LG Display

SPECIFICATION
FOR
APPROVAL

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

Title	24" WUXGA TFT LCD
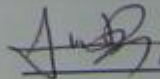
BUYER	HP
MODEL	

SUPPLIER	LG.Philips LCD Co., Ltd.
*MODEL	LM240WU3
SUFFIX	TLC1

*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
H. S. KIM / G.Manager	'08 4/2)

REVIEWED BY

C. K. LEE / Manager

PREPARED BY

S. H. HAN / Engineer

MNT Products Engineering Dept.
LG. Philips LCD Co., Ltd

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RECORD OF REVISIONS

Revision No	Revision Date	Page	Description
0.0	Jan. 24. 2008	-	Preliminary Specifications
0.1	Mar. 20. 2008	6~7	Changed the Electrical Characteristic (The Parts of Power Consumption, Differential Impedance etc..)
		8	Changed the Established Starting Voltage at 0℃ (3000→2900)
		13~15	Added on LVDS Spec
		20	Updated the Power Sequence (Delete T6, Change T7 1s à 500ms)
		27~28	Updated the Drawing of LCM
1.0	Apr. 23. 2008	-	Final Specifications
		29	The Condition of Vibration Test was Changed 10-500Hz à 10-300Hz

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1. General Description

LM240WU3-TLC1 is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Lamp(CCFL) backlight system without inverter. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally white mode. It has a 24.06 inch diagonally measured active display area with WUXGA resolution (1200 vertical by 1920 horizontal pixel array) Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness 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 colors. It has been designed to apply the 6Bit+A_FRC 2 port LVDS interface. It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important.
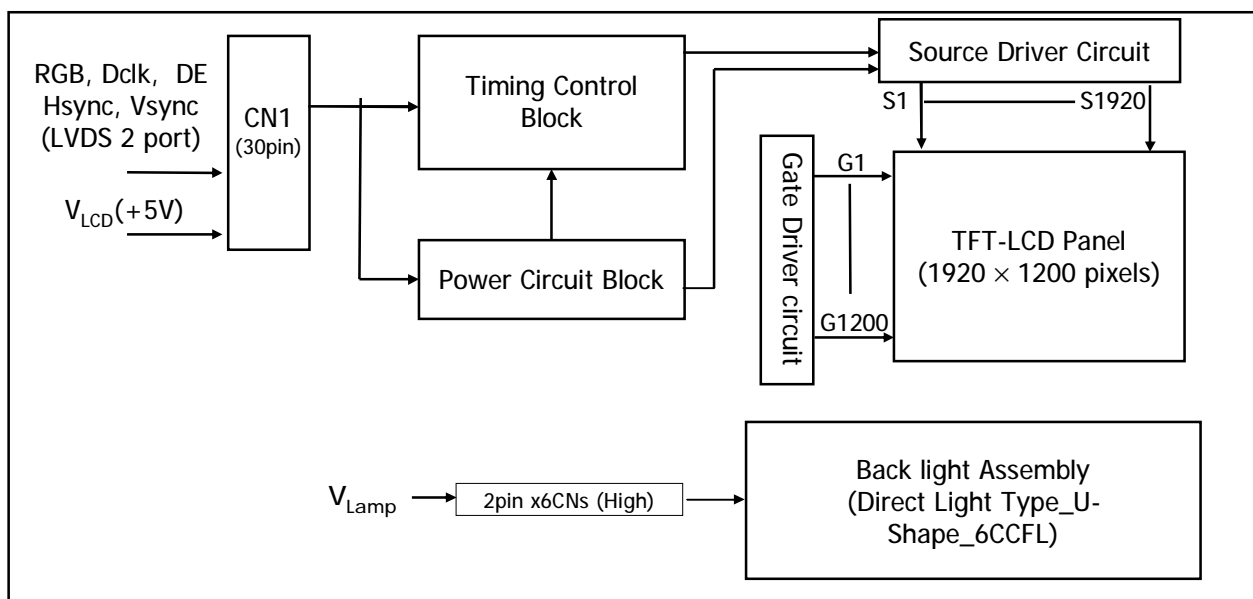
General Features

Active Screen Size	24.06 inches(61.13cm) diagonal
Outline Dimension	546.4(H) x 352.0(V) x 35.7(D) mm(Typ.) * without inverter
Pixel Pitch	0.270 mm x 0.270 mm
Pixel Format	1920 horiz. By 1200 vert. Pixels RGB stripes arrangement
Color Depth	16.7M colors
Luminance, White	400 cd/m^2 (Center 1 point)
Viewing Angle(CR>10)	View Angle Free (R/L 170(Typ.), U/D 160(Typ.))
Power Consumption	Total 67.30 Watt (Typ.) (4.3 Watt @VLCD, 63Watt @[Lamp=6.0mA])
Weight	2480 g(typ.)
Display Operating Mode	Transmissive mode, normally white
Surface Treatment	Hard coating(3H), Glare treatment of the front polarizer

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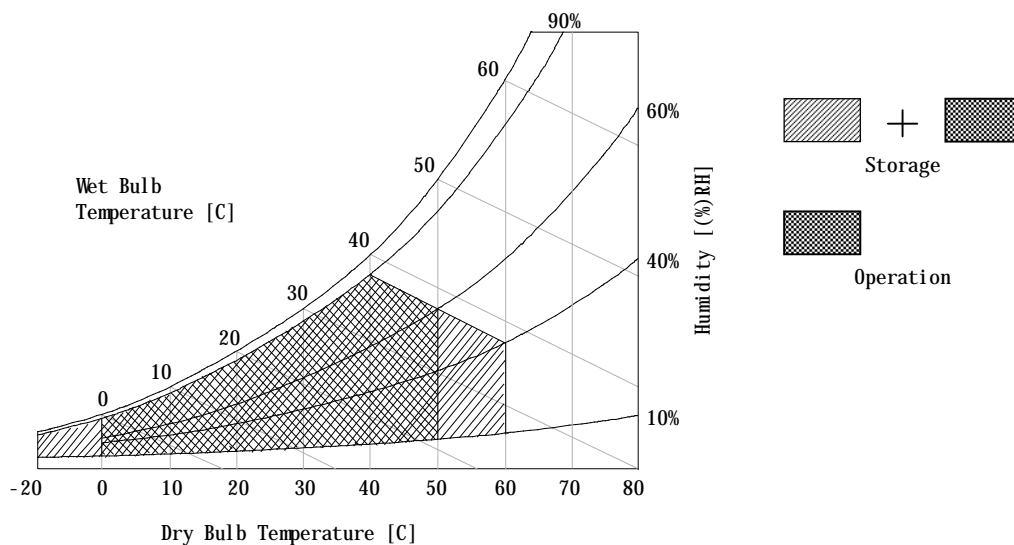
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2. Absolute Maximum Ratings

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

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	V_{LCD}	-0.3	+5.5	Vdc	at 25 ± 2℃
Operating Temperature	T_{OP}	0	50	℃	
Storage Temperature	T_{ST}	-20	60	℃	1
Operating Ambient Humidity	H_{OP}	10	90	%RH	
Storage Humidity	H_{ST}	10	90	%RH	

Note : 1. Temperature and relative humidity range are shown in the figure below.
　　　　Wet bulb temperature should be 39 ℃ Max, and no condensation of water.

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3. Electrical Specifications

3-1. Electrical Characteristics

It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input power for the CCFL, is typically generated by an inverter. The inverter is an external unit to the LCDs.

Table 2-1. ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	V_{LCD}	4.5	5.0	5.5	Vdc	
Permissive Power Input Ripple	V_{dRF}			200	mV$_{p-p}$	1
Differential Impedance	Zm	90	100	110	Ohm	
Power Supply Input Current	I_{LCD}	730	860	990	mA	2
		940	1110	1280	mA	3
Power Consumption	$P_{C\ TYP}$	-	4.30	5.45	Watt	2
	$P_{C\ MAX}$	-	5.55	6.40	Watt	3
Rush current	I_{RUSH}	-	-	3.0	A	3

Note :
1. Permissive power ripple should be measured under VCC=5.0V, 25°C, fV(frame frequency)=MAX condition and At that time, we recommend the bandwidth configuration of oscilloscope is to be under 20Mhz. See the next page.

2. The specified current and power consumption are under the V_{LCD}=12.0V, 25 ± 2°C, f_V=60Hz condition whereas Mosaic and max power pattern shown in the [Figure 3] is displayed.

