SPECIFICATION
FOR
APPROVAL

(◆) Preliminary Specification
( ) Final Specification

Title	27.0" QHD TFT LCD

BUYER	General
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM270WQ5
SUFFIX	SSA1

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

SIGNATURE **DATE**

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APPROVED BY **DATE**

REVIEWED BY

PREPARED BY

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

Monitor Product Engineering Dept.
LG Display Co., Ltd

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RECORD OF REVISIONS

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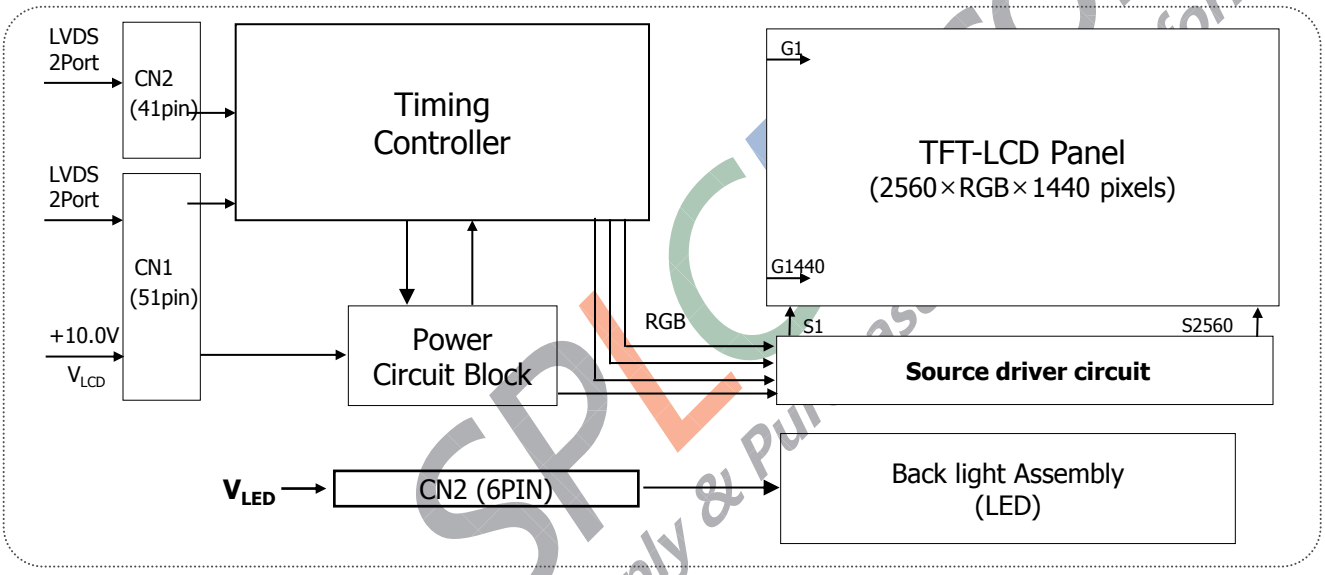
0.1	Jul. 02. 2015	-	First Draft, **Preliminary Specifications.**
0.2	Jul. 16. 2015	8	Update the spec of LED bar electrical characteristics
		16	Modify the spec of signal timing table
		28, 29	Update the mechanical drawing
0.3	Sep. 24. 2015	4, 27	Update the spec of LCD module weight
		4, 6	Update the spec of power consumption and current
0.4	Oct. 15. 2015	21	Update the color coordinate spec of R/G/B and tolerance
0.5	Dec. 24. 2015	4, 6	Update the spec of current and power consumption
		8	Update the note of LED bar electrical characteristics
		21	Update the spec of color coordinate
		32	Update the information of packing form

1. General Description

LM270WQ5 is a Color Active Matrix Liquid Crystal Display with a Light Emitting Diode (LED)backlight Assembly 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 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16.78M colors. It has been designed to apply the 8-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	608.6 (H) x 348.3 (V) x 12.7 (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	16.78M colors, 8Bit
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 21.9 Watt (Typ.) (5.1 Watt @VLCD_Mosaic, 16.8Watt @Is=90mA)
Weight	2,900 g (Typ.)
Display Operating Mode	Transmissive mode, normally black
Module type	4-side borderless
Panel type	Reverse
Surface Treatment	Anti-Glare treatment of the front polarizer (Haze25%, 3H)

2. Absolute Maximum Ratings

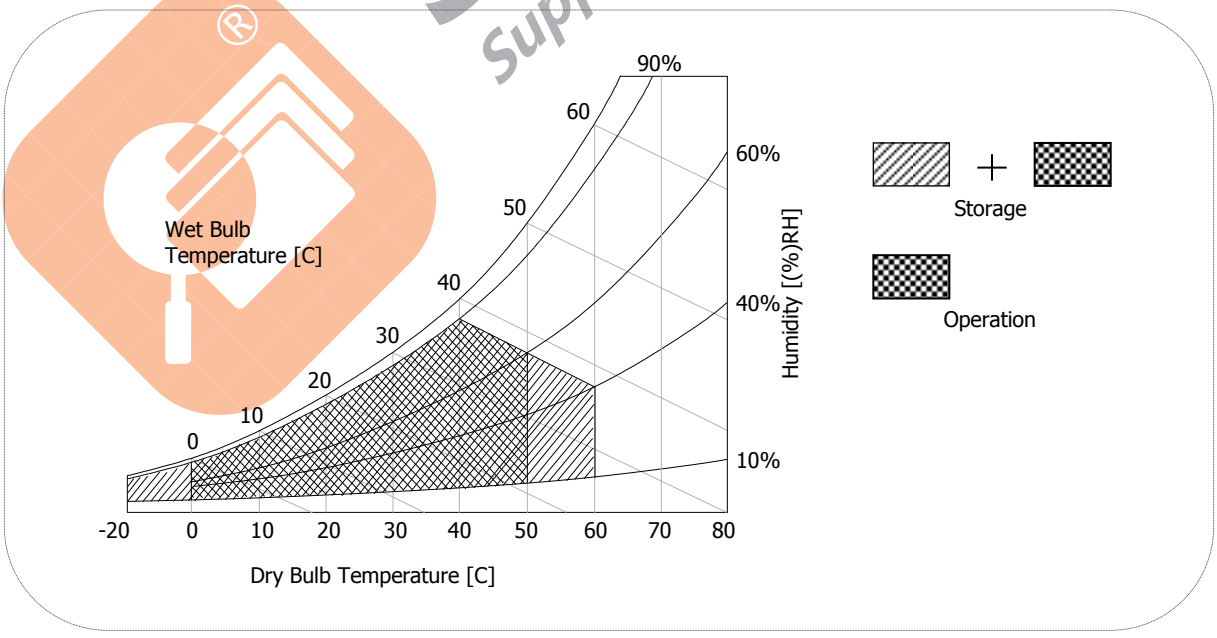
The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	VLCD	-0.3	11.0	Vdc	at 25 ± 2°C
Operating Temperature	TOP	0	50	°C	1, 2
Storage Temperature	TST	-20	60	°C	
Operating Ambient Humidity	HOP	10	90	%RH	
Storage Humidity	HST	10	90	%RH	
LCM Surface Temperature (Operation)	$T_{Surface}$	0	65	℃	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℃, 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℃ and Max. 65℃ under the VLCD=10.0V, fV=60Hz, 25℃ ambient Temperature no humidity control and LED string current is typical value.

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}	9.5	10	10.5	Vdc	5
Permissive Power Input Ripple	V_{ripple}			400	mVp-p	1
Power Supply Input Current	I_{LCD} TYP	-	510	630	mA	2
	I_{LCD} MAX	-	650	810	mA	3
Power Consumption	Pc TYP	-	5.1	6.3	Watt	2
	Pc MAX	-	6.5	8.1	Watt	3
Rush current	IRUSH	-	-	4.0	A	4

Note :

1. Permissive power ripple should be measured under VLCD =10.0V, 25°C, fV(frame frequency)=MAX condition and At that time, we recommend the bandwidth configuration of oscilloscope is to be under 20Mhz. See the next page.

2. The specified current and power consumption are under the VLCD=10.0V, 25± 2°C,fV=60Hz condition whereas Mosaic Pattern(8X6) is displayed and fV is the frame frequency.

