HY-LINE®
COMPUTER COMPONENTS

TFT-Display Datasheet

LG Display
Model: LM340WW1-SSC1

Brief spec.:

Main Feature	Landscape
	High colar saturation
	Wide Aspect Ratio

Active Screen Area	820.8 x 361.0
Diagonal | Format	34" | 21:9
Resolution	2560 X 1080
Colors	16.7 Colors (6bit+A-FRC)
Backlight	LED
Brightness	300 cd/m²
LED Life Time	30K(h)
Interface	LVDS
Viewing Angle	89/89 L/R 89/89
Touchscreen	no
Power Supply	10 V
Module Outline	820.8 x 361 x 19.8 (mm)
Operation Temperature	- 0 ... +50 °C
Storage Temperature	-20... +60 °C
Surface Treatment	Anti-Glare Hard coating (3H)

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SPECIFICATION
FOR
APPROVAL

( ) Preliminary Specification
(●) Final Specification

Title	34.0” WFHD TFT LCD

BUYER	General
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM340WW1
SUFFIX	SSC1

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

APPROVED BY	SIGNATURE / DATE
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Please return 1 copy for your confirmation with your signature and comments.

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Contents

RECORD OF REVISIONS

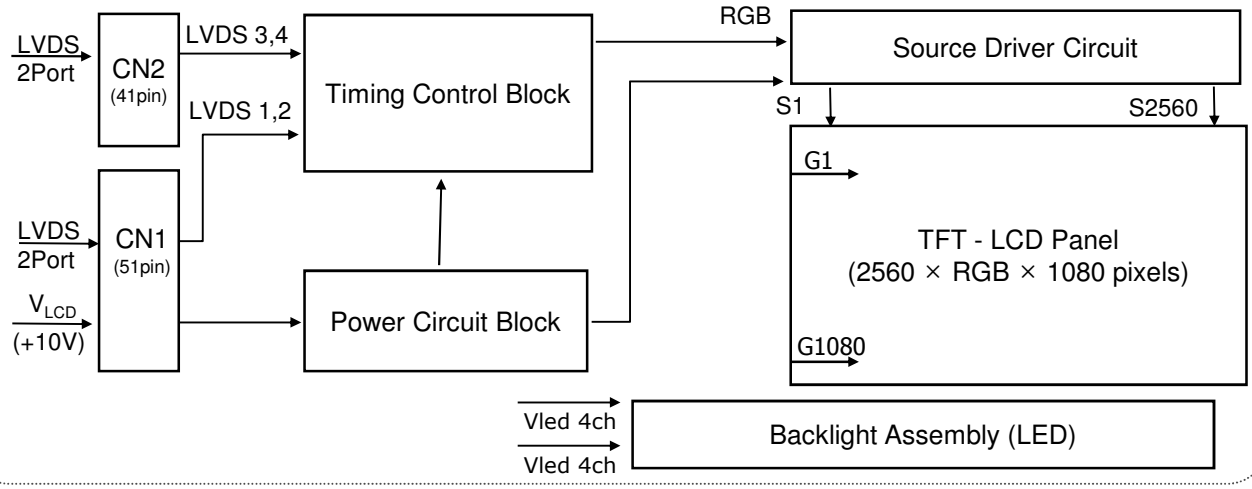
Revision No	Revision Date	Page	Description
0.0	Feb. 02. 2016	-	First Draft, Preliminary Specifications
0.1	Mar. 17. 2016	-	Updated LED String Current
0.2	Mar. 29. 2016	18	Updated Signal Timing (H/V Period Total Min.)
		4, 30	Updated weight
0.3	May. 17. 2016	23	Updated Optical Characteristics
1.0	Jul. 15. 2016	4, 6, 8, 23	Updated Electrical Characteristics
			Final Specifications

1. General Description

LM340WW1 is a Color Active Matrix Liquid Crystal Display Light Emitting Diode (White LED) backlight system without LED driver. The matrix employs a-Si Thin Film Transistor as the active element.

It is a transmissive type display operating in the normally black mode. It has a 34-inch diagonally measured active display area with Wide Full HD resolution (1080 vertical by 2560 horizontal pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,7M(True) colors with A-FRC (Advanced Frame Rate Control). It has been designed to apply the 8Bit 4 port LVDS interface. It is intended to support applications where thin thickness, wide viewing angle, low power are critical factors and graphic displays are important. 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	34 inches (86.704cm) diagonal (Aspect ratio 21:9)
Outline Dimension	820.8 (H) x 361.0 (V) x 18.8 (T) mm (Typ.)
Pixel Pitch	0.312(H) mm x 0.310(V) mm
Pixel Format	2560 horizontal x 1080 vertical Pixels, RGB stripe arrangement
Color Depth	16.7M colors (6bit + A-FRC)
Luminance, White	300 cd/m^2 (Center, 1 point)
Viewing Angle (CR>10)	View Angle Free (R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	Total 27.2W (Typ.) (4.6W @VLCD, 22.6W @ 110mA)
Weight	Typ. : 3960g , Min : 3760g Max : 4160g
Display Operating Mode	Transmissive mode, Normally Black
Panel type	Reverse type
Surface Treatment	Hard coating (3H) & Anti-Glare treatment of the front polarizer

2. Absolute Maximum Ratings

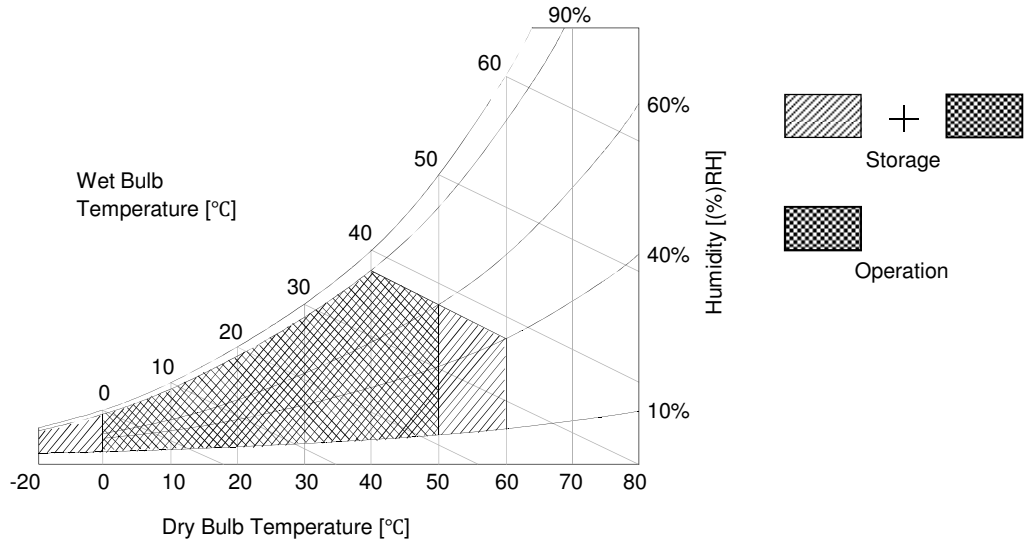
The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 1. Absolute maximum ratings

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Supply Input Voltage	V_{LCD}	-0.3	+11.0	Vdc	At 25℃
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	℃	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 Temp. no humidity control and LED string current is typical value.

FIG. 2 Temperature and relative humidity



3. Electrical Specifications

3-1. Electrical Characteristics

It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The 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. Electrical Characteristics (Module)

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_{LCD}	-	-	0.4	V	1
Power Supply Input Current	I_{LCD}	-	0.460	0.575	A	2
		-	0.520	0.650	A	3
Power Consumption	P_{LCD}	-	4.60	5.75	Watt	2
Inrush current	I_{RUSH}	-	-	2	A	4

Note :

1. Permissive power ripple should be measured under V_{LCD} =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.

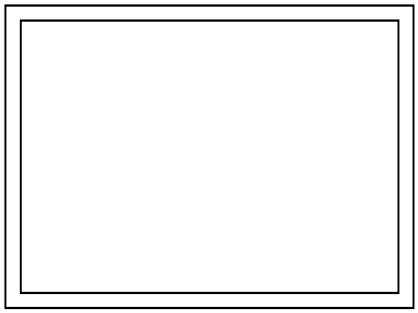
2. The specified current and power consumption are under the V_{LCD}=10.0V, 25± 2°C, fV=60Hz condition whereas Typical Power Pattern [Mosaic] shown in the [Figure 3] is displayed.

3. The current is specified at the maximum current pattern of [Figure 3].

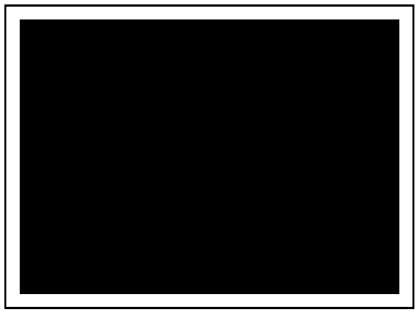
4. Maximum Condition of Inrush current :
   The duration of rush current is about 5ms and rising time of power Input is 500us ± 20%.(min.).

5. VLCD level must be measured from LCM PCB's two points, between VLCD 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} =10.0V, 25°C, fV (frame frequency)=MAX condition**)**

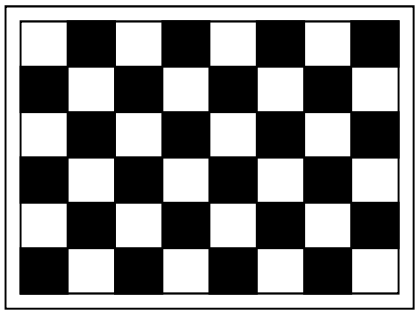


White pattern

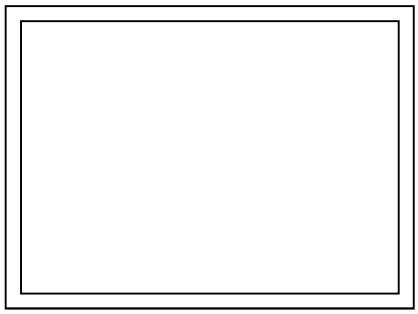


Black pattern

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



Typical power Pattern



Maximum power Pattern

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

Table 3. Electrical Characteristics (Backlight System)

Parameter	Symbol	Values			Unit	Notes
		Min.	Typ.	Max.		
LED String Current	Is	-	110	115	mA	1, 2, 5
LED String Voltage	Vs	47.9	51.3	54.7	V	1, 5
Power Consumption	P_{Bar}	-	22.6	24.1	Watt	1, 2, 4
LED Life Time	LED_LT	30,000	-	-	Hrs	3

Notes) The LED consists of 68 LED packages, 2 strings (parallel) x 17 packages (serial) x 2 bar

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 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.
4. The power consumption shown above does not include loss of external driver.
   The typical power consumption is calculated as P_{Bar} = Vs(Typ.) x Is(Typ.) x No. of strings.
   The maximum power consumption is calculated as P_{Bar} = Vs(Max.) x Is(Typ.) x No. of strings.
5. LED operating conditions are must not exceed Max. ratings.

