

TFT-DISPLAY DATASHEET

LG Display
Model: LB213QX1-SL01

BRIEF SPEC.:

Main Feature	Landscape Ultra High Brightness Wide Aspect Ratio
Active Screen Area	433.152 x 324.864
Diagonal Format	21.3" 4:3
Resolution	2048 X 1536
Colors	10-bit
Backlight	LED
Brightness	1000 cd/m ²
LED Life Time	50K(h)
Interface	LVDS
Viewing Angle	89/89 L/R 89/89
Touchscreen	No
Power Supply	5.0 V
Module Outline	457 x 350 x 22.3 (mm)
Operation Temperature	- 0 ... +50 °C
Storage Temperature	-20... +60 °C
Surface Treatment	Anti-Glare (Hardcoating 3H)

SPECIFICATION FOR APPROVAL

- (●) Preliminary specification
- () Final specification

Title	21.3" QXGA TFT LCD
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BUYER	
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LB213QX1
SUFFIX	SL01

*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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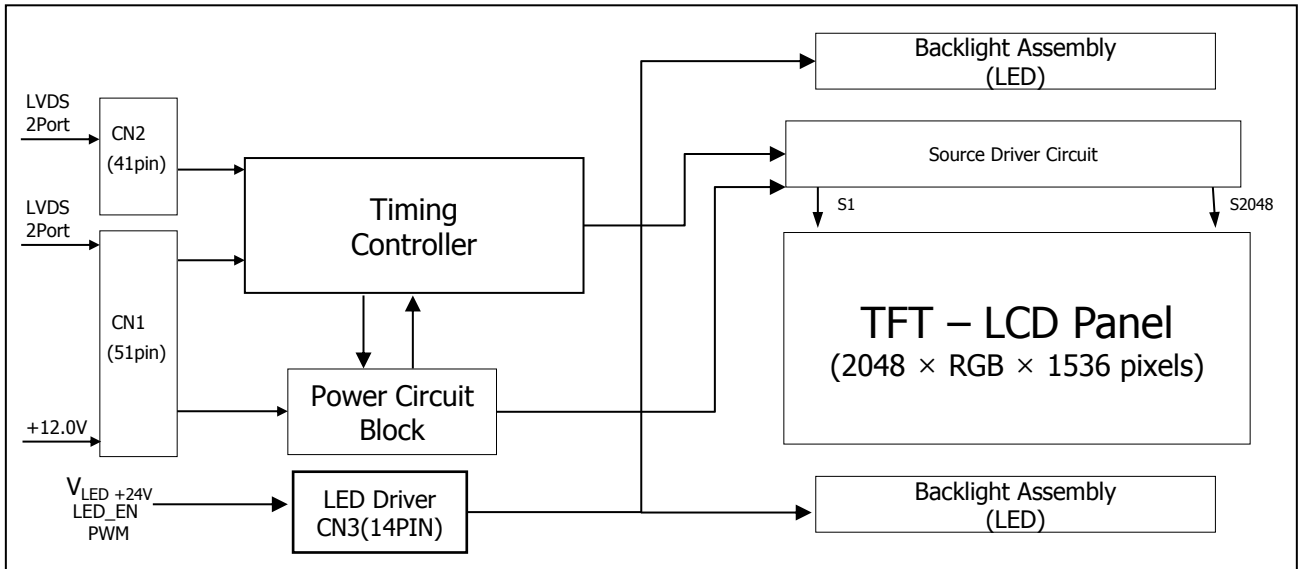
Product engineering dept.
LG Display Co., Ltd

Product specification
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Product specification
1. General description

LB213QX1-SL01 is a color active matrix liquid crystal display with a light emitting diode (WLED) backlight system with 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 21.3 inch diagonally measured active display area with QXGA resolution.(2048 horizontal by 1536 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 1,073,741,824 colors. It has been designed to apply the 10-Bit 4port LVDS interface. It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important._


[FIG. 1] Block diagram
General features

Active screen size	21.3 inches(54.14cm) (Aspect ratio 4:3)
Outline dimension	457.0(H) x 350.0(V) x 22.3(D) mm (Typ.)
Pixel pitch	0.2115(H)mm x 0.2115(V)mm
Pixel format	2048(H) x 1536(V) Pixels. RGB stripes arrangement
Color depth	1,073,741,824 colors (10bit)
Luminance (@White)	1000 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 TBD Watt (5.88 Watt @V _{LCD} , (TBD) Watt @I _s =40mA)
Weight	T.B.D g (Typ.)
Display operating mode	Transmissive mode, normally black
Panel type	Forward type
Surface treatment	Hard coating(3H), Anti-glare treatment of the front polarizer

Product specification

2. Absolute maximum ratings

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

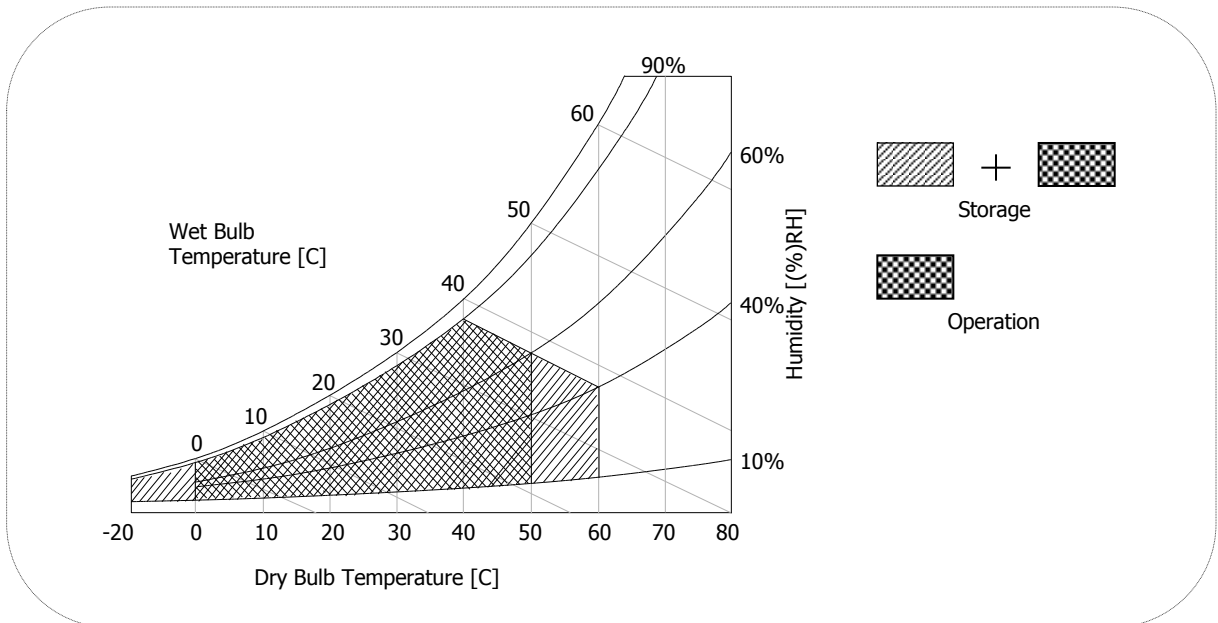
Table 1. Absolute maximum ratings

Parameter	Symbol	Values		Units	Notes
		Min.	Max.		
Power supply input voltage	V_{LCD}	8	14	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

Notes :

- Temperature and relative humidity range are shown in the figure below.
Wet bulb temperature should be 39 °C Max., and no condensation of water.
- Maximum storage humidity is up to 40 °C, 70% RH only for 4 corner light leakage mura.
- Storage condition is guaranteed under packing condition
- LCM surface temperature should be measured under the condition of $V_{LCD}=5.0V$, $f_v=60Hz$, $T_a=25°C$, no humidity and typical LED string current.
※. T_a = Ambient temperature

[FIG. 2] Temperature and relative humidity



Product specification
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			Units	Notes
		Min	Typ	Max		
MODULE :						
Power supply input voltage	V_{LCD}	11.5	12.0	12.5	V	4
Permissive power input ripple	V_{ripple}	-	-	400	mVp-p	1
Power supply input current	I_{LCD} Typ.	-	0.49	0.64	A	2
	I_{LCD} Max.	-	0.59	0.77	A	
Power consumption	P_c Typ.	-	5.88	7.64	Watt	
	P_c Max.	-	7.1	9.23	Watt	
Rush current	I_{RUSH}	-	-	3.5	A	3

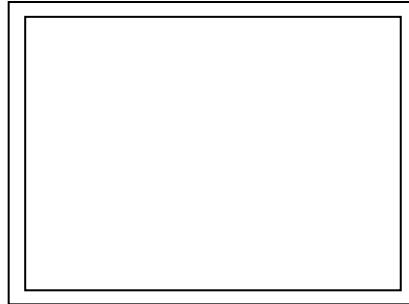
Notes :

- Permissive power ripple should be measured under the condition of $V_{LCD}=12.0V$, $25^{\circ}C$, $*fv=max$. Refer to page 7 for the pattern and more information.
- The specified current and power consumption can be measured under the $V_{LCD}=12.0V$, $25^{\circ}C$, $f_v=60Hz$ 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.
- 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.).
- 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

