

# SPECIFICATION FOR APPROVAL

(•) Preliminary Specification
 () Final Specification

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Title

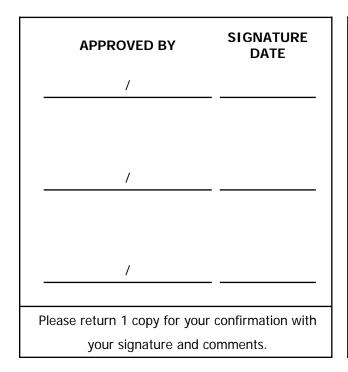
# 24.0" WUXGA TFT LCD

BUYER	APPLE
MODEL	К29

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
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# Product Specification

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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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Devision N	Devision D. J	D	Description
Revision No	Revision Date	Page	Description
0.01	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 Suppy 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	Update Drawing
		34,35,3 6	Update EDID ( Check Sum : 22 $\rightarrow$ 03 )
0.0K	June.24.2008	6	Luminance change 350=>330nit
			HDCP key information add
		20	Luminance spec change
		31	Box size
0.0L	July. 22. 2008	18, 28	Drawing update
		17	T3 min spec change (1ms→0.01ms), Add T10, T11
		11	Delete AUX-power pin function
		6	Power consumption update
0.0M	Aug.8.2008	17	T8 min spec change (1000ms $\rightarrow$ 250ms). T9 min(0 $\rightarrow$ 200ms)
		28	Drawing update
		6,20	Optical spec(Luminance, color cordinate), power consumption update
		20	Aging Time change(30min $\rightarrow$ 120min)
0.0N	Aug.12.2008	17	Power sequence change
0.00	Aug.14.2008	11, 12	Correct the name of 20pin, 30pin CNT
0.0P	Aug.22.2008	25	Gray Scale update.
	Sep.09.2008	6,10	Power consumption update
		10	Life time update
0.0Q	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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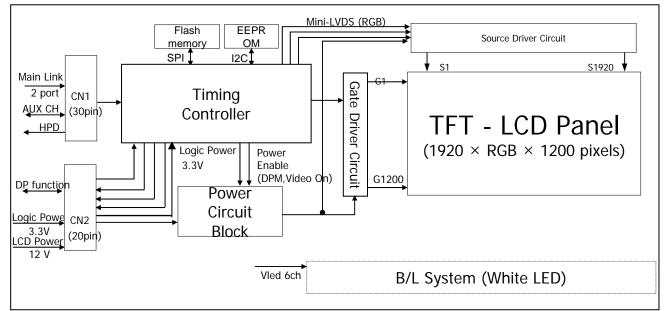


#### **1. General Description**

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**

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



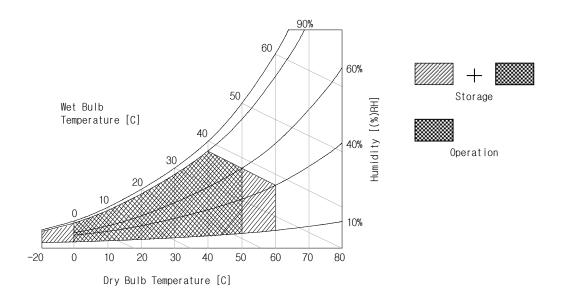
## 2. Absolute Maximum Ratings

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

#### Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Valu	ies	Units	Notes	
Falanietei	Symbol	Min	Max	Units		
Power Input Voltage	VLCD	-0.3	14	Vdc	at 25 $\pm$ 2°C	
Power Input Voltage	VDPLOGIC	-0.5	4	Vdc	at 25 $\pm$ 2°C	
Operating Temperature	Тор	0	50	°C		
Storage Temperature	Tst	-20	60	°C	1	
Operating Ambient Humidity	Нор	10	90	%RH		
Storage Humidity	Нѕт	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.