3-2. Interface Connections

This LCD module employs two kinds of interface connection, 51 pin connector and 41 pin connector are used for the module electronics.

3-2-1. LCD Module

Table 4. Module Connector (CN1) Pin Configuration

- LCD Connector(CN1) : GT05S-51S-H38 (manufactured by LSC) or equivalent
- Mating Connector : FI-RE51HL(JAE) or equivalent

No	Symbol	Description
1	GND	Ground
2	NC	No Connection
3	NC	No Connection
4	NC	LGD internal use for I2C
5	NC	LGD internal use for I2C
6	NC	No Connection
7	PBP Select	'H'= PBP Concept , 'L'=normal
8	NC	No Connection
9	NC	No Connection
10	PWM_OUT	Reference signal for LED dimming control
11	GND	Ground
12	R1AN	1st LVDS Channel Signal (A-)
13	R1AP	1st LVDS Channel Signal (A+)
14	R1BN	1st LVDS Channel Signal (B-)
15	R1BP	1st LVDS Channel Signal (B+)
16	R1CN	1st LVDS Channel Signal (C-)
17	R1CP	1st LVDS Channel Signal (C+)
18	GND	Ground
19	R1CLKN	1st LVDS Channel Clock Signal(-)
20	R1CLKP	1st LVDS Channel Clock Signal(+)
21	GND	Ground
22	R1DN	1st LVDS Channel Signal (D-)
23	R1DP	1st LVDS Channel Signal (D+)
24	NC	No Connection
25	NC	No Connection
26	Reserved	No connection or GND

No	Symbol	Description
27	Reserved	No connection or GND
28	R2AN	2nd LVDS Channel Signal (A-)
29	R2AP	2nd LVDS Channel Signal (A+)
30	R2BN	2nd LVDS Channel Signal (B-)
31	R2BP	2nd LVDS Channel Signal (B+)
32	R2CN	2nd LVDS Channel Signal (C-)
33	R2CP	2nd LVDS Channel Signal (C+)
34	GND	Ground
35	R2CLKN	2nd LVDS Channel Clock Signal(-)
36	R2CLKP	2nd LVDS Channel Clock Signal(+)
37	GND	Ground
38	R2DN	2nd LVDS Channel Signal (D-)
39	R2DP	2nd LVDS Channel Signal (D+)
40	NC	No Connection
41	NC	No Connection
42	Reserved	No connection or GND
43	GND	Ground
44	GND	Ground (AGP)
45	GND	Ground
46	GND	Ground
47	NC	No connection
48	VLCD	Power Supply +10.0V
49	VLCD	Power Supply +10.0V
50	VLCD	Power Supply +10.0V
51	VLCD	Power Supply +10.0V

Note : PBP = Picture By Picture

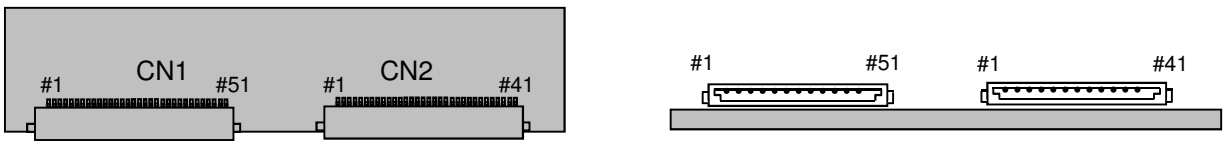
Table 5. Module Connector (CN2) Pin Configuration

- LCD Connector(CN2) : GT05P-41S-H38 (manufactured by LSC) or equivalent
- Mating Connector : FI-RE41HL(JAE) or equivalent

No	Symbol	Description
1	NC	No connection
2	NC	No connection
3	NC	No connection
4	NC	No connection
5	NC	No connection
6	NC	No connection
7	NC	No connection
8	NC	No connection
9	GND	Ground
10	RA3N	3rd LVDS Channel Signal (A-)
11	RA3P	3rd LVDS Channel Signal (A+)
12	RB3N	3rd LVDS Channel Signal (B-)
13	RB3P	3rd LVDS Channel Signal (B+)
14	RC3N	3rd LVDS Channel Signal (C-)
15	RC3P	3rd LVDS Channel Signal (C+)
16	GND	Ground
17	RCLK3N	3rd LVDS Channel Clock Signal(-)
18	RCLK3P	3rd LVDS Channel Clock Signal(+)
19	GND	Ground
20	RD3N	3rd LVDS Channel Signal (D-)
21	RD3P	3rd LVDS Channel Signal (D+)

No	Symbol	Description
22	NC	No Connection
23	NC	No Connection
24	GND	Ground
25	GND	Ground
26	RA4N	4th LVDS Channel Signal (A-)
27	RA4P	4th LVDS Channel Signal (A+)
28	RB4N	4th LVDS Channel Signal (B-)
29	RB4P	4th LVDS Channel Signal (B+)
30	RC4N	4th LVDS Channel Signal (C-)
31	RC4P	4th LVDS Channel Signal (C+)
32	GND	Ground
33	RCLK4N	4th LVDS Channel Clock Signal(-)
34	RCLK4P	4th LVDS Channel Clock Signal(+)
35	GND	Ground
36	RD4N	4th LVDS Channel Signal (D-)
37	RD4P	4th LVDS Channel Signal (D+)
38	NC	No Connection
39	NC	No Connection
40	GND	Ground
41	GND	Ground

Figure 4. Module Connector Diagram



[Rear view of LCM]

Note :

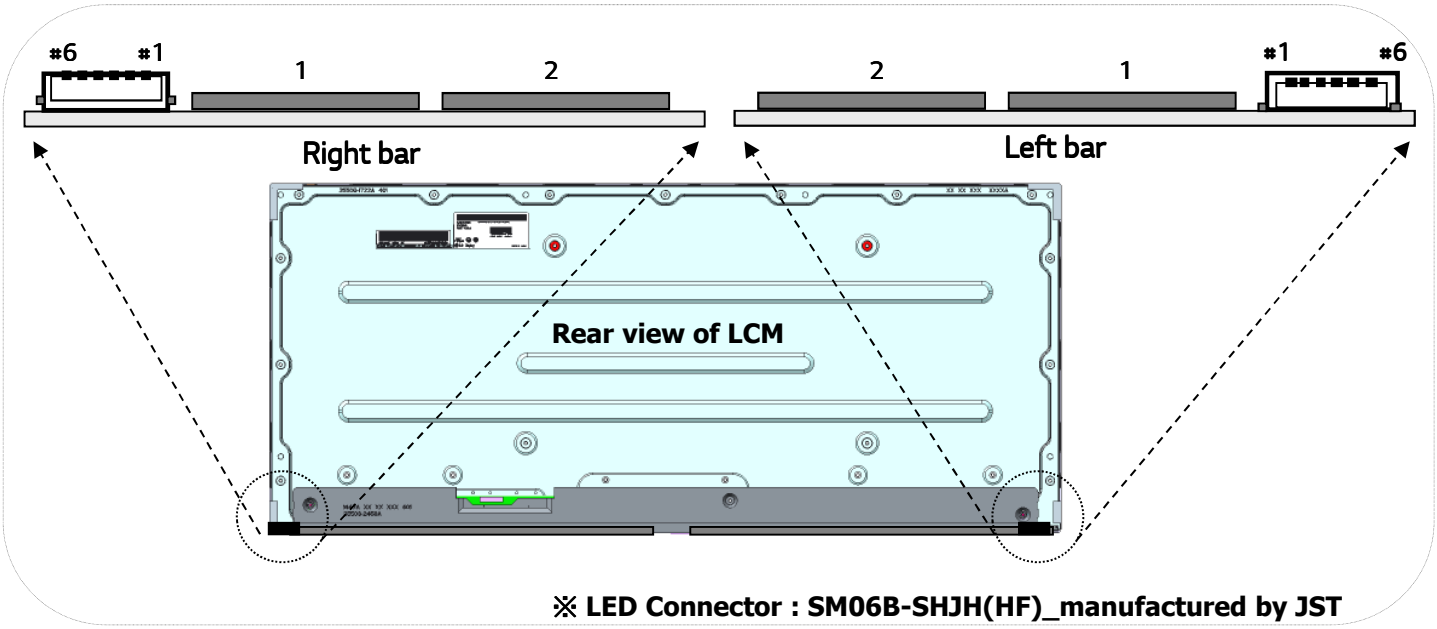
1. All GND (Ground) pins should be connected together to the LCD module's metal frame.
2. All V_{LCD} (power input) pins should be connected together.
3. All Input levels of LVDS signals are based on the EIA 664 Standard.
4. Always all LVDS signal and clock input should be 4 channels and synchronized.
5. PWM_OUT is a reference signal for LED PWM control.
   This PWM signal is synchronized with vertical frequency.
   Its frequency is 6 times of vertical frequency, and its duty ratio is 50%.
   If the system don't use this pin, do not connect.

