

# SPECIFICATION FOR APPROVAL

- ( ● ) Preliminary Specification
- (   ) Final Specification

Title	32.0" WUXGA TFT LCD
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BUYER	General
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LC320WUF
SUFFIX	SBN1(RoHS Verified)

\*When you obtain standard approval, please use the above model name without suffix

APPROVED BY	SIGNATURE DATE
/	_____
/	_____
/	_____

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

<b>APPROVED BY</b>	<b>SIGNATURE DATE</b>
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<b>PREPARED BY</b>	
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**TV Product Development Dept.  
LG Display Co., Ltd.**

## Product Specification

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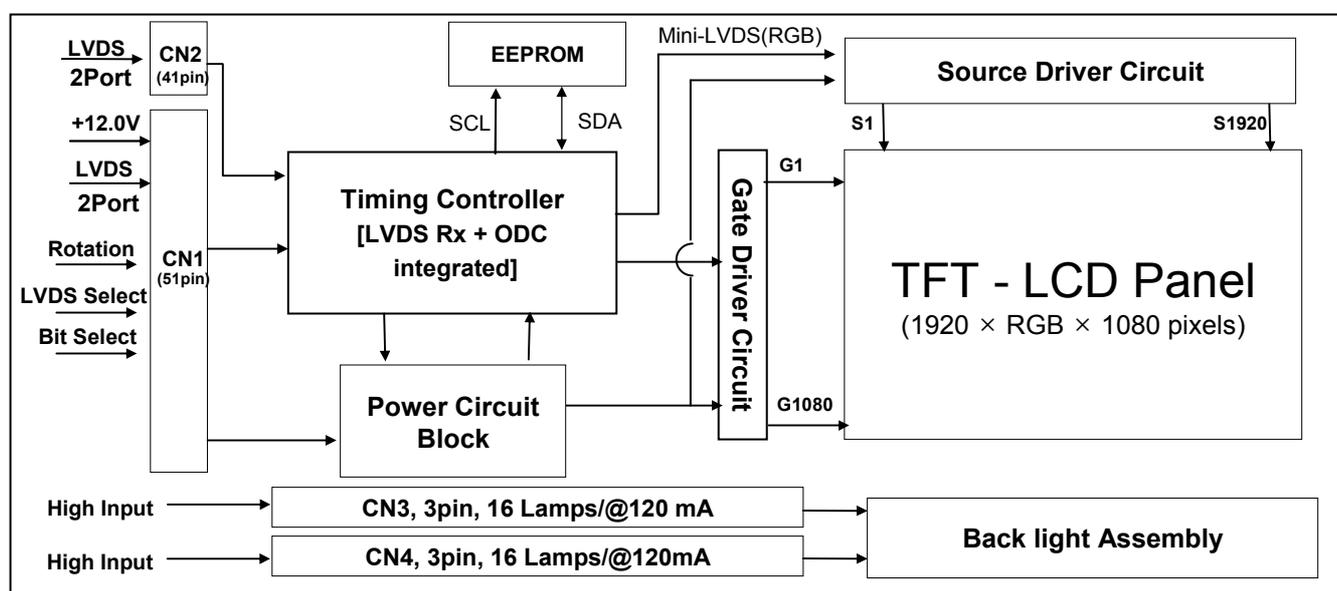
## Product Specification

## 1. General Description

The LC320WUF is a Color Active Matrix Liquid Crystal Display with an integral External Cathode Fluorescent Lamp(EEFL) backlight system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive display type which is operating in the normally black mode. It has a 31.55 inch diagonally measured active display area with WUXGA resolution (1080 vertical by 1920 horizontal pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arrayed in vertical stripes. Gray scale or the luminance of the sub-pixel color is determined with a 10-bit gray scale signal for each dot. Therefore, it can present a palette of more than 1.06B(D) colors.

It has been designed to apply the 10-bit 4-port LVDS interface.

It is intended to support LCD TV, PCTV where high brightness, super wide viewing angle, high color gamut, high color depth and fast response time are important.



## General Features

Active Screen Size	31.55 inches(801.31mm) diagonal
Outline Dimension	731.8(H) x 426.4 (V) x 43.0 mm(D) (Typ.)
Pixel Pitch	0.36375 mm x 0.36375 mm
Pixel Format	1920 horiz. by 1080 vert. Pixels, RGB stripe arrangement
Color Depth	10-bit, 1.06 B colors
Luminance, White	500 cd/m <sup>2</sup> (Center 1point ,Typ.)
Viewing Angle (CR>10)	Viewing angle free ( R/L 178 (Min.), U/D 178 (Min.))
Power Consumption	Total 118.5 W (Typ.) (Logic = 8.5W, Back Light=110W @with inverter )
Weight	5.5Kg (Typ.)
Display Mode	Transmissive mode, Normally black
Surface Treatment	Hard coating(3H), Anti-glare treatment of the front polarizer (Haze 10%)

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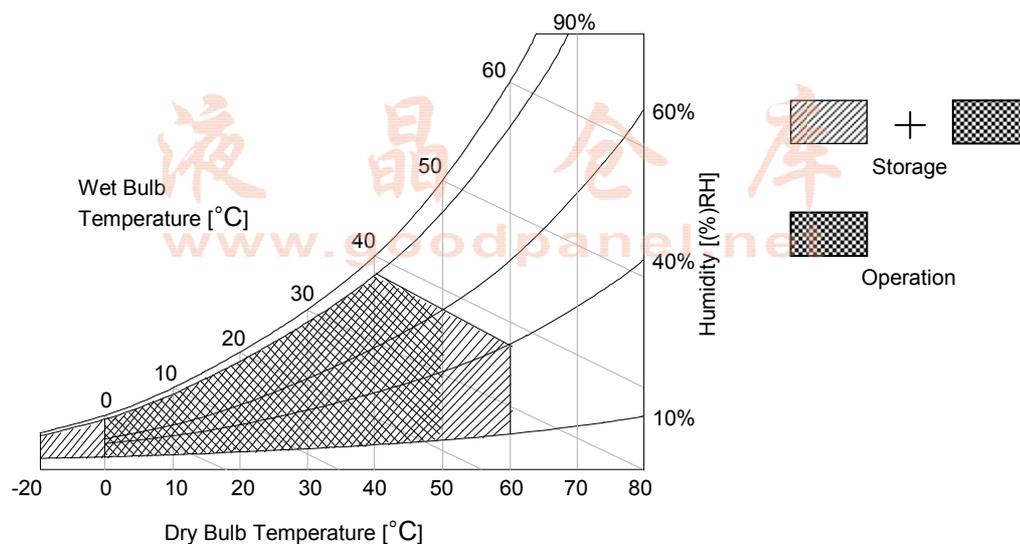
## 2. Absolute Maximum Ratings

The following items are maximum values which, if exceeded, may cause faulty operation or damage to the LCD module.

**Table 1. ABSOLUTE MAXIMUM RATINGS**

Parameter		Symbol	Value		Unit	Remark
			Min	Max		
Power Input Voltage	LCM	$V_{LCD}$	-0.3	+14.0	$V_{DC}$	at $25 \pm 2 \text{ }^\circ\text{C}$
B/L Input voltage	Operating Voltage (one side)	$V_{OP}$	1000	2000	V[ RMS]	at $25 \pm 2 \text{ }^\circ\text{C}$
Operating Temperature		$T_{OP}$	0	+50	$^\circ\text{C}$	Note 1,2
Storage Temperature		$T_{ST}$	-20	+60	$^\circ\text{C}$	
Operating Ambient Humidity		$H_{OP}$	10	90	%RH	
Storage Humidity		$H_{ST}$	10	90	%RH	

- Notes : 1. Temperature and relative humidity range are shown in the figure below.  
 Wet bulb temperature should be Max 39  $^\circ\text{C}$  and no condensation of water.  
 2. Gravity mura can be guaranteed below 40 $^\circ\text{C}$  condition.



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### 3. Electrical Specifications

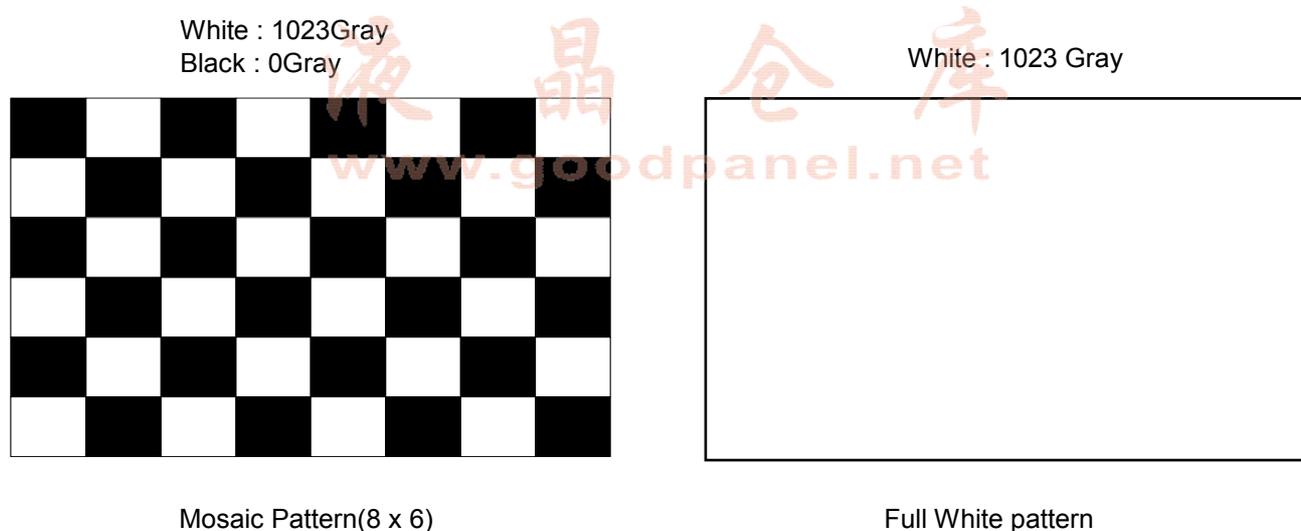
#### 3-1. Electrical Characteristics

It requires two power inputs. One is employed to power for the LCD circuit. The other is used for the EEFL backlight circuit.

**Table 2. ELECTRICAL CHARACTERISTICS**

Parameter	Symbol	Value			Unit	Note
		Min	Typ	Max		
Circuit :						
Power Input Voltage	V <sub>LCD</sub>	10.8	12.0	13.2	V <sub>DC</sub>	
Power Input Current	I <sub>LCD</sub>	-	706	918	mA	1
		-	1080	1400	mA	2
Power Consumption	P <sub>LCD</sub>	-	8.5	11	Watt	1
Rush current	I <sub>RUSH</sub>	-	-	4.0	A	3

- Notes :
1. The specified current and power consumption are under the  $V_{LCD}=12.0V$ ,  $25 \pm 2^{\circ}C$ ,  $f_v=120Hz$  condition whereas mosaic pattern(8 x 6) is displayed and  $f_v$  is the frame frequency.
  2. The current is specified at full white pattern.
  3. Permissible power ripple should be measured under  $V_{LCD} = 12.0V$ ,  $25^{\circ}C$ ,  $f_v = 120Hz$  condition. LGD recommend the bandwidth configuration of oscilloscope is to be under 20MHz. And the Power input ripple is specified at full white pattern.
  4. The duration of rush current is about 2ms and rising time of power input is 0.5ms (min.).



## Product Specification

Table 3. ELECTRICAL CHARACTERISTICS of Back Light Assembly &amp; Lamp (Continue)

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
<b>Backlight Assembly :</b>						
Operating Voltage (one side, f <sub>BL</sub> =63KHz, I <sub>BL</sub> = 120mA <sub>RMS</sub> )	V <sub>BL</sub>	950	1100	1180	V <sub>RMS</sub>	1, 2
Operating Current (one side)	I <sub>BL</sub>	112	120	128	mA <sub>RMS</sub>	1
Established Starting Voltage (one side)	0℃	-	-	1045	V <sub>RMS</sub>	1, 3
	25℃	-	-	900		
Operating Frequency	f <sub>BL</sub>	61	63	65	KHz	4
Striking Time	S TIME	-	-	2	sec	3
Power Consumption	P <sub>BL</sub>	-	110	120	Watt	6
Burst Dimming Duty	{a/T} * 100	20	-	100	%	9
Burst Dimming Frequency	1/T	95	-	182	Hz	9
Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
<b>Lamp : APPENDIX-XIII</b>						
Lamp Voltage (one side)	V <sub>LAMP</sub>	820	1050	1140	V <sub>RMS</sub>	2
Lamp Current (one side)	I <sub>LAMP</sub>	3	7.5	8	mA <sub>RMS</sub>	
Discharge Stabilization Time	T <sub>S</sub>	-	-	3	Min	5
Lamp Frequency	f <sub>LAMP</sub>	40	63	80	KHz	
Lamp Temperature	T <sub>LAMP</sub>			130	℃	
Established Starting Voltage (one side)	0℃	-	-	1045	V <sub>RMS</sub>	3
	25℃	-	-	900		
Life Time		50,000			Hrs	7

Notes : The design of the inverter must have specifications for the lamp in LCD Assembly.

The electrical characteristics of inverter are based on High-High Driving type.

The performance of the lamps in LCM, for example life time or brightness, is extremely influenced by the characteristics of the DC-AC inverter. So, all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter.

When you design or order the inverter, please make sure unwanted lighting caused by the mismatch of the lamp and the inverter (no lighting, flicker, etc) has never been occurred. When you confirm it, the LCD- Assembly should be operated in the same condition as installed in your instrument.

※ Do not attach a conductive tape to lamp connecting wire.

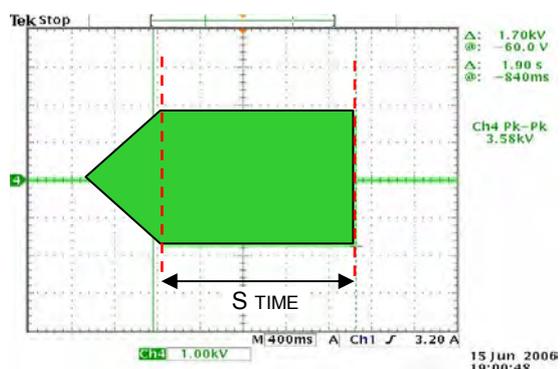
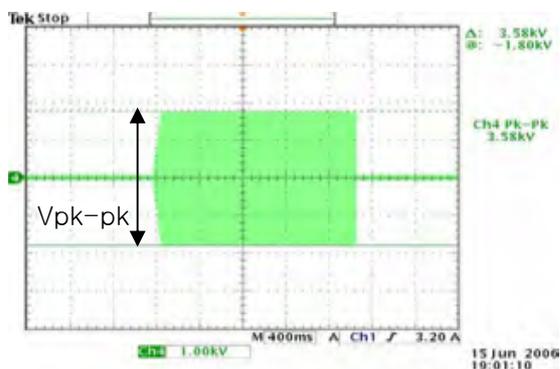
If you attach conductive tape to the lamp wire, not only luminance level can be lower than typical one but also inverter operate abnormally on account of leakage current which is generated between lamp wire and conductive tape.

1. Specified values are defined for a Backlight Assembly.( I<sub>BL</sub> : 16 lamp, 7.5mA/Lamp)

2. Operating voltage is measured at 25 ± 2℃(after 2hr.aging). The variance range for operating voltage is ± 10%.

3. The established starting voltage [ Vs ] should be applied to the lamps for more than Striking time (S TIME) for start-up. Inverter open voltage must be more than established starting voltage. Otherwise, the lamps may not be turned on. The used lamp current is typical value.