### **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	Notoc	
Parameter	Symbol	Min	Тур	Max	Unit	Notes
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	А	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	А	3

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

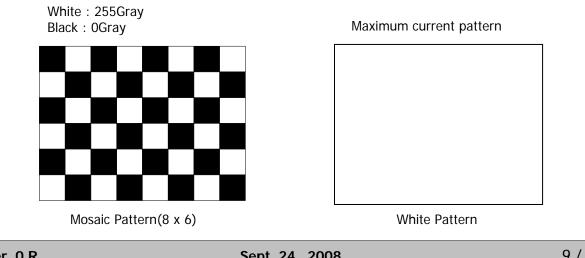
Deremeter	Cumhal		Values	Lineit	Neter	
Parameter	Symbol	Min	Тур	Max	Unit	Notes
DP Logic Input Current	I_DPLOGIC	-	24	60	mA	
DP Logic Power Consumption	P_DPLOGIC	-	80	200	mW	

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

Deremeter	Cumphol		Values	Linit	Netze	
Parameter	Symbol	Min	Тур	Мах	Unit	Notes
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<sub>LCD</sub>=12.0V, 25  $\pm$  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.).



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Parameter	Sumbol	Condition -		Values		Unit	Notes	
Parameter	Symbol		Min.	Тур.	Max.	Unit		
LED :							1,7	
LED String Current	ls		-	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	

#### Table 2-2. LED Bar ELECTRICAL CHARACTERISTICS

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  $25 \pm 2^{\circ}$ 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 PBar = Vs x Is x Nstring Max Power Consumption is calculated with Pbar = Vbar x Is
- 7. LED operating DC Forward Current and Junction Temperature must not exceed LED Max Ratings.



#### **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).





#### **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)



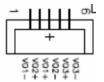


# 3-2-3. Backlight Interface

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

#### Table 5. LED CONNECTOR PIN CONFIGULATION

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.



#### 3-3. Signal Timing Specifications

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

#### Table 6. TIMING TABLE (VESA COORDINATED VIDEO TIMING)

	ITEM	SYMBOL	Min	Тур	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		
	Width-Active	tWH	32	32	32	tCLK	
Vsync	Period	tVP	1233	1235	1237	tHP	
	Frequency	fV	58.85	59.95	61	Hz	
	Width-Active	twv	6	6	6	tHP	
Data	Horizontal Valid	tHV	1920	1920	1920		
Enable	Horizontal Back Porch	thbp	72	80	88	tCLK	
	Horizontal Front Porch	thfp	40	48	56		
	Horizontal Blank	-	152	160	168		twh+ thbp+ thfp
	Vertical Valid	tvv	1200	1200	1200		
	Vertical Back Porch	tVBP	25	26	27		
	Vertical Front Porch	tVFP	2	3	4	tHP	
	Vertical Blank	-	33	35	37		twv+ tvbp+ tvfp

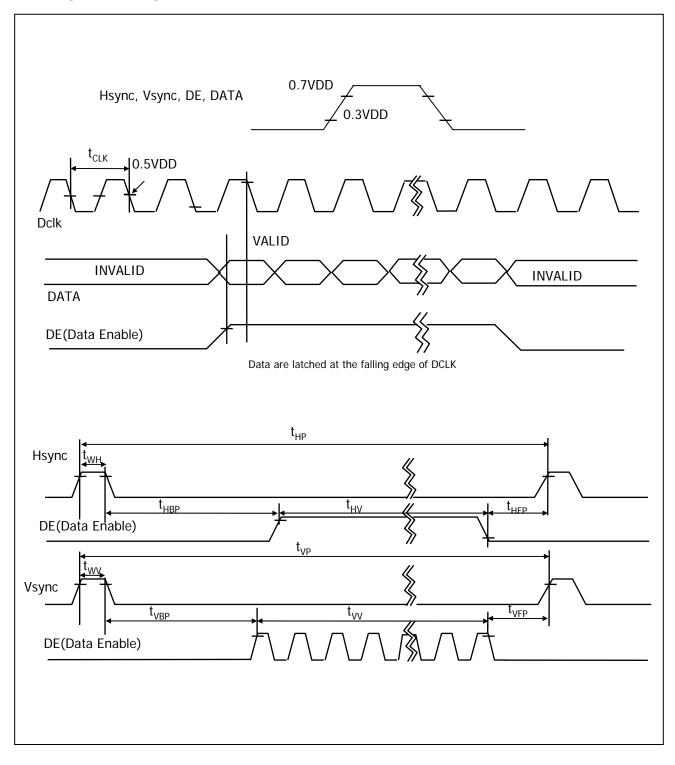
Note: Hsync period and Hsync width-active should be even number times of tCLK. If the value is odd number times of tCLK, display control signal can be asynchronous. In order to operate this LCM a Hsync, Vsyn, and DE(data enable) signals should be used.

