

**Product Specification**

# SPECIFICATION FOR APPROVAL

(    ) Preliminary Specification  
 ( ● ) Final Specification

<b>Title</b>	<b>23.0" WUXGA TFT LCD</b>
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<b>BUYER</b>	<b>HP</b>
<b>MODEL</b>	

<b>SUPPLIER</b>	<b>LG.Philips LCD Co., Ltd.</b>
<b>*MODEL</b>	<b>LM230W02</b>
<b>Suffix</b>	<b>A2</b>

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

SIGNATURE	DATE
/	
/	
/	

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

SIGNATURE	DATE
<i>S.G.Hong / G.Manager</i> _____ <b>REVIEWED BY</b>	
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**MNT Products Engineering Dept.**  
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## Product Specification

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## RECORD OF REVISIONS

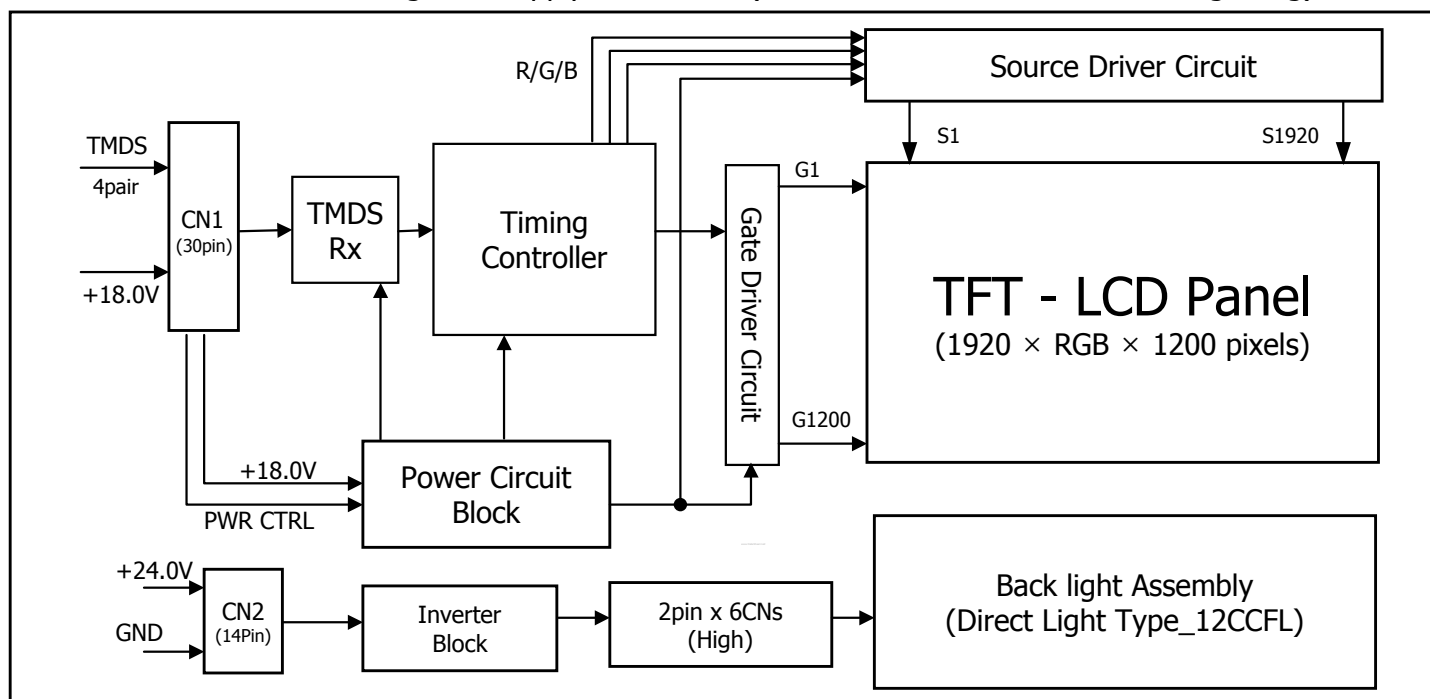
[illegible]

## Product Specification

### 1. General Description

The LM230W02 LCD is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Lamp(CCFL) back light 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. This TFT-LCD has a 23.0 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 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 16,777,216 colors.

The LM230W02 has been designed to apply the TMDS™(Transition Minimized Differential Signaling) interface.



### General Features

Active Screen Size	23.0 inches(58.4cm) diagonal
Outline Dimension	523.4(H) x 335.6(V) x 41.0(D) mm(Typ.)
Active Area	495.36[mm] × 309.6[mm]
Pixel Pitch	0.258 mm x 0.258mm
Pixel Format	1920 horiz. By 1200 vert. Pixels RGB stripes arrangement
Color Depth	8-bit, 16,777,216 colors
Luminance, CR	250 cd/m <sup>2</sup> , 500:1
Viewing Angle(CR>10)	View Angle Free (R/L 176(Typ.), U/D 176(Typ.))
Power Consumption	Total 56 Watt (Typ.) (Logic=5.6 W, Lamp=50.4 W)
Weight	2,870g(typ.)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Hard coating(3H), Anti-glare treatment of the front polarizer
Interface	TMDS

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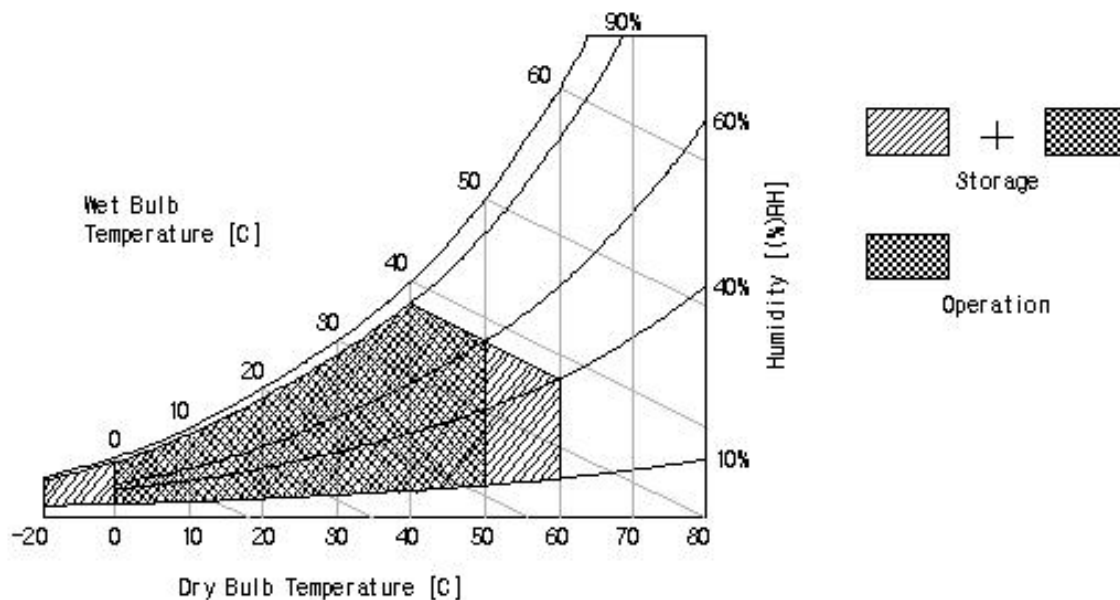
### 2. Absolute Maximum Ratings

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

**Table 1. ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	V <sub>LCD</sub>	-0.3	21	V <sub>dc</sub>	at 25 ± 2°C
Operating Temperature	T <sub>OP</sub>	0	50	°C	1
Storage Temperature	T <sub>ST</sub>	-20	60	°C	
Operating Ambient Humidity	H <sub>OP</sub>	10	90	%RH	
Storage Humidity	H <sub>ST</sub>	10	90	%RH	

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



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### 3. Electrical Specifications

#### 3-1. Electrical Characteristics

The LM230W02 requires two power inputs. One input is employed to power the LCD electronics and to drive the TFT array and liquid crystal. And the second input power for the CCFL / Backlight is to power the inverter.

