

Product Specification

SPECIFICATION FOR APPROVAL

() Preliminary Specification
(●) Final Specification

Title	24.0" WUXGA TFT LCD
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BUYER	APPLE
MODEL	

SUPPLIER	LG. Display Co., Ltd.
*MODEL	LM240WU2
SUFFIX	SLB4

*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	_____
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S.Y Park / Manager	_____
PREPARED BY	
K.H.LEE / Engineer	_____

MNT Products Engineering Dept.
LG Display Co., Ltd

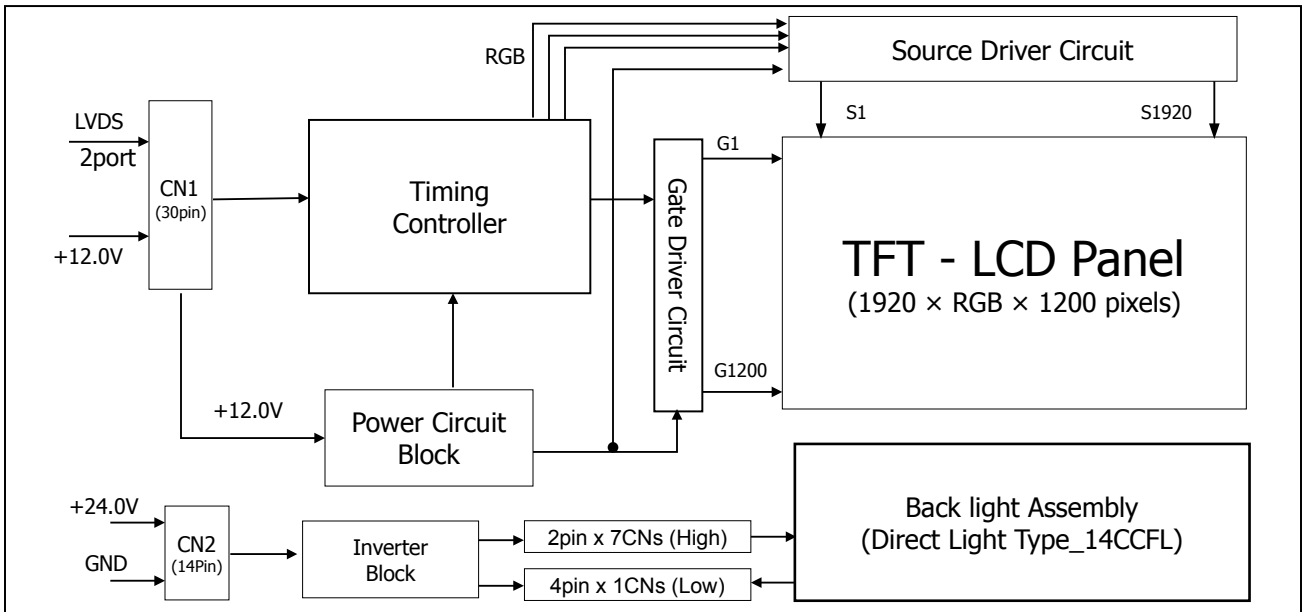
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1. General Description

LM240WU2 is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Lamp(CCFL) backlight system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally black mode. It has a 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 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	24.0 inches(60.96cm) diagonal
Outline Dimension	546.4(H) x 350.0(V) x 28.9(D) mm(Typ.)
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	400 cd/m ² (5 points Avg.)
Viewing Angle(CR>10)	View Angle Free (R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	Total 70.92 Watt (Typ.) (4.92 Watt @V _{LCD} , 66 Watt @400cd)
Weight	2650g (typ.)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Hard coating(2H), Glare(Low Reflection treatment of the front polarizer)

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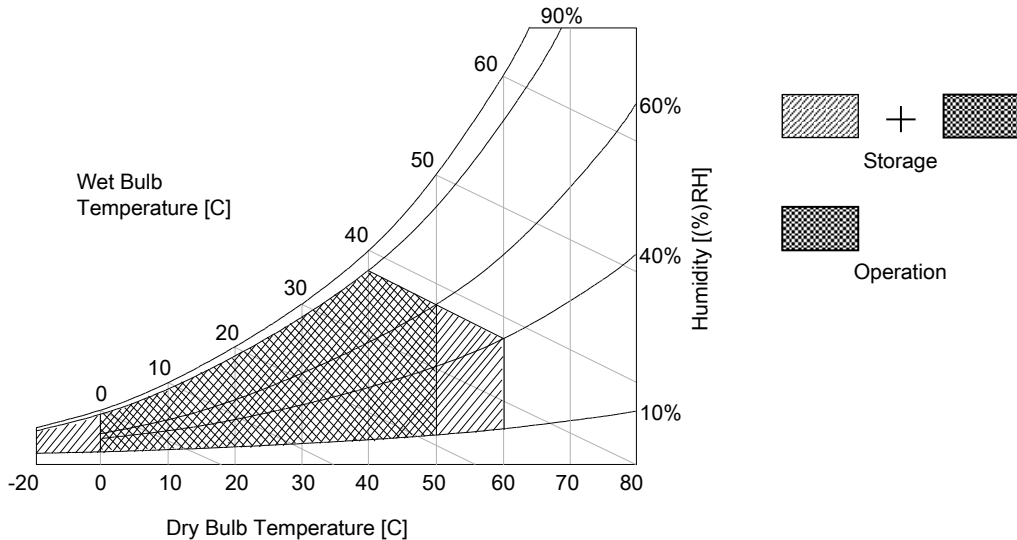
2. Absolute Maximum Ratings

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	21	V _{dc}	at 25 ± 2°C
Operating Temperature	T _{OP}	0	50	°C	1
Storage Temperature	T _{ST}	-20	60	°C	
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 °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 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}	11.4	12.0	12.6	V _{dc}	
Permissive Power Input Ripple	V _{dRF}			400	mV _{p-p}	
Power Supply Input Current	I _{LCD}	-	410	472	mA	1
		-	580	667	mA	2
Power Consumption	P _{LCD}	-	4.92	5.66	Watt	1
Rush current	I _{RUSH}	-	-	3.0	A	3

Note :

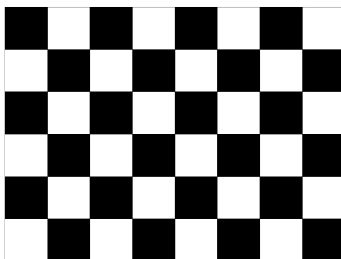
1. The specified current and power consumption are under the V_{LCD}=12.0V, 25 ± 2°C, f_v=60Hz condition

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.

