HY-LINE®
COMPUTER COMPONENTS

TFT-Display Datenblatt

Modell LM270WQ3-SLA1

Kurzdaten

Hersteller	LG Display
Diagonale	27“ / 68,6 cm
Format	wide
Auflösung	2560 x 1440
Backlight	LED / 700 cd/m²
Interface	LVDS
Touchscreen	nein
Temperatur	0… +50°C (Betrieb)

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SPECIFICATION
FOR
APPROVAL

( ) Preliminary Specification
(◆) Final Specification

Title	27.0" QHD TFT LCD

BUYER	General
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM270WQ3
SUFFIX	SLA1

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

SIGNATURE	DATE
/	
/	
/	

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

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IT Development Division 1
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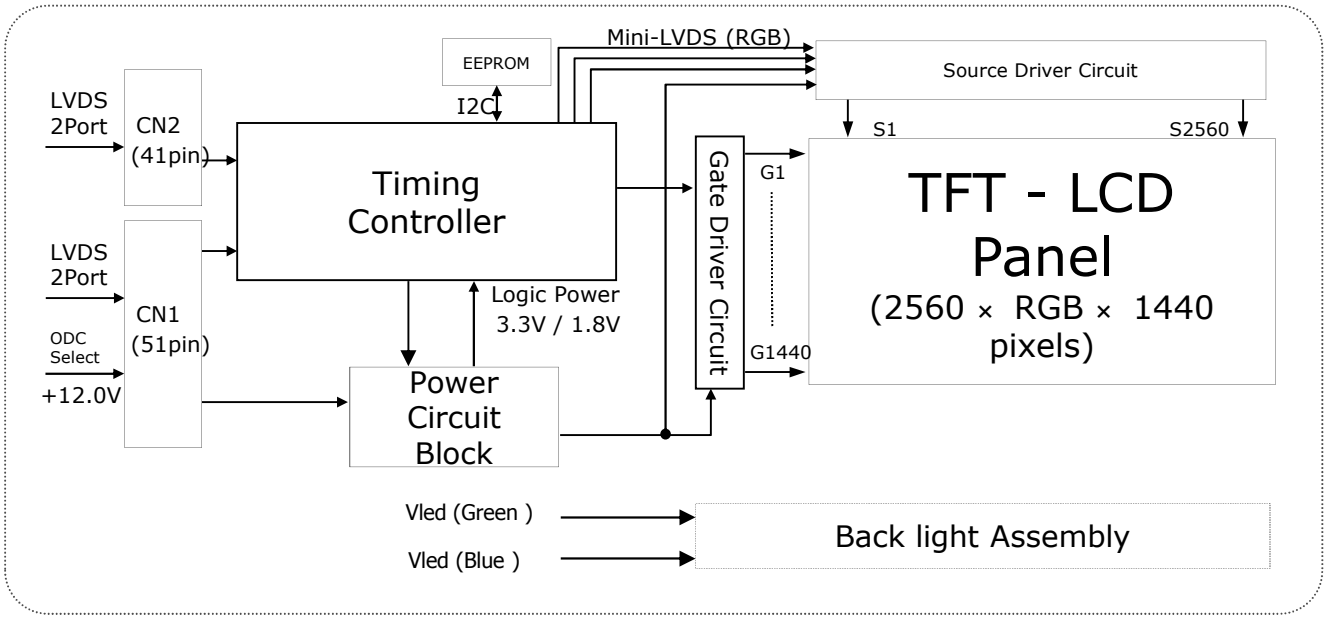
Contents

RECORD OF REVISIONS

Revision No	Revision Date	Page	Description
1.0	Nov. 09. 2012	-	Final Draft

1. General Description

LM270WQ3 is a Color Active Matrix Liquid Crystal Display with Light Emitting Diode (GB-r 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 27inch diagonally measured active display area with QHD resolution (2560 vertical by 1440 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 10-bit gray scale signal for each dot, thus, presenting a palette of more than 1.07Billion colors with Advanced-FRC (Frame Rate Control). It has been designed to apply the 10-bit 4port 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	27.0 inches(68.47cm) diagonal
Outline Dimension	630.0(H) x 368.2(V) x 18.0(D) mm(Typ.)
Pixel Pitch	0.2331 mm x 0.2331 mm
Pixel Format	2560 horiz. By 1440 vert. Pixels RGB stripes arrangement
Color Depth	1.07 Billion colors, 10Bit with A-FRC
Luminance, White	350 cd/m^2 (Center 1Point, Typ.)
Viewing Angle(CR>10)	View Angle Free (R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	Total 51.8 Watt (Typ.) (9.6 Watt @V_{LCD}, 42.2W w/o driver)
Weight	3,600g (Typ.)
Display Operating Mode	Transmissive mode, Normally Black
Surface Treatment	Hard coating(3H), Anti-glare treatment of the front polarizer

2. Absolute Maximum Ratings

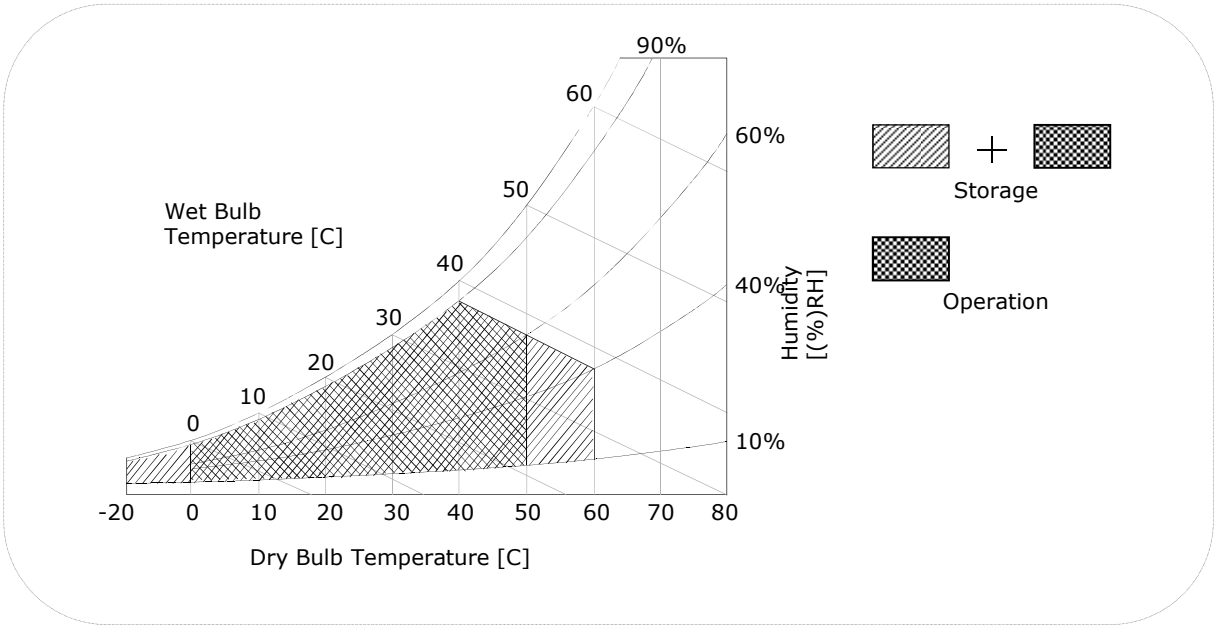
The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	VLCD	-0.3	14	Vdc	at 25 ± 2℃
Operating Temperature	TOP	0	50	℃	1, 2
Storage Temperature	TST	-20	60	℃	
Operating Ambient Humidity	HOP	10	90	%RH	
Storage Humidity	HST	10	90	%RH	

Note : 1. Temperature and relative humidity range are shown in the figure below.
Wet bulb temperature should be 39 ℃ Max, and no condensation of water.
2. Maximum Storage Humidity is up to 40℃, 70% RH only for 4 corner light leakage Mura.
3. Storage condition is guaranteed under packing condition

FIG. 1 Temperature and relative humidity



3. Electrical Specifications

3-1. Electrical Characteristics

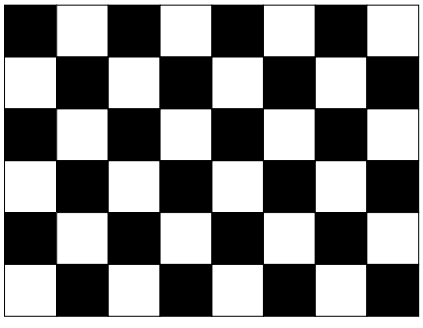
It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input power for the LED/Backlight, is typically generated by a LED Driver. The LED Driver is an external unit to the LCDs.