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$$V_s = (V_{pk-pk}) / [2 \cdot \sqrt{2}]$$

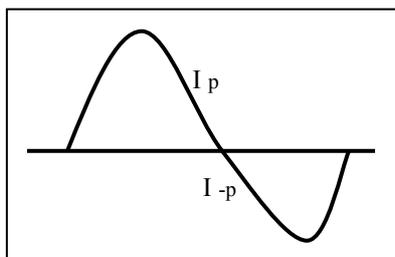
4. Lamp frequency may produce interference with horizontal synchronous frequency. As a result, they may cause beat on the display. Therefore, lamp frequency shall be away as much as possible from the horizontal synchronous frequency and its harmonics range in order to prevent interference.
5. The brightness of the lamp after lighted for 5 minutes is defined as 100%.  
 $T_s$  is the time required for the brightness of the center of the lamp to be not less than 95% at typical current. The screen of LCD module may be partially dark by the time the brightness of lamp is stable after turn on.
6. Maximum level of power consumption is measured at initial turn on.  
 Typical level of power consumption is measured after 2hrs aging at  $25 \pm 2^\circ\text{C}$ .
7. The life time is determined as the time at which brightness of the lamp is 50% compared to that of initial value at the typical lamp current on condition of continuous operating at  $25 \pm 2^\circ\text{C}$ , based on duty 100%.
8. The output of the inverter must have symmetrical (negative and positive) voltage and current waveform (Unsymmetrical ratio is less than 10%). Please do not use the inverter which has not only unsymmetrical voltage and current but also spike wave.

Requirements for a system inverter design, which is intended to achieve better display performance, power efficiency and more reliable lamp characteristics.

It can help increase the lamp lifetime and reduce leakage current.

- a. The asymmetry rate of the inverter waveform should be less than 10%.
- b. The distortion rate of the waveform should be within  $\sqrt{2} \pm 10\%$ .

\* Inverter output waveform had better be more similar to ideal sine wave.



\* Asymmetry rate:

$$|I_p - I_{-p}| / I_{op} \times 100\%$$

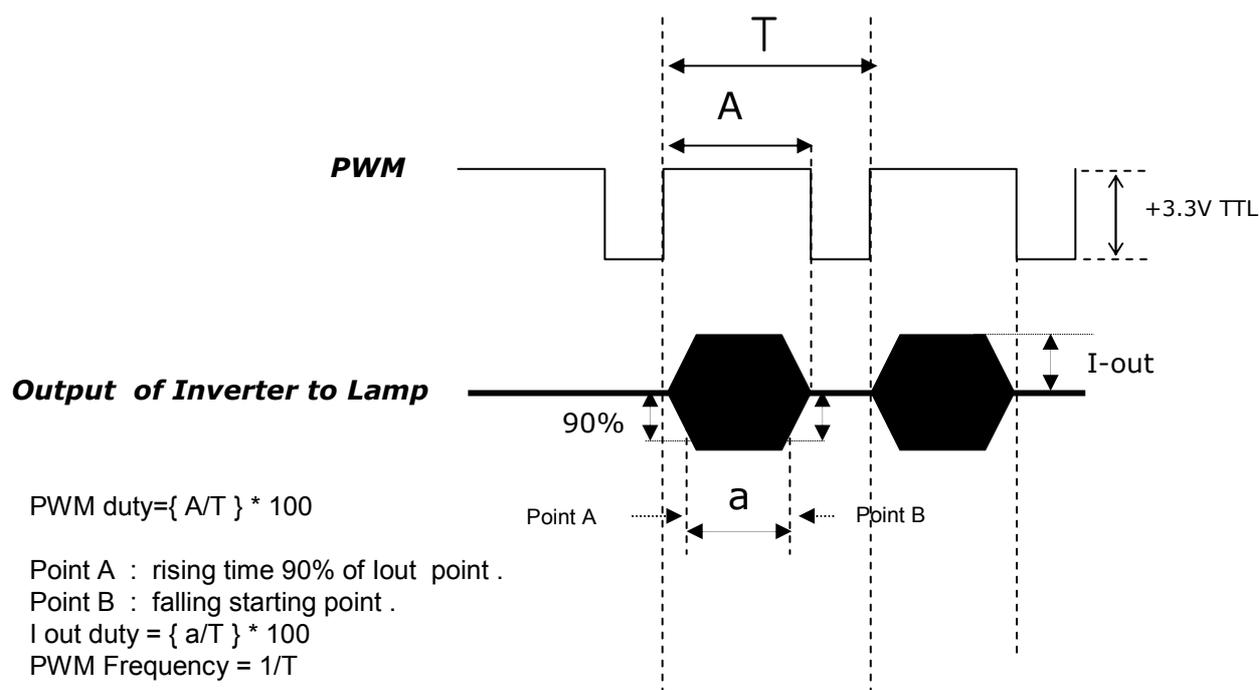
\* Distortion rate

$$I_p \text{ (or } I_{-p}) / I_{op}$$

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## 9. The reference method of burst dimming duty ratio.

It is recommended to use synchronous V-sync frequency to prevent waterfall  
(Vsync x 1 =Burst Frequency)



※ We recommend not to be much different between PWM duty and Iout duty .

※ Dimming current output rising and falling time may produce humming and inverter trans' sound noise.

※ Burst dimming duty should be 100% for more than 1second after turn on.

※ Equipment

Oscilloscope :TDS3054B(Tektronix)

Current Probe : P6022 AC (Tektronix)

High Voltage Probe: P5100(Tektronix)

10. The Cable between the backlight connector and its inverter power supply should be connected directly with a minimized length. The longer cable between the backlight and the inverter may cause the lower luminance of lamp and may require more higher starting voltage ( Vs ).

11. The operating current must be measured as near as backlight assembly input.

12. The operating current unbalance between left and right must be under 10% of Typical current  
| Left(Master) current – Right(Slave) Current | < 10% of typical current

13. The measurement method of  $V_{BL}$  &  $I_{BL}$  refer to appendix VIII.

## Product Specification

**3-2. Interface Connections**

This LCD module employs two kinds of interface connection, 51-pin and 41-pin connector are used for the module electronics and two 3-pin Balance PCB connectors are used for the integral backlight system.

**3-2-1. LCD Module**

- LCD Connector(CN1): FI-RE51S-HF(manufactured by JAE)

Refer to below and next Page table

- Mating Connector : FI-RE51HL(JAE) or compatible

**Table 4-1. MODULE CONNECTOR(CN1) PIN CONFIGURATION**

No	Symbol	Description	No	Symbol	Description
1	Rotation	'H' = Enable , 'L or NC' = Disable	27	Bit Select	'H' or NC= 10bit(D) , 'L' = 8bit
2	NC	No Connection	28	R2AN	SECOND LVDS Receiver Signal (A-)
3	NC	No Connection	29	R2AP	SECOND LVDS Receiver Signal (A+)
4	NC	No Connection	30	R2BN	SECOND LVDS Receiver Signal (B-)
5	NC	No Connection	31	R2BP	SECOND LVDS Receiver Signal (B+)
6	NC	No Connection	32	R2CN	SECOND LVDS Receiver Signal (C-)
7	LVDS Select	'H' =JEIDA , 'L' or NC = VESA	33	R2CP	SECOND LVDS Receiver Signal (C+)
8	NC	No Connection	34	GND	Ground
9	NC	No Connection	35	R2CLKN	SECOND LVDS Receiver Clock Signal(-)
10	NC	No Connection	36	R2CLKP	SECOND LVDS Receiver Clock Signal(+)
11	GND	Ground	37	GND	Ground
12	R1AN	FIRST LVDS Receiver Signal (A-)	38	R2DN	SECOND LVDS Receiver Signal (D-)
13	R1AP	FIRST LVDS Receiver Signal (A+)	39	R2DP	SECOND LVDS Receiver Signal (D+)
14	R1BN	FIRST LVDS Receiver Signal (B-)	40	R2EN	SECOND LVDS Receiver Signal (E-)
15	R1BP	FIRST LVDS Receiver Signal (B+)	41	R2EP	SECOND LVDS Receiver Signal (E+)
16	R1CN	FIRST LVDS Receiver Signal (C-)	42	Reserved	No connection or GND
17	R1CP	FIRST LVDS Receiver Signal (C+)	43	Reserved	No connection or GND
18	GND	Ground	44	GND	Ground
19	R1CLKN	FIRST LVDS Receiver Clock Signal(-)	45	GND	Ground
20	R1CLKP	FIRST LVDS Receiver Clock Signal(+)	46	GND	Ground
21	GND	Ground	47	NC	No connection
22	R1DN	FIRST LVDS Receiver Signal (D-)	48	VLCD	Power Supply +12.0V
23	R1DP	FIRST LVDS Receiver Signal (D+)	49	VLCD	Power Supply +12.0V
24	R1EN	FIRST LVDS Receiver Signal (E-)	50	VLCD	Power Supply +12.0V
25	R1EP	FIRST LVDS Receiver Signal (E+)	51	VLCD	Power Supply +12.0V
26	Reserved	No connection or GND	-	-	-

- Notes :
1. All GND(ground) pins should be connected together to the LCD module's metal frame.
  2. All VLCD (power input) pins should be connected together.
  3. All Input levels of LVDS signals are based on the EIA 644 Standard.
  4. Specific pins(pin No. #2~#6) are used for internal data process of the LCD module.  
If not used, these pins are no connection.
  5. LVDS pin (pin No. #24,25,40,41) are used for 10Bit(D) of the LCD module.  
If used for 8Bit(R), these pins are no connection.
  6. Specific pin No. #44 is used for "No signal detection" of system signal interface.  
It should be GND for NSB(No Signal Black) during the system interface signal is not.  
If this pin is "H", LCD Module displays AGP(Auto Generation Pattern).

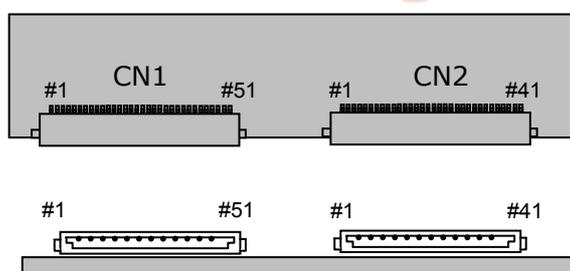
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- LCD Connector(CN2): FI-RE41S-HF, Refer to below table
- Mating Connector : FI-RE41HL

**Table 4-2. MODULE CONNECTOR(CN2) PIN CONFIGURATION**

No	Symbol	Description	No	Symbol	Description
1	NC	No connection(Reserved)	22	R3EN	THIRD LVDS Receiver Signal (E-)
2	NC	No connection	23	R3EP	THIRD LVDS Receiver Signal (E+)
3	NC	No connection	24	GND	Ground
4	NC	No connection	25	GND	Ground
5	NC	No connection	26	R4AN	FORTH LVDS Receiver Signal (A-)
6	NC	No connection	27	R4AP	FORTH LVDS Receiver Signal (A+)
7	NC	No connection	28	R4BN	FORTH LVDS Receiver Signal (B-)
8	NC	No connection	29	R4BP	FORTH LVDS Receiver Signal (B+)
9	GND	Ground	30	R4CN	FORTH LVDS Receiver Signal (C-)
10	R3AN	THIRD LVDS Receiver Signal (A-)	31	R4CP	FORTH LVDS Receiver Signal (C+)
11	R3AP	THIRD LVDS Receiver Signal (A+)	32	GND	Ground
12	R3BN	THIRD LVDS Receiver Signal (B-)	33	R4CLKN	FORTH LVDS Receiver Clock Signal(-)
13	R3BP	THIRD LVDS Receiver Signal (B+)	34	R4CLKP	FORTH LVDS Receiver Clock Signal(+)
14	R3CN	THIRD LVDS Receiver Signal (C-)	35	GND	Ground
15	R3CP	THIRD LVDS Receiver Signal (C+)	36	R4DN	FORTH LVDS Receiver Signal (D-)
16	GND	Ground	37	R4DP	FORTH LVDS Receiver Signal (D+)
17	R3CLKN	THIRD LVDS Receiver Clock Signal(-)	38	R4EN	FORTH LVDS Receiver Signal (E-)
18	R3CLKP	THIRD LVDS Receiver Clock Signal(+)	39	R4EP	FORTH LVDS Receiver Signal (E+)
19	GND	Ground	40	GND	Ground
20	R3DN	THIRD LVDS Receiver Signal (D-)	41	GND	Ground
21	R3DP	THIRD LVDS Receiver Signal (D+)	-		

- Notes : 1. All GND(ground) pins should be connected together to the LCD module's metal frame.  
 2. LVDS pin (pin No. #22,23,38,39) are used for 10Bit(D) of the LCD module.  
 If used for 8Bit(R), these pins are no connection.

**Rear view of LCM**

- [CN1]  
 - Part/No. : FI-RE51S-HF(JAE)  
 - Mating connector : FI-RE51HL  
 (Manufactured by JAE)
- [CN2]  
 - Part/No. : FI-RE41S-HF(JAE)  
 - Mating connector : FI-RE41HL  
 (Manufactured by JAE)

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## 3-2-2. Backlight Module

**[ Master ]****1) Balance Connector**

: 65002WS-03 (manufactured by YEONHO) or equivalent

**2) Mating Connector**

: 65002HS-03 (manufactured by YEONHO) or equivalent.

**[ Slave ]****1) Balance Connector**

: 65002WS-03 (manufactured by YEONHO) or equivalent

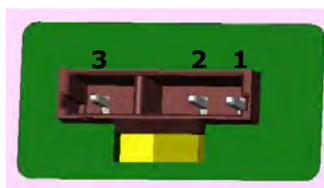
**2) Mating Connector**

: 65002HS-03 (manufactured by YEONHO) or equivalent.

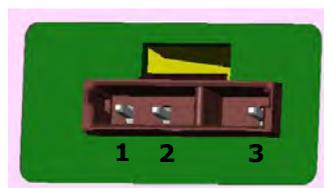
Table 5. BACKLIGHT CONNECTOR PIN CONFIGURATION(CN2,CN3)

No	Symbol	Master	Slave	Note
1	H_Input	High_Input	High_Input	
2	H_Input	High_Input	High_Input	
3	FB	NC	NC	

## ◆ Rear view of LCM



Master



Slave

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## Product Specification

### 3-3. Signal Timing Specifications

Table 6 shows the signal timing required at the input of the LVDS transmitter. All of the interface signal timing should be satisfied with the following specification for normal operation.