3. The current is specified at the maximum current pattern.

4. Maximum Condition of Inrush current :
   The duration of rush current is about 2ms and rising time of Input Voltage is 1ms(min.).
   At any rising time of Input voltage, Keep the I2T Value by below Condition
      Condition : I2T < 32*2ms

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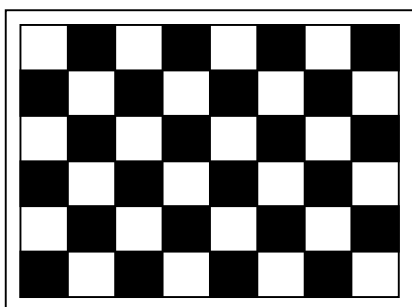• **Permissive Power input ripple (**VCC=5.0V, 25°C, fV(frame frequency)=MAX condition**)**
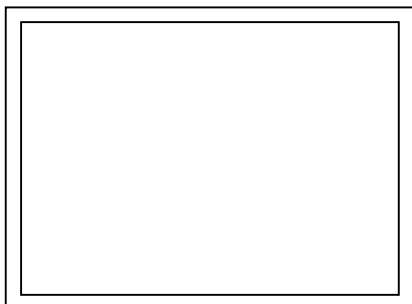
White pattern

Black pattern

• **Power consumption (**VCC=5.0V, 25°C, fV (frame frequency=60Hz condition**)**

Typical power Pattern

Max power Pattern

[Figure 3] Mosaic pattern & Black Pattern for power consumption measurement

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Table 2_2. ELECTRICAL CHARACTERISTICS

Parameter		Symbol	Values			Unit	Notes
			Min	Typ	Max		
LAMP :							
Operating Voltage		V_{BL}	1550(8.0mA)	1750(6.0mA)	1950(3.0mA)	V_{RMS}	1, 2
Operating Current		I_{BL}	3.0	6.0	8.0	mA_{RMS}	1
Established Starting Voltage		Vs					1, 3
	at 25 °C		-	-	2500	V_{RMS}	
	at 0 °C		-	-	2900	V_{RMS}	
Operating Frequency		f_{BL}	40	48	80	kHz	4
Discharge Stabilization Time		Ts			3.0	Min	1, 5
Power Consumption		P_{BL}	35.1	63	74.4	Watt	6
Life Time			40,000			Hrs	1, 7

Note : The design of the inverter must have specifications for the lamp in LCD Assembly**.**
　　　The performance of the Lamp 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) never occurs. When you confirm it, the LCD–Assembly should be operated in the same condition as installed in you instrument.
　※　Do not attach a conducting tape to lamp connecting wire.
　　　If the lamp wire attach to a conducting tape, TFT-LCD Module has a low luminance and the inverter has abnormal action. Because leakage current is occurred between lamp wire and conducting tape.

1. Specified values are for a single lamp.
2. Operating voltage is measured at $25 \pm 2°C$. The variance of the voltage is $\pm 10\%$.
3. The voltage above V_S should be applied to the lamps for more than 1 second for start-up.
   (Inverter open voltage must be more than lamp starting voltage.)
   Otherwise, the lamps may not be turned on. The used lamp current is the lamp typical current.
4. Lamp frequency may produce interface with horizontal synchronous frequency and as a result this may cause beat on the display. Therefore lamp frequency shall be as away possible from the horizontal synchronous frequency and from its harmonics in order to prevent interference.
5. Let's define the brightness of the lamp after being lighted for 5 minutes as 100%.
   T_S is the time required for the brightness of the center of the lamp to be not less than 95%.
6. The lamp power consumption shown above does not include loss of external inverter.
   The used lamp current is the lamp typical current. ($P_{BL} = V_{BL} \times I_{BL} \times N_{Lamp}$)
7. The life 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 $25 \pm 2°C$.

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8. The output of the inverter must have symmetrical(negative and positive) voltage waveform and symmetrical current waveform (Unsymmetrical ratio is less than 10%). Please do not use the inverter which has unsymmetrical voltage and unsymmetrical current and spike wave.
Requirements for a system inverter design, which is intended to have a better display performance, a better power efficiency and a more reliable lamp, are following.
It shall 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.

I_p

I_{-p}
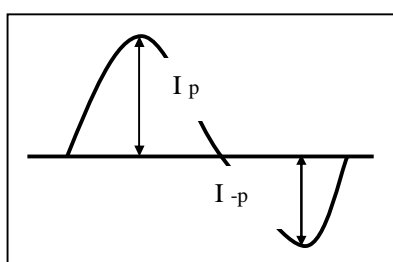
* Asymmetry rate:

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

* Distortion rate

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

9. The inverter which is combined with this LCM, is highly recommended to connect coupling(ballast) condenser at the high voltage output side. When you use the inverter which has not coupling(ballast) condenser, it may cause abnormal lamp lighting because of biased mercury as time goes.
10. In case of edgy type back light with over 4 parallel lamps, input current and voltage wave form should be synchronized

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3-2. Interface Connections

- LCD Connector(CN1): 187024-30091, (Manufactured by P-TWO) or

GT103-30S-H23 (Manufactured by LS Cable)

- Mating Connector : FI-X30C2L (Manufactured by JAE) or Equivalent

### Table 3 MODULE CONNECTOR(CN1) PIN CONFIGURATION

Pin No	Symbol	Description	
1	FR0M	Minus signal of odd channel 0 (LVDS)	
2	FR0P	Plus signal of odd channel 0 (LVDS)	
3	FR1M	Minus signal of odd channel 1 (LVDS)	
4	FR1P	Plus signal of odd channel 1 (LVDS)	
5	FR2M	Minus signal of odd channel 2 (LVDS)	
6	FR2P	Plus signal of odd channel 2 (LVDS)	First data
7	GND	Ground	
8	FCLKINM	Minus signal of odd clock channel (LVDS)	
9	FCLKINP	Plus signal of odd clock channel (LVDS)	
10	FR3M	Minus signal of odd channel 3 (LVDS)	
11	FR3P	Plus signal of odd channel 3 (LVDS)	
12	SR0M	Minus signal of even channel 0 (LVDS)	
13	SR0P	Plus signal of even channel 0 (LVDS)	
14	GND	Ground	
15	SR1M	Minus signal of even channel 1 (LVDS)	
16	SR1P	Plus signal of even channel 1 (LVDS)	
17	GND	Ground	
18	SR2M	Minus signal of even channel 2 (LVDS)	Second data
19	SR2P	Plus signal of even channel 2 (LVDS)	
20	SCLKINM	Minus signal of even clock channel (LVDS)	
21	SCLKINP	Plus signal of even clock channel (LVDS)	
22	SR3M	Minus signal of even channel 3 (LVDS)	
23	SR3P	Plus signal of even channel 3 (LVDS)	
24	GND	Ground	
25	NC	No Connection (I2C Serial interface for P-VCOM)	
26	NC	No Connection (I2C Serial interface for P-VCOM)	
27	PWM_OUT	PWM_OUT signal for control burst frequency of Inverter	
28	V$_{LCD}$	Power Supply +5.0V	
29	V$_{LCD}$	Power Supply +5.0V	
30	V$_{LCD}$	Power Supply +5.0V	

Note: 1. NC: No Connection.

2. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.

3. All V$_{LCD}$ (power input) pins should be connected together.

4. Input Level of LVDS signal is based on the IEA 664 Standard.

5. PWM_OUT signal is synchronized with vertical frequency.

It's frequency is 3 times of vertical frequency, and it's duty ratio is 50%.

If you don't use this pin, it is no connection.