Product specification

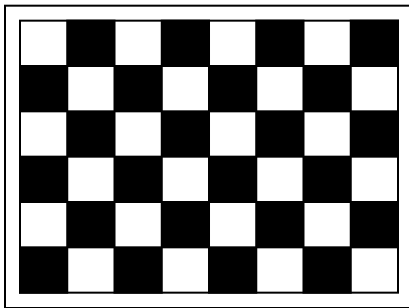
- **Permissive power input ripple** ($V_{LCD} = 12.0V$, $25^{\circ}C$, f_v (frame frequency)=Max. condition)



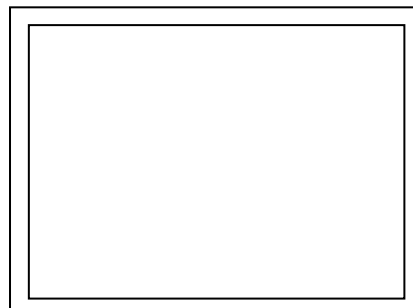
White pattern

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

- **Power consumption** ($V_{LCD} = 12.0V$, $25^{\circ}C$, f_v (frame frequency)=60Hz condition)



Typical power pattern



Maximum power pattern

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

Product specification

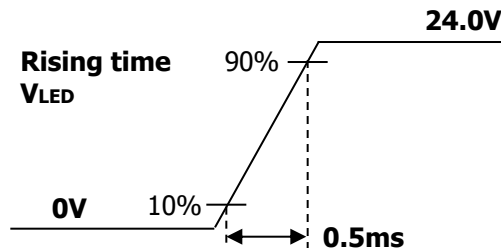
3-2. LED Backlight Electrical Characteristics

Table 3. LED B/L ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes	
		Min	Typ	Max			
LED Power Input Voltage	V _{LED}	23.5	24	24.5	V	1	
LED Power Input Current	I _{LED}	-	TBD	TBD	mA	2	
LED Power Consumption	P _{LED}	-	TBD	TBD	W		
LED Power Inrush Current	I _{LED_P}	-	-	TBD	A	3	
PWM Duty Ratio		TBD	-	TBD	%	4	
PWM Jitter		TBD	-	TBD	%	5	
PWM Frequency	F _{PWM}	TBD	-	TBD	Hz	6	
PWM	High Level Voltage	V _{PWM_H}	TBD	-	TBD	V	
	Low Level Voltage	V _{PWM_L}	TBD	-	TBD	V	
LED_EN	High Voltage	V _{LED_EN_H}	TBD	-	TBD	V	
	Low Voltage	V _{LED_EN_L}	TBD	-	TBD	V	
LED Life Time		50,000	-	-	Hrs	7	

Note)

1. The measuring position is the connector of LCM and the test conditions are under 25°C.
2. The current and power consumption with LED Driver are under the V_{LED} = 24.0V , 25°C, PWM Duty 100% and White pattern with the normal frame frequency operated(60Hz).
3. The V_{LED} rising time is same as the minimum of T9 at Power on sequence.



4. The operation of LED Driver below minimum dimming ratio may cause flickering or reliability issue.
5. If Jitter of PWM is bigger than maximum, it may induce flickering.
6. This Spec. is not effective at 100% dimming ratio as an exception because it has DC level equivalent to 0Hz. In spite of acceptable range as defined, the PWM Frequency should be fixed and stable for more consistent brightness control at any specific level desired.
7. 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.

Product specification
3-3. Interface connections
3-3-1. LCD Module

- LCD Connector(CN1): IS050-C51B-C39-C (manufactured by UJU) or FI-RE51S-HF (manufactured by JAE) or GT05P-51S-H38-E1500 (manufactured by LSM) or equivalent.
- 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 (I2C serial interface for LCM)	30	R2BN	SECOND LVDS Receiver signal (B-)
5	NC	No Connection (I2C serial interface for LCM)	31	R2BP	SECOND LVDS Receiver signal (B+)
6	Interlace mode	'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	SECOND LVDS Receiver signal (E-)
15	R1BP	FIRST LVDS Receiver signal (B+)	41	NC	SECOND LVDS Receiver signal (E+)
16	R1CN	FIRST LVDS Receiver signal (C-)	42	Reserved	No connection or GND
17	R1CP	FIRST LVDS Receiver signal (C+)	43	Reserved	No connection or GND
18	GND	Ground	44	GND	Ground
19	R1CLKN	FIRST LVDS Receiver Clock signal(-)	45	GND	Ground
20	R1CLKP	FIRST LVDS Receiver Clock signal(+)	46	GND	Ground
21	GND	Ground	47	NC	No connection
22	R1DN	FIRST LVDS Receiver signal (D-)	48	VLCD	Power Supply +12.0V
23	R1DP	FIRST LVDS Receiver signal (D+)	49	VLCD	Power Supply +12.0V
24	NC	FIRST LVDS Receiver signal (E-)	50	VLCD	Power Supply +12.0V
25	NC	FIRST LVDS Receiver signal (E+)	51	VLCD	Power Supply +12.0V
26	Reserved	No connection or GND	-	-	-

Notes :

1. All GND(ground) pins should be connected together to the LCD module's metal frame.
2. All V_{LCD} (input power) pins should be connected together.
3. All input level of LVDS signals are based on the EIA 644 standard.
4. ITLC is used for image sticking reduction in interlace mode.
(L: Normal mode, H: Interlace image sticking reduction mode)
This pin should be connected to GND in normal mode.
(Low level Input Voltage : GND ~ 0.4V, High level Input Voltage : 1.6 ~ 3.6V)
5. PWM_OUT is a reference signal for LED PWM control. This PWM signal is synchronized with vertical frequency. If the system don't use this pin, do not connect.

Product specification

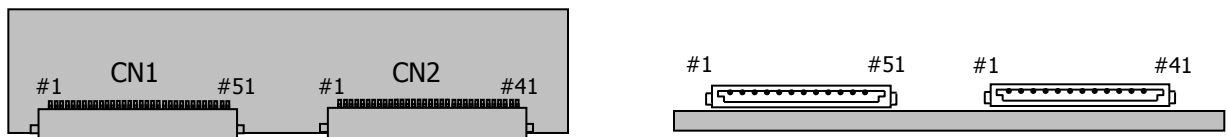
- LCD Connector(CN1): IS050-C51B-C39-A (manufactured by UJU) or FI-RE51S-F (manufactured by JAE)
- or GT05P-51S-H38-E1500 (manufactured by LSM) or equivalent.
- Mating Connector : FI-RE51HL(JAE) or compatible

Table 3-2. Module connector (CN2) pin configuration

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

Notes :

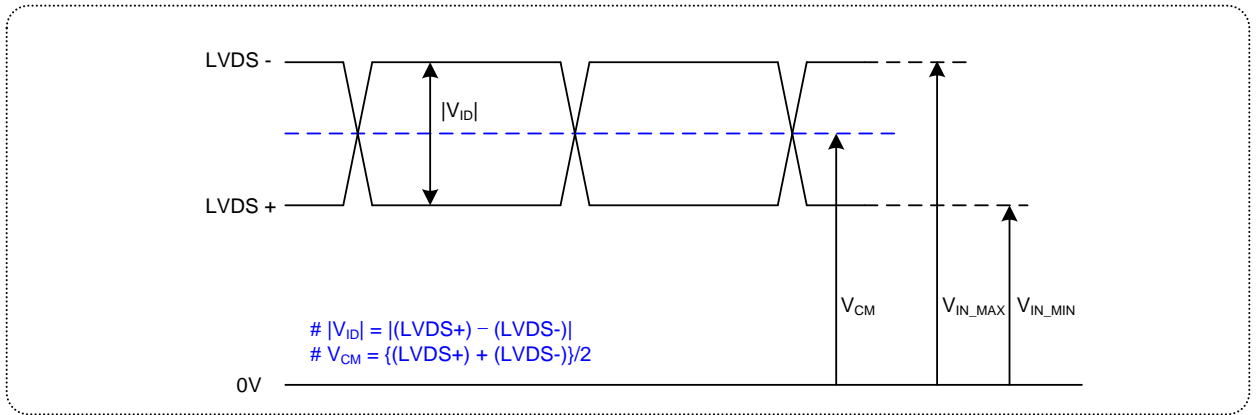
1. All GND(ground) pins should be connected together to the LCD module's metal frame.