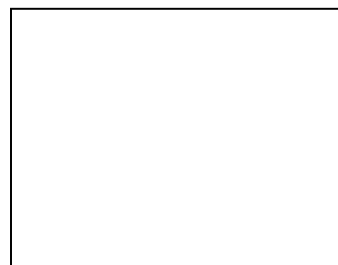
3. The duration of rush current is about 2ms and rising time of power Input is 1ms(min.).

White : 255Gray
Black : 0Gray



Mosaic Pattern(8 x 6)

Maximum current pattern



White Pattern

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Table 2-2. INVERTER ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	Values			Unit	Notes
			Min.	Typ.	Max.		
Inverter :							
Input Voltage	V_{DDB}		21.6	24.0	26.4	V	1
Input Current	I_{DDB}	Vin=24V, Vbr = max	-	2.75	3.02	A	2
Input Power	PB	Vin=24V, Vbr = max	-	66	72.6	Watt	2
B/L on/off control	VON/OFF	Lamp ON = High	2.0	-	5.0	V	
		Lamp OFF =Low	0.0	-	0.8	V	
Lamp Voltage	Vout	Vin=24V, Vbr=max	750	950	1150	Vrms	
Lamp Current	Io(Min)	Vin=24V, Vbr=min	2.5	-	-	mArms	
	Io(Max)	Vin=24V, Vbr=max	3.7	4.2	4.7	mArms	
Brightness Adj	VBR	Vin=24V	0	-	3.3	V	
Frequency	Fo	Vbr=max	40	44	48	KHz	
Burst Frequency	Fb	Vin=24V, Vbr=min	-	240	-	Hz	
Open Lamp Voltage	Vopen	No load Vin=21.6V, Vbr=max	1300	-	-	Vrms	
Asymmetry Ratio		Vin=24V	-	-	10.0	%	3
Distortion Ratio		Vin=24V	1.27	-	1.55		3
Striking Time	Ts	No load Vin=21.6V, Vbr=max	1.0	-	2.0	Sec	
Efficiency	η	Vin=24V Vbr=max	80			%	
LAMP :							
Life time			50,000			Hrs	4

Notes :

- The input voltage ripple is limited below 400mVp-p.
- The specified current and power consumption are under the typical supply Input voltage, 24V.
- Voltage and current is measured for Asymmetry ratio and Distortion ratio.
Asymmetry Ratio: $| I_{peak} - I_{-peak} | / I_L$ Distortion Ratio : $| I_{peak} | (or | I_{-peak} |) / I_L$
- 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 $25 \pm 2^\circ\text{C}$.
- Electrical characteristics are determined after the unit has been 'ON' and stable for approximately 30min in a dark environment at $25 \pm 2^\circ\text{C}$.
- In case of the difference in measured values due to the difference of measuring device was found, correlated value will be used after discussions between both parties.

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3-2. Interface Connections

3-2-1. LCD Module

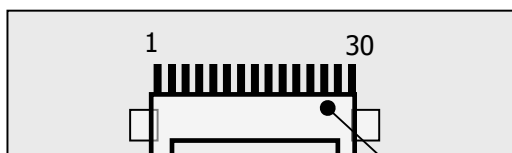
- LCD Connector(CN1). : ISL100-L30B-C23(UJU)
- Mating Connector: 20385-030T-12F (Manufactured by I-PEX) or equivalent

Table 3 MODULE CONNECTOR(CN1) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	FR0M	Minus signal of odd channel 0 (LVDS)	16	SR1P	Plus signal of even channel 1 (LVDS)
2	FR0P	Plus signal of odd channel 0 (LVDS)	17	GND	Ground
3	FR1M	Minus signal of odd channel 1 (LVDS)	18	SR2M	Minus signal of even channel 2 (LVDS)
4	FR1P	Plus signal of odd channel 1 (LVDS)	19	SR2P	Plus signal of even channel 2 (LVDS)
5	FR2M	Minus signal of odd channel 2 (LVDS)	20	SCLKINM	Minus signal of even clock channel (LVDS)
6	FR2P	Plus signal of odd channel 2 (LVDS)	21	SCLKINP	Plus signal of even clock channel (LVDS)
7	GND	Ground	22	SR3M	Minus signal of even channel 3 (LVDS)
8	FCLKINM	Minus signal of odd clock channel (LVDS)	23	SR3P	Plus signal of even channel 3 (LVDS)
9	FCLKINP	Plus signal of odd clock channel (LVDS)	24	GND	Ground
10	FR3M	Minus signal of odd channel 3 (LVDS)	25	CLK_EDID	DDC for Clock
11	FR3P	Plus signal of odd channel 3 (LVDS)	26	DATA_EDID	DDC for Data
12	SR0M	Minus signal of even channel 0 (LVDS)	27	V_EDID	DDC for Power 3.3V
13	SR0P	Plus signal of even channel 0 (LVDS)	28	VLCD	Power Supply +12.0V
14	GND	Ground	29	VLCD	Power Supply +12.0V
15	SR1M	Minus signal of even channel 1 (LVDS)	30	VLCD	Power Supply +12.0V

- Note:
1. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.
 2. All VLCD (power input) pins should be connected together.
 3. Input Level of LVDS signal is based on the IEA 664 Standard.

User Connector Diagram



Rear view of LCM

ISL100-L30B-C23(UJU)

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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.