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User Connector Diagram

Rear view of LCM
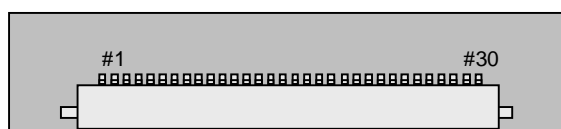
187024-30091 / GT103-30S-H23

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### Table 4. REQUIRED SIGNAL ASSIGNMENT FOR Flat Link (TI:SN75LVDS83) Transmitter

Pin #	Pin Name	Require Signal	Pin #	Pin Name	Require Signal
1	Vcc	Power Supply for TTL Input	29	GND	Ground pin for TTL
2	D5	TTL Input (R7)	30	D26	TTL Input (DE)
3	D6	TTL Input (R5)	31	T_X CLKIN	TTL Level clock Input
4	D7	TTL Input (G0)	32	PWR DWN	Power Down Input
5	GND	Ground pin for TTL	33	PLL GND	Ground pin for PLL
6	D8	TTL Input (G1)	34	PLL Vcc	Power Supply for PLL
7	D9	TTL Input (G2)	35	PLL GND	Ground pin for PLL
8	D10	TTL Input (G6)	36	LVDS GND	Ground pin for LVDS
9	Vcc	Power Supply for TTL Input	37	TxOUT3＋	Positive LVDS differential data output 3
10	D11	TTL Input (G7)	38	TxOUT3－	Negative LVDS differential data output 3
11	D12	TTL Input (G3)	39	T_X CLKOUT＋	Positive LVDS differential clock output
12	D13	TTL Input (G4)	40	T_X CLKOUT－	Negative LVDS differential clock output
13	GND	Ground pin for TTL	41	T_X OUT2＋	Positive LVDS differential data output 2
14	D14	TTL Input (G5)	42	T_X OUT2－	Negative LVDS differential data output 2
15	D15	TTL Input (B0)	43	LVDS GND	Ground pin for LVDS
16	D16	TTL Input (B6)	44	LVDS Vcc	Power Supply for LVDS
17	Vcc	Power Supply for TTL Input	45	T_X OUT1＋	Positive LVDS differential data output 1
18	D17	TTL Input (B7)	46	T_X OUT1－	Negative LVDS differential data output 1
19	D18	TTL Input (B1)	47	T_X OUT0＋	Positive LVDS differential data output 0
20	D19	TTL Input (B2)	48	T_X OUT0－	Negative LVDS differential data output 0
21	GND	Ground pin for TTL Input	49	LVDS GND	Ground pin for LVDS
22	D20	TTL Input (B3)	50	D27	TTL Input (R6)
23	D21	TTL Input (B4)	51	D0	TTL Input (R0)
24	D22	TTL Input (B5)	52	D1	TTL Input (R1)
25	D23	TTL Input (RSVD)	53	GND	Ground pin for TTL
26	Vcc	Power Supply for TTL Input	54	D2	TTL Input (R2)
27	D24	TTL Input (HSYNC)	55	D3	TTL Input (R3)
28	D25	TTL Input (VSYNC)	56	D4	TTL Input (R4)

Notes : Refer to LVDS Transmitter Data Sheet for detail descriptions.

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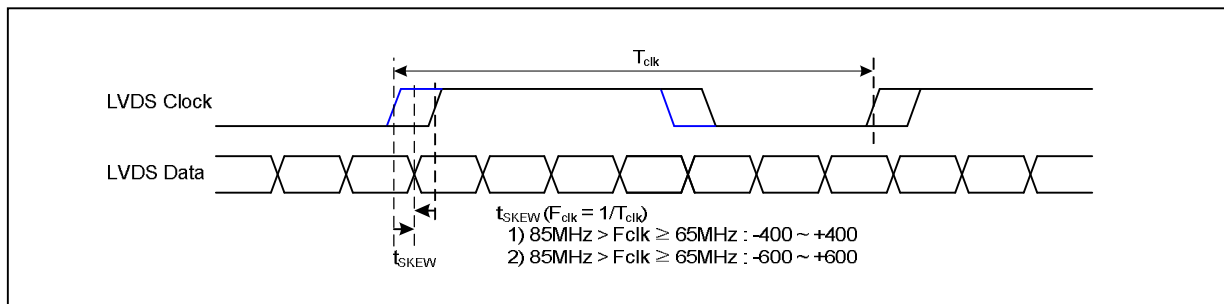
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LVDS Input characteristics

1. DC Specification

$$\# \ |V_{ID}| = |(LVDS+) - (LVDS-)|$$
$$\# \ V_{CM} = \{(LVDS+) + (LVDS-)\}/2$$
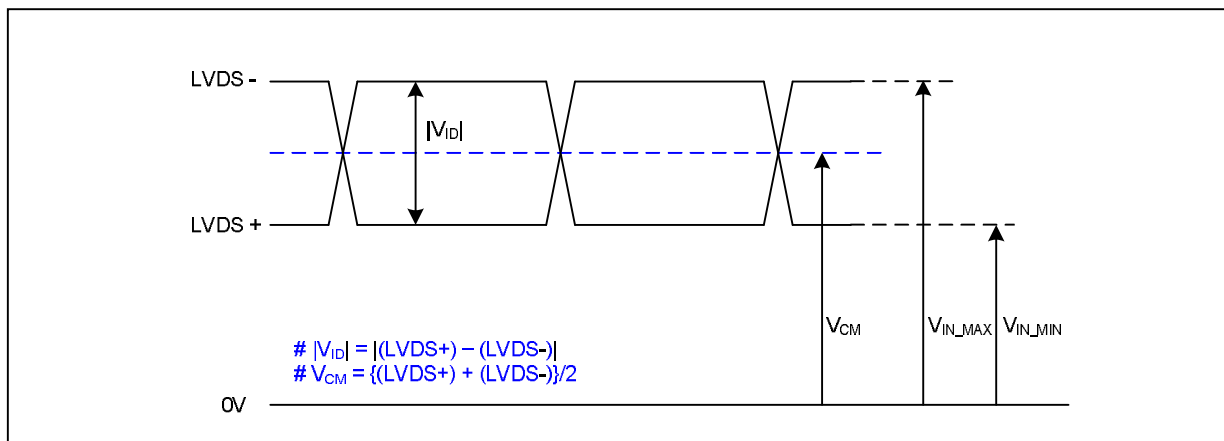
Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$|V_{ID}|$	100	600	mV	-
LVDS Common mode Voltage	V_{CM}	0.6	1.8	V	-
LVDS Input Voltage Range	V_{IN}	0.3	2.1	V	-

2. AC Specification

t_{SKEW} (F_{clk} = 1/T_{clk})
1) 85MHz > Fclk ≥ 65MHz : -400 ~ +400
2) 85MHz > Fclk ≥ 65MHz : -600 ~ +600

Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	- 400	+ 400	ps	85MHz > Fclk ≥ 65MHz
	t_{SKEW}	- 600	+ 600	ps	65MHz > Fclk ≥ 25MHz
LVDS Clock to Clock Skew Margin (Even to Odd)	t_{SKEW_EO}	- 1/7	+ 1/7	T_{clk}	-
Maximum deviation of input clock frequency during SSC	F_{DEV}	-	± 3	%	-
Maximum modulation frequency of input clock during SSC	F_{MOD}	-	200	KHz	-

