



DATA DISPLAY GROUP

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# Datasheet

## DD-Group

**LM240WU8-SLA2-V551B**

**High Bright 550cd/m<sup>2</sup>**

HD-10-512

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## Content

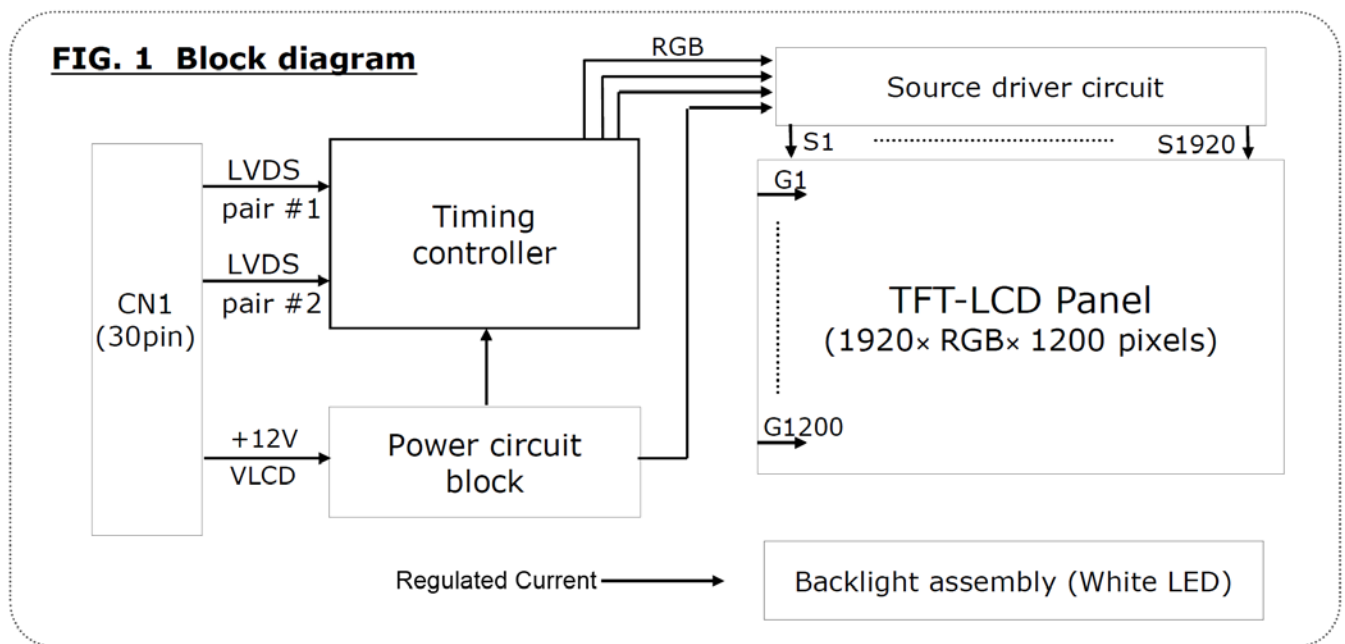
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## Revision History

Version and Date	Page	description
1.0 2012/10/09	All	Preliminary Edition

# 1. General description

LM240WU8-V551B is a Color Active Matrix Liquid Crystal Display with an integral Light Emitting Diode (LED) backlight system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally white mode. It has a 24 inch diagonally measured active display area with WUXGA resolution (1200 vertical by 1920 horizontal pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,7M colors with Advanced-FRC(Frame Rate Control). It has been designed to apply the interface method that enables low power, high speed, low EMI. FPD Link or compatible must be used as a LVDS(Low Voltage Differential Signaling) chip. It is intended to support applications where thin thickness, wide viewing angle, low power are critical factors and graphic displays are important. In combination with the vertical arrangement of the sub-pixels, the LM240WU8's characteristics provide an excellent flat panel display for office automation products such as monitors.



## General features

Active screen size	24.1 inches(61.13cm) diagonal (Aspect ratio 16:10)
Outline Dimension	546.4(H) x 352.0(V) x 14.5(D) mm (Typ.)
Pixel Pitch	0.270 mm x 0.270 mm
Pixel Format	1920 hor. By 1200 Vertical Pixels RGB stripes arrangement
Interface	LVDS 2Port
Color depth	16.7M colors (6bit+A-FRC)
Luminance, white	550 cd/m <sup>2</sup> ( Center 1Point, typ)
Viewing Angle (CR>10)	R/L 178(Typ.), U/D 178(Typ.)
Power Consumption	Total 40.16 Watt (Typ.) ( 5.52Watt @VLCD, 34.64 @LED)
Weight	3700g (typ.)
Display operating mode	Transmissive mode, normally Black
Surface treatments	Hard coating(3H), Anti-Glare treatment of the front polarizer

## 2. Absolut maximum ratings

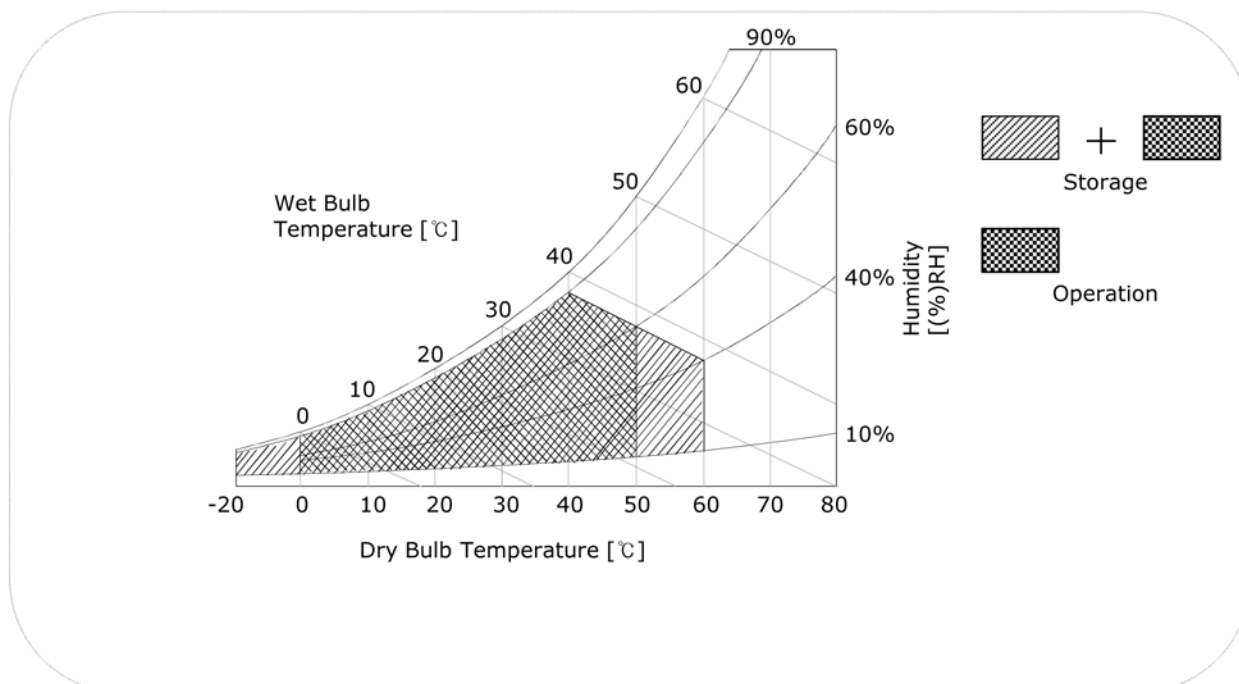
The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table.Absolute maximum ratings

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Supply Input Voltage	$V_{LCD}$	-0.3	+14.0	Vdc	at $25 \pm 2^\circ\text{C}$
Operating Temperature	$T_{OP}$	0	50	$^\circ\text{C}$	1, 2
Storage Temperature	$T_{ST}$	-20	60	$^\circ\text{C}$	
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  $39^\circ\text{C}$  Max, and no condensation of water.  
 2. Storage condition is guaranteed under packing condition  
 3. Storage condition is guaranteed under packing condition

**FIG. 2 Temperature and relative humidity**



### 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 LED Backlight is typically generated by an LED Driver. The LED Driver is an external unit to the LCDs.

