

Product Specification

SPECIFICATION FOR APPROVAL

(●) Preliminary Specification
 () Final Specification

Title	23.8" UHD TFT LCD
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BUYER	
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM238WR3
SUFFIX	SSB1

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

APPROVED BY	SIGNATURE DATE
/	
/	
/	

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

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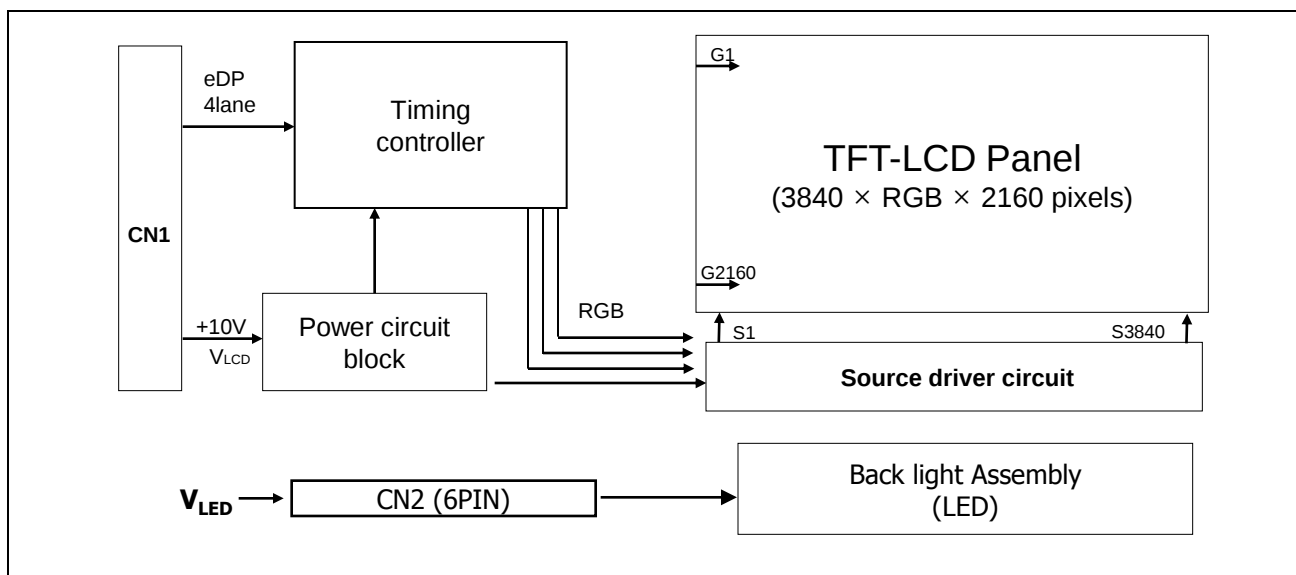
RECORD OF REVISIONS

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Product Specification

1. General Description

LM238WR3-SSB1 is a Color Active Matrix Liquid Crystal Display with a Light Emitting Diode (WLED) 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 23.8 inch diagonally measured active display area with UHD resolution (3840 horizontal by 2160 vertical pixels 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. It has been designed to apply the eDP interface. It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important.



[FIG. 1] Block diagram

General Features

Active Screen Size	23.8 inches(60.31cm) (Aspect ratio 16:9)
Outline Dimension	536.3(H) x 313.9(V) x 12.9(D) mm (Typ.)
Pixel Pitch	0.1369(H)mm x 0.1369(V)mm
Pixel Format	3840(H) x 2160(V) Pixels. RGB stripes arrangement
Color Depth	1.07 Billion colors (8bit + A-FRC)
Luminance, White	350 cd/m ² (Center 1 Point, Typ.)
Viewing Angle(CR>10)	View Angle Free (R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	Total 25.7 Watt (6.3Watt @V _{LCD} , 19.4 Watt @Is=120mA)
Weight	1,610g (Typ.)
Display Operating Mode	Transmissive mode, normally black
Panel type	Reverse type
Surface Treatment	Advanced Anti-glare treatment of the front polarizer (3H)

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2. Absolute Maximum Ratings

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

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Supply Input Voltage	V_{LCD}	-0.3	12	V_{DC}	At 25°C
Operating Temperature	T_{OP}	0	50	°C	1,2,3
Storage Temperature	T_{ST}	-20	60	°C	
Operating Ambient Humidity	H_{OP}	10	90	%RH	
Storage Humidity	H_{ST}	10	90	%RH	
LCM Surface Temperature (Operation)	$T_{Surface}$	0	65	°C	1, 4

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.

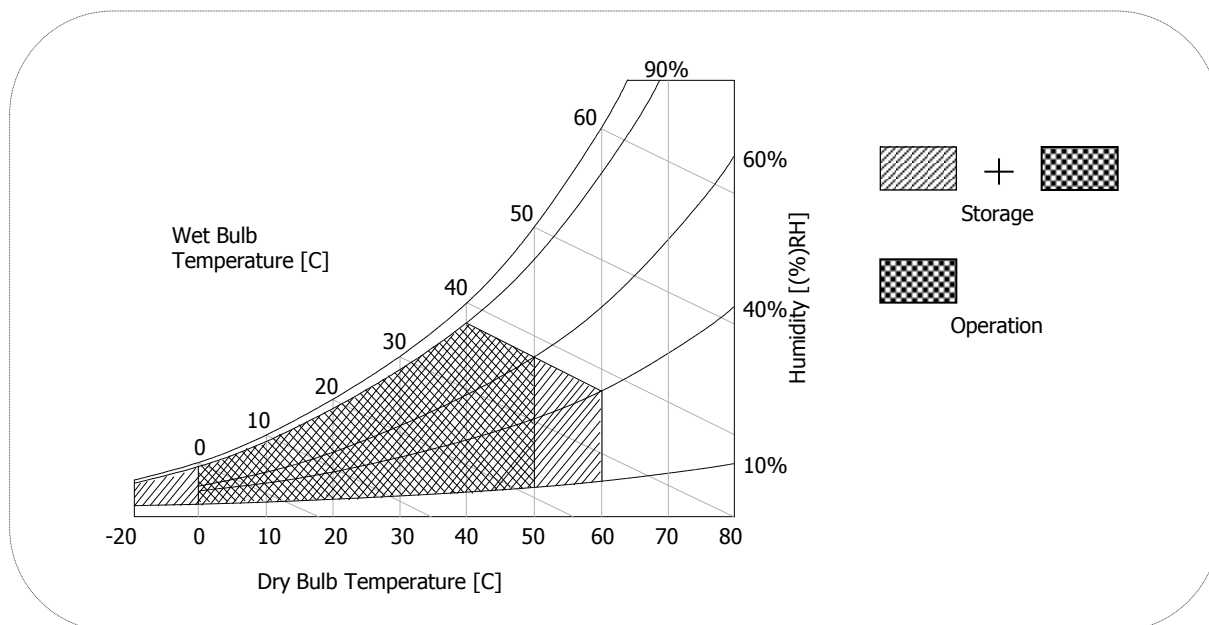
2. Maximum Storage Humidity is up to 40°C, 70% RH only for 4 corner light leakage Mura.

3. Storage condition is guaranteed under packing condition

4. LCM Surface Temperature should be Min. 0°C and Max. 65°C under the VLCD=10.0V,

fV=60Hz, 25°C ambient Temp. no humidity is controlled and LED string current is typical value.