3. The current is specified at the maximum current pattern.

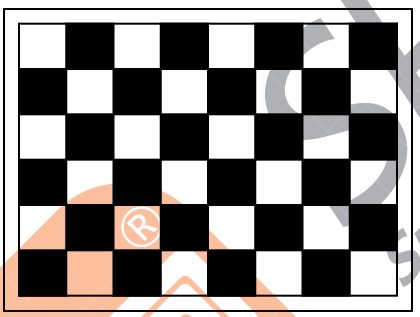
4. Maximum Condition of Inrush current :
   The duration of rush current is about 5ms and rising time of power Input is 500us 20%.(min.).

5. VLCD level must be measured from LCM PCB's two points, between VIN and LCM Ground.
   The measured level need to meet the Power supply input voltage spec.
   (Test condition : maximum power pattern , 25± 2°C, fV=60Hz)

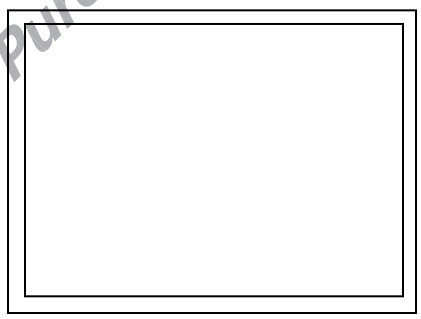
• **Permissive Power input ripple (**V_{LCD} =10V, 25°C, fv (frame frequency)=MAX condition**)**

Full White Pattern

• **Power consumption (**V_{LCD} =10V, 25°C, fV (frame frequency)=60Hz condition**)**



Typical power Pattern



Maximum power Pattern

FIG.2 Mosaic pattern(8x6) & Full White Pattern for power consumption measurement

Table 2-2. LED BAR ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min.	Typ.	Max.		
LED String Current	Is	-	90	95	mA	1, 2, 6
LED String Voltage	Vs	43.4	46.6	49.8	V	1, 3, 6
Power Consumption	PBar	-	16.8	17.9	Watt	1, 2, 5
LED Life Time	LED_LT	30,000	-	-	Hrs	4

Notes) The LED Bar consists of 64 LED packages, 4 strings (parallel) x 16 packages (serial)

LED driver design guide

: The design of the LED driver must have specifications for the LED in LCD Assembly.
The performance of the LED in LCM, for example life time or brightness, is extremely influenced by the characteristics of the LED driver.
So all the parameters of an LED driver should be carefully designed and output current should be Constant current control.
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.

1. The 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 LED life time is defined as the time when brightness of LED packages become 50% or less than the initial value under the conditions at Ta = 25 ± 2°C and LED string current is typical value.
5. The power consumption shown above does not include loss of external driver.
   The typical power consumption is calculated as PBar = Vs(Typ.) x Is(Typ.) x No. of strings.
   The maximum power consumption is calculated as PBar = Vs(Max.) x Is(Typ.) x No. of strings.
6. LED operating conditions are must not exceed Max. ratings.

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	ITLC	'H'(3.3V) = Enable , 'L' = Disable (Connect High or low, No NC Condition)	32	R2CN	SECOND LVDS Receiver Signal (C-)
7	LVDS Format	'H'(3.3V)= MSTAR Concept, 'L'=normal (Connect High or low, No NC Condition)	33	R2CP	SECOND LVDS Receiver Signal (C+)
8	NC	No Connection	34	GND	Ground
9	NC	No Connection	35	R2CLKN	SECOND LVDS Receiver Clock Signal(-)
10	PWM_OUT	Reference signal for LED Driver control	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	NC	No Connection
15	R1BP	FIRST LVDS Receiver Signal (B+)	41	NC	No Connection
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 +10.0V
23	R1DP	FIRST LVDS Receiver Signal (D+)	49	VLCD	Power Supply +10.0V
24	NC	No Connection	50	VLCD	Power Supply +10.0V
25	NC	No Connection	51	VLCD	Power Supply +10.0V
26	Reserved	No connection or GND	-	-	-

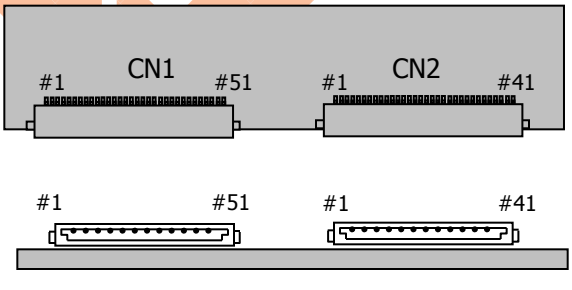
Notes : 1. All GND(ground) pins should be connected together to the LCD module's metal frame.
2. All VLCD (power input) pins should be connected together.
3. All Input levels of LVDS signals are based on the EIA 644 Standard.
4. Specific pins(pin No. #2~#5) are used for internal data process of the LCD module. If not used, these pins are no connection.
5. PWM_OUT is a reference signal for LED PWM control. This PWM signal is synchronized with vertical frequency. Its frequency is 5 times of vertical frequency, and its duty ratio is 50%. If the system don't use this pin, do not connect.

- 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	NC	No Connection
2	NC	No connection	23	NC	No Connection
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	NC	No Connection
18	R3CLKP	THIRD LVDS Receiver Clock Signal(+)	39	NC	No Connection
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.



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 CONNECTOR PIN CONFIGURATION(CN3)

The LED interface connector is a model BM06B-SHJS(HF)_Manufactured by JST or equivalent.
The mating connector is a SHJP-06V-S(HF), 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	FB2	Channel2 Current Feedback	
3	VLED	LED Power Supply	
4	VLED	LED Power Supply	
5	FB3	Channel3 Current Feedback	
6	FB4	Channel4 Current Feedback	

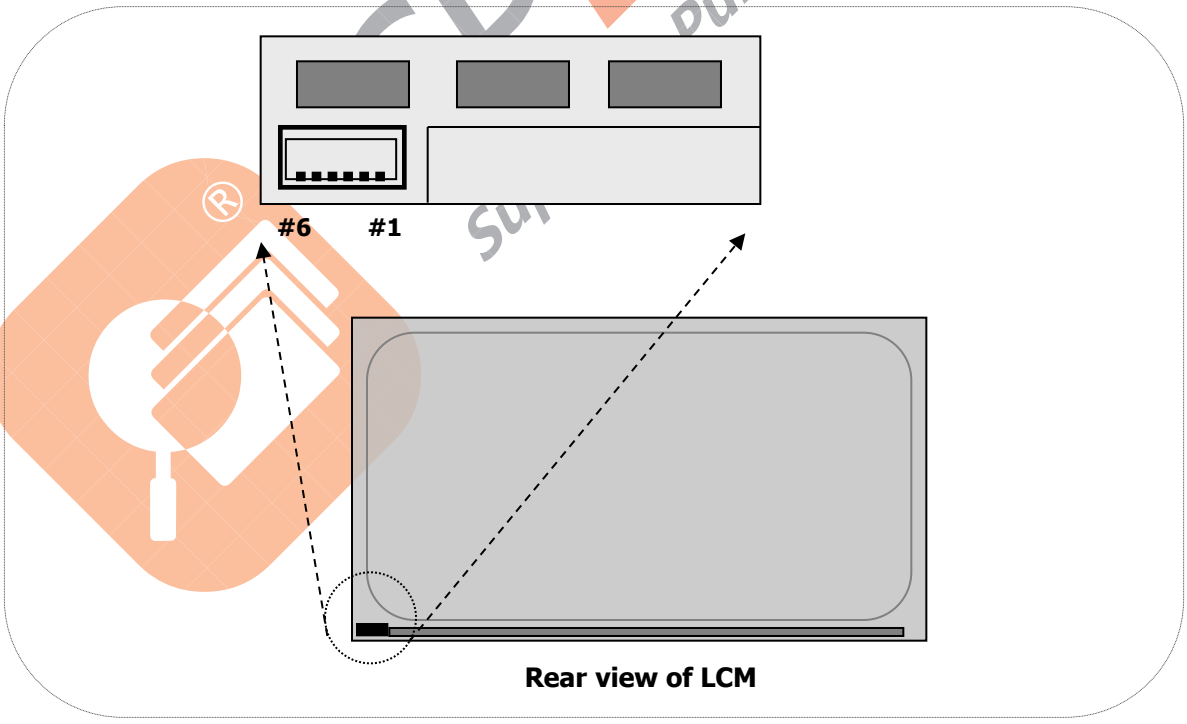
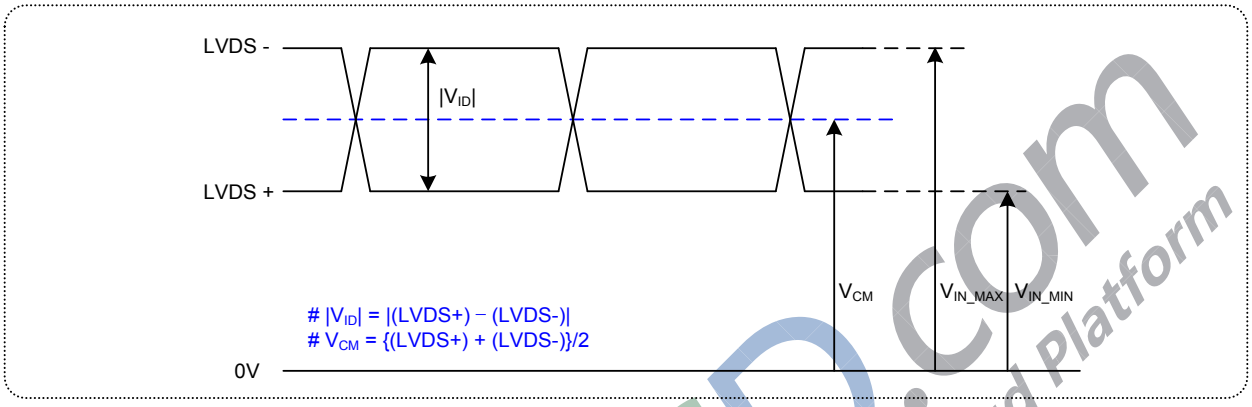


