

Product Specification

SPECIFICATION FOR APPROVAL

- (●) Preliminary Specification
() Final Specification

Title	24.0" WUXGA TFT LCD
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BUYER	APPLE
MODEL	K29

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM240WU6
SUFFIX	SDA1

*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
Hans Kim / G.Manager	_____
REVIEWED BY	
SY.Park / Manager	_____
PREPARED BY	
B.C KIM / Engineer	_____

MNT Products Engineering Dept.
LG Display Co., Ltd.

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RECORD OF REVISIONS

Revision No	Revision Date	Page	Description
0.0	Jan. 9. 2008	-	First Draft(Preliminary)
0.0B	Jan. 14. 2008	6	Table 2-1 DP Logic Voltage added
		8	Table 3 CN_SIG pin mapping fixed
		9	20pin CNT P/N correction
0.0C	Feb.13.2008	7	Table 2-1-2 DP Logic Input Current added (Sleep Mode)
		7	Table 2-1-2 DP Logic Input Current added (Off Mode)
		9	30pin CNT P/N correction
		10	20pin CNT P/N correction
		11	3pin CNT P/N & pin mapping correction
		14	Power Sequence correction
		30	EDID Data added
0.0D	Feb.15.2008	32	EDID Read/Write Protocol added
0.0E	March.26.2008	23,24	Update Drawings
		2	Block diagram delete optical sensor
		6	Table 2-1-1 DP Logic Input Current & Power Consumption correction
		11	Optical sensor Connector delete
		15	Power sequence T8, T12 change
		30	EDID Data correction
0.0F	March.31.2008	16	Power Sequence, EDID Read / Write added
0.0G	April.11.2008	18	State Machine add
		8	Sleep mode, off mode Power
		16	T13 add
		17	EDID read power sequence change
0.0H	April.28.2008	13	Timing change
		16, 17	Power sequence change
		5,25	Update Weight
		9	LED Bar Specification update

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Revision No	Revision Date	Page	Description
0.0I	May. 9. 2008	14	Signal timing specification change (156MHz→154MHz)
		35	EDID change
		9	Stand by mode max power update
		27,28	Update Drawing
		20	Optical spec. update
		7	Add Vdpogic input voltage
0.0J	May. 19. 2008	8	Power Supply Input Current update
		6, 8	Power Consumption update
		17	Power Sequence Change. (T2:min 0.01m→0, T6:min 0.01m→0)
		May. 28.2008	27
0.0K	June.24.2008	34,35,36	Update EDID (Check Sum : 22 →03)
		6	Luminance change 350=>330nit
		20	HDCP key information add
0.0L	July. 22. 2008	31	Luminance spec change
		18, 28	Box size
		17	Drawing update
		11	T3 min spec change (1ms→0.01ms), Add T10, T11
0.0M	Aug.8.2008	11	Delete AUX-power pin function
		6	Power consumption update
		17	T8 min spec change (1000ms → 250ms). T9 min(0 → 200ms)
0.0N	Aug.12.2008	28	T8 min spec change (1000ms → 250ms). T9 min(0 → 200ms)
		28	Drawing update
		6,20	Optical spec(Luminance, color cordinate), power consumption update
0.0O	Aug.14.2008	20	Aging Time change(30min → 120min)
		17	Power sequence change
0.0P	Aug.22.2008	11, 12	Correct the name of 20pin, 30pin CNT
		25	Gray Scale update.
0.0Q	Sep.09.2008	6,10	Power consumption update
		10	Life time update
0.0R	Sep.19.2008	11,12	Delete equivalent connector
		17	Power sequence change
0.0R	Sep.24.2008	17	Power sequence change

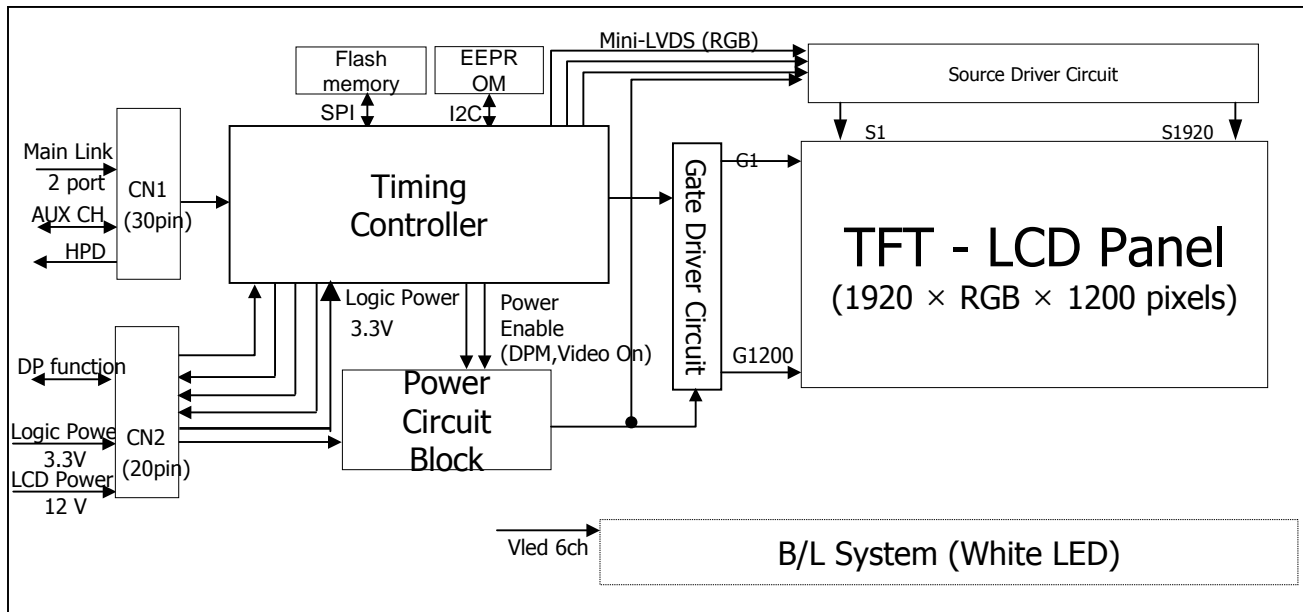
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1. General Description

LM240WU6 is a Color Active Matrix Liquid Crystal Display with Light Emitting Diode (White LED) backlight system without LED driver. 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 24inch 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(True) colors.

It has been designed to apply the 8Bit 2Lane Display port 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	24.0 inches(60.96cm) diagonal
Outline Dimension	546.4(H) x 361.6(V) x 18.3(D) mm(Typ.) <- W/O LED Driver
Pixel Pitch	0.270 mm x 0.270 mm
Pixel Format	1920 horiz. By 1200 vert. Pixels RGB stripes arrangement
Color Depth	8-bit, 16,777,216 colors
Luminance, White	320 cd/m ² (5 points Avg.)
Viewing Angle(CR>10)	View Angle Free (R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	Total 71.17 Watt (Max.) (6.12 Watt @V _{LCD} , Max 65.05 Watt_ Duty 92% of DC356mA_ w/o driver)
Weight	3500g (typ.) 3700g (Max.)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Hard coating(2H), Glare(Low Reflection treatment of the front polarizer)
HDCP	HDCP key implemented in Tcon (DP621)