[FIG. 2] Temperature and relative humidity



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3. Electrical Specifications

3-1. Electrical Characteristics

It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The other 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}	9.5	10	10.5	V	4
Permissive Power Input Ripple	V _{ripple}	-	-	400	mVp-p	1
Power Supply Input Current	I _{LCD} TYP	-	0.63	0.79	A	2
	I _{LCD} MAX	-	0.84	1.05	A	
Power Consumption	Pc TYP	-	6.3	7.88	Watt	
	Pc MAX	-	8.4	10.5	Watt	
Rush current	IRUSH	-	-	3	A	3

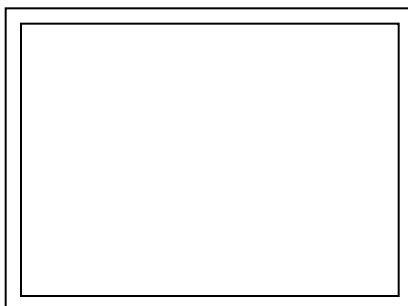
Note :

1. Permissive power ripple should be measured under the condition of $V_{LCD}=10.0V$, $25^{\circ}C$, $*f_v=\max$.
Refer to page 7 for the pattern and more information.
2. The specified current and power consumption can be measured under the $V_{LCD}=10.0V$, $25^{\circ}C$, $f_v=60Hz$ and the pattern should be changed according to the typical or maximum power condition.
The Max current can be measured only with the maximum power pattern.
See the page 7 for details.
3. Maximum Condition of Inrush current :
The duration of rush current is about 5ms and rising time of power Input is $500\mu s \pm 20\%$. (min.).
4. V_{LCD} level must be measured between two points on PCB of LCM (V_{LCD} (test point) ~ LCM Ground)
(Test condition : maximum power pattern, $25^{\circ}C$, $f_v=60Hz$)

* f_v =frame frequency

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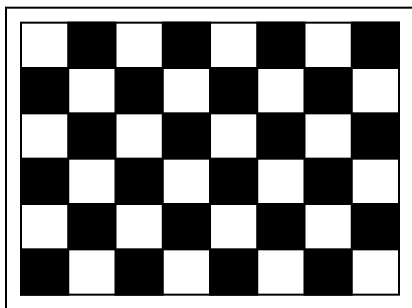
- **Permissive Power input ripple** ($V_{LCD} = 10.0V$, $25^{\circ}C$, f_v (frame frequency)=MAX condition)



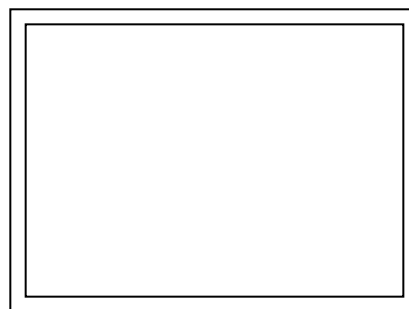
White pattern

For the exact ripple measurement, the condition of Max 20Mhz is recommended in the Bandwidth configuration of oscilloscope.

- **Power consumption** ($V_{LCD} = 10V$, $25^{\circ}C$, f_v (frame frequency)=60Hz condition)



Typical power Pattern



Maximum power Pattern

[FIG. 3] Mosaic pattern & White Pattern for power consumption measurement

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Table 2-2. ELECTRICAL CHARACTERISTICS of LED bar

Parameter	Symbol	Values			Unit	Notes
		Min.	Typ.	Max.		
LED String Current	Is	-	120	125	mA	1, 2
LED String Voltage	Vs	50.4	54.0	57.6	V	1, 3
Power Consumption	P _{Bar}	-	19.4	20.7	Watt	1, 2, 5
LED Life Time	LED_LT	30,000	-	-	Hrs	4

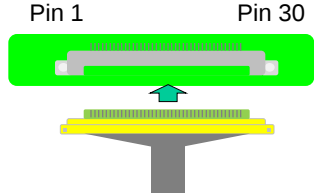
Notes) The LED bar consists of 54 LED packages, 3 strings (parallel) x 18 packages (serial) x 1 bar

1. The specified values are for single LED bar.
2. The specified current is defined as the input current for single LED string with 100% duty cycle.
3. The specified voltage is the input LED string voltage at typical current 100% duty cycle.
4. The LED life time is defined as the time when the LED PKG brightness reach to the 50% of initial value under the conditions at $T_a = 25 \pm 2^\circ\text{C}$ and typical LED string current.
5. The power consumption shown above does not include the loss of external LED driver.
 The typical power consumption is calculated as $P_{\text{Bar}} = V_s(\text{Typ.}) \times I_s(\text{Typ.}) \times \text{No. of strings}$.
 The maximum power consumption is calculated as $P_{\text{Bar}} = V_s(\text{Max.}) \times I_s(\text{Typ.}) \times \text{No. of strings}$.

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3-2. Interface Connections

Table 3. MODULE CONNECTOR(CN1) PIN CONFIGURATION

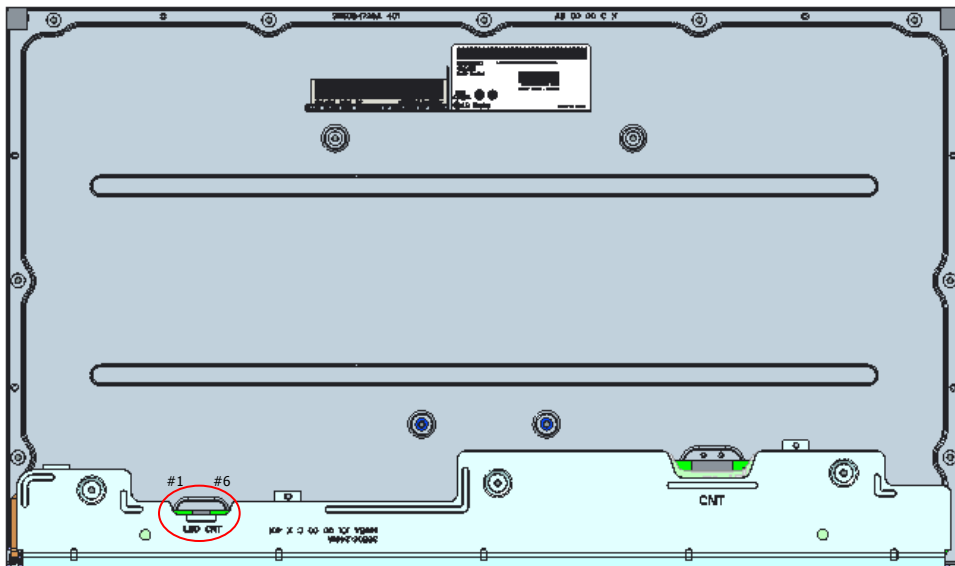
Pin	Symbol	Description	Notes
1	VIN	Power Supply +10.0V	[Connector] GT05Q-30S-H10-MN, LSMtron, 30pin, 0.5pitch or equivalent [Mating Connector] 20453-030T-01, I-Pex series or equivalent [Connector pin arrangement] 
2	VIN	Power Supply +10.0V	
3	VIN	Power Supply +10.0V	
4	VIN	Power Supply +10.0V	
5	VIN	Power Supply +10.0V	
6	NC	No Connection	
7	GND	Ground	
8	NC	Reserved for LCD manufacture's use	
9	NC	Reserved for LCD manufacture's use	
10	GND	Ground	
11	HPD	Hot Plug Detect Signal	
12	GND	Ground	
13	AUX_CHN	Component Signal for Auxiliary Channel	
14	AUX_CHP	True Signal for Auxiliary Channel	
15	GND	Ground	
16	Lane0P	True Signal for Main Link 0	
17	Lane0N	Component Signal for Main Link 0	
18	GND	Ground	
19	Lane1P	True Signal for Main Link 1	
20	Lane1N	Component Signal for Main Link 1	
21	GND	Ground	
22	Lane2P	True Signal for Main Link 2	
23	Lane2N	Component Signal for Main Link 2	
24	GND	Ground	
25	Lane3P	True Signal for Main Link 3	
26	Lane3N	Component Signal for Main Link 3	
27	GND	Ground	
28	BIST	L(GND): Black, H(3.3V): Rotational Pattern	
29	NC	No Connection	
30	GND	Ground	

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Table 4. BACKLIGHT CONNECTOR PIN CONFIGURATION(CN2)

The LED interface connector is SM06B-SHJH(HF)_Wire-locking type manufactured by JST or equivalent.
 The mating connector is a SHJP-06V-S(HF) or SHJP-06V-A-K(HF) or Equivalent.
 The pin configuration for the connector is shown in the table below.