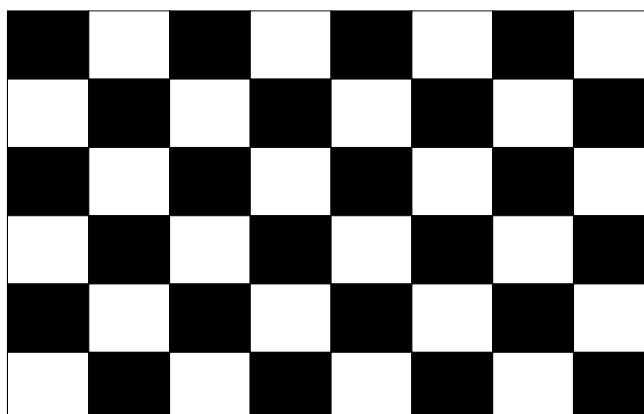
**Table 2-1. ELECTRICAL CHARACTERISTICS**

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	V <sub>LCD</sub>	17.0	18.0	19.0	Vdc	
Power Supply Input Current	I <sub>LCD</sub>	-	310	357	A	1
		-	470	610	A	2
Power Consumption	P <sub>LCD</sub>	-	5.60	6.44	Watt	1
Rush current	I <sub>RUSH</sub>	-	-	3.0	A	3

Note :

1. The specified current and power consumption are under the V<sub>LCD</sub>=18.0V, 25 ± 2°C, f<sub>V</sub>=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f<sub>V</sub> is the frame frequency.
2. The current is specified at the maximum current pattern.
3. The duration of rush current is about 2ms and rising time of power Input is 1ms(min.).

White : 255Gray  
 Black : 0Gray



Mosaic Pattern(8X6)

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**Table 2-2. INVERTER ELECTRICAL CHARACTERISTICS**

Parameter	Symbol	Condition	Values			Unit	Notes
			Min.	Typ.	Max.		
Inverter :							
Input Voltage	V <sub>DDB</sub>		22.0	24.0	26.0	V	1
Input Current	I <sub>DDB</sub>	V <sub>BR</sub> = 3.3V	1.8	2.1	2.4	A	2
Input Power	P <sub>B</sub>	V <sub>BR</sub> = 3.3V	43.2	50.4	57.6	Watt	2
B/L on/off control	V <sub>ON/OFF</sub>	Lamp ON = High	4.0	-	5.0	V	
		Lamp OFF =Low	0.0	-	0.8	V	
Brightness Adj	V <sub>BR</sub>		0	-	3.3	V	
LAMP :							
Life time			50,000			Hrs	3

Notes :

1. The input voltage ripple is limited below 400mVp-p.
2. The specified current and power consumption are under the typical supply Input voltage, 24V.
3. The life is determined as the time at which luminance of the lamp is 50% compared to that of initial value at the typical lamp current on condition of continuous operating at  $25 \pm 2^\circ\text{C}$ .
4. Electrical characteristics are determined after the unit has been 'ON' and stable for approximately 30min in a dark environment at  $25^\circ\text{C} \pm 2^\circ\text{C}$ .
5. The lamp must be turned on in condition of  $0^\circ\text{C}$  temperature.

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### 3-2. Interface Connections

This LCD employs Two interface connections, a 30 pin connector is used for the module electronics and a 14Pin Connector is used for the integral backlight system.

#### 3-2-1. LCD Module

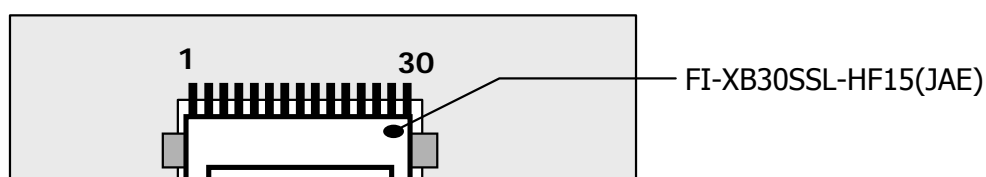
- LCD Connector(CN1):FI-XB30SL-HF, FI-XB30SSL-HF15 (Manufactured by JAE) or Equivalent
- Mating Connector : FI-X30C2L (Manufactured by JAE) or Equivalent
- Interface chips(LCD) : PTFP 403 PZP (TI)

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

No	Symbol	Description	No	Symbol	Symbol
1	GND	Ground	16	OPEN	NC
2	SHLD2	Shield for TMDS channel 2	17	OPEN	NC
3	RX2+	TMDS Differential Output(+) (CH 2)	18	OPEN	NC
4	RX2-	TMDS Differential Output(-) (CH 2)	19	GND	Ground
5	SHLD1	Shield for TMDS channel 1	20	GND	Ground
6	RX1+	TMDS Differential Output(+) (CH 1)	21	GND	Ground
7	RX1-	TMDS Differential Output(-) (CH 1)	22	V <sub>LCD</sub>	Supply voltage for LCD
8	SHLD0	Shield for TMDS channel 0	23	V <sub>LCD</sub>	Supply voltage for LCD
9	RX0+	TMDS Differential Output(+) (CH 0)	24	V <sub>LCD</sub>	Supply voltage for LCD
10	RX0-	TMDS Differential Output(-) (CH 0)	25	PWR_ON	Power ON control signal input 3.3V(H:90%,L:10%)
11	SHLDC	Shield for TMDS channel C	26	HS_OUT	Hsync Output
12	RXC+	TMDS Differential Output(+) (CH C)	27	VS_OUT	Vsync Output
13	RXC-	TMDS Differential Output(-) (CH C)	28	GND	Ground
14	GND	Ground	29	OPEN	DDC -Clk(HDCP) for future use
15	OPEN	NC	30	OPEN	DDC -Data(HDCP) for future use

- Notes:
1. All GND(ground) pins should be connected together and should also be connected to the LCD's metal frame.
  2. All V<sub>LCD</sub>(power input) pins should be connected together.
  3. Input Level of TMDS signal is based on the Digital Visual Interface (DVI 1.0) Standard.