[FIG. 4] Connector diagram

Product specification
Table 4. Required signal assignment for flat link(TI:SN75LVDS83) transmitter

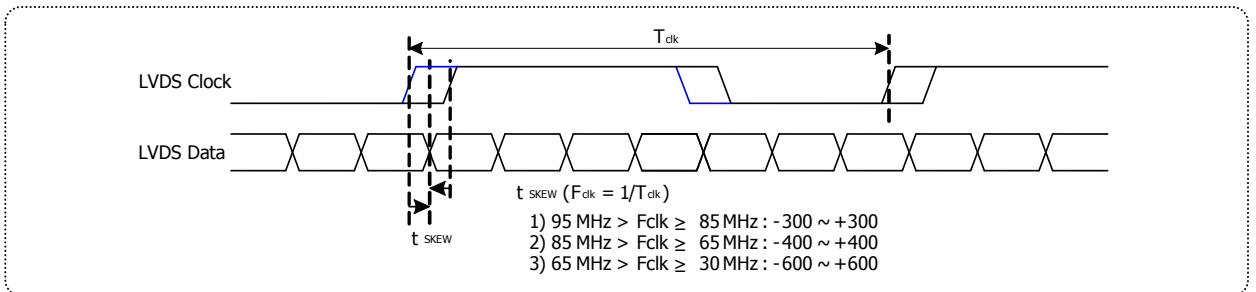
Pin #	Pin Name	Require Signal	Pin #	Pin Name	Require Signal
1	Vcc	Power supply for TTL Input	29	GND	Ground pin for TTL
2	D5	TTL Input (R7)	30	D26	TTL Input (DE)
3	D6	TTL Input (R5)	31	T _x CLKIN	TTL Level clock Input
4	D7	TTL Input (G0)	32	PWR DWN	Power down Input
5	GND	Ground pin for TTL	33	PLL GND	Ground pin for PLL
6	D8	TTL Input (G1)	34	PLL Vcc	Power supply for PLL
7	D9	TTL Input (G2)	35	PLL GND	Ground pin for PLL
8	D10	TTL Input (G6)	36	LVDS GND	Ground pin for LVDS
9	Vcc	Power supply for TTL Input	37	T _x OUT3 +	Positive LVDS differential data output 3
10	D11	TTL Input (G7)	38	T _x OUT3 –	Negative LVDS differential data output 3
11	D12	TTL Input (G3)	39	T _x CLKOUT +	Positive LVDS differential clock output
12	D13	TTL Input (G4)	40	T _x CLKOUT –	Negative LVDS differential clock output
13	GND	Ground pin for TTL	41	T _x OUT2 +	Positive LVDS differential data output 2
14	D14	TTL Input (G5)	42	T _x OUT2 –	Negative LVDS differential data output 2
15	D15	TTL Input (B0)	43	LVDS GND	Ground pin for LVDS
16	D16	TTL Input (B6)	44	LVDS Vcc	Power supply for LVDS
17	Vcc	Power supply for TTL Input	45	T _x OUT1 +	Positive LVDS differential data output 1
18	D17	TTL Input (B7)	46	T _x OUT1 –	Negative LVDS differential data output 1
19	D18	TTL Input (B1)	47	T _x OUT0 +	Positive LVDS differential data output 0
20	D19	TTL Input (B2)	48	T _x OUT0 –	Negative LVDS differential data output 0
21	GND	Ground pin for TTL Input	49	LVDS GND	Ground pin for LVDS
22	D20	TTL Input (B3)	50	D27	TTL Input (R6)
23	D21	TTL Input (B4)	51	D0	TTL Input (R0)
24	D22	TTL Input (B5)	52	D1	TTL Input (R1)
25	D23	TTL Input (RSVD)	53	GND	Ground pin for TTL
26	Vcc	Power supply for TTL Input	54	D2	TTL Input (R2)
27	D24	TTL Input (HSYNC)	55	D3	TTL Input (R3)
28	D25	TTL Input (VSYNC)	56	D4	TTL Input (R4)

Notes : 1. Refer to LVDS transmitter data sheet for detail descriptions.
 2. 7 means MSB and 0 means LSB at R,G,B pixel data

Product specification
3-3-2. LVDS Input characteristics
1. DC Specification


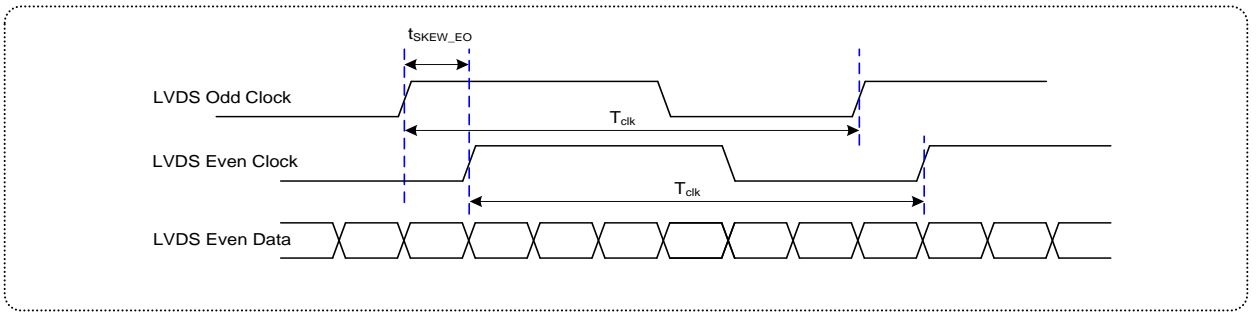
Description	Symbol	Min	Max	Unit	Notes
LVDS Differential voltage	$ V_{ID} $	150	600	mV	-
LVDS Common mode voltage	V_{CM}	1.0	1.5	V	-
LVDS Input voltage range	V_{IN}	0.7	1.8	V	-
Change in common mode voltage	ΔV_{CM}	-	250	mV	-

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

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}	-

Product specification

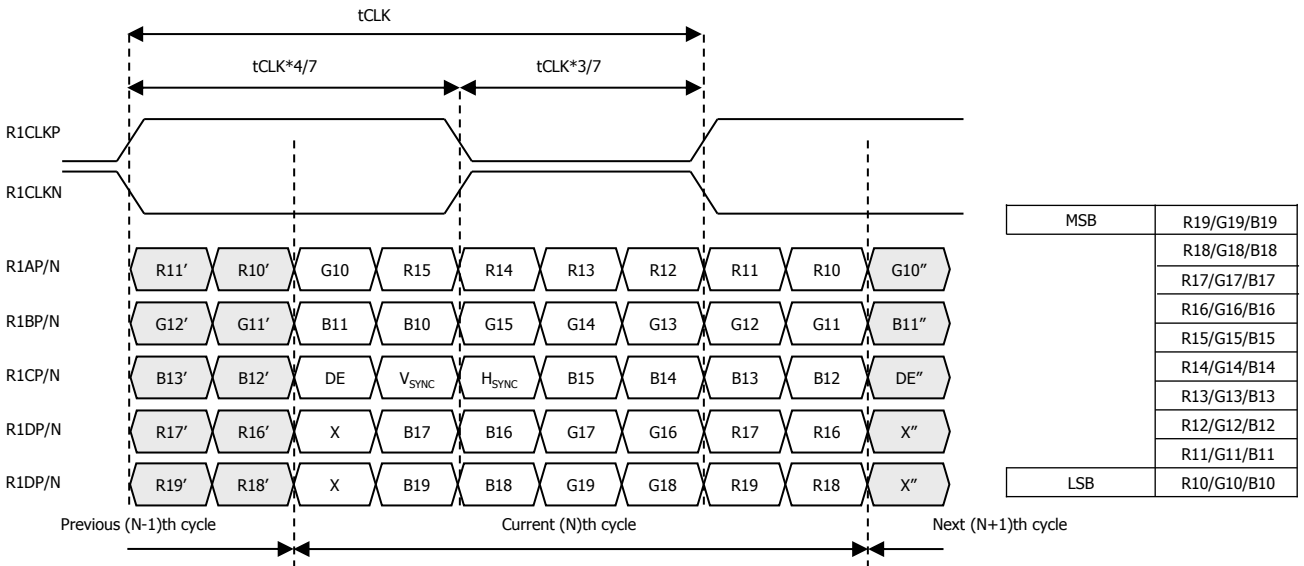


< Clock skew margin between channel >

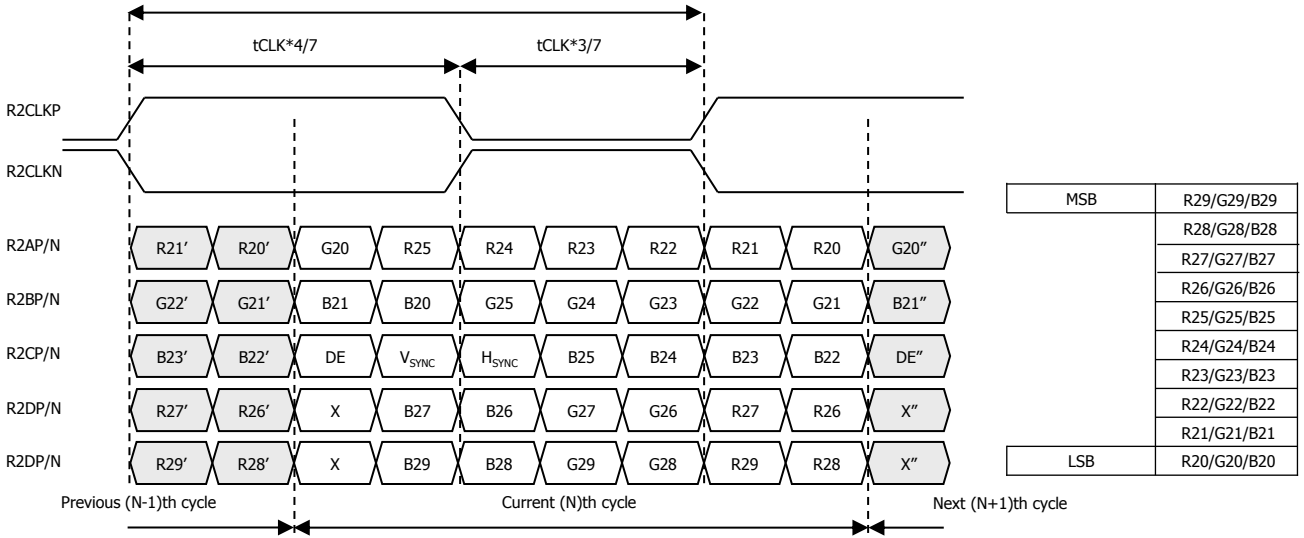
3. Data Format

1) LVDS 4 Port (10Bit, VESA)