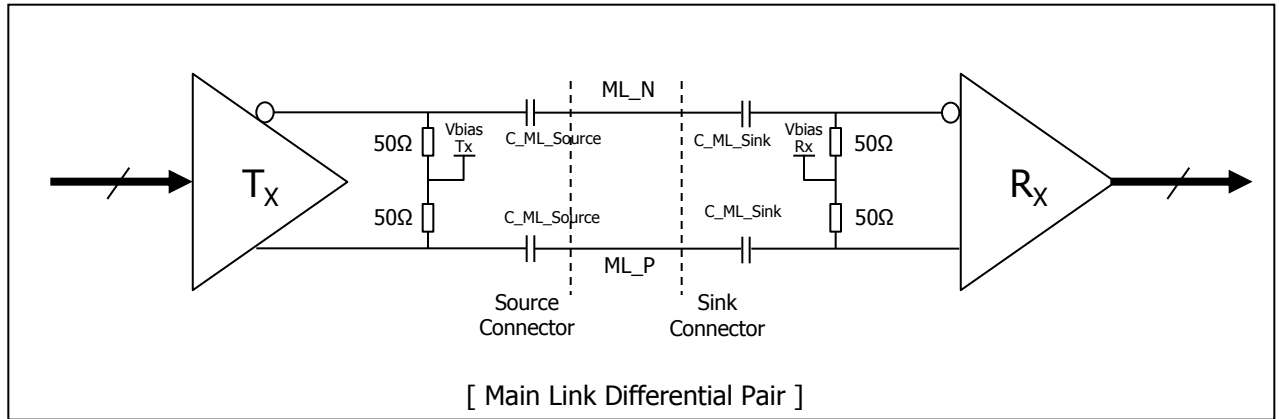
Pin	Symbol	Description	Notes
1	FB1	Channel1 Current Feedback	
2	NC	No Connection	
3	VLED	LED Power Supply	
4	VLED	LED Power Supply	
5	FB2	Channel2 Current Feedback	
6	FB3	Channel3 Current Feedback	


Rear view of LCM
[FIG. 4] Backlight connector view

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3-3. eDP Signal Specifications

3-3-1. eDP Main Link Signal



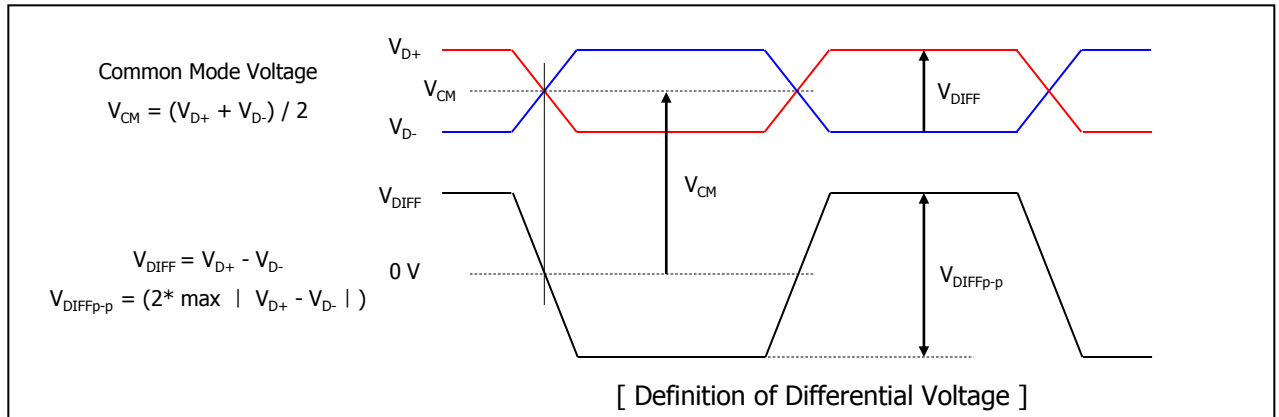
Parameter	Symbol	Min	Typ	Max	Unit	Notes
Unit Interval for high bit rate (5.4Gbps / lane)	UI_HBR2	-	185	-	ps	
Link Clock Down Spreading	Amplitude	0	-	0.5	%	
	Frequency	30		33	kHz	
Differential peak-to-peak voltage at Sink side connector	$V_{RX-DIFFp-p}$	-	-	1.38	V	Note 6,7)
EYE width at Sink side connector	$T_{RX-EYE-CONN}$	0.38	-	-	UI	Note 6,7)
Lane-to-Lane skew	$L_{RX-SKEW-INTER_PAIR}$	-	-	4UI+ 500ps		
Lane intra-pair skew	$L_{RX-SKEW-INTRA_PAIR}$	-	-	50	ps	
AC Coupling Capacitor	$C_{SOURCE-ML}$	75		200	nF	Source side

Note)

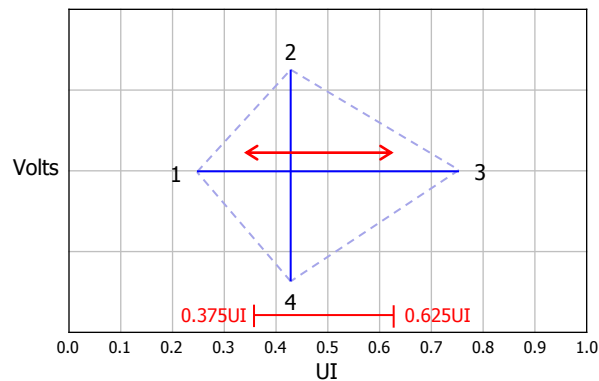
1. Termination resistor is typically integrated into the transmitter and receiver implementations.
2. In cabled embedded system, it is recommended the system designer ensure that EYE width and voltage are met at the sink side connector pins.
3. Mismatched common mode voltage will occur abnormal display.
4. All eDP electrical spec is measured at sink connector side.
5. eDP cable Impedance recommend 100ohm $\pm$ 5%.

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Note6) Definition of Differential Voltage



Note7) Main Link EYE Diagram

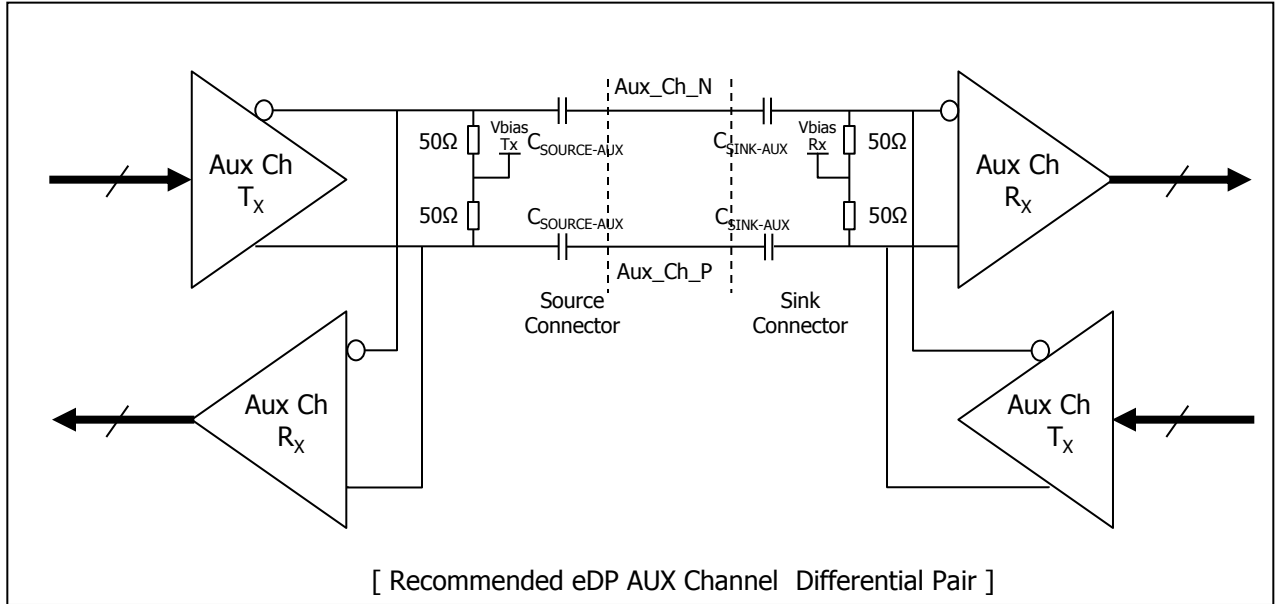


Point	High Bit Rate 2 @ TP3 EQ	
	Time(UI)	Voltage(V)
1	Any UI location (x) where the eye width is open from x to x+0.38UI	0.000
2	Any passing UI location between 0.375UI-0.625UI	0.045
3	Point 1 + 0.38UI	0.000
4	Same as Point 2	-0.045