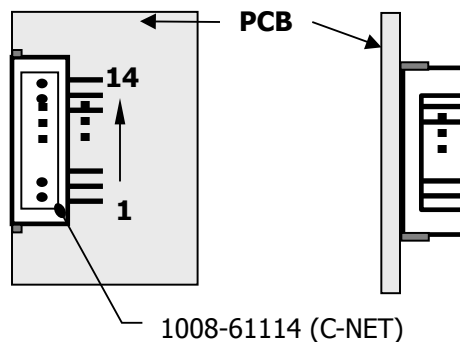
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3-2-2. Backlight Interface

- Inverter Connector : 1008-61114 Top entry type (Manufactured by C-NET)
- Mating Connector : PHR-14(Manufactured by JST) or Equivalent

Table 4. INVERTER CONNECTOR PIN CONFIGURATION

Pin No	Symbol	Description	Remarks
1	V _{BL}	Power Supply +24.0V	
2	V _{BL}	Power Supply +24.0V	
3	V _{BL}	Power Supply +24.0V	
4	V _{BL}	Power Supply +24.0V	
5	V _{BL}	Power Supply +24.0V	
6	GND	Power Ground	Note 1
7	GND	Power Ground	
8	GND	Power Ground	
9	GND	Power Ground	
10	GND	Power Ground	
11	OPEN	NC	
12	V _{ON}	Backlight On/off Signal	(On :2.0V~5V/Off :0.0~0.8V)
13	V _{BR}	Brightness Adjustable Voltage	Note 2
14	Status	NC	

- Notes :
1. GND is connected to the LCD's metal frame.
 2. V_{br} input is PWM signal and the signal level is within 3.3V±3%.
 PWM Duty : Max 100% / Min 0%

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 5. TIMING TABLE (VESA COORDINATED VIDEO TIMING)

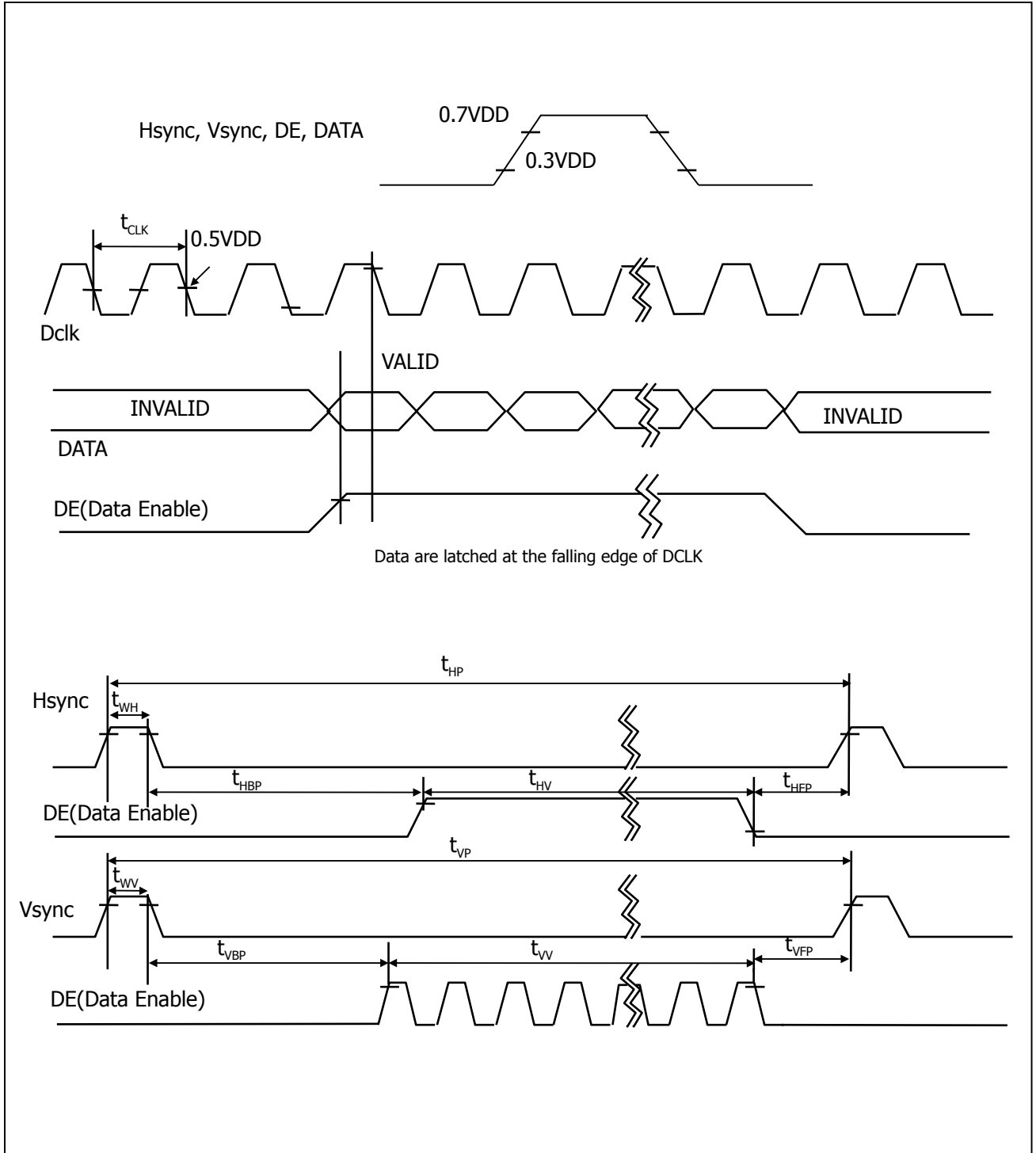
ITEM		SYMBOL	MIN	TYP	MAX	UNIT	NOTE
DCLK	Period	tCLK	6.49	6.41	6.33	Ns	
	Frequency	fCLK	152	156	158	MHz	
Hsync	Period	tHP	2072	2080	2088	tCLK	
	Width-Active	tWH	32	32	32		
Vsync	Period	tVP	1243	1245	1247	tHP	
	Frequency	fV	59.91	60.241	60.57	Hz	
	Width-Active	tWV	6	6	6	tHP	
Data Enable	Horizontal Valid	tHV	1920	1920	1920	tCLK	
	Horizontal Back Porch	tHBP	72	80	88		
	Horizontal Front Porch	tHFP	40	48	50		
	Horizontal Blank	-	152	160	168		tWH+ tHBP+ tHFP(Typ)
	Vertical Valid	tVV	1200	1200	1200	tHP	
	Vertical Back Porch	tVBP	35	36	37		
	Vertical Front Porch	tVFP	2	3	4		
	Vertical Blank	-	43	45	47		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