Figure 3. Backlight connector view

3-3. LVDS characteristics

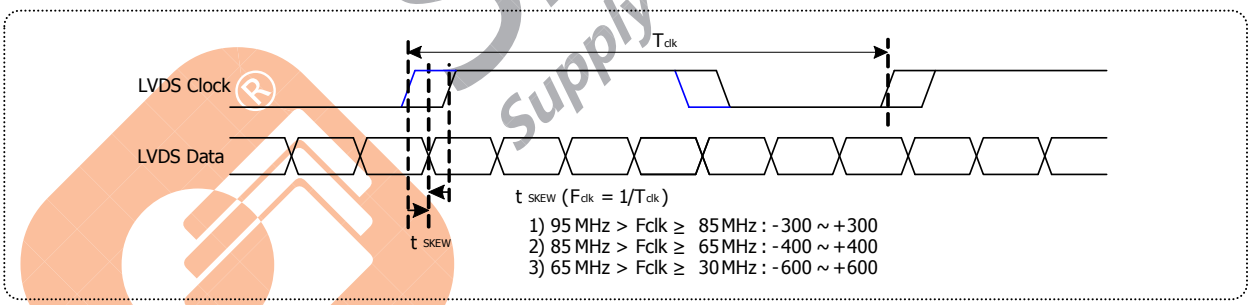
3-3-1. DC Specification



Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$\|V_{ID}\|$	150	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	ΔVCM	-	250	mV	-

Notes : Dose not have any Noise & Peaking in LVDS Signal

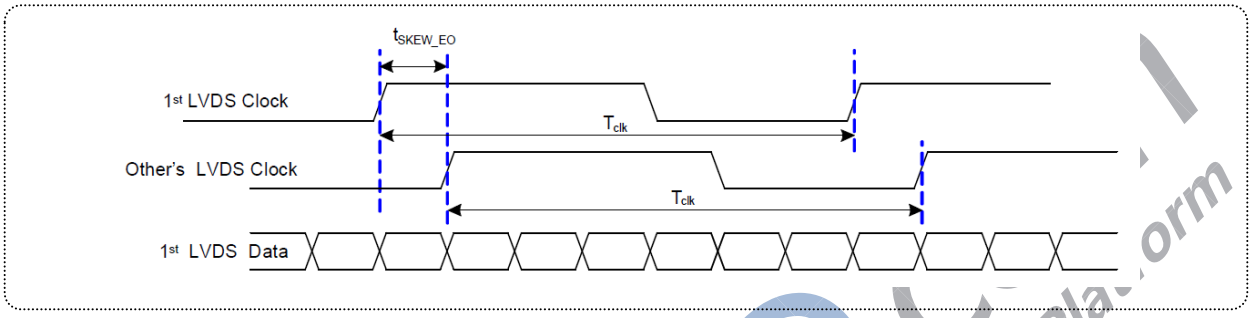
3-3-2. AC Specification



Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	- 300	+ 300	ps	95MHz > Fclk ≥ 85MHz
	t_{SKEW}	- 400	+ 400	ps	85MHz > Fclk ≥ 65MHz
	t_{SKEW}	- 600	+ 600	ps	65MHz > Fclk ≥ 30MHz
LVDS Clock to Clock Skew Margin (Even to Odd)	t_{SKEW_EO}	- 1/7	+ 1/7	T_{clk}	-

Note 1 :
LGD recommend the SI should be adjust the SSC deviation and modulation frequency in order not to happen any kinds of defect phenomenon.

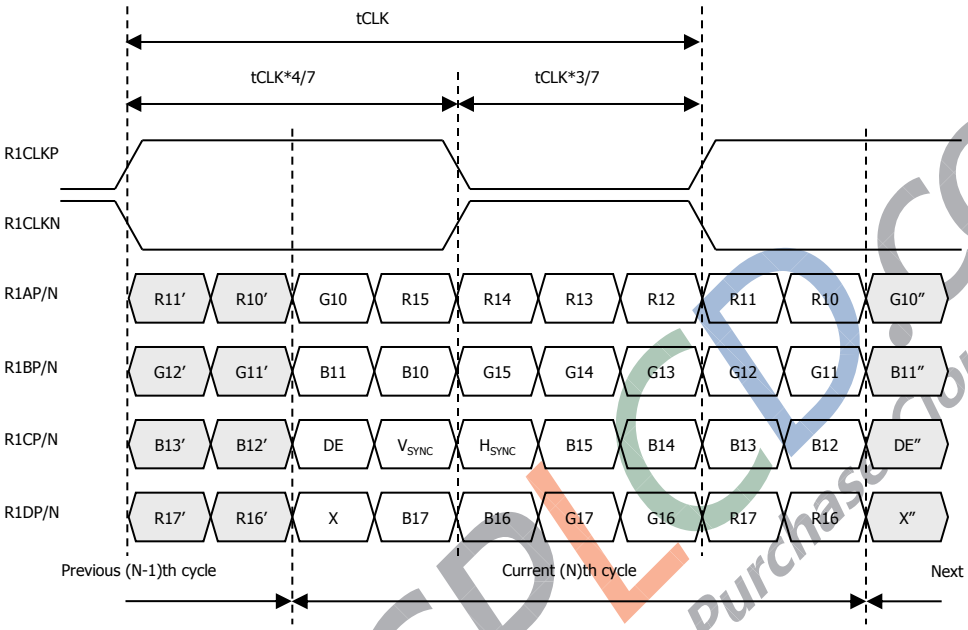
3-3-2. AC Specification



< LVDS Clock to Clock Skew Margin (1st port to other ports >

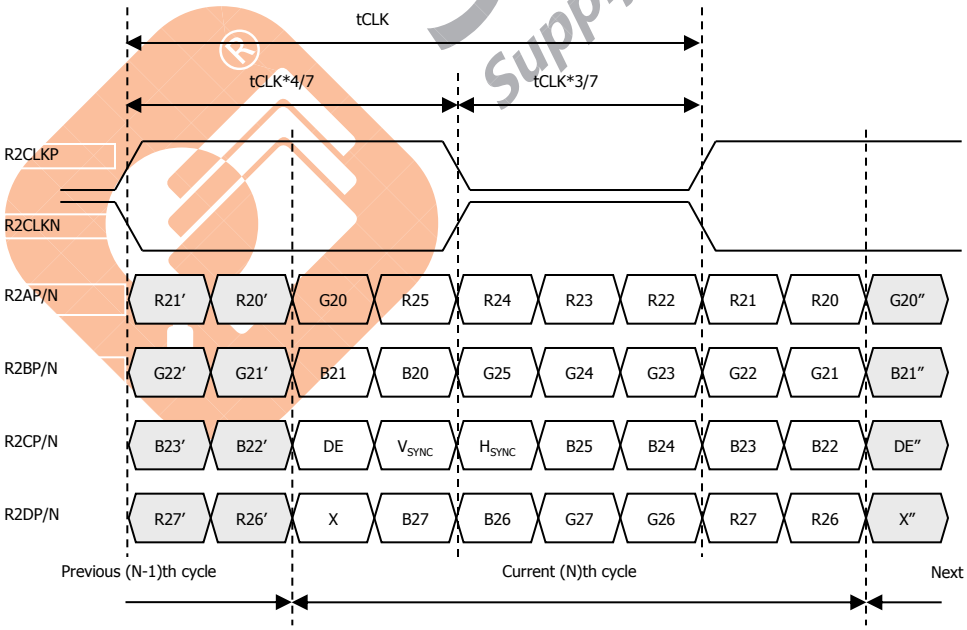
3-3-3. LVDS data format (8bit, VESA)