[EYE Mask Vertices at embedded DP Sink Connector Pins]

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3-3-2. eDP AUX Channel Signal



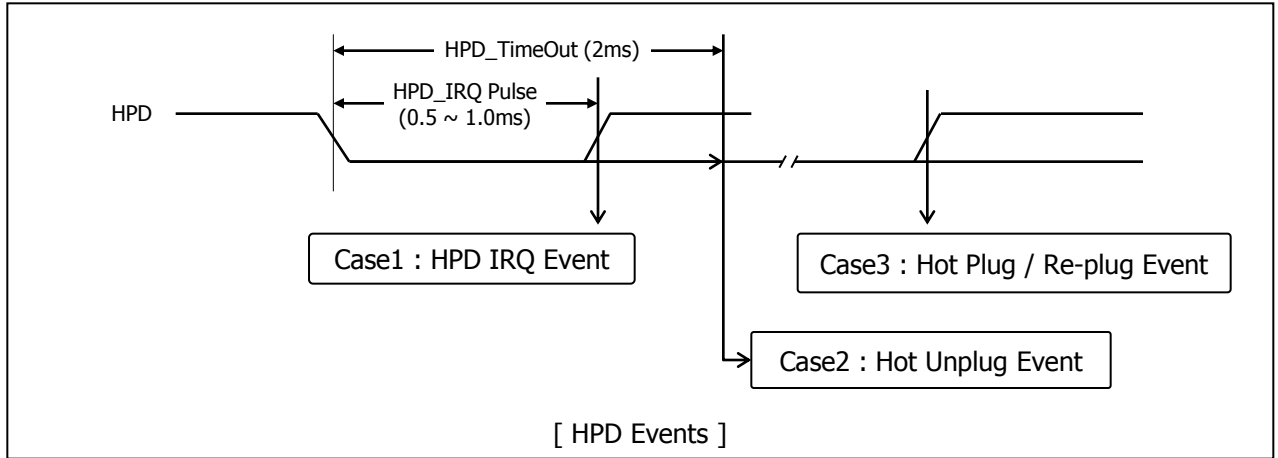
Parameter	Symbol	Min	Typ	Max	Unit	Notes
AUX Unit Interval	UI	0.4	-	0.6	us	
AUX Jitter at Tx IC Package Pins	T_{jitter}	-	-	0.04	UI	Equal to 24ns
AUX Jitter at Rx IC Package Pins		-	-	0.05	UI	Equal to 30ns
AUX Peak-to-peak voltage at Connector Pins of Receiving	$V_{AUX-DIFFp-p}$	0.32	-	1.36	V	
AUX Peak-to-peak voltage at Connector Pins of Transmitting		0.39	-	1.38	V	
AUX EYE width at Connector Pins of Tx and Rx		0.98	-	-	UI	
AUX DC common mode voltage	V_{AUX-CM_Rx}	-	0	2.0	V	
	V_{AUX-CM_Tx}	-	0.15	2.0	V	
AUX AC Coupling Capacitor	$C_{SOURCE-AUX}$	75		200	nF	Source side

Note)

1. Termination resistor is typically integrated into the transmitter and receiver implementations.
2. $V_{AUX-DIFFp-p} = 2 * |V_{AUXP} - V_{AUXN}|$
3. Termination resistor should be $\pm 50\Omega$ at source side to AUX level.
4. At sink side AUX cap. are for protection ESD/EOS damage.
5. Mismatched common mode voltage will occur abnormal display.

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3-3-3. eDP HPD Signal



Parameter	Symbol	Min	Typ	Max	Unit	Notes
HPD Voltage	HPD	2.25	-	3.6	V	Sink side Driving
Hot Plug Detection Threshold		2.0	-	-	V	Source side Detecting
Hot Unplug Detection Threshold		-	-	0.8	V	
HPD_IRQ Pulse Width	HPD_IRQ	0.5	-	1.0	ms	
HPD_TimeOut		2.0	-	-	ms	HPD Unplug Event

Note)

1. HPD IRQ : Sink device wants to notify the Source device that Sink's status has changed so it toggles HPD line, forcing the Source device to read its Link / Sink Receiver DPCD field via the AUX-CH
2. HPD Unplug : The Sink device is no longer attached to the Source device and the Source device may then disable its Main Link as a power saving mode
3. Plug / Re-plug : The Sink device is now attached to the Source device, forcing the Source device to read its Receiver capabilities and Link / Sink status Receiver DPCD fields via the AUX-CH

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3-4. Signal Timing Specifications

This is signal timing requirement from the signal transmitter. All of the interface signal timing should satisfy the following specifications for its proper operation.

Table 5. TIMING TABLE

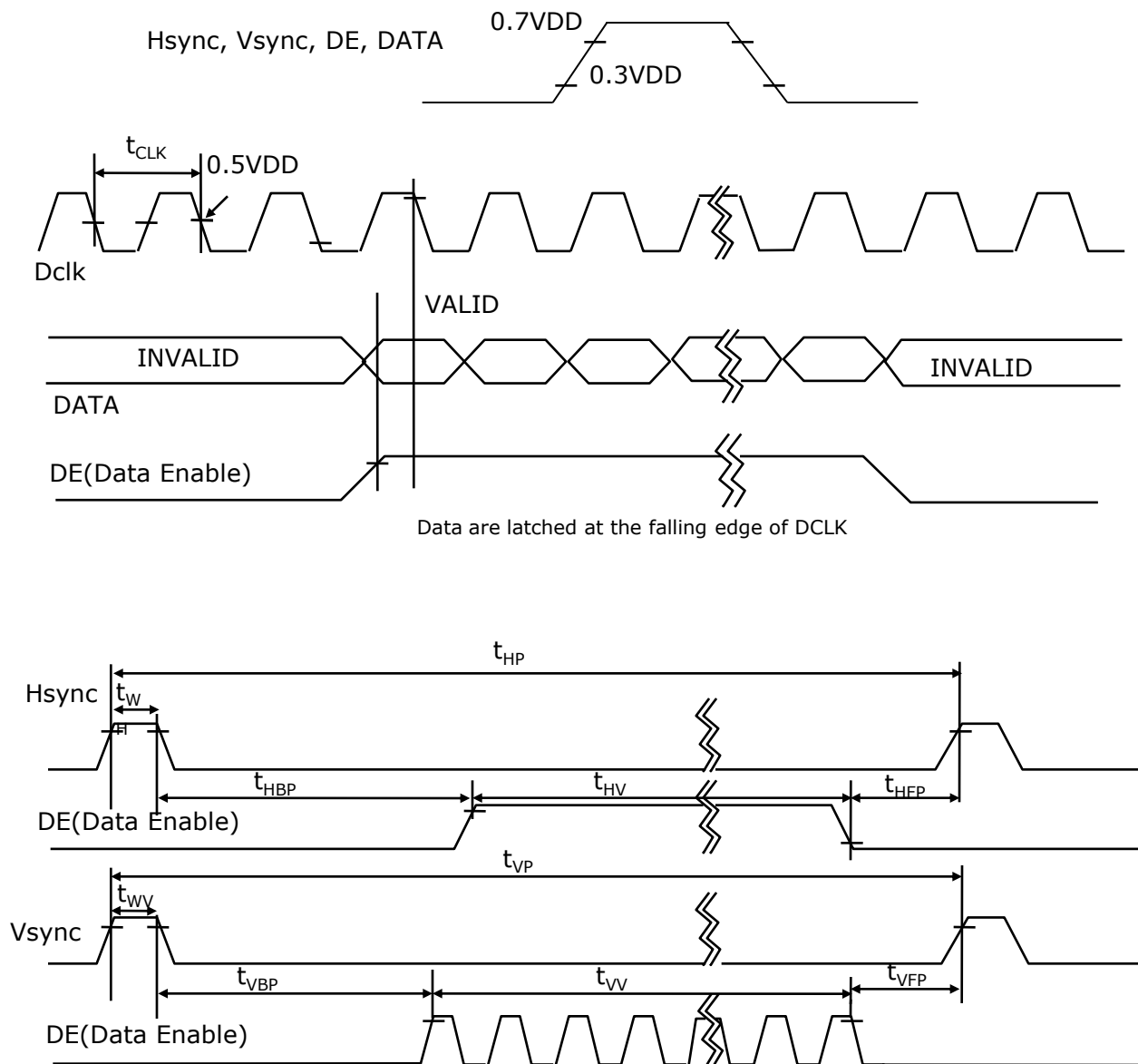
ITEM		SYMBOL	Min	Typ	Max	Unit	Note
DCLK	Period	tCLK	1.82	1.875	1.93	ns	
	Frequency	fCLK	518.25	533.25	548.25	MHz	-
Hsync	Period	tHP	3968	4000	4040	tCLK	1,2,3,4
	Width-Active	tWH	28	32	36		
Vsync	Period	tVP	2220	2222	2268	tHP	
	Frequency	fV	58.2	59.997	61.68	Hz	
	Width-Active	tWV	5	5	5	tHP	
Data Enable	Horizontal Valid	tHV	3840	3840	3840	tCLK	
	Horizontal Back Porch	tHBP	52	80	116		
	Horizontal Front Porch	tHFP	48	48	48		
	Horizontal Blank	tWH+ tHBP+ tHFP	128	160	200		
	Vertical Valid	tVV	2160	2160	2160	tHP	
	Vertical Back Porch	tVBP	52	54	100		
	Vertical Front Porch	tVFP	3	3	3		
	Vertical Blank	tWV+ tVBP+ tVFP	60	62	108		