Table 2-1. ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input voltage	V_{LCD}	11.6	12.0	12.4	Vdc	
Permissive Power Input Ripple	V_{dRF}	-		400	mVp-p	
Power Supply Input Current	$I_{LCD-MOSAIC}$	-	800	1040	mA	1
	$I_{LCD-WHITE}$	-	1150	1495	mA	2
Power Consumption	$P_{LCD-MOSAIC}$	-	9.6	12.48	Watt	1
	$P_{LCD-WHITE}$		13.8	17.94	Watt	2
Rush Current	I_{RUSH}	-	-	3.0	A	3

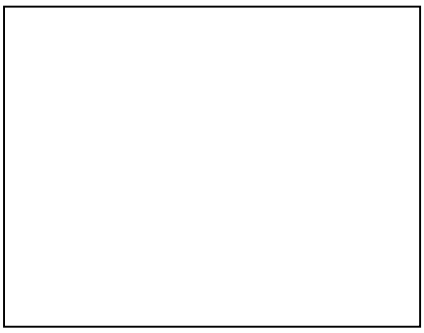
Note :
1. The specified current and power consumption are under the V_{LCD}=12.0V, 25 ± 2℃,f_V=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
2. The current is specified at the maximum current pattern.
3. The duration of rush current is about 2ms and rising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

White : 255Gray
Black : 0Gray



Mosaic Pattern(8 x 6)

Maximum current pattern



White Pattern

Table 3. LED Bar ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min.	Typ.	Max.		
LED String Current	I_Green	15.0	105	110	mA	1, 2, 7
	I_Blue	11.2	65	68	mA	
Blue current Ratio	I_B / I_G	60.0	61.9	63.8	%	1,2,7,8
LED String Voltage	Vs_Green	58.0	62.0	66.0	V	1, 3, 7
	Vs_Blue	58.0	62.0	66.0	V	
Power Consumption	P_{Bar}		42.2	45.0	Watt	1,4,6,7
LED Life Time	LED_LT	30,000			Hrs	5, 7

LED driver design guide

1) 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. Please control feedback current of each string individually to compensate the current variation among the strings of LEDs.
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.

2) LGD recommend that Dimming Control Signal (PWM Signal) is synchronized with Frame Frequency for Wavy Noise Free.

1. Specified values are for a single LED bar.
2. The specified current is defined as the input current for a single LED string with 100% duty cycle
3. The specified voltage is input LED string and Bar voltage at typical Current 100% duty current.
4. The specified power consumption is input LED bar power consumption at typical Current 100% duty current.
5. The life is determined as the time at which luminance of the LED is 50% compared to that of initial value at the typical LED current on condition of continuous operating at 25 ± 2℃.
6. The power consumption shown above does not include loss of external driver.
The used LED bar current is the LED typical current.
The typical power consumption is calculated as
P_{Bar} = Vs(Typ.) x (I_green(Typ.)+I_blue(Typ)) x No. of strings.
The maximum power consumption is calculated as
P_{Bar} = Vs(Max.) x (I_green(Typ.)+I_blue(Typ)) x No. of strings
7. LED operating DC Forward Current must not exceed LED Max Ratings at 25±2 ° C

※ Green & Blue LED can be operated at 0~10mA current range, but LGD can not guarantee the optical performance at this low current level.

8. Blue current Ratio is calculated with I_B(typ.)/I_G(typ.) after 30min. aging time at 25 ± 2 ° C.
It means the Blue current portion comparing with Green current at 100% duty typical current.

3-2. Interface Connections

This LCD module employs two kinds of interface connection, 51-pin and 41-pin connectors are used for the module electronics and 14-pin connectors are used for the integral backlight system.

3-2-1. LCD Module (CN1, CN2)

- LCD Connector(CN1): IS050-C51B-C39-A(manufactured by UJU) or FI-RE51S-HF(manufactured by JAE) or compatible. Refer to below and next Page table.
- Mating Connector : FI-RE51HL(JAE) or compatible

Table 3-1. MODULE CONNECTOR(CN1) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	GND	Ground	27	NC	No Connection
2	NC	No Connection	28	R2AN	SECOND LVDS Receiver Signal (A-)
3	NC	No Connection	29	R2AP	SECOND LVDS Receiver Signal (A+)
4	NC	No Connection	30	R2BN	SECOND LVDS Receiver Signal (B-)
5	NC	No Connection	31	R2BP	SECOND LVDS Receiver Signal (B+)
6	ODC Select	'H' or NC = Enable , 'L' = Disable	32	R2CN	SECOND LVDS Receiver Signal (C-)
7	NC	No Connection	33	R2CP	SECOND LVDS Receiver Signal (C+)
8	NC	No Connection	34	GND	Ground
9	PWM_OUT	Reference signal for LED Driver control	35	R2CLKN	SECOND LVDS Receiver Clock Signal(-)
10	NC	No Connection	36	R2CLKP	SECOND LVDS Receiver Clock Signal(+)
11	GND	Ground	37	GND	Ground
12	R1AN	FIRST LVDS Receiver Signal (A-)	38	R2DN	SECOND LVDS Receiver Signal (D-)
13	R1AP	FIRST LVDS Receiver Signal (A+)	39	R2DP	SECOND LVDS Receiver Signal (D+)
14	R1BN	FIRST LVDS Receiver Signal (B-)	40	R2EN	SECOND LVDS Receiver Signal (E-)
15	R1BP	FIRST LVDS Receiver Signal (B+)	41	R2EP	SECOND LVDS Receiver Signal (E+)
16	R1CN	FIRST LVDS Receiver Signal (C-)	42	Reserved	No connection or GND
17	R1CP	FIRST LVDS Receiver Signal (C+)	43	Reserved	No connection or GND
18	GND	Ground	44	GND	Ground
19	R1CLKN	FIRST LVDS Receiver Clock Signal(-)	45	GND	Ground
20	R1CLKP	FIRST LVDS Receiver Clock Signal(+)	46	GND	Ground
21	GND	Ground	47	NC	No connection
22	R1DN	FIRST LVDS Receiver Signal (D-)	48	VLCD	Power Supply +12.0V
23	R1DP	FIRST LVDS Receiver Signal (D+)	49	VLCD	Power Supply +12.0V
24	R1EN	FIRST LVDS Receiver Signal (E-)	50	VLCD	Power Supply +12.0V
25	R1EP	FIRST LVDS Receiver Signal (E+)	51	VLCD	Power Supply +12.0V
26	Reserved	No connection or GND	-	-	-

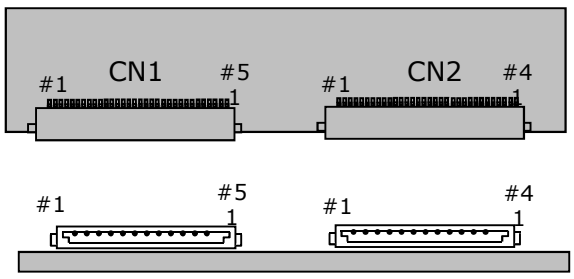
Notes : 1. All GND (ground) pins should be connected together to the LCD module's metal frame.
2. All VLCD (power input) pins should be connected together.
3. All Input levels of LVDS signals are based on the EIA 664 Standard.
4. Specific pins (pin No. #2~#6) are used for internal data process of the LCD module. If not used, these pins are no connection.

- LCD Connector(CN2): IS050-C41B-C39-A(manufactured by UJU) or FI-RE41S-HF(manufactured by JAE) or compatible. Refer to below table.
- Mating Connector : FI-RE41HL or compatible.