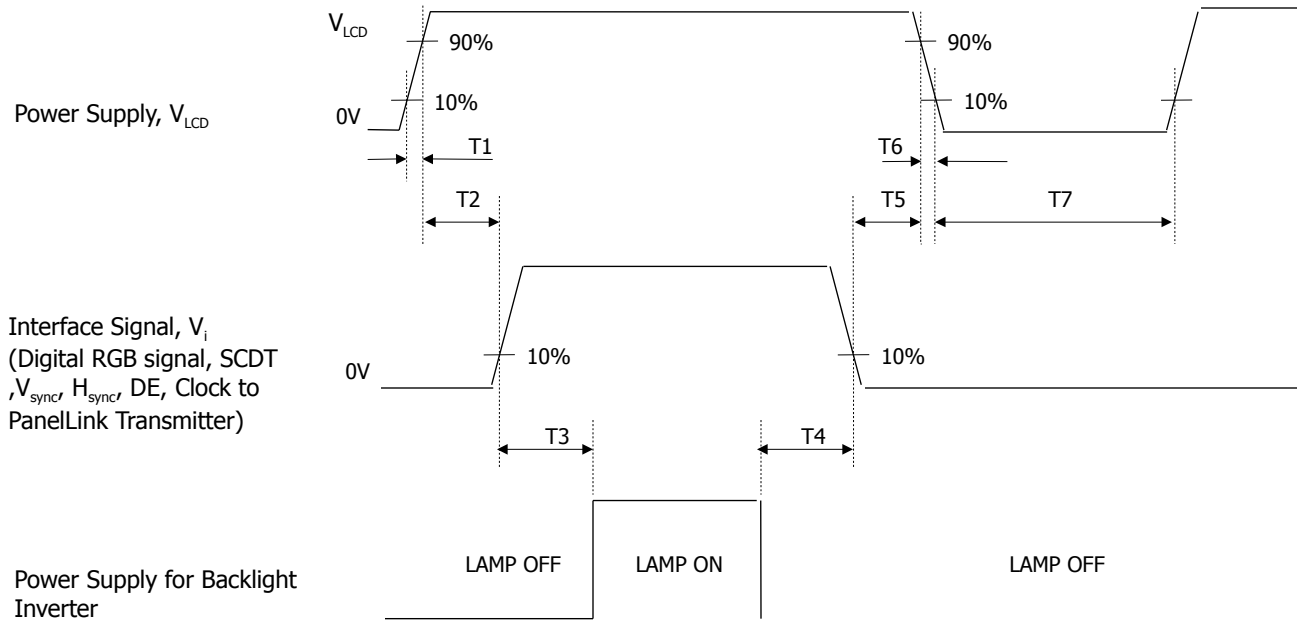


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3-5. Color Data Reference

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.

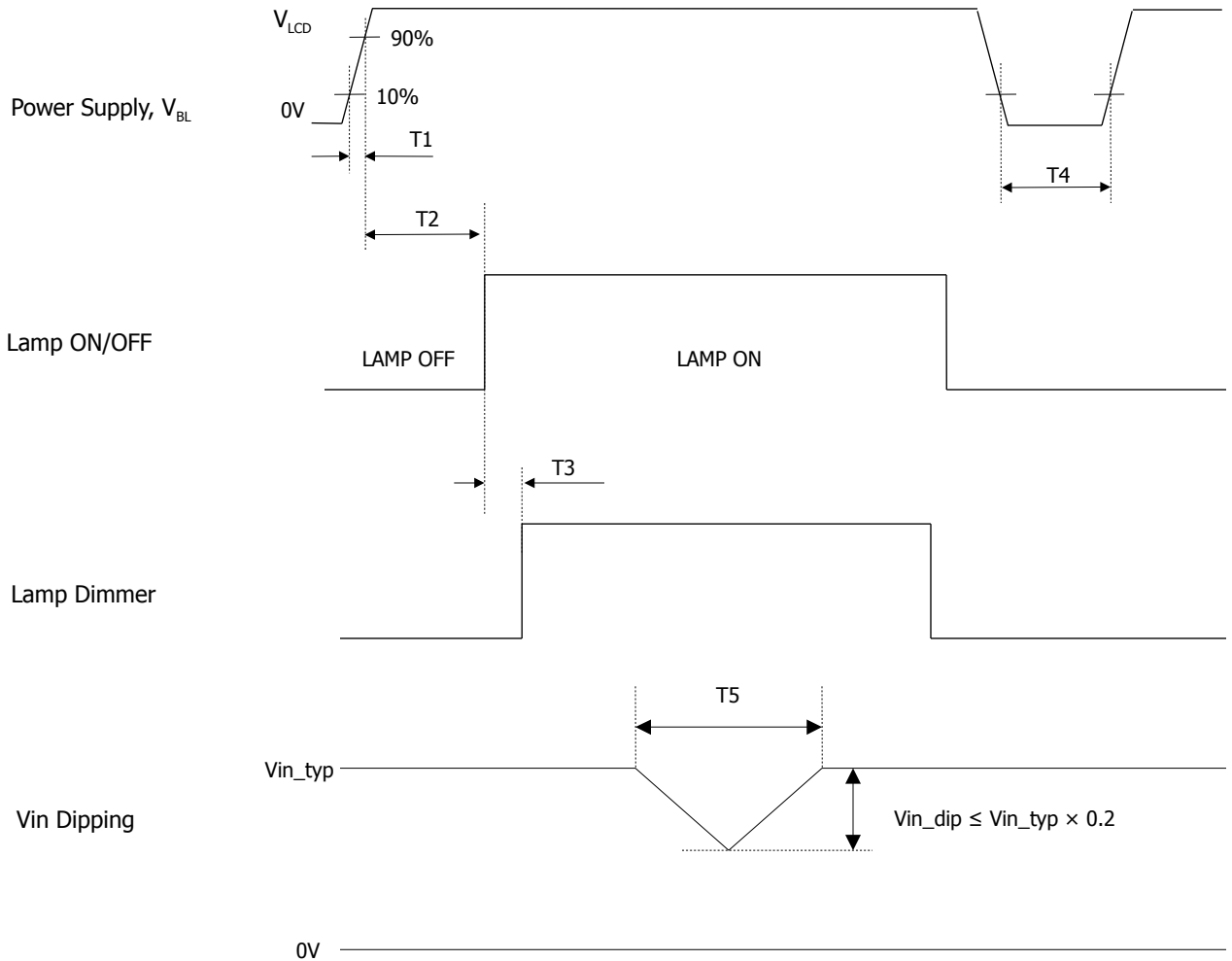
Table 6. COLOR DATA REFERENCE

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	1	0	0	0	0	0	0	0	0	0
							
	GREEN (254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	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	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	0
							