- 1. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
- 2. Vsync and Hsync should be keep the above specification.
- 3. Hsync Period, Hsync Width, and Horizontal Back Porch should be any times of 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

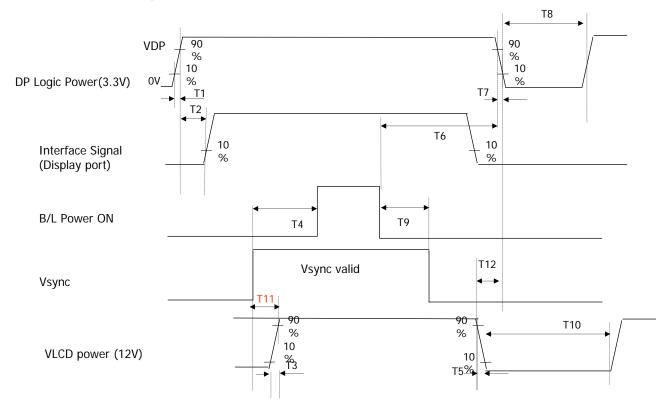
													Inpı	ut Co	olor	Dat	а									
	Color					RE	Đ							GR	EEN							BL	UE			
			MS								MS								MS							SB
									R1																	
	Black		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (255)		1	1	1	1	1	1	1	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)		0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Basic	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
Color	Cyan		0	0	0	0	0	0	0	0		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 (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																										
	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 (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																										
	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 (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																										
	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

Deverenter		Values							
Parameter	Min	Тур	Max	Units					
T1	1.0	-	10	ms					
T2	-	-	-	ms					
Т3	0.01	-	10	ms					
T4	400	-	-	ms					
T5	0.01	-	1000	ms					
T6	0	-	-	ms					
T7	0.01	-	1000	ms					
Т8	250	-	-	ms					
Т9	0	-	-	ms					
T10	250	-	-	ms					
T11	-	-	400	ms					
T12	0	-	-	ms					

Notes : 1. Please avoid floating state of interface signal at invalid period.

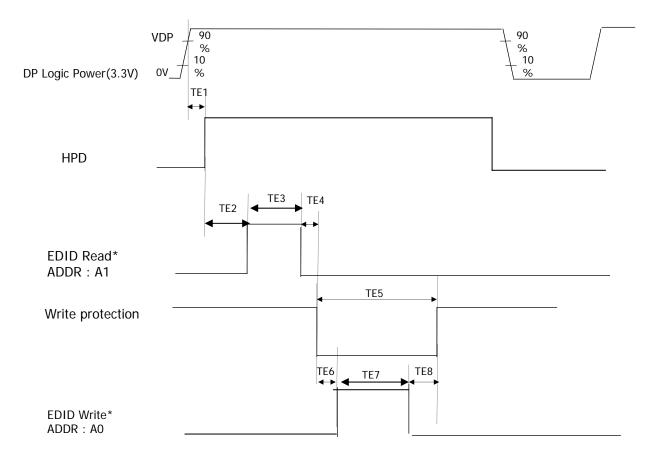
2. When the interface signal is invalid, be sure to pull down the power supply for LCD  $V_{LCD}$  to 0V.