Table 3-2. MODULE CONNECTOR(CN2) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	NC	No connection (Reserved)	22	R3EN	THIRD LVDS Receiver Signal (E-)
2	NC	No connection	23	R3EP	THIRD LVDS Receiver Signal (E+)
3	NC	No connection	24	GND	Ground
4	NC	No connection	25	GND	Ground
5	NC	No connection	26	R4AN	FORTH LVDS Receiver Signal (A-)
6	NC	No connection	27	R4AP	FORTH LVDS Receiver Signal (A+)
7	NC	No connection	28	R4BN	FORTH LVDS Receiver Signal (B-)
8	NC	No connection	29	R4BP	FORTH LVDS Receiver Signal (B+)
9	GND	Ground	30	R4CN	FORTH LVDS Receiver Signal (C-)
10	R3AN	THIRD LVDS Receiver Signal (A-)	31	R4CP	FORTH LVDS Receiver Signal (C+)
11	R3AP	THIRD LVDS Receiver Signal (A+)	32	GND	Ground
12	R3BN	THIRD LVDS Receiver Signal (B-)	33	R4CLKN	FORTH LVDS Receiver Clock Signal(-)
13	R3BP	THIRD LVDS Receiver Signal (B+)	34	R4CLKP	FORTH LVDS Receiver Clock Signal(+)
14	R3CN	THIRD LVDS Receiver Signal (C-)	35	GND	Ground
15	R3CP	THIRD LVDS Receiver Signal (C+)	36	R4DN	FORTH LVDS Receiver Signal (D-)
16	GND	Ground	37	R4DP	FORTH LVDS Receiver Signal (D+)
17	R3CLKN	THIRD LVDS Receiver Clock Signal(-)	38	R4EN	FORTH LVDS Receiver Signal (E-)
18	R3CLKP	THIRD LVDS Receiver Clock Signal(+)	39	R4EP	FORTH LVDS Receiver Signal (E+)
19	GND	Ground	40	GND	Ground
20	R3DN	THIRD LVDS Receiver Signal (D-)	41	GND	Ground
21	R3DP	THIRD LVDS Receiver Signal (D+)	-		

Notes : 1. All GND(ground) pins should be connected together to the LCD module's metal frame.
2. LVDS pin (pin No. #22,23,38,39) are used for 10Bit(D) of the LCD module.



Rear view of LCM

[CN1]
- Part/No. : IS050-C51B-C39-A(UJU)
- Mating connector : FI-RE51HL (Manufactured by JAE)

[CN2]
- Part/No. : IS050-C41B-C39-A(UJU)
- Mating connector : FI-RE41HL (Manufactured by JAE)

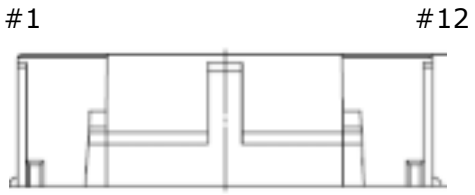
3-2-2. Backlight Interface

- LED Connector : H401K-D12N-12B (Manufactured by E&T)
- Mating Connector : 4530K-F12N-01R (Manufactured by E&T) or Equivalent.

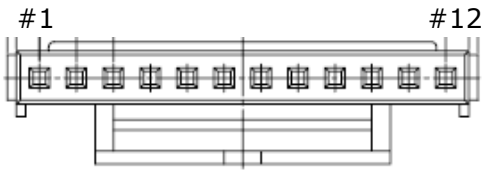
Table 5. LED CONNECTOR PIN CONFIGULATION

Pin No.	Symbol	Description	Note
1	G1-	Green LED channel 1 Cathode	
2	G2-	Green LED channel 2 Cathode	
3	G1+	Green Common Anode	
4	B1+	Blue Common Anode	
5	B1-	Blue LED channel 1 Cathode	
6	B2-	Blue LED channel 2 Cathode	
7	B3-	Blue LED channel 3 Cathode	
8	B4-	Blue LED channel 4 Cathode	
9	B2+	Blue Common Anode	
10	G2+	Green Common Anode	
11	G3-	Green LED channel 3 Cathode	
12	G4-	Green LED channel 4 Cathode	

Notes : 1. Green Common Anode Pin. No. 3 & 10 must be connected electrically for stable operation.
2. Blue Common Anode Pin. No. 4 & 9 must be connected electrically for stable operation.



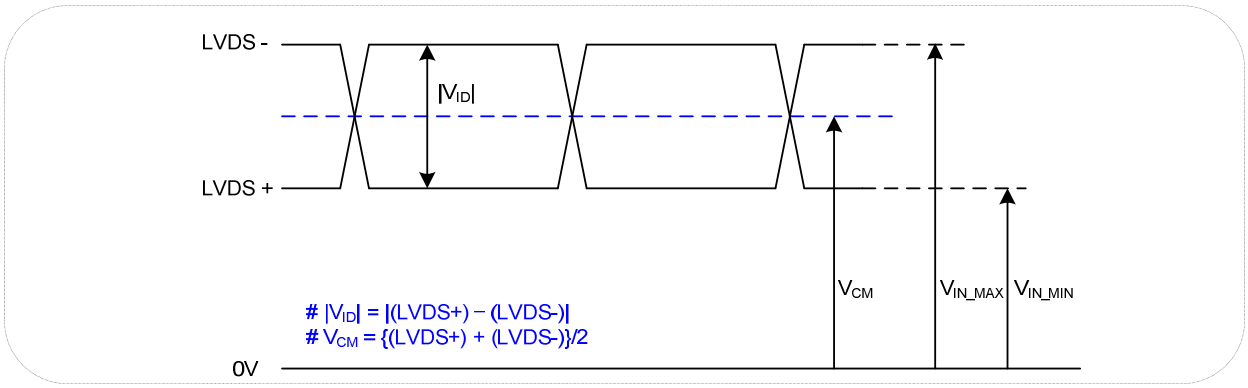
[Top view]



[Side view]