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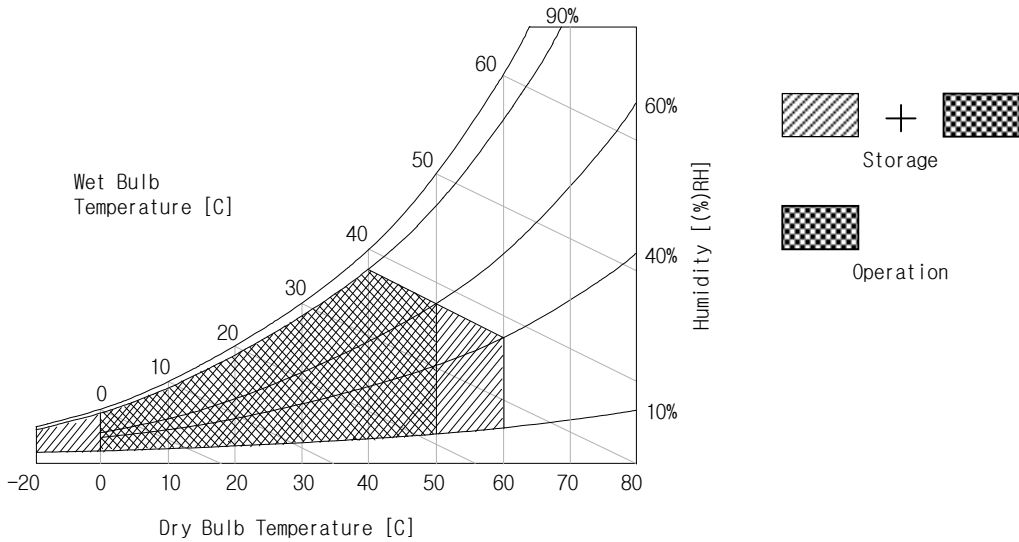
2. Absolute Maximum Ratings

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	VLCD	-0.3	14	Vdc	at 25 ± 2°C
Power Input Voltage	VDPLGIC	-0.5	4	Vdc	at 25 ± 2°C
Operating Temperature	TOP	0	50	°C	1
Storage Temperature	TST	-20	60	°C	
Operating Ambient Humidity	HOP	10	90	%RH	
Storage Humidity	HST	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

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 DP Rx.

Table 2-1-1. ELECTRICAL CHARACTERISTICS (Normal Mode)

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input voltage	VLCD	11.4	12.0	12.6	Vdc	
Permissive Power Input Ripple	VdRF	-		400	mVp-p	
Power Supply Input Current	ILCD	297	350	403	mA	1
		433	510	587	mA	2
Power Consumption	PLCD	-	6.12	7.04	Watt	2
Rush Current	IRUSH_VLCD	-	-	3.0	A	3
DP Logic Input Voltage	VCC_DPLOGIC	3.13	3.3	3.47	Vdc	
DP Logic Input Current	I_DPLOGIC		300		mA	1
			300		mA	2
DP Logic Power Consumption	P_DPLOGIC		1.0		Watt	
DP Rush Current	IRUSH_DPLOGIC	-	-	1.0	A	3

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Table 2-1-2. ELECTRICAL CHARACTERISTICS (Sleep Mode)

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
DP Logic Input Current	I_DPLOGIC	-	24	60	mA	
DP Logic Power Consumption	P_DPLOGIC	-	80	200	mW	

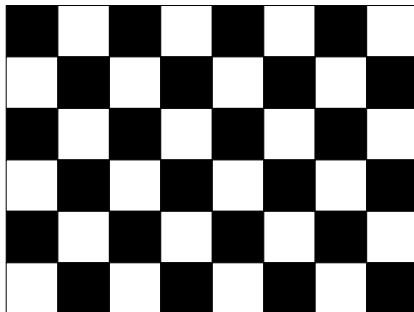
Table 2-1-3. ELECTRICAL CHARACTERISTICS (Off Mode)

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
DP Logic Input Current	I_DPLOGIC	-	21	30	mA	
DP Logic Power Consumption	P_DPLOGIC	-	70	100	mW	

Note :

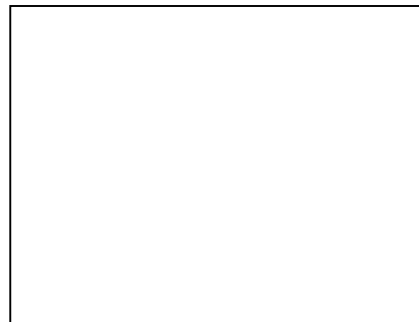
1. The specified current and power consumption are under the $V_{LCD}=12.0V$, $25 \pm 2^{\circ}C$, $f_V=60Hz$ condition whereas mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
2. The current is specified at the maximum current pattern.
3. The duration of rush current is about 2ms and rising time of power Input is 1ms(min.).

White : 255Gray
Black : 0Gray



Mosaic Pattern(8 x 6)

Maximum current pattern



White Pattern

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Table 2-2. LED Bar ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	Values			Unit	Notes
			Min.	Typ.	Max.		
LED :							1,7
LED String Current	Is		-	350	700	mA	2,7
LED String Voltage	Vs		60	-	73.2	V	3,7
LED Bar Voltage	VBar		-	-	198.6	V	3,7
LED String Power	Ps		21	-	25.62	Watt	4,7
Power Consumption	PBar		63	-	69.51	Watt	4,6,7
LED Life Time	LED_LT		39,000	-	-	Hrs	5,7
LED Junction Temperature	Tj		-	-	150	°C	7

LED driver design guide

: The design of the LED driver must have specifications for the LED in LCD Assembly.

The performance of the LED in LCM, for example life time or brightness, is extremely influenced by the characteristics of the LED driver.

So all the parameters of an LED driver should be carefully designed and output current should be Constant current control.

When you design or order the LED driver, please make sure unwanted lighting caused by the mismatch of the LED and the LED driver (no lighting, flicker, etc) never occurs.

When you confirm it, the LCD module should be operated in the same condition as installed in your instrument.

1. Specified values are for a single LED bar.
2. The specified current is input LED chip 100% duty current.
3. The specified voltage is input LED string and Bar voltage at typical 350 mA 100% duty current.
4. The specified power consumption is input LED bar power consumption at typical 350 mA 100% duty current.
5. The life is determined as the time at which luminance of the LED is 50% compared to that of initial value at the typical LED current on condition of continuous operating at 25 ± 2°C.
6. The LED bar power consumption shown above does not include loss of external driver.
The used LED bar current is the LED typical current.
Min Power Consumption is calculated with $P_{Bar} = V_s \times I_s \times N_{string}$
Max Power Consumption is calculated with $P_{bar} = V_{bar} \times I_s$
7. LED operating DC Forward Current and Junction Temperature must not exceed LED Max Ratings.

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3-2. Interface Connections

3-2-1. LCD Module

- LCD Connector(CN1). : KDF71G-30S-1H(500) (manufactured by Hirose)
The pin configuration for the 30 pin connector is shown in the table below.

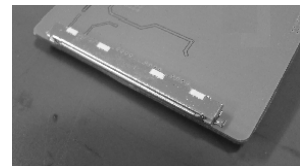
Table 3 MODULE CONNECTOR(CN_SIG) PIN CONFIGURATION

Pin No.	Symbol	Description	Pin No.	Symbol	Description
1	VSYNC	Vertical Sync for signal Checking	16	Lane3P	True Signal for Main Link 3
2	N/C	Reserved	17	Lane3N	Component Signal for Main Link 3
3	H_GND	High Speed Ground for Auxiliary Channel	18	H_GND	High Speed Ground
4	AUX_CH N	Component Signal for Auxiliary Channel	19	AUX2	LCD vender use / No Connection
5	AUX_CH P	True Signal for Auxiliary Channel	20	AUX1	LCD vender use / No Connection
6	H_GND	High Speed Ground for Main Link 0	21	HPD	Hot Plug Detect Signal
7	Lane0P	True Signal for Main Link 0	22	GND	GND for main power
8	Lane0N	Component Signal for Main Link 0	23	GND	GND for main power
9	H_GND	High Speed Ground for Main Link 1	24	GND	GND for main power
10	Lane1P	True Signal for Main Link 1	25	GND	GND for main power
11	Lane1N	Component Signal for Main Link 1	26	VLCD	12V for LCM main power
12	H_GND	High Speed Ground for Main Link 2	27	VLCD	12V for LCM main power
13	Lane2P	True Signal for Main Link 2	28	VLCD	12V for LCM main power
14	Lane2N	Component Signal for Main Link 2	29	VLCD	12V for LCM main power
15	H_GND	High Speed Ground for Main Link 3	30	DP_logic	3.3V for DP Rx power

Notes : 1. Connector

2.1 Connector(Receptacle) : KDF71G-30S-1H(500) (Hirose)

2.2 Mating Connector(Plug) : FI-X30HL(JAE).



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3-2-2. Power Connector

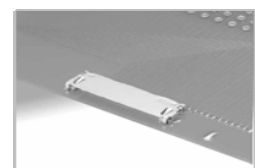
The power connector is DF19G-20P-1H(54) (manufactured by Hirose)
The pin configuration for the 20 pin connector is shown in the table below.