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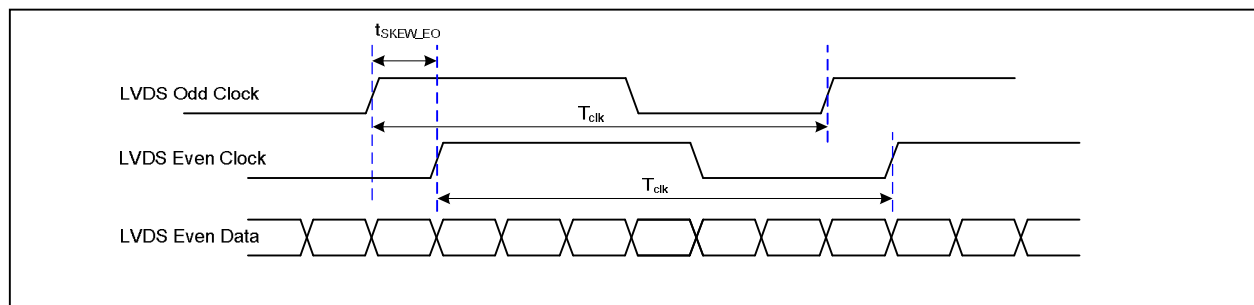
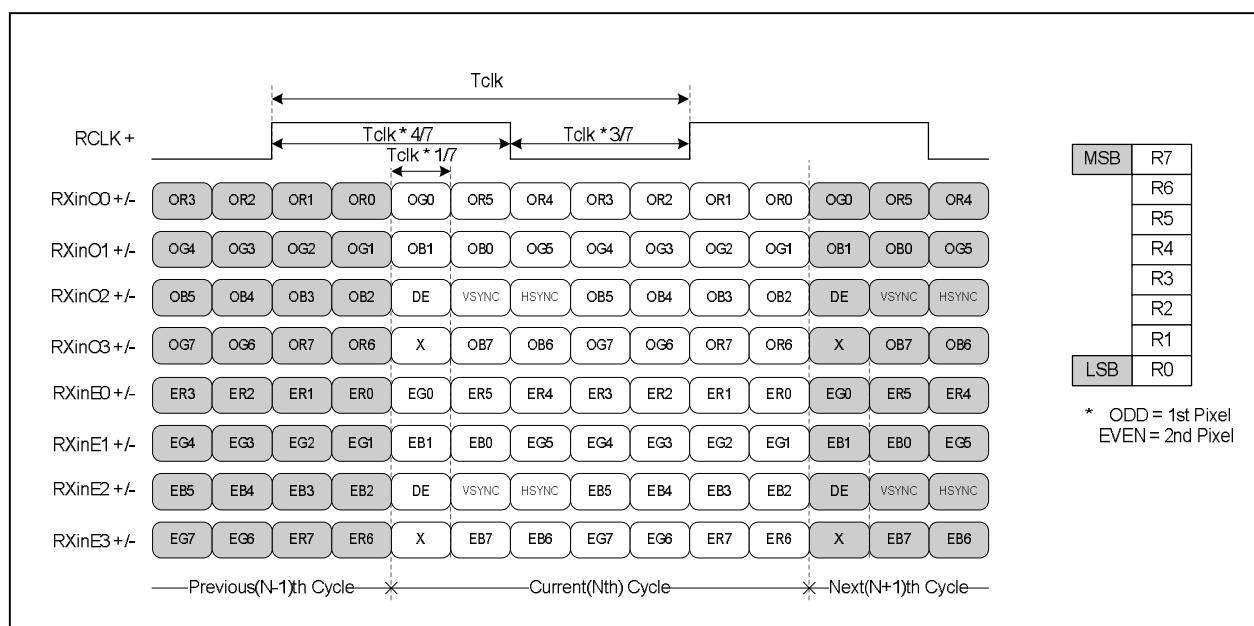< Clock skew margin between channel >
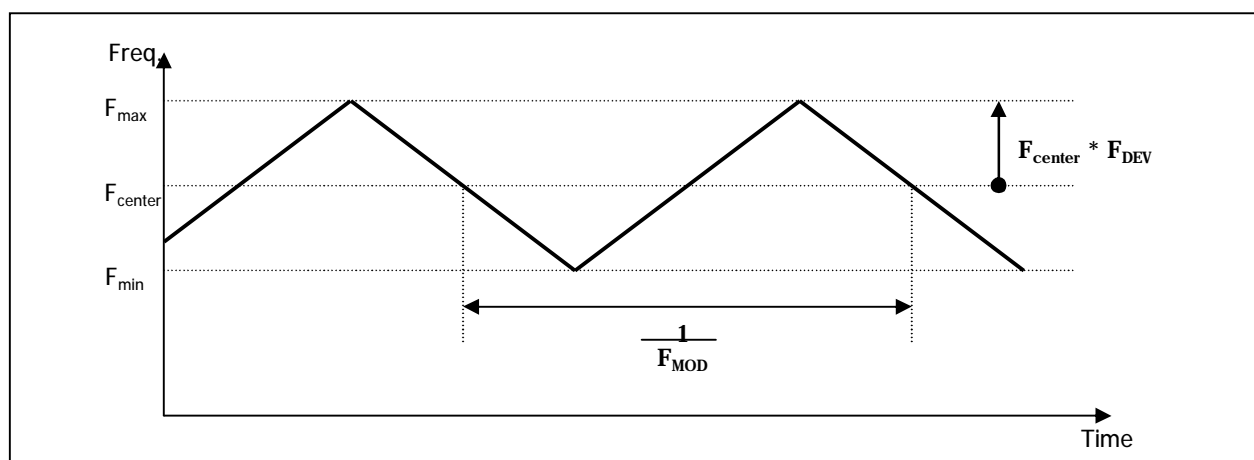
< Spread Spectrum >

3. Data Format
   1) LVDS 2 Port

< LVDS Data Format >

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2) LVDS 1 Port

	RCLK+													
RA+/-	R3	R2	R1	R0	G0	R5	R4	R3	R2	R1	R0	G0	R5	R4
RB+/-	G4	G3	G2	G1	B1	B0	G5	G4	G3	G2	G1	B1	B0	G5
RC+/-	B5	B4	B3	B2	DE	VSYNC	HSYNC	B5	B4	B3	B2	DE	VSYNC	HSYNC
RD+/-	G7	G6	R7	R6	X	B7	B6	G7	G6	R7	R6	X	B7	B6

——Previous (N-1)th Cycle —— ——Current (Nth) Cycle—————— ——Next (N+1)th Cycle ——
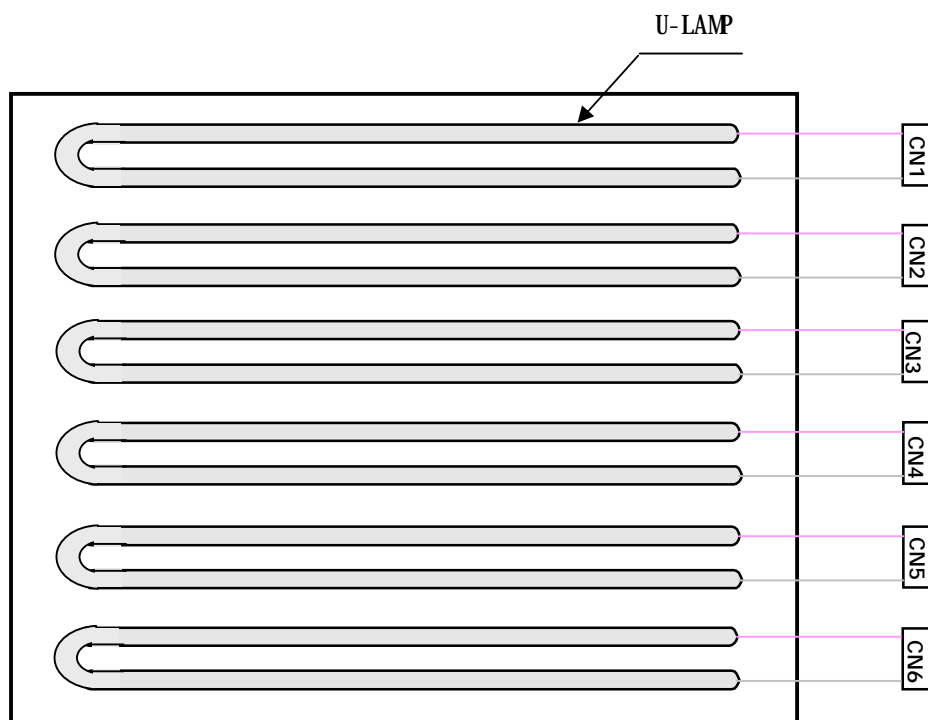
LG Display
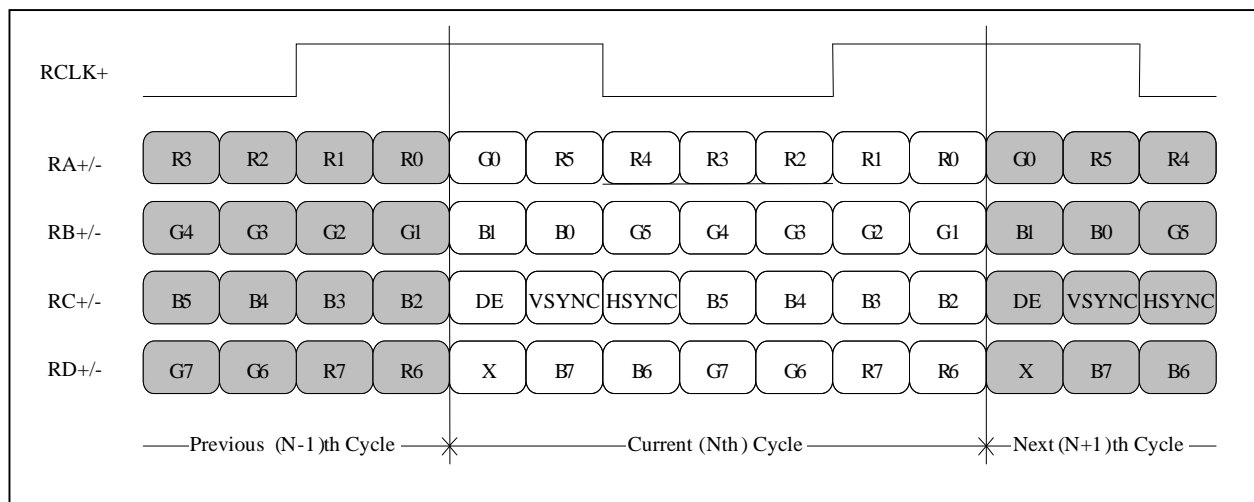
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Table 5. BACKLIGHT CONNECTOR PIN CONFIGURATION(CN1,CN2,CN3,CN4,CN5,CN6)

The backlight interface connector is a model 20015HS-04L (CN1/CN2/CN3/CN4/CN5/CN6) manufactured by Yeon Ho Electronics. The mating connector part number are 20015WR-07L01(manufactured by Yeon Ho Electronics) or equivalent. The pin configuration for the connector is shown in the table below.