**Table Electrical characteristics**

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	$V_{LCD}$	11.4	12.0	12.6	Vdc	
Permissive Power Input Ripple	$V_{LCD}$	-	-	0.4	V	3
Power Supply Input Current	$I_{LCD-MOSAIC}$	391	460	529	mA	1
	$I_{LCD-WHITE}$	553	650	748	mA	2
Power Consumption	$P_{LCD}$	-	5.52	6.67	Watt	1
Inrush current	$I_{RUSH}$	-	-	3.0	A	4

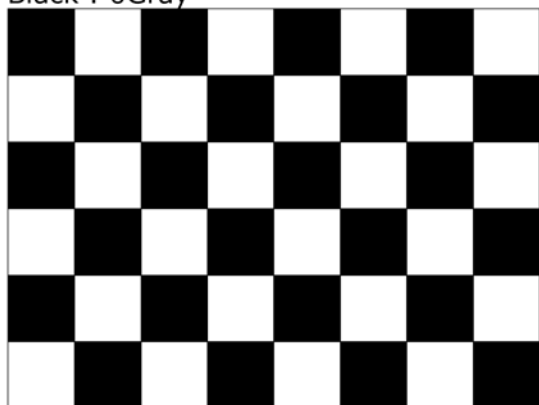
Note :

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. Permissive power ripple should be measured under  $VCC=12.0V$ ,  $25^{\circ}C$ ,  $f_v$  (frame frequency)=Max condition and at that time, we recommend the bandwidth configuration of oscilloscope is to be under 20MHz.
4. The duration of rush current is about 2ms and rising time of power Input is  $500\mu s \pm 20\%$ .

**FIG.3 pattern for Electrical characteristics**

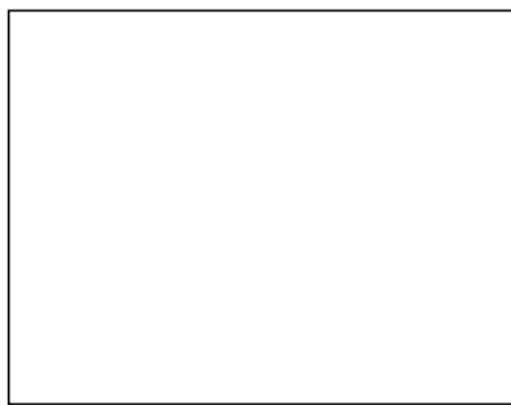
power consumption measurement

White : 255Gray  
Black : 0Gray



Mosaic Pattern(8 x 6)

power input ripple



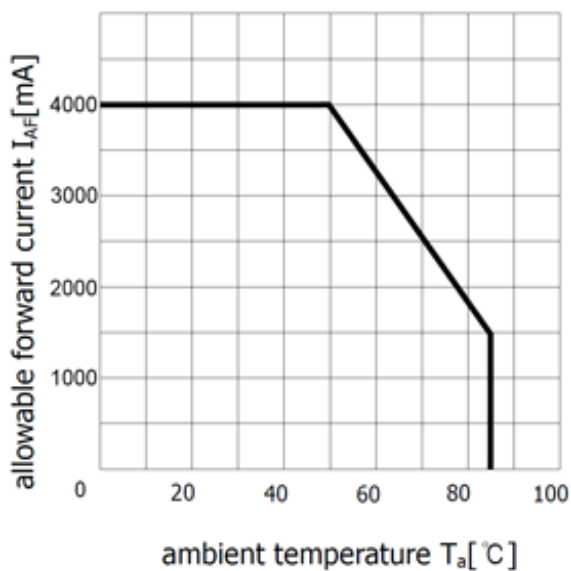
Full White Pattern

### 3.2 Backlight Specification

The backlight consists of one LED rail.

ITEM	SYMBOL	MIN	TYP.	MAX.	UNIT	Remarks
LED Forward Voltage	VL	--	8.66	--	V	*1), IL = 4A
LED Forward Current	IL	--	4000	--	mA	*2)
Power Consumption	WL	--	34.64	--	W	IL = 4A
Backlight Lifetime	BL	50,000	--	--	Hr	*3),*4)

- \*1) VL is specified as the sum of the white LED forward voltages.
- \*2) LEDs are best powered using a constant current source. To avoid chromaticity shifts while dimming use pulse-width modulation (PWM) techniques.
- \*3) Backlight lifetime is defined as the time when brightness becomes 50% of the initial value.
- \*4) The lifetime of the backlight is dependent of the ambient temperature. The lifetime will decrease under temperatures above 80°C unless LED forward current is reduced accordingly.
- \*5) LED forward current derating curve:



6\*) Recommended backlight power supply data

PART NUMBER	MANUFACTURER
2 x SmartLED 2x1.0A 2 x IN-50-001 – analog 2 x IN-51-001 – PWM 3 x Cable CBL-390A	Apollo Display Technologies Corp.

### 3.3 Interface connections

- LCD Connector(CN1) : GT103-30S-H23-D (LSM), KDF71G-30S-1H(Hirose) or Equivalent
- Mating Connector : FI-X30C2L (Manufactured by JAE) or Equivalent

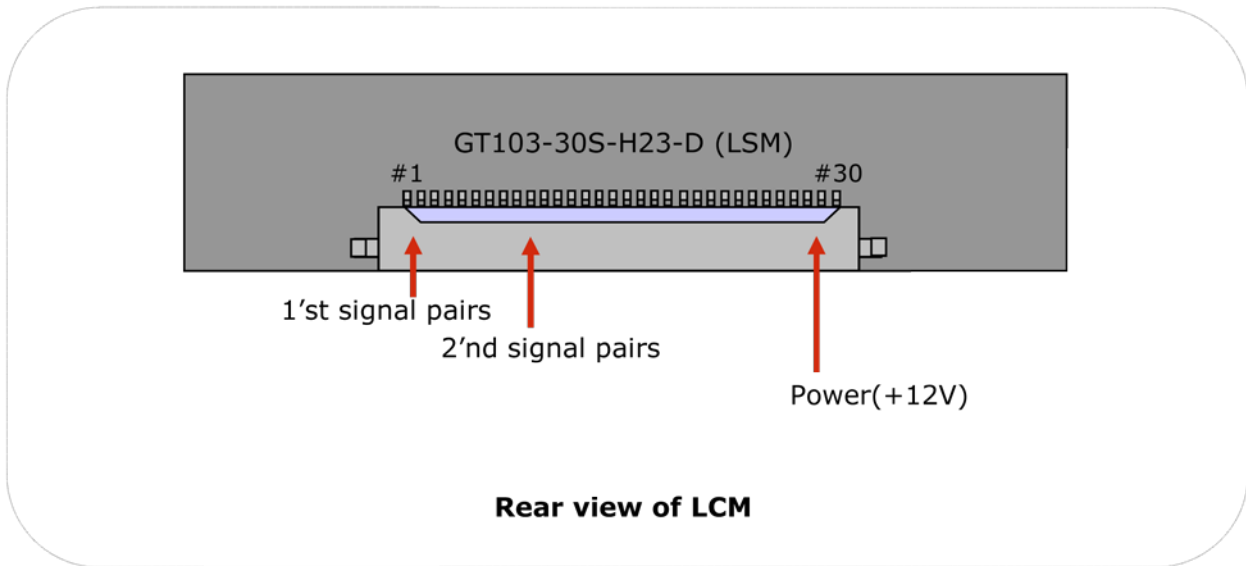
Table Module connector (CN1) pin configuration