Note:

- 1.The value of Hsync period,Hsync width and Hsync valid should be even number times of tCLK.
If the value is odd number times of tCLK, it can make asynchronous signal timing and cause abnormal display.
- 2.The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
- 3.The value of Hsync Period, Hsync Width, and Horizontal Back Porch should be divided by 4 without a remainder.
4. The polarity of Hsync, Vsync is not restricted.

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3-5. Signal Timing Waveforms



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3-6. Color Input 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 6. COLOR DATA REFERENCE

Color		Input Color Data																													
		RED										GREEN										BLUE									
		MSB					LSB					MSB					LSB					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	0	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	0	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	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	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	0
	...	...										...										...									
	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	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

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3-7. Power Sequence

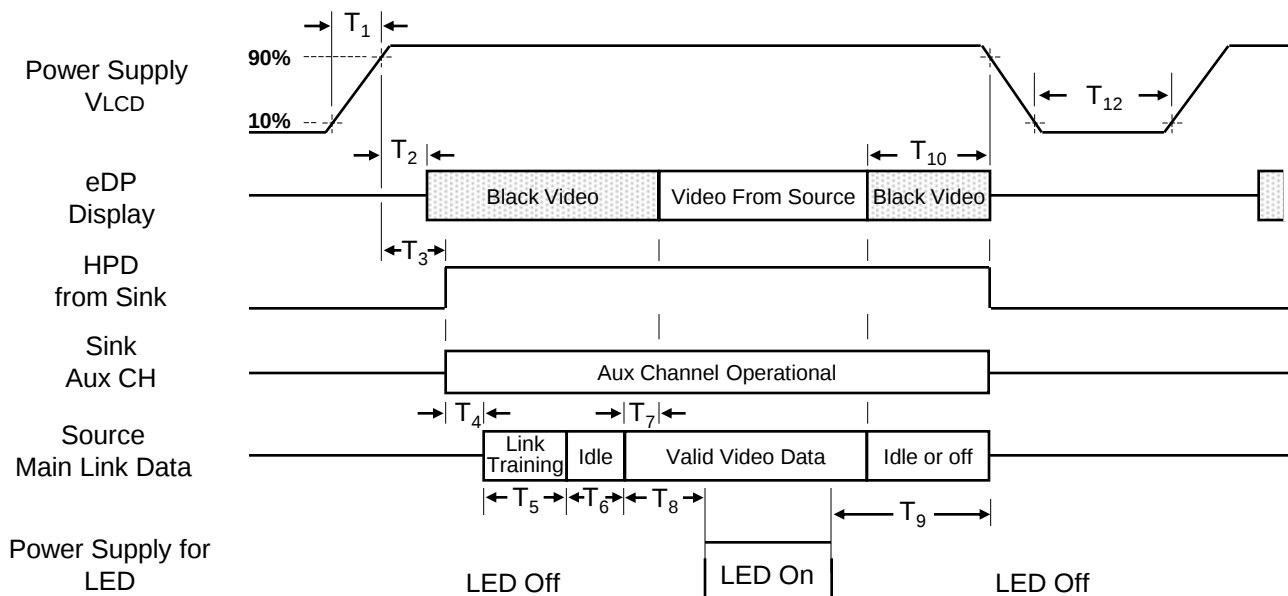


Table 7. Power Sequence

Timing	Required By	Limits		Units	Notes
		Min	Max		
T_1	Source	0.5	10	ms	-
T_2	Sink	10	200	ms	-
T_3	Sink	15	200	ms	-
T_4	Source	-	-	ms	7
T_5	Source	-	-	ms	7
T_6	Source	-	100	ms	-

Timing	Required By	Limits		Units	Notes
		Min	Max		
T_7	Sink	0	50	ms	-
T_8	Source	200	-	ms	
T_9	Source	200	-	ms	8
T_{10}	Source	0	500	ms	-
T_{12}	Source	1000	-	ms	

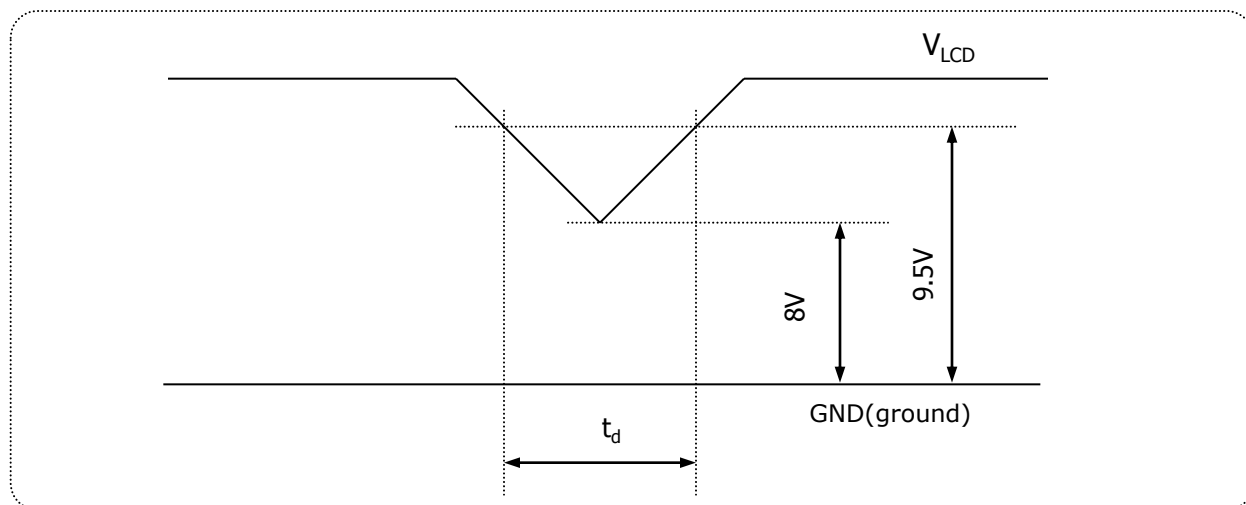
Notes :

- Power sequence should be kept all the time including below cases for normal operation.
 - .AC/DC Power On/Off
 - .Mode change (Resolution, frequency, timing, sleep mode, Color depth change, etc.)

