SPECIFICATION
FOR
APPROVAL

( ) **Preliminary Specification**
(●) **Final Specification**

Title	32.0" WXGA TFT LCD

BUYER	General
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LC320WXE
SUFFIX	SDP2

*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.

APPROVED BY	SIGNATURE DATE
J.Y. Lee / Team Leader	May. 14, 2011
REVIEWED BY	
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PREPARED BY	
S.H. Kim / Engineer	

TV Product Development Dept.
LG Display Co., Ltd

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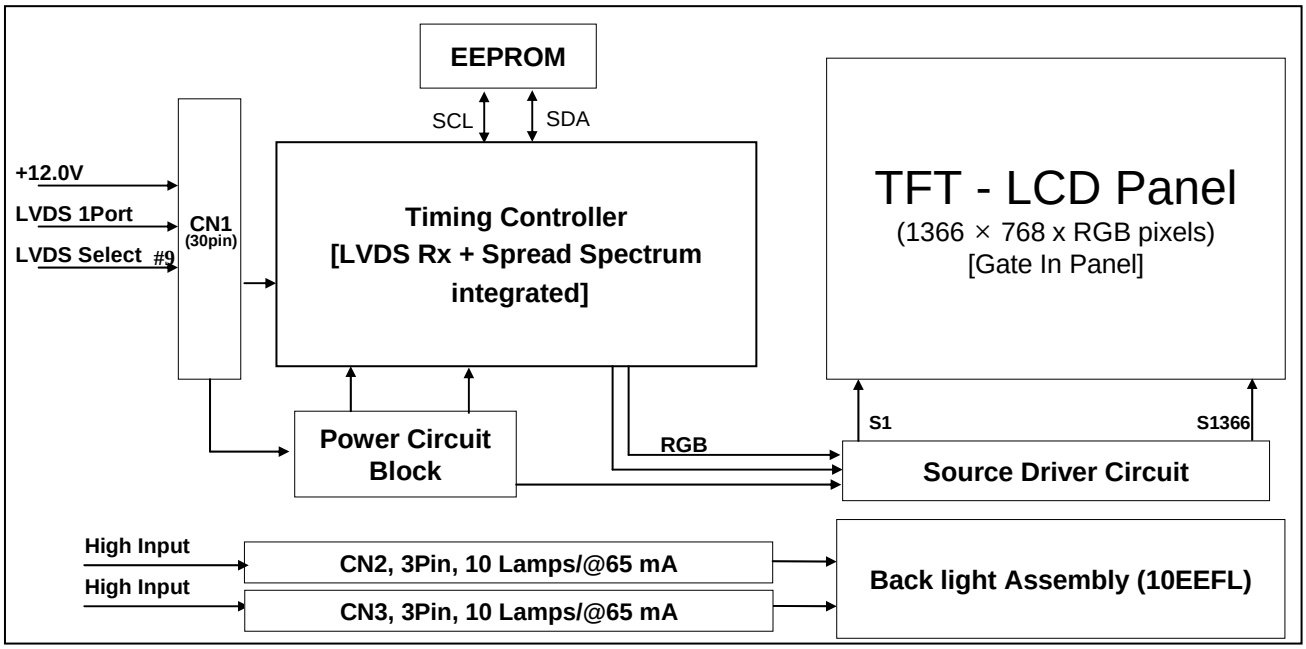
RECORD OF REVISIONS

Revision No.	Revision Date	Page	Description
0.1	Jan, 10, 2011	-	Preliminary Specification (First Draft)
1.0	Mar.14..2011	-	All TBD spec is deleted
		27	8-1 Information of LCM Label is changed
		27	8-2 packing form is changed box->pallet
		16	CR min spec is changed 850-→800
		16	All Color Coordinate specification (TBD) is deleted & some TBD value is changed Gy 0.584(TBD)→0.577 By 0.697(TBD)→0.069 : have a decimal point error in ver 0.1 Wy 0.285(TBD)→0.279 G to G σ Typ:5→6 G to G σ Max:8→9
1.1	Mar.23. 2011	16	Color Coordinate specification is changed Wx/Wy 0.261/0.279 →0.283/0.290 Rx 0.648→ 0.654 Gx/Gy 0.273/0.577→0.278/0.581
		7	Vs : Striking Voltage Min : None, Max : 1100 → Min : 1100, Max : 1320

1. General Description

The LC320WXE is a Color Active Matrix Liquid Crystal Display with an integral External Electrode Fluorescent Lamp(EEFL) backlight system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally black mode. It has a 31.51 inch diagonally measured active display area with WXGA resolution (768 vertical by 1366 horizontal pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in Horizontal stripes. Gray scale or the luminance of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus presenting a palette of more than 16.7M(6bit+AFRC) colors.
It has been designed to apply the 8-bit 1-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	31.51 inches(800.4mm) diagonal
Outline Dimension	760.0 mm(H) x 450.0 mm(V) x 36.0 mm(D) (Typ.)
Pixel Pitch	510.75㎛ x 170.25㎛ x RGB
Pixel Format	1366 horiz. by 768 vert. pixels RGB horizontal stripe arrangement
Color Depth	8bit(D), 16,7 M colors
Luminance, White	340 cd/m^2 (Center 1 point) (Typ.)
Viewing Angle (CR>10)	Viewing angle free (R/L 178(Min.), U/D 178(Min.))
Power Consumption	Total 74.1Watt (Typ.) (Logic=4.1 W, Back Light= 70W @ with Inverter)
Weight	4,000g(Typ.)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Hard coating(2H), Anti-glare treatment of the front polarizer (Haze 10%)

2. Absolute Maximum Ratings

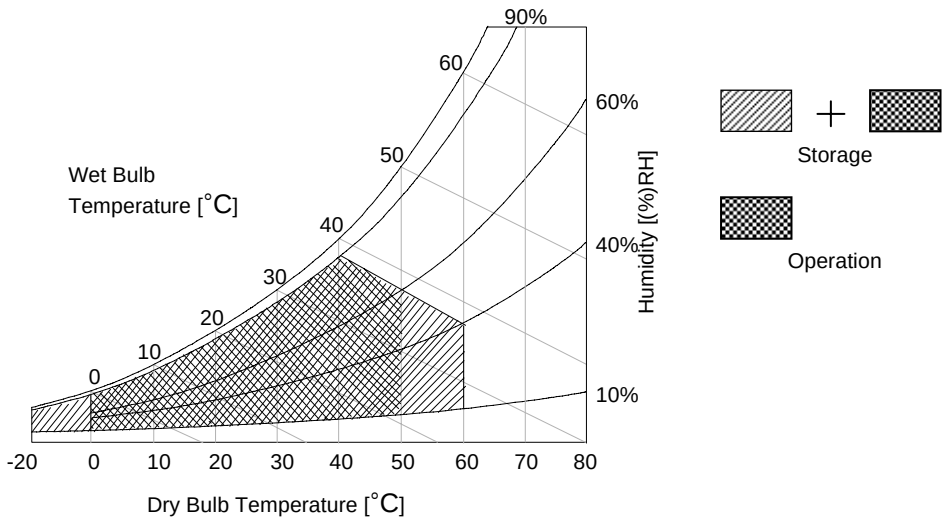
The following items are maximum values which, if exceeded, may cause faulty operation or **permanent** damage to the LCD module.

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Value		Unit	Note
			Min	Max		
Power Input Voltage	LCD Circuit	VLCD	-0.3	+14.0	VDC	1
Backlight Input Voltage	Operating Voltage (One Side)	VBL	600	1300	VRMS	
T-Con Option Selection Voltage		VLOGIC	-0.3	+4.0	VDC	
Operating Temperature		TOP	0	+50	˚C	2,3
Storage Temperature		TST	-20	+60	˚C	
Panel Front Temperature		TSUR	-	+68	˚C	4
Operating Ambient Humidity		HOP	10	90	%RH	2,3
Storage Humidity		HST	10	90	%RH	

Note1. Ambient temperature condition (Ta = 25 ± 2 °C)

2. Temperature and relative humidity range are shown in the figure below.
   Wet bulb temperature should be Max 39°C, and no condensation of water.
3. Gravity mura can be guaranteed below 40°C condition.
4. The maximum operating temperatures is based on the test condition that the surface temperature of display area is less than or equal to 68°C with LCD module alone in a temperature controlled chamber. Thermal management should be considered in final product design to prevent the surface temperature of display area from being over 68℃. The range of operating temperature may degraded in case of improper thermal management in final product design.



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.

Table 2. ELECTRICAL CHARACTERISTICS

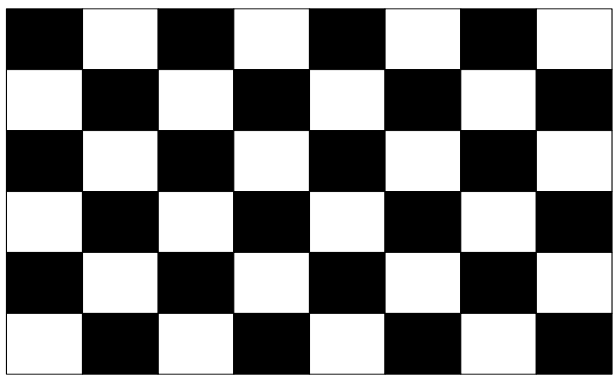
Parameter	Symbol	Value			Unit	Note
		Min	Typ	Max		
Circuit :						
Power Input Voltage	V_{LCD}	10.8	12.0	13.2	V_{DC}	
Power Input Current	I_{LCD}	-	340	445	mA	1
		-	430	560	mA	2
Power Consumption	P_{LCD}	-	4.08	5.3	Watt	1
Rush current	I_{RUSH}	-	-	4.0	A	3

Notes : 1. The specified current and power consumption are under the V_{LCD}=12.0V, 25 ± 2°C, f_V=60Hz condition add mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.

2. The current is specified at maximum current pattern.

3. The duration of rush current is about 2ms and rising time of power input is 0.5ms (min.)

White : 255 Gray
Black : 0 Gray



Mosaic Pattern(8 x 6)

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

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
Backlight Assembly :						
Operating Voltage (one side, fBL=63KHz, I_{BL}= 65mArms))	V_{BL}	873	970	1067	V_{RMS}	1, 2
Operating Current (one side)	I_{BL}	62	65	68	mA_{RMS}	1
Striking Voltage (Open Lamp Voltage @ one side)	V_S	1100	-	1320	V_{RMS}	1, 3
Operating Frequency	f_{BL}	61	63	65	kHz	4
Striking Time	S_{TIME}	1.5	-		sec	3
Power Consumption	P_{BL}		70		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		
Lamp : APPENDIX-IX						
Lamp Voltage (one side)	V_{LAMP}	760	970	1110	V_{RMS}	1, 2
Lamp Current (one side)	I_{LAMP}	3	6.5	8.0	mA_{RMS}	
Discharge Stabilization Time	T_S	-	-	3	Min	1, 5
Lamp Frequency	f_{LAMP}	61	63	65	KHz	
Established Starting Voltage (one side)	V_S			1100	V_{RMS}	3
Life Time		50,000	60,000		Hrs	7

Note 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.

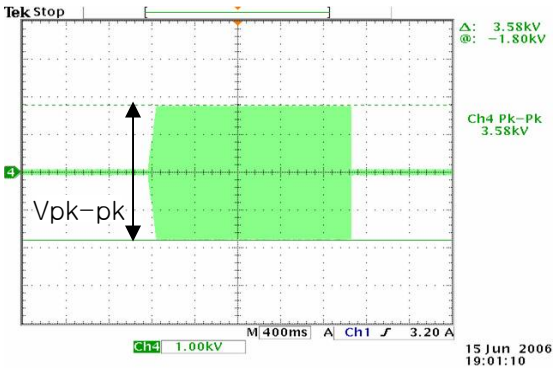
The performance of the lamps in LCM, for example life time or brightness, is extremely influenced by the characteristics of the DC-AC inverter. So, all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter.

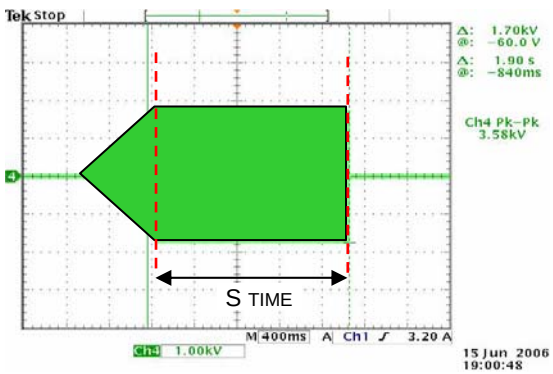
When you design or order the inverter, please make sure unwanted lighting caused by the mismatch of the lamp and the inverter (no lighting, flicker, etc) has never been occurred. When you confirm it, the LCD–Assembly should be operated in the same condition as installed in your instrument.

※ 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.