■ 1st LVDS Channel



MSB	R17/G17/B17
	R16/G16/B16
	R15/G15/B15
	R14/G14/B14
	R13/G13/B13
	R12/G12/B12
	R11/G11/B11
LSB	R10/G10/B10

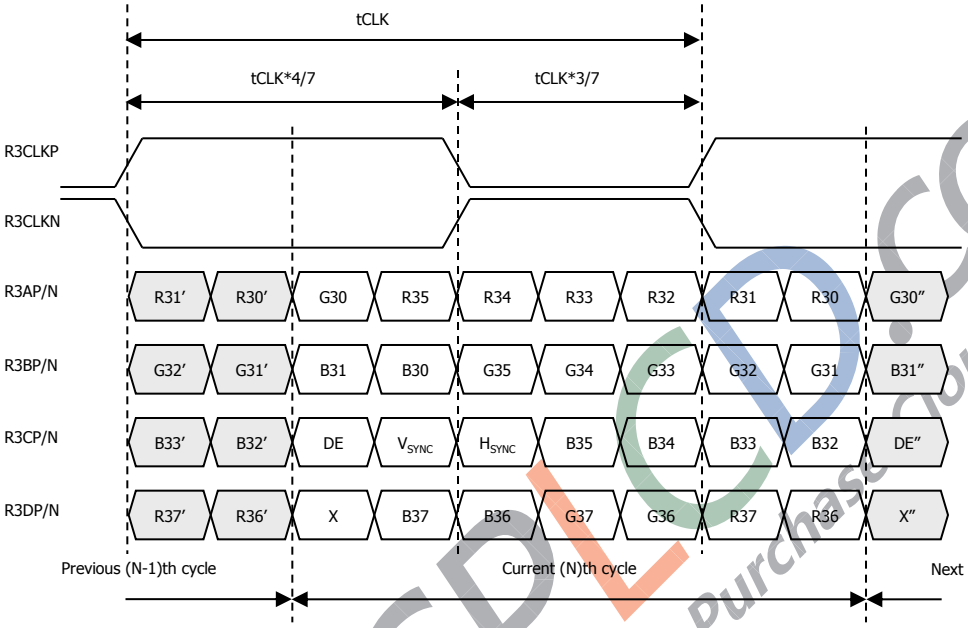
■ 2nd LVDS Channel



MSB	R27/G27/B27
	R26/G26/B26
	R25/G25/B25
	R24/G24/B24
	R23/G23/B23
	R22/G22/B22
	R21/G21/B21
LSB	R20/G20/B20

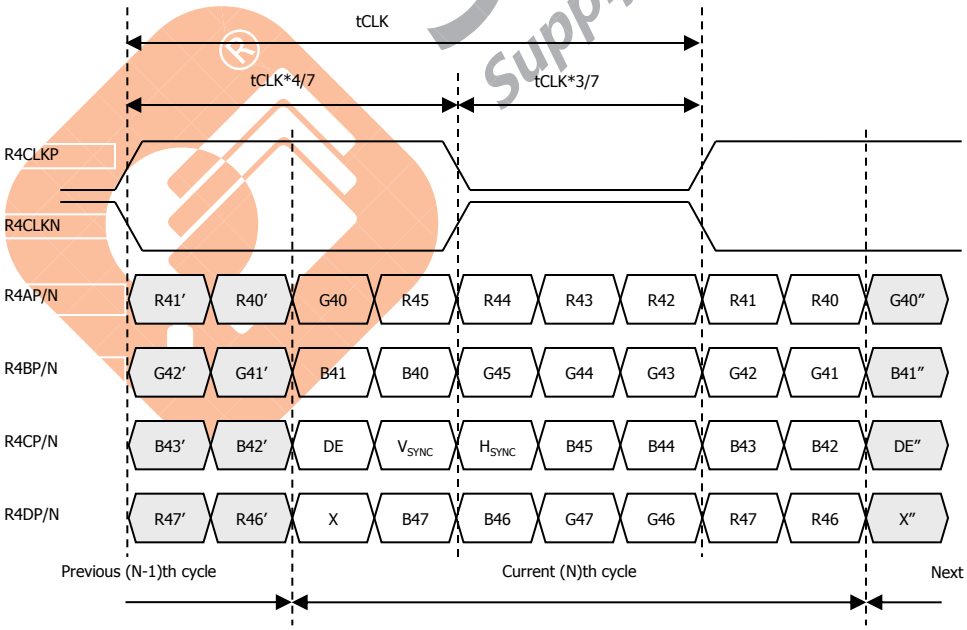
3-3-3. LVDS data format (8bit, VESA)

■ 3rd LVDS Channel



MSB	R37/G37/B37
	R36/G36/B36
	R35/G35/B35
	R34/G34/B34
	R33/G33/B33
	R32/G32/B32
	R31/G31/B31
LSB	R30/G30/B30

■ 4th LVDS Channel



MSB	R47/G47/B47
	R46/G46/B46
	R45/G45/B45
	R44/G44/B44
	R43/G43/B43
	R42/G42/B42
	R41/G41/B41
LSB	R40/G40/B40

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)

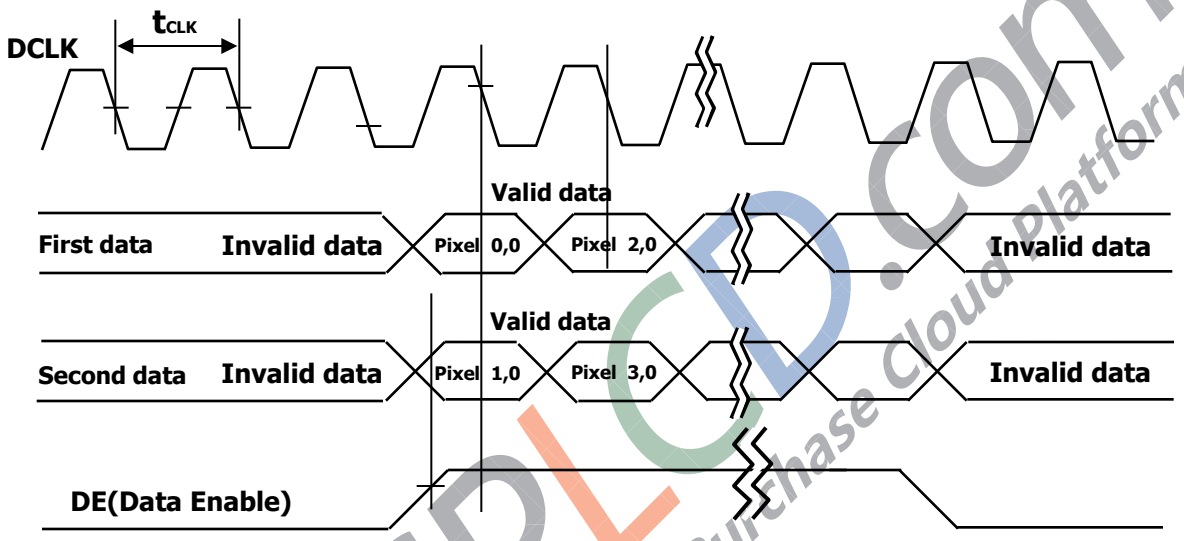
Parameter		Symbol	Min.	Typ.	Max.	Unit	Notes
DCLK	Period	tCLK	15.79	16.26	16.77	ns	Pixel frequency : Typ.245.96MHz
	Frequency	fCLK	59.65	61.49	63.34	MHz	
Hsync	Period	tHP	688	692	696	tCLK	
	Horizontal Valid	tHV	640	640	640	tCLK	
	Horizontal Blank	tHB	48	52	56	tCLK	
	Width-Active	tWH	8	8	8	tCLK	
Vsync	Period	tVP	1479	1481	1483	tHP	
	Vertical Valid	tVV	1440	1440	1440	tHP	
	Vertical Blank	tVB	39	41	43	tHP	
	Frequency	fV	59	60	61	Hz	