Table 4. 20Pin Connector pin configuration (Power Connector CN PWR)

Pin	Symbol	Description	Notes
1	VCC_DPLOGIC	Display Port Logic Power	
2	GND_VCC_DPLOGIC	Display Port Logic Power Return	
3	VLCD	LCD Power	
4	VLCD	LCD Power	
5	VLCD	LCD Power	
6	GND_VLCD	LCD Power Return	
7	GND_VLCD	LCD Power Return	
8	GND_VLCD	LCD Power Return	
9	I2C_SCL	I2C Clock	
10	GND	Signal Ground Return	
11	I2C_SDA	I2C Data	
12	GND	Signal Ground Return	
13	DDC_SCL	DDC Clock	
14	GND	Signal Ground Return	
15	DDC_SDA	DDC Data	
16	GND	Signal Ground Return	
17	Video_ON	High-state indicates a valid video signal for Backlight timing. Output from the LCD panel.	
18	DP_RX_INT	Low-state indicates an interrupt from the DP RX.	
19	EDID_WP	EDID Write Protection. When WP is set High, data rewrite of all address is prohibited.	
20	VSYNC	Vertical Synchronization Signal	

Notes : 1. Connector

- 1) Connector(Receptacle) : DF19G-20P-1H(54) (Hirose)
- 2) Mating Connector(Plug) : DF19G-20S-1C (Hirose)



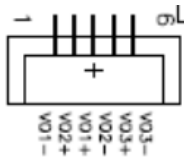
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3-2-3. Backlight Interface

- LED Connector : **H212K-P06N-00B** (Manufactured by E&T)
- Mating Connector : **3807K-Q06N-00R** (Manufactured by E&T)

Table 5. LED CONNECTOR PIN CONFIGURATION

Pin No.	Symbol	Description	Note
1	LED1-	LED channel 1 Cathode	
2	LED2+	LED channel 2 Anode	
3	LED1+	LED channel 1 Anode	
4	LED2-	LED channel 2 Cathode	
5	LED3+	LED channel 3 Anode	
6	LED3-	LED channel 3 Cathode	



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

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3-3. Signal Timing Specifications

All of the interface signal timing should be satisfied with the following specifications for its proper operation.

Table 6. TIMING TABLE (VESA COORDINATED VIDEO TIMING)

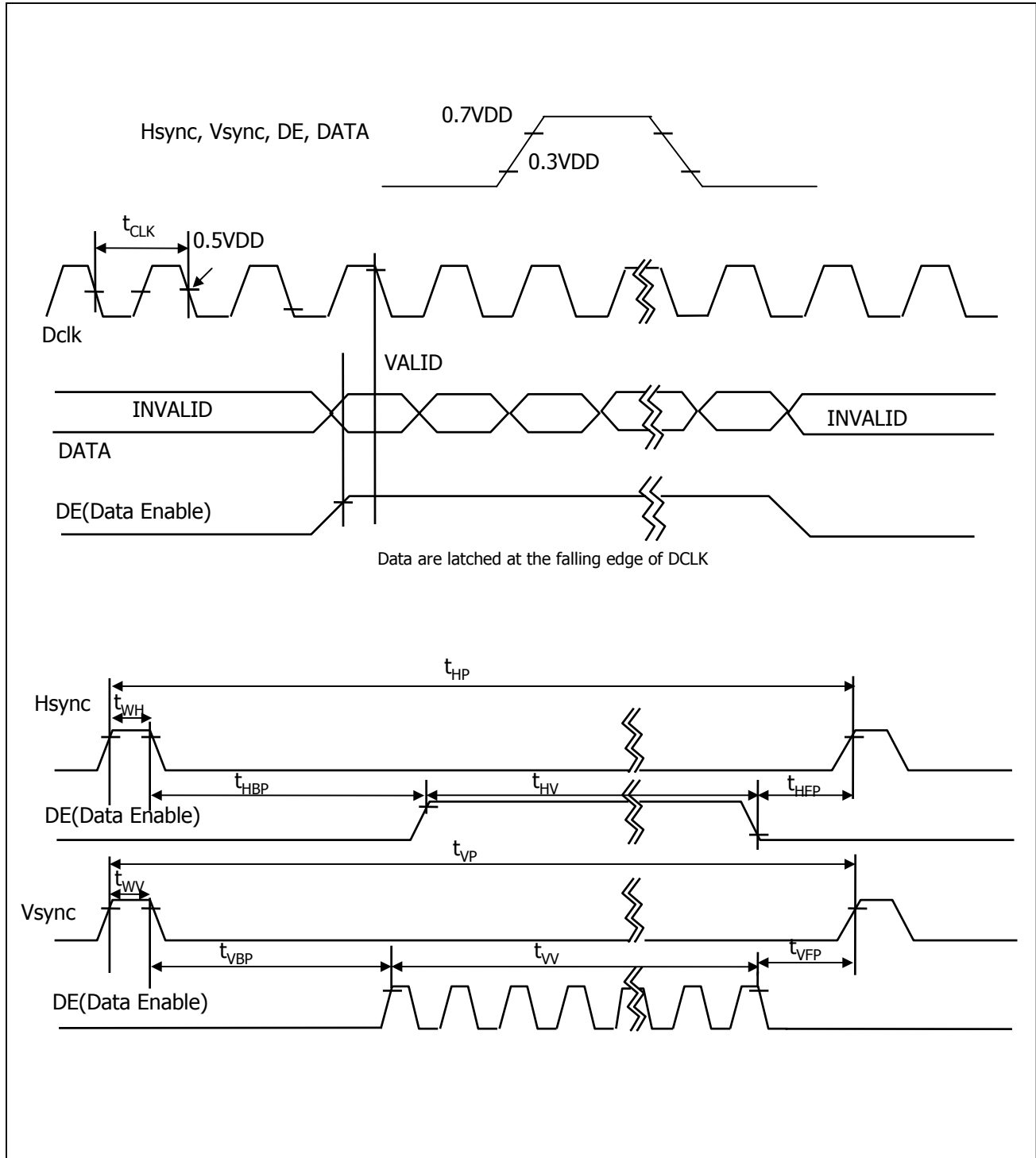
ITEM		SYMBOL	Min	Typ	Max	Unit	Note
DCLK	Period	tCLK	6.41	6.49	6.58	ns	
	Frequency	fCLK	152	154	156	MHz	
Hsync	Period	tHP	2072	2080	2088	tCLK	
	Width-Active	tWH	32	32	32		
Vsync	Period	tVP	1233	1235	1237	tHP	
	Frequency	fV	58.85	59.95	61	Hz	
	Width-Active	tWV	6	6	6	tHP	
Data Enable	Horizontal Valid	tHV	1920	1920	1920	tCLK	
	Horizontal Back Porch	tHBP	72	80	88		
	Horizontal Front Porch	tHFP	40	48	56		
	Horizontal Blank	-	152	160	168		tWH+ tHBP+ tHFP
	Vertical Valid	tVV	1200	1200	1200	tHP	
	Vertical Back Porch	tVBP	25	26	27		
	Vertical Front Porch	tVFP	2	3	4		
	Vertical Blank	-	33	35	37		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).
4. The polarity of Hsync, Vsync is not restricted.