The violation of power sequence can cause a significant trouble in display and reliability.
- Please avoid floating state of interface signal during signal invalid period.
- When the interface signal is invalid, be sure to pull down the V_{LCD}(0V).
- Please turn off the power supply for LED when the level of V_{LCD} changes to prevent noise issue.
- Do not insert the mating cable when system turn on.
- Valid Data have to meet "3-4. Signal Timing Specifications"
- Link training duration is dependent on the customer's system.
- LED power must be turned off while Video data signal is valid

Product Specification

3-8. V_{LCD} Power Dip Condition



[FIG. 5] Power dip condition

For proper operation, stable power supply of V_{LCD} is necessary and power dip is allowed only in below condition. Except this condition, power on/off should follow power sequence specification in page 18 exactly.

1) Dip condition

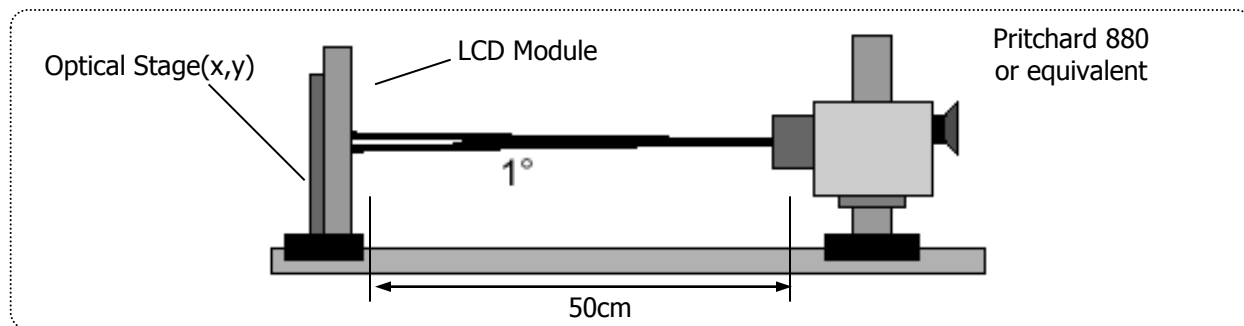
$$8V \leq V_{LCD} < 9.5V, t_d \leq 20ms$$

Product Specification

4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at $25 \pm 2^\circ\text{C}$. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0° and aperture 1 degree.

FIG. 6 presents additional information concerning the measurement equipment and method.



[FIG. 6] Optical Characteristic Measurement Equipment and Method

Table 8. OPTICAL CHARACTERISTICS

($T_a = 25^\circ\text{C}$, $V_{\text{LCD}} = 10.0\text{V}$, $f_v = 60\text{Hz}$ Dclk=533.25MHz, $I_s = 120\text{mA}$)

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	910	1300	-		1
Surface Luminance, white		L_{WH}	280	350	-	cd/m^2	2
Luminance Variation		δ_{WHITE}	75	-	-	%	3
Response Time	Gray To Gray	$T_{\text{GTG_AVR}}$	-	14	25	ms	4
Color Coordinates [CIE1931] (By PR650)	RED	R_x	Typ -0.03	0.655	Typ +0.03		
		R_y		0.333			
	GREEN	G_x		0.304			
		G_y		0.637			
	BLUE	B_x		0.151			
		B_y		0.056			
	WHITE	W_x		0.313			
		W_y		0.329			
Viewing Angle (CR>10)							
General	Horizontal	θ_H	170	178	-	Degree	5
	Vertical	θ_V	170	178	-		
Gray Scale		-		2.2			6

Product Specification

Notes

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

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

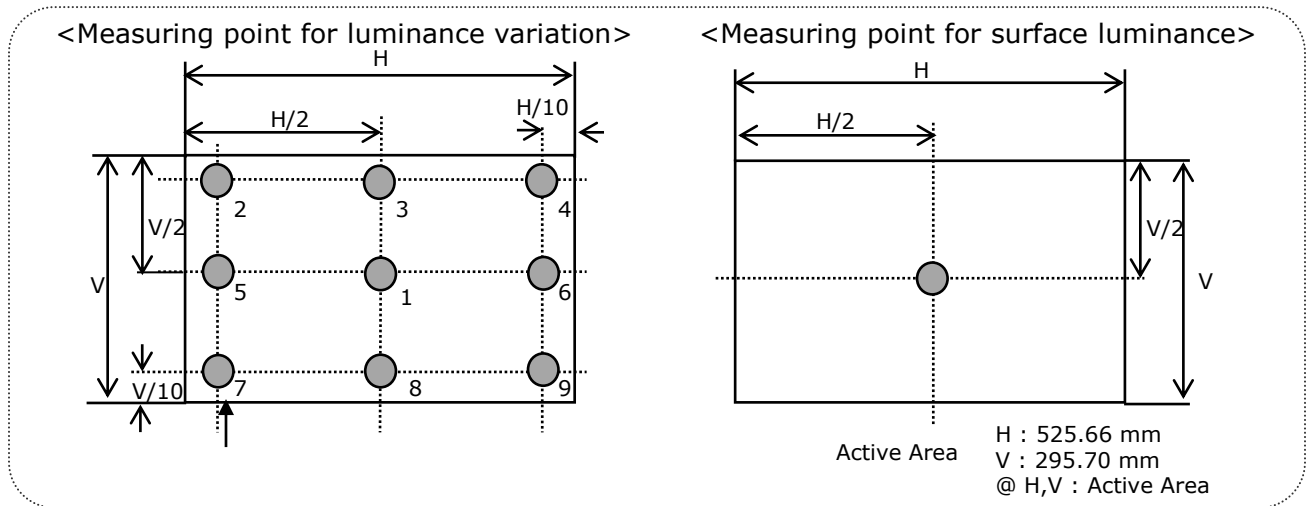
It is measured at center point(Location P1)

2. Surface luminance(L_{WH}) is luminance value at Center 1 point(P1) across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG.7 (By PR880)

3. The variation in surface luminance , δ_{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.7



[FIG. 7] Measure Point for Luminance

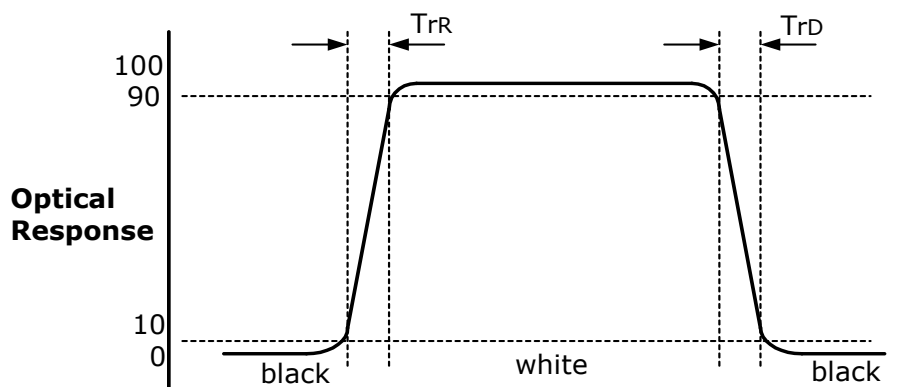
Product Specification

4. Gray to gray response time is the time required for the display to transition from gray to gray.
 For additional information see Table 9. **(By PR880)**