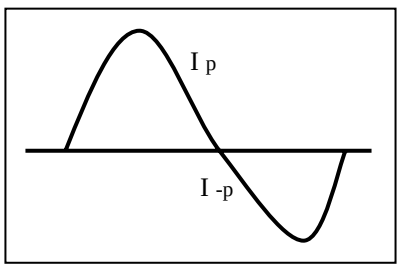
1. Specified values are defined for a Backlight Assembly.(IBL : 10 lamp, 6.5 mA/Lamp)
2. Operating voltage is measured at 25 ± 2°C(after 2hr.aging).The variance range for operating voltage is ± 10%.





Vs = (Vpk-pk) / [2*root(2)]

3. The Striking Voltage (Open Lamp Voltage) [V_{open}] should be applied to the lamps more than Striking time (S TIME) for start-up. Inverter Striking Voltage must be more than Established Starting Voltage of lamp. Otherwise, the lamps may not be turned on. The used lamp current is typical value.
When the Striking Frequency is higher than the Operating Frequency , the parasitic capacitance can cause inverter shut down, therefore It is recommended to check it.
4. Lamp frequency may produce interference with horizontal synchronous frequency.As a result this 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.
There is no reliability problem of lamp, if use out of range of operation frequency (61kHz~65kHz) on CAS
5. The brightness of the lamp after lighted for 5minutes 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 ± 2°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 ± 2°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 √2 ±10%.
* Inverter output waveform had better be more similar to ideal sine wave.



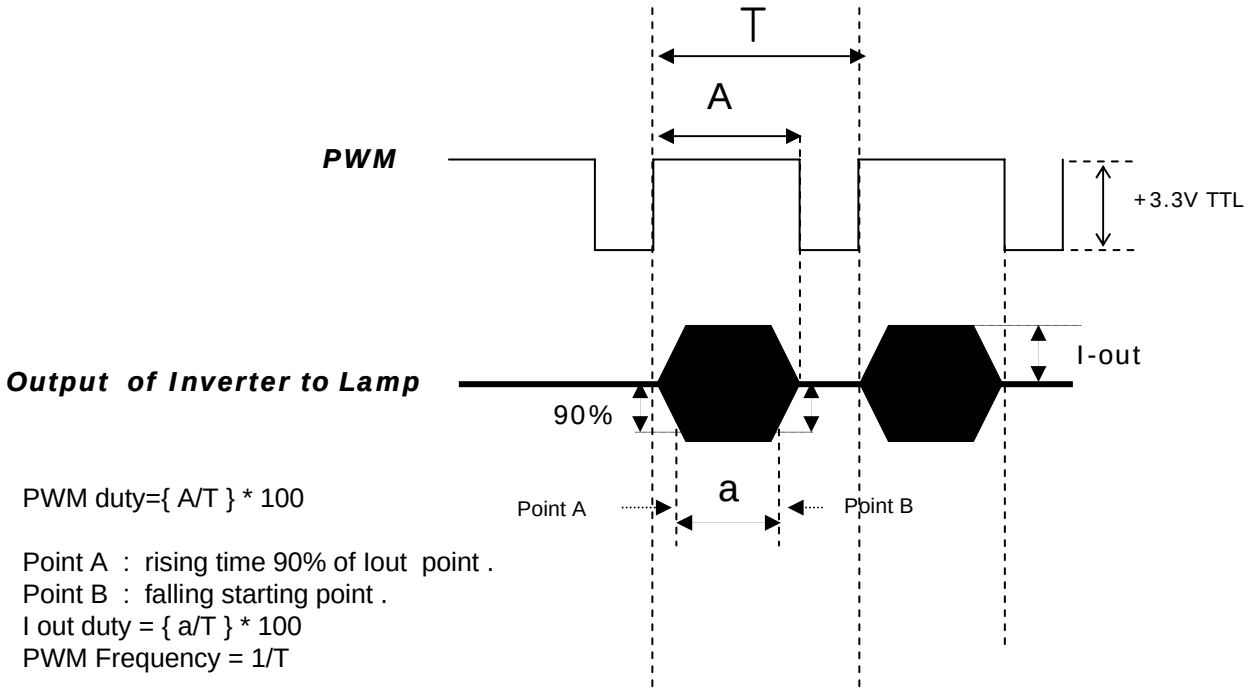
* Asymmetry rate:

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

* Distortion rate

I_p (or I_{-p}) / I_{op}

9. The reference method of burst dimming duty ratio.
   It is recommended to use synchronous V-sync frequency to prevent waterfall
   (Vsync x 2 =Burst Frequency)
   Though PWM frequency is over 182Hz (max252Hz), function of backlight is not affected.



PWM duty={ A/T } * 100

Point A : rising time 90% of Iout point .
Point B : falling starting point .
I out duty = { a/T } * 100
PWM Frequency = 1/T

※ 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

3-2. Interface Connections

This LCD module employs two kinds of interface connection, a 30-pin connector is used for the module electronics and 3-pin (65002HP-03P) connector is used for the internal backlight system.

3-2-1. LCD Module

-LCD Connector(CN1) : FI-X30SSL-HF (Manufactured by JAE) or Equivalent
-Mating Connector : FI-X30C2L (Manufactured by JAE) or Equivalent

Table 4. MODULE CONNECTOR(CN5) PIN CONFIGURATION

Pin No.	Symbol	Description	Note
1	VLCD	Power Supply +12.0V	
2	VLCD	Power Supply +12.0V	
3	VLCD	Power Supply +12.0V	
4	VLCD	Power Supply +12.0V	
5	GND	Ground	
6	GND	Ground	
7	GND	Ground	
8	GND	Ground	
9	LVDS Select	'H' =JEIDA , 'L' or NC = VESA	**Appendix VII**
10	NC	No connection	
11	GND	Ground	
12	RA-	LVDS Receiver Signal(-)	
13	RA+	LVDS Receiver Signal(+)	
14	GND	Ground	
15	RB-	LVDS Receiver Signal(-)	
16	RB+	LVDS Receiver Signal(+)	
17	GND	Ground	
18	RC-	LVDS Receiver Signal(-)	
19	RC+	LVDS Receiver Signal(+)	
20	GND	Ground	
21	RCLK-	LVDS Receiver Clock Signal(-)	
22	RCLK+	LVDS Receiver Clock Signal(+)	
23	GND	Ground	
24	RD-	LVDS Receiver Signal(-)	
25	RD+	LVDS Receiver Signal(+)	
26	GND	Ground	
27	NC	No connection	
28	NC	No connection NC	
29	GND	Ground	
30	GND	Ground	

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. These pins are used only for LGD (Do not connect)
5. Specific pin No. #30 is used for "No signal detection" of system signal interface.
   It should be GND for NSB (No Signal Black) while the system interface signal is not.
   If this pin is "H", LCD Module displays AGP (Auto Generation Pattern).

3-2-2. Backlight Module

[Master]

1) Connector

: 65002HP-03P (YEONHO) or equivalent

2) Mating Connector

: 65002HS-03 (YEONHO) or equivalent.

[Slave]

1) Connector

: 65002HP-03P (YEONHO) or equivalent

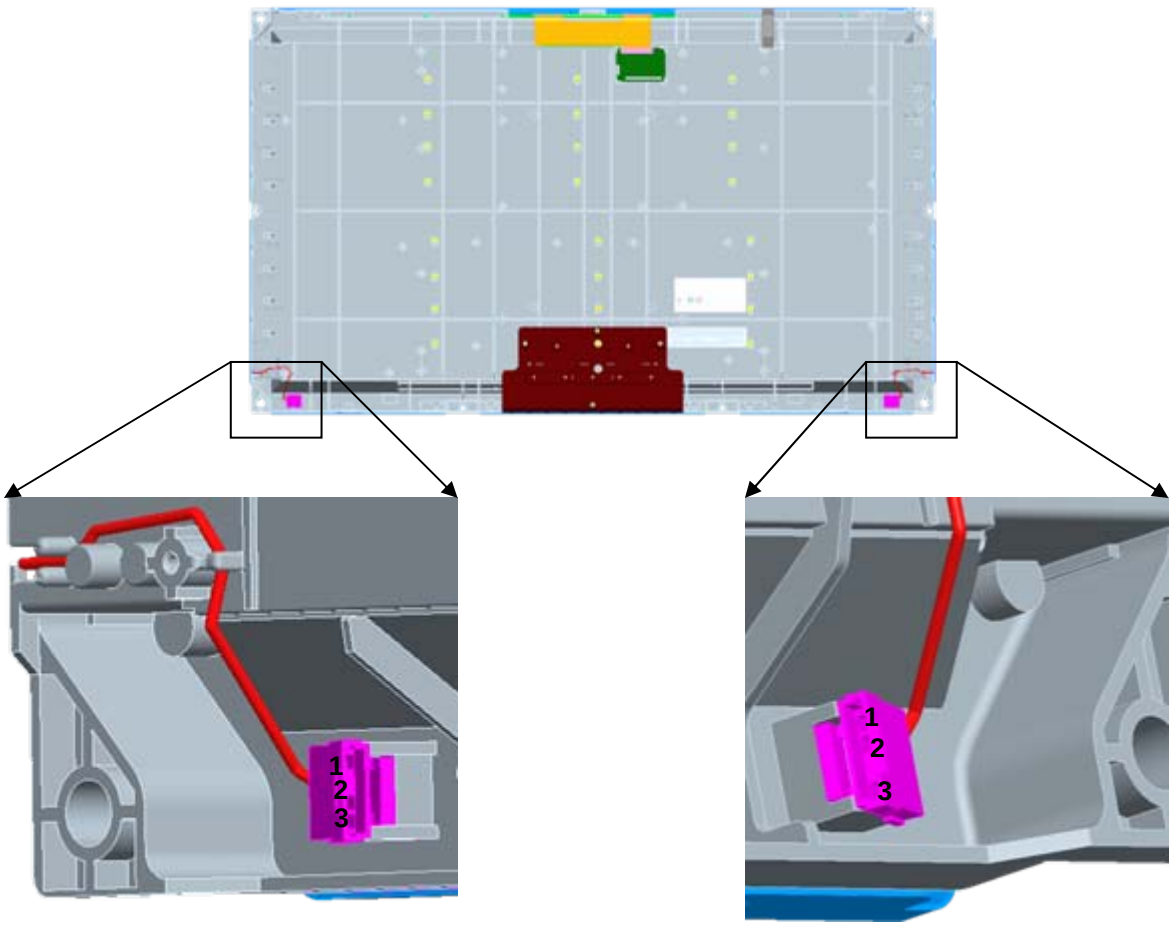
2) Mating Connector

: 65002HS-03 (YEONHO) or equivalent.

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

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

◆ Rear view of LCM



3-3. Signal Timing Specifications

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

Table 6-1. TIMING TABLE for NTSC (DE Only Mode)

ITEM		Symbol	Min	Typ	Max	Unit	Note
Horizontal	Display Period	t_{HV}	-	1366	-	tclk	
	Blank	t_{HB}	90	162	410	tclk	
	Total	t_{HP}	1456	1528	1776	tclk	
Vertical	Display Period	t_{VV}	-	768	-	t_{HP}	
	Blank	t_{VB}	8	22	240	t_{HP}	
	Total	t_{VP}	776	790	1008	t_{HP}	
Frequency	DCLK	f_{CLK}	63.0	72.4	80.0	MHz	
	Horizontal	f_H	45	47.4	55	KHz	
	Vertical	f_V	57	60	63	Hz	