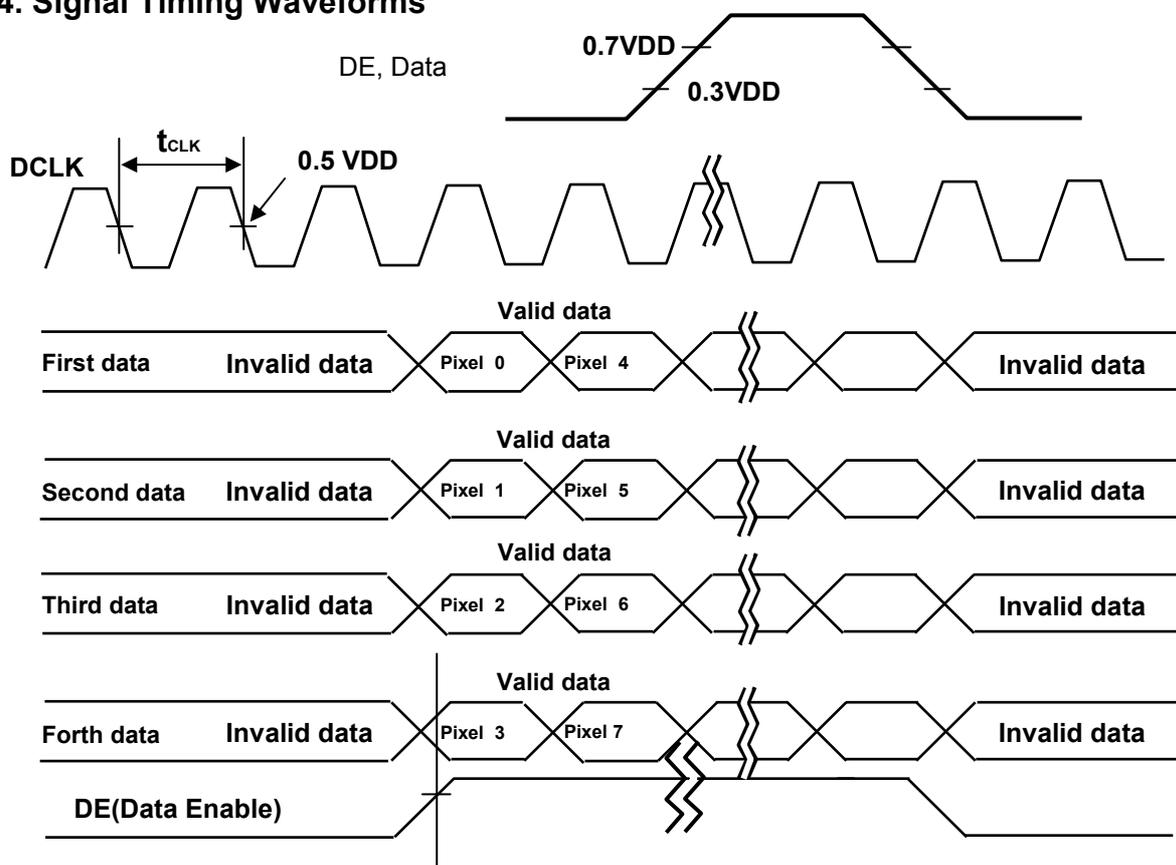
**Table6. TIMING TABLE for NTSC/PAL (DE Only Mode)**

ITEM		Symbol	Min	Typ	Max	Unit	Note
Horizontal	Display Period	$t_{HV}$	480	480	480	$t_{CLK}$	1920/4
	Blank	$t_{HB}$	40	70	200	$t_{CLK}$	1
	Total	$t_{HP}$	520	550	680	$t_{CLK}$	
Vertical	Display Period	$t_{VV}$	1080	1080	1080	Lines	
	Blank	$t_{VB}$	10	45	300	Lines	1
	Total	$t_{VP}$	1090	1125	1380	Lines	

ITEM		Symbol	Min	Typ	Max	Unit	Note
Frequency	DCLK	$f_{CLK}$	66.97	74.25	78.00	MHz	
	Horizontal	$f_H$	121.8	135	136.4	KHz	2
	Vertical	$f_V$	95	120	121.2	Hz	2

- Note : 1. The Input of HSYNC & VSYNC signal does not have an effect on normal operation(DE Only Mode).  
If you use spread spectrum for EMI, add some additional clock to minimum value for clock margin.
2. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rate and the horizontal frequency.
3. Vertical Frequency : NTSC – 57~63Hz  
PAL – 47~53Hz

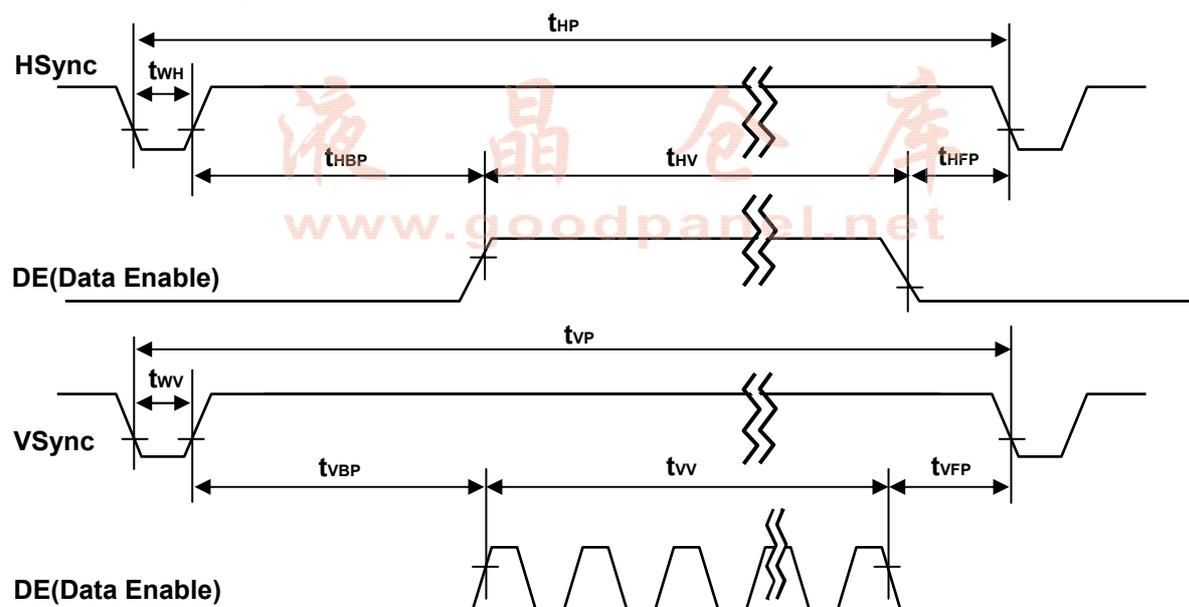
### 3-4. Signal Timing Waveforms



\*  $t_{HB} = t_{HFP} + t_{WH} + t_{HBP}$

\*  $t_{VB} = t_{VFP} + t_{VW} + t_{VBP}$

#### \* Reference : Sync. Relation



## Product Specification

## 3-5. Color Data Reference

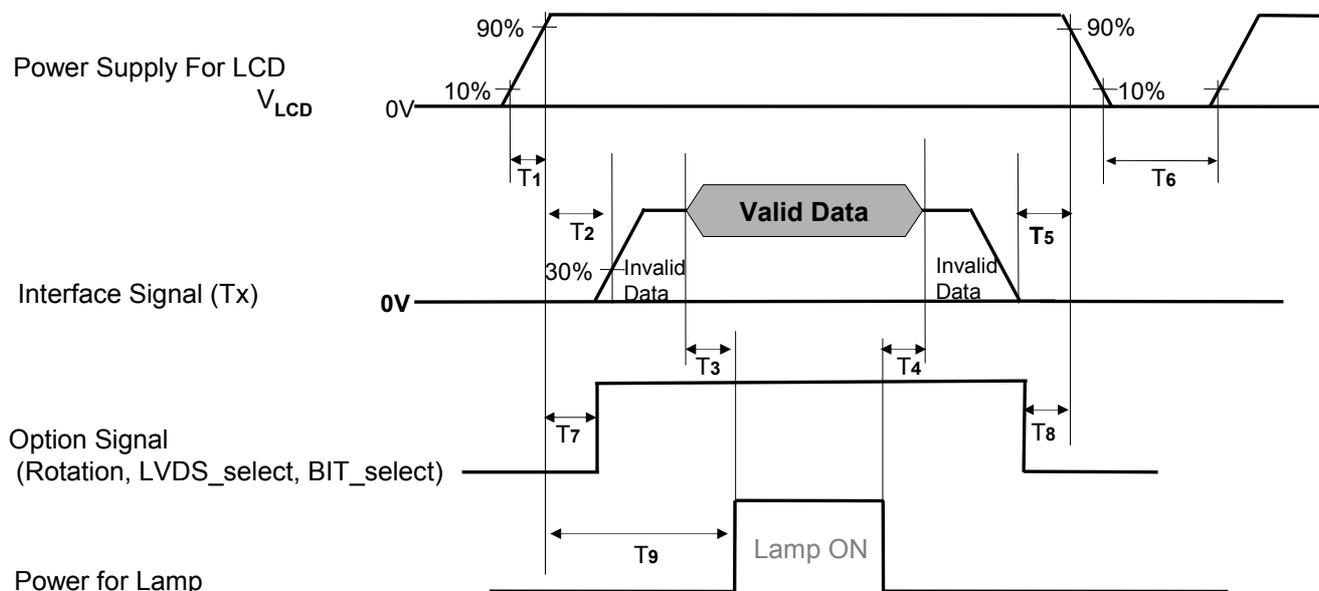
The brightness of each primary color(red,green,blue) is based on the 10-bit gray scale data input for the color. The higher binary input, the brighter the color. Table 7 provides a reference for color versus data input.

Table 7. COLOR DATA REFERENCE

Color		Input Color Data																													
		RED										GREEN										BLUE									
		MSB	LSB								MSB	LSB								MSB	LSB										
		R9	R8	R7	R6	R5	R4	R3	R2	R1	R0	G9	G8	G7	G6	G5	G4	G3	G2	G1	G0	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (1023)	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (1023)	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
	Blue (1023)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	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	1	1	1	1	1	1	1	1	1	1	1	1
RED	RED (000)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	RED (001)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	RED (1019)	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (1020~1023)	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN (000)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	GREEN (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	GREEN (1019)	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
	GREEN (1020~1023)	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
BLUE	BLUE (000)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	BLUE (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	BLUE (1019)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0
	BLUE (1020~1023)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1

### 3-6. Power Sequence

#### 3-6-1. LCD Driving circuit



**Table 8. POWER SEQUENCE**

Parameter	Value			Unit	Notes
	Min	Typ	Max		
T1	0.5	-	20	ms	
T2	0.5	-	-	ms	4
T3	200	-	-	ms	3
T4	200	-	-	ms	3
T5	0	-	-	ms	
T6	2.0	-	-	s	5
T7	0.5	-	T2	ms	4
T8	0	-	-	ms	4
T9	T2 + T3	-	5	s	

- Note :
1. Please avoid floating state of interface signal at invalid period.
  2. When the interface signal is invalid, be sure to pull down the power supply  $V_{LCD}$  to 0V.
  3. The T3/T4 is recommended value, the case when failed to meet a minimum specification, abnormal display would be shown. There is no reliability problem.
  4. If the on time of signals (Interface signal and Option signals) precedes the on time of Power ( $V_{LCD}$ ), it will be happened abnormal display.
  5. T6 should be measured after the Module has been fully discharged between power off and on period.

## 4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' and stable in a dark environment at  $25\pm 2^{\circ}\text{C}$ . The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of  $\phi$  and  $\theta$  equal to  $0^{\circ}$ .

FIG. 1 shows additional information concerning the measurement equipment and method.

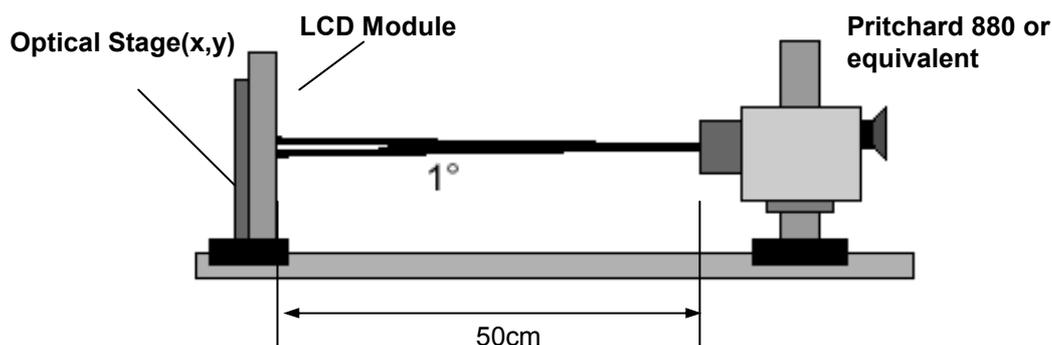


FIG. 1 Optical Characteristic Measurement Equipment and Method

$T_a = 25\pm 2^{\circ}\text{C}$ ,  $V_{\text{LCD}} = 12.0\text{V}$ ,  $f_v = 120\text{Hz}$ ,  $D_{\text{clk}} = 74.25\text{MHz}$

$I_{\text{BI}} = 120\text{mA}$

Table 9. OPTICAL CHARACTERISTICS

Parameter	Symbol		Value			Unit	Note
			Min	Typ	Max		
Contrast Ratio	CR		900	1300	-		1
Surface Luminance, white	$L_{\text{WH}}$		400	500	-	$\text{cd}/\text{m}^2$	2
Luminance Variation	$\delta_{\text{WHITE}}$	5P	-	-	1.3		3
	$\delta_{\text{BLACK}}$	5P	-	-	1.7		
Response Time	Gray-to-Gray	G to G	-	6	9	ms	4
	MPRT	MPRT	-	8	12	ms	5
	Uniformity	$\delta_{\text{MPRT}}$	-	-	1		6
	Uniformity	$\delta_{\text{G TO G}}$	-	-	1		6
Color Coordinates [CIE1931]	RED	Rx	Typ -0.03	0.638	Typ +0.03		
		Ry		0.334			
	GREEN	Gx		0.291			
		Gy		0.607			
	BLUE	Bx		0.145			
		By		0.062			
	WHITE	Wx		0.279			
		Wy		0.292			
Viewing Angle (CR>10)							
	x axis, right( $\phi=0^{\circ}$ )	$\theta_r$	89	-	-	degree	7
	x axis, left ( $\phi=180^{\circ}$ )	$\theta_l$	89	-	-		
	y axis, up ( $\phi=90^{\circ}$ )	$\theta_u$	89	-	-		
	y axis, down ( $\phi=270^{\circ}$ )	$\theta_d$	89	-	-		
Gray Scale			-	-	-		8
Cross Talk					1.8	%	9

## Product Specification

Notes :1. Contrast Ratio(CR) is defined mathematically as :

$$CR = \frac{\text{Surface Luminance at all white pixels}}{\text{Surface Luminance at all black pixels}}$$

It is measured at center 1-point.

2. Surface luminance are determined after the unit has been 'ON' and 1Hour after lighting the backlight in a dark environment at  $25 \pm 2^\circ\text{C}$ . Surface luminance is the luminance value at center 1-point across the LCD surface 50cm from the surface with all pixels displaying white. For more information see the FIG. 2.
3. The variation in surface luminance ,  $\delta$  WHITE and  $\delta$  BLACK are defined as :  
 $\delta$  WHITE(5P) = Maximum( $L_{on1}, L_{on2}, L_{on3}, L_{on4}, L_{on5}$ ) / Minimum( $L_{on1}, L_{on2}, L_{on3}, L_{on4}, L_{on5}$ )  
 $\delta$  BLACK(5P) = Maximum( $L_{on1}, L_{on2}, L_{on3}, L_{on4}, L_{on5}$ ) / Minimum( $L_{on1}, L_{on2}, L_{on3}, L_{on4}, L_{on5}$ )  
 Where Lon1 to Lon5 are the luminance with all pixels displaying white at 5 locations .  
 For more information, see the FIG. 2. (Reference Data)
4. Response time is the time required for the display to transit from G(N) to G(M) (Rise Time,  $Tr_R$ ) and from G(M) to G(N) (Decay Time,  $Tr_D$ ). For additional information see the FIG. 3. (N<M)  
 ※ G to G Spec stands for average value of all measured points.  
 Photo Detector : RD-80S / Field :  $2^\circ$
5. MPRT is defined as the 10% to 90% blur-edge width Bij(pixels) and scroll speed U(pixels/frame)at the moving picture. For more information, see FIG 4
6. Gray to Gray and MPRT Response time uniformity is Reference data. Please see Appendix X.
7. Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD module surface. For more information, see the FIG. 5.
8. Gray scale specification  
 Gamma Value is approximately 2.2. For more information, see the Table 10.
9. Crosstalk is defined as : ( $|L_{A[or C]2} - L_{A[or C]1}| / L_{A[or C]1}$ )  $\times 100(\%)$  [vertical],  
 ( $|L_{B[or D]2} - L_{B[or D]1}| / L_{B[or D]1}$ )  $\times 100(\%)$  [horizontal]  
 For more information, see FIG. 6.

**Table 10. GRAY SCALE SPECIFICATION**

Gray Level	Luminance [%] (Typ.)
L0	0.08
L63	0.20
L127	1.08
L191	2.07
L255	4.51
L319	7.75
L383	12.05
L447	17.06
L511	22.36
L575	28.21
L639	35.56
L703	43.96
L767	53.0
L831	63.37
L895	74.66
L959	88.17
L1023	100

Product Specification

Measuring point for surface luminance & measuring point for luminance variation.