Pin No	Symbol	Description
1	RXO0-	Minus signal of 1st channel 0 (LVDS)
2	RXO0+	Plus signal of 1st channel 0 (LVDS)
3	RXO1-	Minus signal of 1st channel 1 (LVDS)
4	RXO1+	Plus signal of 1st channel 1 (LVDS)
5	RXO2-	Minus signal of 1st channel 2 (LVDS)
6	RXO2+	Plus signal of 1st channel 2 (LVDS)
7	GND	Ground
8	RXOC-	Minus signal of 1st clock channel (LVDS)
9	RXOC+	Plus signal of 1st clock channel (LVDS)
10	RXO3-	Minus signal of 1st channel 3 (LVDS)
11	RXO3+	Plus signal of 1st channel 3 (LVDS)
12	RXE0-	Minus signal of 2nd channel 0 (LVDS)
13	RXE0+	Plus signal of 2nd channel 0 (LVDS)
14	GND	Ground
15	RXE1-	Minus signal of 2nd channel 1 (LVDS)
16	RXE1+	Plus signal of 2nd channel 1 (LVDS)
17	GND	Ground
18	RXE2-	Minus signal of 2nd channel 2 (LVDS)
19	RXE2+	Plus signal of 2nd channel 2 (LVDS)
20	RXEC-	Minus signal of 2nd clock channel (LVDS)
21	RXEC+	Plus signal of 2nd clock channel (LVDS)
22	RXE3-	Minus signal of 2nd channel 3 (LVDS)
23	RXE3+	Plus signal of 2nd channel 3 (LVDS)
24	GND	Ground
25	NC	No Connection (For LCD internal use only.)
26	NC	No Connection (For LCD internal use only.)
27	PWM	PWM_OUT for Wavy Noise
28	V <sub>LCD</sub>	Power Supply (12.0V)
29	V <sub>LCD</sub>	Power Supply (12.0V)
30	V <sub>LCD</sub>	Power Supply (12.0V)

First Pixel data

Second Pixel data

**FIG. 4 Connector diagram**



**Note:**

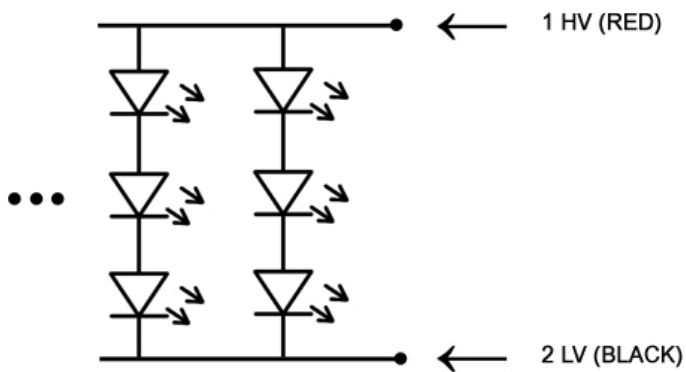
1. NC: No Connection.
2. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.
3. All  $V_{LCD}$  (power input) pins should be connected together.
4. Input Level of LVDS signal is based on the IEA 664 Standard.

### 3.4 LED backlight unit connections

Connector Name / Designation	Lamp Connector
Manufacturer	Molex
Connector Model Number	22-01-3027
Mating Model Number	22-05-3021

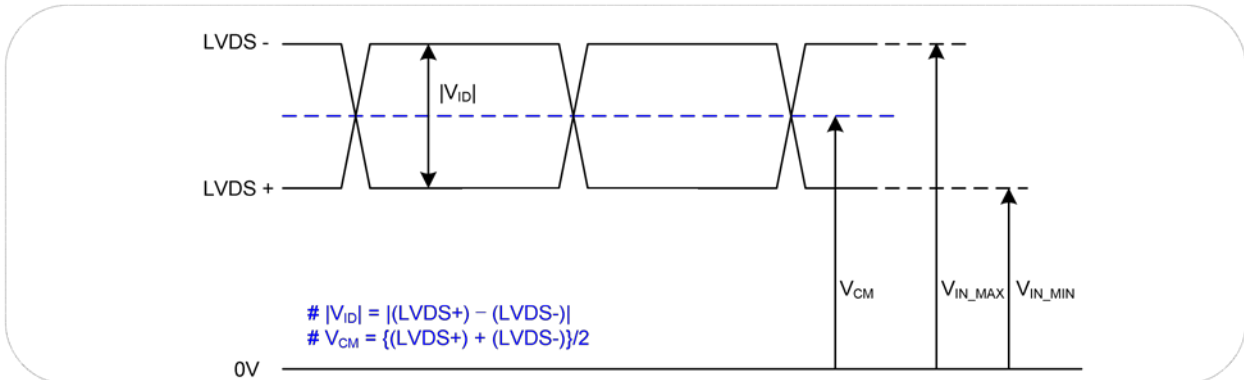
Pin No.	symbol	description	Color
Pin1	HV	Input Power	Red
Pin2	LV	GND	Black

VL = HV – LV



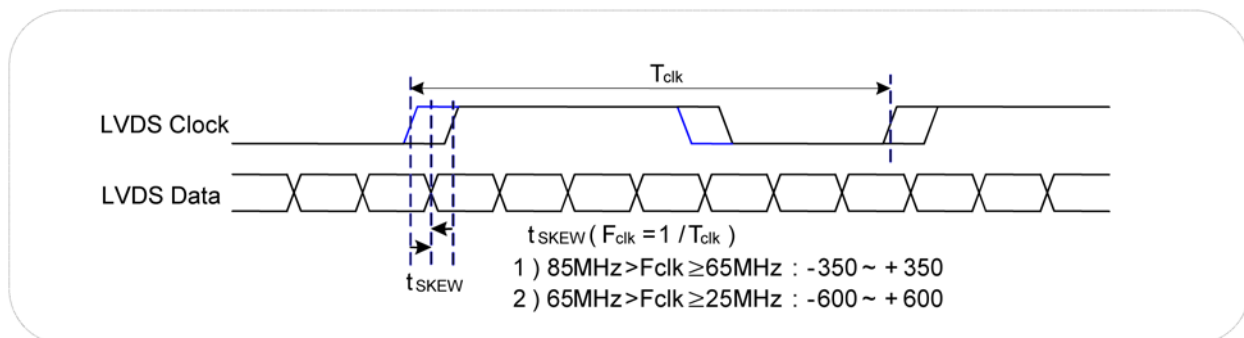
### 3.5 LVDS characteristics

#### 3.5.1 DC Specification



Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$ V_{ID} $	200	600	mV	-
LVDS Common mode Voltage	$V_{CM}$	0.6	1.8	V	-
LVDS Input Voltage Range	$V_{IN}$	0.3	2.1	V	-

