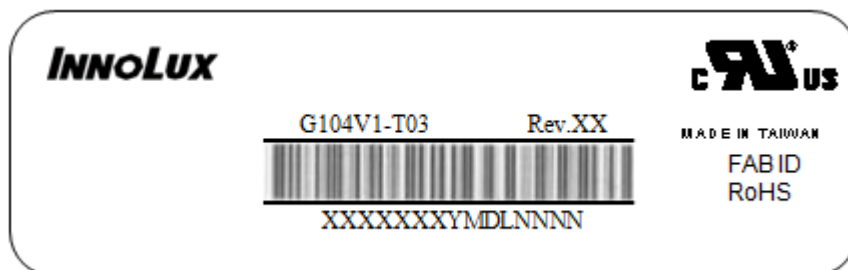


**Figure. 9-3 UN-Packing method**

## 10. DEFINITION OF LABEL

### 10.1 INX MODULE LABEL

The barcode nameplate is pasted on each module as illustration, and its definitions are as following explanation.



(a) Model Name: G104V1-T03

(b) Revision: Rev. XX, for example: A0, A1... B1, B2... or C1, C2...etc.

(c) Serial ID: XX-XX-X-XX-YMD-L-NNNN

Code	Meaning	Description
XX	INX internal use	-
XX	Revision	Cover all the change
X	INX internal use	-
XX	INX internal use	-
YMD	Year, month, day	Year: 0~9, 2001=1, 2002=2, 2003=3...2010=0, 2011=1, 2012=2... Month: 1~12=1, 2, 3, ~, 9, A, B, C Day: 1~31=1, 2, 3, ~, 9, A, B, C, ~, W, X, Y, exclude I, O, and U.
L	Product line #	Line 1=1, Line 2=2, Line 3=3, ...
NNNN	Serial number	Manufacturing sequence of product

(d) FAB ID(UL Factory ID):

Region	Factory ID
TWINX	GEMN
NBINX	LEOO
NBINX	VIRO
NBINX	COCKN
NHINX	CAPG



## 11. PRECAUTIONS

### 11.1 ASSEMBLY AND HANDLING PRECAUTIONS

- (1) Do not apply rough force such as bending or twisting to the module during assembly.
- (2) To assemble or install module into user's system can be only in clean working areas. The dust and oil may cause electrical short or worsen the polarizer.
- (3) It's not permitted to have pressure or impulse on the module because the LCD panel and Backlight will be damaged.
- (4) Always follow the correct power sequence when LCD module is connecting and operating. This can prevent damage to the CMOS LSI chips during latch-up.
- (5) Do not pull the I/F connector in or out while the module is operating.
- (6) Do not disassemble the module.
- (7) Use a soft dry cloth without chemicals for cleaning, because the surface of polarizer is very soft and easily scratched.
- (8) It is dangerous that moisture come into or contacted the LCD module, because moisture may damage LCD module when it is operating.
- (9) High temperature or humidity may reduce the performance of module. Please store LCD module within the specified storage conditions.
- (10) When ambient temperature is lower than 10°C may reduce the display quality, the response time will become slowly.
- (11) Do not keep same pattern in a long period of time. It may cause image sticking on LCD.

### 11.2 SAFETY PRECAUTIONS

- (1) Do not disassemble the module or insert anything into the Backlight unit.
- (2) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contact with hands, skin or clothes, it has to be washed away thoroughly with soap.
- (3) After the module's end of life, it is not harmful in case of normal operation and storage.

## 12. MECHANICAL CHARACTERISTICS