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3-4. Signal Timing Waveforms



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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 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

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3-6. Power Sequence

3-6-1. Power Sequence

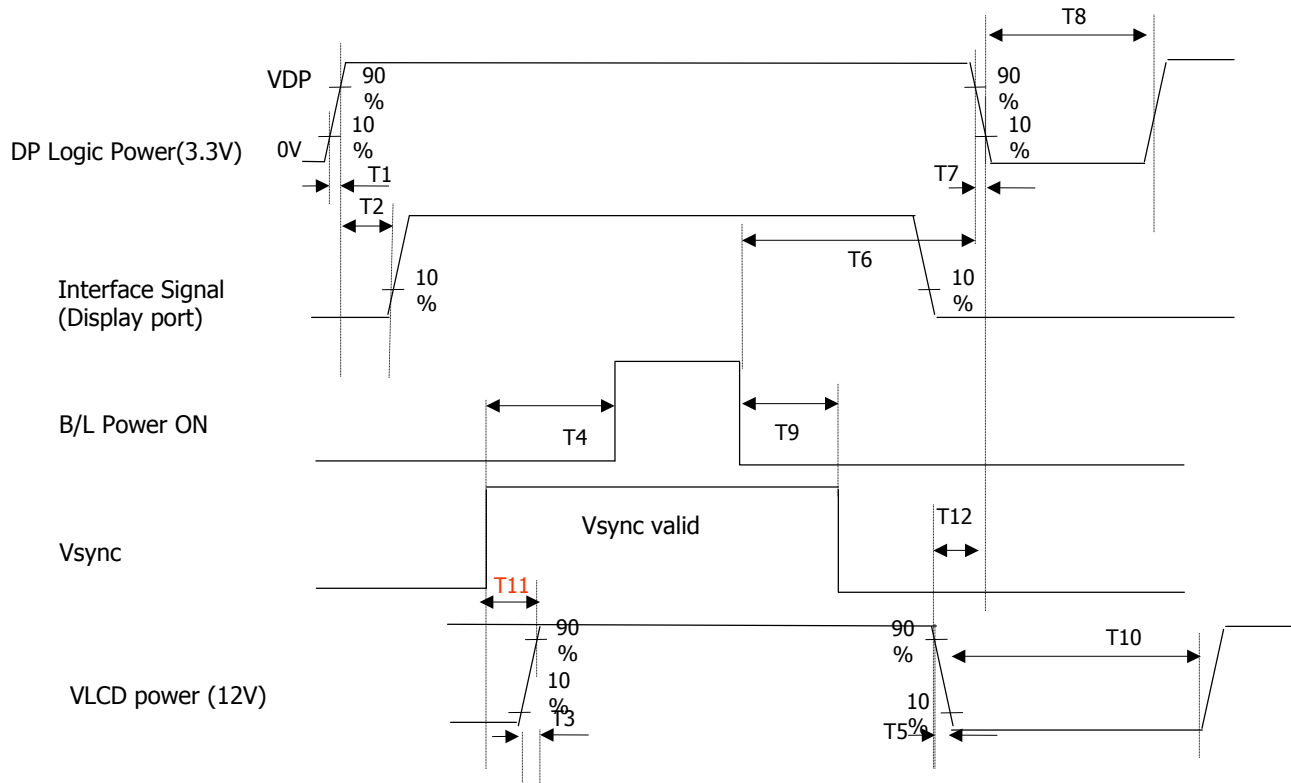


Table 8. POWER SEQUENCE

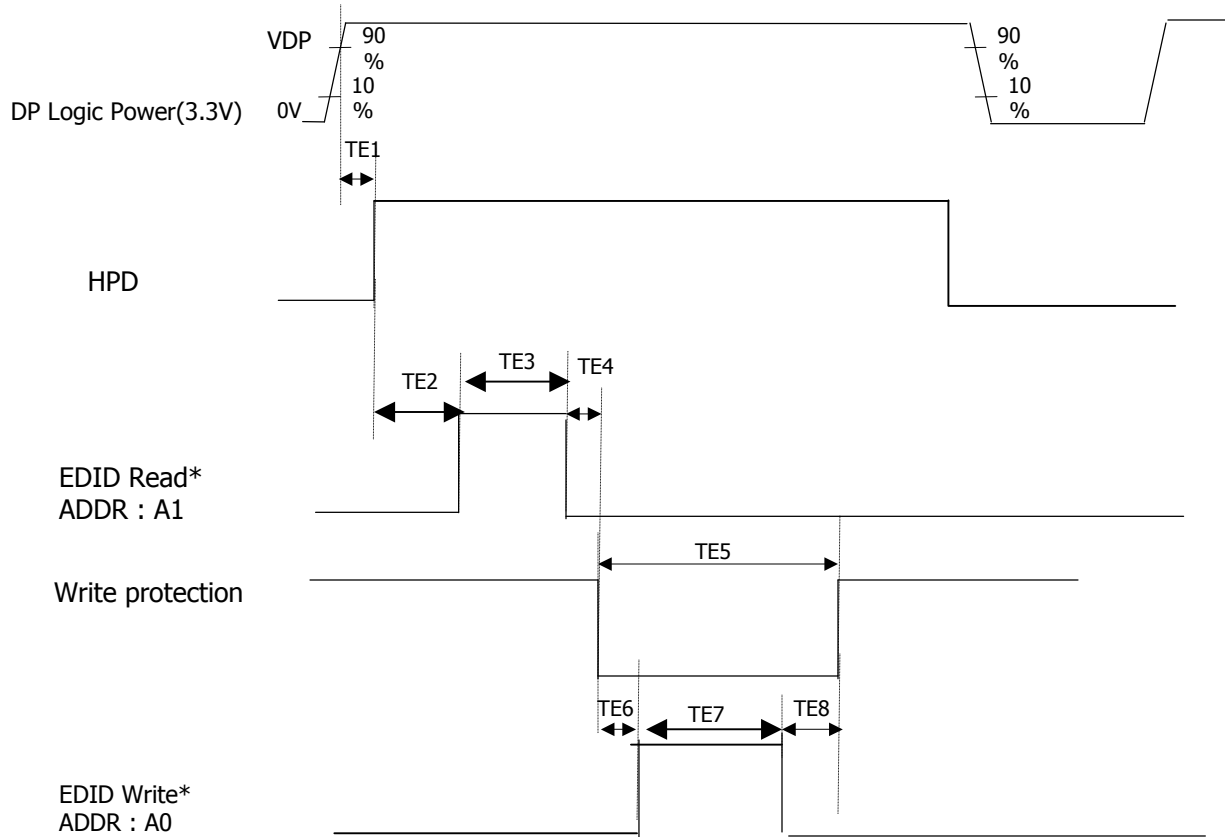
Parameter	Values			Units
	Min	Typ	Max	
T1	1.0	-	10	ms
T2	-	-	-	ms
T3	0.01	-	10	ms
T4	400	-	-	ms
T5	0.01	-	1000	ms
T6	0	-	-	ms
T7	0.01	-	1000	ms
T8	250	-	-	ms
T9	0	-	-	ms
T10	250	-	-	ms
T11	-	-	400	ms
T12	0	-	-	ms

- 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. LED power must be turn on after power supply for LCD and interface signal are valid.