#### Rear view of LCM





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**Table 4 REQUIRED SIGNAL ASSIGNMENT FOR TMDS TRANSMITTER**

Graphics Controller		PanelLink		Flat Panel Controller	
24-bits	18-bits	Si1160	Si1161	18-bits	24-bits
B0 - 0		DIE0	QE0		B0 - 0
B1 - 0		DIE1	QE1		B1 - 0
B2 - 0	B0 - 0	DIE2	QE2	B0 - 0	B2 - 0
B3 - 0	B1 - 0	DIE3	QE3	B1 - 0	B3 - 0
B4 - 0	B2 - 0	DIE4	QE4	B2 - 0	B4 - 0
B5 - 0	B3 - 0	DIE5	QE5	B3 - 0	B5 - 0
B6 - 0	B4 - 0	DIE6	QE6	B4 - 0	B6 - 0
B7 - 0	B5 - 0	DIE7	QE7	B5 - 0	B7 - 0
G0 - 0		DIE8	QE8		G0 - 0
G1 - 0		DIE9	QE9		G1 - 0
G2 - 0	G0 - 0	DIE10	QE10	G0 - 0	G2 - 0
G3 - 0	G1 - 0	DIE11	QE11	G1 - 0	G3 - 0
G4 - 0	G2 - 0	DIE12	QE12	G2 - 0	G4 - 0
G5 - 0	G3 - 0	DIE13	QE13	G3 - 0	G5 - 0
G6 - 0	G4 - 0	DIE14	QE14	G4 - 0	G6 - 0
G7 - 0	G5 - 0	DIE15	QE15	G5 - 0	G7 - 0
R0 - 0		DIE16	QE16		R0 - 0
R1 - 0		DIE17	QE17		R1 - 0
R2 - 0	R0 - 0	DIE18	QE18	R0 - 0	R2 - 0
R3 - 0	R1 - 0	DIE19	QE19	R1 - 0	R3 - 0
R4 - 0	R2 - 0	DIE20	QE20	R2 - 0	R4 - 0
R5 - 0	R3 - 0	DIE21	QE21	R3 - 0	R5 - 0
R6 - 0	R4 - 0	DIE22	QE22	R4 - 0	R6 - 0
R7 - 0	R5 - 0	DIE23	QE23	R5 - 0	R7 - 0
B0 - 1		DIO0	QO0		B0 - 1
B1 - 1		DIO1	QO1		B1 - 1
B2 - 1	B0 - 1	DIO2	QO2	B0 - 1	B2 - 1
B3 - 1	B1 - 1	DIO3	QO3	B1 - 1	B3 - 1
B4 - 1	B2 - 1	DIO4	QO4	B2 - 1	B4 - 1
B5 - 1	B3 - 1	DIO5	QO5	B3 - 1	B5 - 1
B6 - 1	B4 - 1	DIO6	QO6	B4 - 1	B6 - 1
B7 - 1	B5 - 1	DIO7	QO7	B5 - 1	B7 - 1
G0 - 1		DIO8	QO8		G0 - 1
G1 - 1		DIO9	QO9		G1 - 1
G2 - 1	G0 - 1	DIO10	QO10	G0 - 1	G2 - 1
G3 - 1	G1 - 1	DIO11	QO11	G1 - 1	G3 - 1
G4 - 1	G2 - 1	DIO12	QO12	G2 - 1	G4 - 1
G5 - 1	G3 - 1	DIO13	QO13	G3 - 1	G5 - 1
G6 - 1	G4 - 1	DIO14	QO14	G4 - 1	G6 - 1
G7 - 1	G5 - 1	DIO15	QO15	G5 - 1	G7 - 1
R0 - 1		DIO16	QO16		R0 - 1
R1 - 1		DIO17	QO17		R1 - 1
R2 - 1	R0 - 1	DIO18	QO18	R0 - 1	R2 - 1
R3 - 1	R1 - 1	DIO19	QO19	R1 - 1	R3 - 1
R4 - 1	R2 - 1	DIO20	QO20	R2 - 1	R4 - 1
R5 - 1	R3 - 1	DIO21	QO21	R3 - 1	R5 - 1
R6 - 1	R4 - 1	DIO22	QO22	R4 - 1	R6 - 1
R7 - 1	R5 - 1	DIO23	QO23	R5 - 1	R7 - 1
Shift CLK	Shift CLK	IDCK	ODCK	Shift CLK	Shift CLK
VSYNC	VSYNC	VSYNC	VSYNC	VSYNC	VSYNC
HSYNC	HSYNC	HSYNC	HSYNC	HSYNC	HSYNC
DE	DE	DE	DE	DE	DE

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### 3-2-2. Backlight Interface

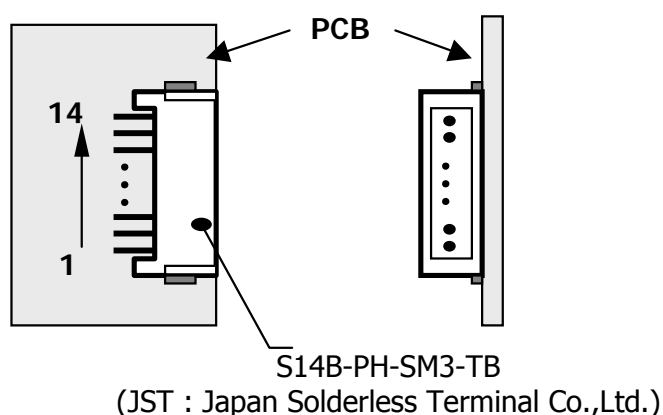
- Inverter Connector : S14B-PH-SM3 Side entry type (Manufactured by JST) or Equivalent
- Mating Connector : PHR-14(Manufactured by JST) or Equivalent

**Table 5. INVERTER CONNECTOR PIN CONFIGURATION**

Pin No	Symbol	Description	Remarks
1	VDDDB	Power Supply +24.0V (Back light)	
2	VDDDB	Power Supply +24.0V (Back light)	
3	VDDDB	Power Supply +24.0V (Back light)	
4	VDDDB	Power Supply +24.0V (Back light)	
5	VDDDB	Power Supply +24.0V (Back light)	
6	GND	Power Ground (Back light)	Note 1
7	GND	Power Ground (Back light)	
8	GND	Power Ground (Back light)	
9	GND	Power Ground (Back light)	
10	GND	Power Ground (Back light)	
11	OPEN	NC	
12	VON/OFF	Backlight On/off Signal	(On :4.0V~5V/Off :0.0~0.8V)
13	VBR	Brightness Adjustable Voltage	(Max :3.3V / Min :0.0V)
14	OPEN	NC	

Notes : 1. GND is connected to the LCD's metal frame.

#### Rear view of LCM



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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 6. TIMING TABLE**