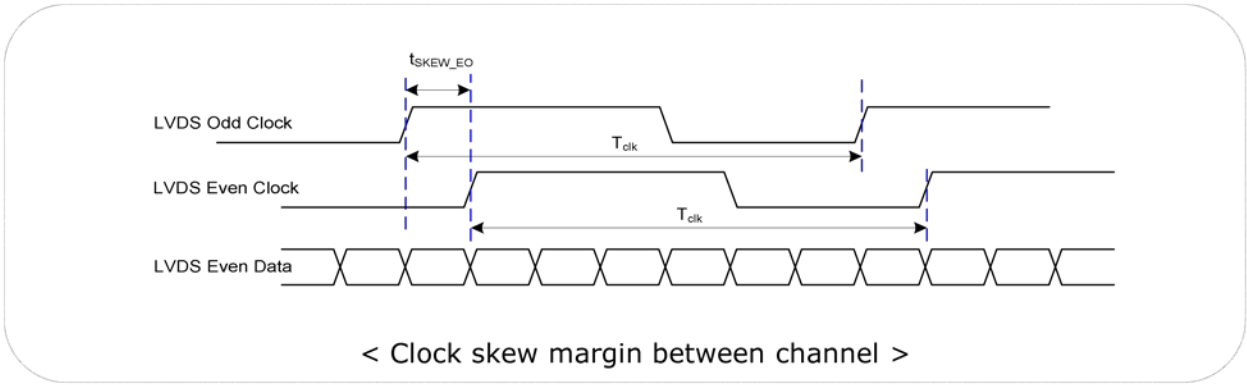
#### 3.5.2 AC Specification



Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	$t_{SKEW}$	- 350	+ 350	ps	$85MHz > F_{clk} \geq 65MHz$
	$t_{SKEW}$	- 600	+ 600	ps	$65MHz > F_{clk} \geq 25MHz$
LVDS Clock to Clock Skew Margin (Even to Odd)	$t_{SKEW\_EO}$	- 1/7	+ 1/7	$T_{clk}$	-

**Note 1:**

These SSC specifications are just T-CON operation specifications. In case of various system conditions, the optimum setting value of SSC can be different. LGD recommend the SI should be adjusted the SSC deviation and modulation frequency in order not to happen any kinds of defect phenomenon.



### 3.5.3 LVDS Data format

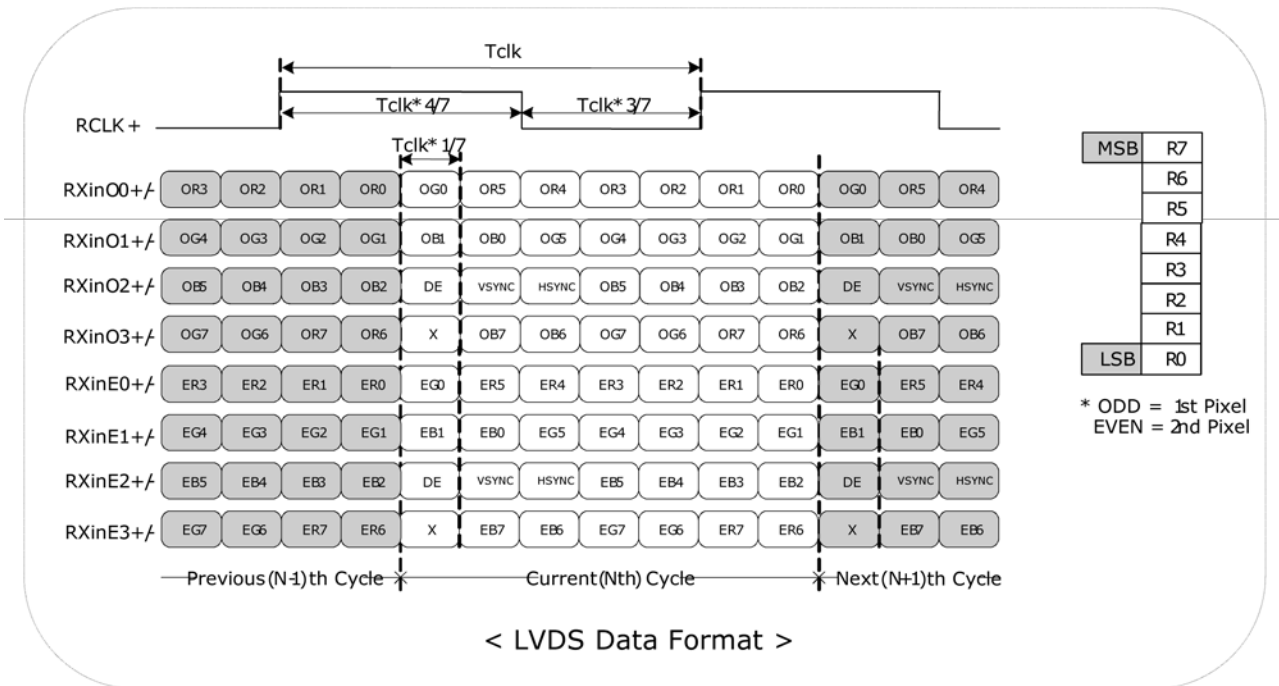


Table Required signal assignment for Flat Link (NS:DS90CF383)transmitter

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 <sub>x</sub> 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	T <sub>x</sub> OUT3 +	Positive LVDS differential data output 3
10	D11	TTL Input (G7)	38	T <sub>x</sub> OUT3 –	Negative LVDS differential data output 3
11	D12	TTL Input (G3)	39	T <sub>x</sub> CLKOUT +	Positive LVDS differential clock output
12	D13	TTL Input (G4)	40	T <sub>x</sub> CLKOUT –	Negative LVDS differential clock output
13	GND	Ground pin for TTL	41	T <sub>x</sub> OUT2 +	Positive LVDS differential data output 2
14	D14	TTL Input (G5)	42	T <sub>x</sub> 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 <sub>x</sub> OUT1 +	Positive LVDS differential data output 1
18	D17	TTL Input (B7)	46	T <sub>x</sub> OUT1 –	Negative LVDS differential data output 1
19	D18	TTL Input (B1)	47	T <sub>x</sub> OUT0 +	Positive LVDS differential data output 0
20	D19	TTL Input (B2)	48	T <sub>x</sub> 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 :
1. Refer to LVDS Transmitter Data Sheet for detail descriptions.
  2. 7 means MSB and 0 means LSB at R,G,B pixel data

### 3.6 Signal Timing specifications

This is the signal timing required at the input of the User connector. All of the interface signal timing should be satisfied with the following specifications for its proper operation.

Table TIMING TABLE (VESA COORDINATED VIDEO TIMING)

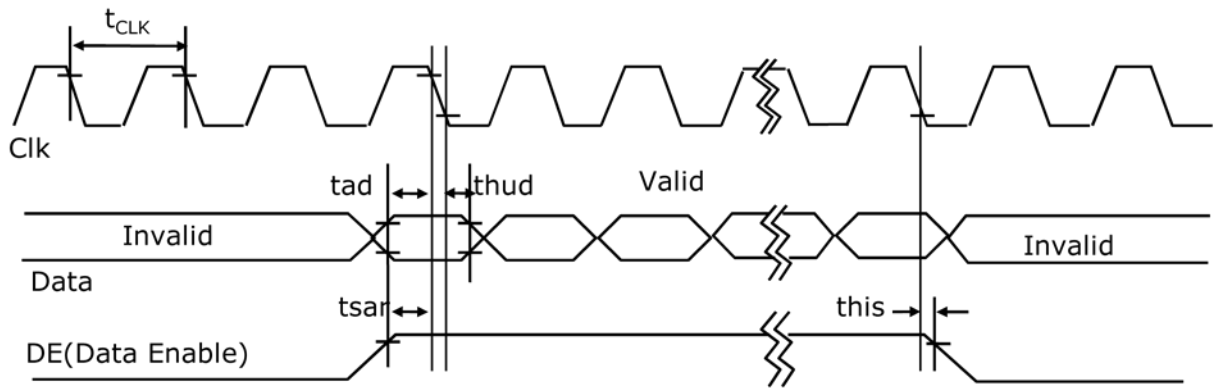
ITEM		SYMBOL	Min	Typ	Max	Unit	Note
DCLK	Period	tCLK	12.82	12.98	13.16	ns	Pixel frequency : Typ. 154MHz
	Frequency	fCLK	76	77	78	MHz	
Hsync	Period	tHP	1036	1040	1044	tCLK	
	Width-Active	tWH	16	16	16		
Vsync	Period	tVP	1233	1235	1237	tHP	
	Frequency	fv	58.85	59.95	61	Hz	
	Width-Active	tWV	6	6	6	tHP	
Data	Horizontal Valid	tHV	960	960	960	tCLK	
	Horizontal Back Porch	tHBP	36	40	44		
	Horizontal Front Porch	tHFP	20	24	28		
	Horizontal Blank	-	76	80	84		
Enable	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		

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.