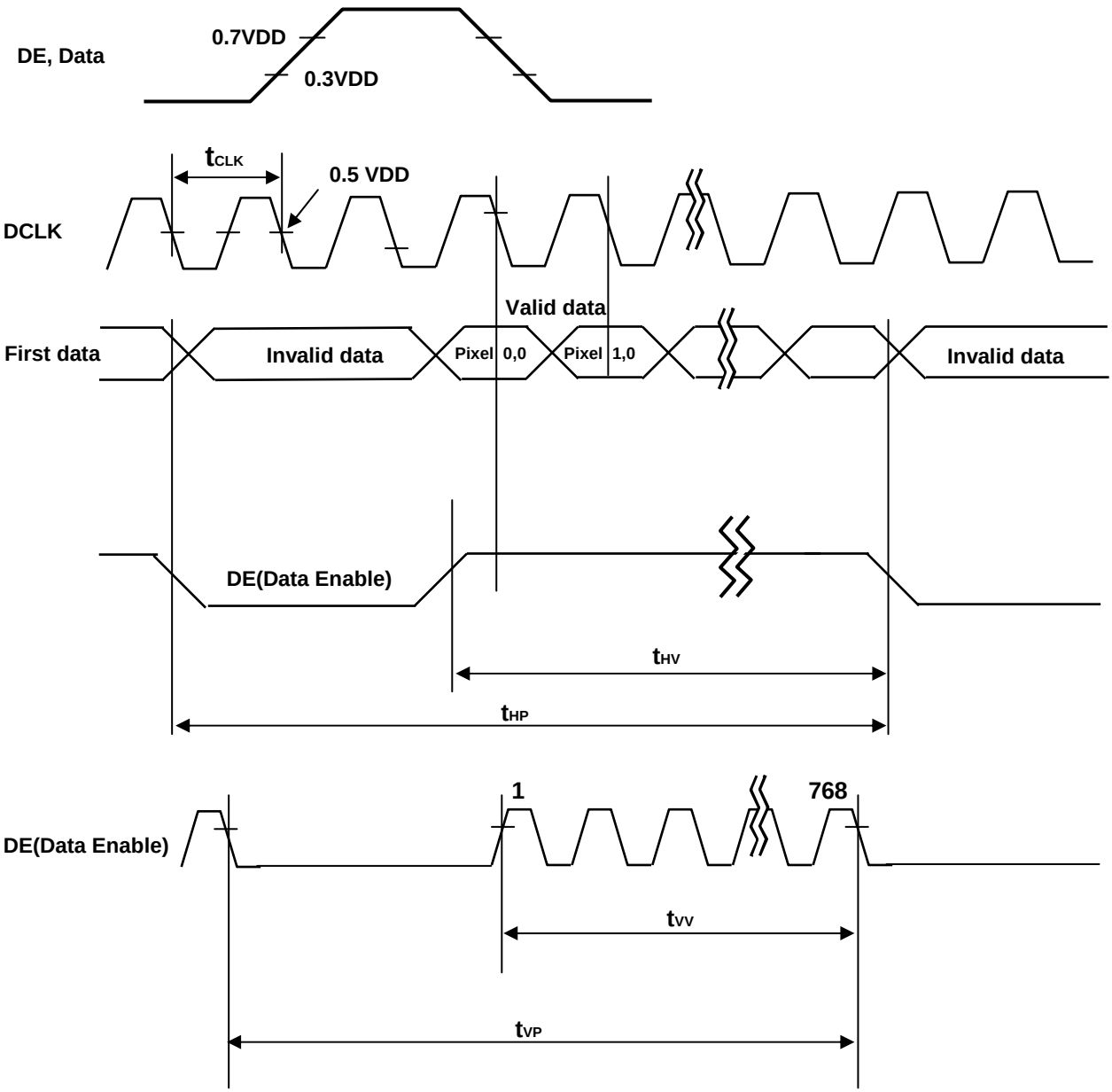
Table 6-2. TIMING TABLE for PAL (DE Only Mode)

ITEM		Symbol	Min	Typ	Max	Unit	Note
Horizontal	Display Period	t_{HV}	-	1366	-	tclk	
	Blank	t_{HB}	90	162	410	tclk	
	Total	t_{HP}	1456	1528	1776	tclk	
Vertical	Display Period	t_{VV}	-	768	-	t_{HP}	
	Blank	t_{VB}	126	180	295	t_{HP}	
	Total	t_{VP}	894	948	1063	t_{HP}	
Frequency	DCLK	f_{CLK}	63.0	72.4	80.0	MHz	
	Horizontal	f_H	45	47.4	55	KHz	
	Vertical	f_V	47	50	53	Hz	

Note: 1. The input of HSYNC & VSYNC signal does not have an effect on normal operation (DE Only Mode). If you use spread spectrum of 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
※ Timing should be set based on clock frequency.

3-4. LVDS Signal Specification

3-4-1. LVDS Input Signal Timing Diagram



3-5. Color Data Reference

The brightness of each primary color (red, green, blue) is based on the 8-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
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	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
	Red (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	0	0	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	0	0	0	0	0	0	0	0	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	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
RED	RED (000) Dark	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	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	...	...								...								...							
	RED (254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN (000) Dark	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	1	0	0	0	0	0	0	0	0
	...	...								...								...							
	GREEN (254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	GREEN (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
BLUE	BLUE (000) Dark	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	1
	...	...								...								...							
	BLUE (254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	BLUE (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

3-6. Power Sequence

3-6-1. LCD Driving circuit

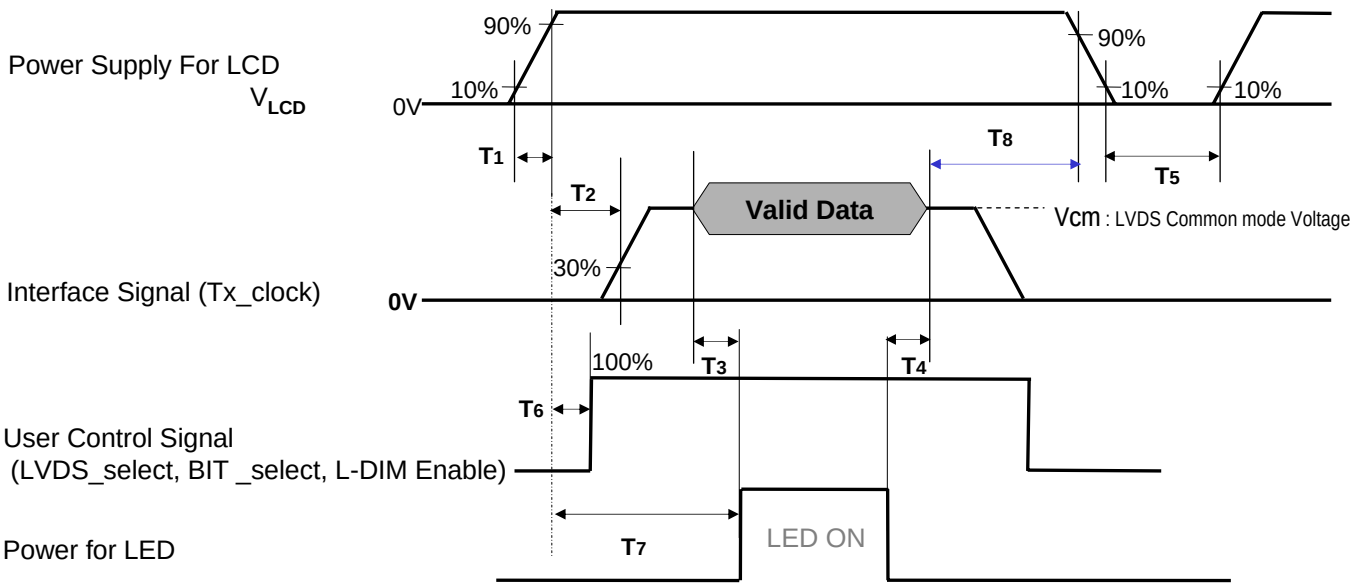


Table 8. POWER SEQUENCE

Parameter	Value			Unit	Notes
	Min	Typ	Max		
T1	0.5	-	20	ms	1
T2	0	-	-	ms	2
T3	500	-	-	ms	3
T4	200	-	-	ms	3
T5	1.0	-	-	s	4
T6	-	-	T2	ms	5
T7	0.5	-	-	s	6
T8	100	-	-	ms	7

Note :

1. Even though T1 is over the specified value, there is no problem if I2T spec of fuse is satisfied.
2. If T2 is satisfied with specification after removing LVDS Cable, there is no problem.
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. T5 should be measured after the Module has been fully discharged between power off and on period.
5. If the on time of signals (Interface signal and user control signals) precedes the on time of Power (V_{LCD}), it will be happened abnormal display. When T6 is NC status, T6 doesn't need to be measured.
6. If there is no abnormal display, no problem.
7. It is recommendation specification that T8 has to be 100ms as a minimum value.

※ Please avoid floating state of interface signal at invalid period.

※ When the power supply for LCD (VLCD) is off, be sure to pull down the valid and invalid data to 0V.

4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' and for 60 minutes in a dark environment at 25±2°C. The values are specified at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0 °.
FIG. 1 shows additional information concerning the measurement equipment and method.

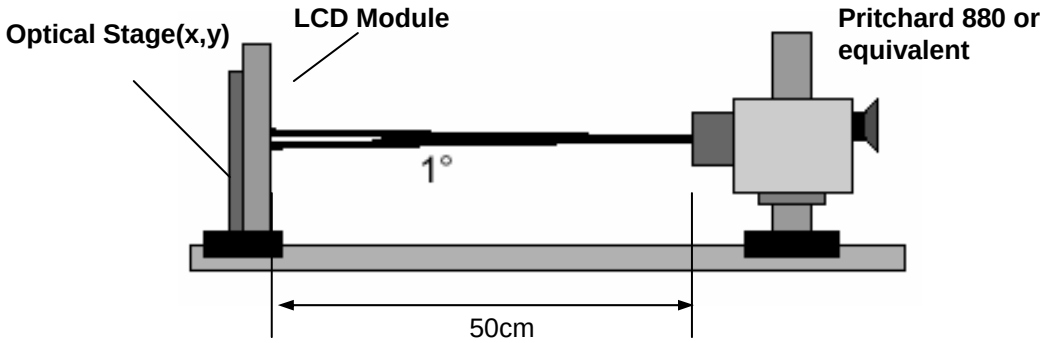


FIG. 1 Optical Characteristic Measurement Equipment and Method

Table 9. OPTICAL CHARACTERISTICS

Ta= 25±2°C, V_{LCD}=12.0V, fv=60Hz, Dclk=72.4MHz, I_{BL}=65mArms

Parameter			Symbol		Value Min	Value Typ	Value Max	Unit	Note
Contrast Ratio			CR		800	**1100**	-		1
Surface Luminance, white			L_{WH}	2D	270	**340**	-	cd/m²	2
				3D	100	127	-		8
Luminance Variation			δ_{WHITE}	5P	-	-	1.3		3
Response Time	Gray-to-Gray(BW)		G to G $_{BW}$		-	9	14	ms	4
	Variation		G to G $_{\sigma}$		-	6	9	ms	5
Color Coordinates [CIE1931]	RED		Rx		Typ -0.03	**0.654**	Typ +0.03		
			Ry			**0.331**			
	GREEN		Gx			**0.278**			
			Gy			**0.581**			
	BLUE		Bx			**0.145**			
			By			**0.069**			
	WHITE		Wx			**0.283**			
			Wy			**0.290**			
Viewing Angle	2D (CR>10)	right(ϕ=0°)	θr (x axis)		89	-	-	degree	6
		left (ϕ=180°)	θl (x axis)		89	-	-		
		up (ϕ=90°)	θu (y axis)		89	-	-		
		down (ϕ=270°)	θd (y axis)		89	-	-		
	3D (CT≤10%)	up + down	θu (y axis) +θd (y axis)		9	-	-		8
Gray Scale						2.2			7

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 is determined after the unit has been 'ON' and 60min after lighting the backlight in a dark environment at 25±2°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 , δ WHITE is defined as :
   δ WHITE(5P) = Maximum(L_{on1},L_{on2}, L_{on3}, L_{on4}, L_{on5}) / Minimum(L_{on1},L_{on2}, L_{on3}, L_{on4}, L_{on5})
   Where L_{on1} to L_{on5} are the luminance with all pixels displaying white at 5 locations .
   For more information, see the FIG. 2.
4. Response time is the time required for the display to transit from black to white (Rise Time, Tr_R) and from white to black (Decay time, Tr_D). For additional information see the FIG. 3.
   ※ G to GBW Spec stands for average value of all measured points.

5. G to G $_\sigma$ is Variation of Gray to Gray response time composing a picture

$$G \text{ to } G\ (\sigma) = \sqrt{\frac{\Sigma(Xi - u)^2}{N}}$$

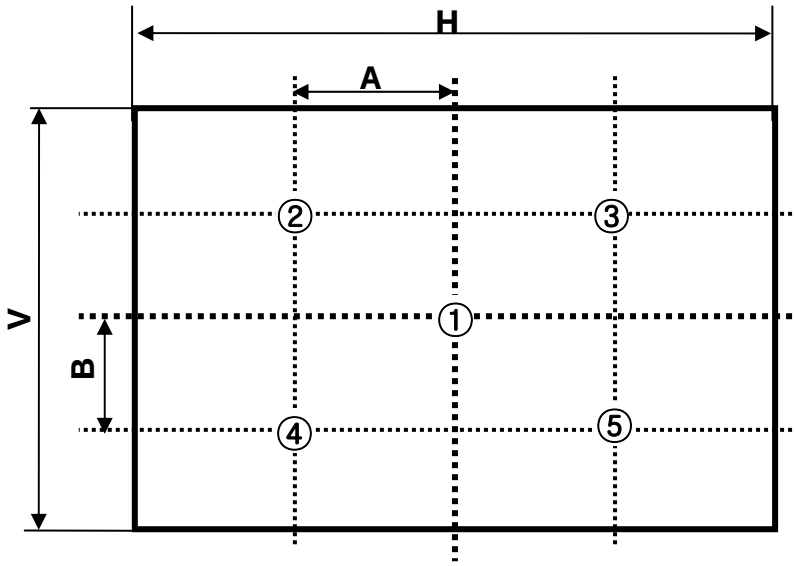
Xi = Individual Data
u = Data average
N : The number of Data

6. 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. 4.
7. Gray scale specification
   Gamma Value is approximately 2.2. For more information, see the Table 10.
8. 3D performance specification is expressed by 3D luminance and 3D viewing angle.