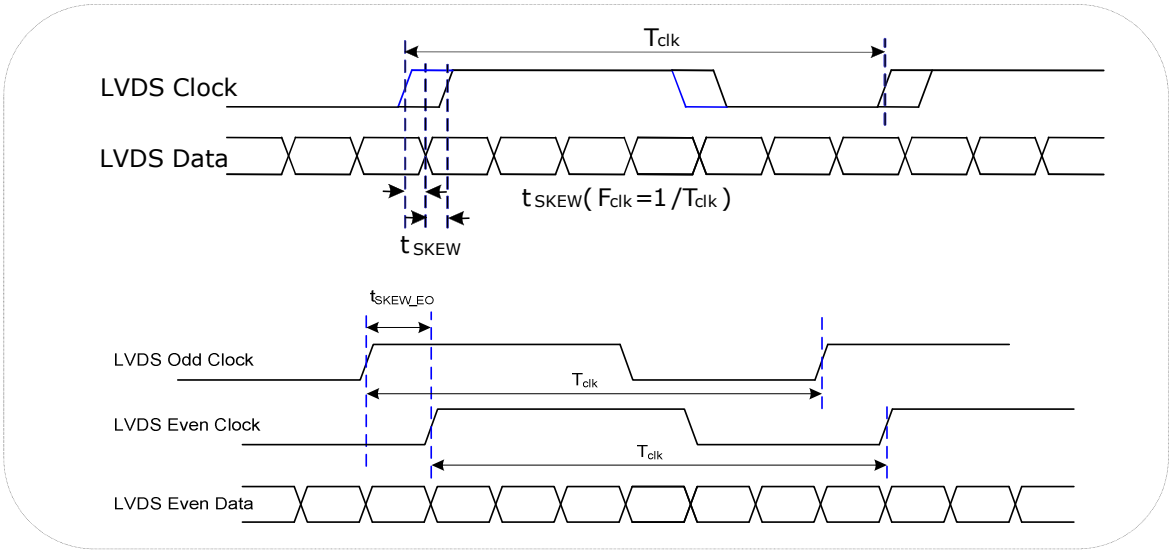
3-3. LVDS characteristics

3-3-1. DC Specification



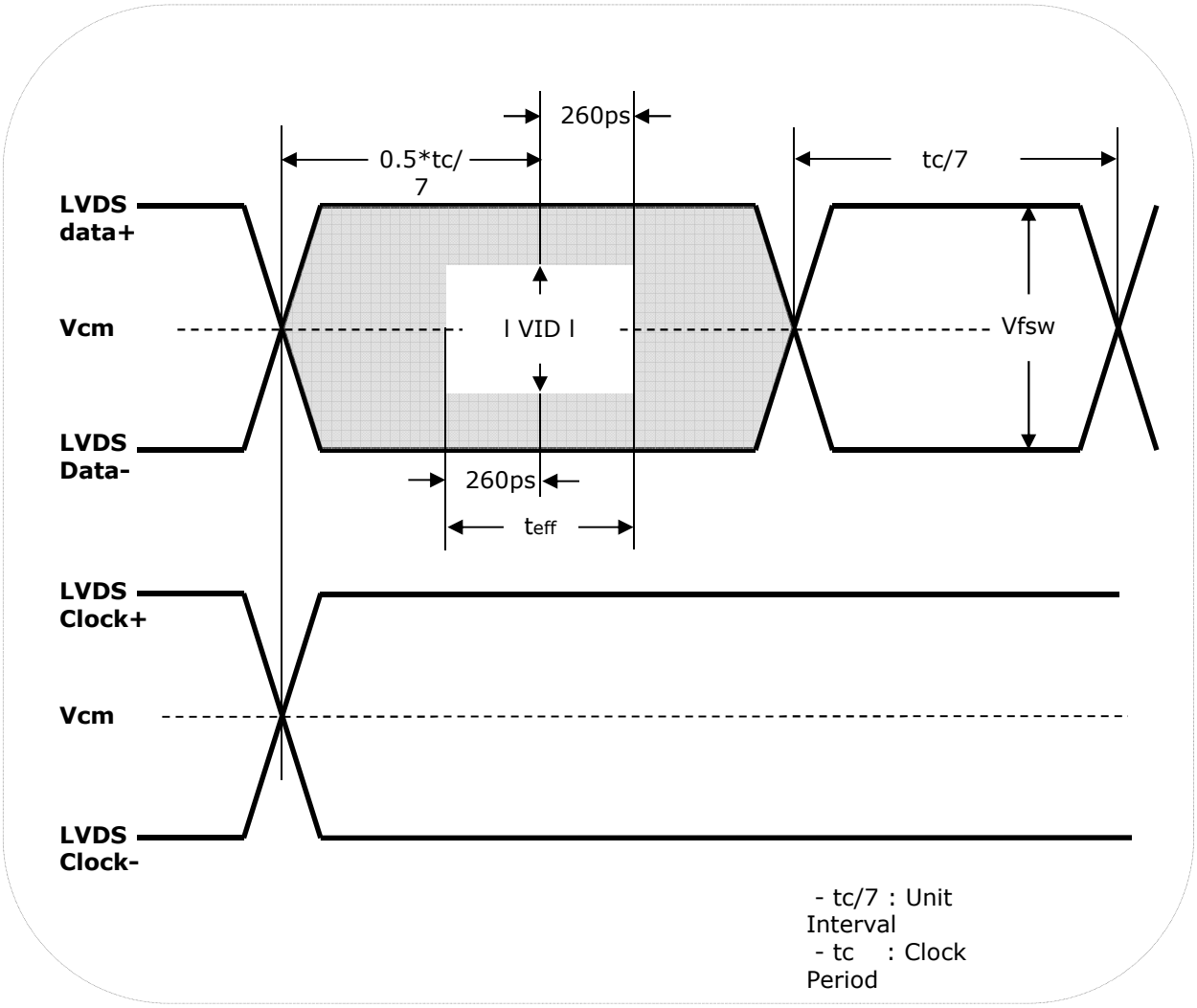
Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$\|V_{ID}\|$	200	600	mV	-
LVDS Common mode Voltage	V_{CM}	1.0	1.5	V	-
LVDS Input Voltage Range	V_{IN}	0.7	1.8	V	-
Change in common mode Voltage	ΔV_{CM}	-	250	mV	-

3-3-2. AC Specification



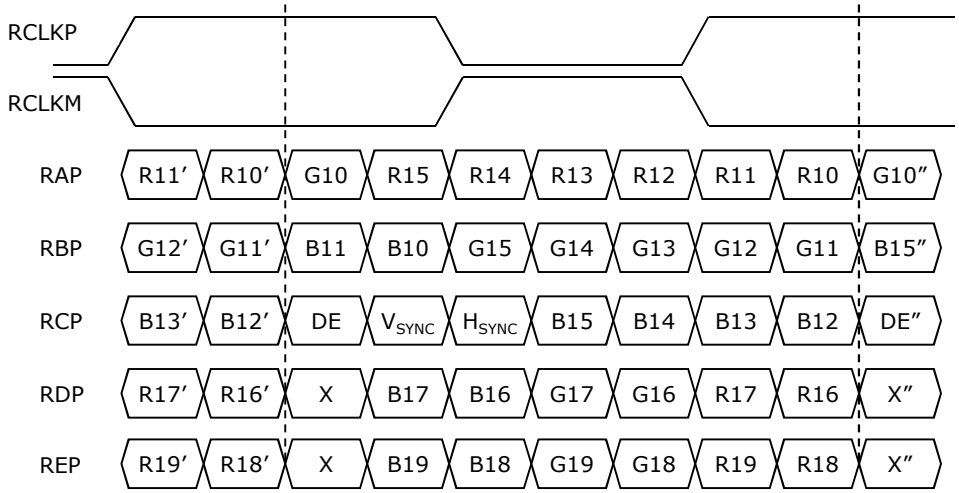
Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	- (0.25*t_{CLK})/7	+ (0.25*t_{CLK})/7	ps	
LVDS Clock to Clock Skew Margin	t_{SKEW_EO}	- 1/7	+ 1/7	T_{clk}	-
Effective time of LVDS	t_{eff}	520		ps	-

- LVDS Effective Period



3-3-3. LVDS Data format

■ **10Bit Data-Mapping (VESA format)**



3-4. 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 it's proper operation.

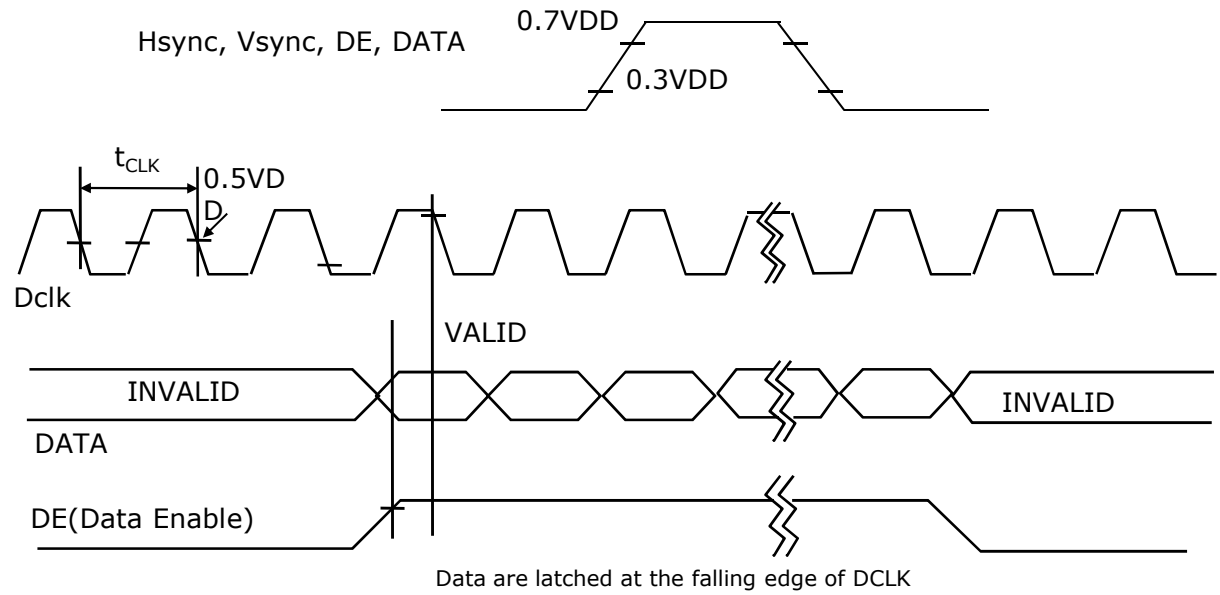
Table 4. TIMING TABLE (VESA COORDINATED VIDEO TIMING)