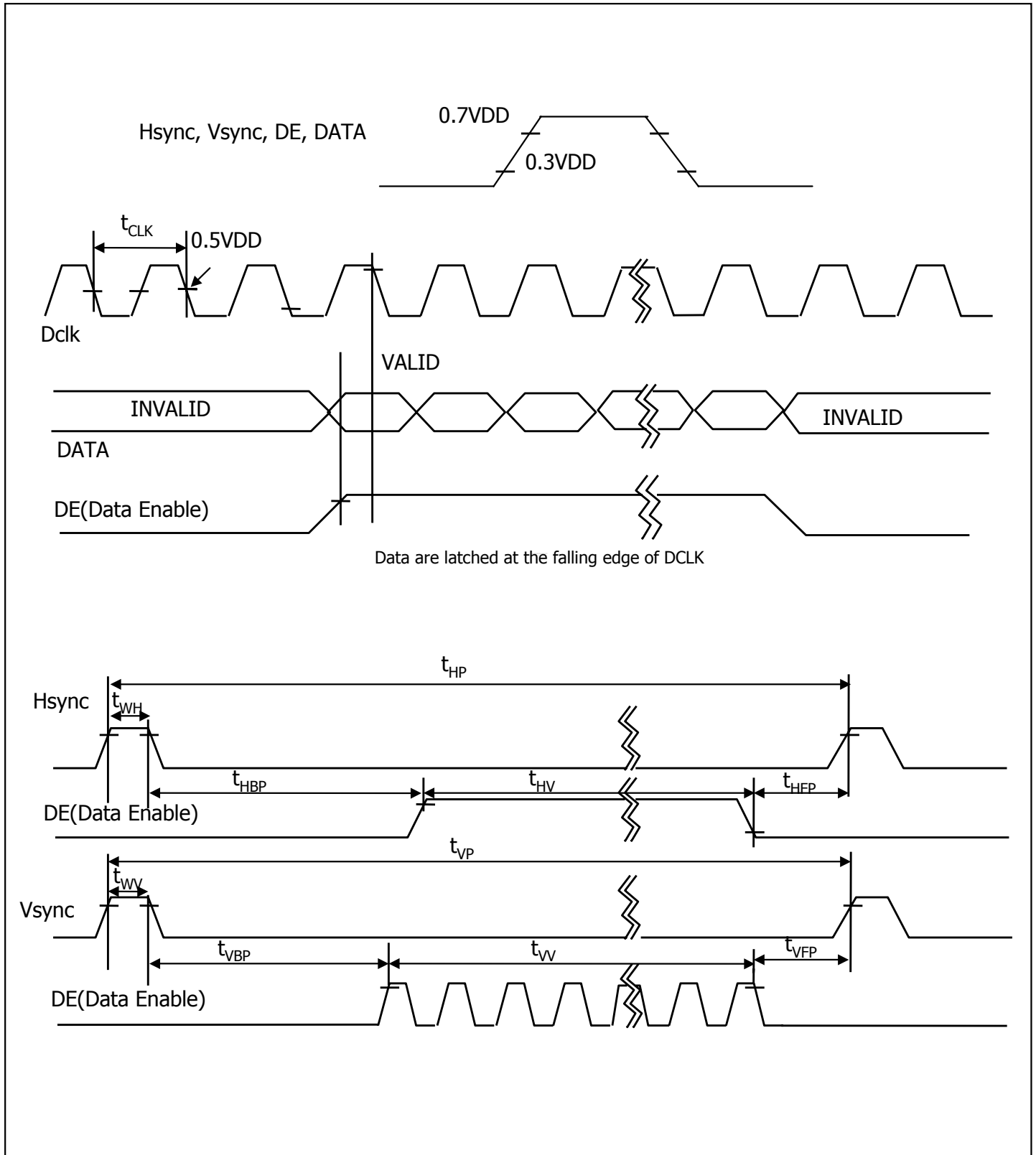
ITEM		SYMBOL	Min	Typ	Max	Unit	Note
DCLK	Period	tCLK	6.49	6.41	6.33	ns	
	Frequency	fCLK	154	156	158	MHz	
Hsync	Period	tHP	1984	2144	-	tCLK	
	Width-Active	tWH	32	32	32		
Vsync	Period	tVP	1206	1212	-	tHP	
	Frequency	fV	56	60	64	Hz	
	Width-Active	tWV	2	3	-	tHP	
Data Enable	Horizontal Valid	tHV	1920	1920	1920	tCLK	
	Horizontal Back Porch	tHBP	16	128	-		
	Horizontal Front Porch	tHFP	16	64	-		
	Horizontal Blank	-	64	224	-		tWH+ tHBP+ tHFP
	Vertical Valid	tVW	1200	1200	1200	tHP	
	Vertical Back Porch	tVBP	3	6	-		
	Vertical Front Porch	tVFP	1	3	-		
	Vertical Blank	-	6	12	-		tWV+ tVBP+ tVFP

Note: Hsync period and Hsync width-active should be even number times of tCLK. If the value is odd number times of tCLK, display control signal can be asynchronous. In order to operate this LCM a Hsync, Vsync, 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).

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### 3-4. Signal Timing Waveforms



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### 3-5. Color Data Reference

The luminance 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.

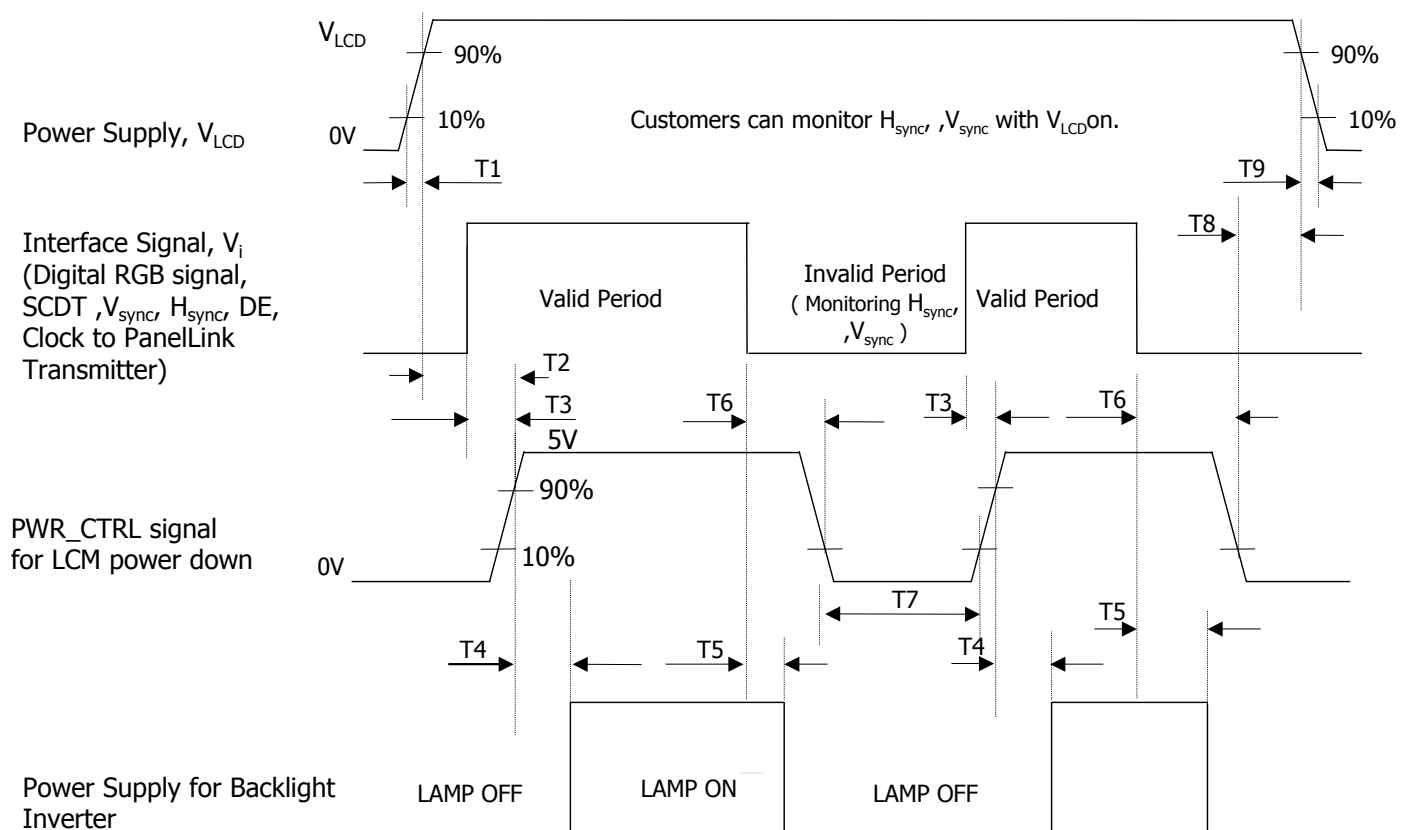
**Table 7. COLOR DATA REFERENCE**

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	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

Note : Users should be input true 8 Bit data streams via TMDS transmitter.