Table 10. GRAY SCALE SPECIFICATION

Gray Level	Luminance [%] (Typ.)
L0	0.08
L15	0.32
L31	1.10
L47	2.60
L63	4.90
L79	8.10
L95	12.1
L111	16.7
L127	21.6
L143	28.0
L159	35.4
L175	43.9
L191	53.3
L207	64.1
L223	75.8
L239	88.0
L255	100

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



A : H / 4 mm
B : V / 4 mm
@ H,V : Active Area

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 "Black or White".

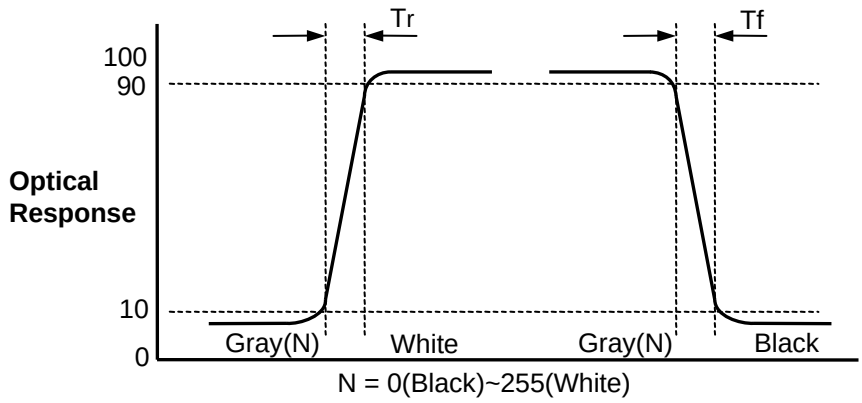


FIG. 3 Response Time

Dimension of viewing angle range

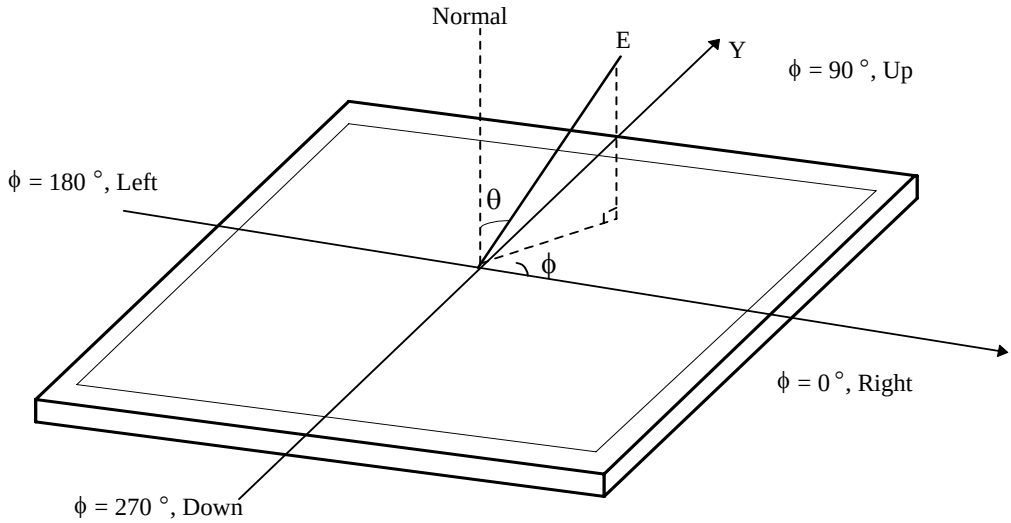
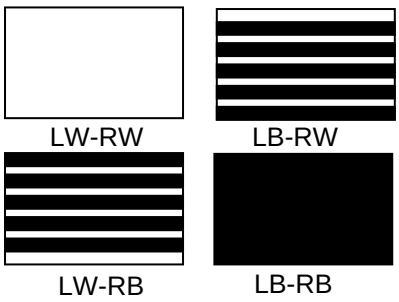
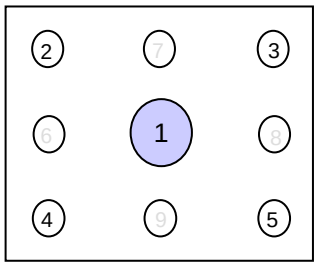


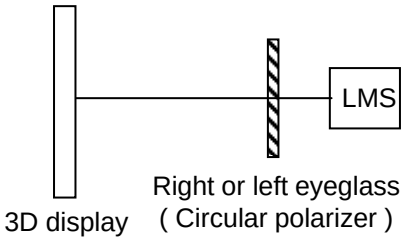
FIG. 4 Viewing Angle



(a) Test pattern image

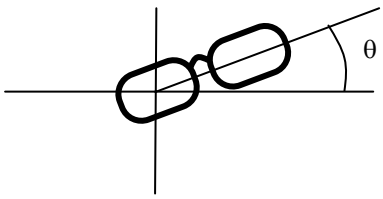


(b) Measurement position

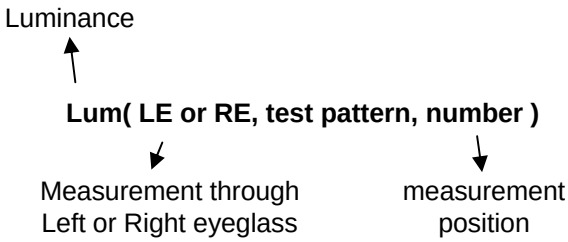


(c) Setup

< Figure 6. Measurement configuration>



< Figure 7. Positioning eyeglass >



< Figure 8. notation of luminance measurement >

In order to measure 3D luminance, 3D crosstalk and 3D viewing angle, it need to be prepared as below;

1) Measurement configuration

4-Test pattern images. Refer to FIG 8.

-. LW-RW : White for left and right eye

-. LW-RB : White for left eye and Black for right eye

-. LB-RW : Black for left eye and white for right eye

-. LB-RB : Black for left eye and right eye

Image files where black and white lines are displayed on even or odd lines.

Luminance measurement system (LMS) with narrow FOV (field of view) is used. Refer to FIG 1.

2) Positioning Eyeglass (refer to appendix-VII for standard specification of eyeglass)

Find angle of minimum transmittance.

This value would be provided beforehand or measured by the following steps;

(i) Test image (LB-RW) is displayed.

(ii) Left eyeglass are placed in front of LMS and luminance is measured,
rotating right eyeglass such as FIG 7. The notation for luminance measurement is “Lum(LE, LB-RW,1)”.

(iii) Find the angle where luminance is minimum.

* Following measurements should be performed at the angle of minimum transmittance of eyeglass.

3) Measurement of 3D luminance
(i) Test image (LW-RW) is displayed.
(ii) Left or right eyeglass are placed in front of LMS successively and luminance is measured at center 1 point where the notation for luminance measurement is "Lum(LE, LW-RW,1)" or "Lum(RE, LW-RW,1).

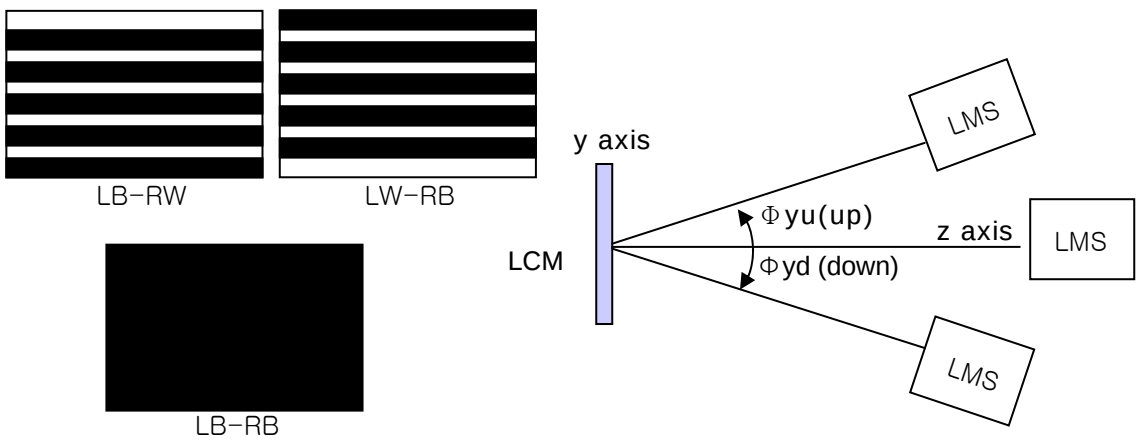
4) Measurement of 3D crosstalk
(i) Test image (LB-RW, LW-RB and LB-RB) is displayed.
(ii) Right or left eyeglass are placed in front of LMS successively and luminance is measured for position 1.
with rotating LMS or sample vertically.

$$\text{Average of } \frac{\text{Lum(LE, LB-RW,1) - Lum(LE, LB-RB,1)}}{\text{Lum(LE, LW-RB,1) - Lum(LE, LB-RB,1)}}$$

and

$$\frac{\text{Lum(RE, LW-RB,1) - Lum(RE, LB-RB,1)}}{\text{Lum(RE, LB-RW,1) - Lum(RE, LB-RB,1)}}$$

5) Measurement of 3D Viewing Angle
3D viewing angle is the angle at which the 3D crosstalk is under 10%. The angles are determined for the vertical or y axis with respect to the z axis which is normal to the LCD module surface and measured for position 1. For more information , see the Fig 9



(a) Test pattern image (b) Measurement of 3D viewing angle (up/down)

< Figure 9. Measurement of 3D crosstalk and 3D viewing angle >

5. Mechanical Characteristics

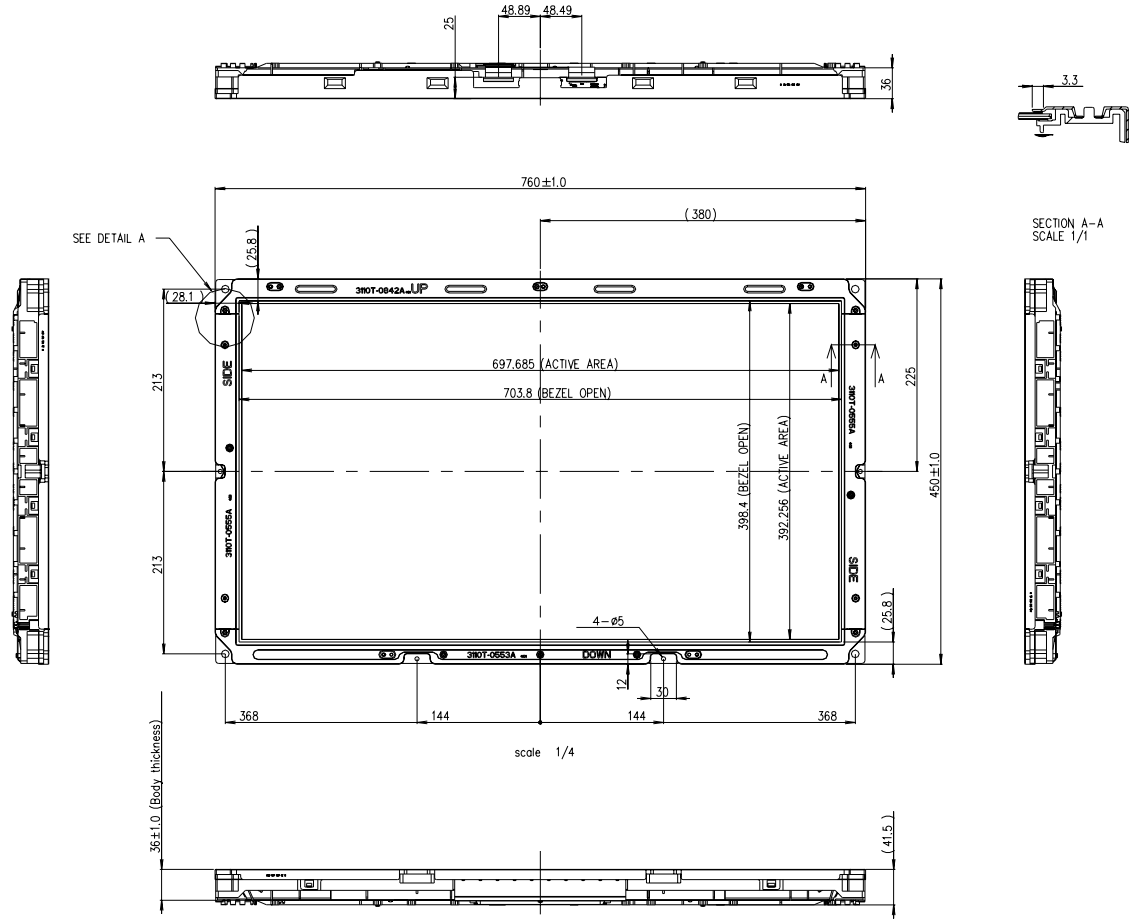
Table 12 provides general mechanical characteristics.