Parameter		Symbol	Min.	Typ.	Max.	Unit	Notes
DCLK	Period	tCLK	16.46	16.56	16.67	ns	Pixel frequency : Typ.241.5MHz
	Frequency	fCLK	60	60.38	60.75	MHz	
Hsync	Period	tHP	678	680	682	tCLK	
	Width-Active	tWH	8	8	8		
Vsync	Period	tVP	1479	1481	1483	tHP	
	Frequency	fV	59.38	59.95	60.12	Hz	
	Width-Active	tWV	5	5	5	tHP	
Data Enable	Horizontal Valid	tHV	640	640	640	tCLK	
	Horizontal Back Porch	tHBP	18	20	22		
	Horizontal Front Porch	tHFP	10	12	14		
	Horizontal Blank	-	36	40	44		tWH+ tHBP+ tHFP
	Vertical Valid	tVV	1440	1440	1440	tHP	
	Vertical Back Porch	tVBP	32	33	34		
	Vertical Front Porch	tVFP	2	3	4		
	Vertical Blank	-	39	41	43		tWV+ tVBP+ tVFP

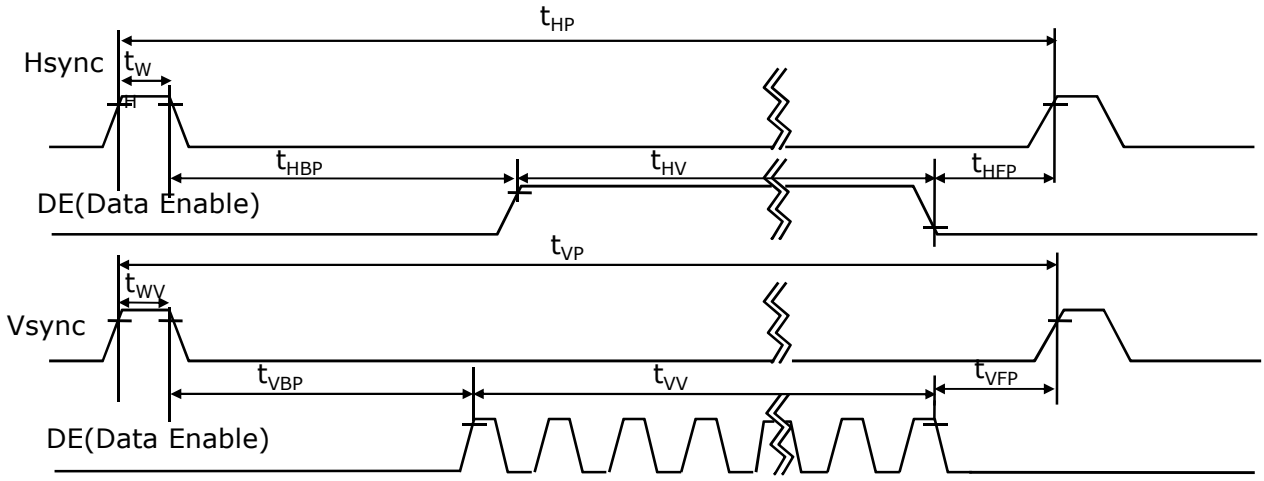
Note:

1. DE Only mode operation. The input of Hsync & Vsync signal does not have an effect on LCD normal operation.
2. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
3. Horizontal period should be even.

3-5. Signal Timing Waveforms



Data are latched at the falling edge of DCLK



3-6. Color Data Reference

The Brightness of each primary color(red,green,blue) is based on the 10-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 5. COLOR DATA REFERENCE

Color		Input Color Data		
		RED MSB LSB	GREEN MSB LSB	BLUE MSB LSB
		R9 R8 R7 R6 R5 R4 R3 R2 R1 R0	G9 G8 G7 G6 G5 G4 G3 G2 G1 G0	B9 B8 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 0 0 0 0 0 0
	Red (1023)	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
	Green (1023)	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0
	Blue (1023)	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1
	Cyan	0 0 0 0 0 0 0 0 0 0	1 1 1 1 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 1 1	0 0 0 0 0 0 0 0 0 0	1 1 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 1 1 1 1	0 0 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 1 1 1 1 1 1
RED	RED (000)	0 0 0 0 0 0 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 0 0 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
	...	...	...	...
	RED (1022)	1 1 1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
	RED (1023)	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
GREEN	GREEN (000)	0 0 0 0 0 0 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 0 0 0 0 1	0 0 0 0 0 0 0 0 0 0
	...	...	...	...
	GREEN (1022)	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 0 0 0
	GREEN (1023)	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0
BLUE	BLUE (000)	0 0 0 0 0 0 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 0 0 0 0 0 0 1
	...	...	...	...
	BLUE (1022)	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 0
	BLUE (1023)	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1

3-7. Power Sequence & Dip condition for LCD Module

3-7-1. Power Sequence

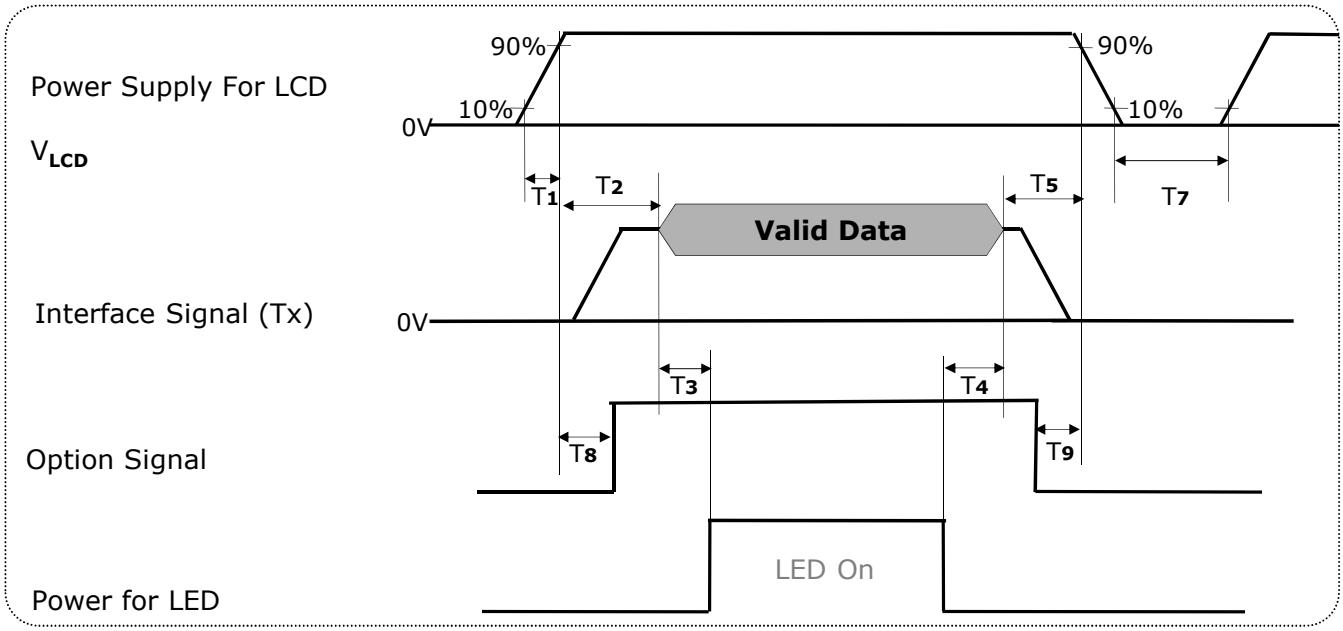


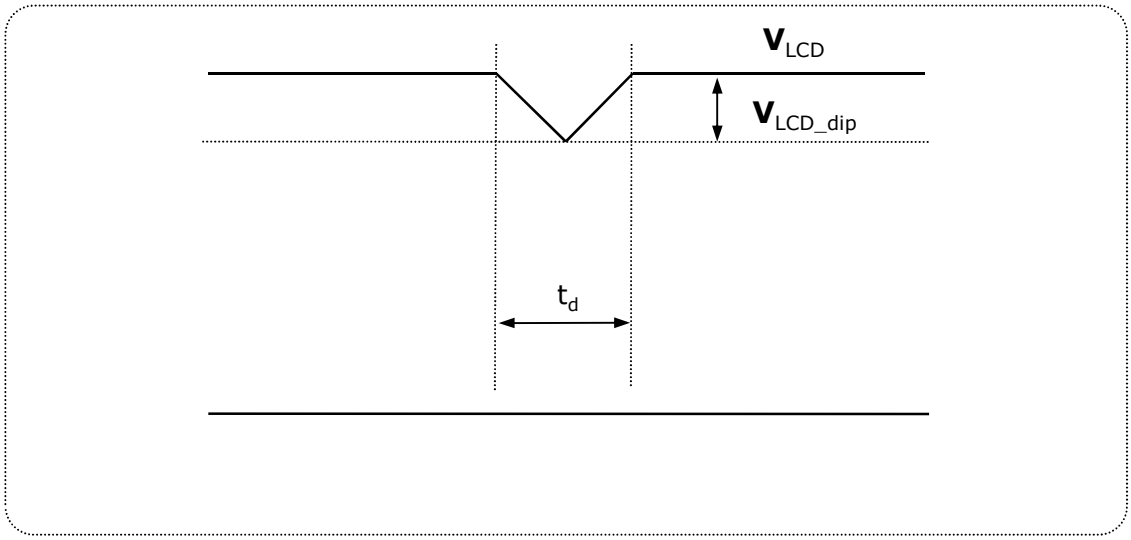
Table 6. Power sequence

Parameter	Values			Units
	Min	Typ	Max	
T1	0.5	-	10	ms
T2	0.5	-	50	ms
T3	500	-	-	ms
T4	200	-	-	ms
T5	0.01	-	50	ms
T7	1		-	s
T8	0 < T8 < T2			ms
T9	0 < T9 < T5			ms