■ 1st LVDS Channel

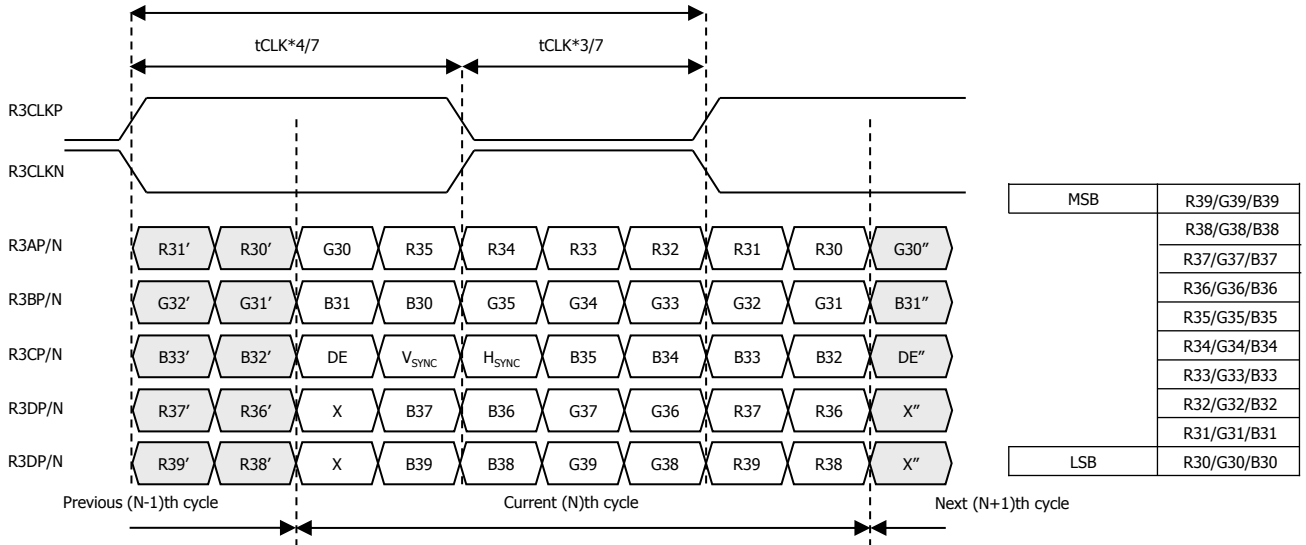


■ 2nd LVDS Channel

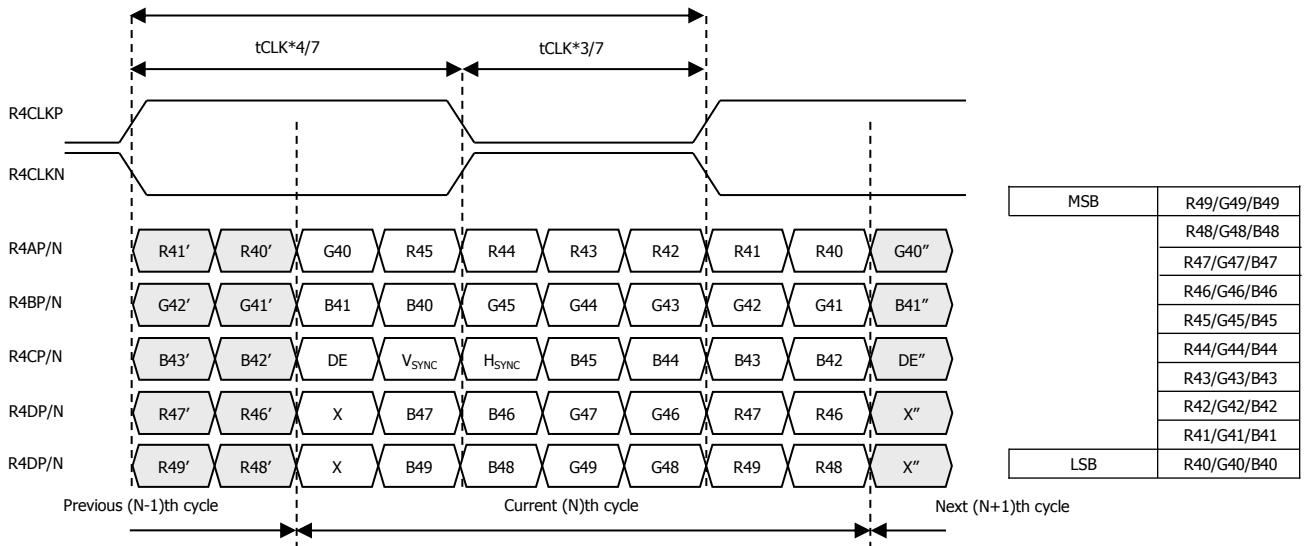


Product specification

■ 3rd LVDS Channel

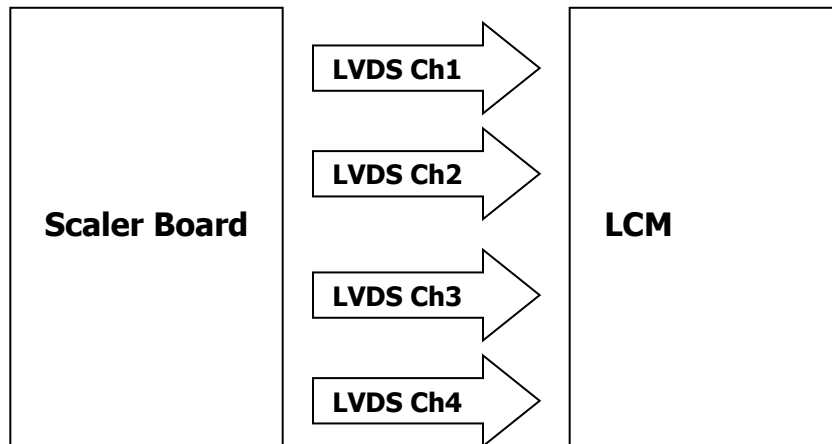
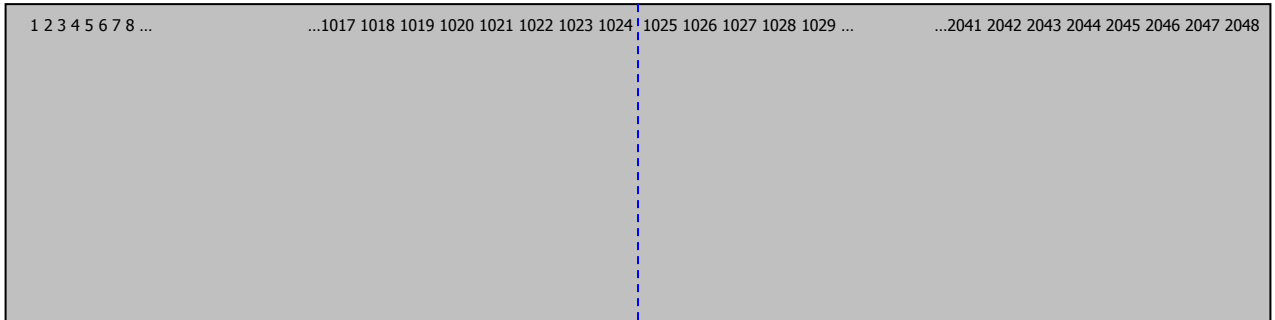


■ 4th LVDS Channel



Product specification

4. LVDS description of Dara Re-Arrange



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

- LVDS Ch1 : 1 → 5 → ... 1017 → 1021 → 1025 → 1029 → ... 2041 → 2045
- LVDS Ch2 : 2 → 6 → ... 1018 → 1022 → 1026 → 1030 → ... 2042 → 2046
- LVDS Ch3 : 3 → 7 → ... 1019 → 1023 → 1027 → 1031 → ... 2043 → 2047
- LVDS Ch4 : 4 → 8 → ... 1020 → 1024 → 1028 → 1032 → ... 2044 → 2048

■ DRA (Data Re-Arrange, Pin # 7 of CN1 = High)

- LVDS Ch1 : 1 → 3 → 5 → 7 → ... 1017 → 1019 → 1021 → 1023
- LVDS Ch2 : 2 → 4 → 6 → 8 → ... 1018 → 1020 → 1022 → 1024
- LVDS Ch3 : 1025 → 1027 → 1029 → 1031 → ... 2041 → 2043 → 2045 → 2047
- LVDS Ch4 : 1026 → 1028 → 1030 → 1032 → ... 2042 → 2044 → 2046 → 2048