Table 12. MECHANICAL CHARACTERISTICS

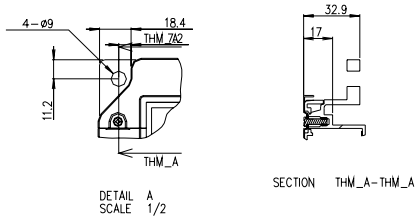
Item	Value	
Outline Dimension	Horizontal	760.0mm
	Vertical	450.0 mm
	Depth	36.0 mm
Bezel Area	Horizontal	703.8mm
	Vertical	398.4mm
Active Display Area	Horizontal	697.685mm
	Vertical	392.256mm
Weight	4000 g (Typ.), 4200g (Max)	

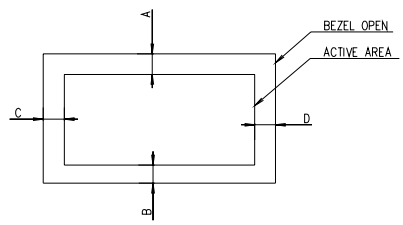
Note : Please refer to a mechanical drawing in terms of tolerance at the next page.

<Front VIEW>



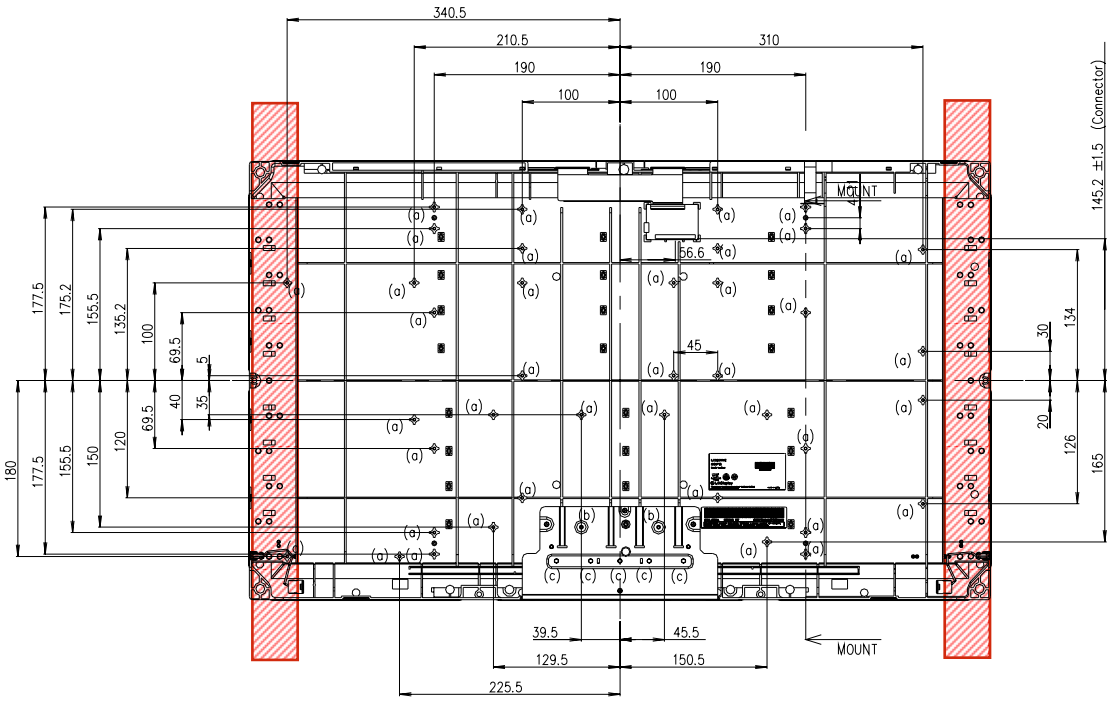
NOTES
1.UNSPECIFIED TOLERANCES TO BE ±0.5MM
2.TILT AND PARTIAL DISPOSITION TOLERANCE OF DISPLAY AREA ARE AS FOLLOWING.
(1) Y-DIRECTION: | A-B | < 1.5.
(2) X-DIRECTION: | C-D | < 1.5.

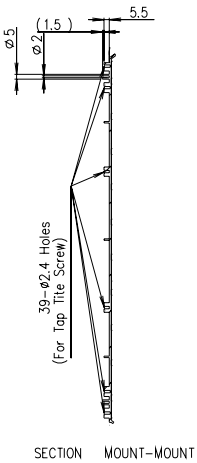




<REAR VIEW>

Set : Top





Set : Down

ITEM	TAP	Max Depth (mm)	TORQUE (Kgf.cm)	NOTES
(a)	M3	5.5	TBD	
(b)	M3	4.2	TBD	
(c)	M4	5.0	TBD	

Forbidden Area

Notes : It should be recommended that any exterior materials do not pass within the forbidden area (for example, electrical cable, system board, etc) not to cause abnormal voltage waveform of Backlight unit.
If any exterior materials pass within the forbidden area, It should be carefully designed to satisfy with ‘Table 3. Electrical characteristics for IPB & Lamp’.

6. Reliability

Table 13. ENVIRONMENT TEST CONDITION

No.	Test Item	Condition
1	High temperature storage test	Ta= 60˚C 240h
2	Low temperature storage test	Ta= -20˚C 240h
3	High temperature operation test	Ta= 50˚C 50%RH 240h
4	Low temperature operation test	Ta= 0˚C 240h
5	Vibration test (non-operating)	Wave form : random Vibration level : 1.0G RMS Bandwidth : 10-300Hz Duration : X,Y,Z Each direction per 10 min.
6	Shock test (non-operating)	Shock level : 50G Waveform : half sine wave, 11ms Direction : ±X, ±Y, ±Z One time each direction
7	Humidity condition Operation	Ta= 40 ˚C ,90%RH
8	Altitude operating storage / shipment	0 - 15,000 ft 0 - 40,000 ft

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

7. International Standards

7-1. Safety

a) UL 60065, Seventh Edition, Underwriters Laboratories Inc.
Audio, Video and Similar Electronic Apparatus - Safety Requirements.

b) CAN/CSA C22.2 No.60065:03, Canadian Standards Association.
Audio, Video and Similar Electronic Apparatus - Safety Requirements.

c) EN 60065:2002 + A11:2008, European Committee for Electrotechnical Standardization (CENELEC).
Audio, Video and Similar Electronic Apparatus - Safety Requirements.

d) IEC 60065:2005 + A1:2005, The International Electrotechnical Commission (IEC).
Audio, Video and Similar Electronic Apparatus - Safety Requirements.

7-2. EMC

a) ANSI C63.4 “American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.” American National Standards Institute (ANSI), 2003.

b) CISPR 22 “Information technology equipment – Radio disturbance characteristics – Limit and methods of measurement." International Special Committee on Radio Interference (CISPR), 2005.

c) CISPR 13 “Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and method of measurement." International Special Committee on Radio Interference (CISPR), 2006.

7-3. Environment

a) RoHS, Directive 2002/95/EC of the European Parliament and of the council of 27 January 2003

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)
D : YEAR
E : MONTH
F ~ M : SERIAL NO.

Note

1. YEAR

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mark	A	B	C	D	E	F	G	H	J	K

2. MONTH

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	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 pallet : 30 pcs

b) Pallet Size : 1140 mm X 870 mm X 1161 mm.

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 the 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 benzine. 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=±200mV(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 minimized 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 causes conductive particles and deal LCM a fatal blow)
(9) Please do not set LCD on its edge.
(10) The conductive material and signal cables are kept away from transformers to prevent abnormal display, sound noise and temperature rising.
(11) 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℃). This phenomenon which disappears naturally after 3~5 minutes is not a problem about reliability but LCD characteristic.

(12) Partial darkness may happen under the long-term operation of any dimming without power on/off. This phenomenon which disappears naturally after 5 minutes is not a problem about reliability but LCD characteristics.

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.
(3) Storage condition is guaranteed under packing conditions.
(4) The phase transition of Liquid Crystal in the condition of the low or high storage temperature will be recovered when the LCD module returns to the normal condition

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.

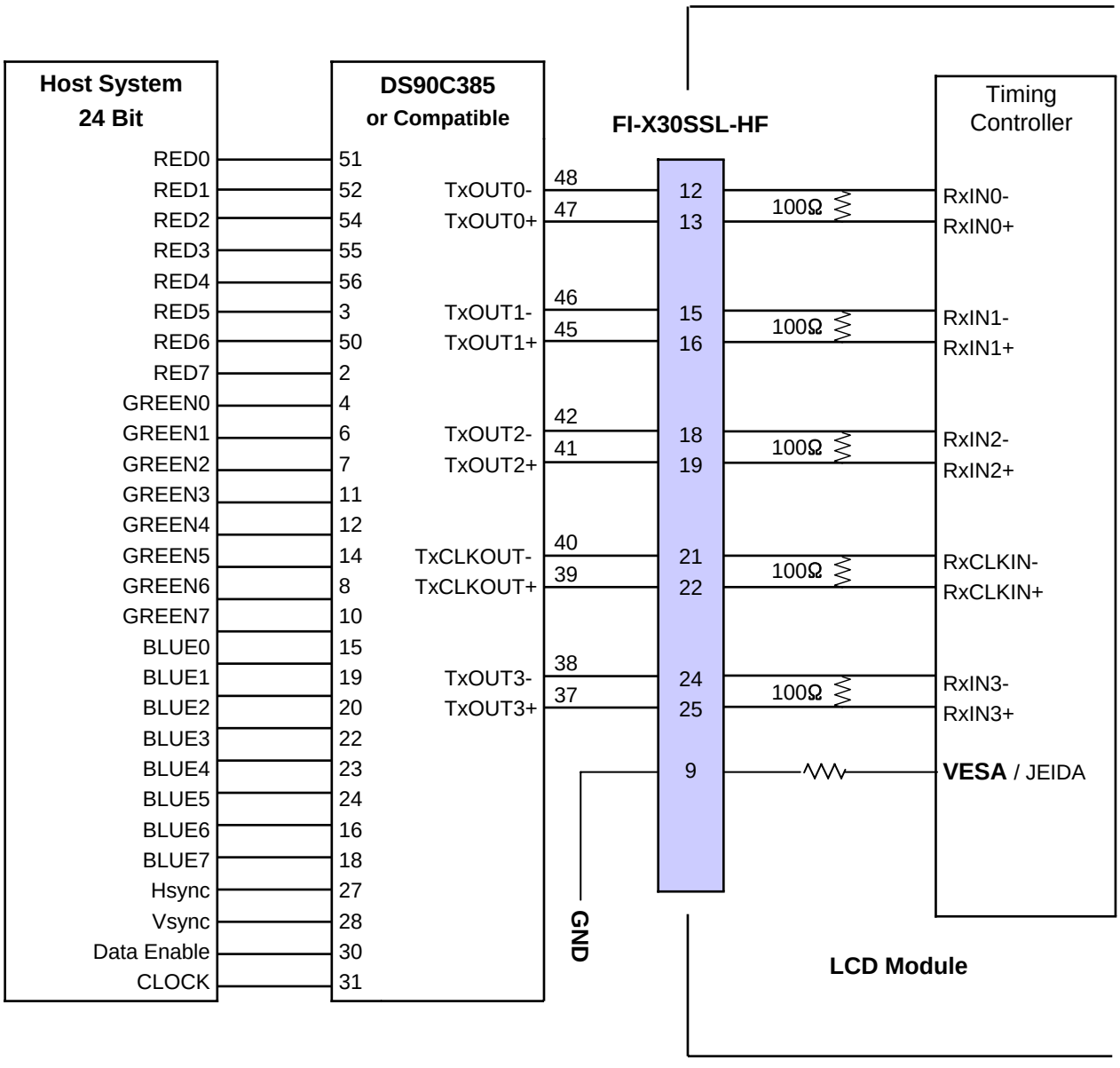
9-7. Operating condition guide

(1) The LCD product should be operated under normal conditions. Normal condition is defined as below;
- Temperature : 5 ~ 40 ℃
- Display pattern : continually changing pattern (Not stationary)

(2) If the product will be used in extreme conditions such as high temperature, display patterns or operation time etc..,
It is strongly recommended to contact LGD for Qualification engineering advice. Otherwise, its reliability and function may not be guaranteed. Extreme conditions are commonly found at Airports, Transit Stations, Banks, Stock market, and Controlling systems. The LCD product should be applied by global standard environment. (refer ETSI EN 300, IEC 60721)