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3-6-2. Power Sequence, EDID Read / Write

*** This timing is for fabrication purpose only, not for normal operation. ***



* EDID Read time and EDID write time will be exclusive.

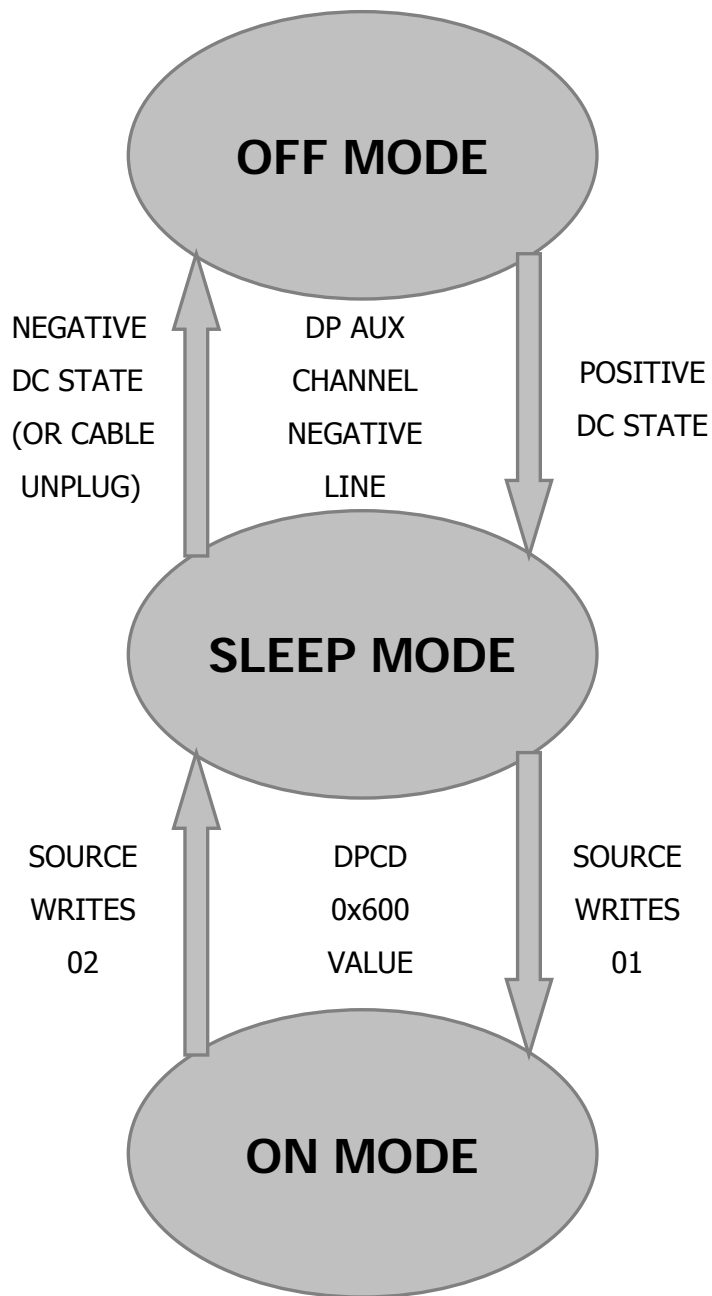
Notes.

In case of without DP signal after DP logic power on, check HPD after TE1 time and if HPD is low status then any time can read EDID

Table 8.1 POWER SEQUENCE, EDID

Parameter	Values			Units
	Min	Typ	Max	
TE1	-	30	50	ms
TE2	1000	-	-	ms
TE3	-	20	-	ms
TE4	1	-	-	ms
TE5	-	-	2000	ms
TE6	1	-	-	ms
TE7	-	20	-	ms
TE8	1	-	-	ms

3-6-3. State Machine



Product Specification

4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 120 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 Φ and θ equal to 0° and aperture 1 degree.

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

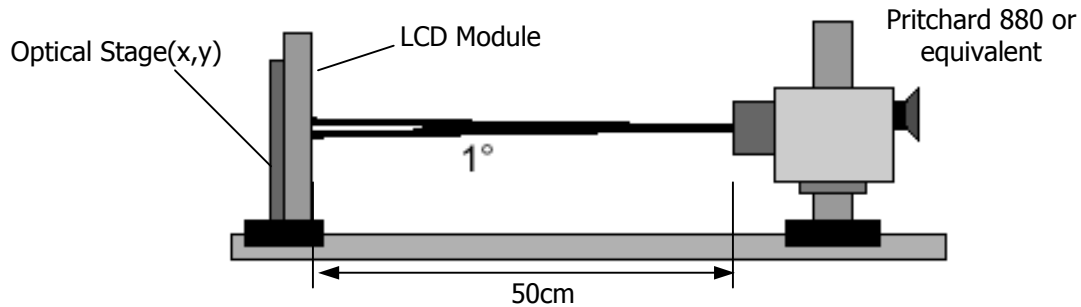


FIG. 1 Optical Characteristic Measurement Equipment and Method

Table 9. OPTICAL CHARACTERISTICS

($T_a=25^\circ\text{C}$, $V_{\text{LCD}}=12.0\text{V}$, $f_v=60\text{Hz}$ Dclk=156MHz)

Parameter	Symbol	Values			Units	Notes	
		Min	Typ	Max			
Contrast Ratio	CR	700	1000	-		1	
Surface Luminance, white	L_{WH}	270	320	-	cd/m ²	2	
Luminance Variation	δ_{WHITE}			30	%	3	
Response Time	Rise Time	T_{R}	6.5	12	ms	4	
	Decay Time	T_{D}	-	7.5	12	ms	4
Color Coordinates [CIE1931]	RED	R_x	0.654	Typ +0.03			
		R_y	0.333				
	GREEN	G_x	0.302				
		G_y	0.616				
	BLUE	B_x	0.147				
		B_y	0.053				
	WHITE	W_x	0.313				
	W_y	0.329					
Color Shift	Horizontal	θ_{CST_H}	-	178	-	Degree	5
	Vertical	θ_{CST_V}	-	178	-		
Viewing Angle (CR>10)							
General	Horizontal	θ_H	170	178	-	Degree	6
	Vertical	θ_V	170	178	-		
Effective	Horizontal	θ_{GMA_H}		178	-	Degree	7
	Vertical	θ_{GMA_V}		178	-		
Gray Scale			2.2				8

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 5 points average across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 2.

$$L_{WH} = \text{Average}[L_{on1}, L_{on2}, L_{on3}, L_{on4}, L_{on5}]$$

3. The variation in surface luminance, δ_{WHITE} is defined as :

$$\delta_{WHITE} = \frac{\text{Maximum}(L_{on1}, L_{on2}, \dots, L_{on13}) - \text{Minimum}(L_{on1}, L_{on2}, \dots, L_{on13})}{\text{Average}(L_{on1}, L_{on2}, \dots, L_{on5})} \times 100(\%)$$

Where L1 to L13 are the luminance with all pixels displaying white at 13 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. 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

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 surface. For more information see FIG 5.

7. 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.