Product specification

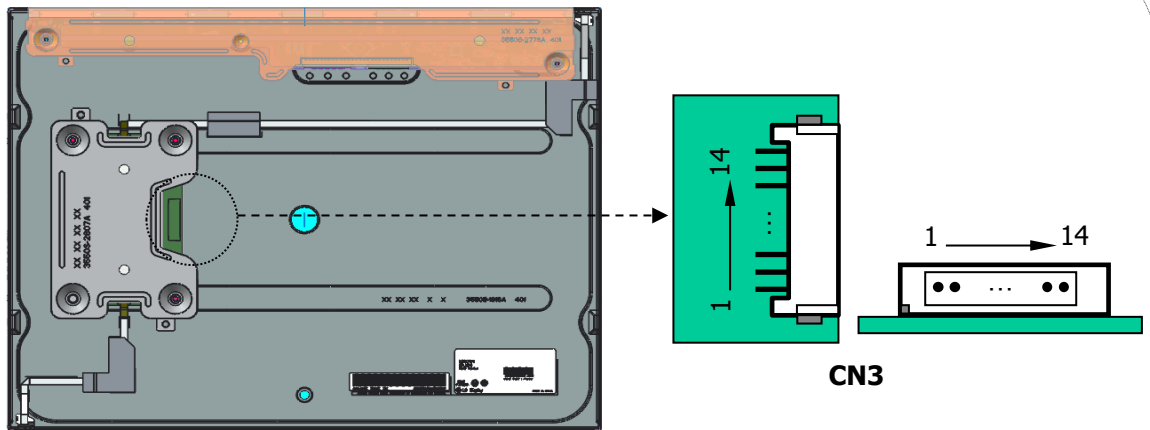
3-3-3. Backlight connector pin configuration

Table 5. Backlight connector pin configuration(CN3)

The LED Driver interface connector is 20022WR-H14B2 type manufactured by YEON-HO or equivalent. The mating connector is a or or equivalent.

The pin configuration for the connector is shown in the table below.

No	Symbol	Description
1	VBL	Power Supply +24.0V
2	VBL	Power Supply +24.0V
3	VBL	Power Supply +24.0V
4	VBL	Power Supply +24.0V
5	VBL	Power Supply +24.0V
6	GND	Backlight Ground
7	GND	Backlight Ground
8	GND	Backlight Ground
9	GND	Backlight Ground
10	GND	Backlight Ground
11	NC	NC
12	LED_EN	Backlight ON/OFF control
13	NC	NC
14	PWM	External PWM



Rear view of LCM

[FIG. 5] Backlight connector view

Product specification
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 6. Timing table

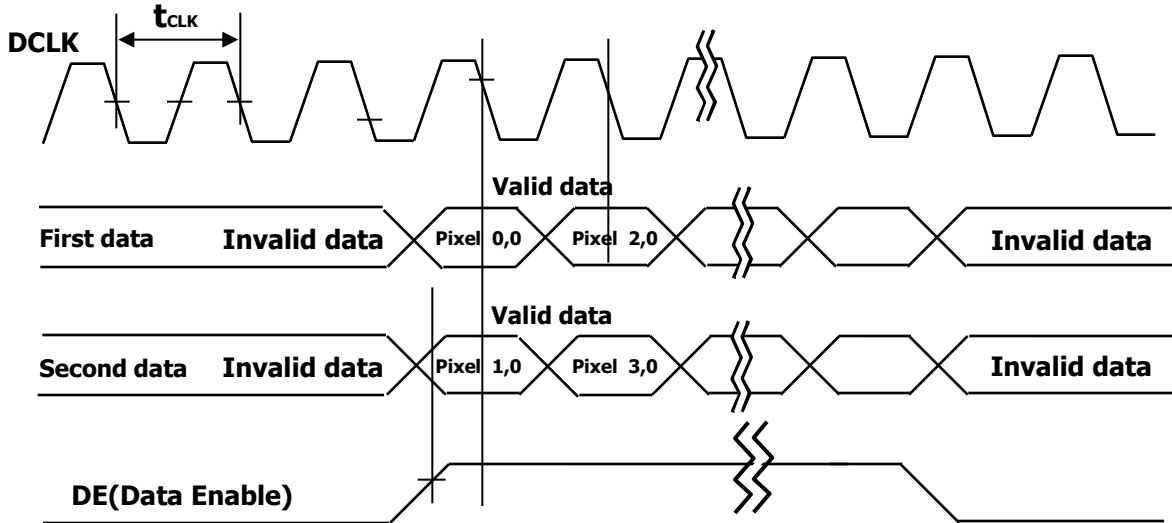
ITEM	Symbol		Min.	Typ.	Max.	Unit	Note
DCLK	Period	tCLK	14.9	15.4	15.9	ns	Pixel frequency : Typ.260MHz
	Frequency	-	63	65	67	MHz	
Hsync	Period	tHP	648	672	696	tCLK	1,3,4
	Horizontal Valid	tHV	512	512	512	tCLK	
	Horizontal Blank	tHB	136	160	184		
	Frequency	fH	96.7	96.7	99.9	KHz	
	Width	tWH	8	8	8	tCLK	
	Horizontal Back Porch	tHBP	64	80	96		
	Horizontal Front Porch	tHFP	64	72	80		
Vsync	Period	tVP	1565	1612	1631	tHP	2,4
	Vertical Valid	tVV	1536	1536	1536	tHP	
	Vertical Blank	tVB	29	76	95	tHP	
	Frequency	fV	58	60	62	Hz	
	Width	tWV	5	5	5	tHP	
	Vertical Back Porch	tVBP	22	68	86		
	Vertical Front Porch	tVFP	2	3	4		

Notes :

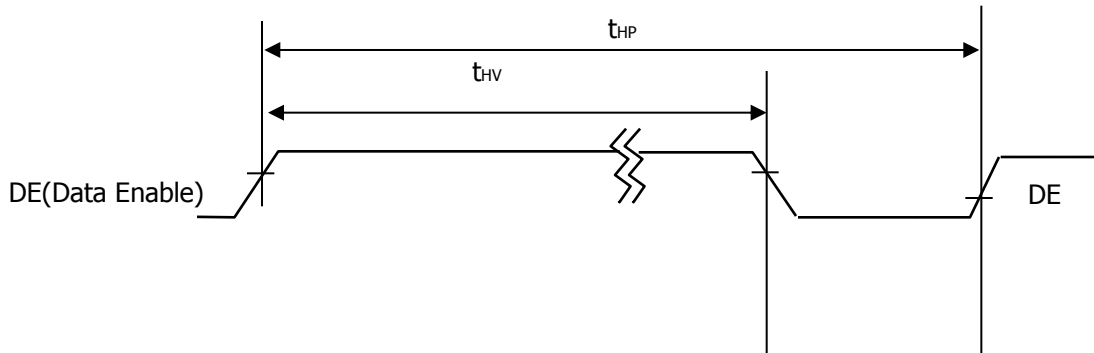
- 1.The value of Hsync period, Hsync width and Hsync valid should be even number times of tCLK.
If the value is odd number times of tCLK, it can make asynchronous signal timing and cause abnormal display.
- 2.The performance of the electro-optical characteristics may be influenced by variance of the 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.

3-5. Signal timing waveforms

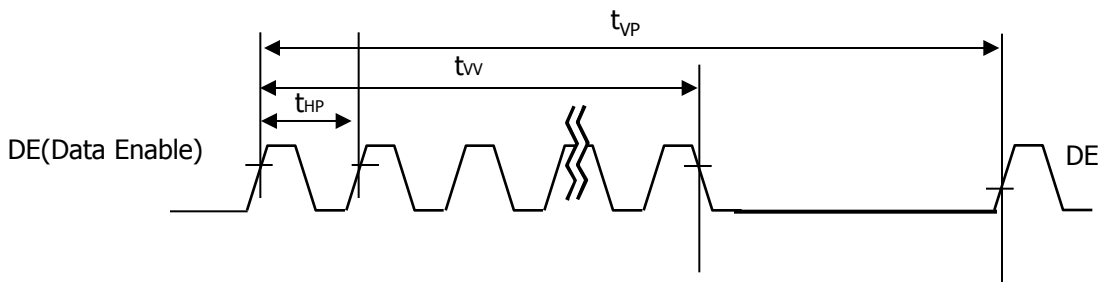
1. DCLK, DE, DATA waveforms



2. Horizontal waveform



3. Vertical waveform



Product specification

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 7. 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		
	Red (1023)	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		
	Green (1023)	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		
	Blue (1023)	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		
	Cyan	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		
	Magenta	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		
	Yellow	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		
	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		
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			
	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	1		
	...																														
	RED (1022)	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		
	RED (1023)	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		
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			
	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	1		
	...																														
	GREEN (1022)	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	0		
	GREEN (1023)	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		
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			
	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	1		
	...																														
	BLUE (1022)	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	0		
	BLUE (1023)	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		