APPENDIX-I-1

■ **Required signal assignment for Flat Link Transmitter(Pin9="L", or NC")**

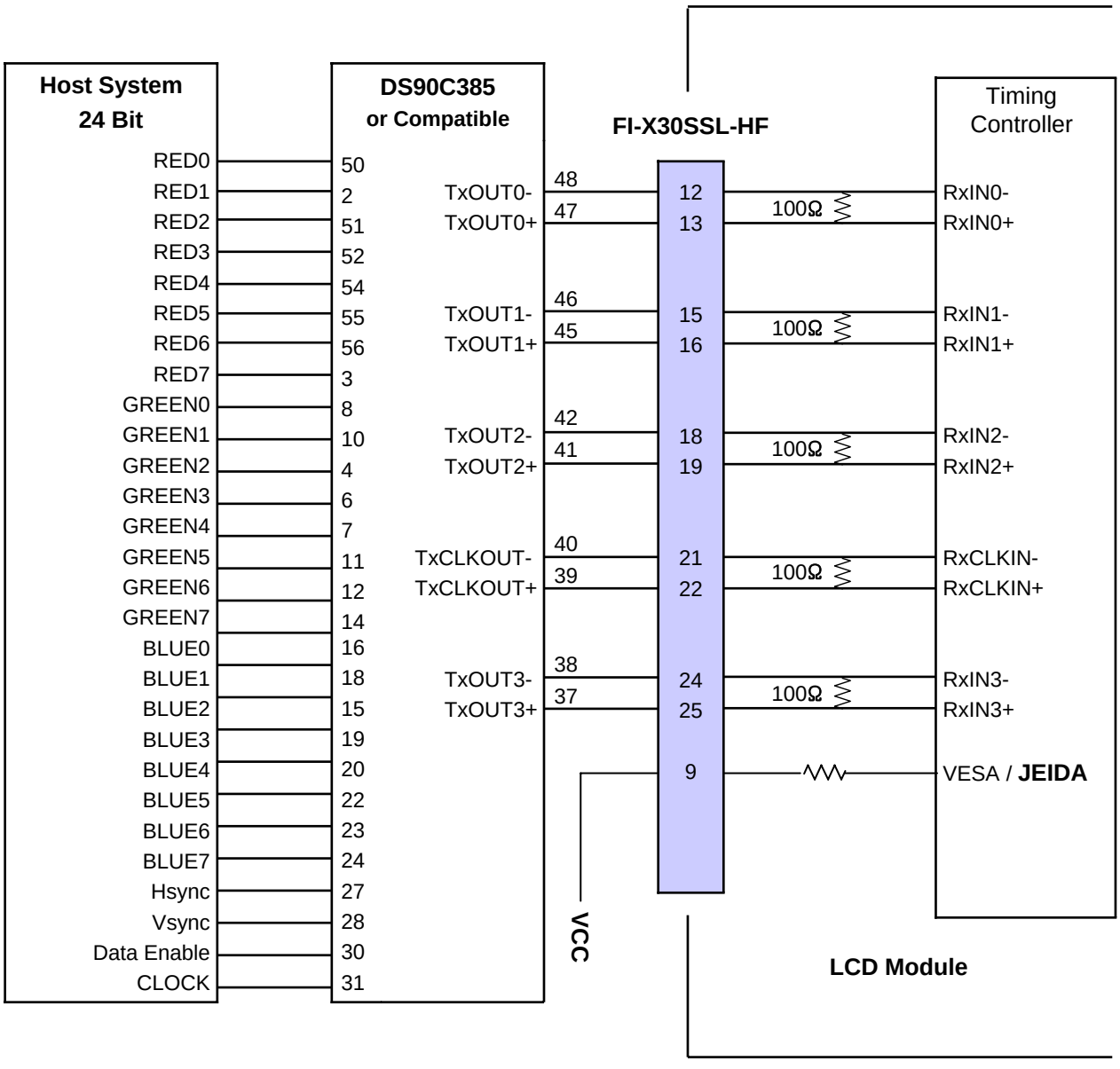


Notes:

1. The LCD module uses a 100 Ohm(Ω) resistor between positive and negative lines of each receiver input.
2. Refer to LVDS transmitter data sheet for detail descriptions. (DS90C385 or Compatible)
3. '7' means MSB and '0' means LSB at R,G,B pixel data.

APPENDIX-I-2

■ **Required signal assignment for Flat Link Transmitter(Pin9="H")**

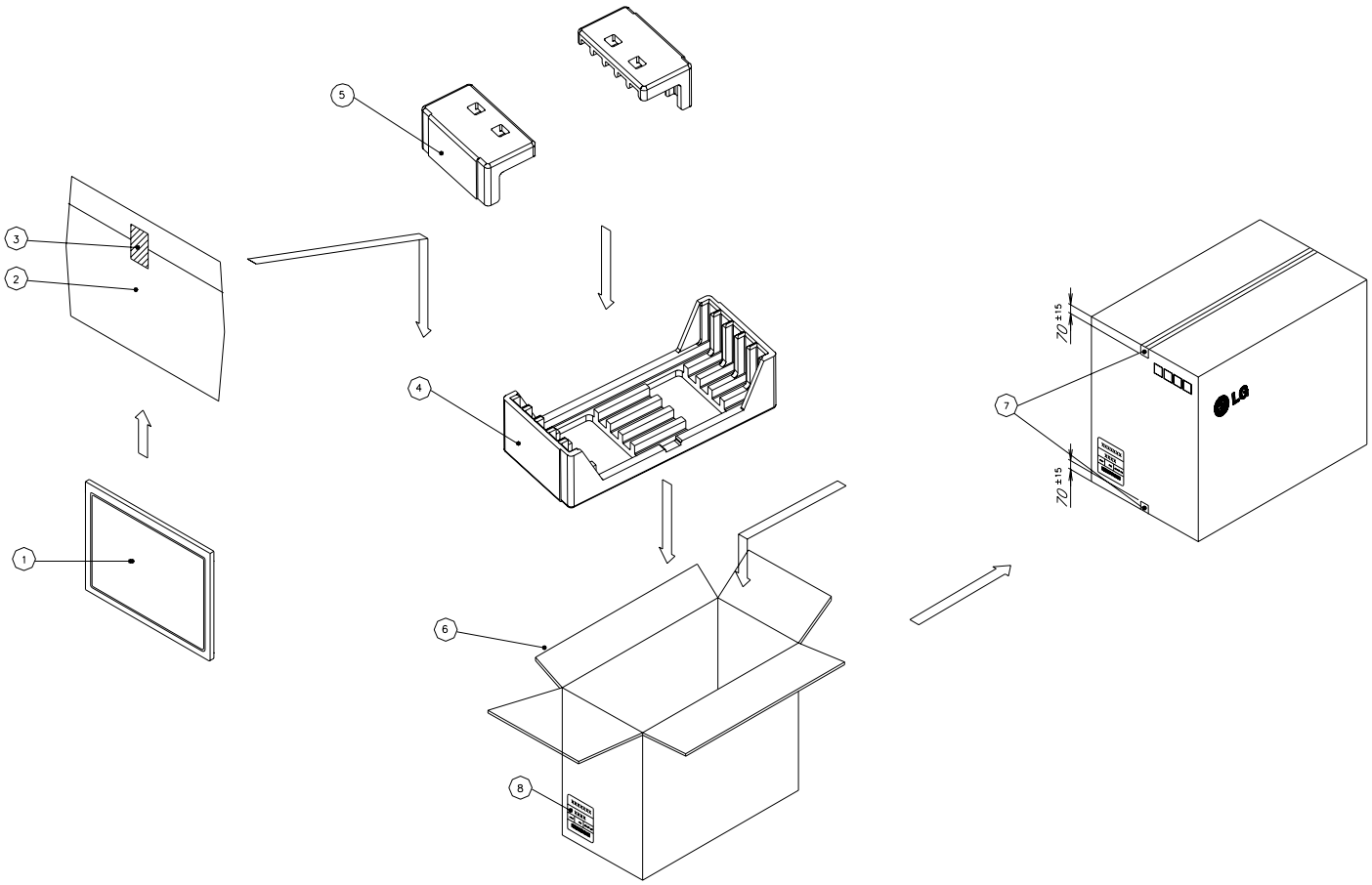


Notes:

1. The LCD module uses a 100 Ohm(Ω) resistor between positive and negative lines of each receiver input.
2. Refer to LVDS transmitter data sheet for detail descriptions. (DS90C385 or Compatible)
3. '7' means MSB and '0' means LSB at R,G,B pixel data.

APPENDIX- II **-1**

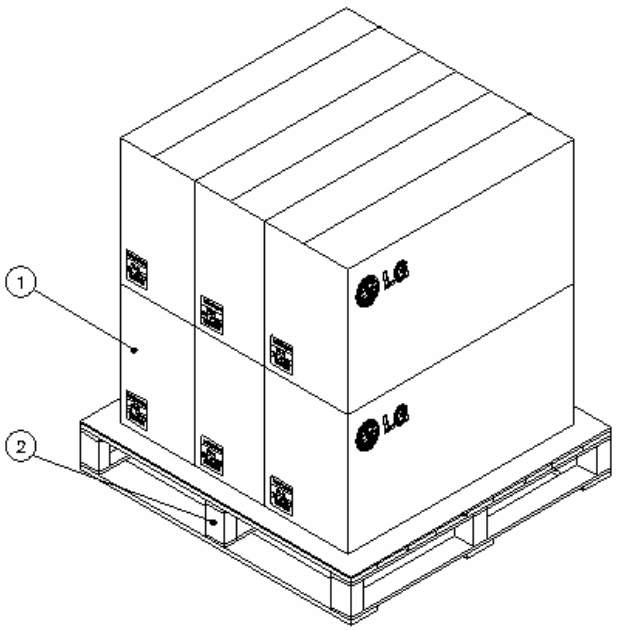
■ LC320WXE Packing Ass'y

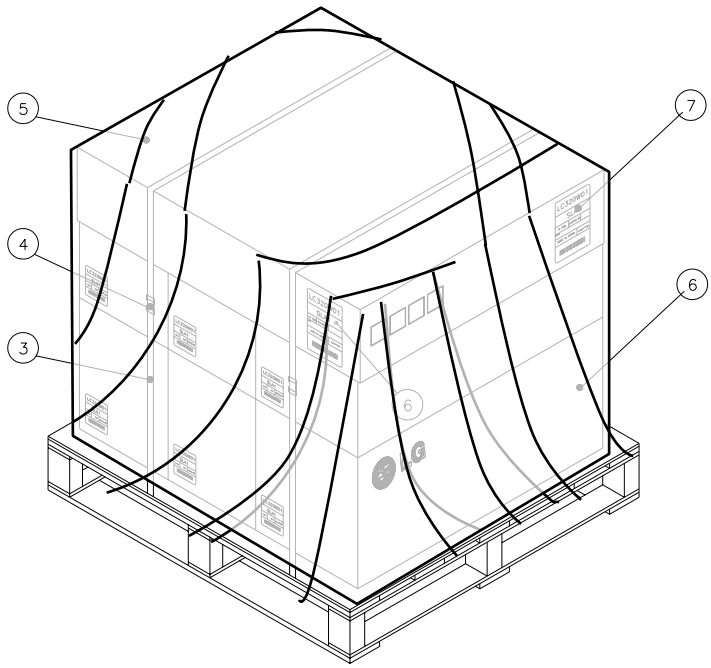


NO.	DESCRIPTION	MATERIAL
1	LCD Module	
2	BAG	AL
3	TAPE	MASKING 20MMX50M
4	Packing	EPS
5	Packing	EPS
6	BOX	PAPER_DW3
7	TAPE	OPP 70MMX300M
8	Label	ART 100X70

APPENDIX- II **-2**

■ LC320WXE Pallet Ass'y

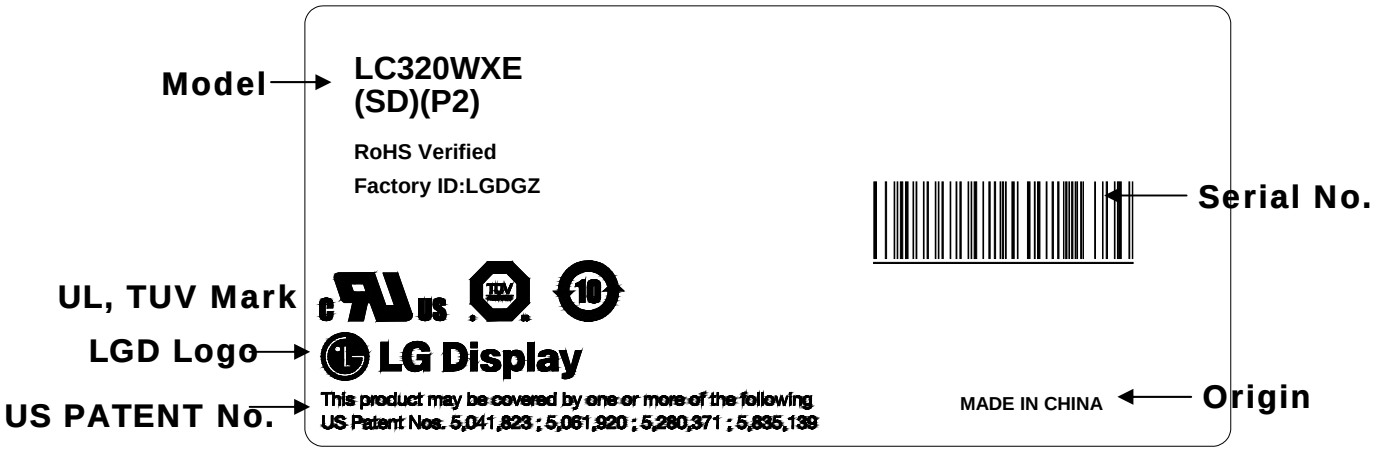




NO.	DESCRIPTION	MATERIAL
1	PACKING ASS'Y	
2	PALLET	Plywood
3	BAND	PP
4	CLIP, BAND	STEEL
5	Angle Cover	PAPER
6	WRAP	LDPE
7	LABEL	ART 100X70