Pin	Symbol	Description	NOTES
1,2	HV	High Voltage for Lamp	1

Note : 1. The high voltage power terminal is colored Pink/White

<BACKLIGHT CONNECTOR DIAGRAM>

U-LAMP

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3-3. Signal Timing Specifications

This is signal timing required at the input of the TMDS transmitter. All of the interface signal timing should be satisfied with the following specifications for it's proper operation.
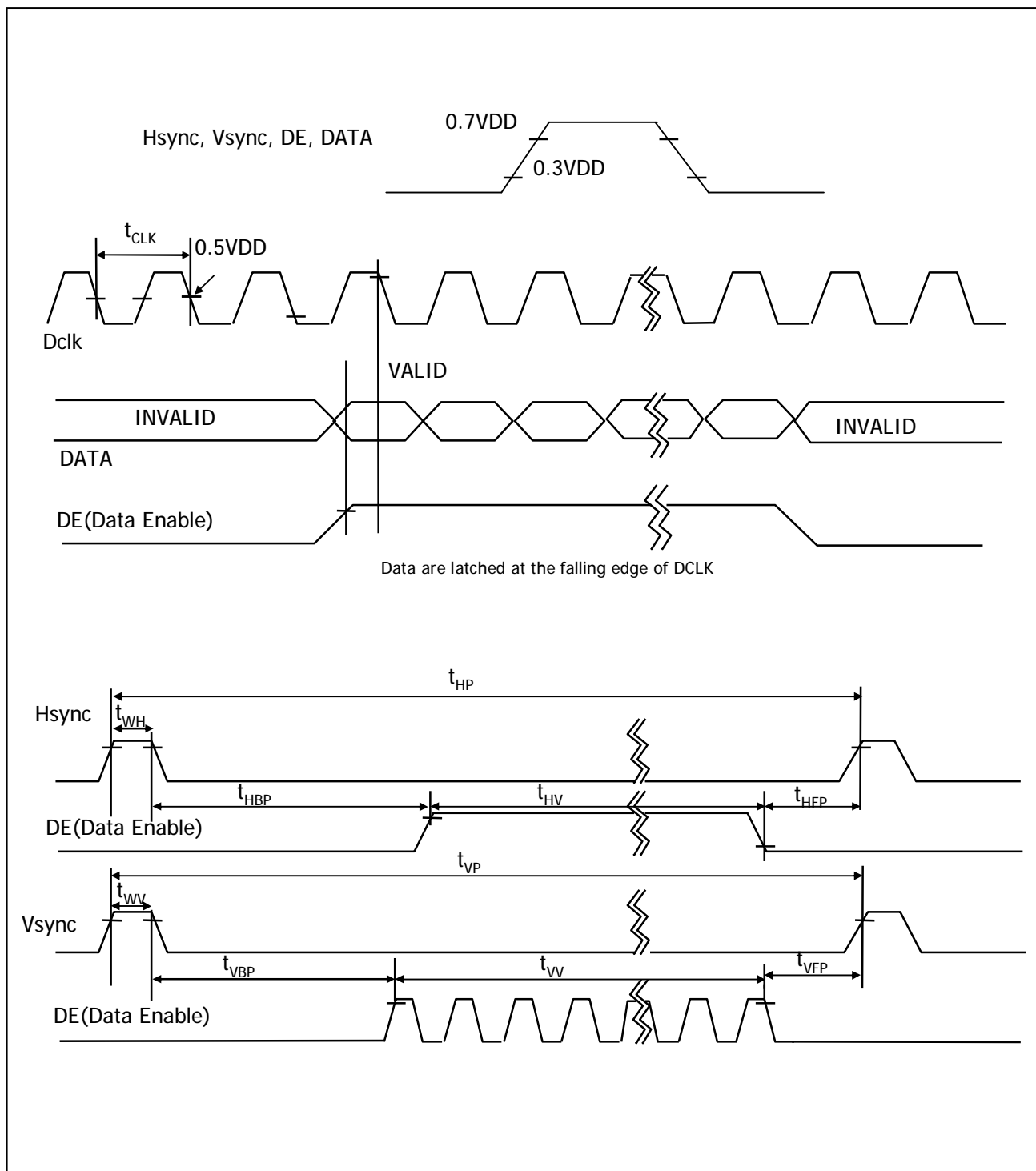
Table 5. TIMING TABLE (VESA COORDINATED VIDEO TIMING)

ITEM		SYMBOL	Min	Typ	Max	Unit	Note
DCLK	Period	t_{CLK}	6.41	6.49	6.58	ns	
	Frequency	f_{CLK}	144	154	162	MHz	Pixel frequency 154Mhz
Hsync	Period	t_{HP}	2032	2080	2088	t_{CLK}	
	Width-Active	t_{WH}	32	32	32		
Vsync	Period	t_{VP}	1233	1235	1245	t_{HP}	
	Frequency	f_V	57	60	63	Hz	
	Width-Active	t_{WV}	6	6	6	t_{HP}	
Data Enable	Horizontal Valid	t_{HV}	1920	1920	1920	t_{CLK}	
	Horizontal Back Porch	t_{HBP}	56	80	88		
	Horizontal Front Porch	t_{HFP}	24	48	56		
	Horizontal Blank	-	112	160	168		t_{WH}+ t_{HBP}+ t_{HFP}
	Vertical Valid	t_{VV}	1200	1200	1200	t_{HP}	
	Vertical Back Porch	t_{VBP}	25	26	35		
	Vertical Front Porch	t_{VFP}	2	3	4		
	Vertical Blank	-	33	35	45		t_{WV}+ t_{VBP}+ t_{VFP}

Note: Hsync period and Hsync width-active should be even number times of t_{CLK}. If the value is odd number times of t_{CLK}, display control signal can be asynchronous. In order to operate this LCM a Hsync, Vsyn, and DE(data enable) signals should be used.
1. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
2. Vsync and Hsync should be keep the above specification.
3. Hsync Period, Hsync Width, and Horizontal Back Porch should be any times of of character number(8).
4. The polarity of Hsync, Vsync is not restricted.

3-4. Signal Timing Waveforms

Hsync, Vsync, DE, DATA

0.7VDD
0.3VDD

t_{CLK} 0.5VDD

Dclk

VALID

INVALID

DATA

INVALID

DE(Data Enable)

Data are latched at the falling edge of DCLK

t_{HP}

Hsync t_{WH}

t_{HBP} t_{HV} t_{HFP}

DE(Data Enable)

t_{VP}

t_{WV}

Vsync

t_{VBP} t_{VV} t_{VFP}

DE(Data Enable)

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 the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 6. COLOR DATA REFERENCE

Color		Input Color Data																							
		RED MSB							LSB	GREEN MSB							LSB	BLUE 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