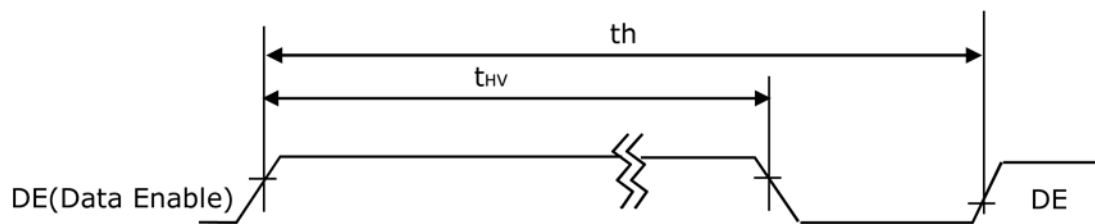
1. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
2. Vsync and Hsync should be keep the above specification.
3. Hsync Period, Hsync Width, and Horizontal Back Porch should be any times of of character number(8).
4. The polarity of Hsync, Vsync is not restricted.

### 3.7 Signal timing wave forms

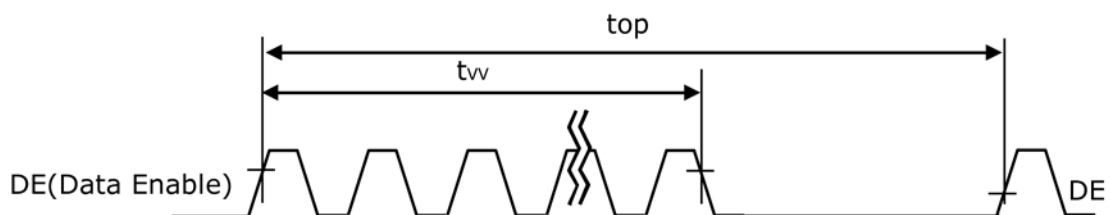
#### 1. D<sub>CLK</sub> , DE, DATA waveforms



#### 2. Horizontal waveform



#### 3. Vertical waveform



### 3.8 Color input data reference

The brightness of each primary color (red, green and blue) is based on the 8bit 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. 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(002)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Red(253)	1	1	1	1	1	1	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) Bright	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(002)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Green(253)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	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)Bright	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(002)	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(253)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	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) Bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

### 3.9 Power sequence

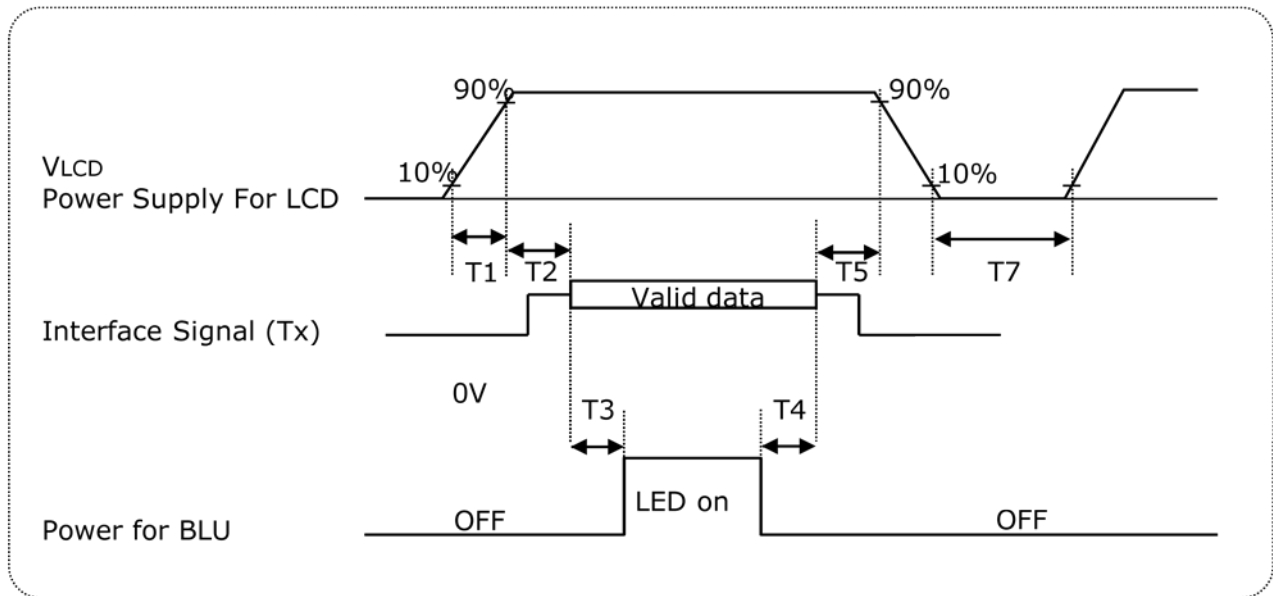


Table. Power sequence

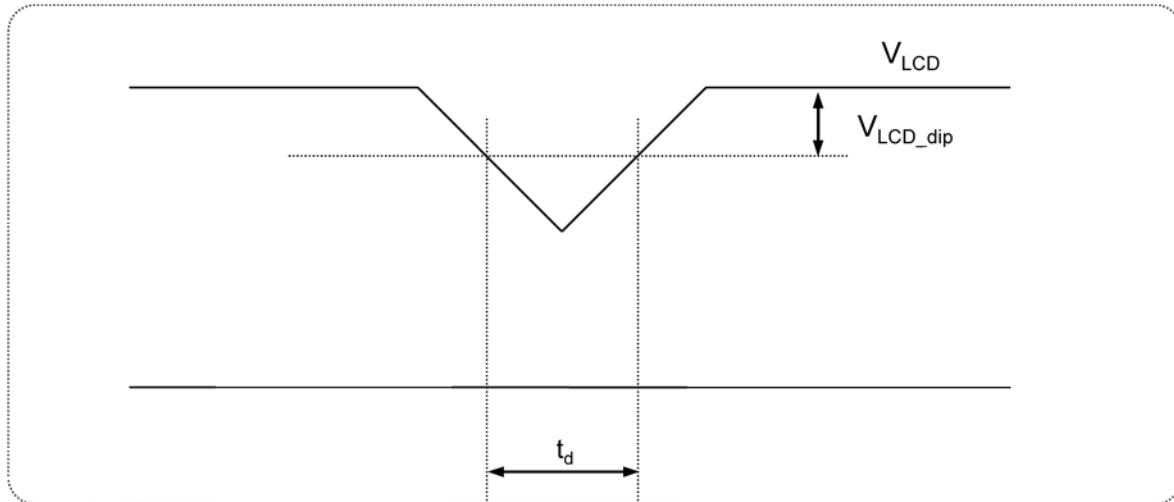
Parameter	Values			Units
	Min	Typ	Max	
T1	0.5	-	10	ms
T2	0.01	-	50	ms
T3	200	-	-	ms
T4	200	-	-	ms
T5	0.01	-	50	ms
T7	1	-	-	s

Notes :

1. Please  $V_{LCD}$  power on only after connecting interface cable to LCD.
2. Please avoid floating state of interface signal at invalid period.
3. When the interface signal is invalid, be sure to pull down the power supply for LCD  $V_{LCD}$  to 0V.
4. Lamp power must be turn on after power supply for LCD an interface signal are valid.