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

3-7-2. VLCD Power Dip Condition



Notes :

Dip condition

V_{LCD}_dip $\leq V_{LCD\_typ}$ X 0.2, $t_d \leq 10ms$

4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at 25± 2℃. 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. 2 presents additional information concerning the measurement equipment and method.

Table 7. OPTICAL CHARACTERISTICS (Ta=25 ℃, V_{LCD}=12.0V, f_V=60Hz Dclk=241.5MHz)

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	700	1000	-		1
Surface Luminance, white		L_{WH}	280	350	-	cd/m^2	2
Luminance Variation		δ_{WHITE}	75			%	3
Response Time	Gray to Gray	T_{GTG}	-	6	12	ms	5
Color Coordinates [CIE1931]	RED	Rx	Typ -0.03	0.680	Typ +0.03		
		Ry		0.310			
	GREEN	Gx		0.210			
		Gy		0.700			
	BLUE	Bx		0.147			
		By		0.054			
	WHITE	Wx		0.313			
		Wy		0.329			
Color Coordinates [CIE1976]	RED	Ru'	-	0.507	-		
		Rv'		0.521			
	GREEN	Gu'		0.077			
		Gv'		0.573			
	BLUE	Bu'		0.175			
		Bv'		0.145			
	WHITE	Wu'		0.198			
		Wv'		0.468			
Color Shift	Horizontal	θ_{CST_H}	-	178	-	Degree	6
	Vertical	θ_{CST_V}	-	178	-		
Viewing Angle (CR>10)							
General	Horizontal	θ_H	170	178	-	Degree	7
	Vertical	θ_V	170	178	-		
Effective	Horizontal	θ_{GMA_H}		178	-	Degree	8
	Vertical	θ_{GMA_V}		178	-		
Gray Scale				2.2			9

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 center 1 point(1) across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 3.

3. The variation in surface luminance , δ WHITE is defined as : *(By PR880)*

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

Where L1 to L9 are the luminance with all pixels displaying white at 9 locations. For more information see FIG 3.

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 4.

5. Gray to gray response time is the time required for the display to transition from gray to gray. For additional information see Table 8. *(By PR880)*

6. Color shift is the angle at which the color difference is lower than 0.04. For more information see FIG 5. *(By EZ Contrast)*
   - Color difference (Δu'v')

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

$$\Delta u'v' = \sqrt{(u'_1 - u'_2)^2 + (v'_1 - v'_2)^2}$$

u'1, v'1 : u'v' value at viewing angle direction
u'2, v'2 : u'v' value at front (θ=0)

   - Pattern size : 25% Box size
   - Viewing angle direction of color shift : Horizontal, Vertical

7. Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see FIG 6. *(By PR880)*

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

9. Gray scale specification
   Gamma Value is approximately 2.2. For more information see Table 9.

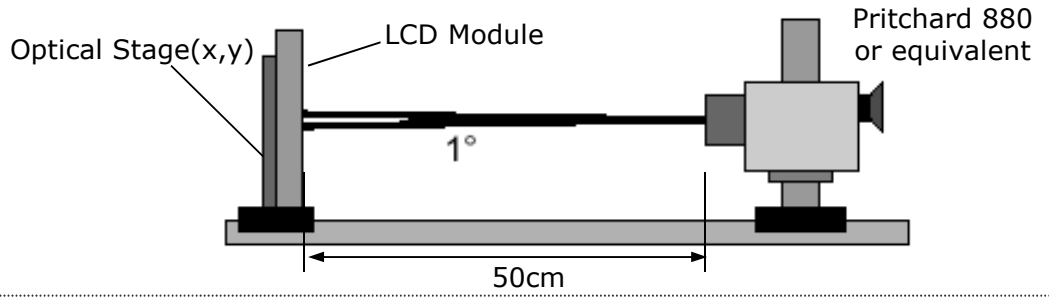


FIG. 2 Optical Characteristic Measurement Equipment and Method

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

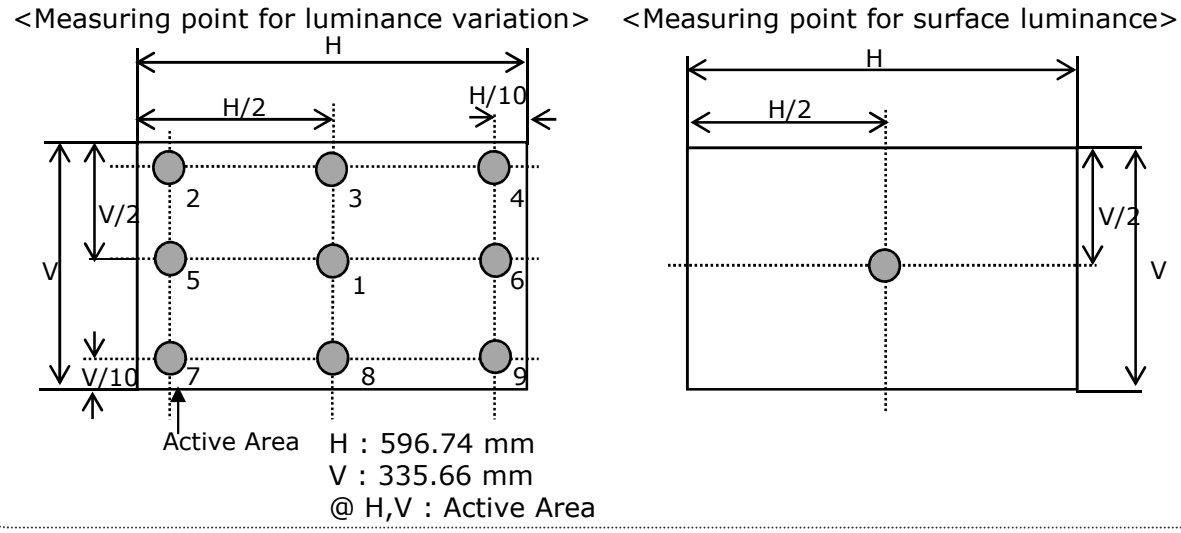


FIG. 3 Measure Point for Luminance

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

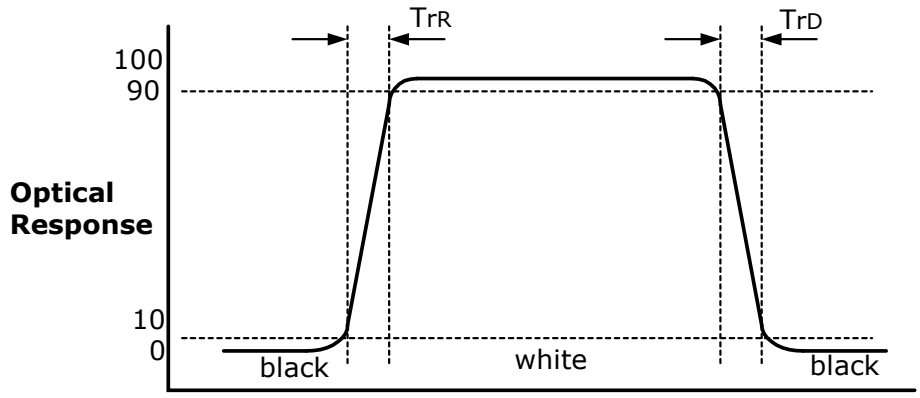


FIG. 4 Response Time

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

- Gray step : 5 step
- T_{GTG_AVR} is the total average time at rising time and falling time for "Gray To Gray".
- T_{GTG_MAX} is the max time at rising time or falling time for "Gray To Gray".