Product specification

3-7. Power sequence

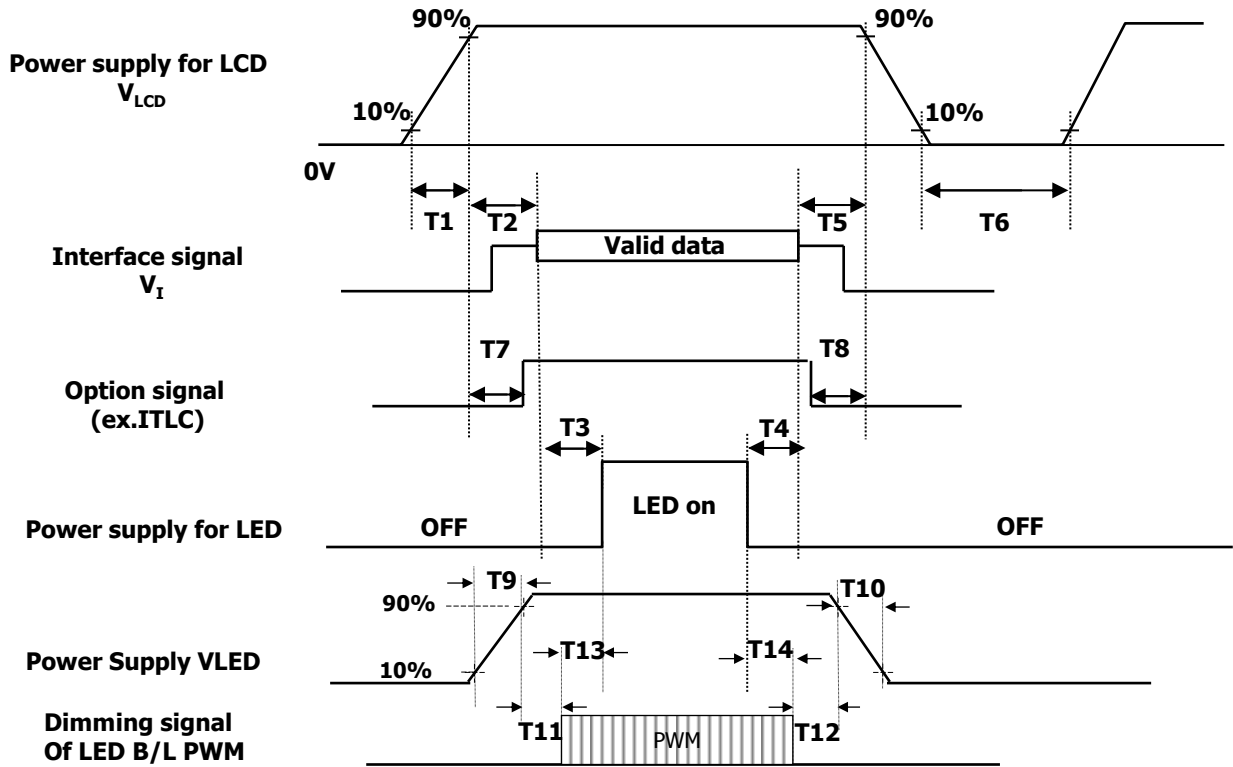


Table 8. Power sequence

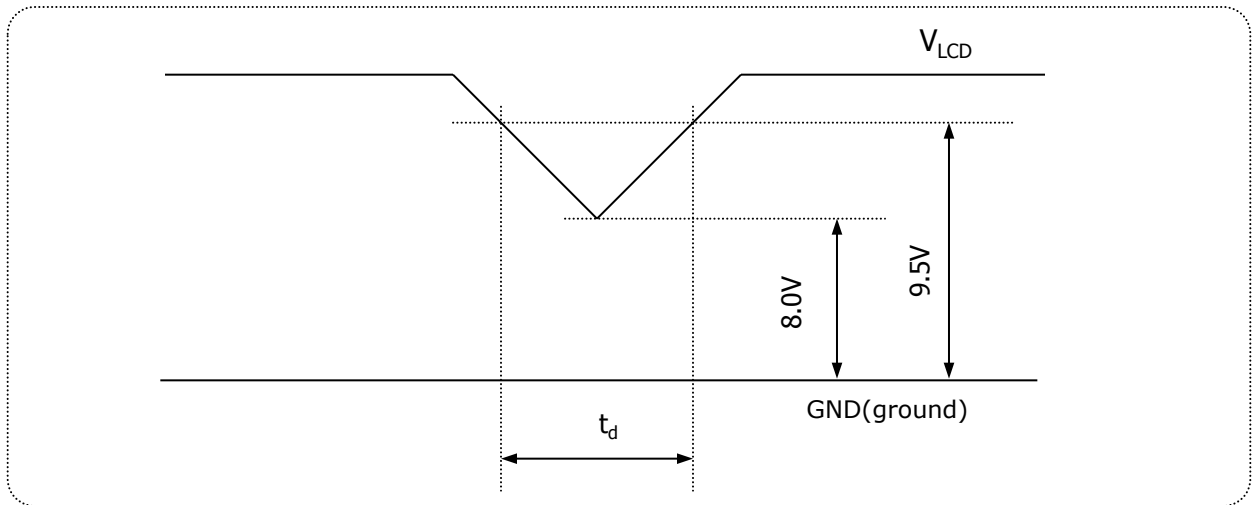
Parameter	Values			Units
	Min.	Typ.	Max.	
T1	0.5	-	10	ms
T2	0.01	-	50	ms
T3	500	-	-	ms
T4	200	-	-	ms
T5	0.01	-	50	ms
T6	1000	-	-	ms
T7	0.5	-	T2	ms

Parameter	Values			Units
	Min.	Typ.	Max.	
T8	0	-	-	ms
T9	TBD	-	TBD	ms
T10	TBD	-	TBD	ms
T11	TBD	-	TBD	ms
T12	TBD	-	TBD	ms
T13	TBD	-	TBD	ms
T14	TBD	-	TBD	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.
- When measuring valid data starting point, it can be measured that LVDS signal starts swing.

3-8. V_{LCD} Power dip condition



[FIG. 6] 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 previous page exactly.

1) Dip condition

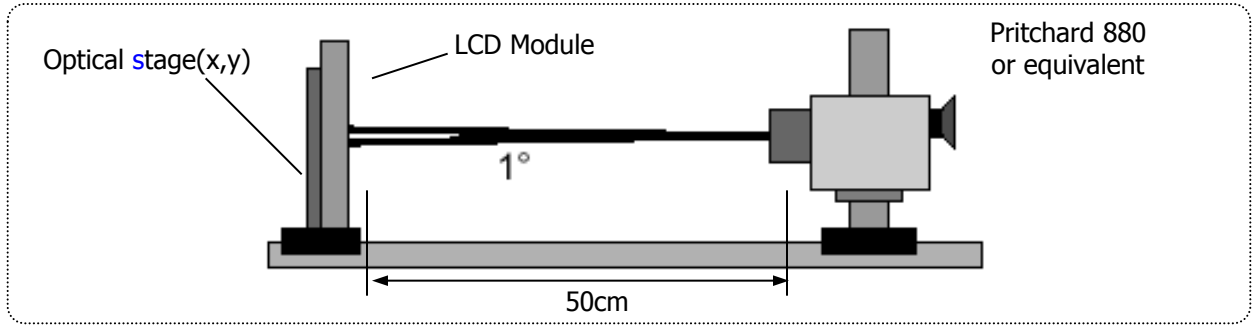
$$8.0V \leq V_{LCD} < 9.5V, t_d \leq 20ms$$

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



[FIG. 7] Optical characteristic measurement equipment and method

Table 9. Optical characteristics (Ta=25 °C, V_{LCD}=12.0V, V_{LED} = 24V f_v=60Hz Dclk=260MHz, I_S=40mA)

Parameter	Symbol	Values			Units	Notes	
		Min.	Typ.	Max.			
Contrast Ratio	CR	900	1300	-		1	
Surface luminance, white	L _{WH}	800	1000	-	cd/m ²	2	
Luminance variation	δ _{WHITE}	75	(85)	-	%	3	
Response time	Gray To Gray	T _{GTG_AVR}	14	28	ms	4	
Color gamut (CIE1931)	NTSC	-	72	-	%		
Color coordinates [CIE1931] (By PR650)	Red	Rx	Typ. -0.03	TBD	Typ. +0.03		
		Ry		TBD			
	Green	Gx		TBD			
		Gy		TBD			
	Blue	Bx		TBD			
		By		TBD			
	White	Wx		(0.303)			
Wy		(0.333)					
Color temperature	-	-	(7000)	-	K		
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)**