### 3.10 $V_{LCD}$ Power dip condition

**FIG. Power dip condition**



Dip condition

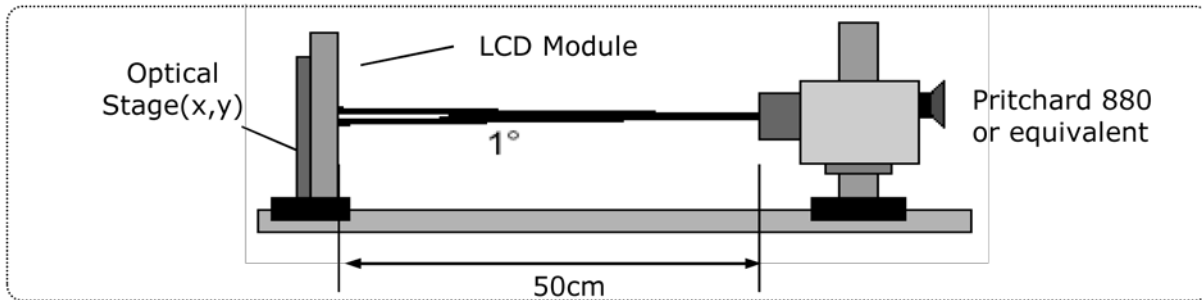
$$V_{LCD\_dip} \leq V_{LCD\_typ} \times 0.2, \quad t_d \leq 20ms$$

## 4. Optical specifications

Optical characteristics are determined after the unit has been 'ON' for 30 minutes in a dark environment at 25°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°.

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

**FIG. Optical characteristic measurement equipment and method**



**Table. Optical characteristics**

$T_a = 25^\circ\text{C}$ ,  $V_{\text{LCD}} = 12.0\text{V}$ ,  $f_v = 60\text{Hz}$ ,  $D_{\text{CLK}} = 154\text{MHz}$ ,  $I_s = 4\text{A}$

Parameter	Symbol	Values			Units	Notes	
		Min	Typ	Max			
Contrast Ratio	CR	700	1000			1	
Surface Luminance, white	$L_{\text{WH}}$	500	550		cd/m <sup>2</sup>	2	
Luminance Variation	$\delta_{\text{WHITE}}$	75			%	3	
Response Time	Gray to Gray	$T_{\text{GTG\_AVR}}$	14	28	ms	4	
Color Coordinates [CIE1931] (By PR650)	RED	$R_x$		0.640			
		$R_y$		0.331			
	GREEN	$G_x$		0.314			
		$G_y$	Typ	0.618	Typ		
	BLUE	$B_x$	-0.03	0.152	+0.03		
		$B_y$		0.071			
	WHITE	$W_x$		0.313			
	$W_y$		0.329				
Color Shift (Avg. $\Delta u'v' < 0.02$ )	Horizontal	$\theta_{\text{CST\_H}}$	-	140	-	Degree	5
	Vertical	$\theta_{\text{CST\_V}}$	-	100	-		
Viewing Angle (CR>10)							
General	Horizontal	$\theta_{\text{H}}$	170	178	-	Degree	6
	Vertical	$\theta_{\text{V}}$	170	178	-		
GSR @ 60degree (Gamma shift rate)	Horizontal	$\delta_{\text{Gamma\_H}}$	-	-	20	%	7
	Vertical	$\delta_{\text{Gamma\_V}}$	-	-	20		
Gray Scale			2.2			8	

Notes 1. Contrast Ratio(CR) is defined mathematically as : (By PR880)

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

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 7. (By PR880)

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

3. The variation in surface luminance,  $\delta$  WHITE is defined as : (By PR880)

$$\delta_{WHITE} = \frac{\text{Minimum}(L_{P1}, L_{P2}, \dots, L_{P9})}{\text{Maximum}(L_{P1}, L_{P2}, \dots, L_{P9})} \times 100$$

Where L1 to L9 are the luminance with all pixels displaying white at 9 locations.  
For more information see FIG 8.

4. Gray to gray response time is the time required for the display to transition from gray to gray. For additional information see Table 10. (By RD80S)

5. Color shift is the angle at which the average color difference for all Macbeth is lower than 0.02. For more information see FIG 9. (By EZ Contrast)

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

$$u' = \frac{4x}{-2x + 12y + 3} \quad v' = \frac{9y}{-2x + 12y + 3} \quad \Delta u'v' = \sqrt{(u'_1 - u'_2)^2 + (v'_1 - v'_2)^2}$$

$$\text{Avg}(\Delta u'v') = \frac{\sum_{i=1}^{24} (\Delta u'v')_i}{24}$$

$u'_1, v'_1$  :  $u'v'$  value at viewing angle direction  
 $u'_2, v'_2$  :  $u'v'$  value at front ( $\theta=0$ )  
 $i$  : Macbeth chart number (Define 22 page)

- 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 10. (By PR880)

7. GSR is the rate of gamma shift at up, down, left and right 60 degree viewing angle compare with center gamma. For more information see FIG 11 and FIG 12 (By EZ Contrast)

- GSR ( $\delta_{Gamma}$ ) is defined as :

$$\text{GSR} = \frac{\text{View angle Gamma Value (Up, Down, Reft, Light 60 Degree)}}{\text{Center Gamma Value (0 Degree)}} \times 100$$

Notes 8. Gray scale specification  
Gamma Value is approximately 2.2. For more information see Table 11.

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

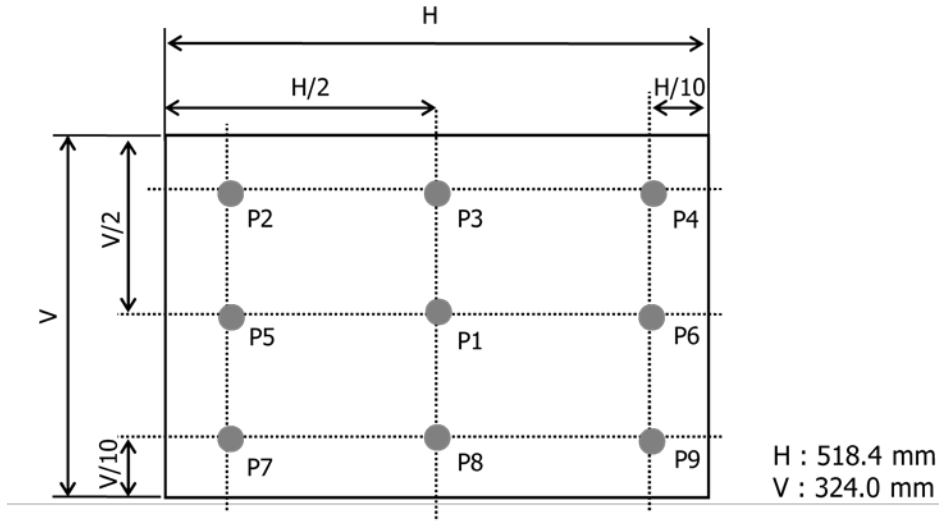


FIG. 8 Measure Point for Luminance

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

- Gray step : 5 step
- $T_{GTG\_AVR}$  is the total average time at rising time and falling time for “Gray To Gray”.
- In case of the difference in measured values due to the difference of measuring device or program was found, correlated value will be used after discussions between both parties.

Table 10. Gray to gray response time table

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

Dimension of viewing angle range.