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



#### 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.

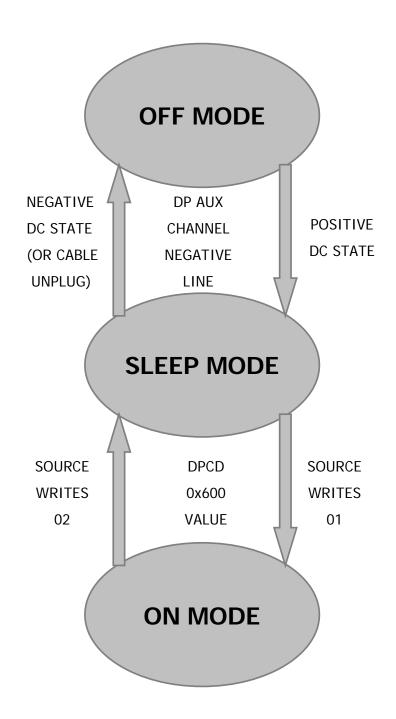
In case of without DP signal after DP logic power on, check HPD after TE1 time and if HPD is low status then any time can read EDID

#### Table 8.1 POWER SEQUENCE, EDID

Decemeter		Unito		
Parameter	Min	Тур	Max	Units
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



# 🕒 LG Display

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## 4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 120 minutes in a dark environment at  $25\pm2^{\circ}$ 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 ° and aperture 1 degree.

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

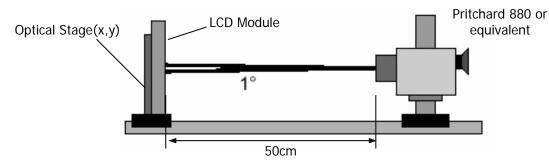


FIG. 1 Optical Characteristic Measurement Equipment and Method

#### Table 9. OPTICAL CHARACTERISTICS

 $(Ta=25 \text{ °C}, V_{LCD}=12.0V, f_V=60Hz \text{ Dclk}=156MHz)$ 

	Parame	tor	Sumbol		Values		Units	Notes	
	Parame	lei	Symbol	Min	Тур	Мах	Units	notes	
Contrast Ratio		CR	700	1000	-		1		
Surface Lur	ninance, v	white	L <sub>WH</sub>	270	320	-	cd/m <sup>2</sup>	2	
Luminance	Variation		δ <sub>WHITE</sub>			30	%	3	
D		Rise Time	Tr <sub>R</sub>	-	6.5	12	ms	4	
Response T	Ime	Decay Time	Tr <sub>D</sub>	-	7.5	12	ms	4	
		RED	Rx		0.654				
			Ry	1	0.333				
		GREEN	Gx	1	0.302				
Color Coord	linates		Gy	Тур	0.616	Тур +0.03			
[CIE1931]		BLUE	Bx	-0.03	0.147				
			Ву		0.053				
		WHITE	Wx		0.313				
			Wy		0.329				
Color Chift		Horizontal	$\theta_{\text{CST}_{\text{H}}}$	-	178	-	Degree	F	
Color Shift		Vertical	$\theta_{CST_V}$	-	178	-	Degree	5	
Viewing Ang	gle (CR>1	0)							
Comorol	Horizo	ntal	θ <sub>H</sub>	170	178	-	Degrae	,	
General	Vertica	l	$\theta_{V}$	170	178	-	Degree	6	
Effective	Horizon	ital	$\theta_{\text{GMA}\_\text{H}}$	1	178	-	Degree	_	
Effective	Vertical		$\theta_{GMA\_V}$	1	178	-	Degree	7	
Gray Scale					2.2			8	

Ver. O.R



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

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

It is measured at center point(Location P1)

- 2. Surface luminance(LwH) 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.  $L_{WH} = = Average[L_{on}1,L_{on}2,L_{on}3,L_{on}4,L_{on}5]$
- 3. The variation in surface luminance ,  $\delta$  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 ( $\Delta u'v'$ )

$$u' = \frac{4x}{-2x + 12y + 3} \qquad v' = \frac{9y}{-2x + 12y + 3}$$
  
$$\Delta u'v' = \sqrt{(u'_1 - u'_2)^2 + (v'_1 - v'_2)^2} \qquad u'1, v'1 : u'v' \text{ value at viewing angle direction} u'2, v'2 : u'v' \text{ value at front } (\Theta = 0)$$

- 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.