8. Gray scale specification

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

Product Specification

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

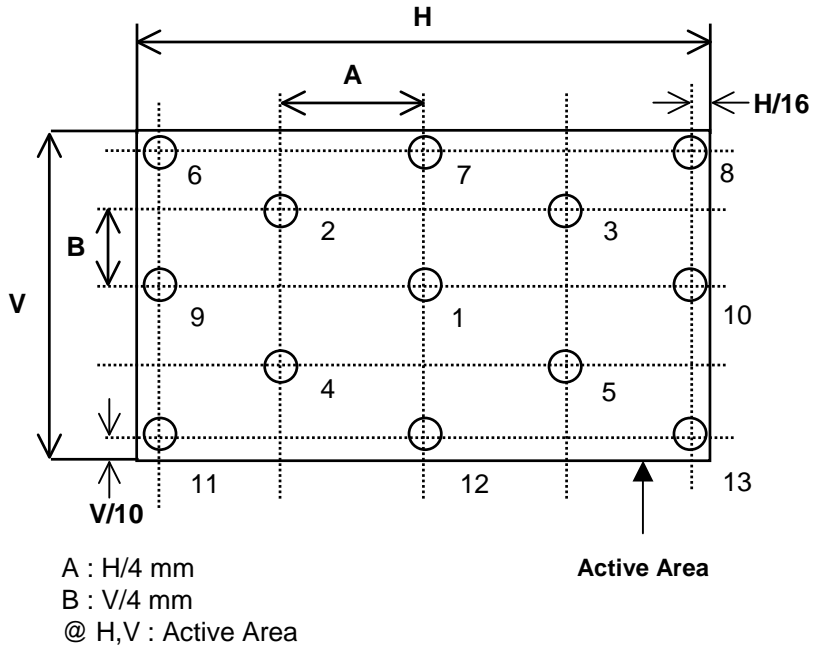


FIG. 2 Measure Point for Luminance

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

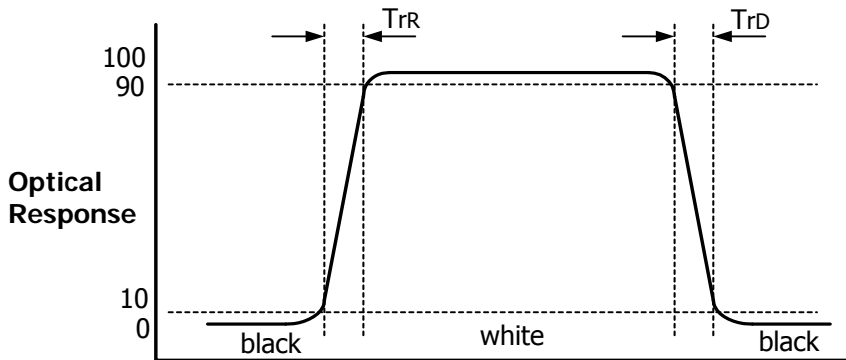


FIG. 3 Response Time

Product Specification

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

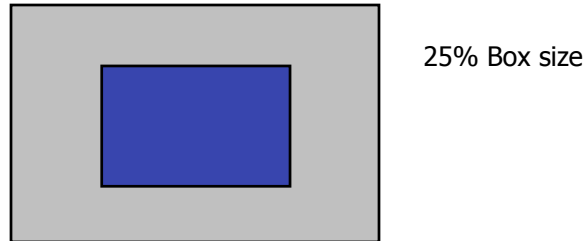


FIG. 4 Test Pattern

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.

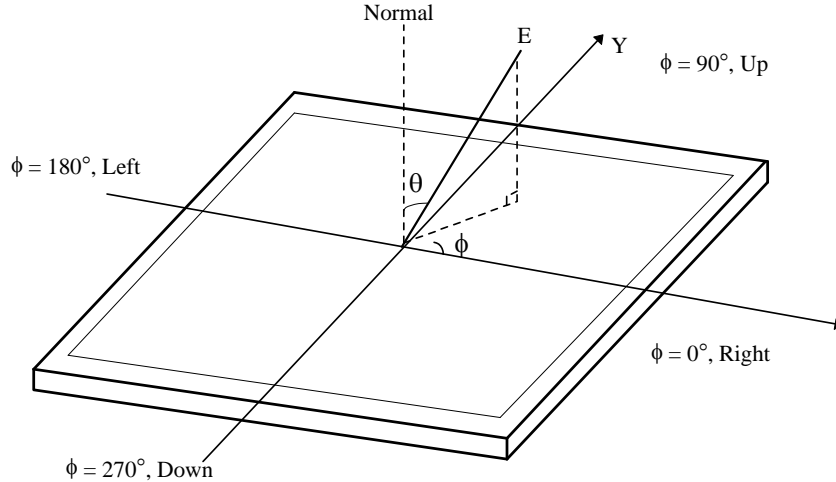


FIG. 5 Viewing angle

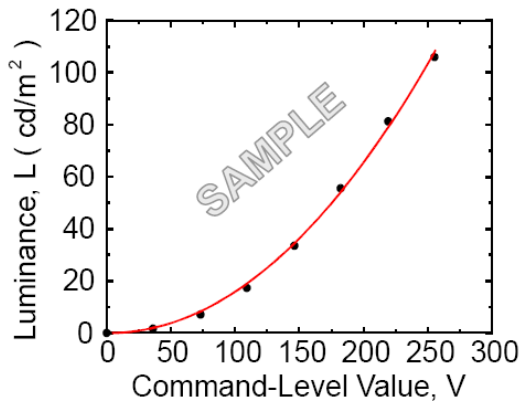


FIG. 6 Sample Luminance vs. gray scale (using a 256 bit gray scale)

$$L = aV^r + L_b$$

Here the Parameter α and γ relate the signal level V to the luminance L .
The GAMMA we calculate from the log-log representation (FIG. 7)

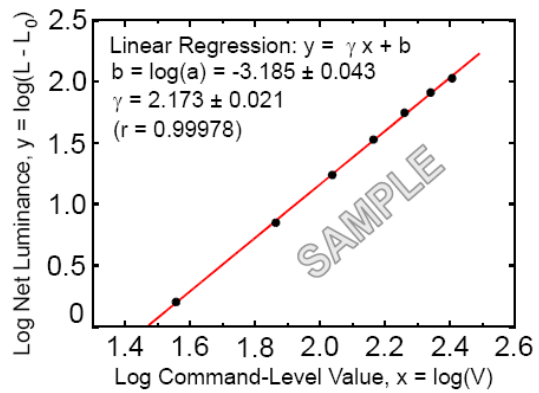


FIG. 7 Sample Log-log plot of luminance vs. gray scale

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

Product Specification

Table 10. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.10
31	1.08
63	4.71
95	11.5
127	21.7
159	35.5
191	53.1
223	74.5
255	100