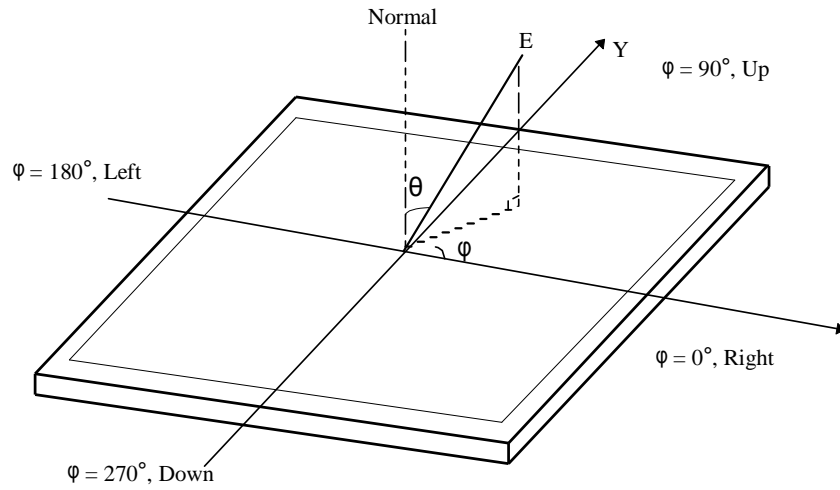


FIG. 10 Viewing angle

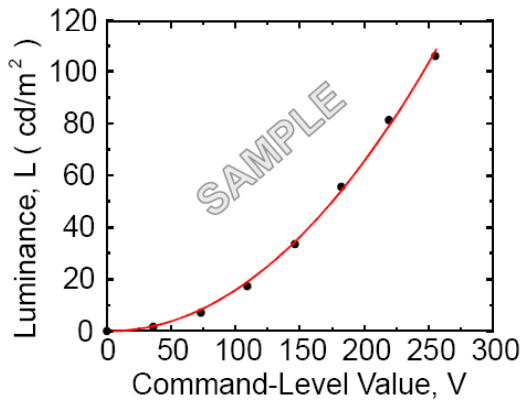


FIG. 11 Sample Luminance vs. gray scale (using a 256 bit gray scale)

$$L = aV^r + L_b$$

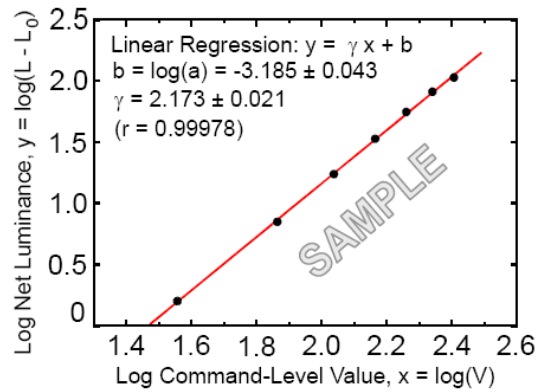


FIG. 12 Sample Log-log plot of luminance vs. gray scale

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

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. 11)

Table 11. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.1
31	1.2
63	4.7
95	11.7
127	21.2
159	35.2
191	53.0
223	75.4
255	100

## 5. Mechanical characteristics

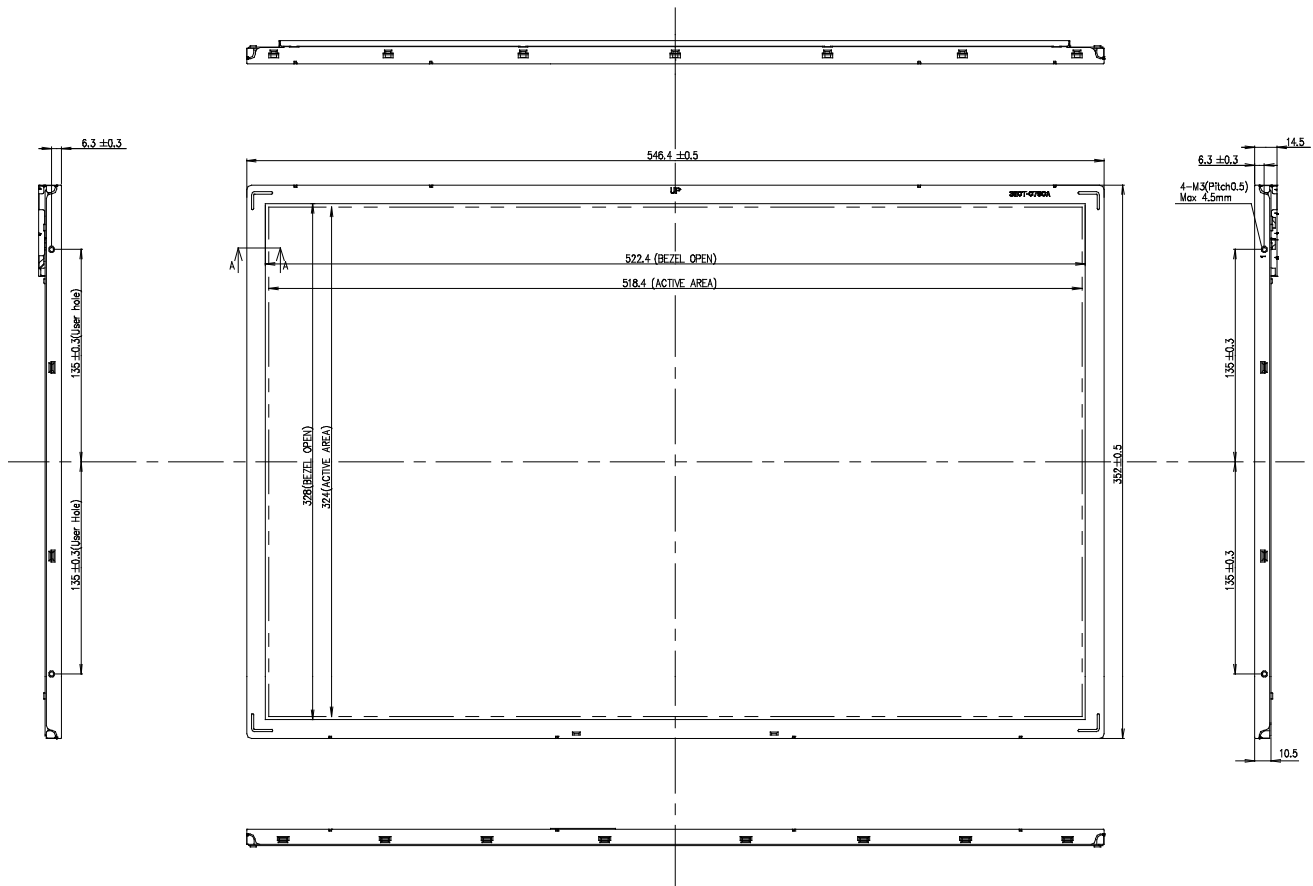
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Table.Mechanical characteristics

Outline dimension	Horizontal	546.4mm
	Vertical	352.0mm
	Depth	14.5 mm
Bezel area	Horizontal	522.4mm
	Vertical	328.0mm
Active display area	Horizontal	518.4mm
	Vertical	324.0mm
Weight	3700g (Typ.), 3820g (Max.)	
Surface treatment	Hard coating(3H) Anti-Glare treatment of the front polarizer	

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

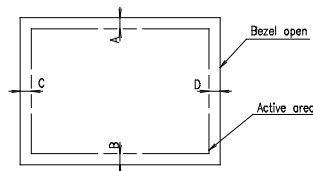
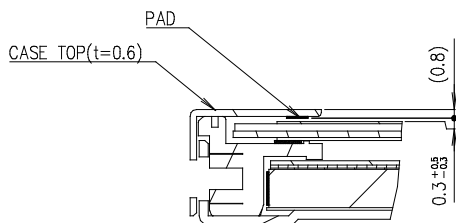
### 5.1. Front view