 $| \underbrace{\mathsf{H}}_{\mathsf{H}} | \underbrace{\mathsf{H}} | \underbrace{$ 

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

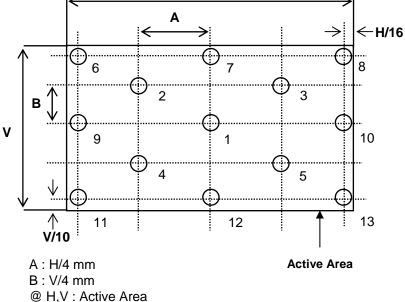


FIG. 2 Measure Point for Luminance

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

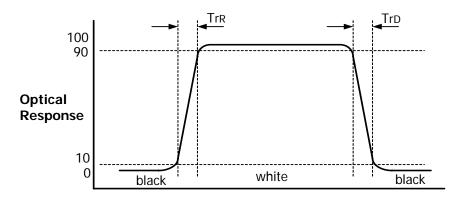
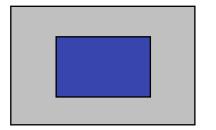


FIG. 3 Response Time



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



25% Box size

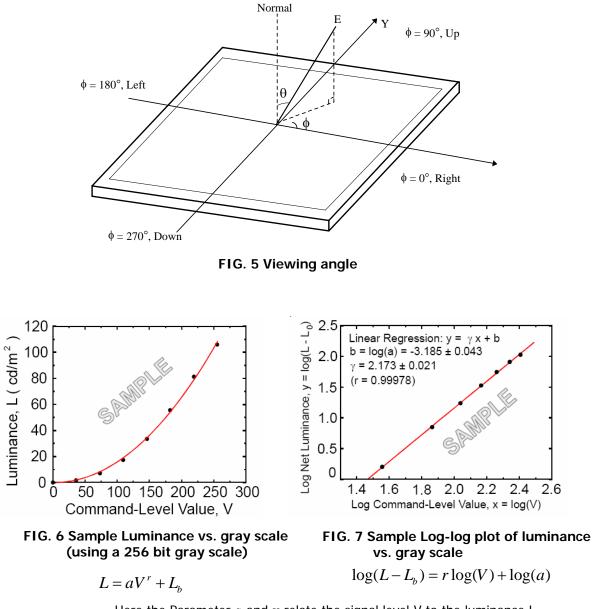
FIG. 4 Test Pattern

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
В	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
В	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
В	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
В	240	206	155	110	63	22



Dimension of viewing angle range.



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)



#### 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



#### 5. Mechanical Characteristics

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

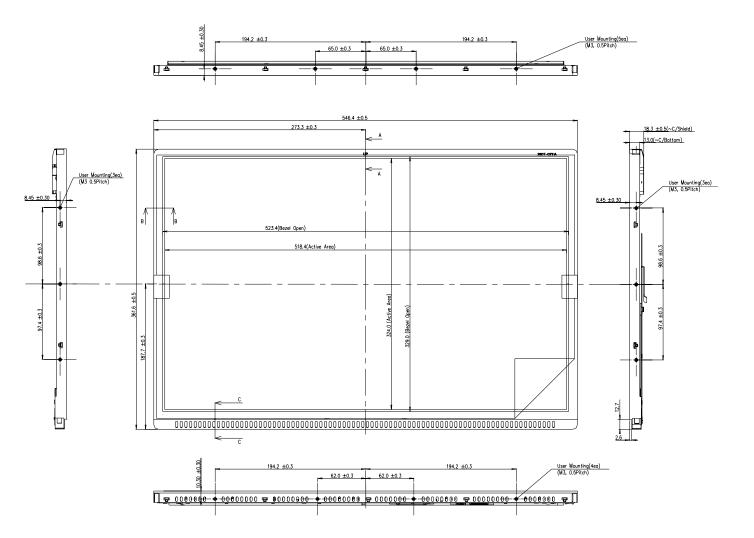
	Horizontal	546.4mm			
Outline Dimension	Vertical	361.6mm			
	Depth	18.3mm(W/O LED Driver)			
Bezel Area	Horizontal	523.4mm			
Bezel Alea	Vertical	329.0mm			
Active Display Area	Horizontal	518.4mm			
Active Display Area	Vertical	324.0mm			
Weight	3500g (Typ.) / 3700g (Max.)				
Surface Treatment	Hard 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>