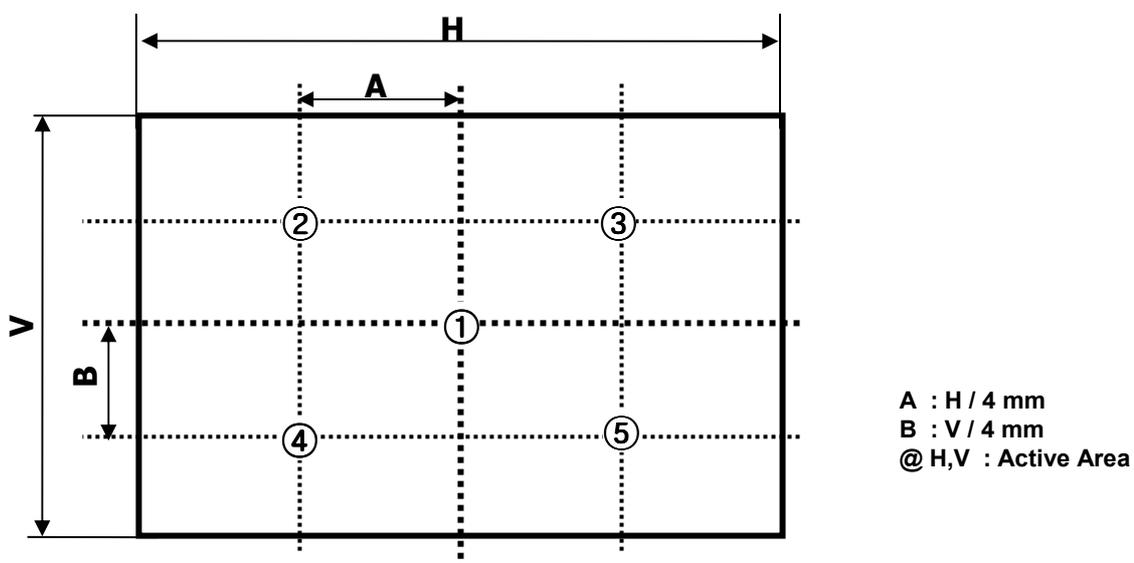


FIG. 2 5 Points for Luminance Measure

Response time is defined as the following figure and shall be measured by switching the input signal for "Gray(N)" and "Gray(M)".

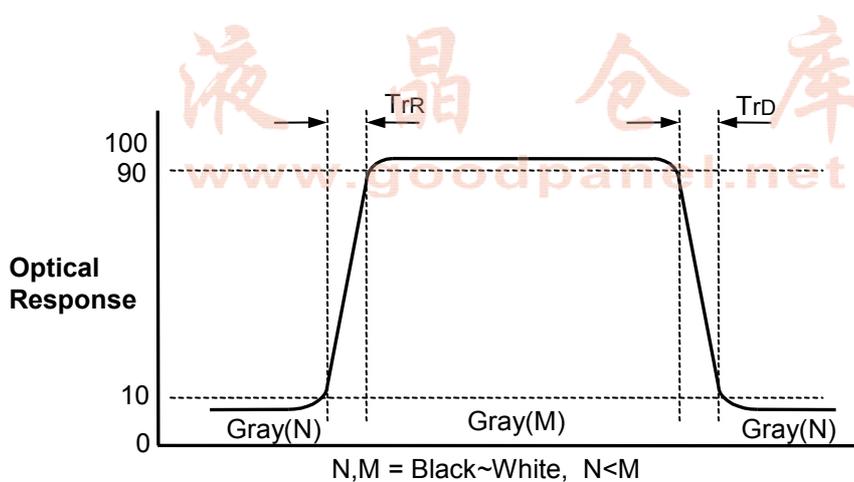


FIG. 3 Response Time

Product Specification

MPRT is defined as the 10% to 90% blur-edge with  $B_{ij}$ (pixels) and scroll speed  $U$ (pixels/frame)at the moving picture.

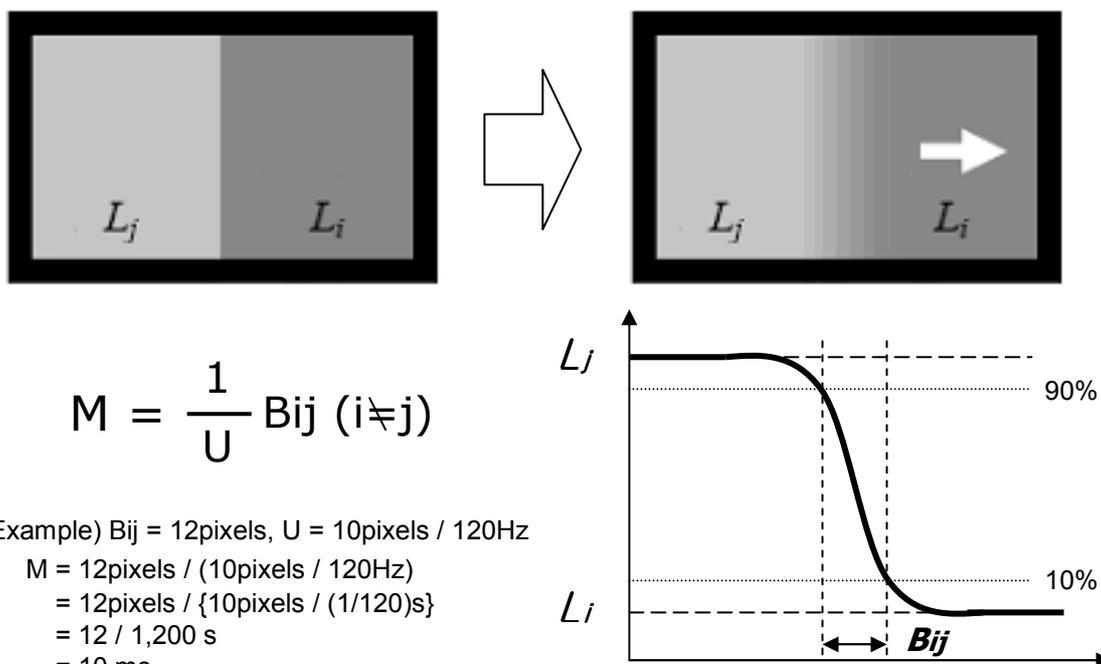


FIG. 4 MPRT

Dimension of viewing angle range

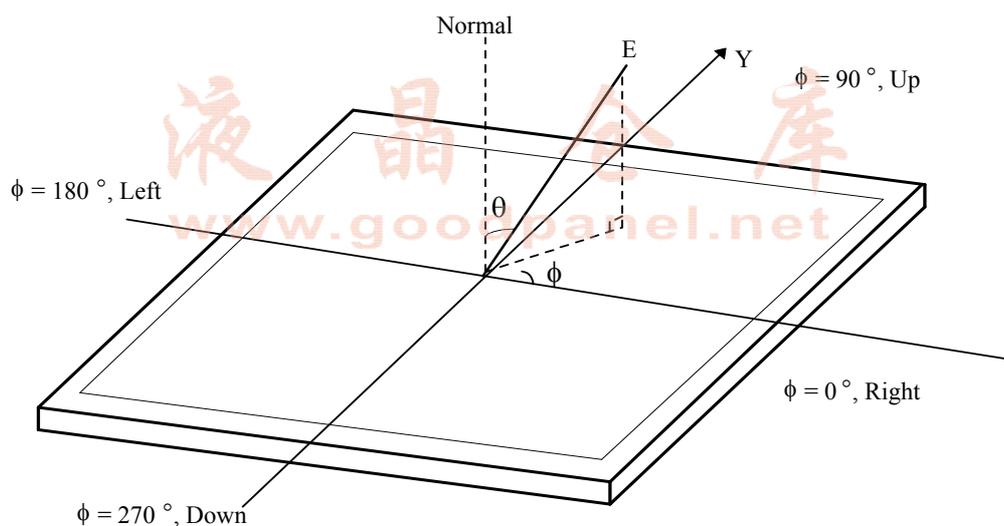


FIG. 5 Viewing Angle

## Product Specification

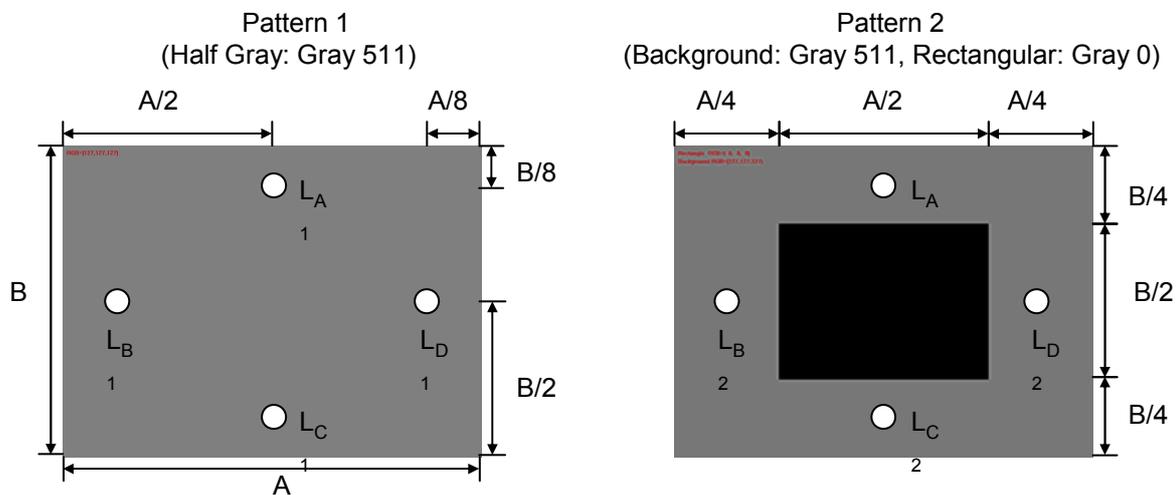


FIG. 6 Cross Talk

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## 5. Mechanical Characteristics

Table 11 provides general mechanical characteristics.

**Table 11. MECHANICAL CHARACTERISTICS**

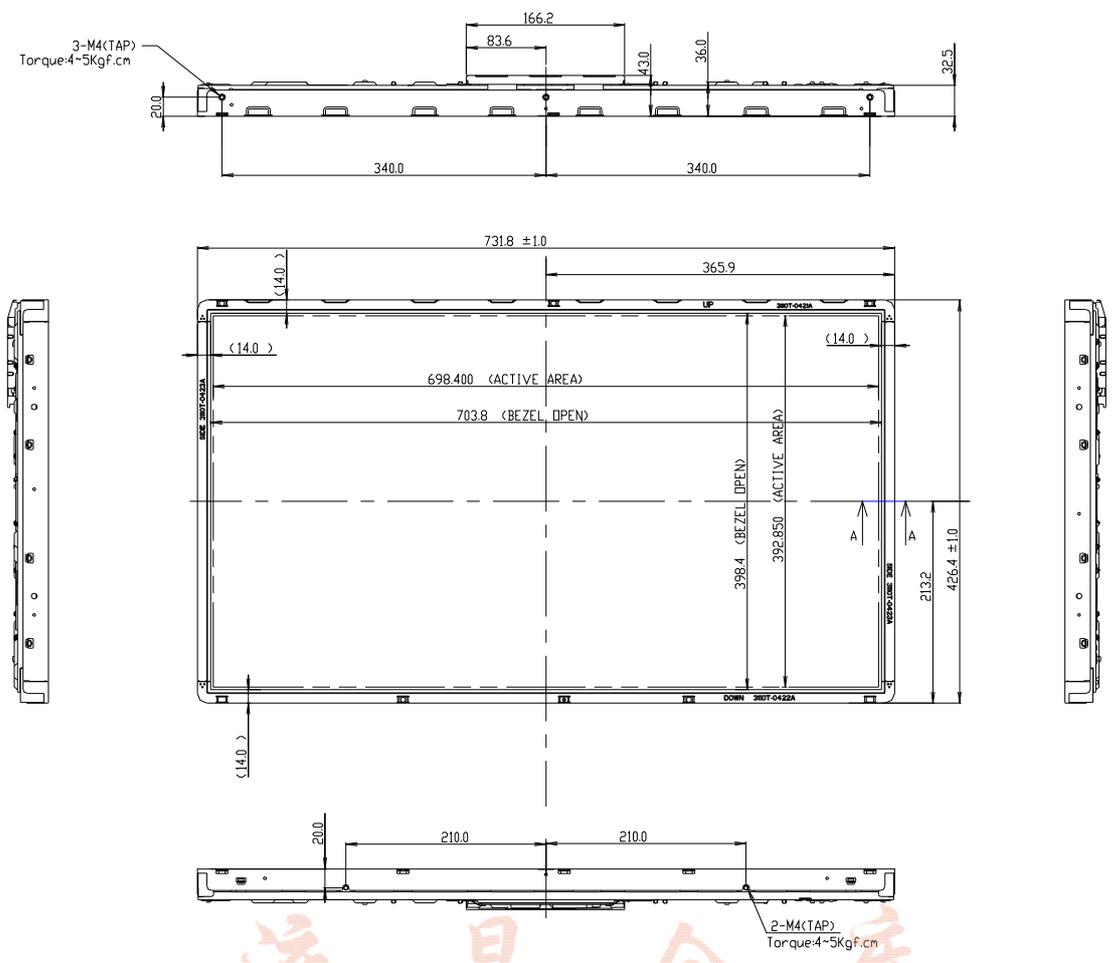
Item	Value	
Outline Dimension	Horizontal	731.8 mm
	Vertical	426.4 mm
	Depth	43.0 mm
	Body	32.5 mm
Bezel Area	Horizontal	703.8 mm
	Vertical	398.4 mm
Active Display Area	Horizontal	698.4 mm
	Vertical	392.85 mm
Weight	5.5 Kg (Typ.) , 6.0Kg (Max.)	

Note : Please refer to a mechanical drawing in terms of tolerance at the next page.

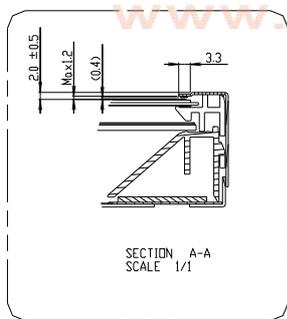
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Product Specification

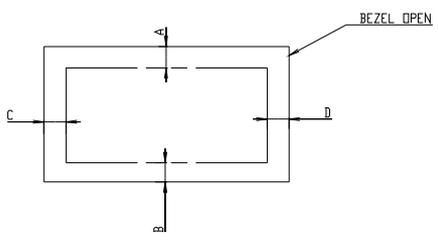
<FRONT VIEW>



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NOTES  
1) UNSPECIFIED TOLERANCES TO BE ±1.0mm  
2) TILT AND PARTIAL DISPOSITION TOLERANCE OF DISPLAY AREA ARE AS FOLLOWING  
(1) Y-DIRECTION: | A-B | < 1.5mm  
(2) X-DIRECTION: | C-D | < 1.5mm





## Product Specification

## 6. Reliability

Table 12. ENVIRONMENT TEST CONDITION

No.	Test Item	Condition
1	High temperature storage test	Ta= 60°C 75%RH 240h
2	Low temperature storage test	Ta= -20°C 240h
3	High temperature operation test	Ta= 50°C 60%RH 240h
4	Low temperature operation test	Ta= 0°C 240h
5	Vibration test (non-operating)	Wave form : random Vibration level : 1.0Grms Bandwidth : 10-300Hz Duration : X,Y,Z, 10 min One time each direction
6	Shock test (non-operating)	Shock level : 100Grms Waveform : half sine wave, 2ms Direction : ± X, ± Y, ± Z One time each direction
7	ESD test	Condition : 150pF, 330 ohm Case , air Evaluation : ± 15kV
8	Humidity condition Operation	Ta= 40 °C ,90%RH, 240h
9	Altitude operating storage / shipment	0 - 14,000 ft 0 - 40,000 ft

Note : Before and after Reliability test, LCM should be operated with normal function.

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## 7. International Standards

### 7-1. Safety

- a) UL 60065, 7<sup>th</sup> Edition, dated June 30, 2003, Underwriters Laboratories, Inc., Standard for Audio, Video and Similar Electronic Apparatus.
- b) CAN/CSA C22.2, No. 60065:03, Canadian Standards Association, Standard for Audio, Video and Similar Electronic Apparatus.
- c) IEC60065:2001, 7<sup>th</sup> Edition CB-scheme and EN 60065:2002, Safety requirements for Audio, Video and Similar Electronic Apparatus..