	BLUE (254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	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

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3-6. Power Sequence

Table 7. POWER SEQUENCE

Parameter	Values			Units
	Min	Typ	Max	
T1	1.0	-	10	ms
T2	0.01	-	50	ms
T3	200	-	-	ms
T4	200	-	-	ms
T5	0.01	-	50	ms
T6	0.01	-	10	ms
T7	400	-	-	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. Lamp power must be turn on after power supply for LCD and interface signal are valid.

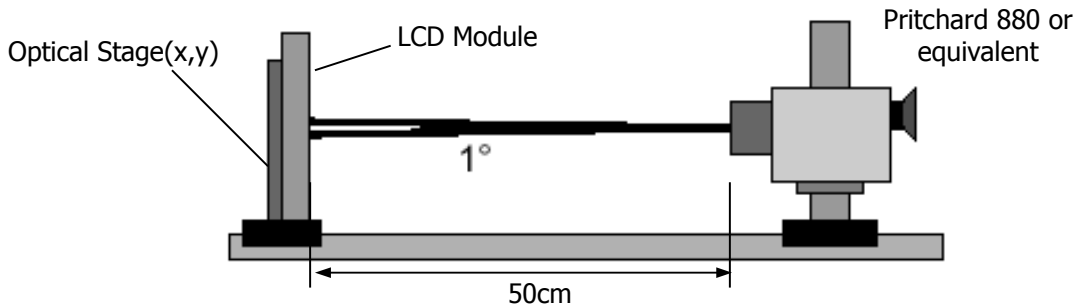
Product Specification
3-7. Power Sequence for Inverter

Table 8. POWER SEQUENCE

Parameter	Values			Units
	Min	Typ	Max	
T1	1	-	30	ms
T2	200	-	-	ms
T3	-	-	50	ms
T4	500	-	-	ms
T5	-	-	10	ms

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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 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

 ($T_a=25^\circ\text{C}$, $V_{LCD}=12.0\text{V}$, $f_v=60\text{Hz}$ Dclk=156MHz, $V_{BR}=3.3\text{V}$)

Parameter	Symbol	Values			Units	Notes	
		Min	Typ	Max			
Contrast Ratio	CR	550	800	-		1	
Surface Luminance, white	L_{WH}	320	400	-	cd/m ²	2	
Luminance Variation	δ_{WHITE}			30	%	3	
Response Time	Rise Time	Tr_R	-	5.5	12	ms	4
	Decay Time	Tr_D	-	6.5	12	ms	4
Color Coordinates [CIE1931]	RED	R_x		0.640			
		R_y		0.340			
	GREEN	G_x		0.290			
		G_y	Typ -0.03	0.615	Typ +0.03		
	BLUE	B_x		0.145			
		B_y		0.070			
	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.

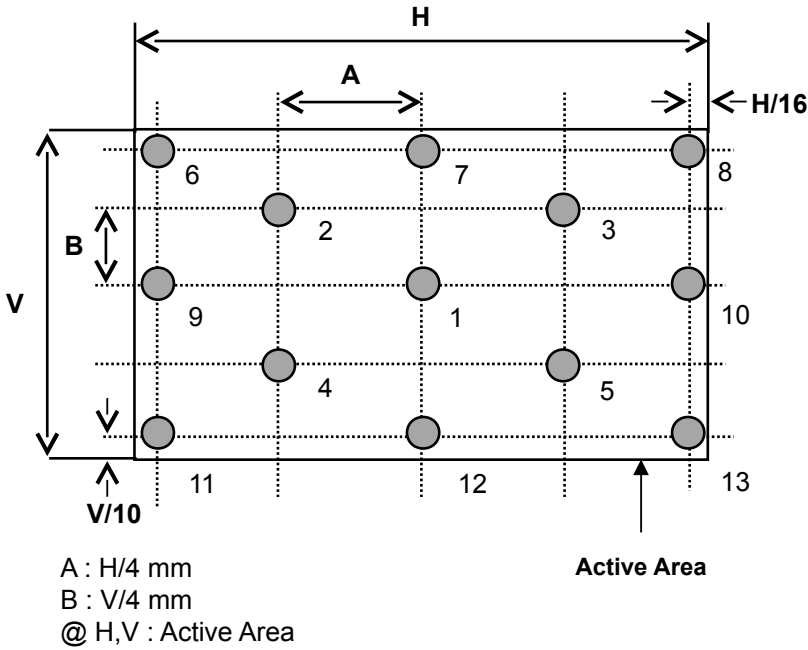


FIG. 2 Measure Point for Luminance

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

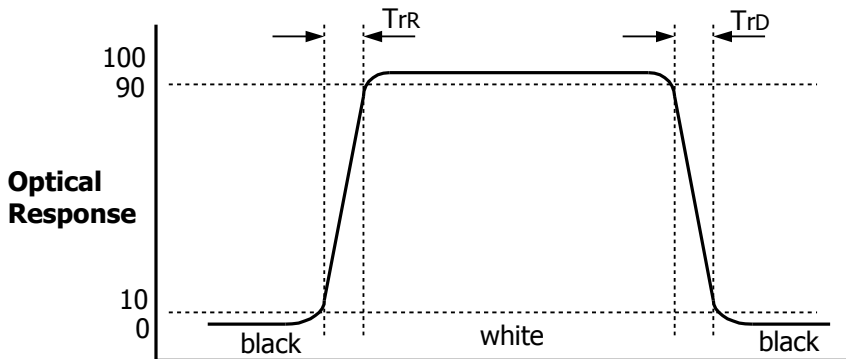


FIG. 3 Response Time

Product Specification

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

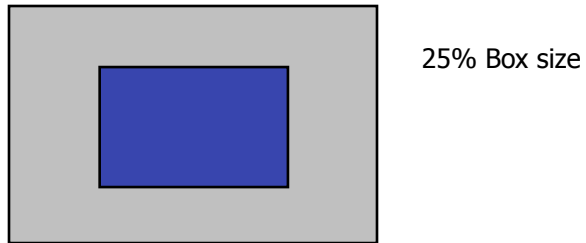


FIG. 4 Test Pattern

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.