Product Specification

5. Mechanical Characteristics

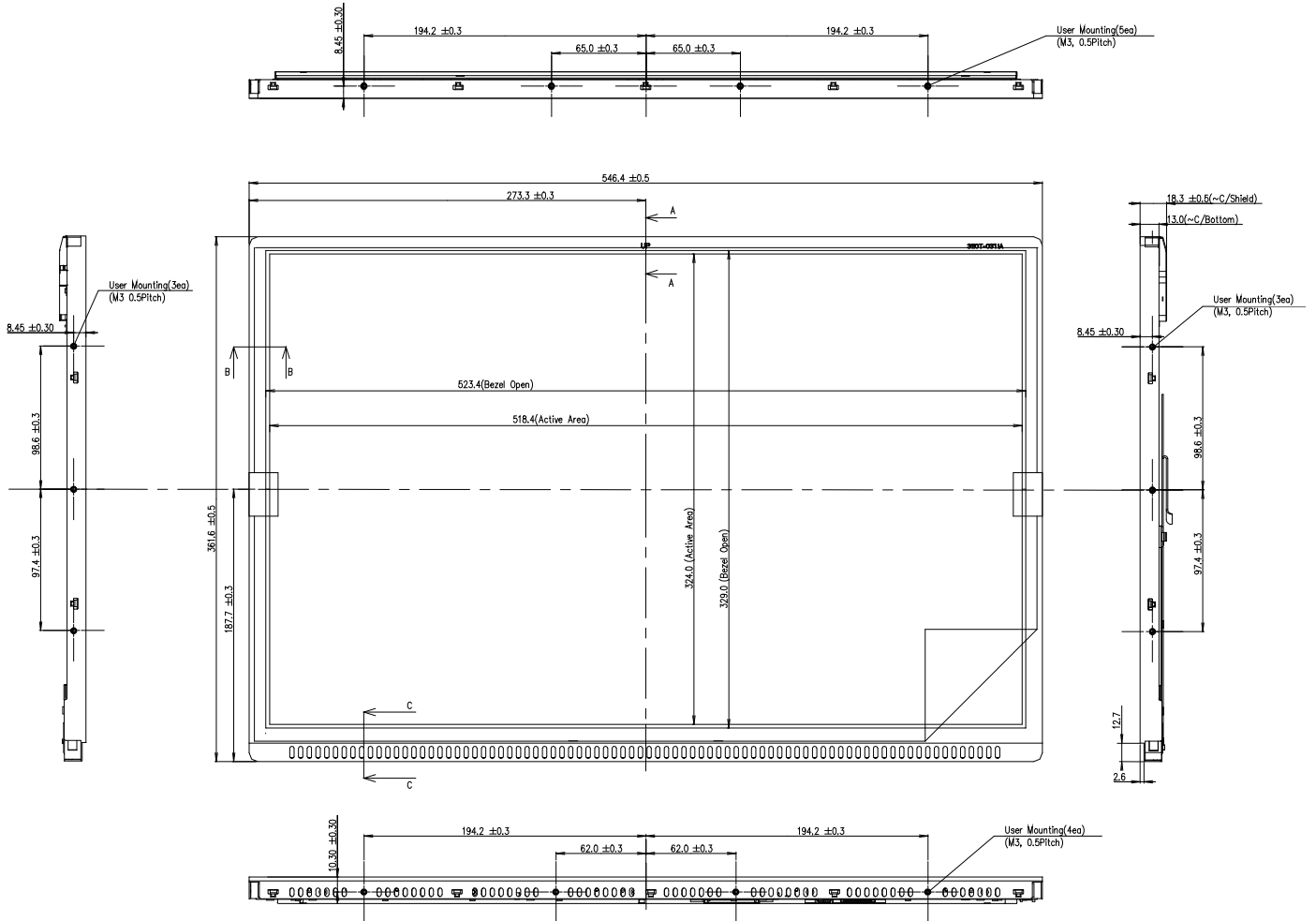
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline Dimension	Horizontal	546.4mm
	Vertical	361.6mm
	Depth	18.3mm(W/O LED Driver)
Bezel Area	Horizontal	523.4mm
	Vertical	329.0mm
Active Display Area	Horizontal	518.4mm
	Vertical	324.0mm
Weight	3500g (Typ.) / 3700g (Max.)	
Surface Treatment	Hard coating(2H) Glare, Low Reflection treatment of the front polarizer	

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

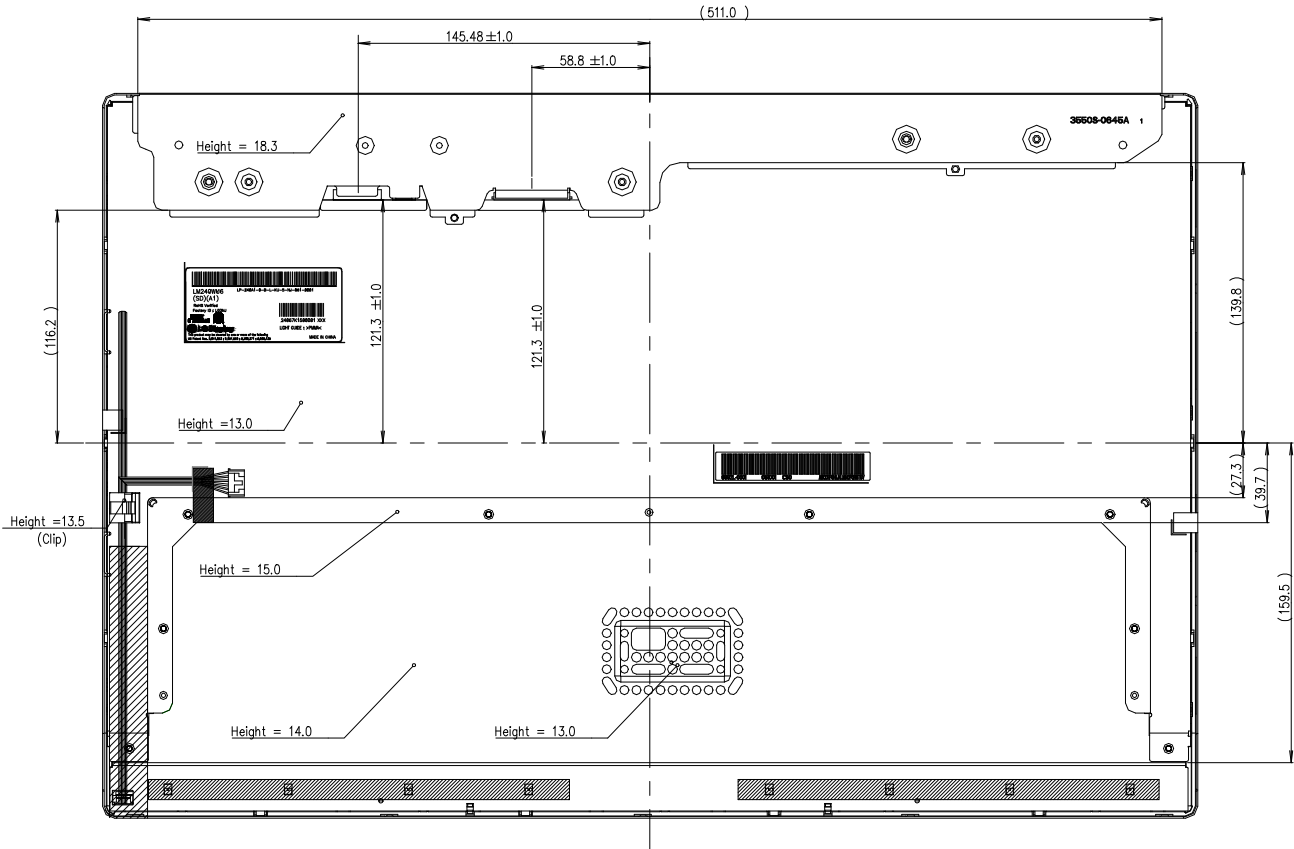
Product Specification

<FRONT VIEW>



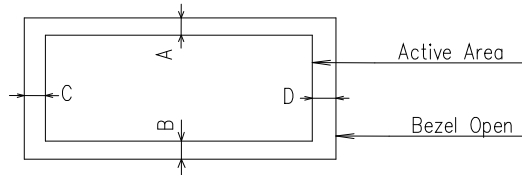
Product Specification

<REAR VIEW>



Notes

1. Unspecified tolerances are to be $\pm 0.5\text{mm}$.
2. Tilt and partial disposition tolerance of display area are following.
 - (1) Y-direction : $|A-B| \leq 1.4\text{mm}$
 - (2) X-direction : $|C-D| \leq 1.4\text{mm}$



3. Unspecified contents have to be discussed with designer
4. Both backlight wires and contraction tubes are excluded from outline dimensions.
5. Torque Spec of User Mounting : 7.0 ~ 8.0kgf cm
6. LCM Weight : 3500g (Typ.) , 3700g (Max.)
7. The ass'y should have no defect in appearance.
8. Panel ~ Case top Gap: 0.4 ± 0.1
9. LCM Flatness spec : Max 0.5mm
 - Measuring method : The gap is less than 0.5 from the flat surface plate to front side.