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

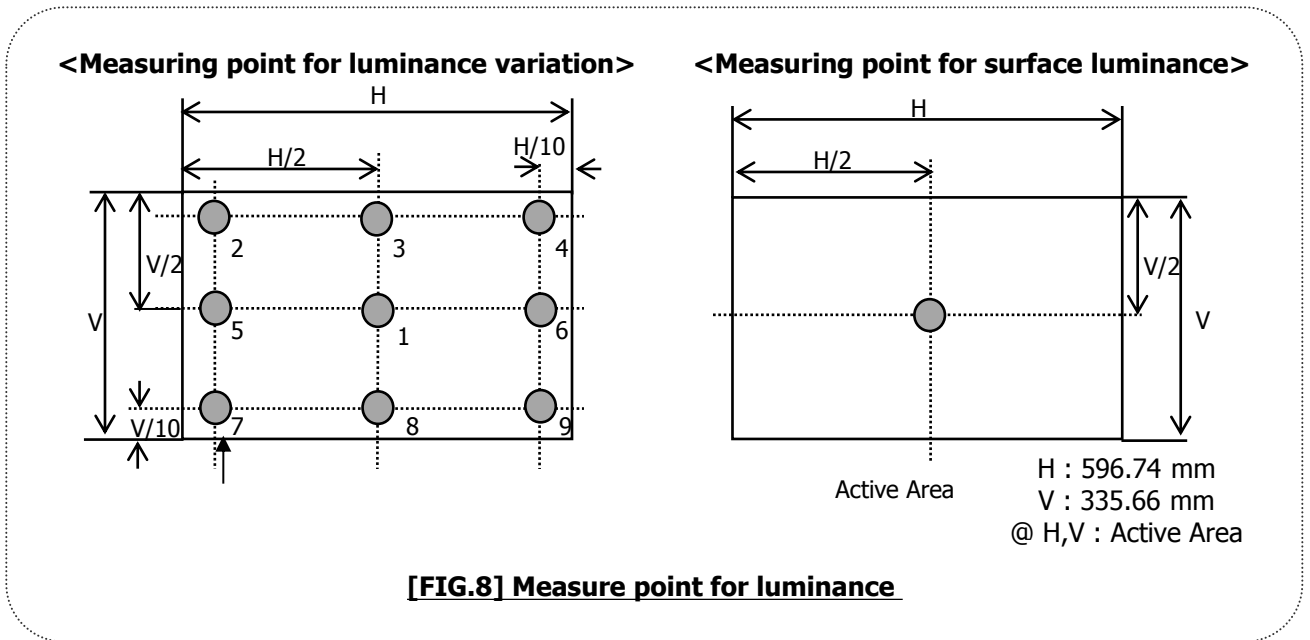
It is measured at center point(Location P1)

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.8



Product specification

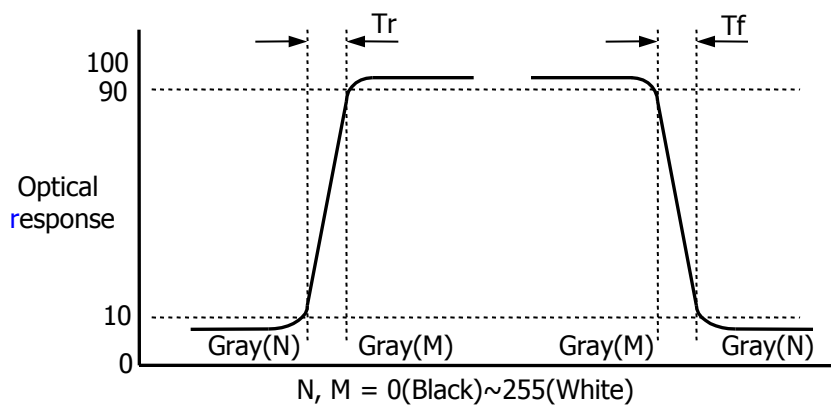
4. The Gray To Gray response time is defined as the following figure and shall be measured by switching the input signal for "Gray To Gray".

- Gray step : 5 Step
- TGTG_AVR is the total average time at rising time and falling time for "Gray To Gray".
- By RD80S

Table 10. GTG Gray table

Gray To Gray		Rising time				
		G255	G191	G127	G63	G0
Falling time	G255					
	G191					
	G127					
	G63					
	G0					

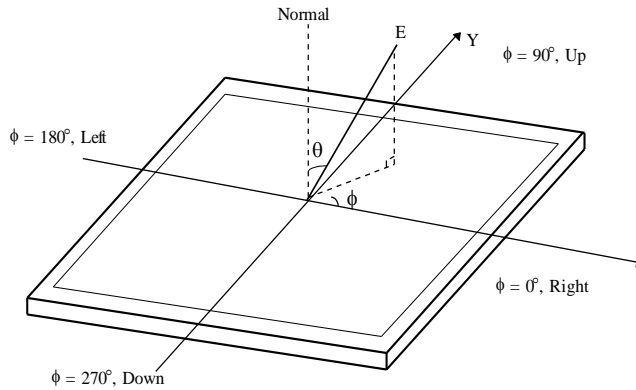
Response time is defined as the following figure and shall be measured by switching the input signal for "Gray(N)" and "Gray(M)".



[FIG. 9] 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.10 **(By PR880)**



[FIG. 10] Viewing angle

6. Gamma Value is approximately 2.2. For more information see Table 11.

Table 11. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ)
L0	0.10
L63	0.30
L127	1.08
L191	2.50
L255	4.71
L319	7.70
L383	11.52
L447	16.18
L511	21.72
L575	28.15
L639	35.51
L703	43.81
L767	53.07
L831	63.30
L895	74.52
L959	86.75
L1023	100

Product specification
5. Mechanical characteristics

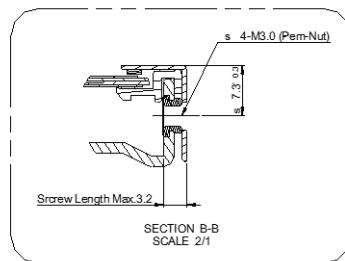
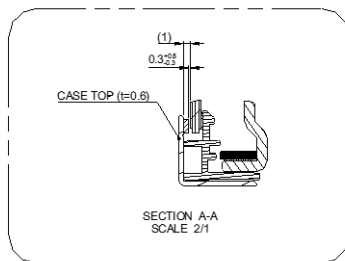
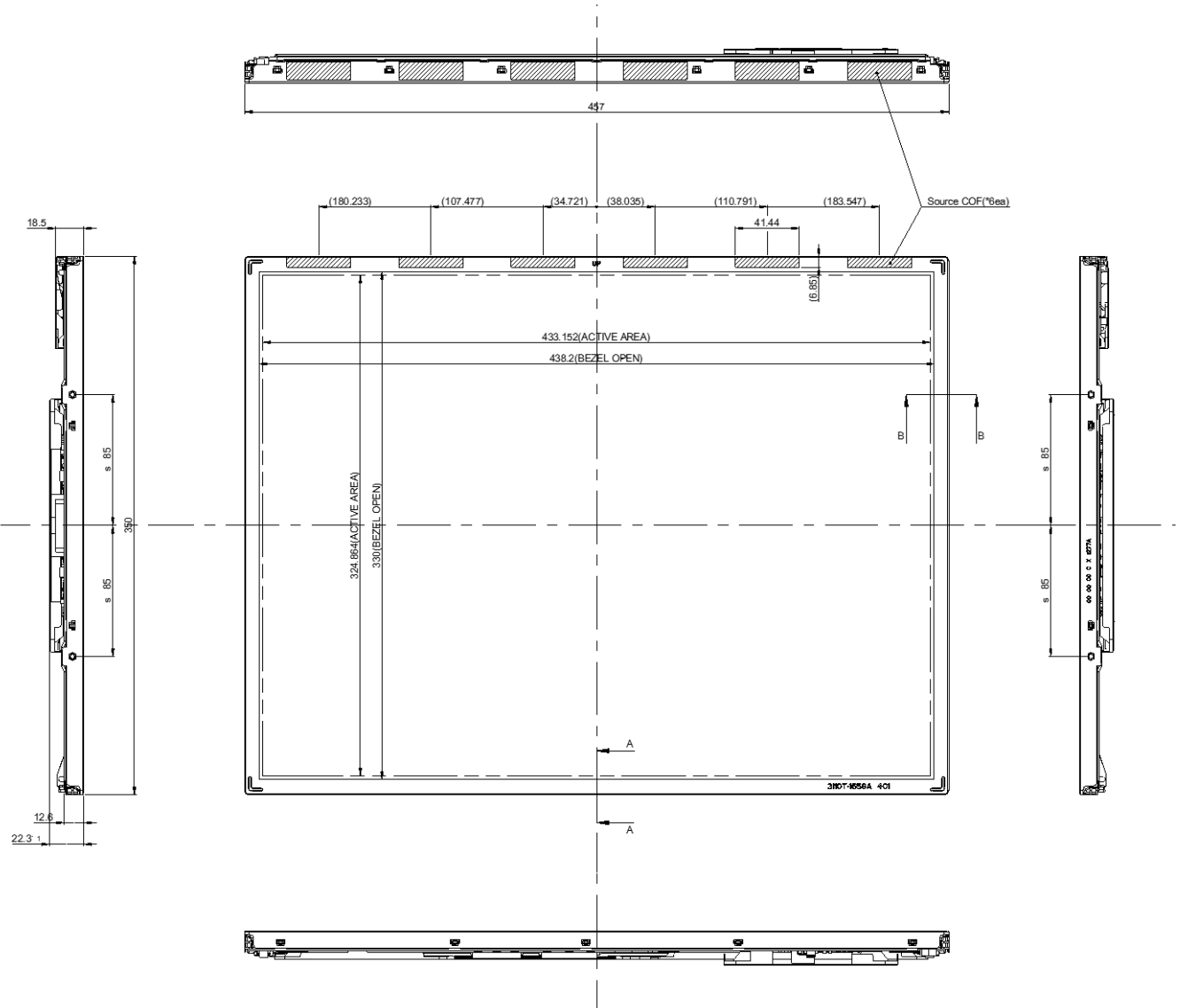
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline dimension	Horizontal	457.00mm
	Vertical	350.00mm
	Depth	22.3 (PCB 18.50) mm
Bezel area	Horizontal	438.20mm
	Vertical	330.00mm
Active display area	Horizontal	433.15mm
	Vertical	324.86mm
Weight	Typ. : T.B.D g, Max. : T.B.D g	
Surface treatment	Low Haze treatment of the front polarizer (3H)	