Table 9. Gray to gray response time table

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

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

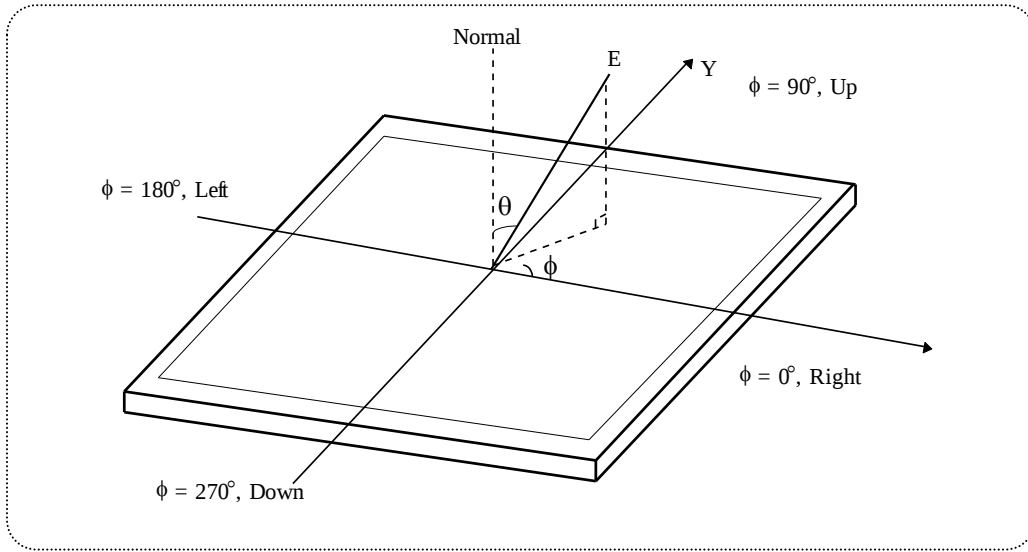


[FIG. 8] Response time

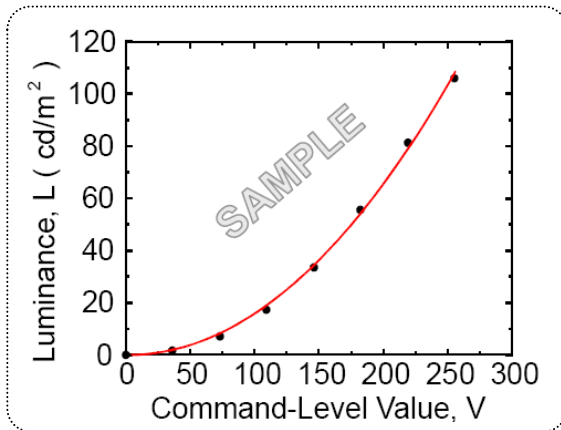
Product Specification

5. 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.9 **(By PR880)**

Dimension of viewing angle range.

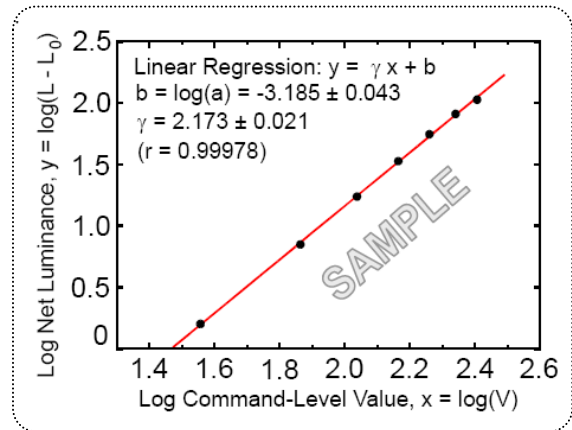


[FIG. 9] Viewing angle



[FIG. 10] Sample Luminance vs. gray scale
(using a 256 bit gray scale)

$$L = aV^r + L_b$$



[FIG. 11] Sample Log-log plot of
luminance vs. gray scale

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

Here the Parameter a and γ relate the signal level V to the luminance L .

The GAMMA we calculate from the log-log representation (FIG.11)

Product Specification

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

Table 10. 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

Product Specification

5. Mechanical Characteristics

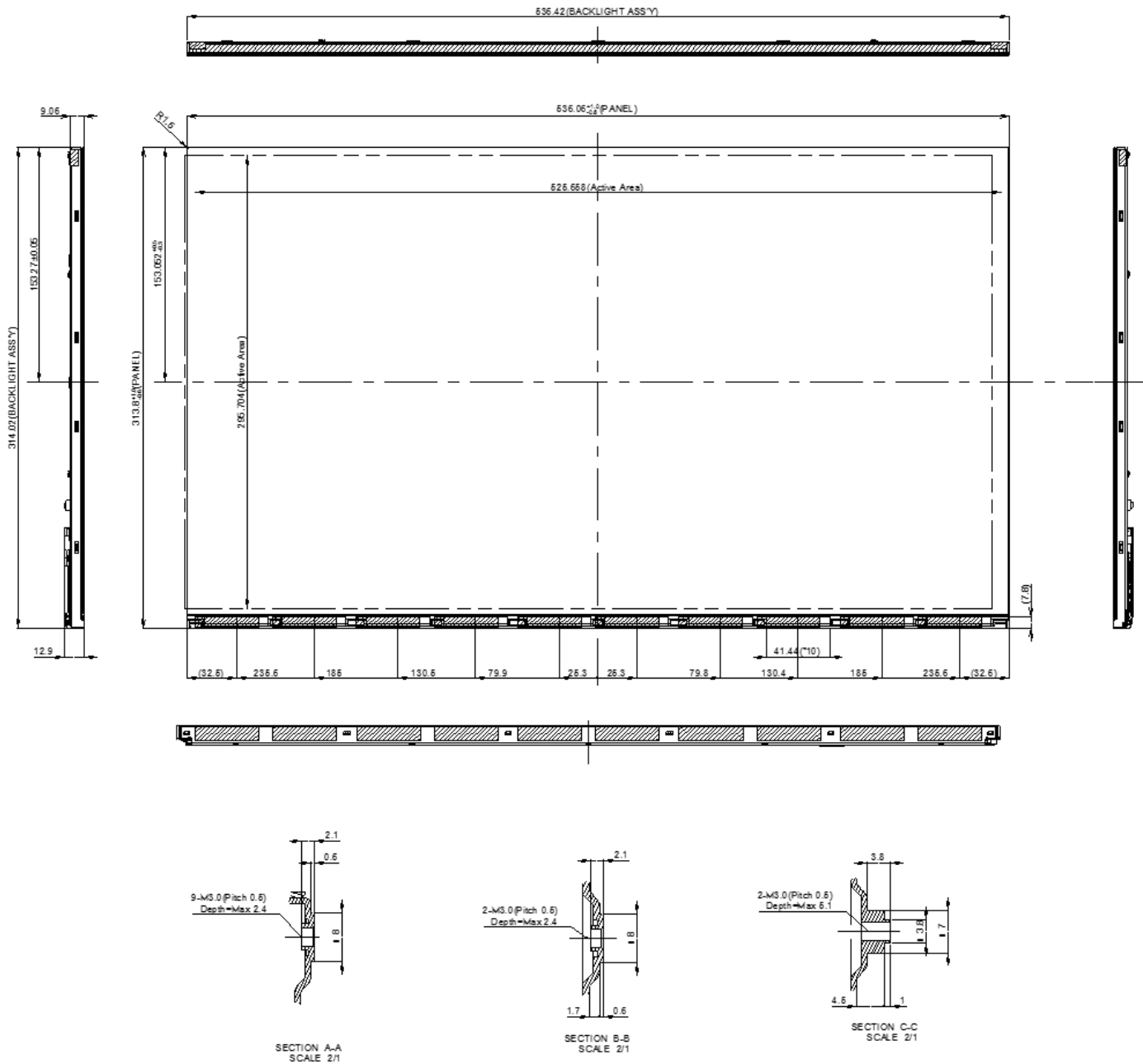
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline Dimension	Horizontal	536.3mm
	Vertical	313.9mm
	Depth	12.9 mm
Bezel Area	Horizontal	-
	Vertical	-
Active Display Area	Horizontal	525.66mm
	Vertical	295.70mm
Weight	1610g (Typ.) 1690g (Max.)	
Surface Treatment	Advanced Anti-glare treatment of the front polarizer (3H)	