3-2-2. Backlight system

Table 6. BACKLIGHT CONNECTOR PIN CONFIGURATION

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

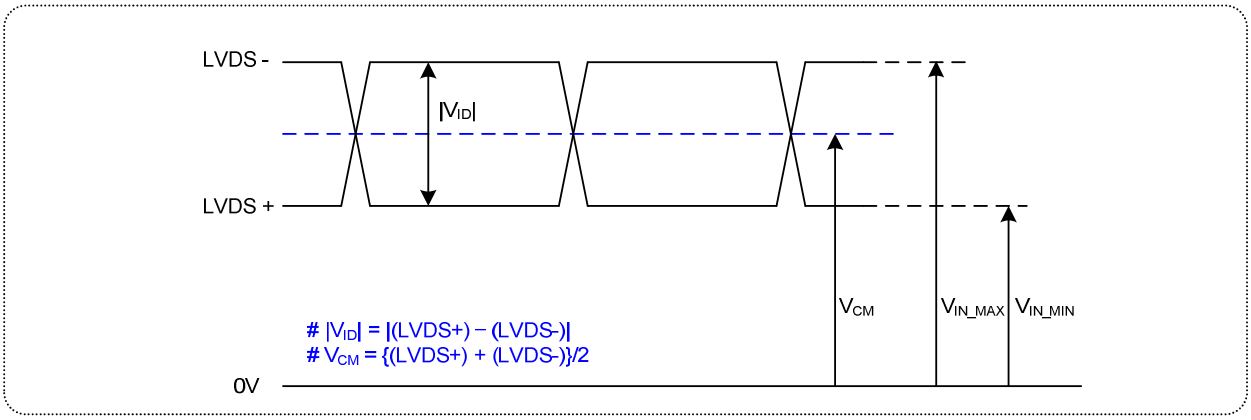
Pin	Symbol	Description	Remark	Pin	Symbol	Description	Remark
1	FB1	Channel1 Current Feedback	Left bar	1	FB1	Channel1 Current Feedback	Right bar
2	NC	No Connection		2	NC	No Connection	
3	VLED	LED Power Supply		3	VLED	LED Power Supply	
4	VLED	LED Power Supply		4	VLED	LED Power Supply	
5	NC	No Connection		5	NC	No Connection	
6	FB2	Channel2 Current Feedback		6	FB2	Channel2 Current Feedback	



[Figure 5] Backlight connector view

3-3. LVDS characteristics

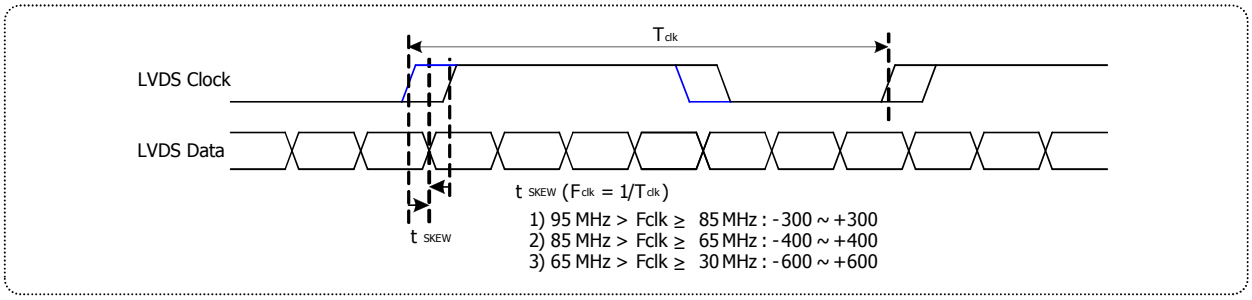
3-3-1. DC Specification



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	ΔV_{CM}	-	250	mV	-

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

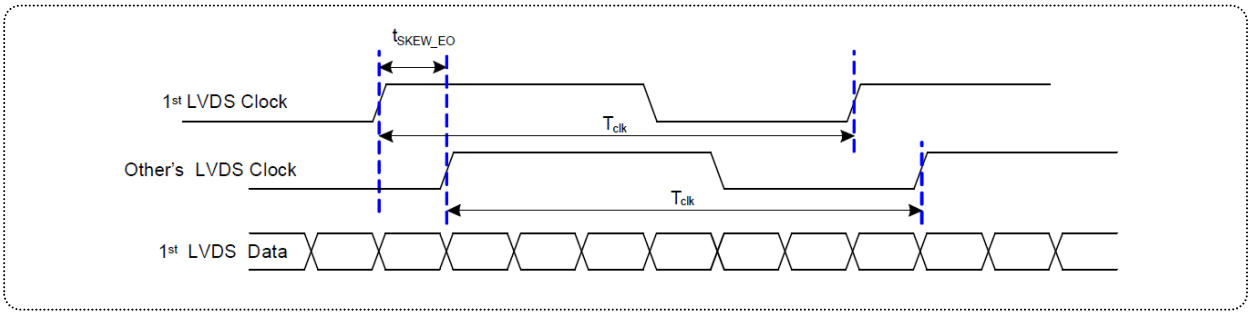
3-3-2. AC Specification



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}	-

3-3. LVDS characteristics

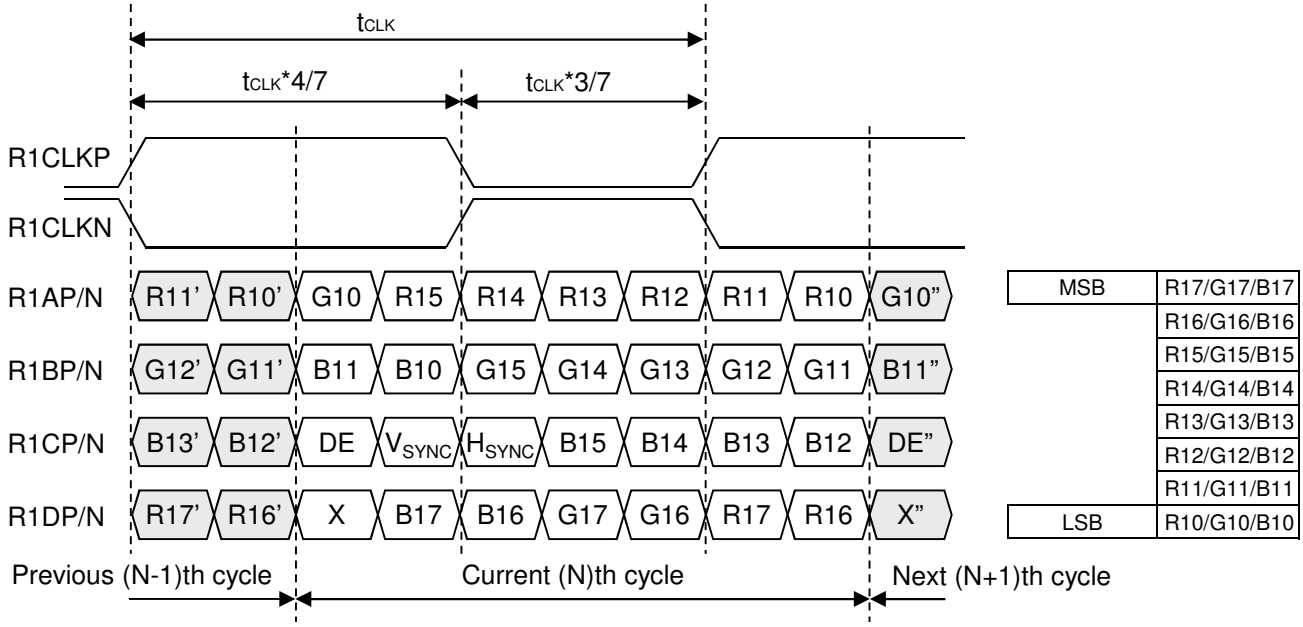
3-3-2. AC Specification



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

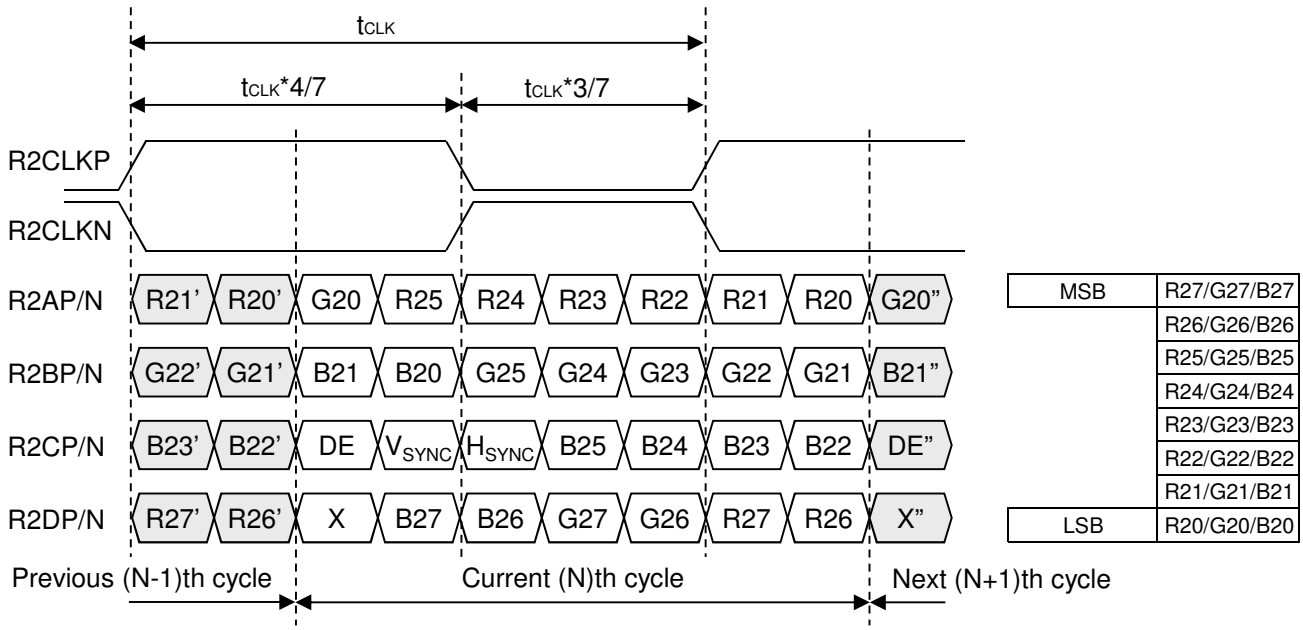
3-3-3. LVDS data format (8bit, VESA)