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### 3-6. Power Sequence



**Table 8. POWER SEQUENCE**

Parameter	Values			Units
	Min	Typ	Max	
T1	-	-	10	ms
T2	-	-	50	ms
T3	-	-	50	ms
T4	100	-	-	ms
T5	-	-	50	ms
T6	-	-	80	ms
T7	400	-	-	ms
T8	50	-	-	
T9	-	-	10	

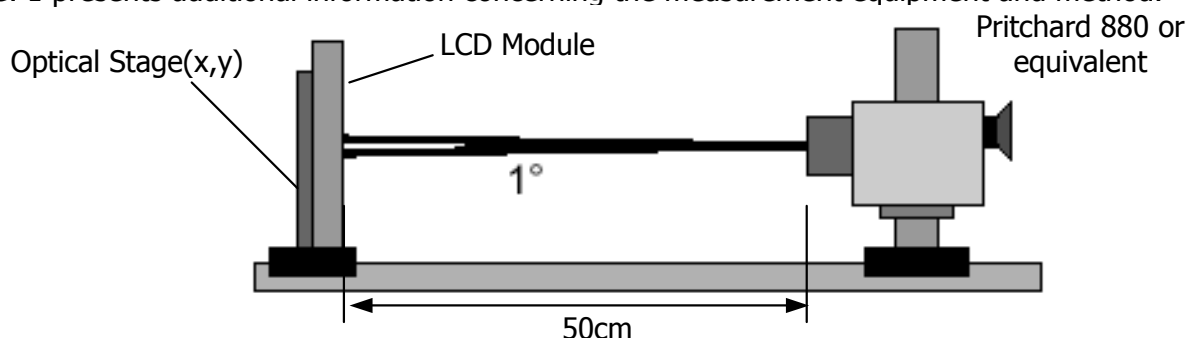
- Notes :
1. Please avoid floating state of interface signal at invalid period.
  2. When the interface signal is invalid, be sure to pull down the power supply for LCD  $V_{LCD}$  to 0V.
  3. Lamp power must be turn on after power supply for LCD and interface signal are valid.
  4. When connector is hot-plug and plug, T2 & T8 min spec can be 0ms.

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### 4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes 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  $0^\circ$  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**

( $T_a = 25^\circ\text{C}$ ,  $V_{\text{LCD}} = 18.0\text{V}$ ,  $f_v = 60\text{Hz}$  Dclk=156MHz,  $V_{\text{BR}} = 3.3\text{V}$ )

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	350	500			1
Surface Luminance, white		$L_{\text{WH}}$	200	250		cd/m <sup>2</sup>	2
Luminance Variation		$\delta_{\text{WHITE}}$			1.3		3
Response Time	Rise Time	$\text{Tr}_R$	-	8.5	15	ms	4
	Decay Time	$\text{Tr}_D$	-	7.5	15	ms	4
	Gray to Gray	$\text{T}_{\text{GTG\_AVR}}$	-	12		ms	5
		$\text{T}_{\text{GTG\_MAX}}$	-	18		ms	5
Color Coordinates [CIE1931]	RED	$\text{Rx}$	Typ -0.03	0.640	Typ +0.03		
		$\text{Ry}$		0.332			
	GREEN	$\text{Gx}$		0.288			
		$\text{Gy}$		0.601			
	BLUE	$\text{Bx}$		0.146			
		$\text{By}$		0.065			
	WHITE	$\text{Wx}$		0.313			
Color Shift		$\text{Wy}$		0.329			
	Horizontal	$\theta_{\text{CST\_H}}$	-	176	-	Degree	6
	Vertical	$\theta_{\text{CST\_V}}$	-	176	-		
Viewing Angle (CR>10)							
General	Horizontal	$\theta_H$	170	176	-	Degree	7
	Vertical	$\theta_V$	170	176	-		
Effective	Horizontal	$\theta_{\text{GMA\_H}}$		176	-	Degree	8
	Vertical	$\theta_{\text{GMA\_V}}$		176	-		
Gray Scale				2.2			9
Crosstalk					1.8	%	FIG.8
Luminance Uniformity (TCO'99)		LR			1.7		FIG.9

## 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 ,  $\delta$  WHITE is defined as :

$$\delta_{\text{WHITE}} = \frac{\text{Maximum}(L_{P1}, L_{P2}, \dots, L_{P5})}{\text{Minimum}(L_{P1}, L_{P2}, \dots, L_{P5})}$$

Where P1 to P5 are the luminance with all pixels displaying white at 5 locations.  
For more information see FIG 2.

4. Response time is the time required for the display to transition from black to white (Rise Time,  $Tr_R$ ) and from white to black (Decay Time,  $Tr_D$ ). For additional information see FIG 3.

5. Gray to gray response time is the time required for the display to transition from gray to gray. For additional information see Table 10.

6. Color shift is the angle at which the color difference is lower than 0.04.

For more information see FIG 4.

- Color difference ( $\Delta u'v'$ )

$$u' = \frac{4x}{-2x + 12y + 3} \quad v' = \frac{9y}{-2x + 12y + 3}$$

$$\Delta u'v' = \sqrt{(u'_1 - u'_2)^2 + (v'_1 - v'_2)^2} \quad \begin{array}{l} u'_1, v'_1 : u'v' \text{ value at viewing angle direction} \\ u'_2, v'_2 : u'v' \text{ value at front } (\theta=0) \end{array}$$

- Pattern size : 25% Box size

- Viewing angle direction of color shift : Horizontal, Vertical

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 surface. For more information see FIG 5.

8. Effective viewing angle is the angle at which the gamma shift of gray scale is lower than 0.3. For more information see FIG 6 and FIG 7.

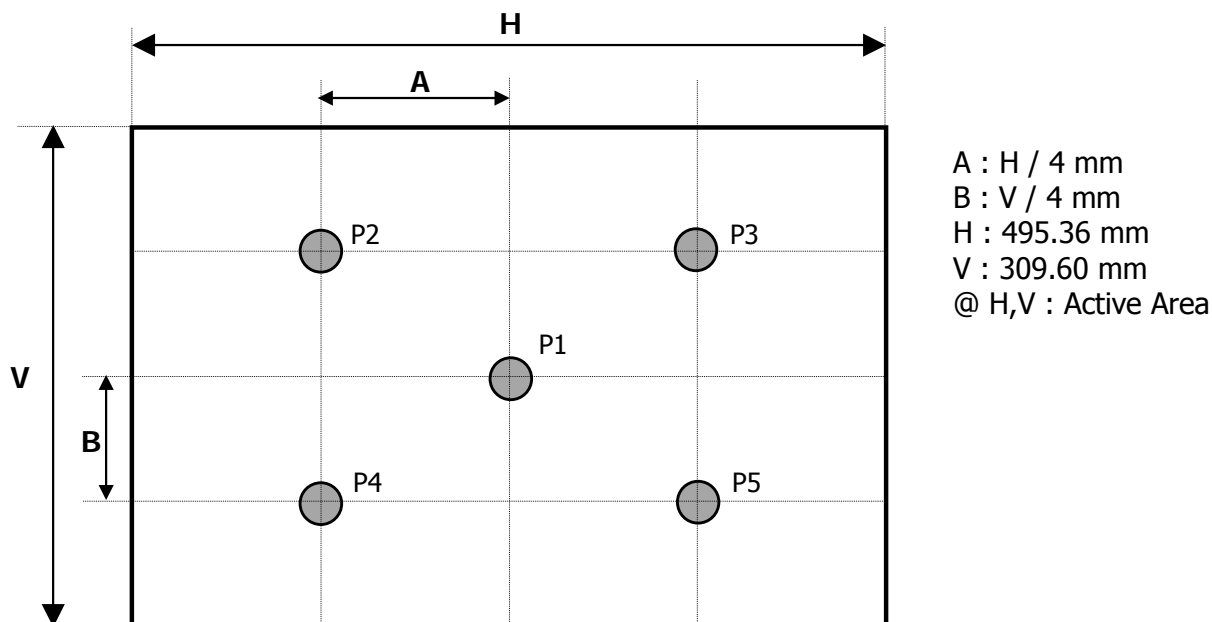
9. Gray scale specification

Gamma Value is approximately 2.2. For more information see Table 11.