Product Specification

3-6. Power Sequence
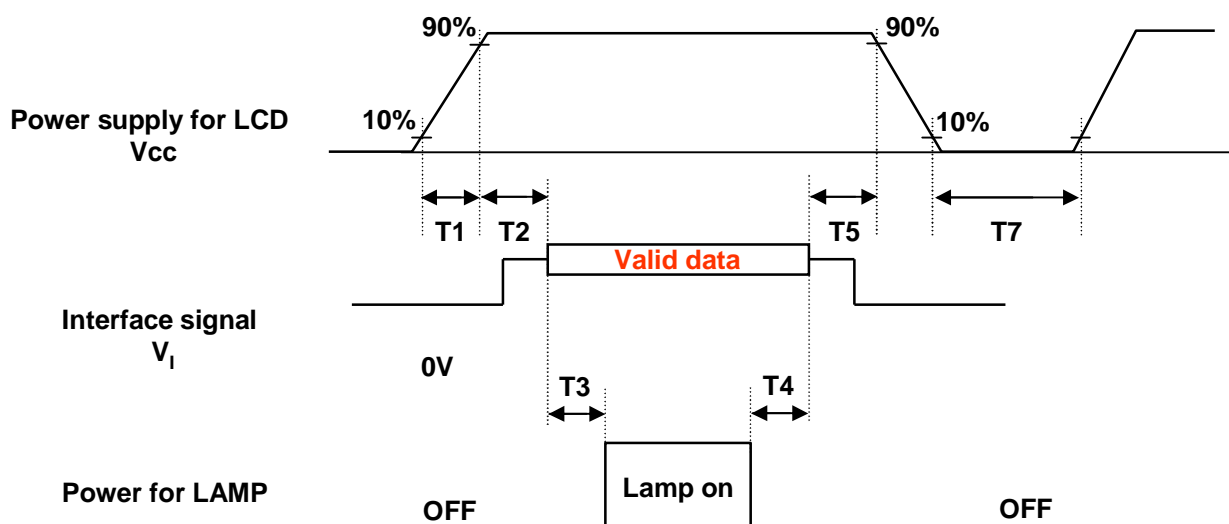
Table 7. POWER SEQUENCE

Parameter	Values			Units
	Min	Typ	Max	
T1	-	-	10	ms
T2	0.01	-	50	ms
T3	200	-	-	ms
T4	200	-	-	ms
T5	0.01	-	50	ms
T7	500		-	s

Notes : 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 for LCD V_{LCD} to 0V.
3. Lamp power must be turn on after power supply for LCD and interface signal are valid.

LG Display

Product Specification

3-6. V$_{LCD}$ Power Dip Condition
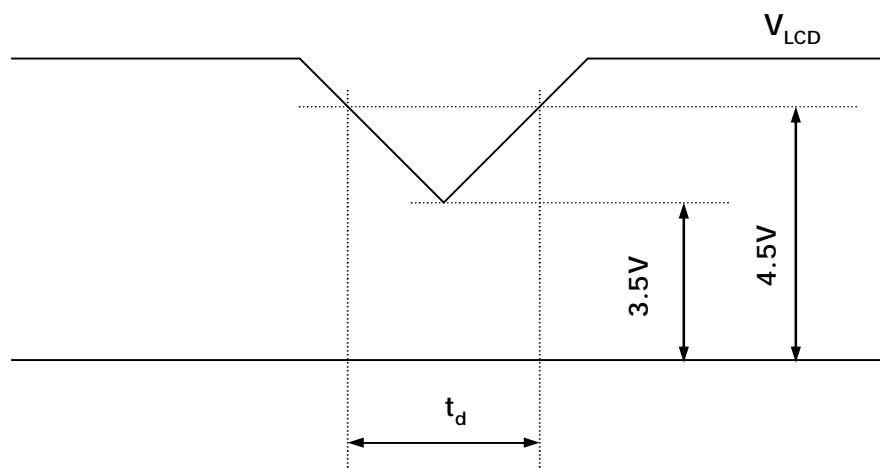
1) Dip condition

$3.5V \leq V_{LCD} < 4.5V$, $t_d \leq 20ms$

2) V$_{LCD}$ < 3.5V

V$_{LCD}$-dip conditions should also follow the Power On/Off conditions for supply voltage.

LG Display

| Product Specification |

4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at $25\pm2°C$. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0 ° and aperture 1 degree.
FIG. 1 presents additional information concerning the measurement equipment and method.
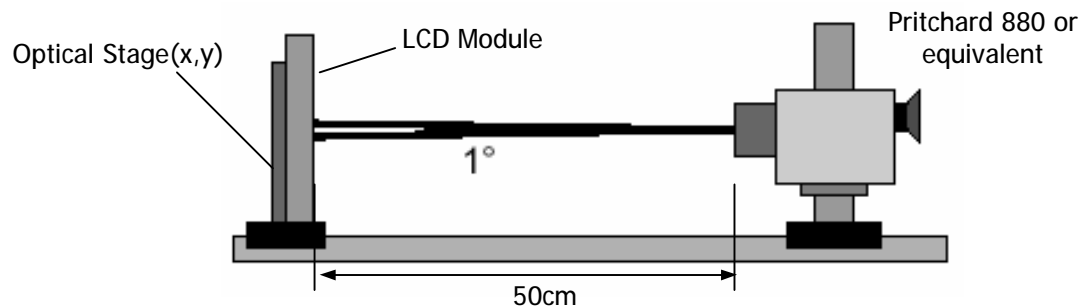
FIG. 1 Optical Characteristic Measurement Equipment and Method

Table 9. OPTICAL CHARACTERISTICS
(Ta=25 °C, V_{LCD}=5.0V, f_V=60Hz, Dclk=154MHz, I_{BL}=6.0mA)

Parameter		Symbol		Values			Units	Notes
				Min	Typ	Max		
Contrast Ratio		CR		600	1000	-		1
Surface Luminance, white		L_{WH}		320	400	-	cd/m²	2
Luminance Variation		δ_{WHITE}		75			%	3
Response Time	Rise Time	Tr_R	Total	-	5ms	10	ms	4
	Decay Time	Tr_D					ms	4s
Color Coordinates [CIE1931]	RED	Rx		Typ -0.03	0.660	Typ +0.03		
		Ry			0.323			
	GREEN	Gx			0.210			
		Gy			0.667			
	BLUE	Bx			0.147			
		By			0.060			
	WHITE	Wx			0.313			
		Wy			0.329			
Color Gamut				92%				
Viewing Angle (CR>10)								
	x axis, right(ϕ=0°)	θr		70	85	-	Degree	5
	x axis, left (ϕ=180°)	θl		70	85	-		
	y axis, up (ϕ=90°)	θu		65	75	-	Degree	
	y axis, down (ϕ=270°)	θd		75	85	-		
Gray Scale						-		6

Product Specification

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

$$\text{Contrast Ratio} = \frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$$

It is measured at center point(Location P1)

2. Surface luminance(L$_{WH}$)is luminance value at center point(P1) across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 2.

3. The variation in surface luminance , δ WHITE is defined as :

$$d_{WHITE} = \frac{\text{Minimum}(L_{on1}, L_{on2}, \ldots L_{on9})}{\text{Maximum }(L_{on1}, L_{on2}, \ldots L_{on9})} \times 100(\%)$$

Measuring point for surface luminance & measuring point for luminance variation

A : H/4 mm
B : V/4 mm
@ H,V : Active Area
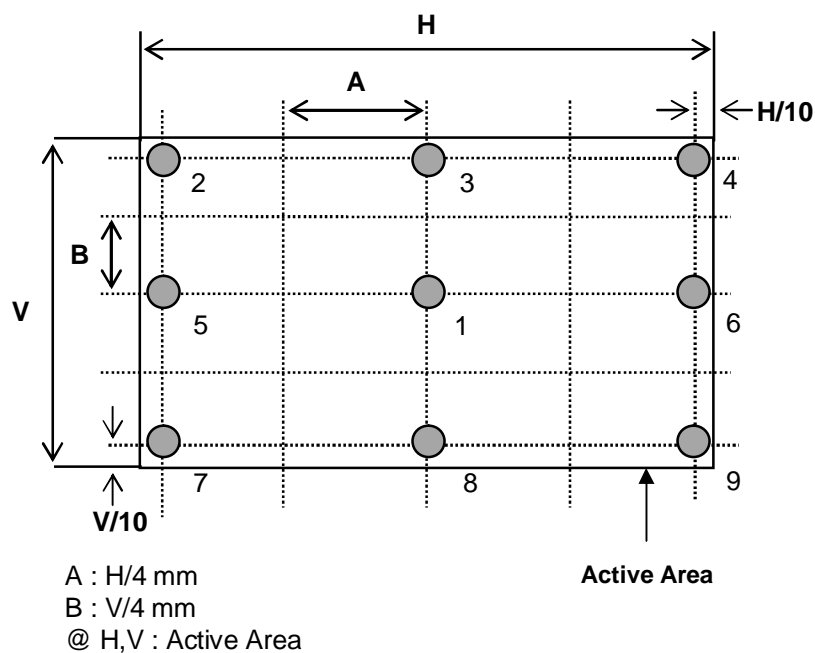
FIG. 2 Measure Point for Luminance