■ 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

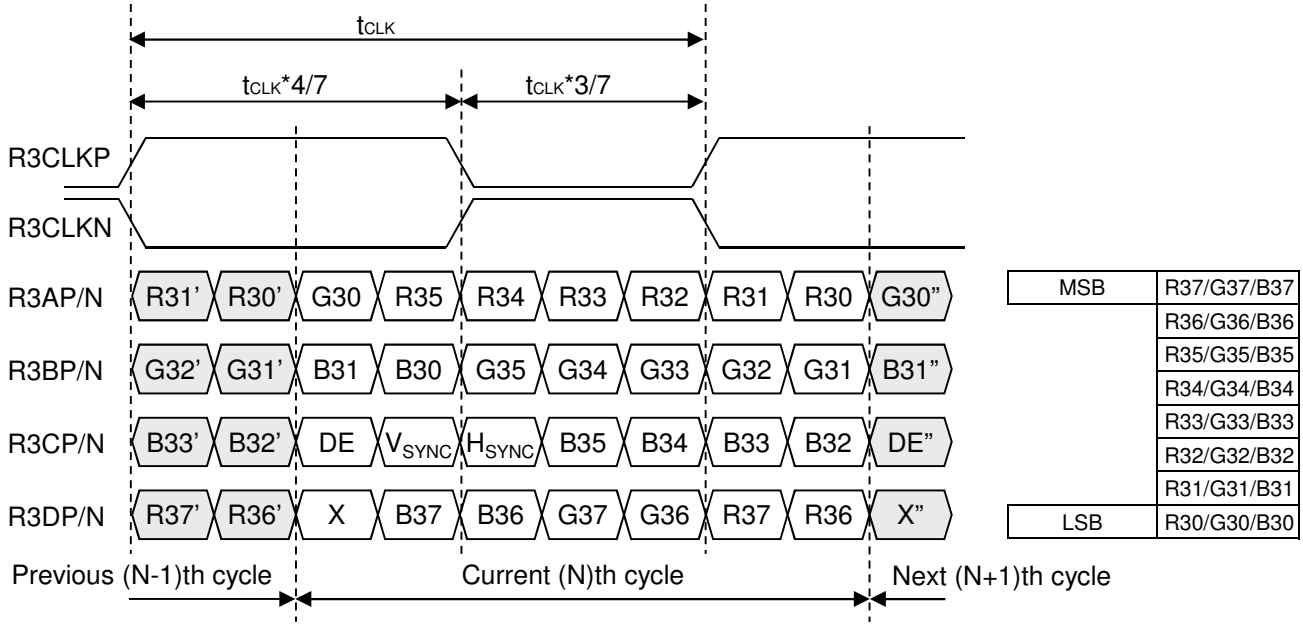
■ 2nd LVDS Channel



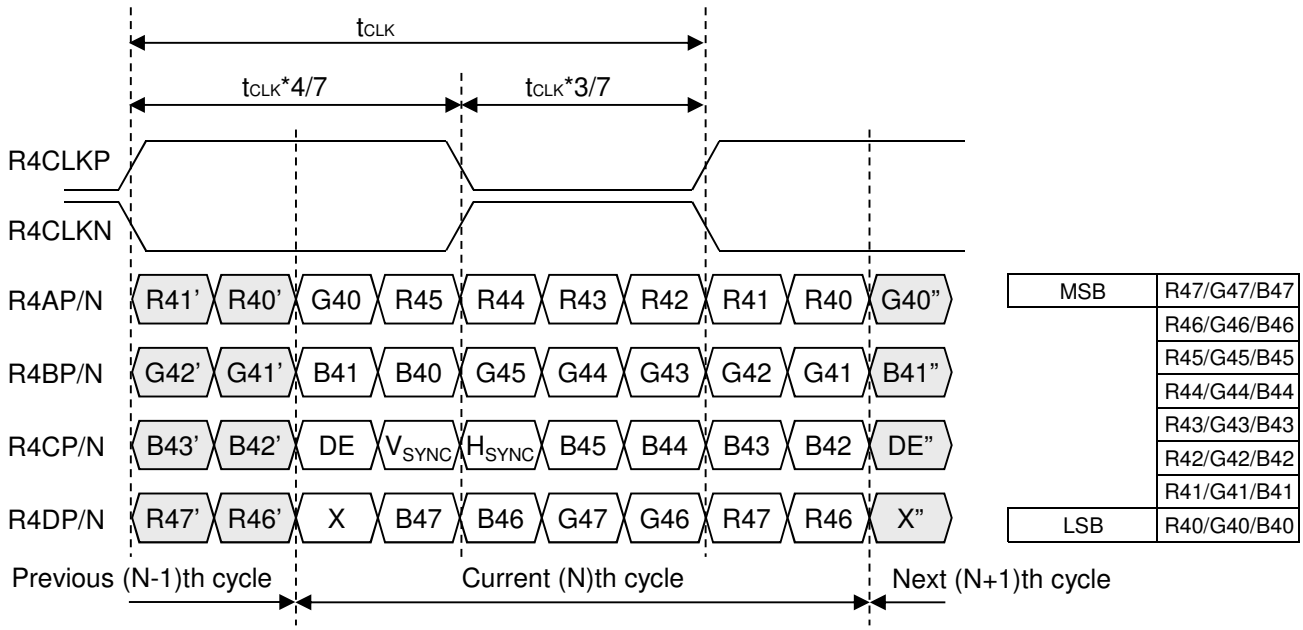
MSB	R27/G27/B27
	R26/G26/B26
	R25/G25/B25
	R24/G24/B24
	R23/G23/B23
	R22/G22/B22
	R21/G21/B21
LSB	R20/G20/B20

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

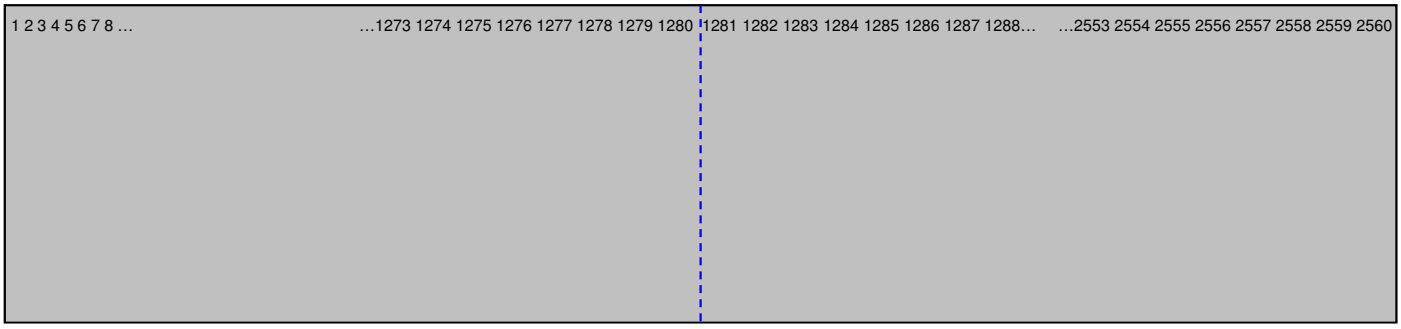
■ 3rd LVDS Channel

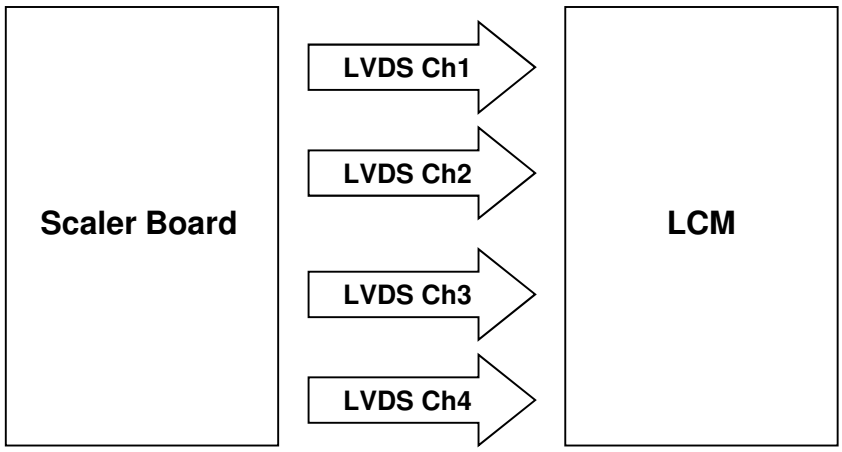


■ 4th LVDS Channel



3-3-4. LVDS description of Dual Screen





■ Normal (Single Screen, Pin # 7 of CN1 = Low)

LVDS Ch1 : 1 → 5 → … 1273 → 1277 → 1281 → 1285 → … 2553 → 2557

LVDS Ch2 : 2 → 6 → … 1274 → 1278 → 1282 → 1286 → … 2554 → 2558

LVDS Ch3 : 3 → 7 → … 1275 → 1279 → 1283 → 1287 → … 2555 → 2559

LVDS Ch4 : 4 → 8 → … 1276 → 1280 → 1284 → 1288 → … 2556 → 2560

■ PBP (Dual Screen, Pin # 7 of CN1 = High)

LVDS Ch1 : 1 → 3 → 5 → 7 → … 1273 → 1275 → 1277 → 1279

LVDS Ch2 : 2 → 4 → 6 → 8 → … 1274 → 1276 → 1278 → 1280

LVDS Ch3 : 1281 → 1283 → 1285 → 1287 → … 2553 → 2555 → 2557 → 2559

LVDS Ch4 : 1282 → 1284 → 1286 → 1288 → … 2554 → 2556 → 2558 → 2560

Note : PBP = Picture By Picture

3-4. Signal Timing Specifications

This is signal timing required at the input of the Module connector. All of the interface signal timing should be satisfied with the following specifications for it's proper operation.