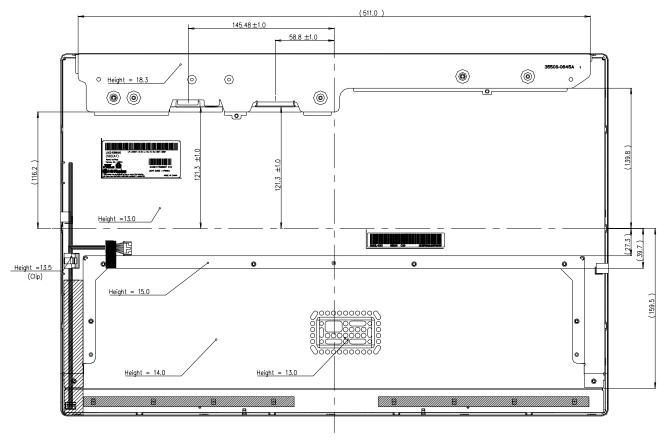
Sept. 24 . 2008

# 🕒 LG Display

#### LM240WU6 Liquid Crystal Display

#### **Product Specification**

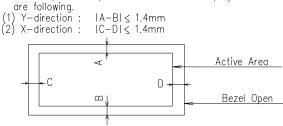
#### <REAR VIEW>



Notes

1. Unspecified tolerances are to be  $\pm 0.5$ mm.

2. Tilt and partial disposition tolerance of display area



- 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:  $0.4\pm0.3$
- 9. LCM Flatness spec : Max 0.5mm
- Measuring method : The gap is less than 0.5 from the flat surface plate to front side.



# 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 : $\pm X$ , $\pm Y$ , $\pm Z$ One time each direction					
7	Altitude Operating Storage / Shipment	0 - 10,000 feet(3,048m) 0 - 40,000 feet(12,192m)					



## 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 1<sup>st</sup> 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)

# 🕒 LG Display

#### **Product Specification**

### 8. Packing

## 8-1. Designation of Lot Mark

a) Lot Mark



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	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	А	В	С

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



## 9. PRECAUTIONS

Please pay attention to the followings when you use this TFT LCD module.

## 9-1. MOUNTING PRECAUTIONS

- (1) You must mount a module using holes arranged in four corners or four sides.
- (2) You should consider the mounting structure so that uneven force (ex. Twisted stress) is not applied to the module. And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
- (3) Please attach the surface transparent protective plate to the surface in order to protect the polarizer. Transparent protective plate should have sufficient strength in order to the resist external force.
- (4) You should adopt radiation structure to satisfy the temperature specification.
- (5) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
- (6) Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment. Do not touch the surface of polarizer for bare hand or greasy cloth. (Some cosmetics are detrimental to the polarizer.)
- (7) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
- (8) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
- (9) Do not open the case because inside circuits do not have sufficient strength.

## 9-2. OPERATING PRECAUTIONS

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

Ver. 0.R



#### 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 ionblown 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#	Byte#		Value	Value	
(decimal)	(HEX)	Field Name and Comments	(HEX)	(binary)	
		Header	00	00000000	
1	1		FF	11111111	
2	2		FF	11111111	
3	3		FF	111111111	Header
4	4		FF	111111111	, includi
5	5		FF	111111111	
6	6		FF	111111111	
7	7		00	000000000	
8	8	EISA Manuf. Code LSB ( 3 character ID = APP	06	00000110	
9	9	Compressed ASCII	10	00010000	
10	0A	Product Code (9C,97)	97	10010111	product ID for LM240WU6-SDA2 = 9C97
10			90	10011100	0x9c97
		Hex, LSB first			
12	OC .	32-bit serial #	01	00000001	Vender/
13	OD		01	00000001	Product ID
14	OE		01	00000001	
15	OF		01	00000001	
16	10	Week of manufacture	00	00000000	
17	11	Year of manufacture 2008	12	00010010	
18		EDID Structure Ver # = 1	01	00000001	EDID Version/
19		EDID revision # = 3	03	00000011	Revision
20		Video input definition	80	10000000	
21		Max H image size = 52cm	34	00110100	Display
22		Max V image size =32cm	20	00100000	Parameter
23		Display Gamma = 2.2	78	01111000	, and hoter
24		Feature support (DPMS) = Active off, RGB color	ÓĂ	00001010	
25		Red/Green low Bits	C7	11000111	
26		Blue/White Low Bits	74	01110100	
27		Red X Rx =0.654	A7	10100111	
28		Red Y Ry =0.332	54	01010100	
29	1D	Green X Gx = 0.304	4D	01001101	Color
30		Green Y Gy = 0.621	9E	10011110	Characteristic
31		Blue X Bx =0.150	 26	00100110	Characteristic
32		Blue Y By =0.050	0 0C	00001100	
33		White X Wx = 0.313	50	01010000	
34		White Y Wy = 0.329	54	010101000	
34		Established timing 1	00	00000000	Established
35		Established timing 2	00	00000000	4
	24	Establisheu timiriy 2			Timings
37	25	Manufacturer's timings	10	00010000	kAppleNoncoherentTMDSFlag = 0x10, kAppleCoherentTMDSFlag = 0x08
38	26	Standard timing #1 was not used	01	00000001	
39	27		01	00000001	
40	28	Standard timing #2 was not used	01	00000001	
41	29		01	00000001	1
42	2A	Standard timing #3 was not used	01	00000001	1
43	2B		01	00000001	1
44	20 20	Standard timing #4 was not used	01	00000001	Standard
45	20 20	טלמועמיע עוווויץ איד יייס דוטג עזפע	01	00000001	
					Timing ID
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	1
	- 55		01	1000001	