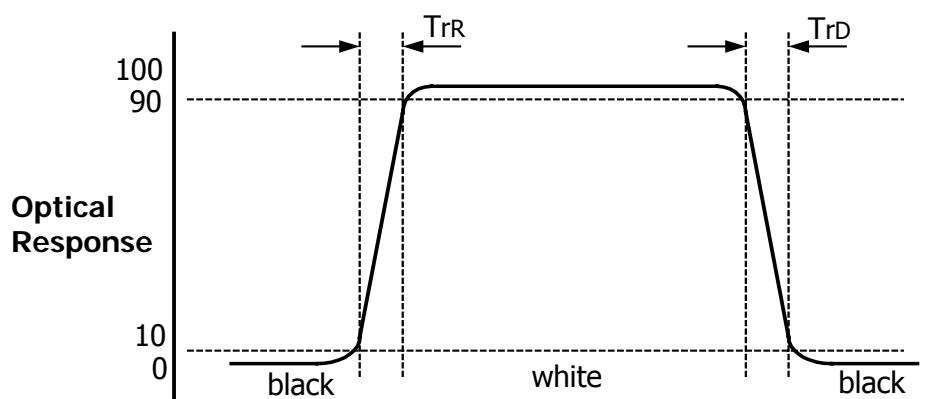
## Product Specification

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



**FIG. 2 Measure Point for Luminance**

The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white".



**FIG. 3 Response Time**

## Product Specification

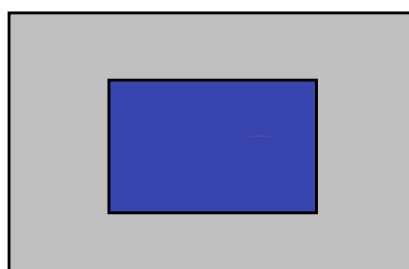
The gray to gray response time is defined as the following figure and shall be measured by switching the input signal for "Gray To Gray".

- Gray step : 5 step
- $T_{GTG\_AVR}$  is the total average time at rising time and falling time for "Gray To Gray".
- $T_{GTG\_MAX}$  is the max time at rising time or falling time for "Gray To Gray".

**Table 10. Gray to gray response time table**

Gray to Gray		Rising Time				
		G255	G191	G127	G63	G0
Falling Time	G255					
	G191					
	G127					
	G63					
	G0					

Color shift is defined as the following test pattern and color.



25% Box size

**FIG. 4 Test Pattern**

Average RGB values in Bruce RGB for Macbeth Chart

	Dark skin	Light skin	Blue sky	Foliage	Blue flower	Bluish green
R	98	206	85	77	129	114
G	56	142	112	102	118	199
B	45	123	161	46	185	178
	Orange	Purplish blue	Moderate red	Purple	Yellow green	Orange yellow
R	219	56	211	76	160	230
G	104	69	67	39	193	162
B	24	174	87	86	58	29
	Blue	Green	Red	Yellow	Magenta	cyan
R	26	72	197	241	207	35
G	32	148	27	212	62	126
B	145	65	37	36	151	172
	White	Neutral 8	Neutral 6.5	Neutral 5	Neutral 3.5	black
R	240	206	155	110	63	22
G	240	206	155	110	63	22
B	240	206	155	110	63	22

## Product Specification

Dimension of viewing angle range.

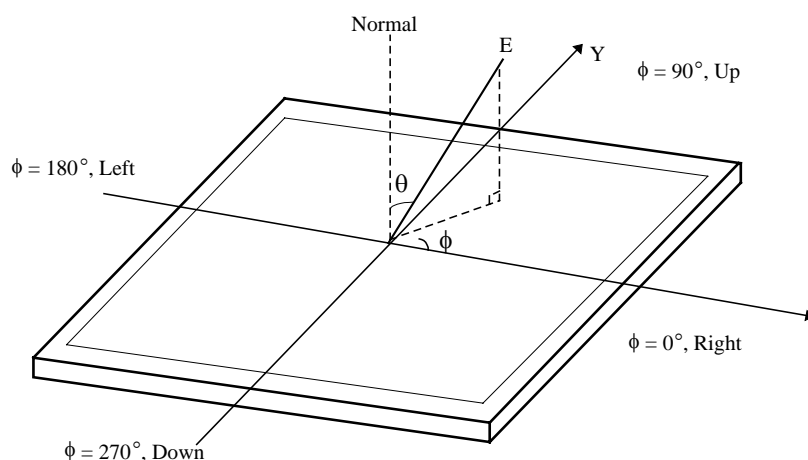


FIG. 5 Viewing angle

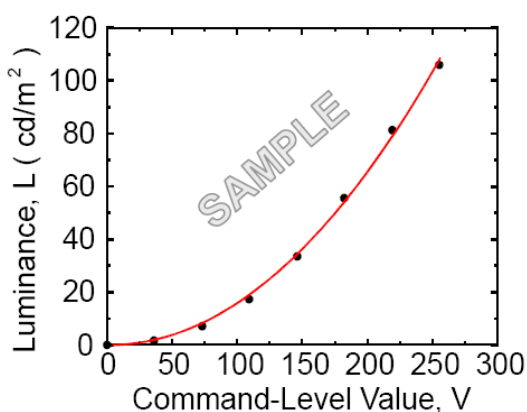


FIG. 6 Sample Luminance vs. gray scale  
(using a 256 bit gray scale)

$$L = aV^r + L_b$$

Here the Parameter  $\alpha$  and  $\gamma$  relate the signal level  $V$  to the luminance  $L$ .

The GAMMA we calculate from the log-log representation (FIG. 7)

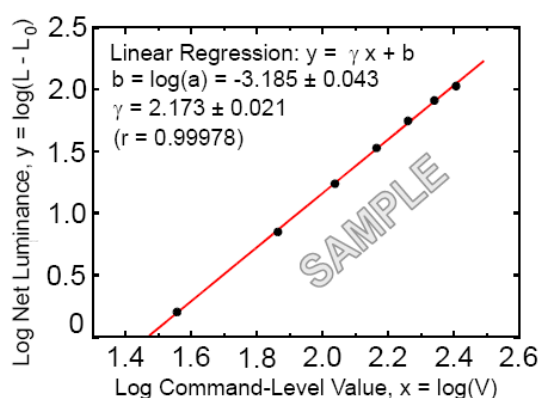


FIG. 7 Sample Log-log plot of luminance  
vs. gray scale

$$\log(L - L_b) = r \log(V) + \log(a)$$

Table 11. Gray Scale Specification

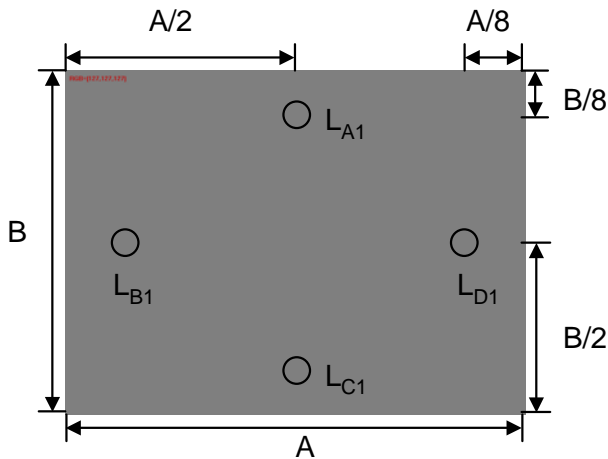
Gray Level	Relative Luminance [%] (Typ.)
0	0.3
31	1.2
63	4.7
95	11.7
127	21.2
159	35.2
191	53.0
223	75.4
255	100