Table 7 . Timing Table

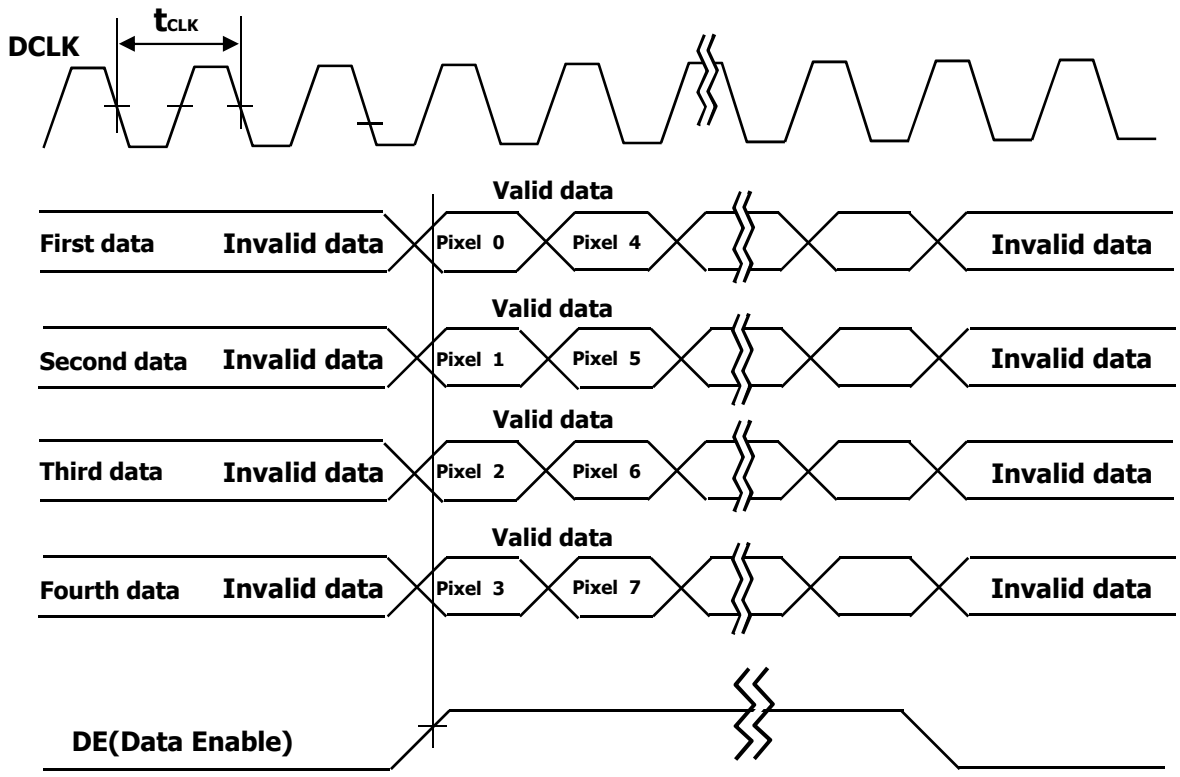
Parameter		Symbol	Min.	Typ.	Max.	Unit	Notes
D_{CLK}	Period	t_{CLK}	17.2	21.6	25.9	ns	Pixel frequency : Typ. 185.58MHz
	Frequency	f_{CLK}	38.7	46.4	58.0	MHz	
Hsync	Horizontal Valid	t_{HV}	640	640	640	t_{CLK}	
	H Period Total	t_{HP}	688	696	712		
	Hsync Frequency	f_H	55.6	66.7	83.3	kHz	
Vsync	Vertical Valid	t_{VV}	1080	1080	1080	t_{HP}	
	V Period Total	t_{VP}	1102	1111	1330		For D_{CLK}
	Vsync Frequency	f_V	50	60	75	Hz	

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

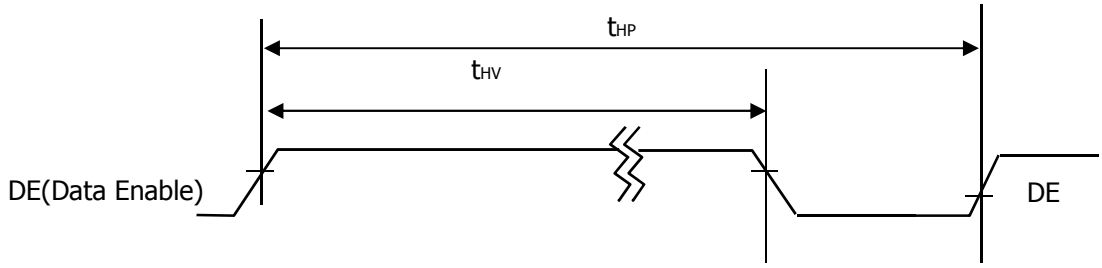
1. The Input of Hsync & Vsync signal does not have an effect on normal operation (DE Only Mode). If you use spread spectrum for EMI, add some additional clock to minimum value for clock margin.
2. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
3. Horizontal period should be even.
4. Vsync and Hsync should be keep the above specification.
5. Hsync Horizontal Valid and H Period Total should be any times of of character number(4).
6. The polarity of Hsync, Vsync is not restricted.
7. The Max fCLK of 2560X1080 resolution is 58Mhz

3-5. Signal Timing Waveforms

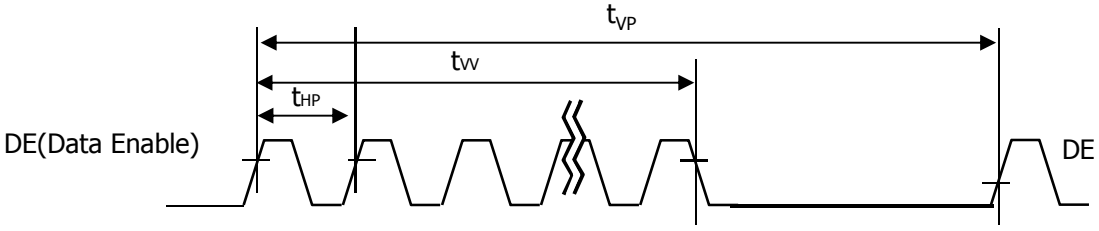
1. DCLK , DE, DATA waveforms



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 8. Color Data Reference

Color		Input Color Data																							
		Red								Green								Blue							
		MSB							LSB	MSB							LSB	MSB							LSB
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red	Red(000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(001)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(002)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	- - - - - - - - -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	- - - - - - - - -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Red(253)	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(255) Bright	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green	Green(000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green(001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Green(002)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	- - - - - - - - -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	- - - - - - - - -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Green(253)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
	Green(254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	Green(255)Bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Blue	Blue(000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue(001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Blue(002)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	- - - - - - - - -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	- - - - - - - - -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Blue(253)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
	Blue(254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	Blue(255) Bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

3-7. Power Sequence

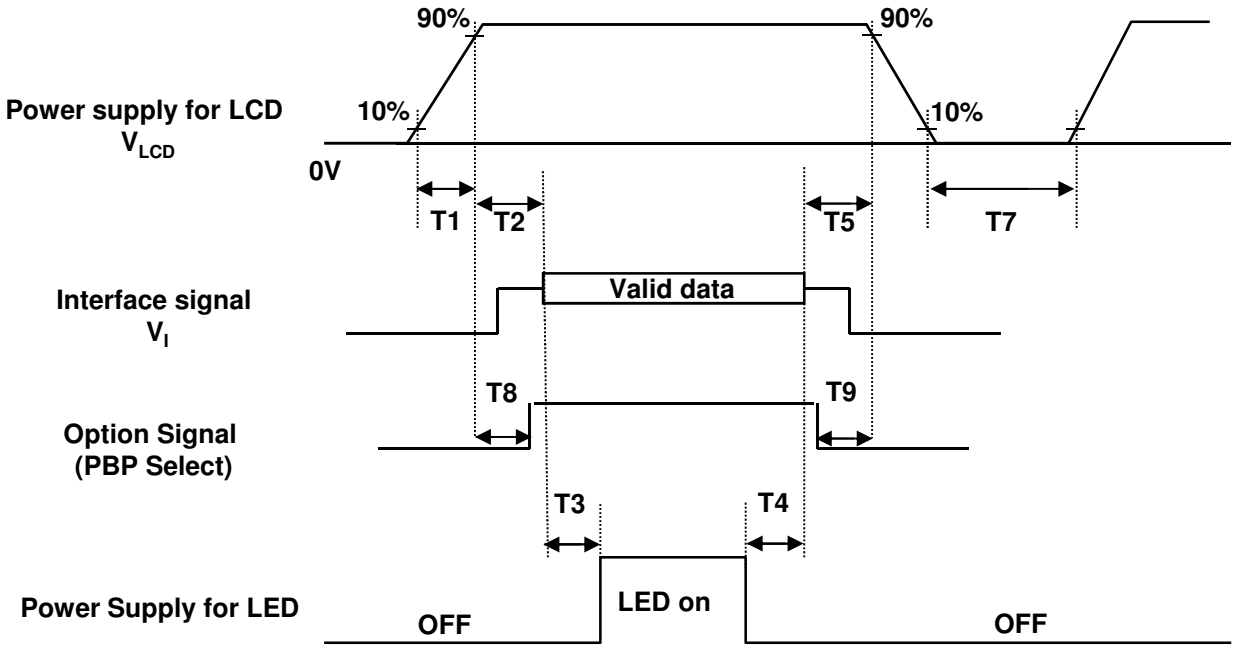


Table 9. Power Sequence

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	-	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 V_{LCD} to 0V.
4. The invalid signal means out of the signal timing specification which define as page 14.
5. The above power sequence should be satisfied the basic power on/off and resolution, timing transition.
6. LED power must be turn on after power supply for LCD and interface signal are valid..