Product Specification

4. **The response time** is defined as the following figure and shall be measured by switching the input signal for "black" and "white".
Response time is the time required for the display to transition from white to black (Rise Time, Tr_R) and from black to white (Decay Time, Tr_D).
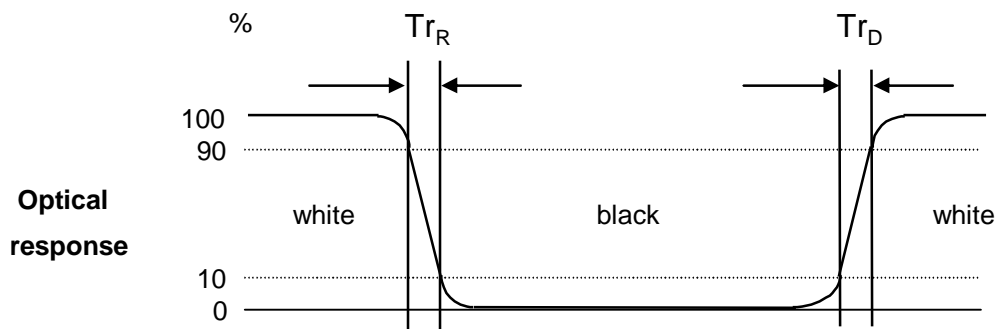

FIG. 3 Response Time

5. **Viewing angle** is the angle at which the contrast ratio is greater than 10 or 5. 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 surface. For more information see FIG. 10 .

<Dimension of viewing angle range>

FIG. 10 Viewing angle

PDF created with pdfFactory Pro trial version www.pdffactory.com
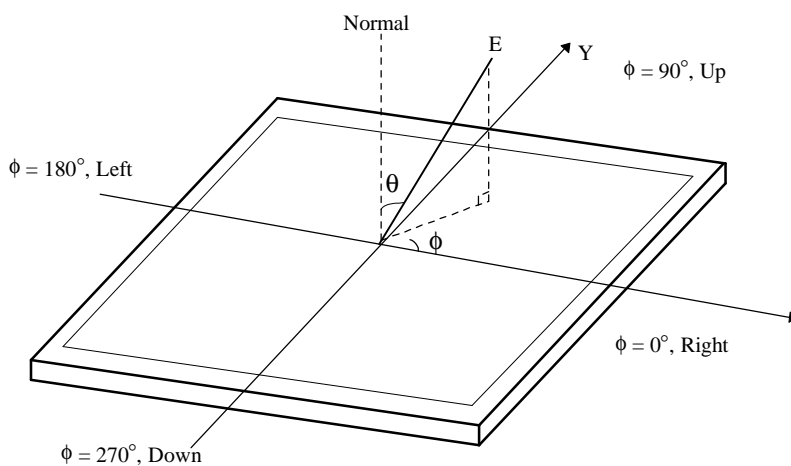
Product Specification

6. **Gray scale** specification

Gamma Value is approximately 2.2. For more information see Table 10.

Table 10. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.14
31	1.23
63	4.98
95	12.30
127	23.58
159	40.03
191	61.30
223	84.03
255	100

LG Display

| Product Specification |

5. Mechanical Characteristics

The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline Dimension	Horizontal	546.4mm
	Vertical	352.0mm
	Depth	35.7mm
Bezel Area	Horizontal	522.4mm
	Vertical	328.0mm
Active Display Area	Horizontal	518.4mm
	Vertical	324.0mm
Weight	Typ : 2480g , Max : 2600g	
Surface Treatment	Hard coating(3H) Anti-glare treatment of the front polarizer	

Notes : Please refer to a mechanic drawing in terms of tolerance at the next page.
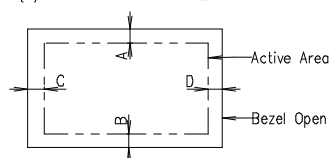
Product Specification

<FRONT VIEW>

Product Specification

<REAR VIEW>
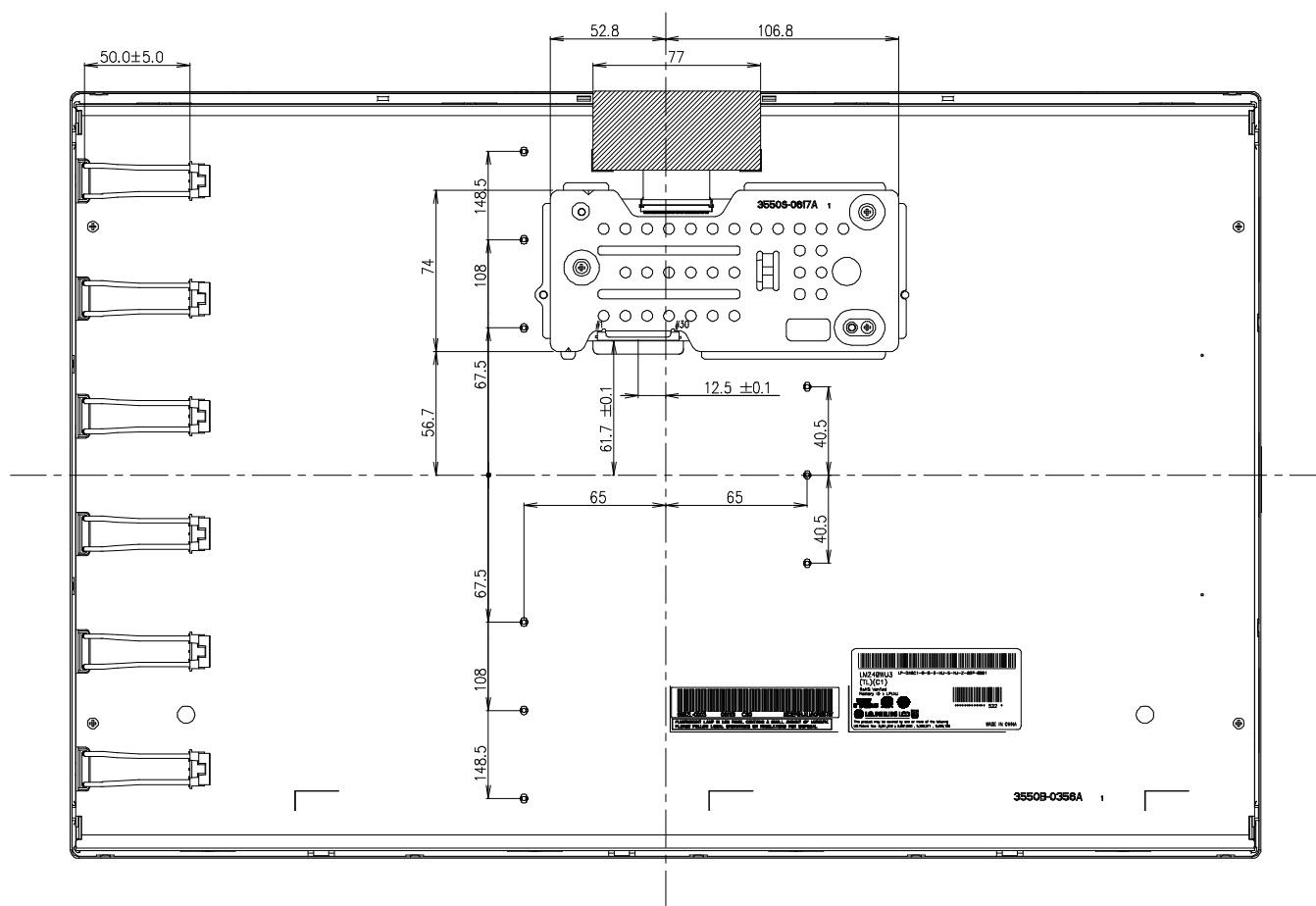
Notes
1. Unspecified tolerances are to be ±0.5mm.
2. Tilt and partial disposition tolerance of display area are as following.
   (1) Y-direction : IA-BI ≤ 1.4mm
   (2) X-direction : IC-DI ≤ 1.4mm

3. Torque Spec of User Mounting : 6.0 ~ 7.0kgf cm

4. Lamp Connector Specification.
   – 20015HS–04L(Gray) (YEONHO, LOCKING)
5. I/F Connector Specification : GT103–30S–H23(LSC) or compatible