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

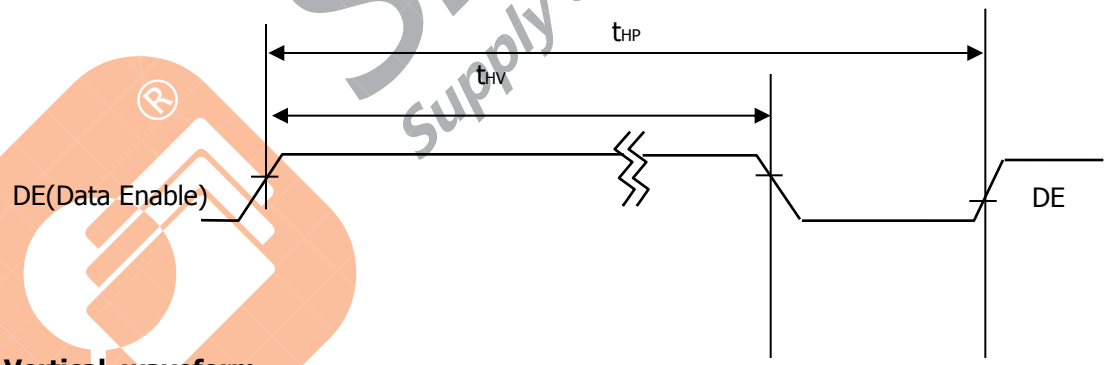
1. The Input of Hsync & Vsync signal does not have an effect on normal operation (DE Only Mode). If you use spread spectrum for EMI, add some additional clock to minimum value for clock margin.
2. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
3. Vsync and Hsync should be keep the above specification.
4. Hsync Period, Hsync Width, and Horizontal Back Porch should be any times of character number(4).
5. The polarity of Hsync, Vsync is not restricted.

3-5. Signal Timing Waveforms

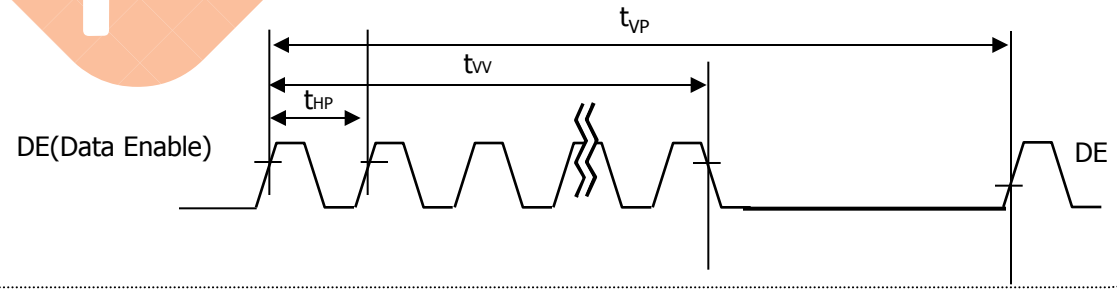
1. DCLK , DE, DATA waveforms



2. Horizontal waveform



3. Vertical waveform



3-6. Color Data Reference

The Brightness of each primary color(red,green,blue) is based on the 8-bit gray scale data input for the color; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 5. COLOR DATA REFERENCE

Color		Input Color Data																			
		RED								GREEN								BLUE			
		MSB							LSB	MSB							LSB	MSB			LSB
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RED	RED (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (001)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	...				...								...								...				
	RED (254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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)	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 (254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	BLUE (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

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

3-7-1. Power Sequence

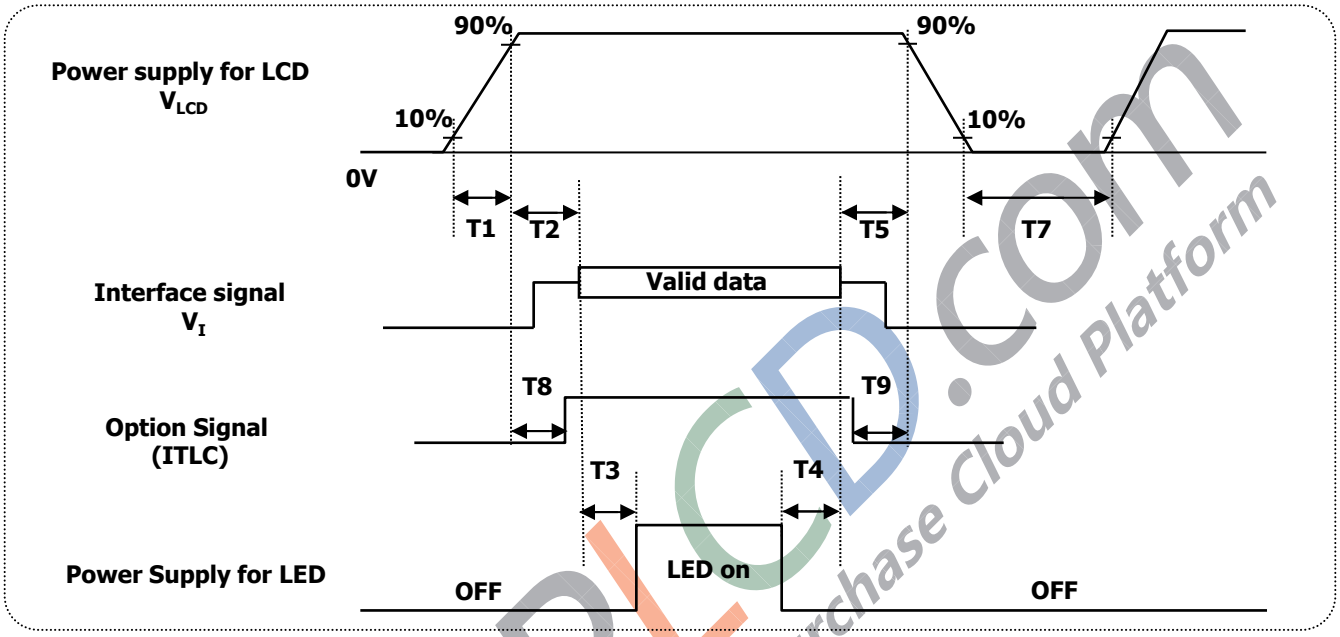


Table 7. POWER SEQUENCE

Parameter	Values			Units
	Min	Typ	Max	
T1	0.5	-	10	ms
T2	0.01	-	50	ms
T3	500	-	-	ms
T4	200	-	-	ms
T5	0.01	-	50	ms
T7	1000		-	ms
T8	0.5	-	T2	ms
T9	0		-	ms

Notes :

1. Recommend to follow Power sequence at these case
   -.AC/DC Power On/Off
   -.Mode change (Resolution, frequency, timing, sleep mode, Color depth change, etc.)
   If not to follow power sequence, there is a risk of abnormal display.
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 VLCD to 0V.
4. LED power must be turn on after power supply for LCD an interface signal are valid.
5 . If VLCD Power is Changed during on status, be sure to Pull down the LED Power on to 0V.