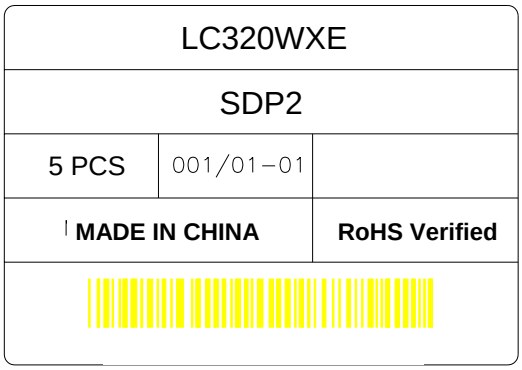
APPENDIX- III

■ LCM Label

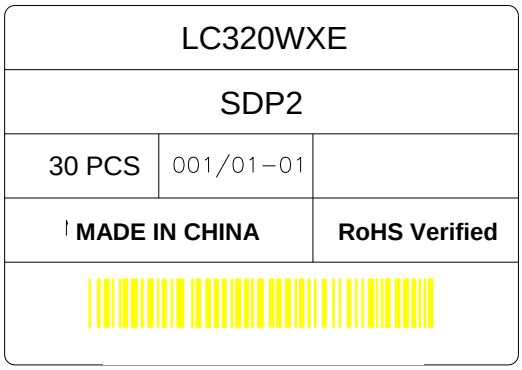


APPENDIX- IV

■ Box Label



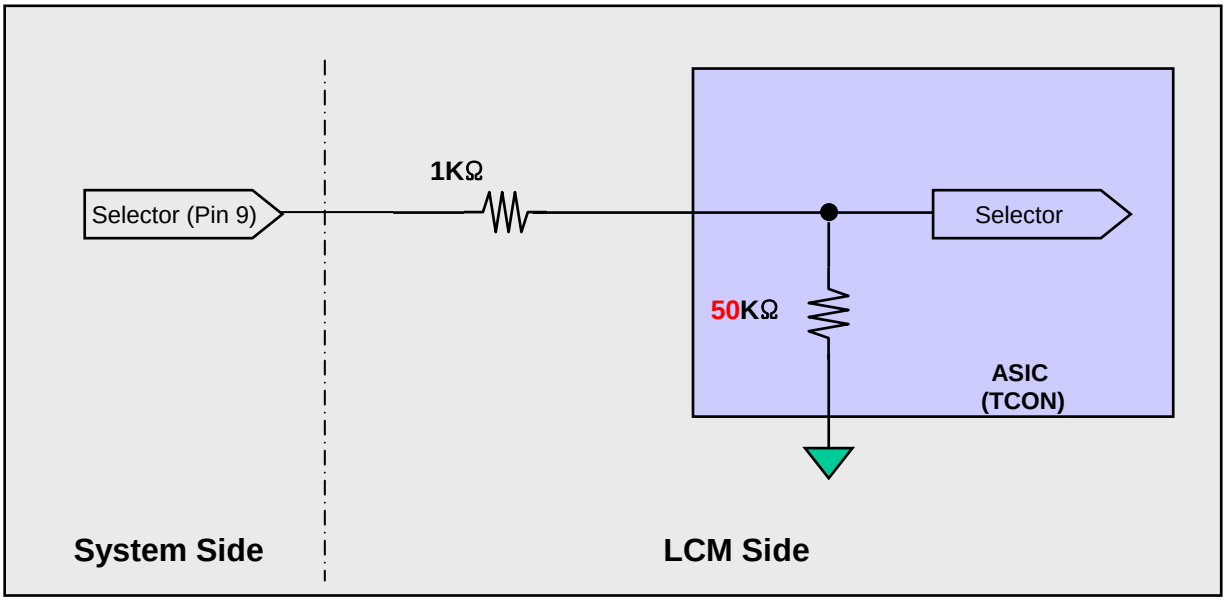
■ Pallet Label



 # APPENDIX- V

Option Pin Circuit Block Diagram

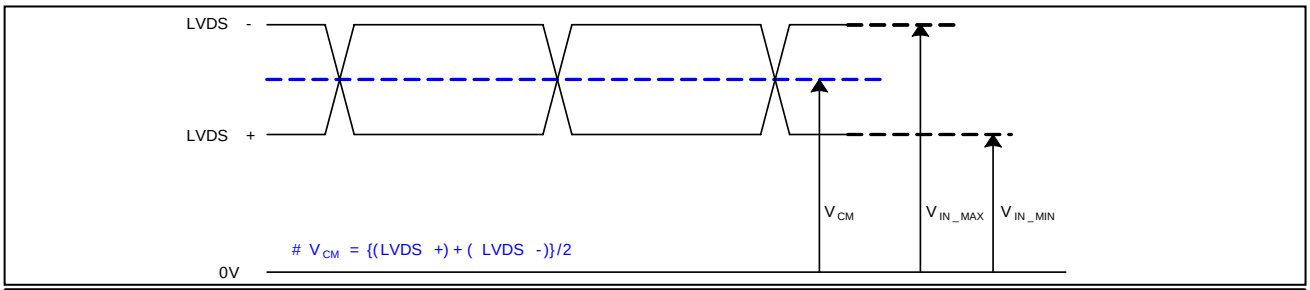
Circuit Block Diagram of LVDS Format Selection pin



APPENDIX- VI-1

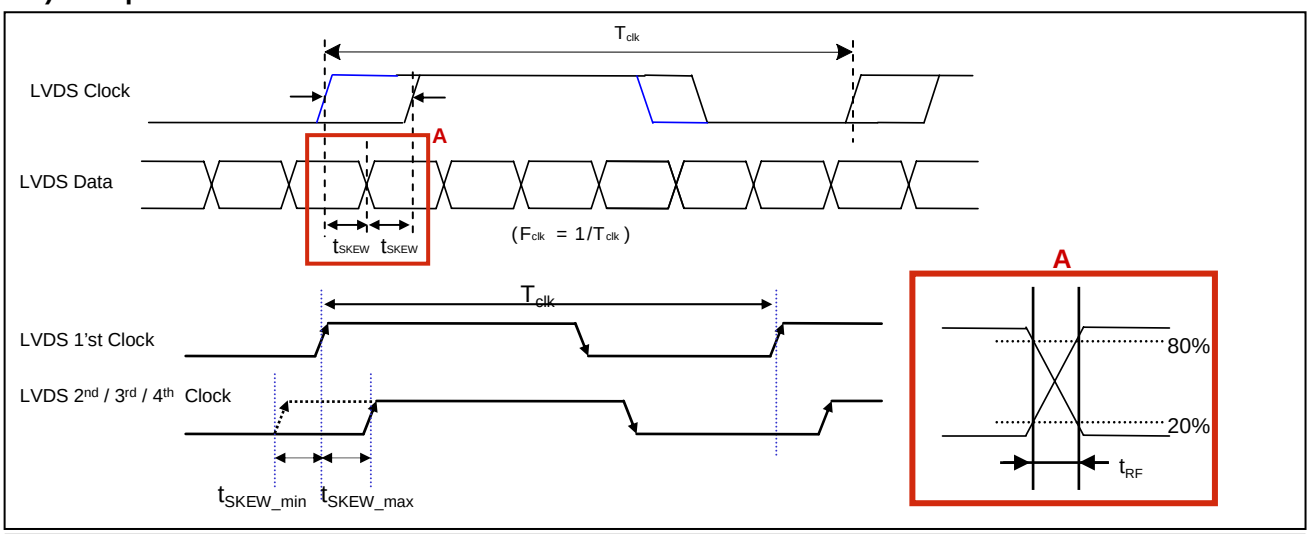
LVDS Input Signal Characteristics

1) DC Specification



Description	Symbol	Min	Max	Unit	Note
LVDS Common mode Voltage	V_{CM}	1.0	1.5	V	-
LVDS Input Voltage Range	V_{IN}	0.7	1.8	V	-
Change in common mode Voltage	ΔVCM	-	250	mV	-

2) AC Specification

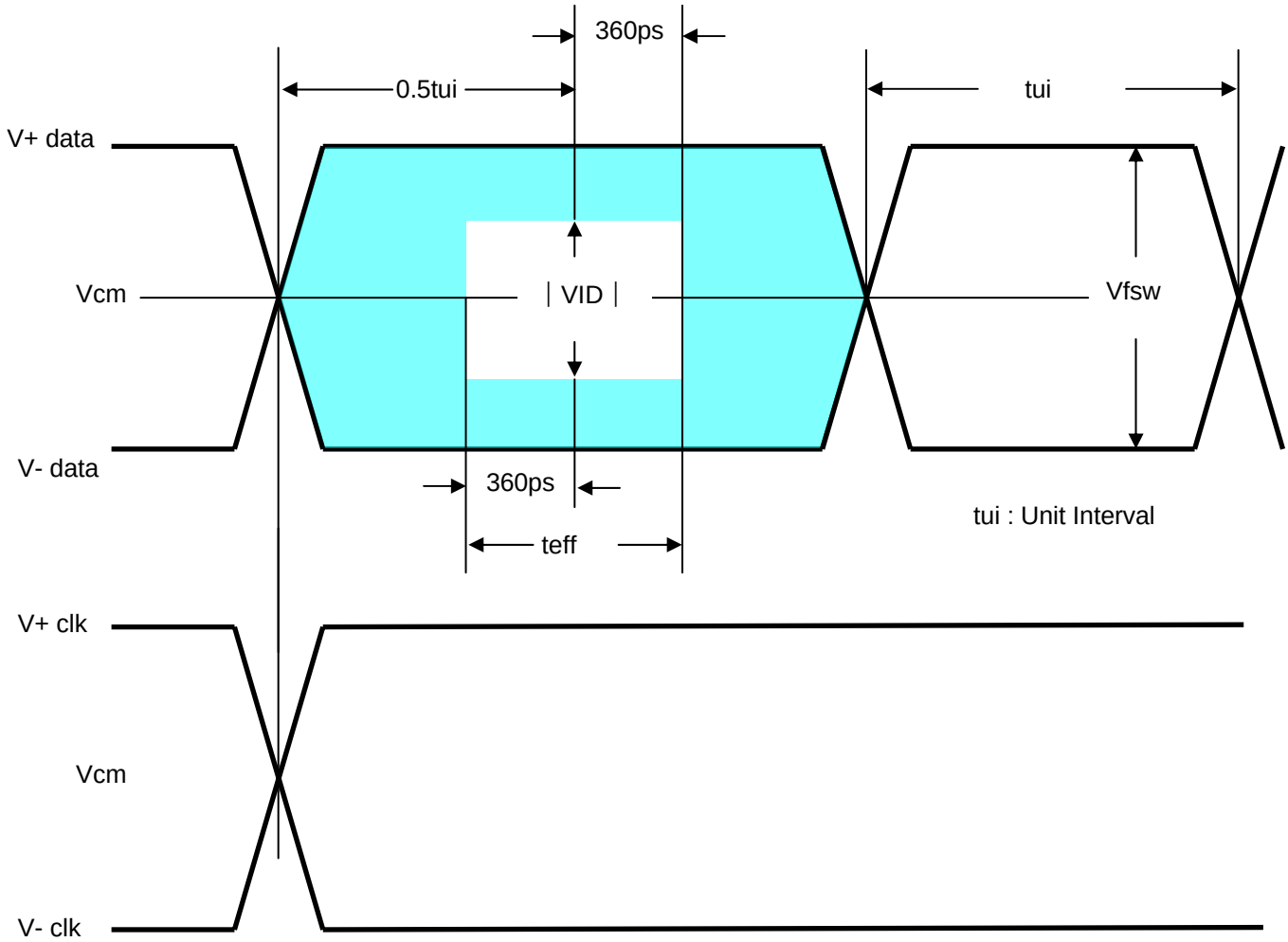


Description		Symbol	Min	Max	Unit	Note
LVDS Differential Voltage	High Threshold	V_{TH}	100	300	mV	3
	Low Threshold	V_{TL}	-300	-100	mV	
LVDS Clock to Data Skew		t_{SKEW}	-	$\|(0.20*T_{clk})/7\|$	ps	-
LVDS Clock/DATA Rising/Falling time		t_{RF}	260	$\|(0.3*T_{clk})/7\|$	ps	2
Effective time of LVDS		t_{eff}	$\|\pm 360\|$	-	ps	-
LVDS Clock to Clock Skew (Even to Odd)		t_{SKEW_EO}	-	$\|1/7* T_{clk}\|$	ps	-