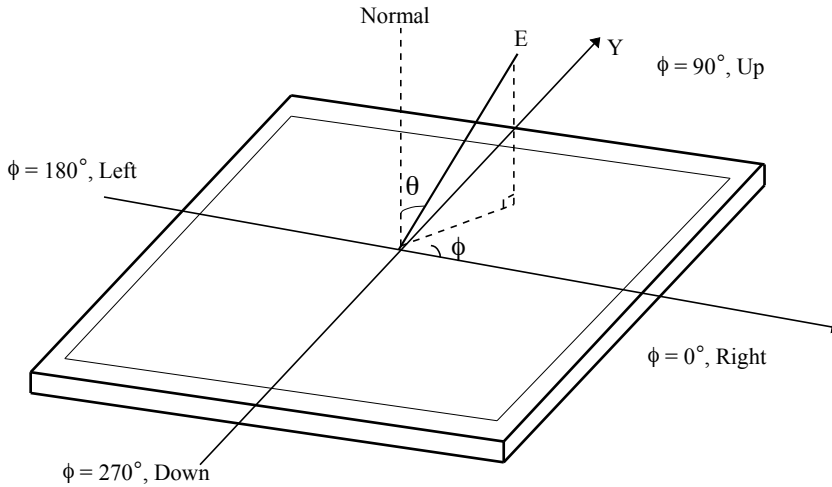


FIG. 5 Viewing angle

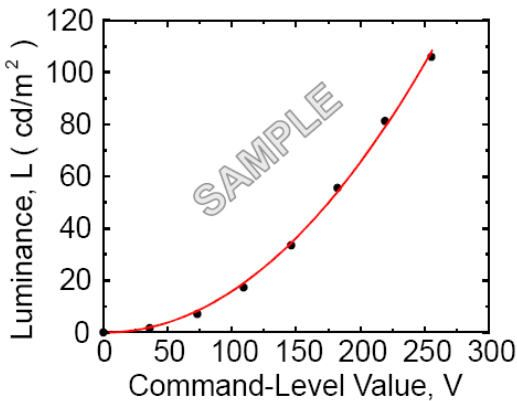


FIG. 6 Sample Luminance vs. gray scale (using a 256 bit gray scale)

$$L = aV^r + L_b$$

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

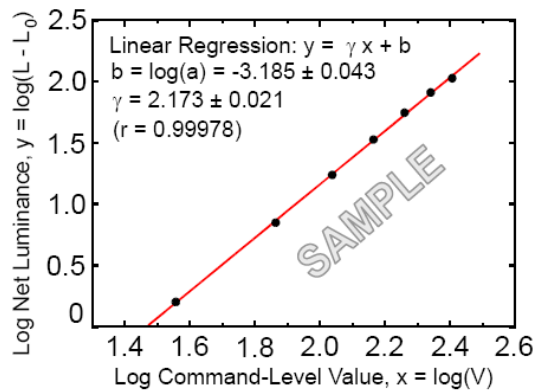


FIG. 7 Sample Log-log plot of luminance vs. gray scale

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

Product Specification

Table 10. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.3
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
5. Mechanical Characteristics

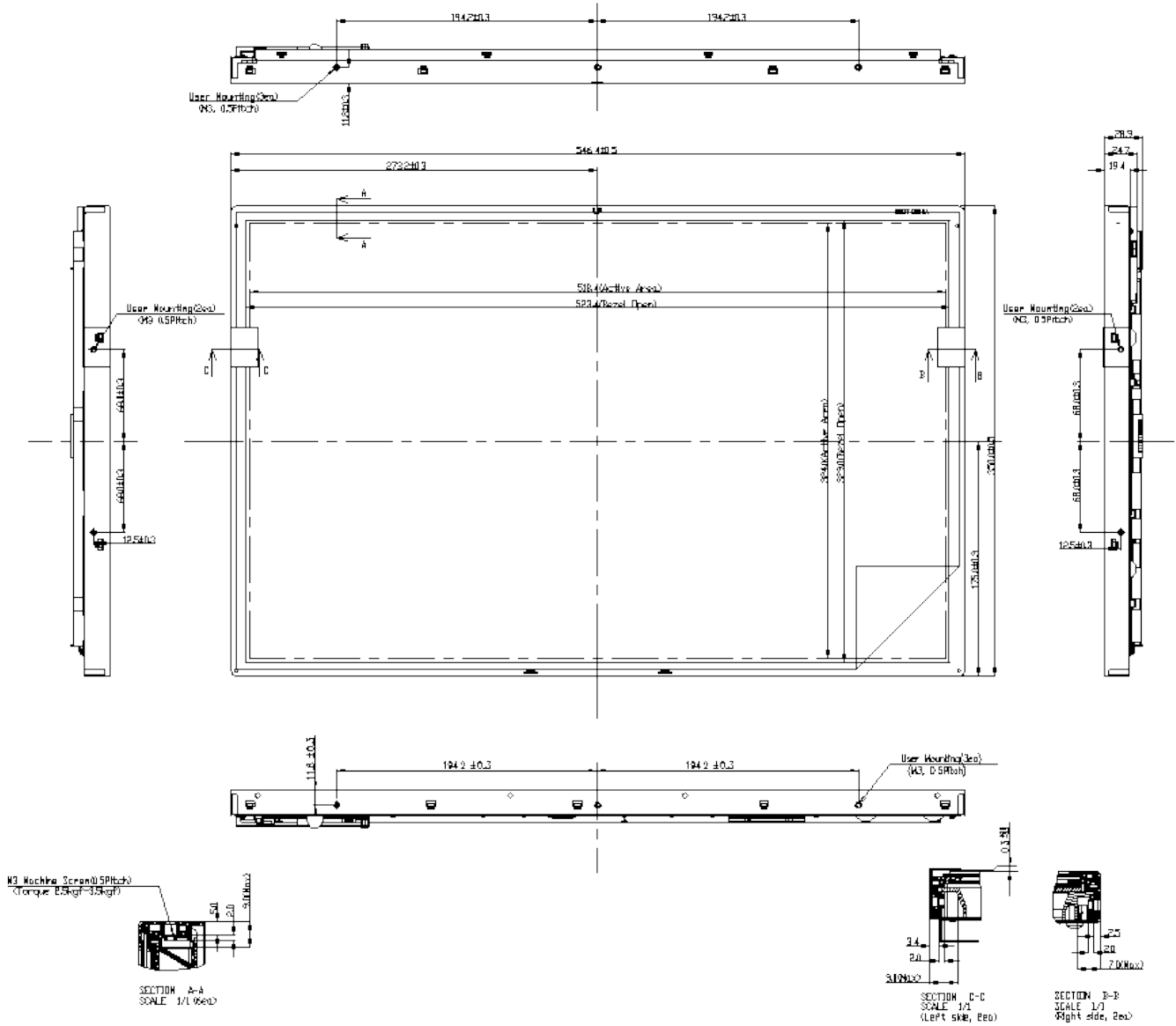
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline Dimension	Horizontal	546.4mm
	Vertical	350.0mm
	Depth	28.9mm
Bezel Area	Horizontal	523.4mm
	Vertical	329.0mm
Active Display Area	Horizontal	518.4mm
	Vertical	324.0mm
Weight	2,650g (Typ.) / 2,800g (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.