3-8. V_{LCD} Power Dip Condition

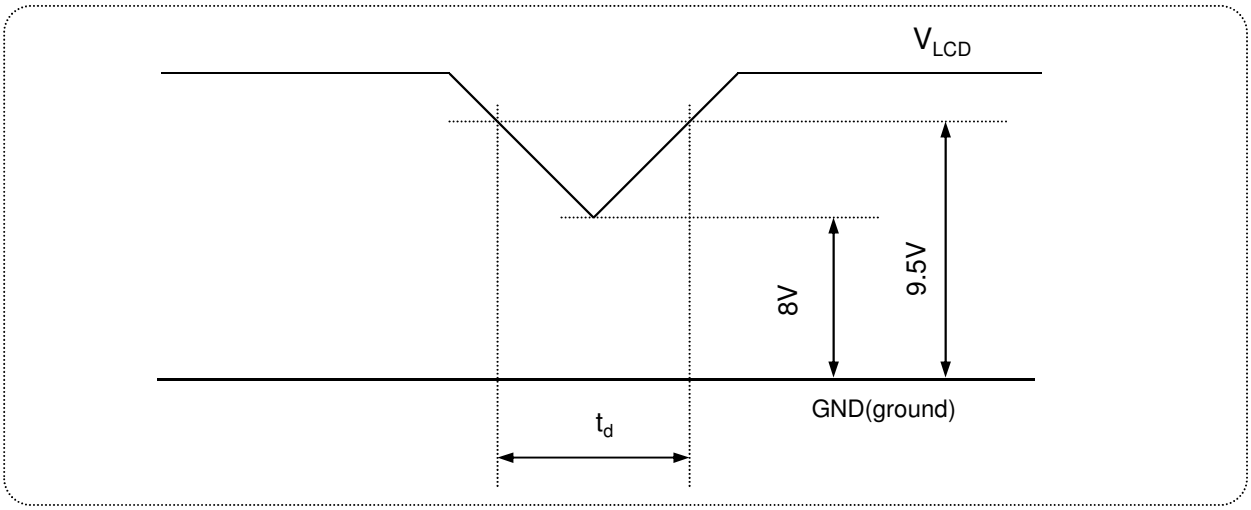


FIG.5 Power dip condition

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

Figure 6. Optical Characteristic Measurement Equipment and Method

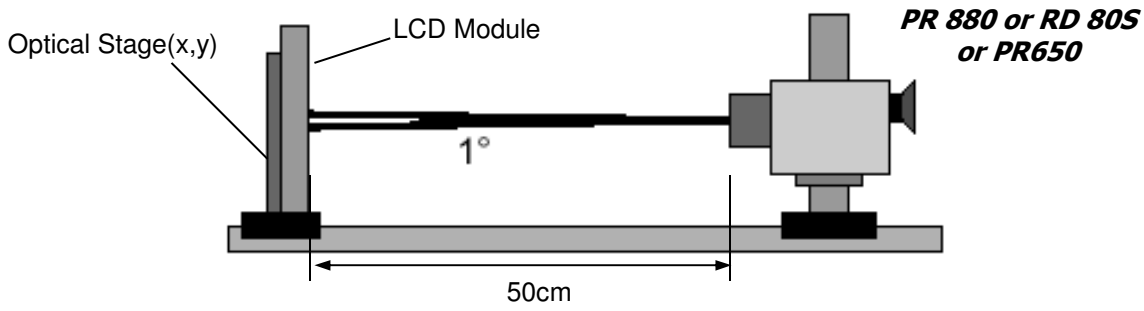


Table 10. Optical Characteristics (Ta=25 °C, V_{LCD}=10.0V, f_V=60Hz D_{CLK}=185.58MHz, Is=110mA)

Parameter		Symbol	Values			Units	10
			Min	Typ	Max		
Contrast Ratio		CR	700	1000	-		1
Surface Luminance, white		L_{WHITE}	240	300	-	cd/m^2	2
Luminance Variation		δ_{WHITE}	75	-	-	%	3
Response Time	GTG	T_{GTG_AVR}	-	14	28	ms	4
Color Gamut			-	sRGB	-	%	
Color Coordinates [CIE1931] (By PR650)	RED	Rx	Typ -0.03	0.650	Typ +0.03		
		Ry		0.336			
	GREEN	Gx		0.307			
		Gy		0.634			
	BLUE	Bx		0.151			
		By		0.059			
	WHITE	Wx		0.313			
		Wy		0.329			
Viewing Angle (CR>10)							
General	Horizontal	θ_H	170	178	-	Degree	5
	Vertical	θ_V	170	178	-		
GSR @ 60dgree (Gamma shift rate)	Horizontal	δ_{Gamma_H}	-	-	20	%	6
	Vertical	δ_{Gamma_V}	-	-	20		
Luminance uniformity - Angular dependence (TCO 6.0)		-	-	-	1.73		7
Color uniformity - Angular dependence (TCO 6.0)		-	-	-	0.025		8
Gray Scale				2.2			9

Notes :

1. **Contrast ratio (CR)** is defined mathematically as :

   It is measured at center point (1)

$$\text{Contrast ratio} = \frac{\text{Surface luminance with all white pixels}}{\text{Surface luminance with all black pixels}}$$

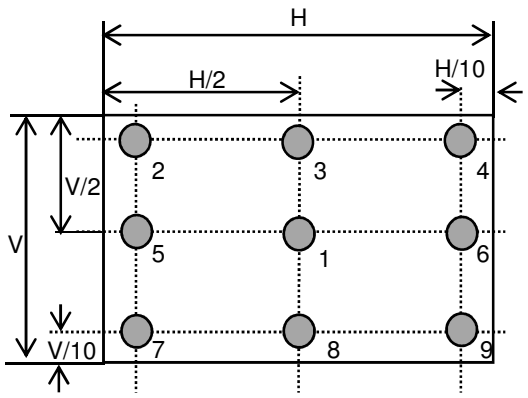
2. **Surface luminance** is the luminance value at center 1 point (1) across the LCD surface 50cm from the surface with all pixels displaying white.
   For more information see Figure 7.

3. The **variation in surface luminance** , δ_{WHITE} is defined as :

$$\delta_{WHITE} = \frac{\text{Minimum (P1,P2, ….., P9)}}{\text{Maximum (P1,P2, ….., P9)}} \times 100\ (\%)$$

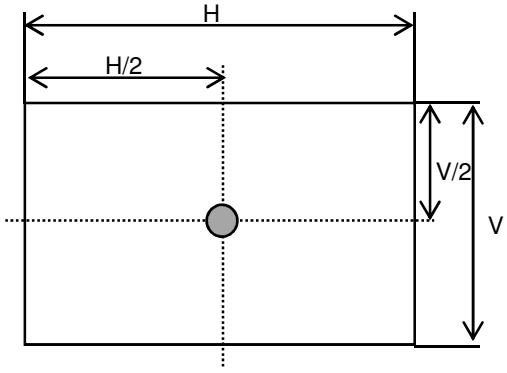
   For more information see Figure 7.

Figure 7. Luminance measuring point



@ H,V : Active Area

<Measuring point for luminance variation>



<Measuring point for surface luminance>

4. 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 “.
   - By RD80S

Table 11. GTG Gray Table

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

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

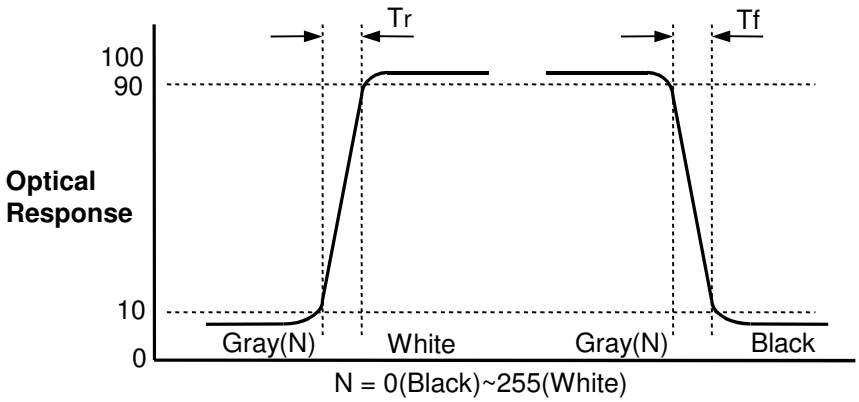
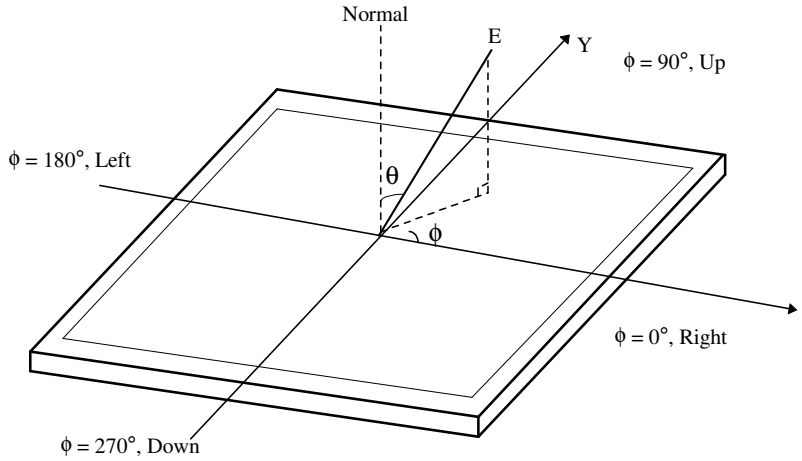


Figure 8. Response Time

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 Figure 10 .