## Product Specification

Crosstalk is defined as

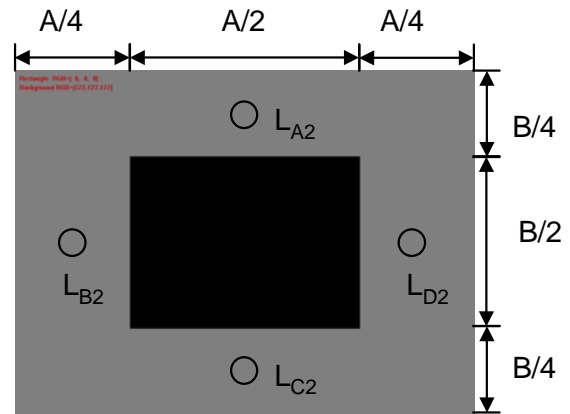
$$\text{Crosstalk} : \left( \frac{|L_{A[\text{or } C]2} - L_{A[\text{or } C]1}|}{L_{A[\text{or } C]1}} \times 100(\%) \right) [\text{Vertical}],$$

$$\left( \frac{|L_{B[\text{or } D]2} - L_{B[\text{or } D]1}|}{L_{B[\text{or } D]1}} \times 100(\%) \right) [\text{Horizontal}]$$



Pattern 1

- Half Gray: Gray 127



Pattern 2

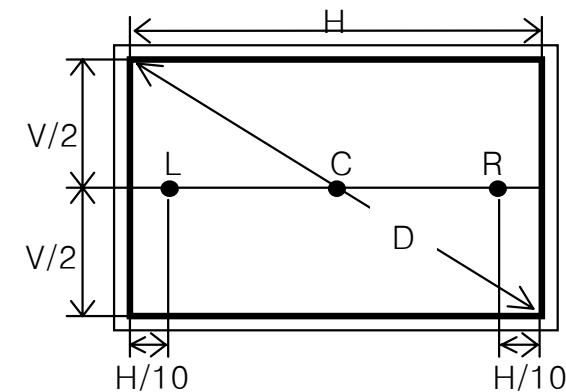
- Background : Gray 127  
- Window : Gray 0/255

FIG. 8 Crosstalk

Luminance Uniformity - angular – dependent ( $L_R$ )

TCO '99 Certification requirements and test methods for environmental labelling of Display [Flat]  
report No.2 (Luminance uniformity- angular – dependent)

- Test pattern : White pattern when the DUT luminance is 125 cd/m<sup>2</sup>
- Test point : 2-point
- Test distance : 87.63 cm
- Test method :  $L_R = ((L_{\text{max.}+30\text{deg.}} / L_{\text{min.}+30\text{deg.}}) + (L_{\text{max.}-30\text{deg.}} / L_{\text{min.}-30\text{deg.}})) / 2$



\*H,V : Active area

FIG. 9 Luminance Uniformity-Angular dependent

**Product Specification**

## 5. Mechanical Characteristics

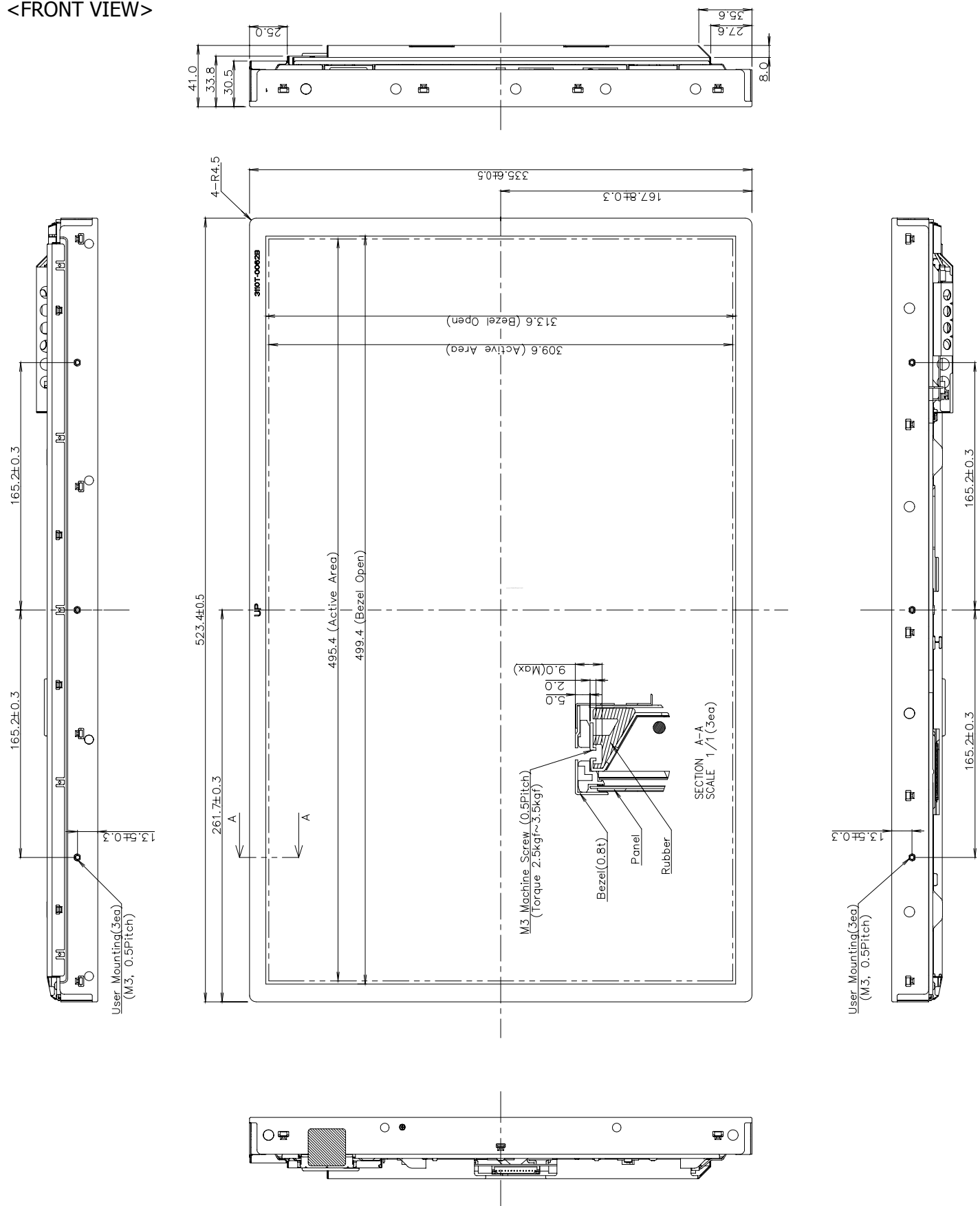
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline Dimension	Horizontal	523.4mm
	Vertical	335.6mm
	Depth	41mm
Bezel Area	Horizontal	499.4mm
	Vertical	313.6mm
Active Display Area	Horizontal	495.36mm
	Vertical	309.6mm
Weight	2870g (Typ.)	
Surface Treatment	Hard coating(3H) Anti-glare(13%) treatment of the front polarizer	