Table 8. Gray to gray response time table

Gray to Gray		Rising Time				
		G1023	G767	G511	G255	G0
Falling Time	G1023					
	G767					
	G511					
	G255					
	G0					

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

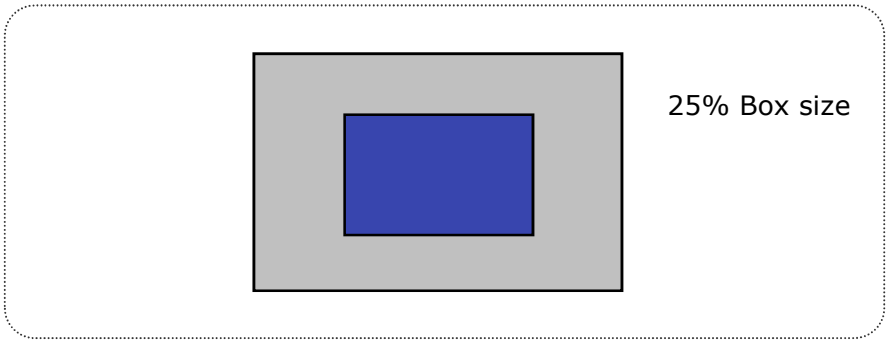


FIG. 5 Test Pattern

Average RGB values in Bruce RGB for Macbeth Chart

	Dark skin	Light skin	Blue sky	Foliage	Blue flower	Bluish green
R	395	827	343	311	519	459
G	227	571	451	411	475	799
B	183	495	647	187	743	715
	Orange	Purplish blue	Moderate red	Purple	Yellow green	Orange yellow
R	879	227	847	307	643	923
G	419	279	271	159	775	651
B	99	699	351	347	235	119
	Blue	Green	Red	Yellow	Magenta	cyan
R	107	291	791	967	831	143
G	131	595	111	851	251	507
B	583	263	151	147	607	691
	White	Neutral 8	Neutral 6.5	Neutral 5	Neutral 3.5	black
R	963	827	623	443	255	91
G	963	827	623	443	255	91
B	963	827	623	443	255	91

Dimension of viewing angle range.

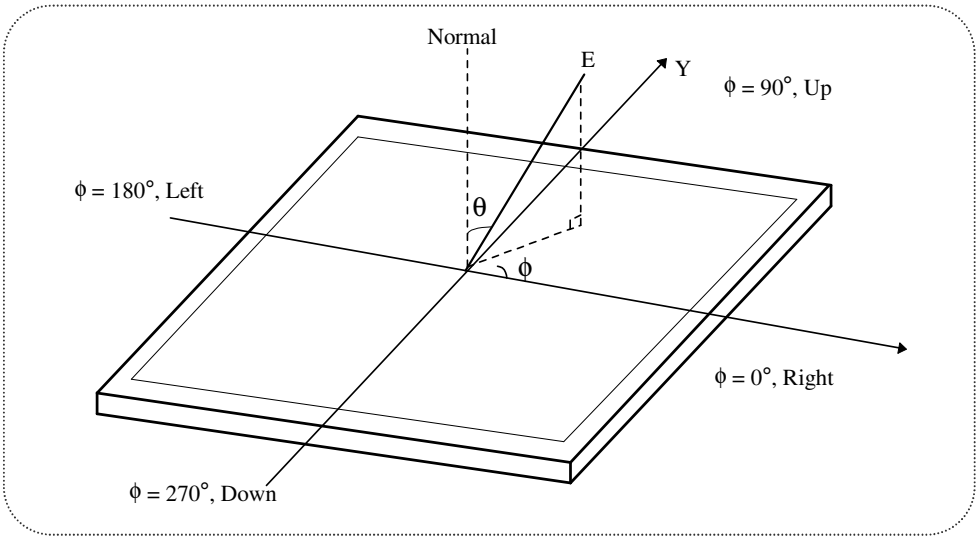


FIG. 6 Viewing angle

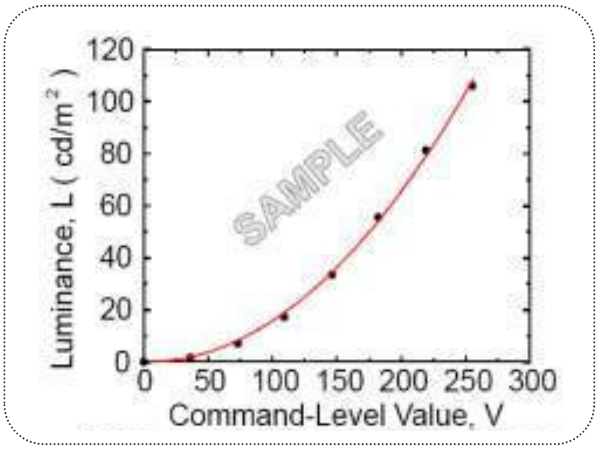


FIG. 7 Sample Luminance vs. gray scale (using a 256 bit gray scale)

$$L = aV^{r} + L_b$$

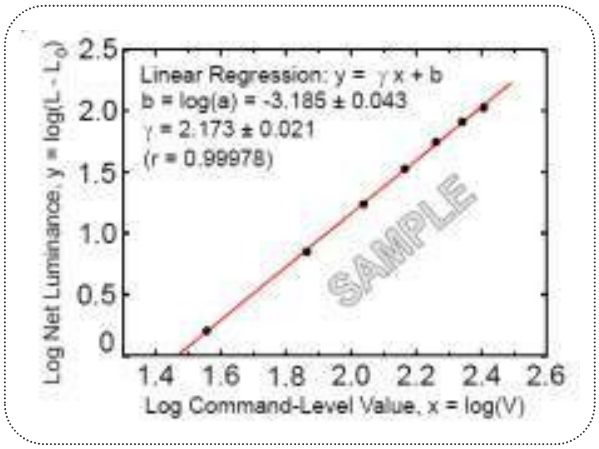


FIG. 8 Sample Log-log plot of luminance vs. gray scale

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

Here the Parameter α and γ relate the signal level V to the luminance L.
The GAMMA we calculate from the log-log representation (FIG. 8)

Table 9. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.10
63	0.30
127	1.08
191	2.50
255	4.71
319	7.70
383	11.52
447	16.18
511	21.72
575	28.15
639	35.51
703	43.81
767	53.07
831	63.30
895	74.52
959	86.75
1023	100