3-7-2. VLCD Power Dip Condition

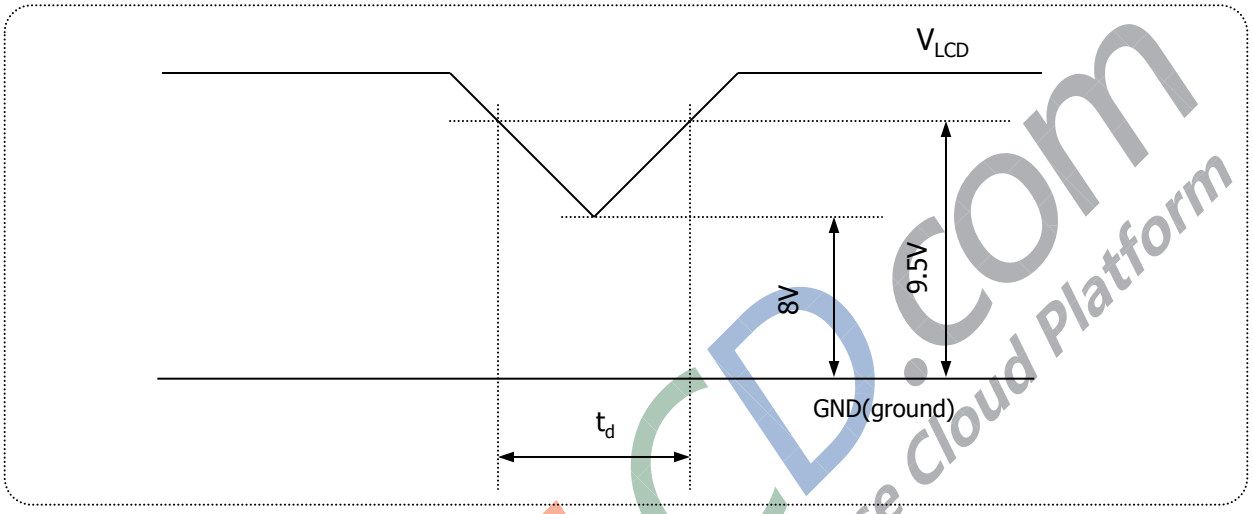


FIG.5 Power dip condition

1) Dip condition

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

2) $V_{LCD} < 8V$

V_{LCD}-dip conditions should also follow the Power On/Off conditions for supply voltage.

4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at 25±2°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. 4 presents additional information concerning the measurement equipment and method.

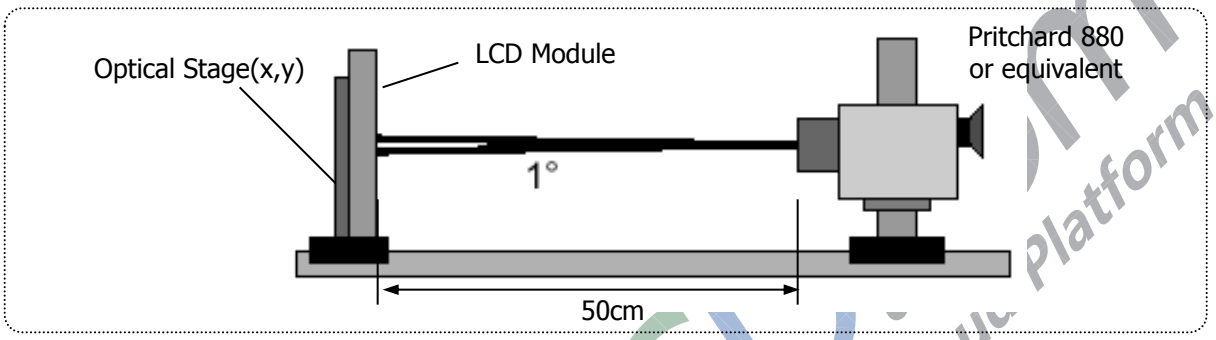


FIG. 4 Optical Characteristic Measurement Equipment and Method

Table 7. OPTICAL CHARACTERISTICS

(Ta=25°C, V_{LCD}=10.0V, f_V=60Hz Dclk=245.96MHz, I_s=(90)mA)

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	700	1000	-		1
Surface Luminance, white		L_{WH}	280	350	-	cd/m²	2
Luminance Variation		δ_{WHITE}	75	-	-	%	3
Response Time	Gray To Gray	T_{GTG_AVR}	-	14	28	ms	4
Color Coordinates [CIE1931] ***(By PR650)***	RED	Rx	Typ -0.03	0.661	Typ +0.03		
		Ry		0.330			
	GREEN	Gx		0.298			
		Gy		0.615			
	BLUE	Bx		0.149			
		By		0.064			
	WHITE	Wx		0.313			
		Wy		0.329			
Color Shift (Avg. Δu'v' < 0.02)	Horizontal	θ_{CST_H}	-	178	-	Degree	5
	Vertical	θ_{CST_V}	-	178	-		
Viewing Angle (CR>10)							
General	Horizontal	θ_H	170	178	-	Degree	6
	Vertical	θ_V	170	178	-		
Gray Scale		-		2.2			7

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.8 (By PR880)

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.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 9. ***(By RD80S)***

5. **Color shift** is the angle at which the average color difference for all Macbeth is lower than 0.04. For more information see FIG.9 ***(By EZ Contrast)***
- Color difference (Δu'v')

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

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

u'1, v'1 : u'v' value at viewing angle direction
u'2, v'2 : u'v' value at front (θ=0)
i : Macbeth chart number (Define 23 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. Gamma Value is approximately 2.2. For more information see Table 10.

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

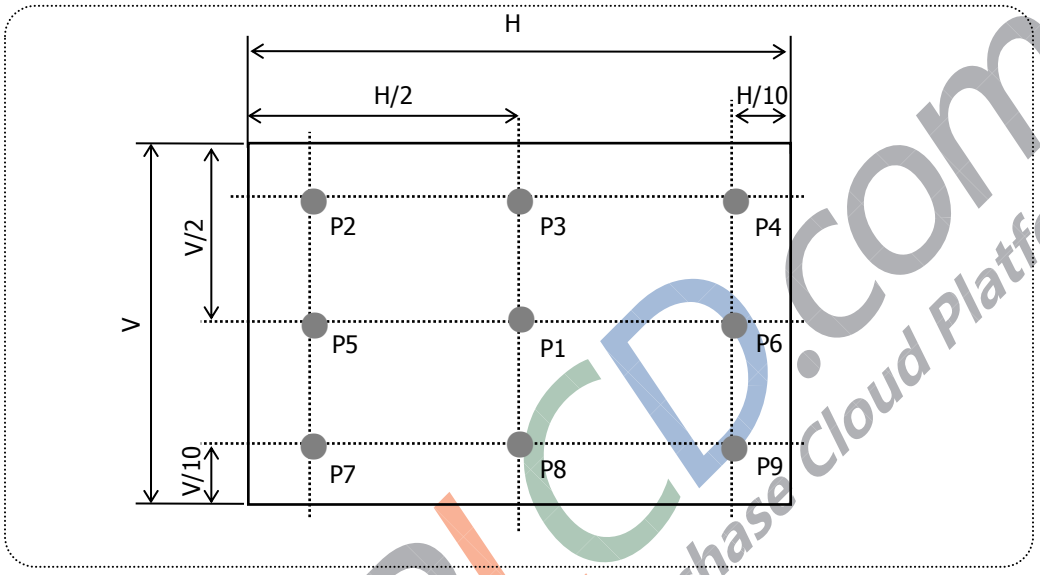


FIG.8 Measure Point for Luminance

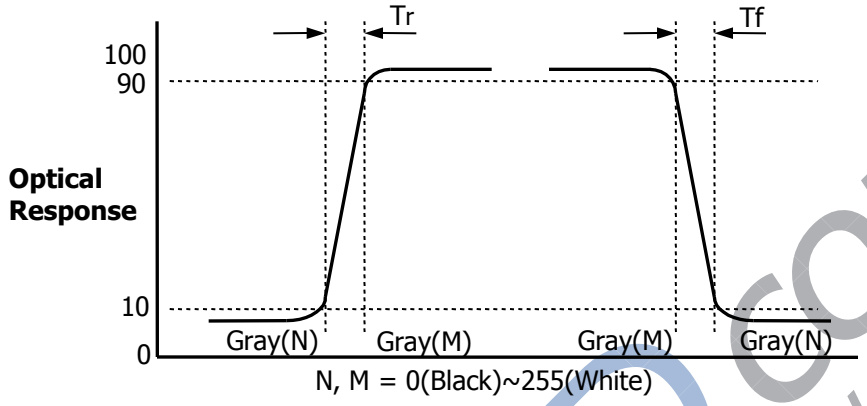
The Gray to Gray response time is defined as the following figure and shall be measured by switching the input signal for "Gray To Gray ".

- Gray step : 5 Step
- TGTG_AVR is the total average time at rising time and falling time for "Gray To Gray ".
- if system use ODC (Over Driving Circuit) function, Gray to Gary response time may be 5ms~8ms GtG
  * it depends on Overshoot rate.

Table 9. GTG Gray Table

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

G to G(BW) Response time is defined as the following figure and shall be measured by switching the input signal for "Gray(N)" and "Black or White".