### 7-2. EMC

- a) ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electrical Equipment in the Range of 9kHz to 40GHz. "American National Standards Institute(ANSI), 1992
- b) CISPR13 "Limits and Methods of Measurement of Radio interference characteristics of Sound and Television broadcast receivers and associated equipment"  
CISPR22 "Limits and Methods of Measurement of Radio interference characteristics of Information Technology Equipment" International Special Committee on Radio Interference.
- c) EN55013 "Limits and Methods of Measurement of Radio interference characteristics of Sound and Television broadcast receivers and associated equipment"  
EN55022 "Limits and Methods of Measurement of Radio interference characteristics of Information Technology Equipment" European Committee for Electro Technical Standardization.(CENELEC), 1988(Including A1:2000)

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## Product Specification

**8. Packing****8-1. Information of LCM Label**

## a) Lot Mark

A	B	C	D	E	F	G	H	I	J	K	L	M
---	---	---	---	---	---	---	---	---	---	---	---	---

A,B,C : SIZE(INCH)

E : MONTH

D : YEAR

F ~ M : SERIAL NO.

## Note

## 1. YEAR

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Mark	1	2	3	4	5	6	7	8	9	0

## 2. MONTH

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	4	4	5	6	7	8	9	A	B	C

## b) Location of Lot Mark

Serial NO. is printed on the label. The label is attached to the backside of the LCD module.  
This is subject to change without prior notice.

**8-2. Packing Form**

a) Package quantity in one box : 6 pcs

b) Box size : 848mm(W) X 494mm(D) X 539mm(H)

## 9. Precautions

Please pay attention to the followings when you use this TFT LCD module.

### 9-1. Mounting Precautions

- (1) You must mount a module using specified mounting holes (Details refer to the drawings).
- (2) You should consider the mounting structure so that uneven force (ex. Twisted stress) is not applied to the module. And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
- (3) Please attach the surface transparent protective plate to the surface in order to protect the polarizer. Transparent protective plate should have sufficient strength in order to resist external force.
- (4) You should adopt radiation structure to satisfy the temperature specification.
- (5) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
- (6) Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment. Do not touch the surface of polarizer for bare hand or greasy cloth. (Some cosmetics are detrimental to the polarizer.)
- (7) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
- (8) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
- (9) Do not open the case because inside circuits do not have sufficient strength.

### 9-2. Operating Precautions

- (1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :  
 $V = \pm 200\text{mV}$  (Over and under shoot voltage)
- (2) Response time depends on the temperature. (In lower temperature, it becomes longer.)
- (3) Brightness depends on the temperature. (In lower temperature, it becomes lower.)  
 And in lower temperature, response time (required time that brightness is stable after turned on) becomes longer
- (4) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
- (5) When fixed patterns are displayed for a long time, remnant image is likely to occur.
- (6) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.
- (7) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
- (8) A screw which is fastened up the steels should be a machine screw.  
 (if not, it can cause conductive particles and deal LCM a fatal blow)
- (9) Please do not set LCD on its edge.
- (10) Partial darkness may happen during 3~5 minutes when LCM is operated initially in condition that luminance is under 40% at low temperature (under 5°C). This phenomenon which disappears naturally after 3~5 minutes is not a problem about reliability but LCD characteristic

### 9-3. Electrostatic Discharge Control

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

### 9-4. Precautions for Strong Light Exposure

Strong light exposure causes degradation of polarizer and color filter.

### 9-5. Storage

When storing modules as spares for a long time, the following precautions are necessary.

- (1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
- (2) The polarizer surface should not come in contact with any other object.  
It is recommended that they be stored in the container in which they were shipped.

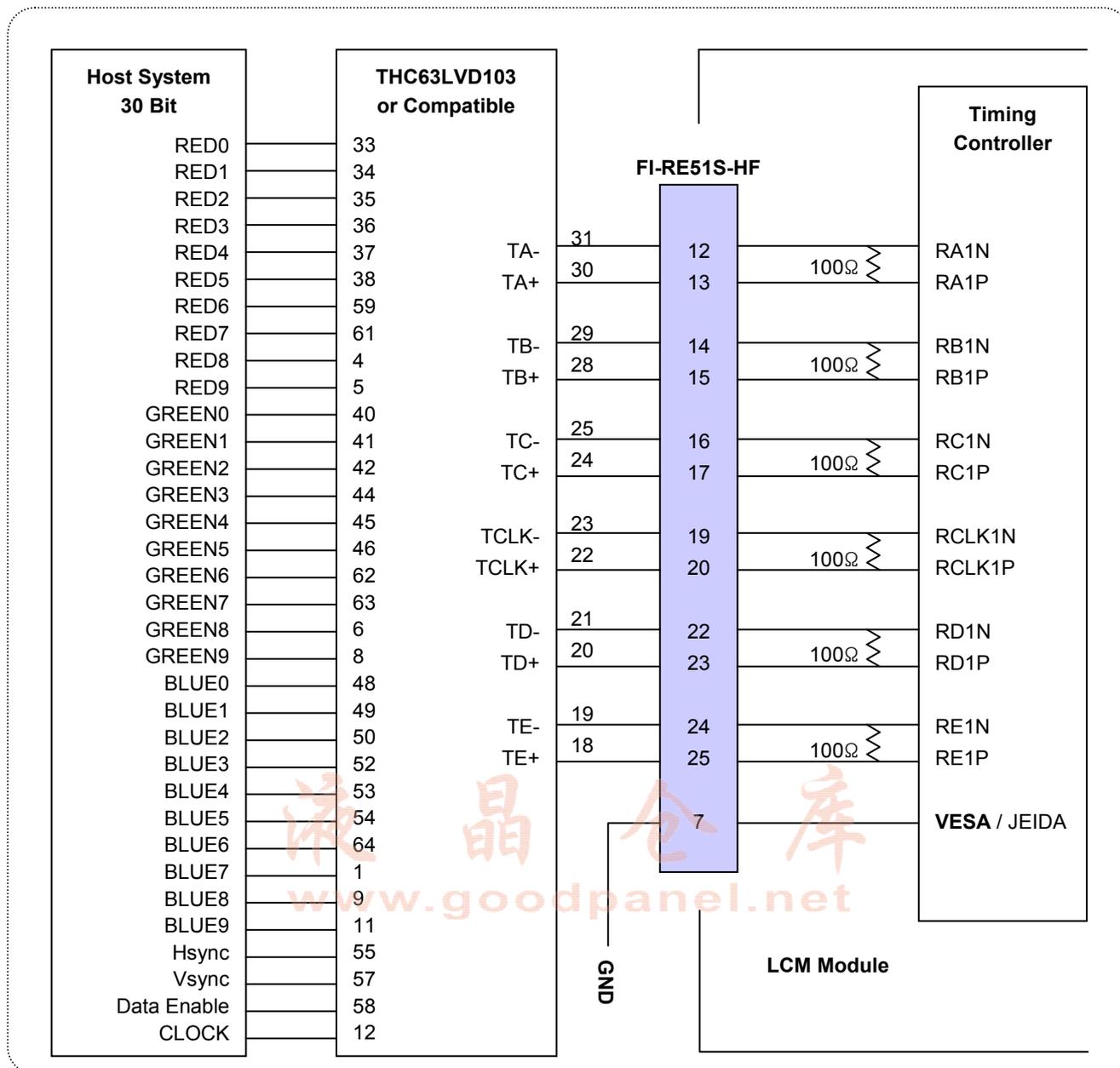
### 9-6. Handling Precautions for Protection Film

- (1) The protection film is attached to the bezel with a small masking tape.  
When the protection film is peeled off, static electricity is generated between the film and polarizer.  
This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
- (2) When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the bezel after the protection film is peeled off.
- (3) You can remove the glue easily. When the glue remains on the bezel surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.

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## # APPENDIX- I-1

## ■ Required signal assignment for Flat Link (Thine : THC63LVD103) Transmitter (Pin7="L or NC")

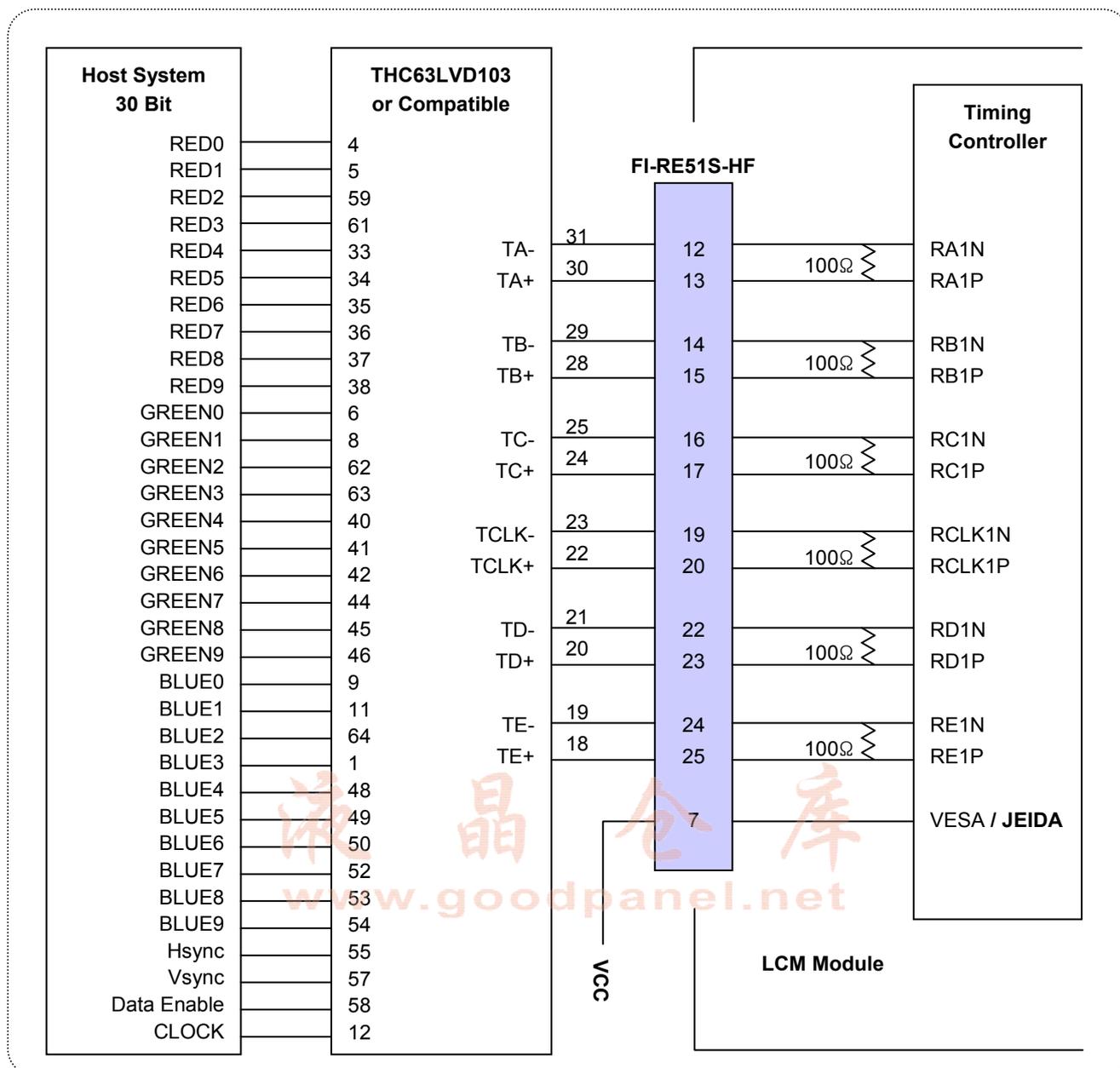


## Notes:

1. The LCD module uses a 100 Ohm( $\Omega$ ) resistor between positive and negative lines of each receiver input.
2. Refer to LVDS transmitter data sheet for detail descriptions. (THC63LVD103 or Compatible)
3. '9' means MSB and '0' means LSB at R,G,B pixel data.

## # APPENDIX- I-2

## ■ Required signal assignment for Flat Link (Thine : THC63LVD103) Transmitter (Pin7="H")



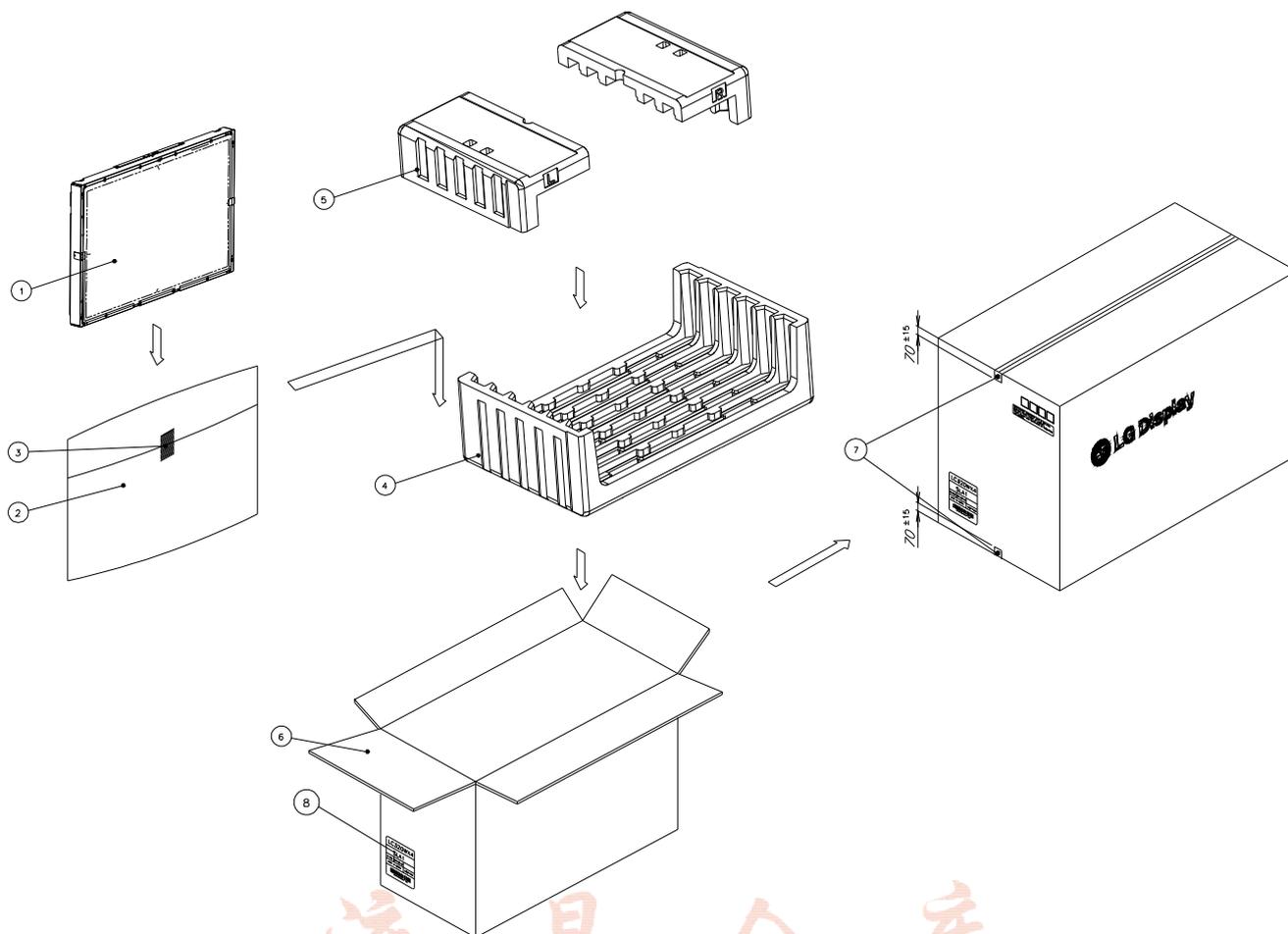
## Notes:

1. The LCD module uses a 100 Ohm( $\Omega$ ) resistor between positive and negative lines of each receiver input.
2. Refer to LVDS transmitter data sheet for detail descriptions. (THC63LVD103 or Compatible)
3. '9' means MSB and '0' means LSB at R,G,B pixel data.