Figure 10. Viewing Angle



6. **GSR** is the rate of gamma shift at up, down, left and right 60 degree viewing angle compare with center gamma. For more information see FIG.10 and FIG.11 ***(By EZ Contrast)***

- GSR (δ Gamma) is defined as :

$$GSR = \left(1 - \frac{\text{View angle Gamma Value (Up, Down, Reft, Light 60 Degree)}}{\text{Center Gamma Value (0 Degree)}}\right) \times 100$$

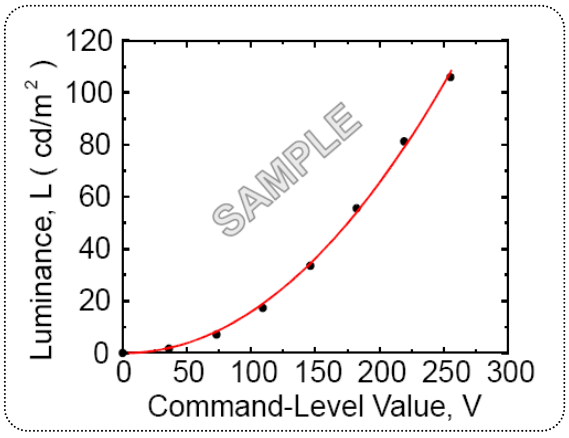


Figure11. Sample Luminance vs. gray scale (using a 256 bit gray scale)

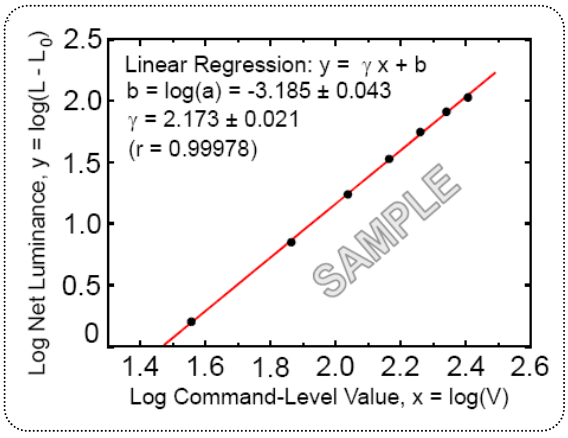


Figure 12. Sample Log-log plot of luminance vs. gray scale

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

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

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

The Gamma we calculate from the log-log representation (Figure 12.)

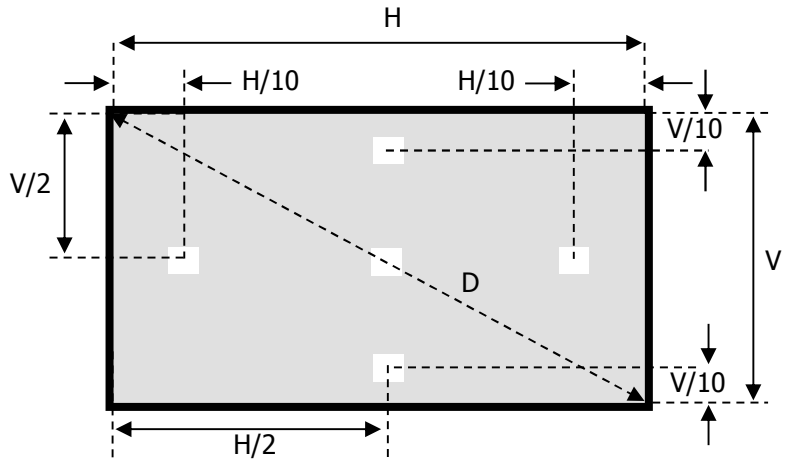
7. Luminance Uniformity - angular – dependence (LR& TB)

TCO 6.0 Luminance uniformity – angular dependence, is the capacity of the VDU to present the same Luminance level independently of the viewing direction.
The angular-dependent luminance uniformity is calculated as the ratio of maximum luminance to minimum luminance in the specified measurement areas.

- Test pattern : Full white 4°× 4°square size, back ground shall be set to 80% image loading, RGB 204, 204, 204
- Test luminance : ≥200cd/㎡
- Test point : 5-point
- Test distance : D * 1.5
- Test method : $L_R = ((L_{max.+30deg.} / L_{min.+30deg.}) + (L_{max.-30deg.} / L_{min.-30deg.})) / 2$
  $T_B = ((L_{max.+15deg.} / L_{min.+15deg.})$

FIG. 13 Luminance Uniformity angular dependence

< Luminance uniformity - angular dependence measuring point >



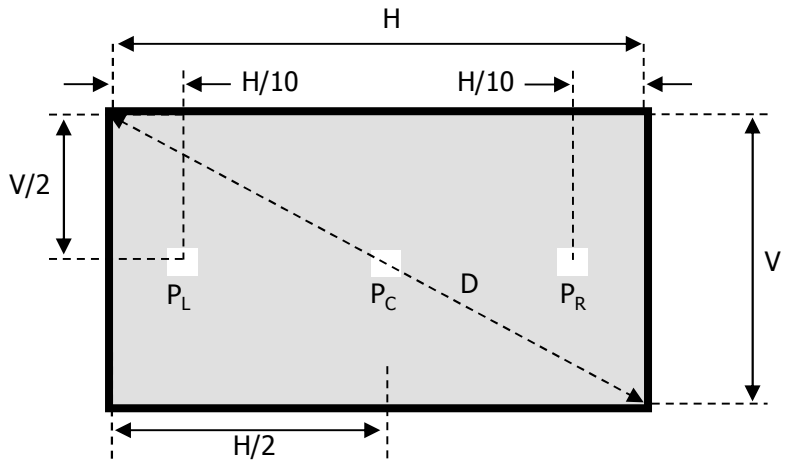
8. Color uniformity Angular dependence (LR)

TCO 6.0 Color uniformity – angular dependence, is the capacity of the VDU to present the same color level independently of the viewing direction.
The angular-dependent color uniformity is calculated as the largest difference in △u'v' value

- Test pattern : Full white 4°× 4°square size, back ground shall be set to 80% image loading, RGB 204, 204, 204
- Test luminance : ≥200cd/㎡
- Test point : 3-point
- Test distance : D * 1.5
- Test method
  1. The screen shall then be rotated ±30 degrees around a vertical axis through the screen centre-point and the chromaticity co-ordinates at positions P_L, P_R, ($u'_{PL/\pm 30^o}$, $v'_{PL/\pm 30^o}$ and $u'_{PR/\pm 30^o}$, $v'_{PR/\pm 30^o}$ respectively) shall be recorded.
  2. △u'v' shall be calculated for each measured position using the formula
     a. $\triangle u'v'_{+30^o} = ((u'_{PL/+30^o} - u'_{PR/+30^o})^2 + (v'_{PL/+30^o} - v'_{PR/+30^o})^2)^{\wedge 1/2}$
     b. $\triangle u'v_{-30^o} = ((u'_{PL/-30^o} - u'_{PR/-30^o})^2 + (v'_{PL/-30^o} - v'_{PR/-30^o})^2)^{\wedge 1/2}$
  3. The largest difference in △ u'v' value shall be reported

FIG. 14 Color uniformity Angular dependence

< Color uniformity - angular dependence measuring point >



9. **Gray scale** specification
Gamma Value is approximately 2.2.

Table 12. Gray Scale Specification

Gray Level	
0	0.10
15	0.35
31	0.80
47	1.80
63	3.80
79	6.30
95	10.0
111	15.0
127	20.5
143	27.3
159	34.6
175	42.5
191	51.3
207	61.2
223	72.3
239	85.3
255	100

5. Mechanical Characteristics

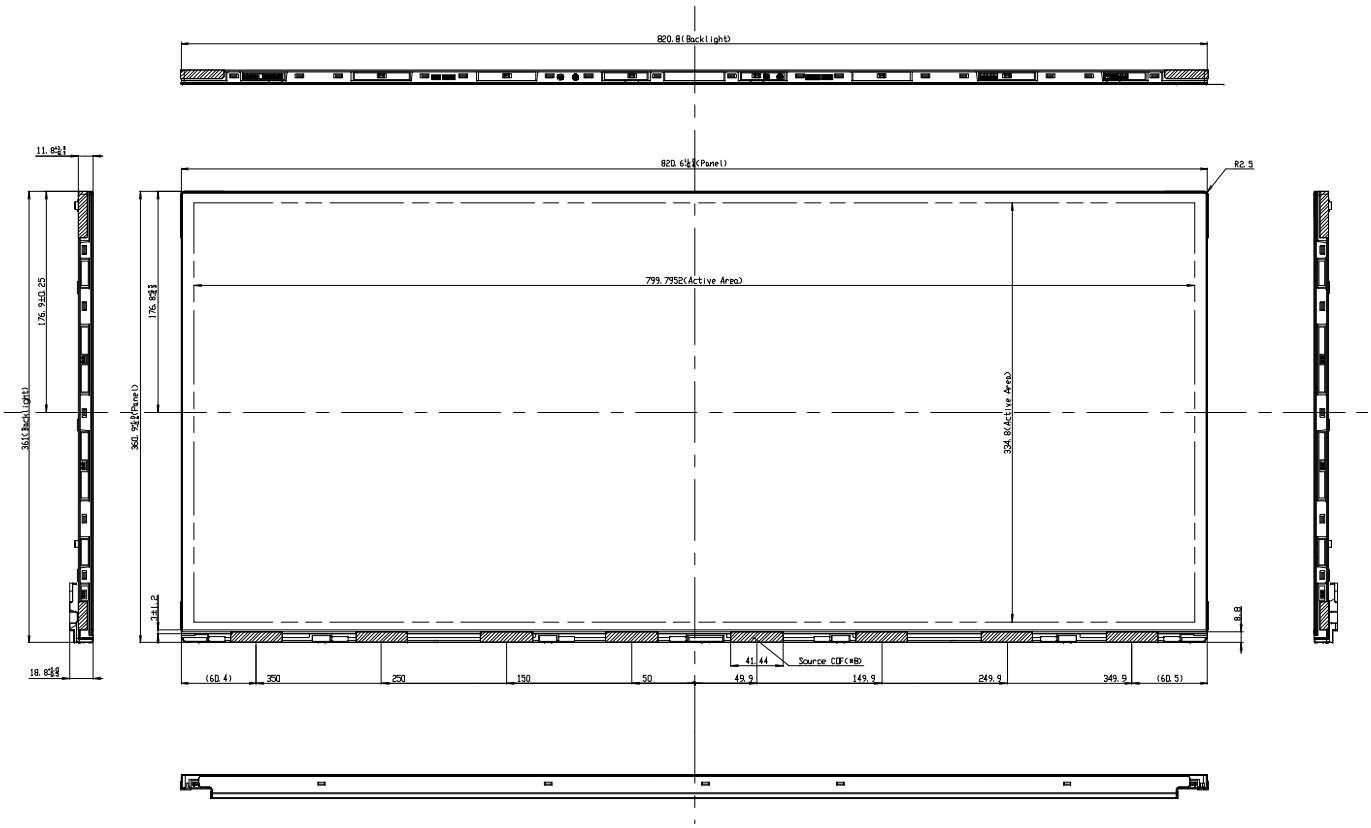
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Table 13. Mechanical characteristics