# **Product Specification**

		,			
54	36	Detailed timing/monitor	28	00101000	
55	37	Pixel Clock = 154 MHz	3C	00111100	
56		Hor active= 1920 pixels	80	10000000	
57		Hor blanking= 160 pixels	AO	10100000	
58	3A		70	01110000	
59	3B	Vertcal active= 1200 lines	BO	10110000	
60	30	Vertical blanking= 35 lines	23	00100011	Detailed
61	3D		40	01000000	Timina
62		H sync. Offset= 48 pixels	30	00110000	Description
63		H sync, Width= 32 pixels	20	00100000	#1
64		V sync. Offset= 3 lines	36	00110110	*1
65		V sync. Width= 6 lines	00		
66		H image size= 518 mm	06	00000110	
67			44	01000100	
		V image size = 324 mm			
68	44	No. Llovinevetal Daviday	21	00100001	
		No Horizontal Border	00	00000000	
70		No Vertical Border	00	00000000	
71		Non-interlaced, Normal display, No stereo, Digital separate sync, H/V pol Negatives	1A	00011010	
		Detailed timing/monitor	00	00000000	
73	49	descriptor #2	00	00000000	
	4A			00000000	
75	4B		01	00000001	
	4C	Version	00	00000000	
77		Apple edid signature	06	00000110	
78		Apple edid signature	10	00010000	Detailed
79	4F	Link Type (LVDS, Dual Link, MSB)	30	00110000	Timing
80	50	Pixel and link component format (8bit)	11	00010001	Description
81	51	Panel features	01	00000001	#2
82	52		00	00000000	
83	53		00	00000000	
84	54		00	00000000	
85	55		00	00000000	
86	56		00	00000000	
87	57			00000000	
88	58			00001010	
89	59		20	00100000	
90		Detailed timing/monitor	00		
91		descriptor #3	00		
91		LM240WU6-SDA2			
92			FE	111111110	
93	5E		<u>rc</u>		
94	DE 5F	n n	4C	01001100	
95	 60	"M"		01001100	Detailed
			4D		
	61	"2" "4"		00110010	Timing
98	62	"4" "0"	34	00110100	Description
99	63			00110000	#3
100	64	"W"	57	01010111	
101	65	"U"	55	01010101	Ascii Data String:
102	66	"6"	36	00110110	LM240WU6-SDA2
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	
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	0	6F	01101111	Detailed
115	73		6C	01101100	Timing
116	74	0	6F	01101111	Description
117	75	r	72	01110010	#4
118	76		20	00100000	
119	77	L	4C	01001100	Monitor Name:
120	78	C	43	01000011	Color LCD
121	79	D	44	01000100	
122	7A		ΟA	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)

Туре			Нех						
IS24C02B	1	0	1	0	0	0	0	RW	0xA0 + RW

#### - Byte Address

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