## Product Specification

## # APPENDIX- II-1

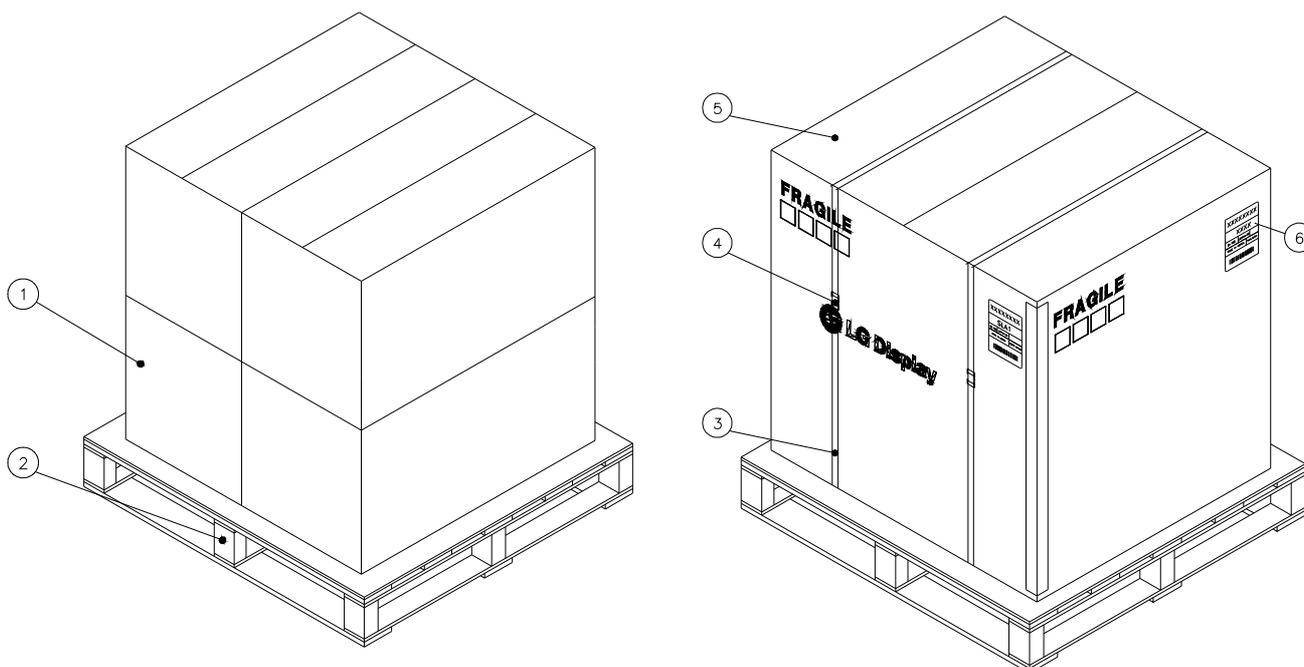
## ■ Packing Ass'y



NO.	DESCRIPTION	MATERIAL
1	LCD Module	
2	BAG	AL
3	TAPE	MASKING 20MMX50M
4	Packing	EPS
5	Packing	EPS
6	BOX	PAPER_DW3
7	TAPE	OPP 70MMX300M
8	Label	ART 100X70

## # APPENDIX- II-2

## ■ Pallet Ass'y

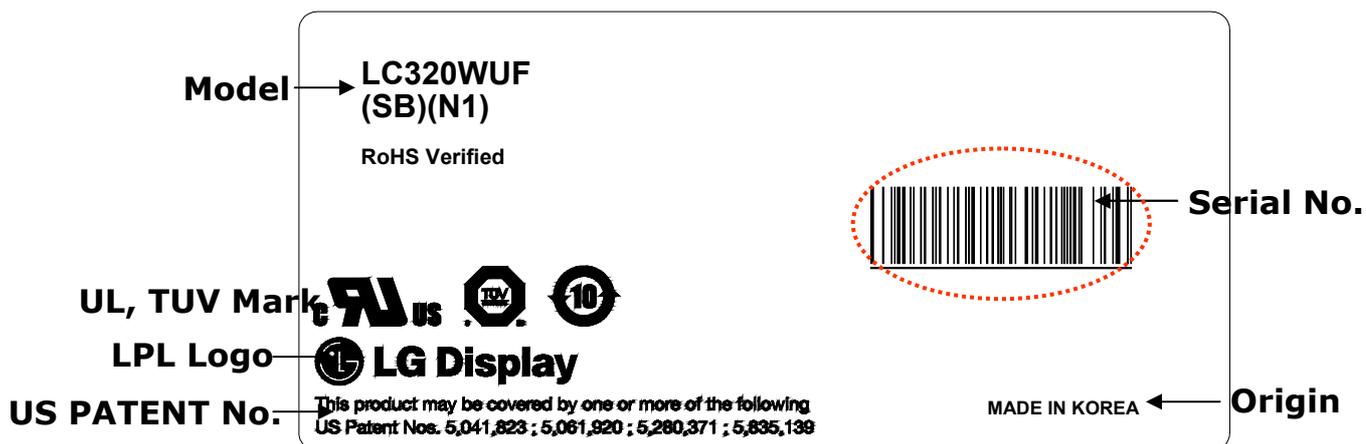


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NO.	DESCRIPTION	MATERIAL
1	PACKING ASS'Y	
2	PALLET	Plywood
3	BAND	PP
4	CLIP, BAND	STEEL
5	ANGLE, PACKING	PAPER (SWR4)
6	LABEL	PAPER

# APPENDIX- III

■ LCM Label



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## # APPENDIX- IV

## ■ Box Label and Pallet Label

## ■ Box Label

LC320WUF		
SBN1		
6 PCS	001/01-01	
MADE IN KOREA		RoHS Verified
		

## ■ Pallet Label

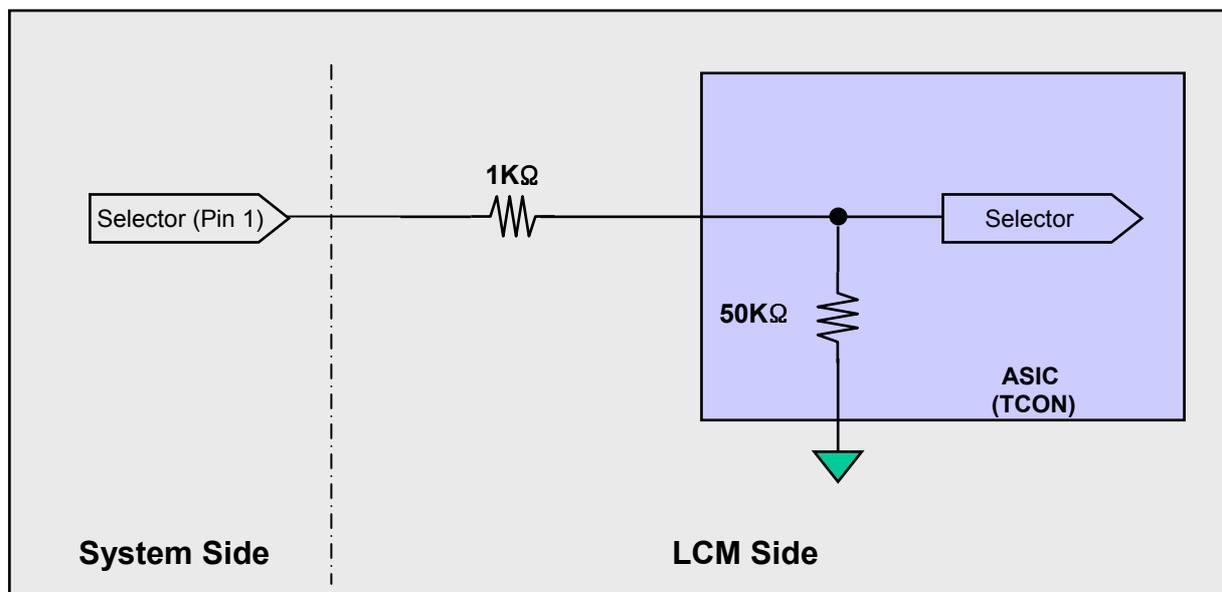
LC320WUF		
SBN1		
24 PCS	001/01-01	
MADE IN KOREA		RoHS Verified
		

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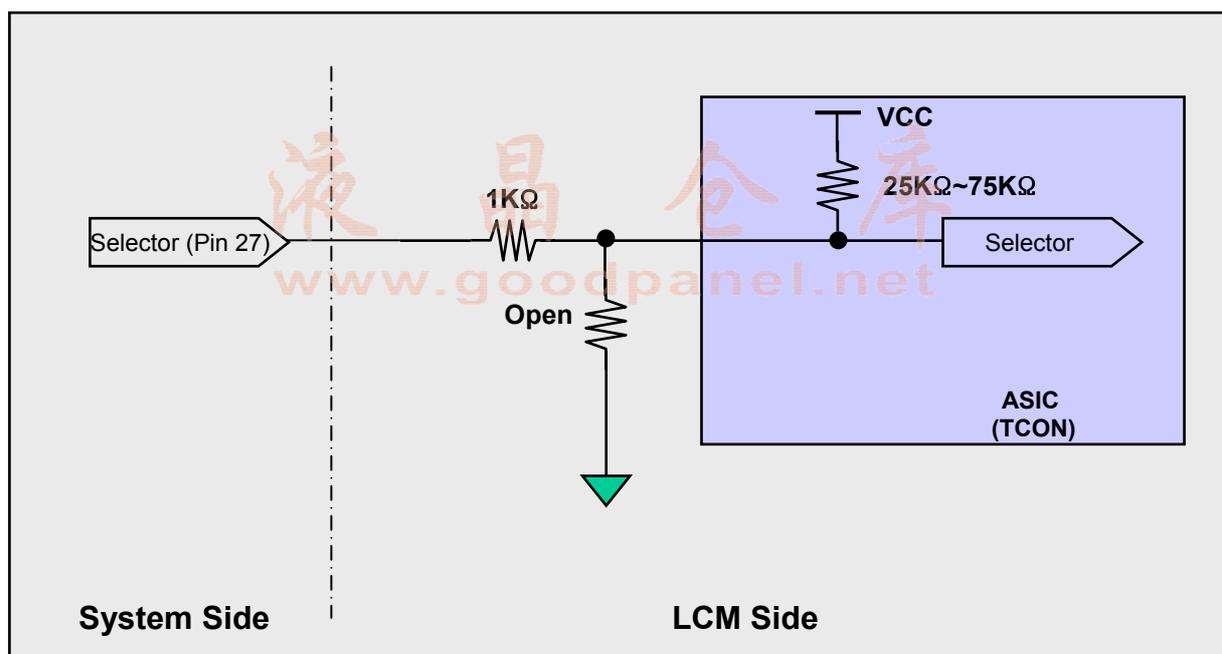
## # APPENDIX- V-1

## Option Pin Circuit Block Diagram

## Circuit Block Diagram of LVDS Format Selection pin



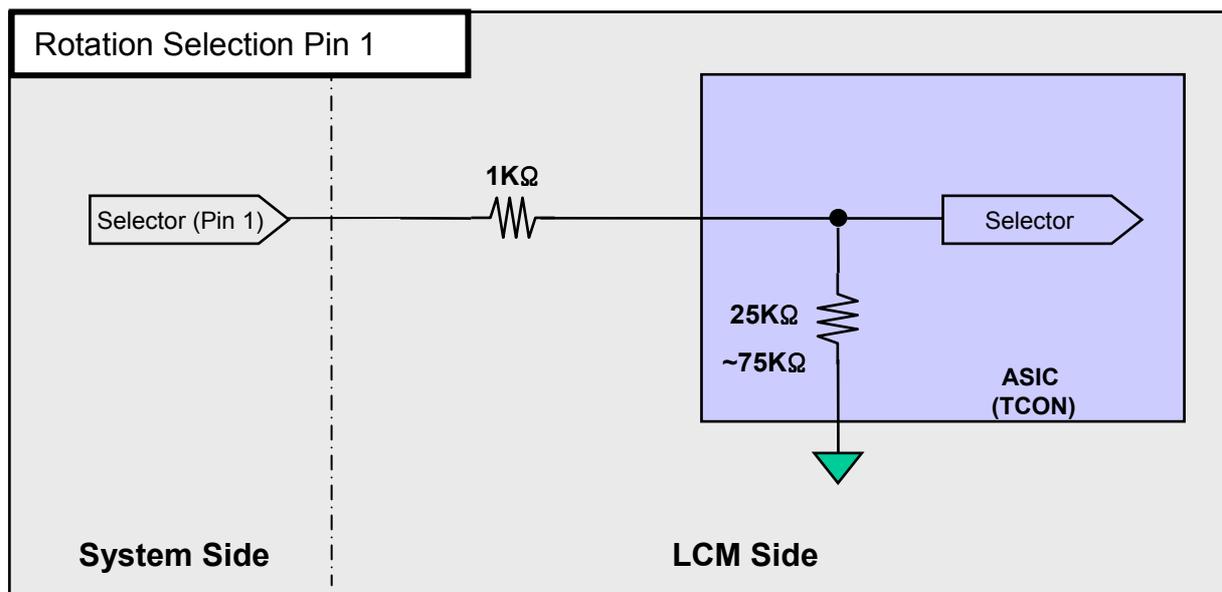
## Circuit Block Diagram of Bit Selection pin



## # APPENDIX- V-2

## Rotation Function

## Circuit Block Diagram of Rotation Enable Selection pin



- Normal operation : Pin #1 = "L or NC"

- Rotation operation : Pin #1 = "H"

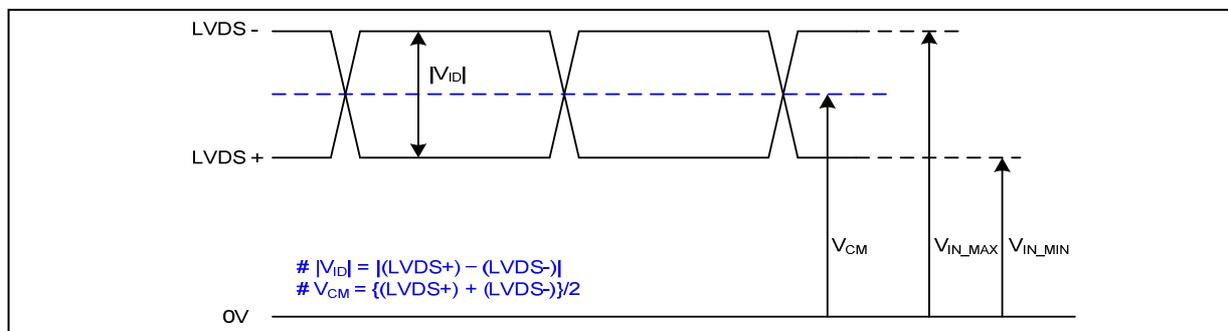
※ Rotation function exists electrically only.