Notes

1. I/F connector specification : GT103-30S-H23 (LSC)
2. LED connector specification : 10019HR-06PIN
3. Torque of user hole : 2.5~3.5kgf-cm.
4. Tilt and partial disposition tolerance of display area as following

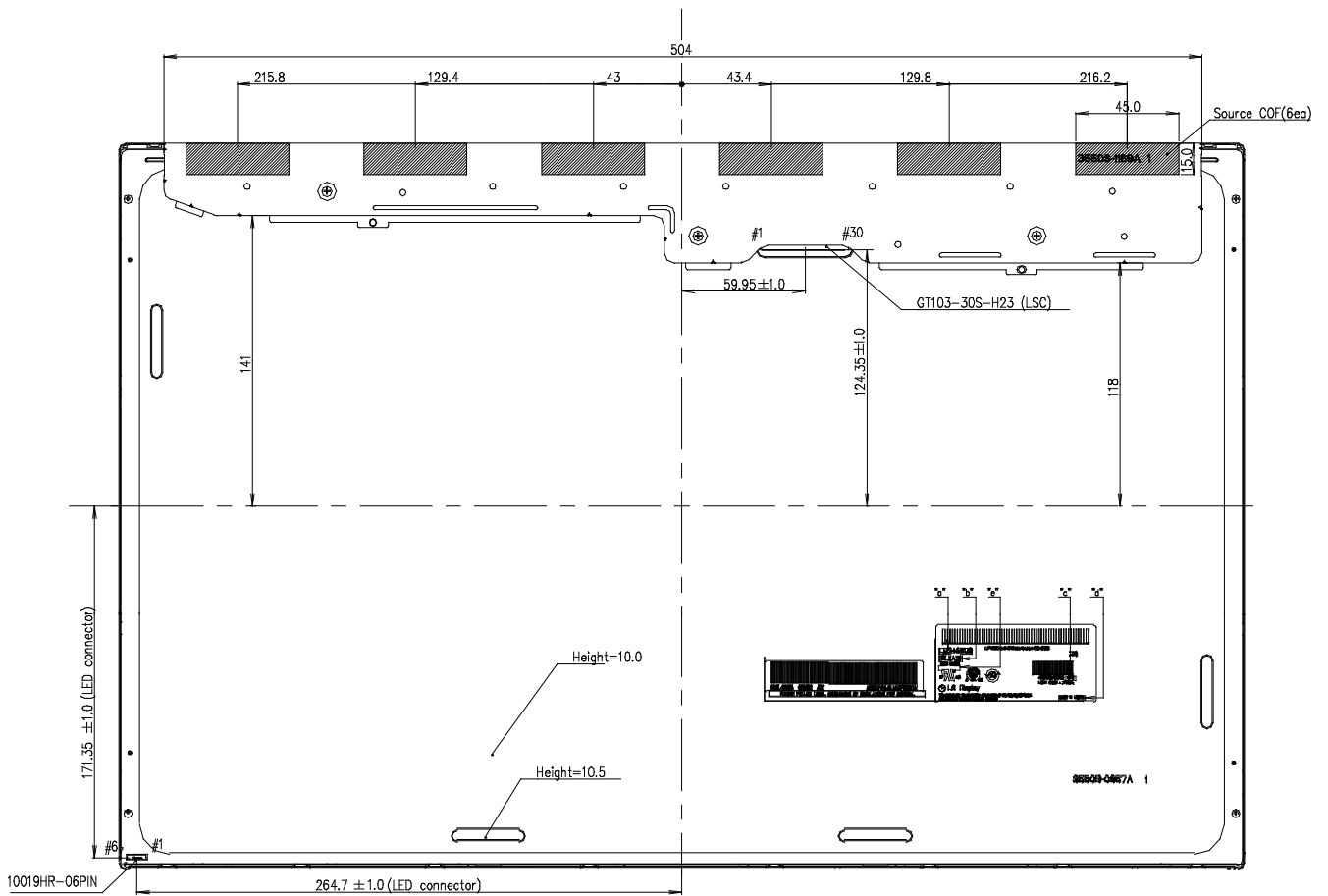
- (1) Y-direction : |A-B| ≤ 1.4
- (2) X-direction : |C-D| ≤ 1.4



5. Unspecified tolerances to be ± 0.5mm
6. The COF area is weak & sensitive, so please don't press the COF area

PAD Thickness: 0.2mm (+0.05/0)

## 5.2. Rear view



## 6. Reliability

Table.Environment test conditions

No	Test Item	Condition
1	High temperature storage test	Ta= 60℃ 240h
2	Low temperature storage test	Ta= -20℃ 240h
3	High temperature operation test	Ta= 50℃ 50%RH 240h
4	Low temperature operation test	Ta= 0℃ 240h
5	Vibration test (non-operating)	Wave form : random Vibration level : 1.0G RMS Bandwidth : 10-300Hz Duration : X,Y,Z, 10 min One time each direction
6	Shock test (non-operating)	Shock level : 100G Waveform : half sine wave, 2ms Direction : ± X, ± Y, ± Z One time each direction
7	Humidity condition Operation	Ta= 40 °C ,90%RH
8	Altitude storage / shipment	0 - 40,000 feet(12192m)
9	Maximum Storage Humidity for 4 corner light leakage Mura.	Max 70%RH , Ta=40℃

{Result evaluation criteria}

There should be no change which might affect the practical display function when the display quality test is conducted under normal operating condition.

## 7. International standards

### 7.1. Safety

- a) UL 60950-1, Second Edition, Underwriters Laboratories Inc.  
Information Technology Equipment - Safety - Part 1 : General Requirements.
- b) CAN/CSA C22.2 No.60950-1-07, Second Edition, Canadian Standards Association.  
Information Technology Equipment - Safety - Part 1 : General Requirements.
- c) EN 60950-1:2006 + A11:2009, European Committee for Electrotechnical Standardization (CENELEC).  
Information Technology Equipment - Safety - Part 1 : General Requirements.
- d) IEC 60950-1:2005, Second Edition, The International Electrotechnical Commission (IEC).  
Information Technology Equipment - Safety - Part 1 : General Requirements.  
(Including report of IEC60825-1:2001 clause 8 and clause 9)

#### Notes

- 1. Laser (LED Backlight) Information

Class 1M LED Product IEC60825-1 : 2001 Embedded LED Power (Class1M)
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- 2. Caution  
: LED inside.  
Class 1M laser (LEDs) radiation when open.  
Do not open while operating.

### 7.2. EMC

- a) ANSI C63.4 "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."  
American National Standards Institute (ANSI), 2003.
- b) CISPR 22 "Information technology equipment – Radio disturbance characteristics – Limit and methods of measurement." International Special Committee on Radio Interference (CISPR), 2005.
- c) CISPR 13 "Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and method of measurement." International Special Committee on Radio Interference (CISPR), 2006.

### 7-3. Environment

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

## 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	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mark	A	B	C	D	E	F	G	H	J	K

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 : 8pcs

b) Box size : 408mm X 355mm X 600mm

## 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 not be operated its full characteristics perfectly.
- (8) A screw which is fastened up the steels should be a machine screw (if not, it causes metal foreign material and deal LCM a fatal blow)
- (9) Please do not set LCD on its edge.
- (10) When LCMs are used for public display defects such as Yogure, image sticking can not be guarantee.

### 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

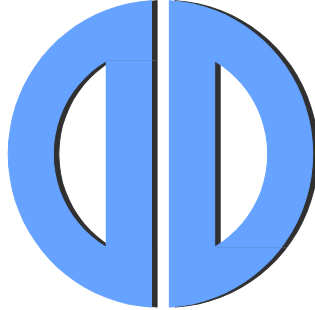
- (1) The protection film is attached to the bezel with a small masking tape.  
When the protection film is peeled off, static electricity is generated between the film and polarizer. This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment 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.



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