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

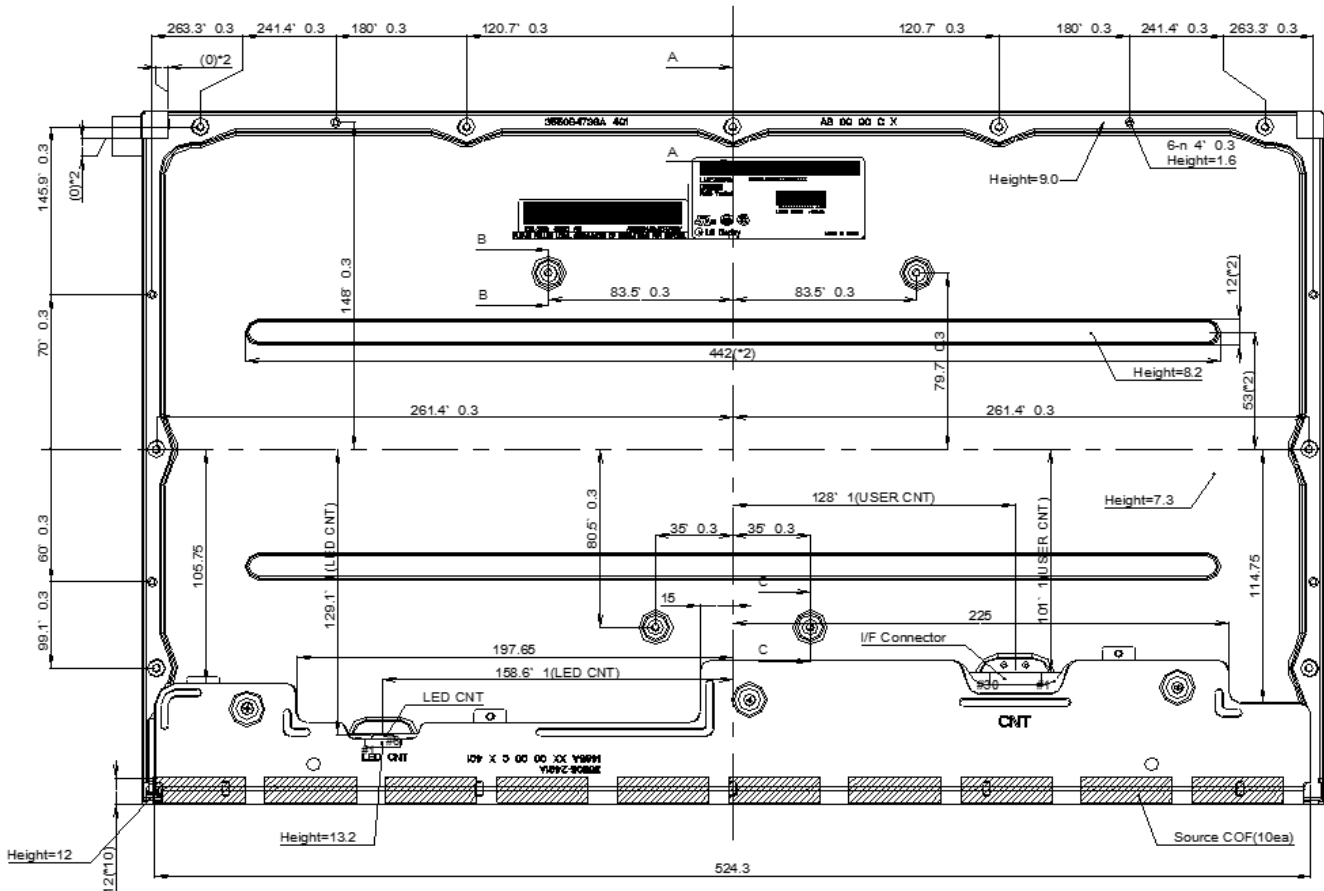
Product Specification

<FRONT VIEW>



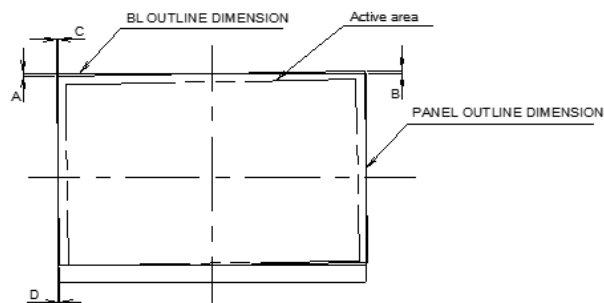
Product Specification

<REAR VIEW>



Notes

1. I/F connector specification : GT05Q-30S-H10-MN(LSMtron) or Equivalent.
2. LED connector specification : SM08B-SHJS(HF)(Manufactured by JST) or Equivalent.
3. Torque of user hole: 3.0~4.0kgf-cm.
4. Tilt and partial disposition tolerance of display area as following
(1) Y-direction : $-0.45 \leq A \leq 0.45$, $-0.45 \leq B \leq 0.45$
(2) X-direction : $-0.45 \leq C \leq 0.45$, $-0.45 \leq D \leq 0.45$



5. Unspecified tolerances to be ± 0.5
6. The LCM warp(warpage) is less than 1.0 on the surface plate
7. The COF area is weak & sensitive, so please don't press the COF area

Product Specification

6. Reliability

Environment test condition

No	Test Item	Condition	Notes
1	High temperature storage test	Ta= 60°C 240h	1
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	Humidity condition Operation	Ta= 40 °C ,90%RH	
6	Altitude operating storage / shipment	0 – 16,400 feet(5,000m) 0 - 40,000 feet(12,192m)	
7	Maximum Storage Humidity for 4 corner light leakage Mura.	Max 70%RH , Ta=40°C	

Note 1. Result Evaluation Criteria:

TFT-LCD panels test should take place after cooling enough at room temperature.

In the standard condition, there should be no particular problems that may affect the display function.

※. T_a= Ambient Temperature

Product Specification**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

7-2. Environment

- a) RoHS, Directive 2011/65/EU of the European Parliament and of the council of 8 June 2011

Product Specification

8. Packing

8-1. Designation of Lot Mark

a) Lot Mark

A	B	C	D	E	F	G	H	I	J	K	L	M
---	---	---	---	---	---	---	---	---	---	---	---	---

A,B,C : SIZE(INCH)
 E : MONTH

D : YEAR
 F ~ M : SERIAL NO.

Note

1. YEAR

Year	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

1) Package quantity in one box : 10 pcs

b) Box Size : 635mm X 370mm X 400mm

Product Specification

9. PRECAUTIONS

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

9-1. MOUNTING PRECAUTIONS

- (1) You must mount a module using holes arranged in rear side.
- (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 soaked 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 :
 $V = \pm 200\text{mV}$ (Over and under shoot voltage)
- (2) Response time depends on the temperature. (In lower temperature, it becomes longer.)
- (3) Brightness depends on the temperature. (In Higher temperature, it becomes lower.)
And in lower temperature, response time (required time that brightness is stable after turned on) becomes longer.
- (4) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
- (5) When fixed patterns are displayed for a long time, remnant image is likely to occur.
- (6) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.
- (7) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
- (8) A screw which is fastened up the steels should be a machine screw.
(if not, it causes metallic foreign material and deal LCM a fatal blow)
- (9) Please do not set LCD on its edge.
- (10) When LCMs are used for public display defects such as Yogore, image sticking can not be guaranteed.
- (11) LCMs cannot support "Interlaced Scan Method"
- (12) When this reverse model is used as a forward-type model (PCB on top side), LGD can not guarantee any defects of LCM.
- (13) Please conduct image sticking test after 2-hour aging with Rolling Pattern and normal temperature. (25~40°C)

Product Specification

9-3. ELECTROSTATIC DISCHARGE CONTROL

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

9-4. PRECAUTIONS FOR STRONG LIGHT EXPOSURE

Strong light exposure causes degradation of polarizer and color filter.

9-5. STORAGE

When storing modules as spares for a long time, the following precautions are necessary.

- (1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
- (2) The polarizer surface should not come in contact with any other object.
It is recommended that they be stored in the container in which they were shipped.

9-6. HANDLING PRECAUTIONS FOR PROTECTION FILM

- (1) The protection film is attached to the bezel with a small masking tape.
When the protection film is peeled off, static electricity is generated between the film and polarizer.
This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
- (2) When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the bezel after the protection film is peeled off.
- (3) You can remove the glue easily. When the glue remains on the bezel surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.