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## # APPENDIX- VI-1

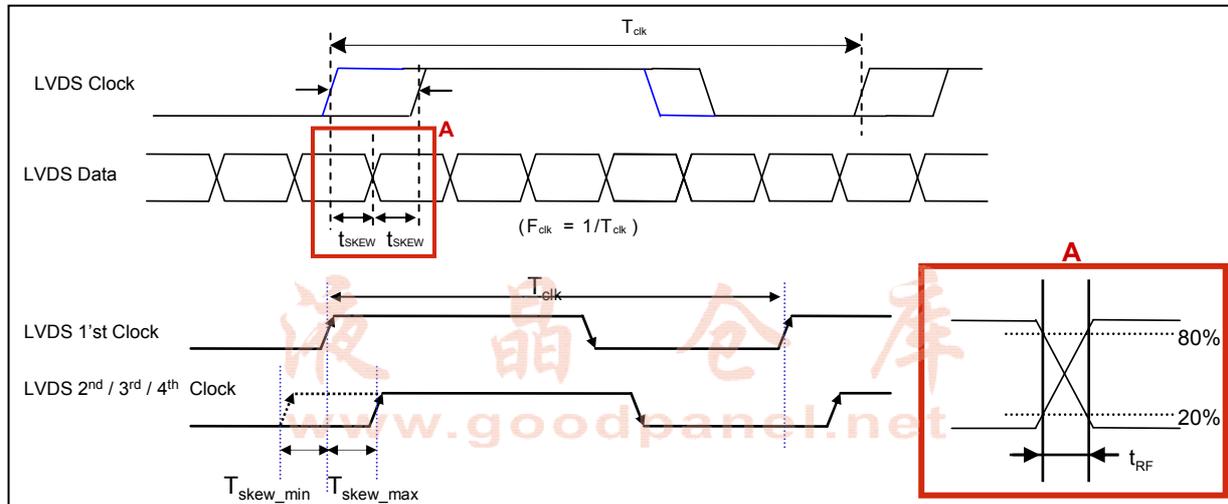
## LVDS Input characteristics

## 1. DC Specification



Description	Symbol	Min	Max	Unit	Notes
LVDS Single end Voltage	$ V_{ID} $	200	600	mV	-
LVDS Common mode Voltage	$V_{CM}$	1.1	1.5	V	-
LVDS Input Voltage Range	$V_{IN}$	0.7	1.8	V	-
Change in common mode Voltage	$\Delta V_{CM}$		250	mV	-

## 2. AC Specification

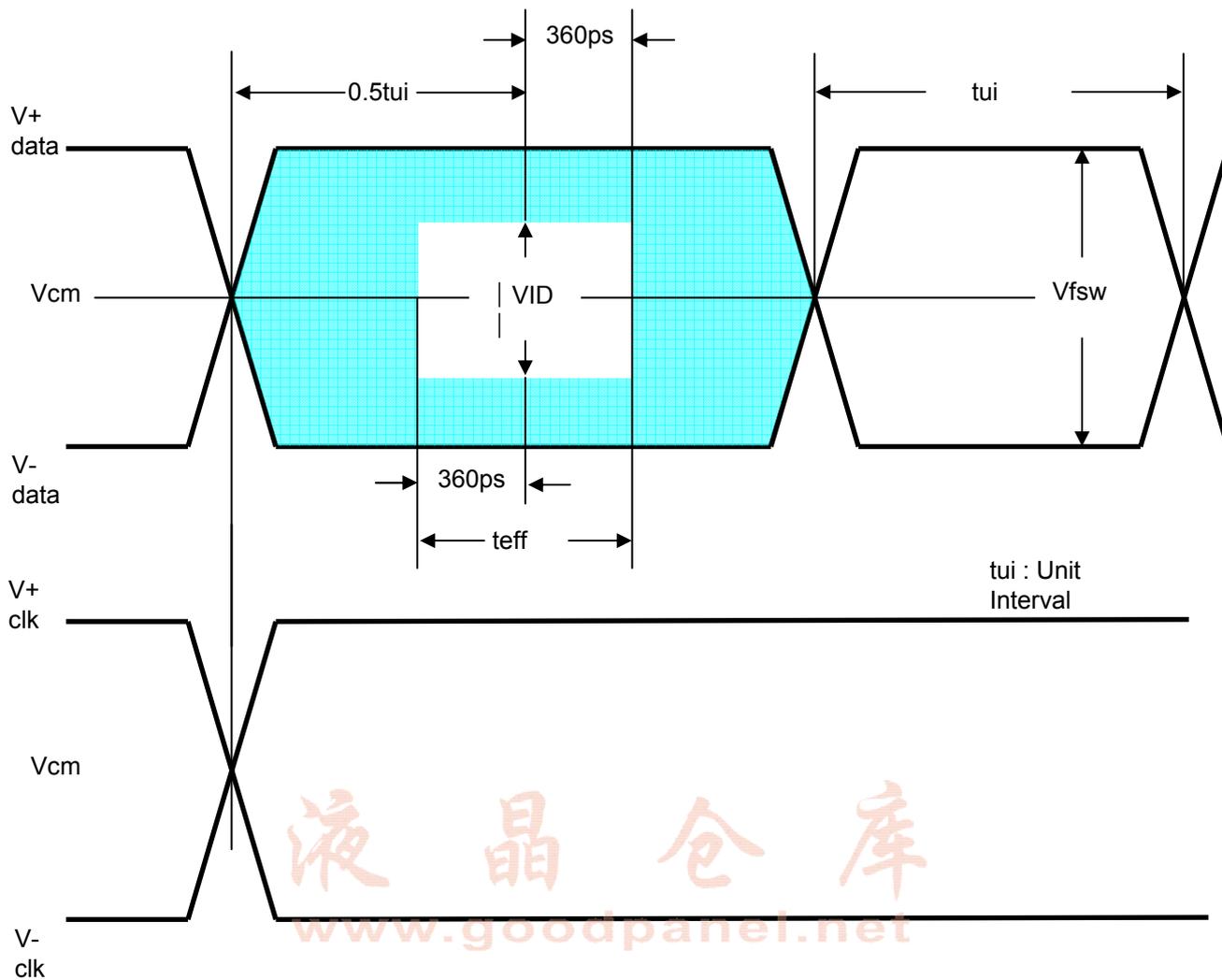


Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	$t_{SKEW}$		$ (0.25 * T_{clk})/7 $	ps	-
LVDS Clock/DATA Rising/Falling time	$t_{RF}$	260	$(0.3 * T_{clk})/7$	ps	2
Effective time of LVDS	$t_{eff}$	$\pm 360$		ps	-
LVDS Clock to Clock Skew Margin (Even to Odd)	$t_{SKEW\_EO}$		$1/7 * T_{clk}$	$T_{clk}$	-

- Notes : 1. All Input levels of LVDS signals are based on the EIA 644 Standard.  
 2. If  $t_{RF}$  isn't enough,  $t_{eff}$  should be meet the range.

# APPENDIX- VI-2

LVDS Input characteristics

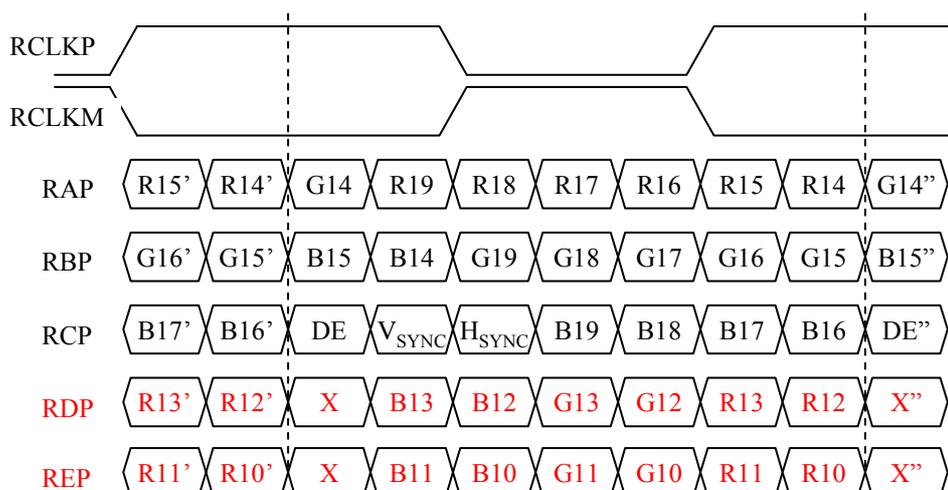


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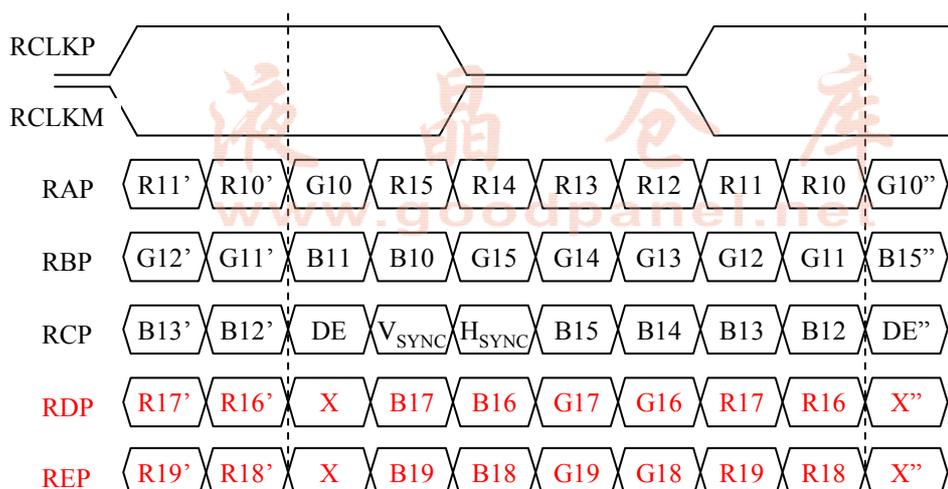
## # APPENDIX- VII-1

## LVDS Data-Mapping info. (10bit)

## ■ LVDS Select : "H" Data-Mapping (JEIDA format)



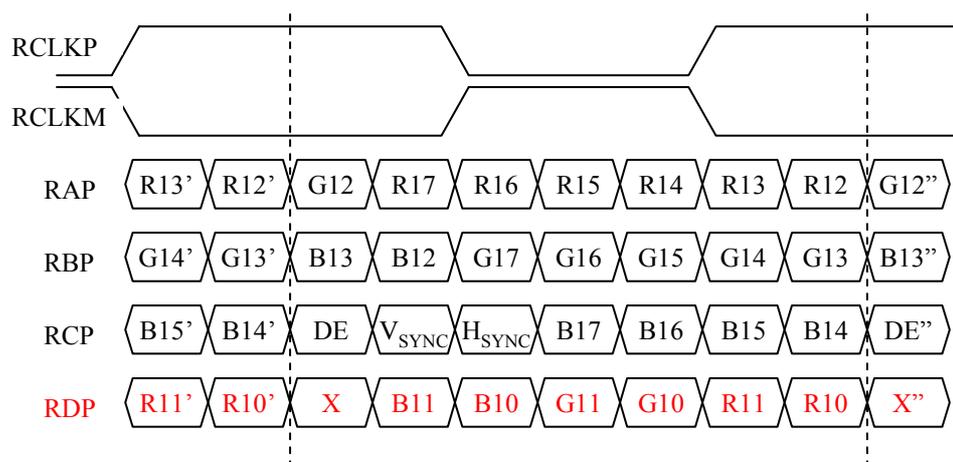
## ■ LVDS Select : "L" Data-Mapping (VESA format)



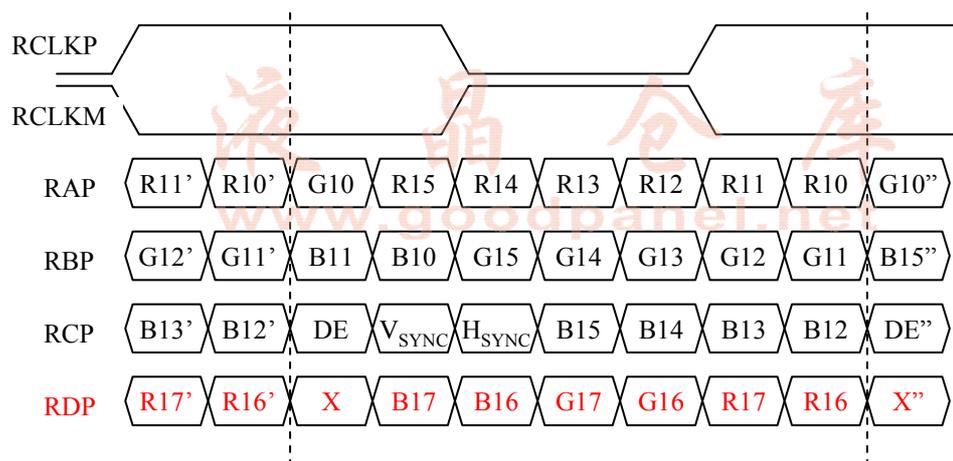
## # APPENDIX- VII-2

## LVDS Data-Mapping info. (8bit)

## ■ LVDS Select : "H" Data-Mapping (JEIDA format)

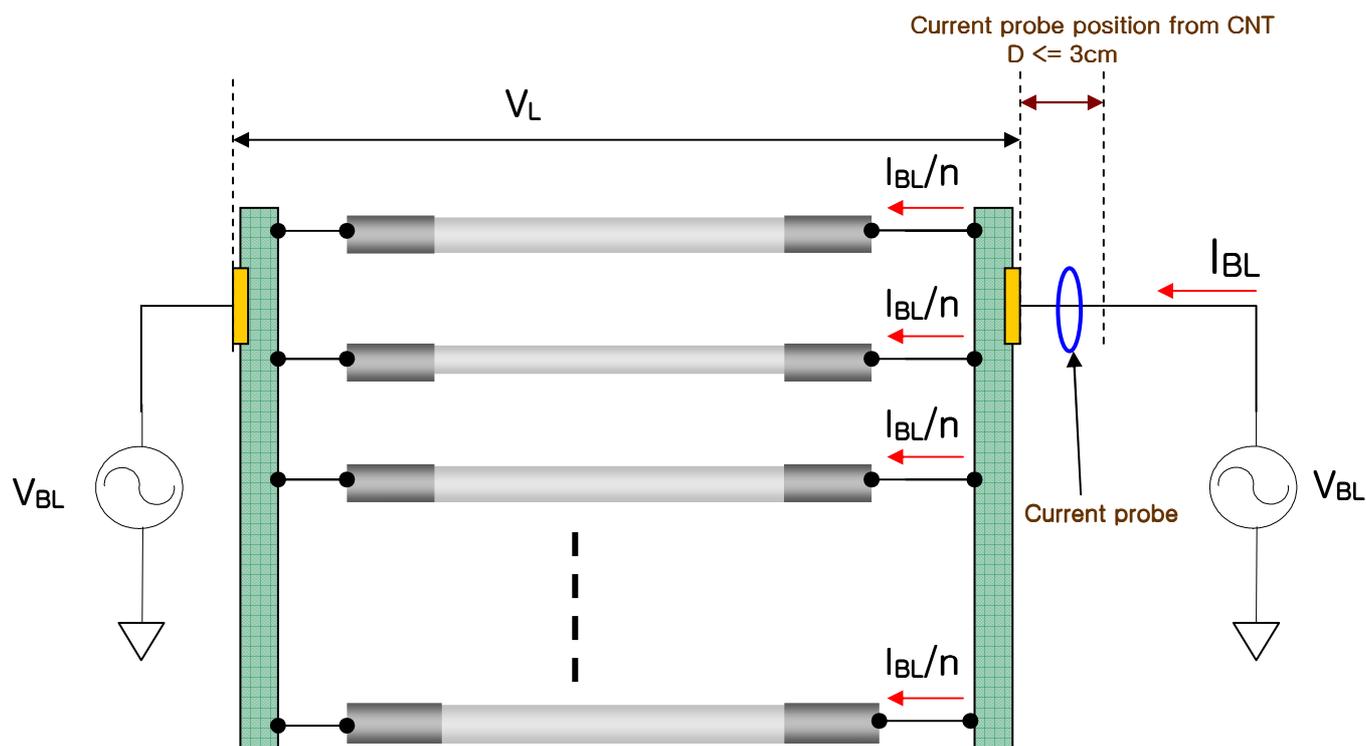


## ■ LVDS Select : "L" Data-Mapping (VESA format)



## # APPENDIX- VIII

## Voltage and Current Measure



 : Balance PCB

 : CNT(=connector)

1.  $V_{BL}$  is the voltage measured on connector to ground
2.  $I_{BL}$  is current input to connector

## # APPENDIX- IX

**Black Level & Black Uniformity**

This is only the reference data of black level and black uniformity for LC320WUF-SBN1 model.

## 1. Black Level :

Surface Luminance of Black ( $L_{BLACK}$ ) is the luminance value at center 1-point.

## 2. Black Uniformity

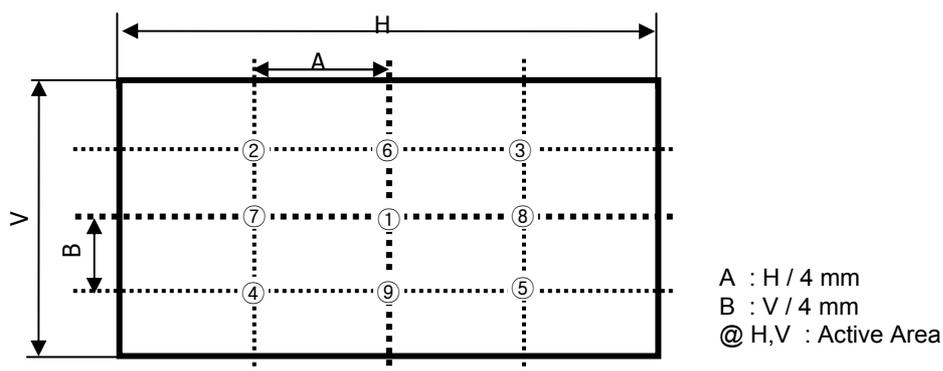
The variation of surface luminance of black,  $\delta_{BLACK}$  is defined as :

$$\delta_{BLACK} = \text{Maximum}(L_{on1}, L_{on2}, L_{on3}, L_{on4}, L_{on5}) / \text{Minimum}(L_{on1}, L_{on2}, L_{on3}, L_{on4}, L_{on5})$$

## 3. Sampling Size : 5 pcs

## 4. Measurement Method : Follow the same rule as optical characteristics measurement.

## 5. Measurement location: refer to below.



## 6. Current Status

Below table is actual data of production on Nov. , 2008 ( LPL RV Event Sample)

No.	Uniformity	Black Level
1	1.07	0.35
2	1.2	0.37
3	1.16	0.38
4	1.15	0.37
5	1.12	0.36

## 7. Black Level and Black Uniformity Control Method

-. LPL will continue to monitor the quality level of mass production regularly in terms of black level and black uniformity.