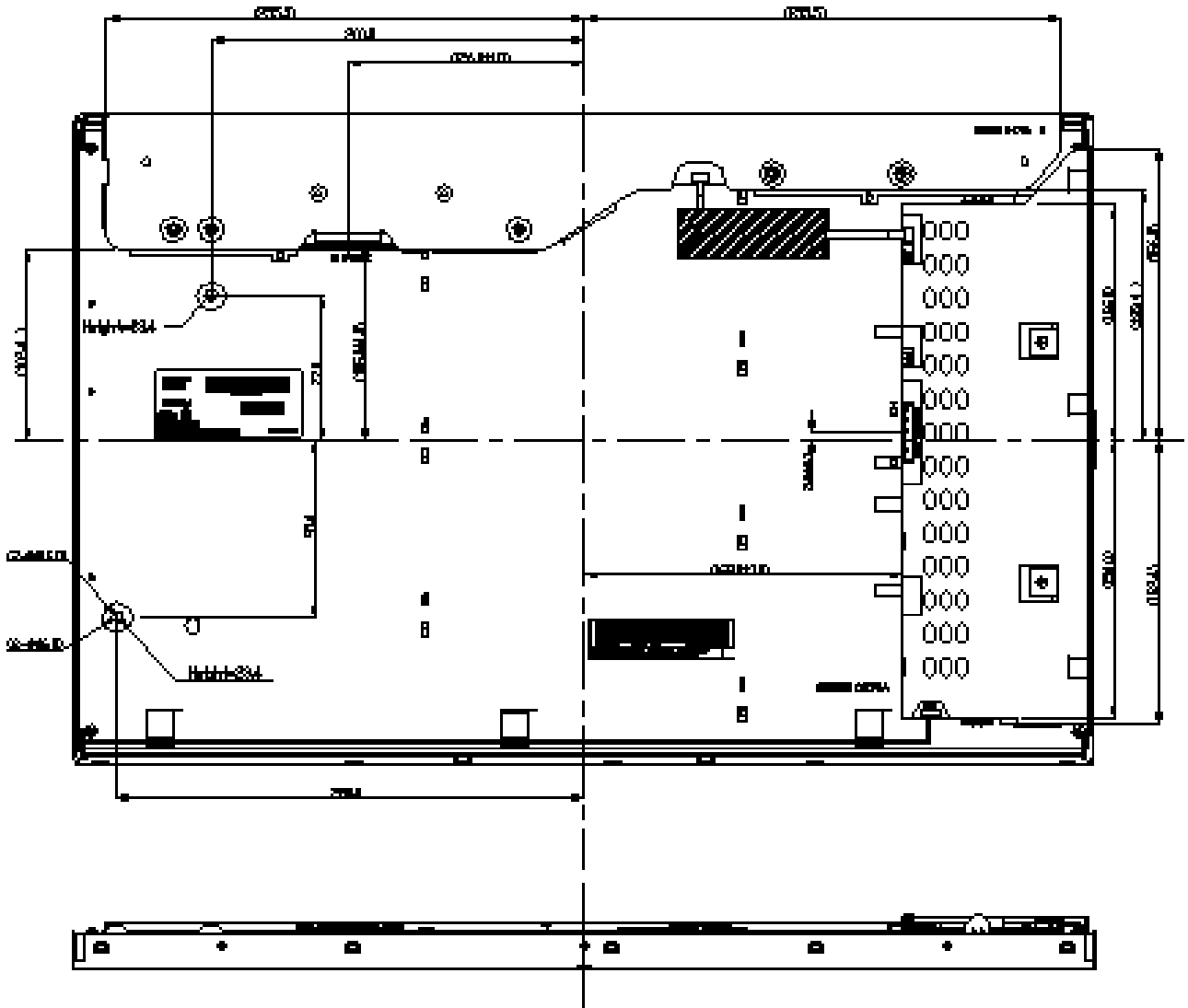
Product Specification

<FRONT VIEW>

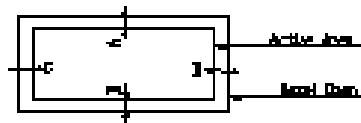


Product Specification

<REAR VIEW>



- Note
- 1 Unspecified tolerances are to be ±0.5mm
 - 2 Both backlight strip and conduction tubes are selected from either direction
 - 3 T1 and parallel disposition tolerance of display area are following
- ⊙ Y-direction (A-B) 0.4mm
 ⊙ X-direction (C-D) 0.4mm



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 : ±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)

7-3. Environment

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

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 : 6EA

b) Box Size : 436X346X613

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 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.