Product Specification

6. Reliability

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, 10 min 　　　　　One time each direction
6	Shock test (non-operating)	Shock level : 100G Waveform : half sine wave, 2ms Direction : ±X, ±Y, ±Z 　　　　　One time each direction
7	Altitude 　　　operating 　　　storage / shipment	0 - 10,000 feet(3048m) 0 - 40,000 feet(12,192m)

Product Specification

7. International Standards

7-1. Safety

a) UL 60950-1:2003, First Edition, Underwriters Laboratories, Inc.,
Standard for Safety of Information Technology Equipment.
b) CAN/CSA C22.2, No. 60950-1-03 1st Ed. April 1, 2003, Canadian Standards Association,
Standard for Safety of Information Technology Equipment.
c) EN 60950-1:2001, First Edition,
European Committee for Electro technical Standardization(CENELEC)
European Standard for Safety of Information Technology Equipment.
 d) RoHS, Directive 2002/95/EC of the European Parliament and of the council of 27 January 2003

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) C.I.S.P.R. "Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment." International Special Committee on Radio Interference.
c) EN 55022 "Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment." European Committee for Electro technical Standardization.(CENELEC), 1998
 (Including A1: 2000)

Product Specification

8. Packing

8-1. Designation of Lot Mark

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

2. MONTH

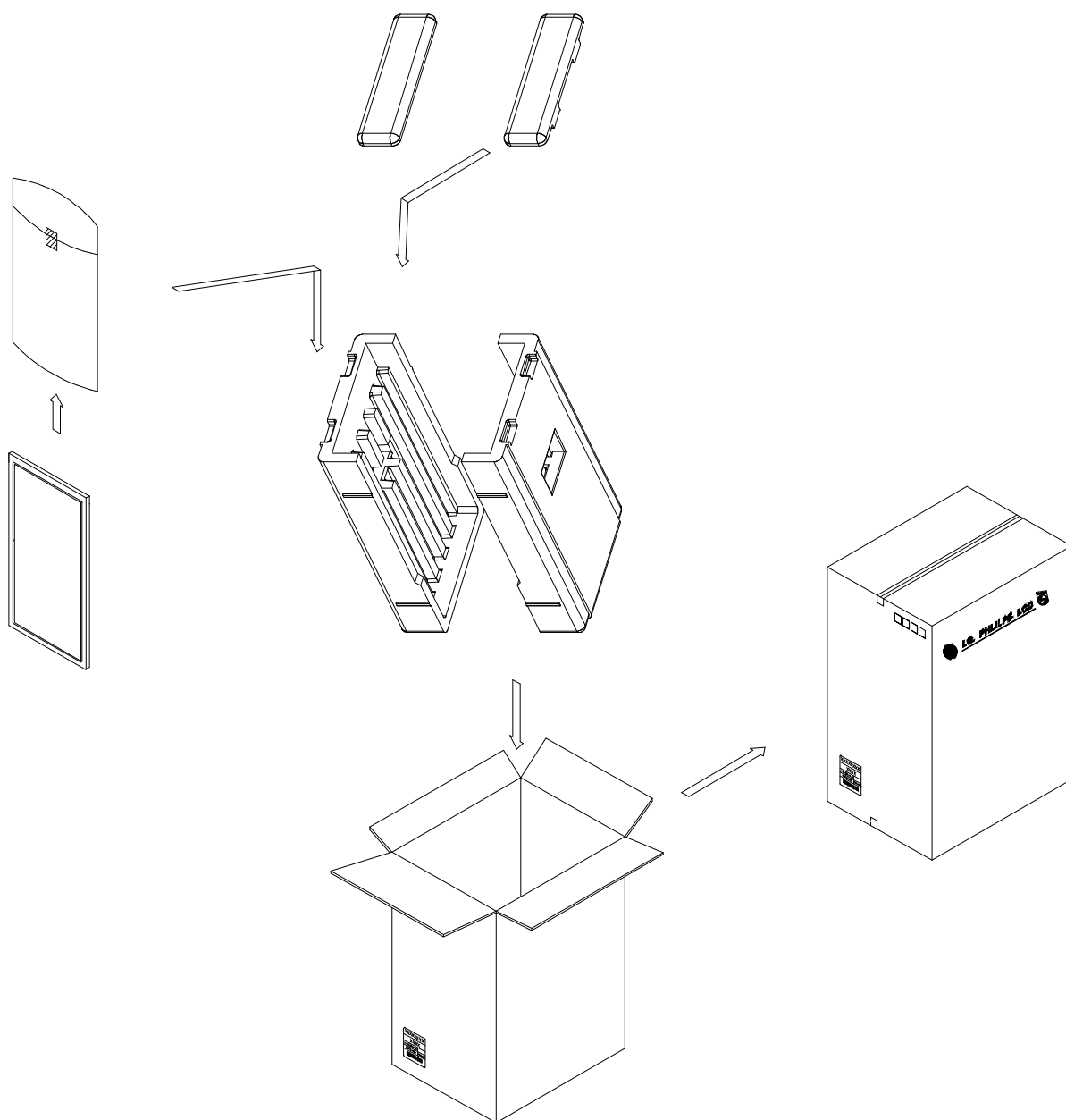| Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	A	B	C

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 box : 5EA

b) Box Size : 436 X 346 X 628
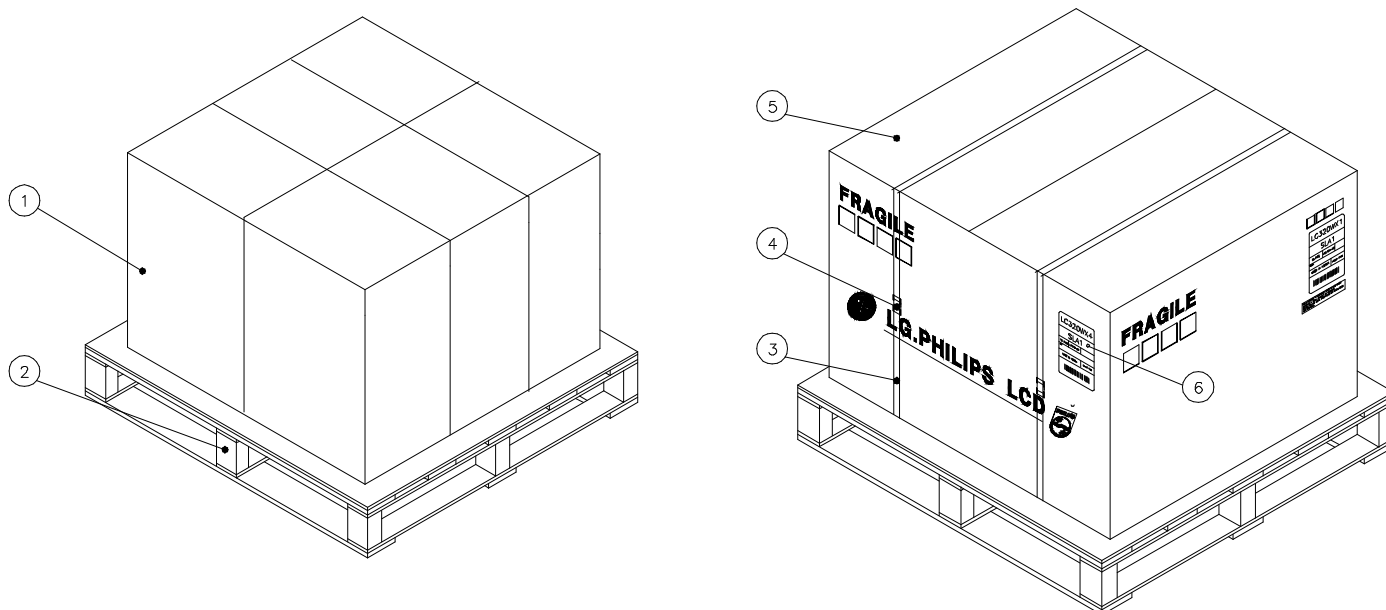
Product Specification

8-3. Pallet Form

NO.	DESCRIPTION	MATERIAL
1	PACKING ASS'Y	
2	PALLET	Paper_1030X870X130
3	ANGLE, PACKING	SWR4
4	LABEL	YUPO PAPER
5	TAPE	OPP
6	BAND	PP
7	BAND, CLIP	CLIP 18MM

Product Specification

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 holes arranged in four corners or four sides.
(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 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 :
$V=\pm200mV$(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 causes metallic foreign material and deal LCM a fatal blow)
(9) Please do not set LCD on its edge.

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.