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

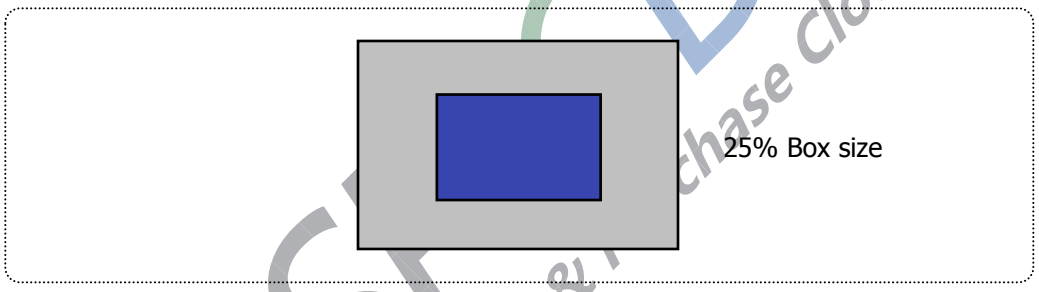


FIG.9 Color Shift Test Pattern

Average RGB values in Bruce RGB for Macbeth Chart

	Dark skin (i=1)	Light skin	Blue sky	Foliage	Blue flower	Bluish green
R	98	206	85	77	129	114
G	56	142	112	102	118	199
B	45	123	161	46	185	178
	Orange	Purplish blue	Moderate red	Purple	Yellow green	Orange yellow
R	219	56	211	76	160	230
G	104	69	67	39	193	162
B	24	174	87	86	58	29
	Blue	Green	Red	Yellow	Magenta	Cyan
R	26	72	197	241	207	35
G	32	148	27	212	62	126
B	145	65	37	36	151	172
	White	Neutral 8	Neutral 6.5	Neutral 5	Neutral 3.5	Black
R	240	206	155	110	63	22
G	240	206	155	110	63	22
B	240	206	155	110	63	22

Dimension of viewing angle range.

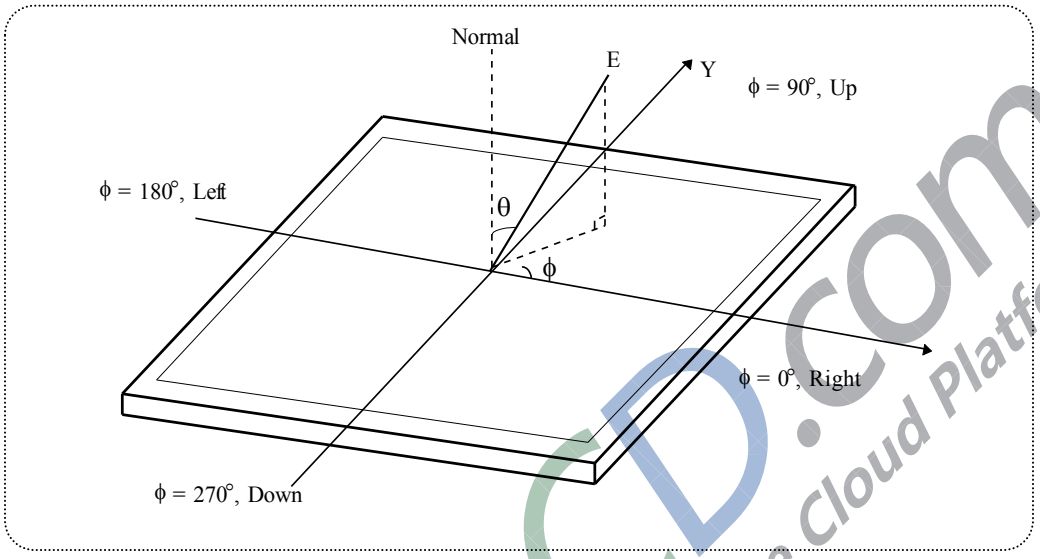


FIG.10 Viewing angle

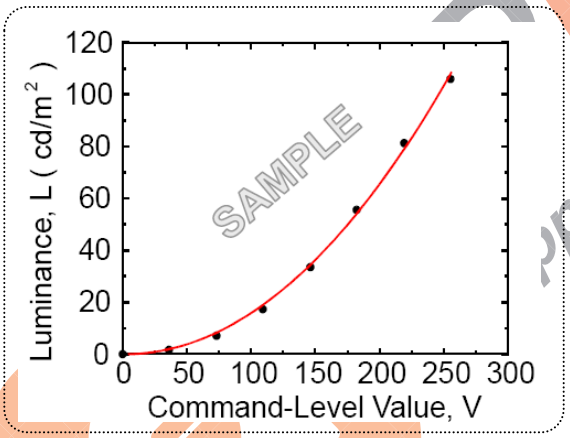


FIG.11 Sample Luminance vs. gray scale (using a 256 bit gray scale)

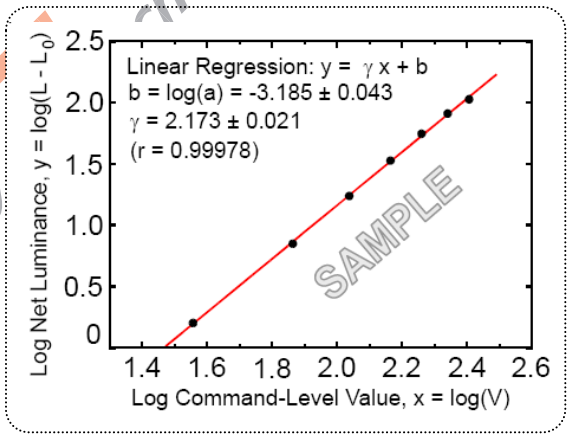


FIG.12 Sample Log-log plot of luminance vs. gray scale

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

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

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.11)

Table 9. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.10
15	0.30
31	1.08
47	2.50
63	4.72
79	7.70
95	11.49
111	16.20
127	21.66
143	28.20
159	35.45
175	43.80
191	53.00
207	63.30
223	74.48
239	86.80
255	100