Note 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.
3. LVDS Differential Voltage is defined within t_{eff}

 # APPENDIX- VI-2

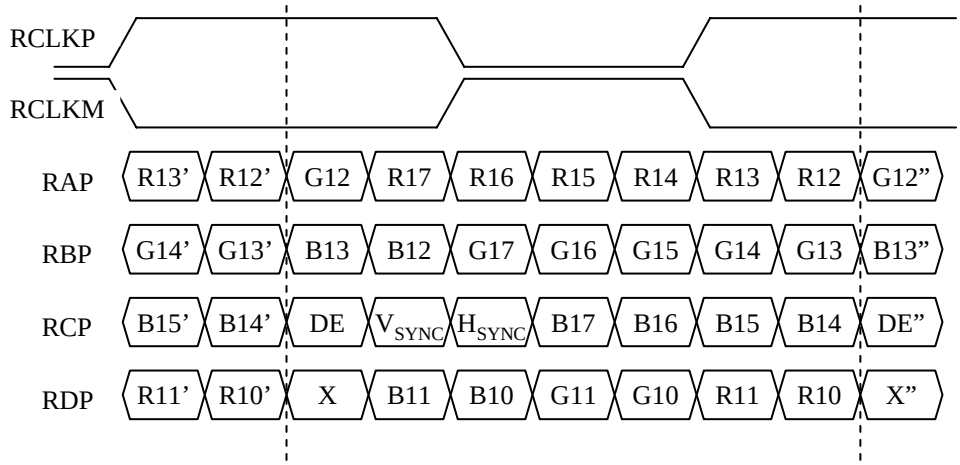
LVDS Input characteristics



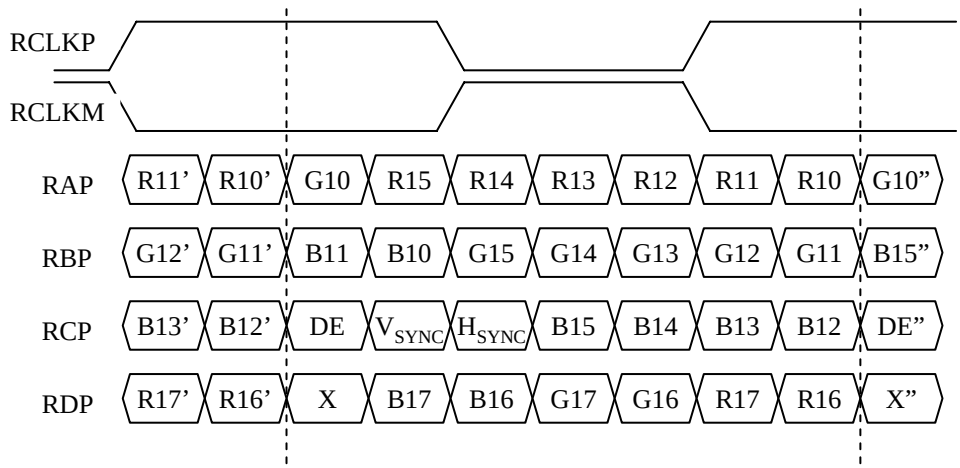
 # APPENDIX- VII

LVDS Data-Mapping info. (8bit)

■ LVDS Select : “H” Data-Mapping (JEIDA format)



■ LVDS Select : “L” Data-Mapping (VESA format)



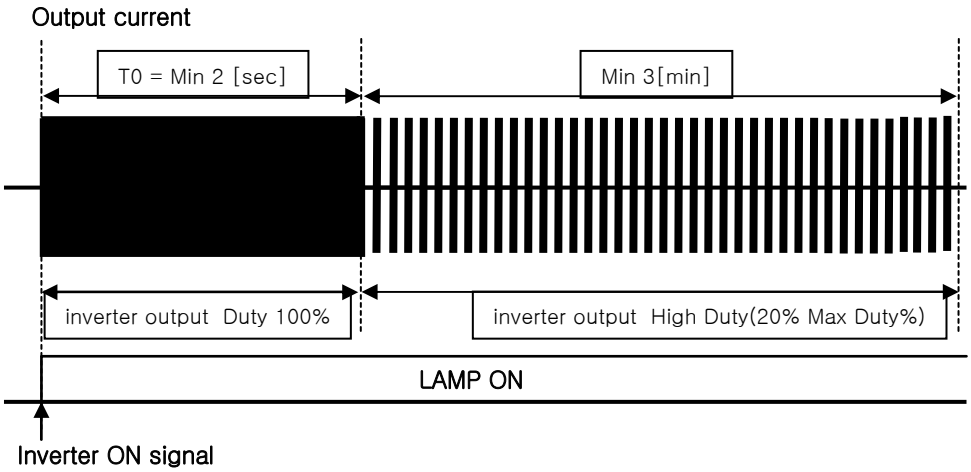
 # APPENDIX- VIII-1

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 (Inverter output Low Duty 0%~20%).**

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.

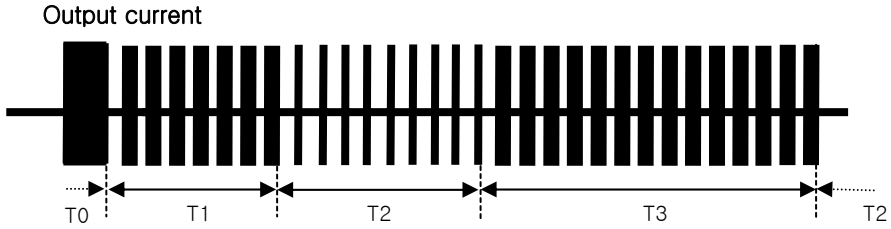
- Ratio : the period of the low duty operation must be less than 1/5 compare to that of the high duty operation(20~Max duty%) in a certain period to prevent unwanted operation.

- 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- VIII-2

Mega DCR using condition(2)



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

3) The output current duty may not be same as input PWM duty due to rise/fall time of output.

4) Following the recommended conditions as aforementioned, there is no difference of lamp lifetime between conventional method and new one.

APPENDIX- IX

■ Lamp Electrical spec

Table –1: Initial Characteristics Items and Standards

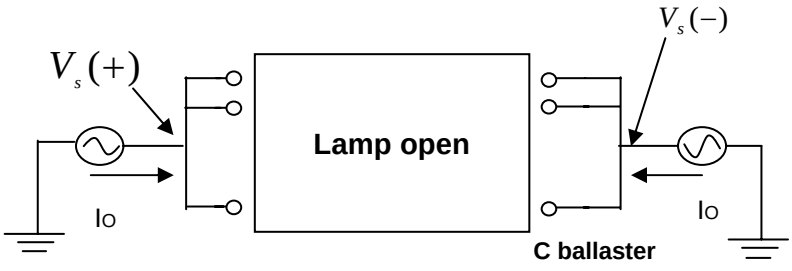
№	Item	Unit	Standards		Notes
			Frequency	INV(High-High)	
1	Lamp Voltage V_L	Vrms	63kHz	1520±7% (I_L=3.00mA) 1680±7% (I_L=5.00mA) 1940±7% (I_L=6.50mA) 2220±7% (I_L=8.0mA)	Note1,3,10
2	Starting Voltage V_S	Vrms	63kHz	Typ 1600 (0℃) Max 2200 (0℃) Typ 1500 (25℃) Max 1980 (25℃)	Note10,11,12
3	Lamp Current I_L	mA	63kHz	Min 3.00 mA Typ 6.50 mA Max 8.0 mA	Note 1,3
4	Lamp Power $I_L \times V_L$	W	63kHz	3.8 (I_L=3.00mA) 6.0 (I_L=5.00mA) 7.7 (I_L=6.50mA) 9.4 (I_L=8.0mA)	Note 1,3
5	Average Luminance At Lamp Center L	Cd/m^2	63kHz	12000±10% (I_L=3.00mA) 18500±10% (I_L=5.00mA) 23500±10% (I_L=6.50mA) 27000±10% (I_L=8.0mA)	Note 1,3,4
6	Effective Light Emitting Area LE	mm		Min 690	Note 1,3,9
8	Color Coordinates	x		0.253±0.01	Note1,3,4
		y		0.225±0.01	

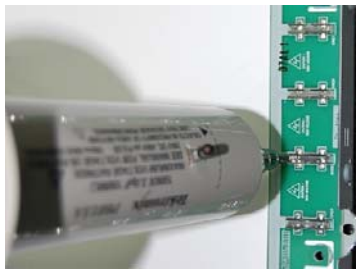
 # APPENDIX-X

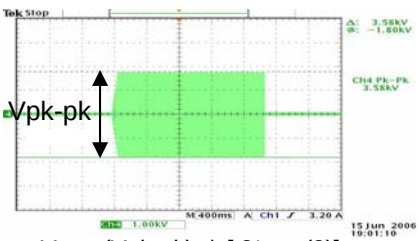
■ Starting(Striking) Voltage measurement method.

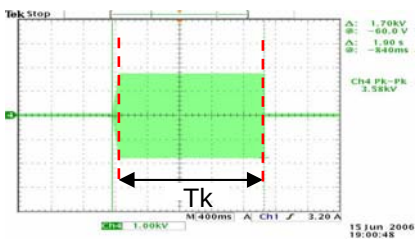
Measure the high voltage point of Balance Ass'y after removing all lamp.

a) EEFL Structure









※Equipment

1.TDS7254B(Tek.)

2.P6015(Tek.)

Vs = (Vpk-pk) / [2*root(2)]

Figure 1 . EEFL Vopen

APPENDIX- VIII

■ Standard specification of Eyeglasses

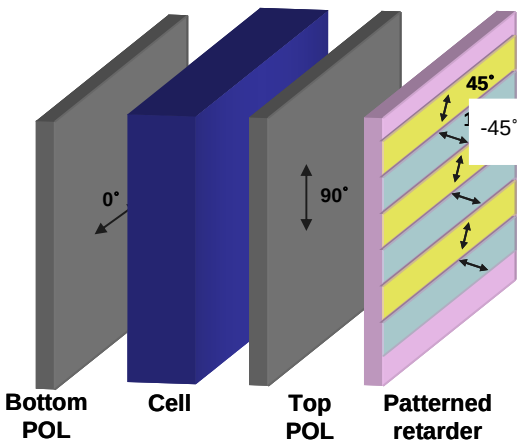
This is recommended data of Eyeglasses for LC420WUE-SDP1 model. (details refer to table)

For each item, depending on the eyeglass manufacturer tolerances may occur, this tolerance can affect 3D performance. (3D Crosstalk, 3D luminance, 3D viewing angle)

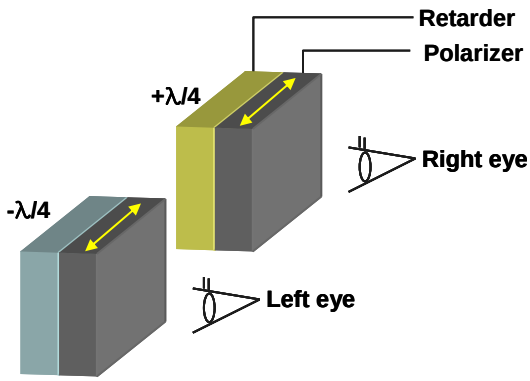
<Table. Standard specification of Eyeglasses>

Design item of Eyeglasses		Left	Right	Remark
Optical axis	a) Slow axis of retarder	-45˚	45˚	Refer to drawing
	b) Transmission axis of polarizer	0˚	0˚	
Retardation value	Retarder	125nm		@550nm

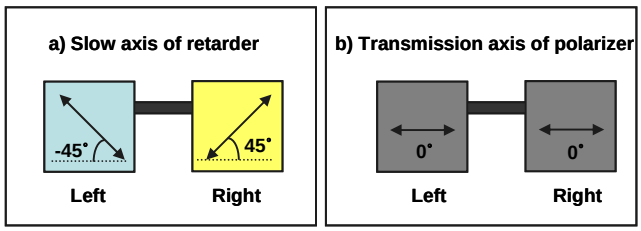
※Recommended polarizer
Polarization efficiency: more than 99.90%



(a) Configuration of 3D module



Direction from viewer



(b) Configuration of Eyeglasses

<Drawing. Information of optical axis>