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

## Product Specification

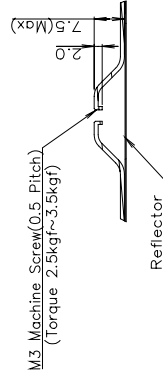
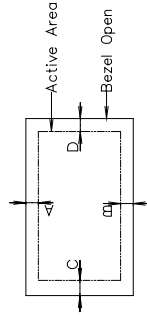
<FRONT VIEW>



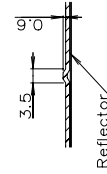
# Product Specification

## <REAR VIEW>

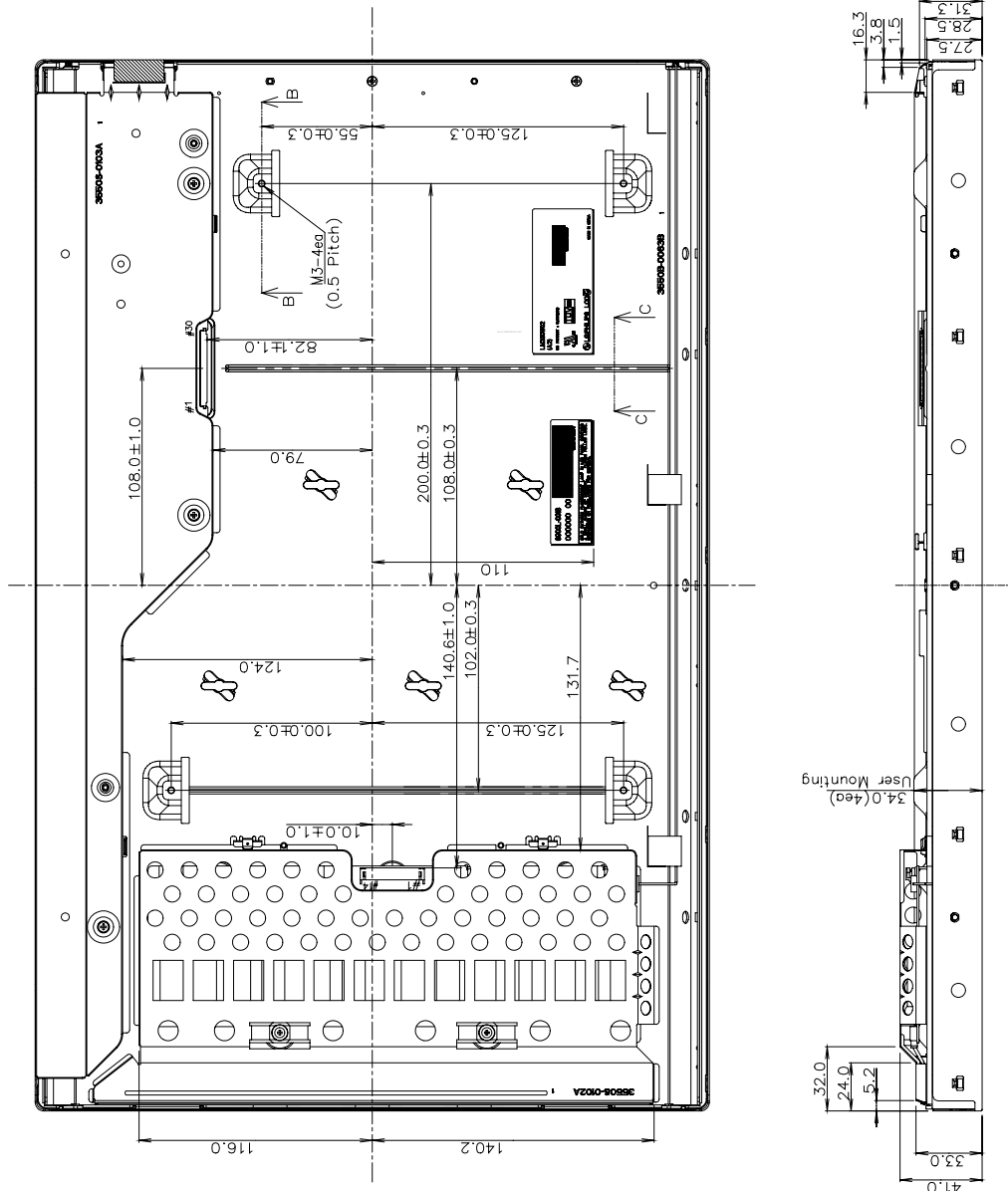
- Notes
1. Unspecified tolerances are to be  $\pm 0.5\text{mm}$ .
  2. Gap Between Bezel and Panel is  $0.3 \sim 0.5$ .
  3. Both backlight wires and contraction tubes are excluded from outline dimensions.
  4. Tilt and partial disposition tolerance of display area are as following:
    - (1) Y-direction :  $1A-B1 < 1.4\text{mm}$
    - (2) X-direction :  $1A-B1 < 1.4\text{mm}$



SECTION B-B  
SCALE 1/1 (4ea)



SECTION C-C  
SCALE 1/1 (2ea)



## 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 : 10-500Hz Duration : X,Y,Z, 10 min One time each direction
6	Shock test (non-operating)	Shock level : 100Grms Waveform : half sine wave, 2ms Direction : $\pm X$ , $\pm Y$ , $\pm Z$ One time each direction
7	Humidity condition Operation	Ta= 40 °C ,90%RH
8	Altitude storage / shipment	0 - 40,000 feet(12192m)



## Product Specification

## 7. International Standards

### 7-1. Safety

- a) UL 60950, Third Edition, Underwriters Laboratories, Inc., Dated Dec. 11, 2000.  
Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment.
- b) CAN/CSA C22.2, No. 60950, Third Edition, Canadian Standards Association, Dec. 1, 2000.  
Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment.
- c) EN 60950 : 2000, Third Edition  
IEC 60950 : 1999, Third Edition  
European Committee for Electrotechnical Standardization(CENELEC)  
EUROPEAN STANDARD for Safety of Information Technology Equipment Including Electrical Business Equipment.

### 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 Electrotechnical 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

F : PANEL CODE

H : ASSEMBLY CODE

E : MONTH

G : FACTORY CODE

I,J,K,L,M : SERIAL NO.

##### Note

##### 1. YEAR

Year	97	98	99	2000	2001	2002	2003	2004	2005	2006	2007
Mark	7	8	9	0	1	2	3	4	5	6	7

##### 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

##### 3. PANEL CODE

Panel Code	P1 Factory	P2 Factory	P3 Factory	P4 Factory	P5 Factory	Hydis Panel
Mark	1	2	3	4	5	H

##### 4. FACTORY CODE

Factory Code	LPL Gumi	LPL Nanjing
Mark	K	C

##### 5. SERIAL NO.

Year	1 ~ 99999	100000 ~
Mark	00001 ~ 99999	A0001 ~ A9999, ..... , Z9999

##### 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 : 4PCS

b) Box Size : 434 X 334 X 666

## 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 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 soaked 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 causes metallic foreign material and deal LCM a fatal blow)
- (9) Please do not set LCD on its edge.

## Product Specification

**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.