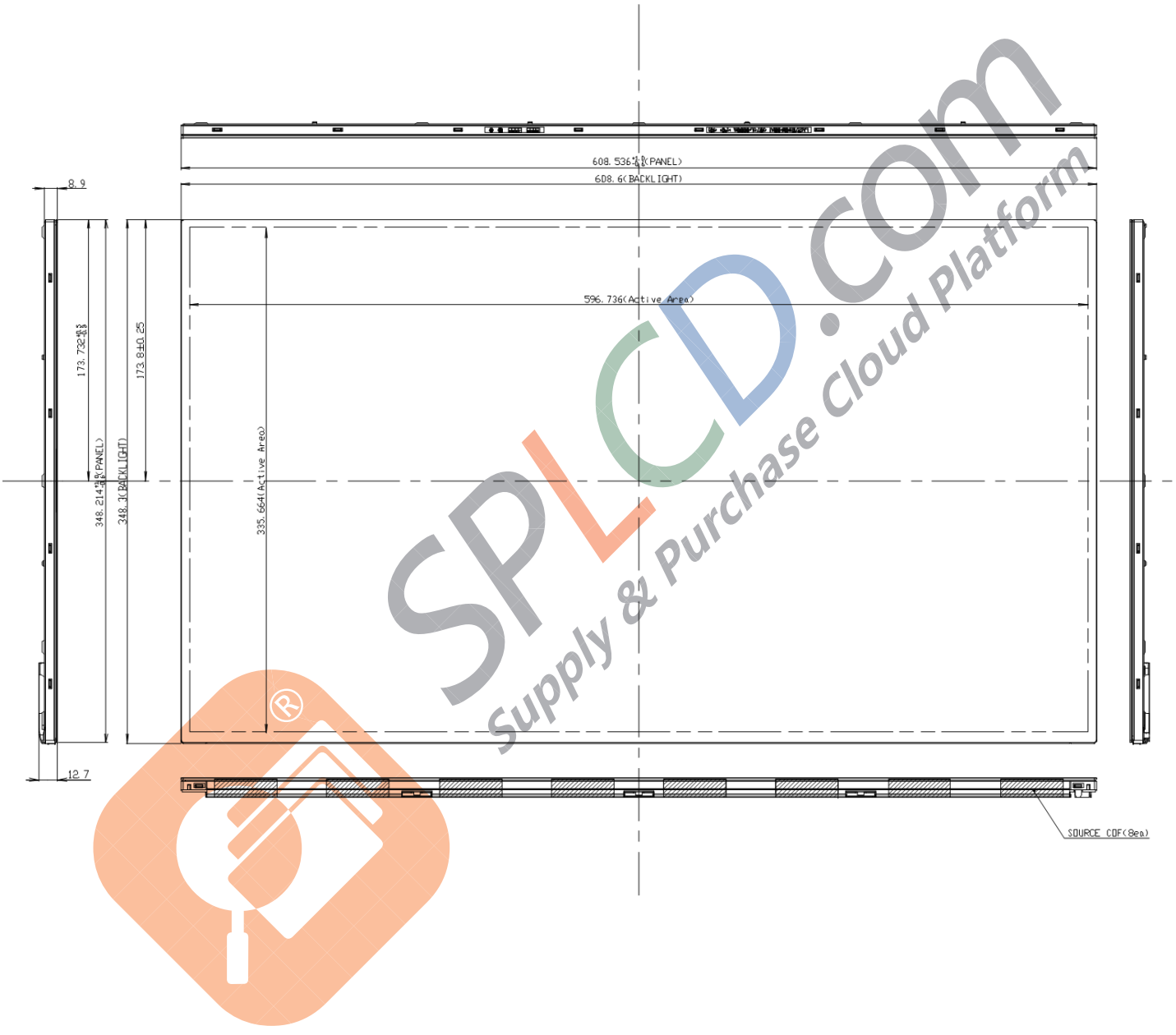
5. Mechanical Characteristics

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

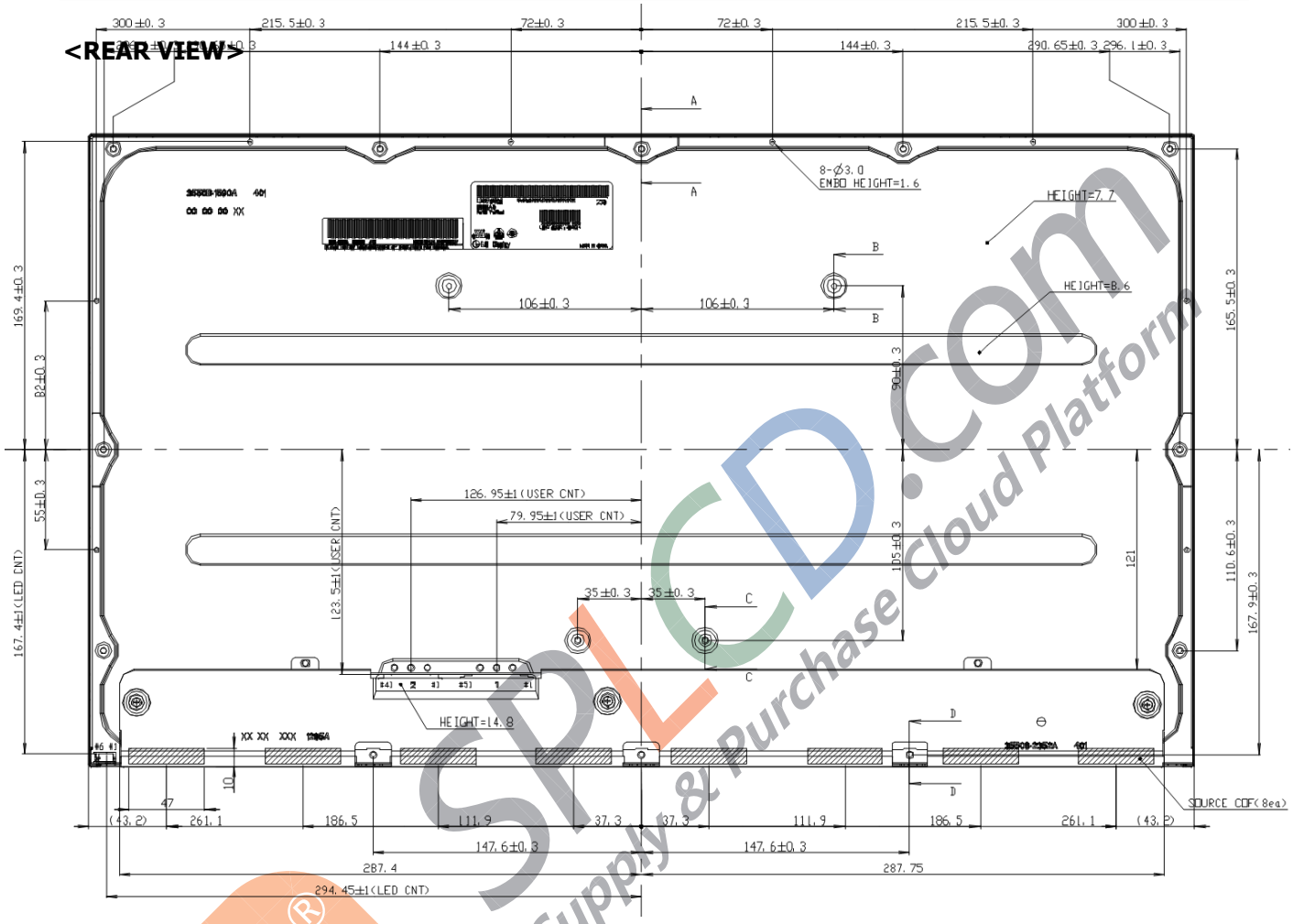
Outline Dimension	Horizontal	608.6 mm
	Vertical	348.3 mm
	Depth	12.7 mm
Bezel Area	Horizontal	-
	Vertical	-
Active Display Area	Horizontal	596.74mm
	Vertical	335.66mm
Weight	2,900 g (Typ.) / 3,045 g (Max.)	
Surface Treatment	Anti-Glare treatment of the front polarizer (Haze25%, 3H)	

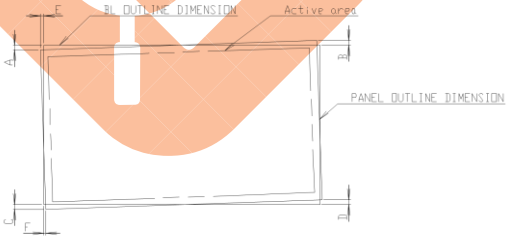
Notes : Please refer to a mechanic drawing in terms of tolerance at the next page.

<FRONT VIEW>

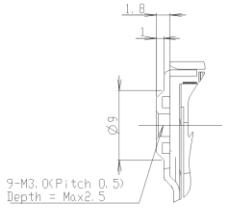


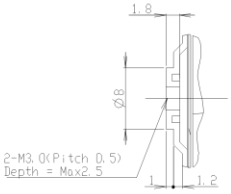
<REAR VIEW>

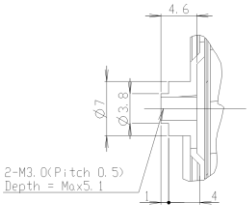


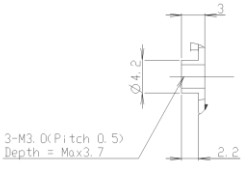


Notes
1. I/F Connector specification : FI-RE51S-HF(JAE), FI-RE41S-HF(JAE)
2. LED connector specification : JST, BM06B-SHJS(HF)
3. Torque of user hole : 3.0~4.0kgf.cm
4. Tilt and partial disposition tolerance of display area as following
   (1) Y-direction
      a. Upper side : $-0.45 \leq A \leq 0.45$, $-0.45 \leq B \leq 0.45$
      b. Lower side : $-0.45 \leq C \leq 0.6$, $-0.45 \leq D \leq 0.6$
   (2) X-direction : $-0.45 \leq E \leq 0.45$, $-0.45 \leq F \leq 0.45$
5. Unspecified tolerance is ±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









LGD Highly recommendation :
System chassis or frame should be designed to keep the IPS Panel flat as it is vulnerable to panel light-leakage caused by deformation.

6. Reliability

Environment test condition

No	Test Item	Condition	Note
1	High temperature storage test	Ta= 60°C 240h	1
2	Low temperature storage test	Ta= -20°C 240h	1
3	High temperature operation test	Ta= 50°C 50%RH 240h	1
4	Low temperature operation test	Ta= 0°C 240h	1
5	Humidity condition Operation	Ta= 40 °C ,90%RH	1
6	Altitude operating storage / shipment	 0 – 10,000 feet(3,048m) 0 - 40,000 feet(12,192m)	
7	Maximum Storage Humidity for 4 corner light leakage Mura.	Max 70%RH , Ta=40℃	

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

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

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)
D : Year
E : Month
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 : 10 pcs

b) Box Size : 700mm X 355mm 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 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 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'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℃)

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.