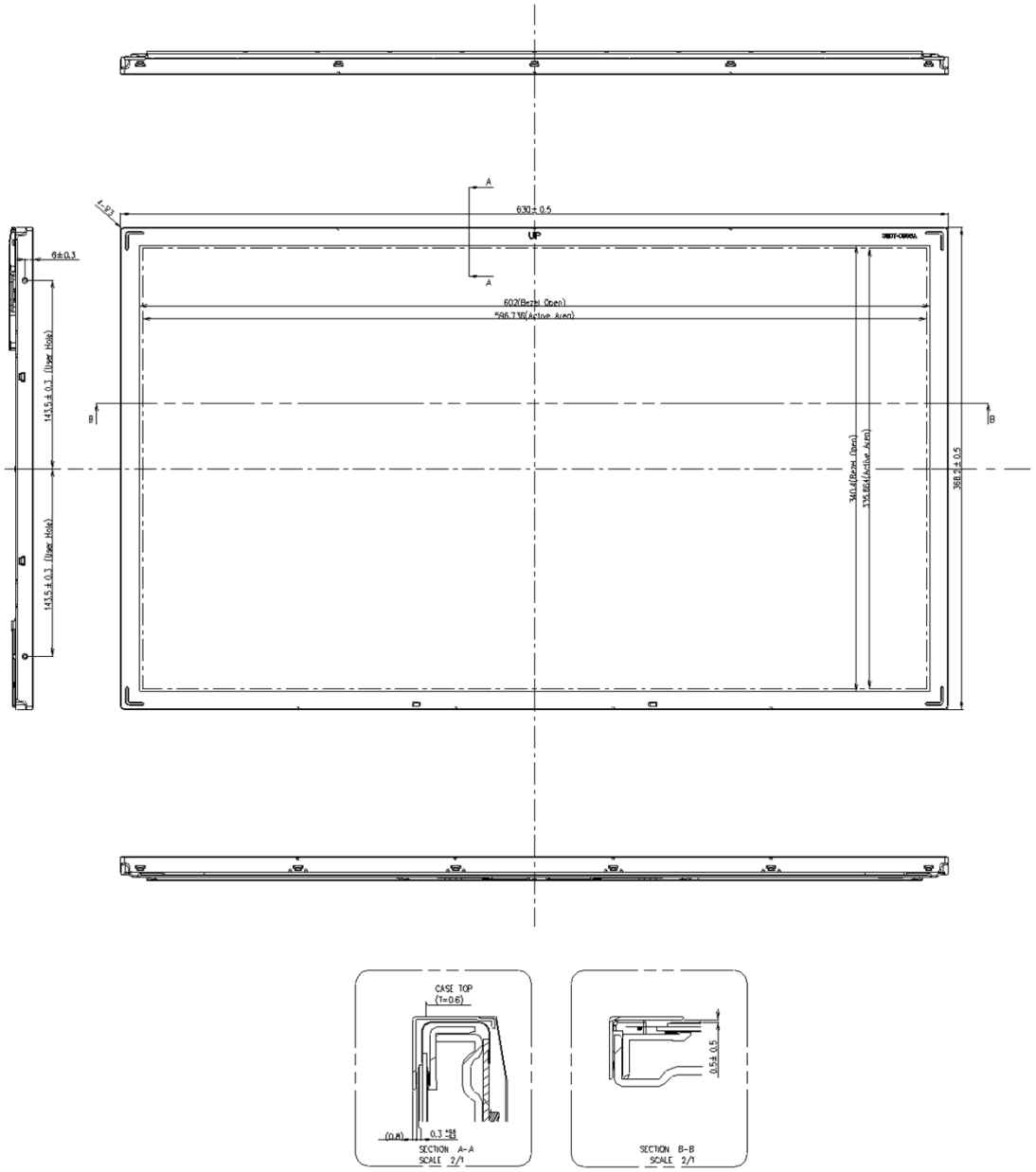
5. Mechanical Characteristics

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

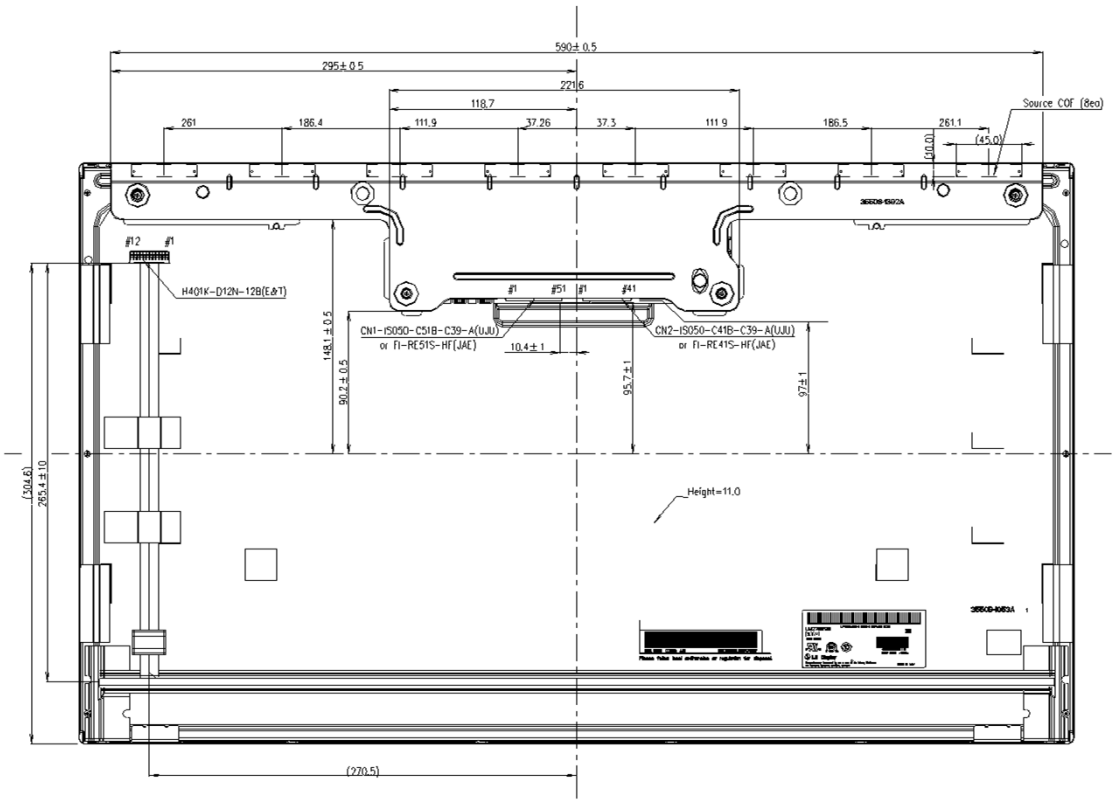
Outline Dimension	Horizontal	630.0mm
	Vertical	368.2mm
	Depth	18.0mm
Bezel Area	Horizontal	602.0mm
	Vertical	340.4mm
Active Display Area	Horizontal	596.74mm
	Vertical	335.66mm
Weight	3,600g(Typ.) / 3,780g (Max.)	
Surface Treatment	Hard coating(3H) Anti-glare treatment of the front polarizer	

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

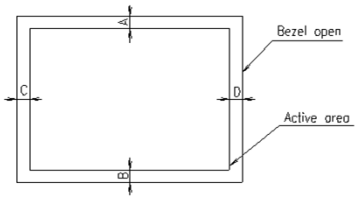
<FRONT VIEW>



<REAR VIEW>



Notes
1. Unspecified tolerances are to be ± 0.5
2. Tilt and partial disposition tolerance of display area are as following.
   (1) Y-direction : | A-B | ≦ 1.4mm
   (2) X-direction : | C-D | ≦ 1.4mm



3. Torque of User Hole(Mount) : 3.0 ~4.0kgf.cm
4-1. I/F Connector Specification(CN1) : IS050-C51B-C39-A(UJU) or FI-RE51S-HF(JAE)
4-2. I/F Connector Specification(CN2) : IS050-C41B-C39-A(UJU) or FI-RE41S-HF(JAE)
5. LED Connector Specification : H401K-D12N-12B(E&T)
6. The COF area is weak & sensive, so please don't press the COF area

6. Reliability

Environment test condition

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 : 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)

7. International Standards

7-1. Safety

a) UL 60950-1, Underwriters Laboratories Inc.
Information Technology Equipment - Safety - Part 1 : General Requirements.
b) CAN/CSA C22.2 No.60950-1-07, Canadian Standards Association.
Information Technology Equipment - Safety - Part 1 : General Requirements.
c) EN 60950-1, European Committee for Electrotechnical Standardization (CENELEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.
d) IEC 60950-1, 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)

2. Caution
: LED inside.
Class 1M laser (LEDs) radiation when open.
Do not open while operating.

7-2. EMC

a) ANSI C63.4–2003 "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40GHz."
American National Standards Institute (ANSI), 2003.
b) C.I.S.P.R. Pub. 22. Limits and methods of measurement of radio interference characteristics of information technology equipment." International Special Committee on Radio Interference (C.I.S.P.R.), 2005.
c) EN 55022 "Limits and methods of measurement of radio interference characteristics of information technology equipment." European Committee for Electrotechnical Standardization (CENELEC), 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 : 8ea

b) Box Size : 355mm X 700mm X 430mm

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.
(10) As The IPS panel is sensitive & slim, please recommend the metal frame of the system supports the panel by the double side-mount.

9-2. Operating precautions

(1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage : V=± 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 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 Yogore, image sticking can not be guarantee.
(11) Partial darkness may happen during 3~5 minutes when LCM is operated initially in condition that luminance is under 40% at low temperature (under 5℃). This phenomenon which disappears naturally after 3~5 minutes is not a problem about reliability but LCD characteristic
(12) LCMs cannot support "Interlaced Scan Method"

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℃ and 35℃ 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.