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 : 100Grms Waveform : half sine wave, 2ms Direction : ±X, ±Y, ±Z One time each direction
7	Altitude Operating Storage / Shipment	0 - 10,000 feet(3,048m) 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 Electrotechnical Standardization(CENELEC)
European Standard for Safety of Information Technology 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)

E : MONTH

D : YEAR

F ~ M : SERIAL NO.

Note

1. YEAR

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

2. MONTH

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	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 : 5pcs

b) Box Size : 470*270*610

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 soaks with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
- (8) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
- (9) Do not open the case because inside circuits do not have sufficient strength.

9-2. OPERATING PRECAUTIONS

- (1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :
 $V = \pm 200\text{mV}$ (Over and under shoot voltage)
- (2) Response time depends on the temperature.(In lower temperature, it becomes longer.)
- (3) Brightness depends on the temperature. (In higher 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.

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.

Product Specification

10. EDID DATA FOR LM240WU6-SDA1

Byte# (decimal)	Byte# (HEX)	Field Name and Comments	Value (HEX)	Value (binary)		
0	0	Header	00	00000000	Header	
1	1		FF	11111111		
2	2		FF	11111111		
3	3		FF	11111111		
4	4		FF	11111111		
5	5		FF	11111111		
6	6		FF	11111111		
7	7		00	00000000		
8	8	EISA Manuf. Code LSB (3 character ID = APP	06	00000110	Vendor/ Product ID	
9	9	Compressed ASCII	10	00010000		
10	0A	Product Code (9C,97)	97	10010111		product ID for LM240WU6-SDA2 = 9C97
11	0B	Hex, LSB first	9C	10011100		0x9C97
12	0C	32-bit serial #	01	00000001		
13	0D		01	00000001		
14	0E		01	00000001		
15	0F		01	00000001		
16	10	Week of manufacture	00	00000000		
17	11	Year of manufacture 2008	12	00010010		
18	12	EDID Structure Ver # = 1	01	00000001	EDID Version/ Revision	
19	13	EDID revision # = 3	03	00000011		
20	14	Video input definition	80	10000000	Display Parameter	
21	15	Max H image size = 52cm	34	00110100		
22	16	Max V image size = 32cm	20	00100000		
23	17	Display Gamma = 2.2	78	01111000		
24	18	Feature support (DPMS) = Active off, RGB color	0A	00001010		
25	19	Red/Green low Bits	C7	11000111	Color Characteristic	
26	1A	Blue/White Low Bits	74	01110100		
27	1B	Red X Rx = 0.654	A7	10100111		
28	1C	Red Y Ry = 0.332	54	01010100		
29	1D	Green X Gx = 0.304	4D	01001101		
30	1E	Green Y Gy = 0.621	9E	10011110		
31	1F	Blue X Bx = 0.150	26	00100110		
32	20	Blue Y By = 0.050	0C	00001100		
33	21	White X Wx = 0.313	50	01010000		
34	22	White Y Wy = 0.329	54	01010100		
35	23	Established timing 1	00	00000000	Established Timings	
36	24	Established timing 2	00	00000000		
37	25	Manufacturer's timings	10	00010000	kAppleNoncoherentTMDSFlag = 0x10, kAppleCoherentTMDSFlag = 0x08	
38	26	Standard timing #1 was not used	01	00000001	Standard Timing ID	
39	27		01	00000001		
40	28	Standard timing #2 was not used	01	00000001		
41	29		01	00000001		
42	2A	Standard timing #3 was not used	01	00000001		
43	2B		01	00000001		
44	2C	Standard timing #4 was not used	01	00000001		
45	2D		01	00000001		
46	2E	Standard timing #5 was not used	01	00000001		
47	2F		01	00000001		
48	30	Standard timing #6 was not used	01	00000001		
49	31		01	00000001		
50	32	Standard timing #7 was not used	01	00000001		
51	33		01	00000001		
52	34	Standard timing #8 was not used	01	00000001		
53	35		01	00000001		

Product Specification

54	36	Detailed timing/monitor	28	00101000	Detailed Timing Description #1	
55	37	Pixel Clock = 154 MHz	3C	00111100		
56	38	Hor active= 1920 pixels	80	10000000		
57	39	Hor blanking= 160 pixels	A0	10100000		
58	3A		70	01110000		
59	3B	Vertical active= 1200 lines	80	10110000		
60	3C	Vertical blanking= 35 lines	23	00100011		
61	3D		40	01000000		
62	3E	H sync. Offset= 48 pixels	30	00110000		
63	3F	H sync. Width= 32 pixels	20	00100000		
64	40	V sync. Offset= 3 lines	36	00110110		
65	41	V sync. Width= 6 lines	00	00000000		
66	42	H image size= 518 mm	06	00000110		
67	43	V image size = 324 mm	44	01000100		
68	44		21	00100001		
69	45	No Horizontal Border	00	00000000		
70	46	No Vertical Border	00	00000000		
71	47	Non-interfaced, Normal display, No stereo, Digital separate sync, H/V pol Negatives	1A	00011010		
72	48	Detailed timing/monitor	00	00000000		Detailed Timing Description #2
73	49	descriptor #2	00	00000000		
74	4A		00	00000000		
75	4B		01	00000001		
76	4C	Version	00	00000000		
77	4D	Apple edid signature	06	00000110		
78	4E	Apple edid signature	10	00010000		
79	4F	Link Type (LVDS, Dual Link, MSB)	30	00110000		
80	50	Pixel and link component format (8bit)	11	00010001		
81	51	Panel features	01	00000001		
82	52		00	00000000		
83	53		00	00000000		
84	54		00	00000000		
85	55		00	00000000		
86	56		00	00000000		
87	57		00	00000000		
88	58		0A	00001010		
89	59		20	00100000		
90	5A	Detailed timing/monitor	00	00000000	Detailed Timing Description #3	
91	5B	descriptor #3	00	00000000		
92	5C	LM240WU6-SDA2	00	00000000		
93	5D		FE	11111110		
94	5E		00	00000000		
95	5F	"L"	4C	01001100		
96	60	"M"	4D	01001101		
97	61	"2"	32	00110010		
98	62	"4"	34	00110100		
99	63	"0"	30	00110000		
100	64	"W"	57	01010111		
101	65	"U"	55	01010101		
102	66	"6"	36	00110110		
103	67	"."	2D	00101101		
104	68	"S"	53	01010011		
105	69	"D"	44	01000100		
106	6A	"A"	41	01000001		
107	6B	"2"	32	00110010		

Product Specification

108	6C	Detailed timing/monitor	00	00000000	Detailed Timing Description #4 Monitor Name: Color LCD
109	6D	descriptor #4	00	00000000	
110	6E	Color LCD	00	00000000	
111	6F		FC	11111100	
112	70		00	00000000	
113	71	C	43	01000011	
114	72	o	6F	01101111	
115	73	l	6C	01101100	
116	74	o	6F	01101111	
117	75	r	72	01110010	
118	76		20	00100000	
119	77	L	4C	01001100	
120	78	C	43	01000011	
121	79	D	44	01000100	
122	7A		0A	00001010	
123	7B		20	00100000	
124	7C		20	00100000	
125	7D		20	00100000	
126	7E	Extension Flag = 00	00	00000000	Extension Flag
127	7F	Checksum	03	00000011	Checksum

10-2. EDID DATA READ/WRITE PROTOCOL

10-2-1. READ Operation

<Start><Slave Address, RW=0><Byte Address><Start><Slave Address, RW=1><Data><Stop>

10-2-2. WRITE Operation

<Start><Slave Address, RW=0><Byte Address><Data><Stop>

- Device Address (Slave Address)

Type	Device (Slave) Address								Hex
IS24C02B	1	0	1	0	0	0	0	RW	0xA0 + RW

- Byte Address

Byte Address	
Decimal	0 ~ 127
Hex	0x00 ~ 0x7F