Product Specification
10. EDID DATA FOR LM240WU2-SLB4

Byte# (HEX)	Field Name and Comments	Value (HEX)	Value (binary)	
0	Header	00	00000000	Header
1		FF	11111111	
2		FF	11111111	
3		FF	11111111	
4		FF	11111111	
5		FF	11111111	
6		FF	11111111	
7		00	00000000	
8	EISA Manuf. Code LSB (3 character ID = APP	06	00000110	product ID for LM240WU2-SLB4 = 9C96
9	Compressed ASCII	10	00010000	
0A	Product Code (9C,96)	96	10010110	Vender/ Product ID
0B	Hex, LSB first	9C	10011100	
0C	32-bit serial #	01	00000001	
0D		01	00000001	
0E		01	00000001	
0F		01	00000001	
10	Week of manufacture	00	00000000	
11	Year of manufacture 2008	12	00010010	
12	EDID Structure Ver # = 1	01	00000001	EDID Version/ Revision
13	EDID revision # = 3	03	00000011	Display Parameter
14	Video input definition	80	10000000	
15	Max H image size = 52cm	34	00110100	
16	Max V image size =32cm	20	00100000	
17	Display Gamma = 2.2	78	01111000	
18	Feature support (DPMS) = Active off, RGB color	0A	00001010	
19	Red/Green low Bits	C7	11000111	Color Characteristic
1A	Blue/White Low Bits	74	01110100	
1B	Red X Rx =0.640	A3	10101000	
1C	Red Y Ry =0.340	57	01010010	
1D	Green X Gx =0.290	4A	00110100	
1E	Green Y Gy =0.615	9D	10101001	
1F	Blue X Bx =0.145	25	00100101	
20	Blue Y By =0.070	11	00010001	
21	White X Wx = 0.313	50	01010000	
22	White Y Wy = 0.329	54	01010100	
23	Established timing 1	00	00000000	Established Timings
24	Established timing 2	00	00000000	
25	Manufacturer's timings	10	00010000	kAppleNoncoherentTMDSFlag = 0x10, kAppleCoherentTMDSFlag = 0x08
26	Standard timing #1 was not used	01	00000001	
27		01	00000001	
28	Standard timing #2 was not used	01	00000001	
29		01	00000001	

Product Specification

Byte# (HEX)	Field Name and Comments	Value (HEX)	Value (binary)		
2A	Standard timing #3 was not used	01	00000001	Standard Timing ID	
2B		01	00000001		
2C	Standard timing #4 was not used	01	00000001		
2D		01	00000001		
2E	Standard timing #5 was not used	01	00000001		
2F		01	00000001		
30	Standard timing #6 was not used	01	00000001		
31		01	00000001		
32	Standard timing #7 was not used	01	00000001		
33		01	00000001		
34	Standard timing #8 was not used	01	00000001		
35		01	00000001		
36	Detailed timing/monitor	F0	11110000		Detailed Timing Description #1
37	Pixel Clock = 156 MHz	3C	00111100		
38	Hor active= 1920 pixels	80	10000000		
39	Hor blanking= 160 pixels	A0	10100000		
3A		70	01110000		
3B	Vertical active= 1200 lines	B0	10110000		
3C	Vertical blanking= 45 lines	2D	00101101		
3D		40	01000000		
3E	H sync. Offset= 48 pixels	30	00110000		
3F	H sync. Width= 32 pixels	20	00100000		
40	V sync. Offset= 3 lines	36	00110110		
41	V sync. Width= 6 lines	00	00000000		
42	H image size= 518 mm	06	00000110		
43	V image size = 324 mm	44	01000100		
44		11	00010001		
45	No Horizontal Border	00	00000000	Detailed Timing Description #2	
46	No Vertical Border	00	00000000		
47	Non-interlaced, Normal display, No stereo, Digital separate sync, H/V pol Negatives	1E	00011110		
48	Detailed timing/monitor	00	00000000		
49	descriptor #2	00	00000000		
4A		00	00000000		
4B		01	00000001		
4C	Version	00	00000000		
4D	Apple edid signature	06	00000110		
4E	Apple edid signature	10	00010000		
4F	Link Type (LVDS, Dual Link, MSB)	30	00110000		
50	Pixel and link component format (8bit)	11	00010001		
51	Panel features	01	00000001		
52		00	00000000		
53		00	00000000		
54		00	00000000		
55		00	00000000		
56		00	00000000		
57		00	00000000		
58		0A	00001010		
59		20	00100000		

Product Specification

Byte# (HEX)	Field Name and Comments	Value (HEX)	Value (binary)	
5A	Detailed timing/monitor	00	00000000	Detailed Timing Description #3 Ascii Data String: LM240WU2-SLB4
5B	descriptor #3	00	00000000	
5C	LM240WU2-SLB4	00	00000000	
5D		FE	11111110	
5E		00	00000000	
5F	"L"	4C	01001100	
60	"M"	4D	01001101	
61	"2"	32	00110010	
62	"4"	34	00110100	
63	"0"	30	00110000	
64	"w"	57	01010111	
65	"J"	55	01010101	
66	"2"	32	00110010	
67	"_"	2D	00101101	
68	"S"	53	01010011	
69	"L"	4C	01001100	
6A	"B"	42	01000010	
6B	"4"	34	00110100	
6C	Detailed timing/monitor	00	00000000	Detailed Timing Description #4 Monitor Name: Color LCD
6D	descriptor #4	00	00000000	
6E	Color LCD	00	00000000	
6F		FC	11111100	
70		00	00000000	
71	C	43	01000011	
72	o	6F	01101111	
73	l	6C	01101100	
74	o	6F	01101111	
75	r	72	01110010	
76		20	00100000	
77	L	4C	01001100	
78	C	43	01000011	
79	D	44	01000100	
7A		0A	00001010	
7B		20	00100000	
7C		20	00100000	
7D		20	00100000	
7E	Extension Flag = 00	00	00000000	Extension Flag
7F	Checksum	38	00111000	Checksum