## # APPENDIX- X

**Gray to Gray Response Time Uniformity**

This is only the reference data of G to G and uniformity for LC320WUF-SBN1 model.

## 1. G to G Response Time :

Response time is defined as Figure3 and shall be measured by switching the input signal for "Gray (N) " and "Gray(M)".(32Gray Step at 8bit)

## 2. G to G Uniformity

The variation of G to G Uniformity ,  $\delta_{G \text{ to } G}$  is defined as :

$$G \text{ to } G \text{ Uniformity} = \frac{\text{Maximum}(G \text{ to } G) - \text{Typical}(G \text{ to } G)}{\text{Typical}(G \text{ to } G)} \leq 1$$

\*Maximum (GtoG) means maximum value of measured time (N, M = 0 (Black) ~ 255(White), 32 gray step).

	0Gray	32Gray	64Gray	...	223Gray	255Gray
0Gray		TrR:0G→32G	TrR:0G→64G	...	TrR:0G→223G	TrR:0G→255G
32Gray	TrD:32G→0G		TrR:32G→64G	...	TrR:32G→223G	TrR:32G→255G
64Gray	TrD:64G→0G	TrD:64G→32G		...	TrR:64G→223G	TrR:64G→255G
...	...	...	...	...	...	...
223Gray	TrD:223G→0G	TrD:223G→32G	TrD:223G→64G	...		TrR:223G→255G
255Gray	TrD:255G→0G	TrD:255G→32G	TrD:255G→64G	...	TrD:255G→223G	

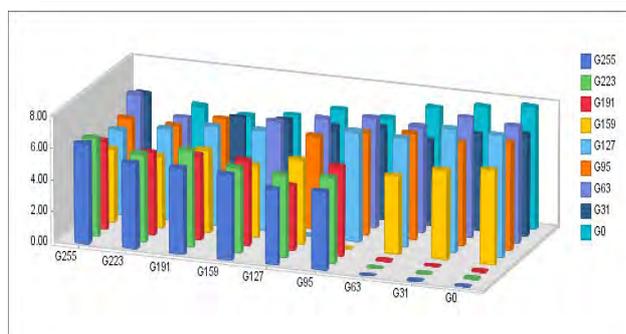
## 3. Sampling Size : 2 pcs

## 4. Measurement Method : Follow the same rule as optical characteristics measurement.

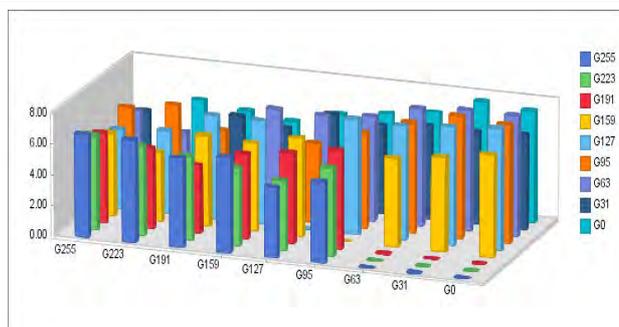
## 5. Current Status

Below table is actual data of production on Nov. , 2008 ( LPL RV Event Sample)

	G to G Response Time [ms]		Uniformity
	Min.	Max.	
# 1	4.61	7.85	0.31
# 2	4.47	7.97	0.33



&lt; # 1 &gt;



&lt; # 2 &gt;

## # APPENDIX- XI

## Audible Noise Level (Without Inverter)

These are measurement method and condition of Audible Noise Level for LC320WUF-SBN1 model at worse case conditions

1. Sample : RV Typical Sample(N=3)
2. Audible Noise Level (Without Inverter)

<b>Type of room</b>	<b>Anechoic</b>
<b>Distance to display</b>	<b>0.5m (Typical)</b>
<b>Measurement Point</b>	<b>@ LCM Center</b>
<b>Audible Noise Level</b>	<b>≤ Front (20dB(A)) / Back (23dB(A))</b>

## ※ Measurement Equipment Properties and Settings

Frequency range	50Hz to 20KHz (Typical)
Measurement Step Width	1/1 octave
Duration	60 sec (Typical)
Weighted Filter (thus dB A Scale)	A - type
Background Noise	Under 15dB(A)
Measurement Pattern	Full White

## # APPENDIX- XII

**White Uniformity for PWM Duty 50%**

This is only the reference data of white uniformity for LC320WUF-SBN1 model at the condition of PWM Duty 50%.

## 1. White Uniformity

The variation of surface luminance of white,  $\delta_{\text{WHITE}}$  is defined as :

$$\delta_{\text{WHITE}} = \text{Maximum}(L_{\text{on1}}, L_{\text{on2}}, L_{\text{on3}}, L_{\text{on4}}, L_{\text{on5}}) / \text{Minimum}(L_{\text{on1}}, L_{\text{on2}}, L_{\text{on3}}, L_{\text{on4}}, L_{\text{on5}})$$

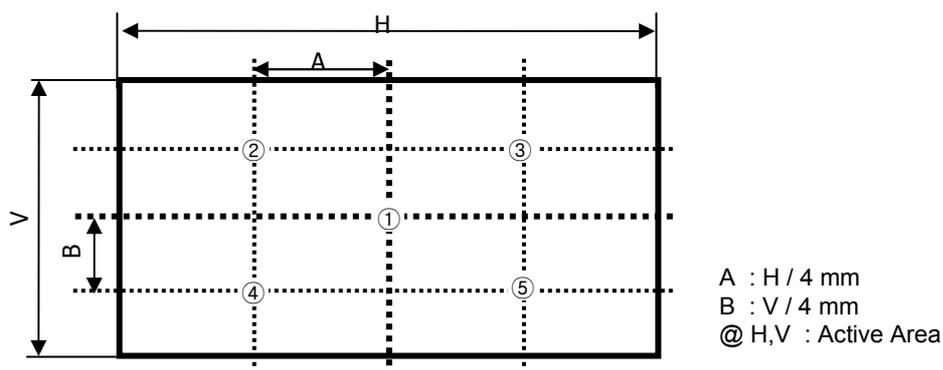
## 2. Sampling Size : 5 pcs ( RV Typical Sample )

## 3. Measurement Method : Follow the same rule as optical characteristics measurement except PWM 50% condition.

1) Boost level should be typical value. ( 1.65 Volt)

2) PWM 50% duty period should be measured at the inverter input connector #13 Pin.

## 4. Measurement location: refer to below.



## 5. Current Status

Below table is actual data of production on Nov.25.2008 ( LGD RV Event Sample)

Position	Luminance for PWM Duty 100%					Luminance for PWM Duty 50%				
	# 1	# 2	# 3	# 4	# 5	# 1	# 2	# 3	# 4	# 5
①	511	513	527	512	509	205	213	220	224	209
②	470	472	480	463	464	198	207	196	199	190
③	479	483	487	465	487	200	201	201	202	196
④	482	492	495	484	491	203	198	197	210	206
⑤	477	501	515	494	499	185	206	205	213	200
$\delta_{\text{WHITE@5pts}}$	1.09	1.08	1.10	1.11	1.10	1.11	1.08	1.12	1.13	1.10

## Product Specification

## # APPENDIX- XIII

## Lamp Electrical spec

№	Item	Unit	Standards		Notes
			Frequency	INV(High-High)	
1	Lamp Voltage VL	Vrms	63kHz	1,480±7% (I <sub>L</sub> =3.0mA) 1,730±7% (I <sub>L</sub> =5.0mA) 2,100±7% (I <sub>L</sub> =7.0mA) 2,200±7% (I <sub>L</sub> =7.5mA) 2,300±7% (I <sub>L</sub> =8.0mA)	Note1,3,10
2	Starting Voltage VS	Vrms	63kHz	Typ 1,740 (0℃) Max 2,090 (0℃) Typ 1,500 (25℃) Max 1,800 (25℃)	Note 10,11,12
3	Lamp Current IL	mA		Min 3.0 mA Typ 7.5 mA Max 8.0 mA	Note 1,3
4	Lamp Power IL × VL	W	63kHz	3.04 (I <sub>L</sub> =3.0mA) 4.41 (I <sub>L</sub> =5.0mA) 5.07 (I <sub>L</sub> =7.0mA) 5.45 (I <sub>L</sub> =7.5mA) 5.89 (I <sub>L</sub> =8.0mA)	Note 1,3
5	Average Luminance At Lamp Center L	Cd/m <sup>2</sup>	65kHz	12,500±10% (I <sub>L</sub> =3.0mA) 19,000±10% (I <sub>L</sub> =5.0mA) 24,500±10% (I <sub>L</sub> =7.0mA) 25,500±10% (I <sub>L</sub> =7.5mA) 27,000±10% (I <sub>L</sub> =8.0mA)	Note 1,3,4
6	Effective Light Emitting Area LE	mm		Min 670	Note 1,3,10
8	Color Coordinates	x		0.250±0.01	Note1,3,4
		y		0.225±0.01	
9	Peak spectrum (reference)	nm		Red 611 Green 543 Blue 450	

## # APPENDIX- XIV

## ■ Starting(Striking) Voltage measurement method.

Measure the high voltage point of Balance Ass'y after removing all lamp.

## EEFL Structure

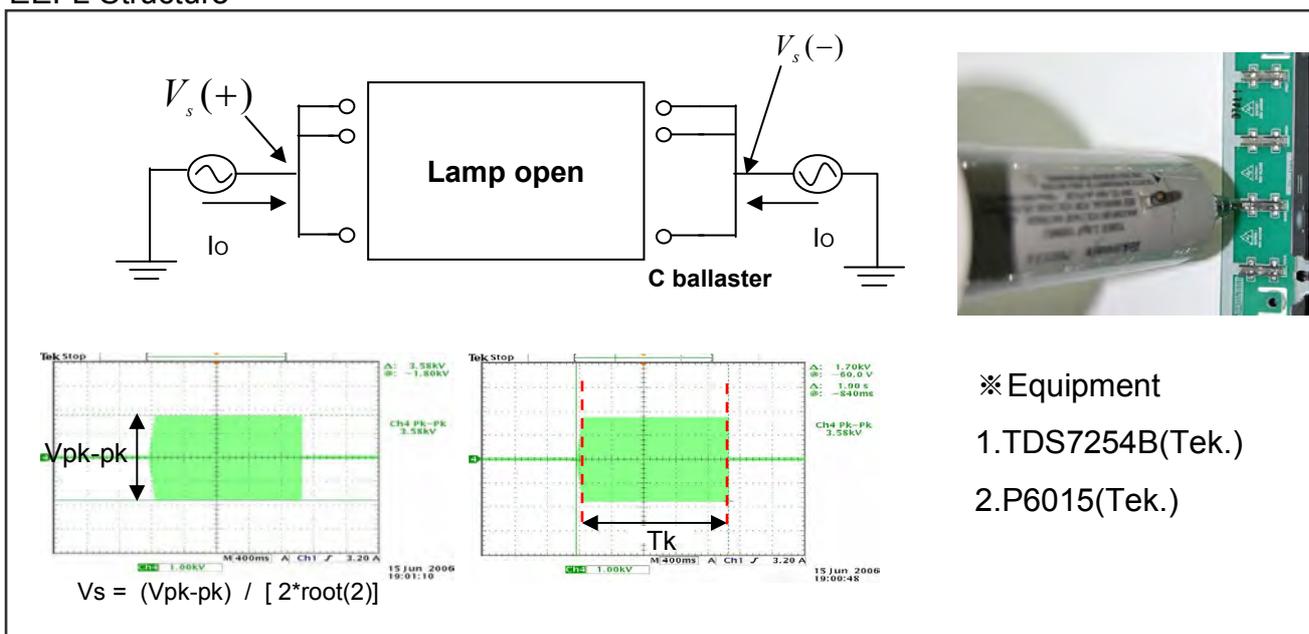


Figure 7 . EEFL Vopen

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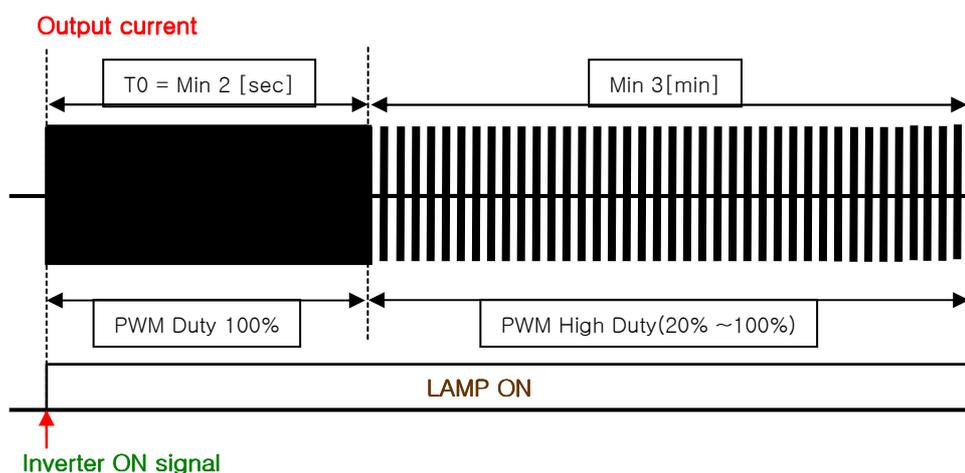
## # APPENDIX- XV

**Mega DCR using condition(1)**

- After Inverter ON signal, PWM Duty 100% should be sustained during 2sec.
- It is recommended not to sustain more than 10 min for Deep Dimming (Low duty of the inverter output current 0%~20%).  
(About the input PWM duty see the table 3 (min duty)).

The deep dimming must be used very carefully due to limitation of lamp characteristics and specification.

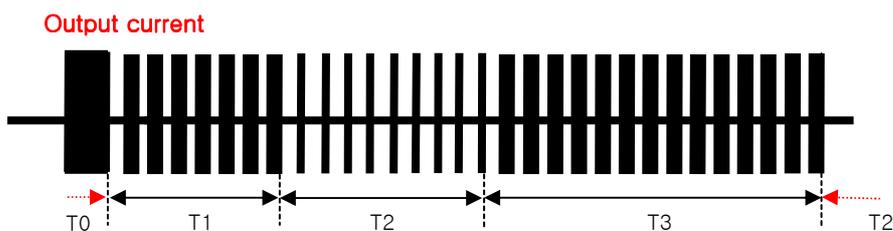
- 1) For stable lamp on, its duty condition should follow below the condition.  
After Inverter ON signal, T0 duration should be sustained.



- 2) Low duty(0%~20%) of the inverter output current, B/L may not satisfy some of LCM specification.
  - Duration : the low duty operation(0 ~ 20%) must be limited within 10 minutes for one time operation.
  - Ratio : the period of the low duty operation must be less than 1/5 compare to that of the high duty operation(20~100%) in a certain period to prevent unwanted operation.
  - FOS : partial darkness or darkness of center area during the low duty might be happened due to insufficient lamp current.
  - Warm up : the low duty must be used 3 min after the lamps "ON". In case of low temperature, more warm up time may be needed.

## # APPENDIX- XVI

## Mega DCR using condition(2)



Parameter	Value			Unit	Note
	Min	Typ	Max		
T1	3	-	-	min	PWM High Duty[20~100%]
T2	-	-	10	min	PWM Low Duty[0~20%]
T3	T2 x 5	-	-	min	PWM High Duty[20~100%]

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