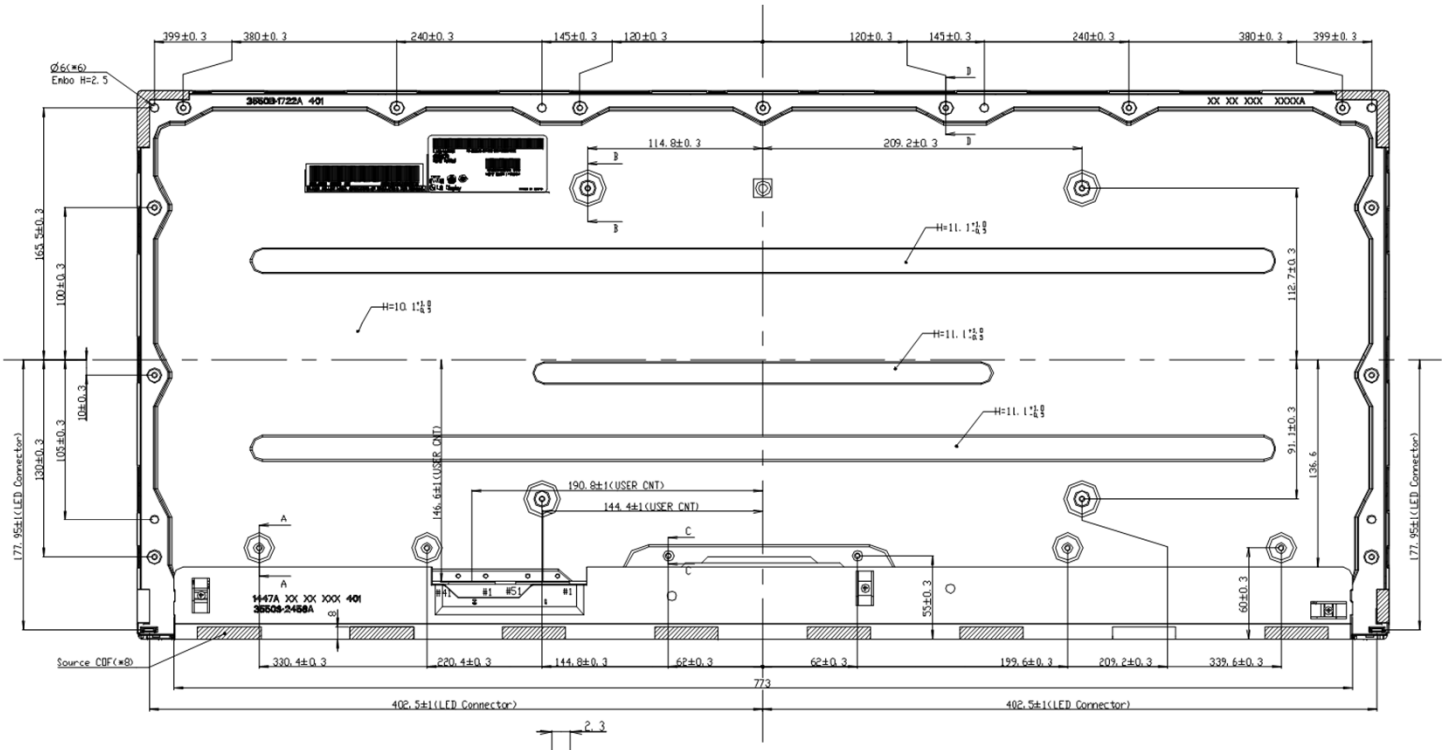
Outline Dimension	Horizontal	820.8mm
	Vertical	361.0mm
	Depth	18.8mm
Bezel Area	Horizontal	-
	Vertical	-
Active Display Area	Horizontal	799.7952 mm
	Vertical	334.800 mm
Weight	Typ. : 3960g , Min : 3760g Max : 4160g	
Surface Treatment	(Hard coating (3H) Anti-glare treatment of the front polarizer)	

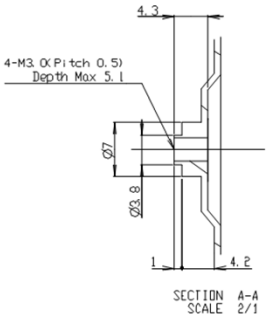
Notes : Please refer to a mechanic drawing in terms of tolerance at the next page.

<FRONT VIEW>

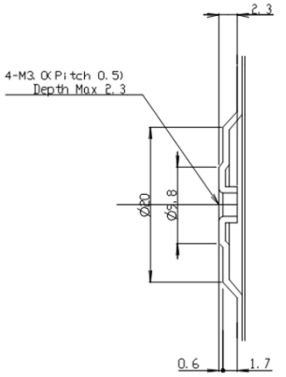

820.8(Backlight)
820.6±0.3(Panel)
R2.5
799.795E(Active Area)
394.8(Active Area)
176.8±0.3
176.9±0.25
11.8±0.1
18.8±0.8
341.2
8.8
41.44
Source CIF(×8)
(60.4)
350
250
150
50
49.9
149.9
249.9
349.9
(60.5)

<REAR VIEW>

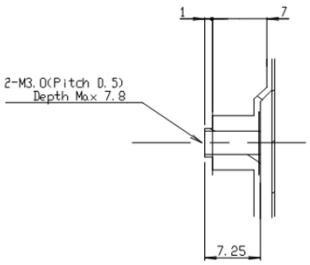




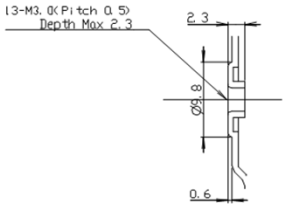
SECTION A-A
SCALE 2/1



SECTION B-B
SCALE 2/1

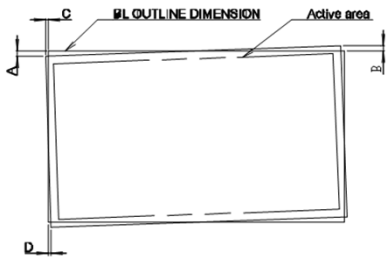


SECTION C-C
SCALE 2/1



SECTION D-D
SCALE 2/1

Notes
1. I/F connector specification
   (1) CN1 : GT05P-51S-H3B(LSM)
   (2) CN2 : GT05P-41S-H3B(LSM)
2. LED connector specification : JST, SM06B-SHJK(HF)
3. Torque of user hole: 3.0~4.0kgf-cm.
4. Tilt and partial disposition tolerance of display area as following
   (1) X-direction : $-0.65 \leq C \leq +0.50$, $-0.65 \leq D \leq +0.50$
   (2) Y-direction : $-0.60 \leq A \leq +0.45$, $-0.60 \leq B \leq +0.45$



5. The LCM warp(warpage) is less than 1.5 on the surface plate.
6. Unspecified tolerance is ±0.5
7. The COF area is weak & senstive, so please don't press the COF area

6. Reliability

Table 14. Environment test conditions

No	Test Item	Condition	Notes
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	
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℃	

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

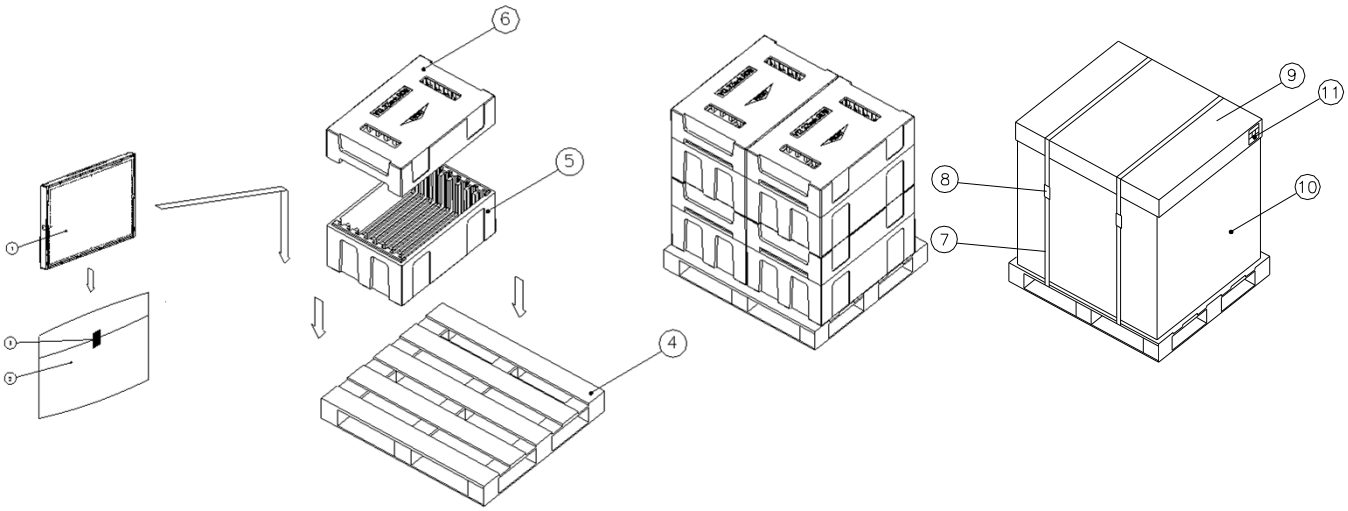
Serial No. is printed on the label. The label is attached to the backside of the LCD module.
This is subject to change without prior notice.

8. Packing

8-2. Packing Form

a) Package quantity in one box : 12 pcs

b) Box Size : 542mm×934mm×450mm



NO.	DESCRIPTION	MATERIAL
1	LCM	-
2	BAG	AL
3	TAPE	OPP
4	PALLET	PLYWOOD_1140X990X117.5
5	PACKING, BOTTOM	EPS
6	PACKING, TOP	EPS
7	BAND	PP
8	BAND, CLIP	CLIP 18MM
9	Angle Cover	PAPER
10	Angle Packing	PAPER
11	LABEL	PP

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'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 guarantee.
(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.