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

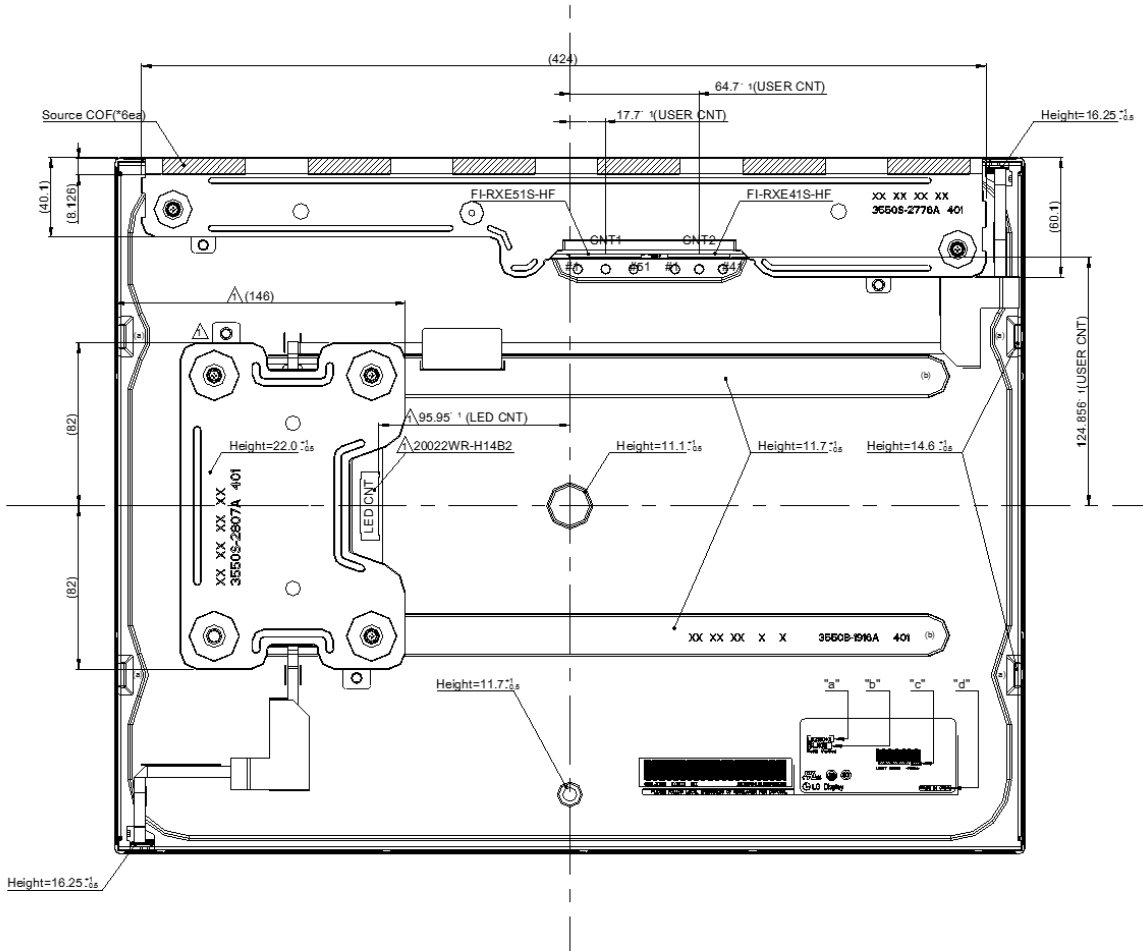
Product specification

<FRONT VIEW>



Product specification

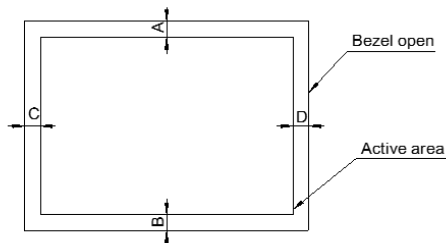
<REAR VIEW>



NOTES

1. Unspecified tolerances are to be ± 0.5
2. Tilt and partial disposition tolerance of display area are as following.

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



3. Torque SPEC of Mounting : 3.0~4.0kgf.cm
4. I/F Connector Specification
 - 1) CNT1 : JAE, F/R-XE51S-HF or Compatible.
 - 2) CNT2 : JAE, F/R-XE41S-HF or Compatible.
5. LED Connector Specification : YEONHO, 2002WR-H14B2 or compatible.
6. The LCM warp(warpage) is less than 1.5mm on the surface plate.
7. The COF area is weak and sensitive, so please don't press the COF area.
8. Unspecified height should follow 3D modeling data.

Product specification
6. Reliability

Environment test condition

No	Test Item	Condition
1	High temperature storage test	Ta= 60°C 240h
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	Vibration test (non-operating)	Wave form : random Vibration level : 1.0G RMS Bandwidth : 10-300Hz Duration : X,Y,Z, 10 min One time each direction
6	Shock test (non-operating)	Shock level : 100Grms Waveform : half sine wave, 2ms Direction : ±X, ±Y, ±Z One time each direction
7	Altitude Operating Storage / Shipment	0 – 10,000 feet (3,048m) 0 - 40,000 feet (12,192m)

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 Electro technical Standardization (CENELEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.
- d) IEC 60950-1, The International Electro technical 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

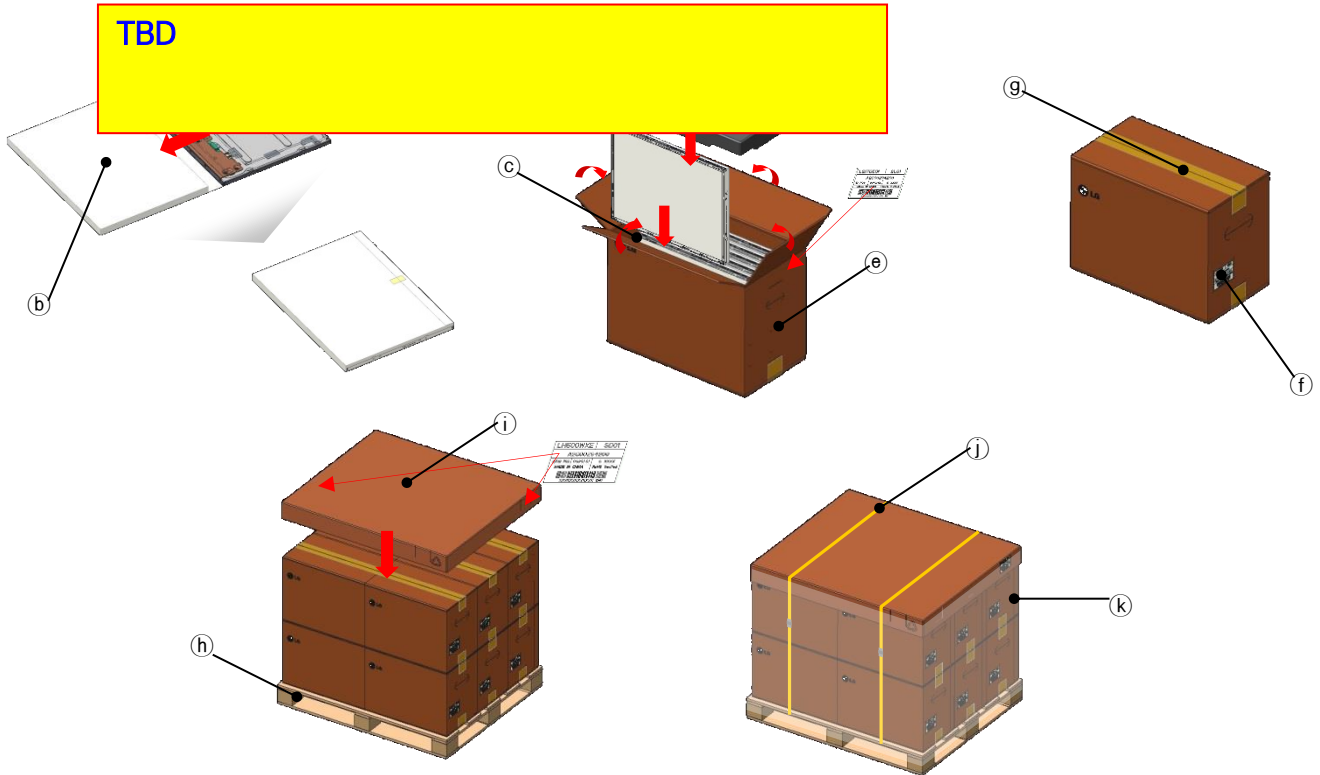
b) Location of lot mark

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.

Product specification

8-2. Packing form

- a) Package quantity in one box : 6ea
Package quantity in one Pallet : 72ea
- b) Box Size : 553mm x 315mm x 408mm
- c) Pallet Ass'y Size: 1140mm x 990mm x 937.5mm



No.	Description	Material
(a)	LCM	-
(b)	AL-Bag	AL
(c)	Packing,Bottom	EPS
(d)	Packing,Top	EPS
(e)	Box	Paper(SW)
(f)	LABEL	YUPO PAPER
(g)	Tape	OPP
(h)	Pallet	Plywood
(i)	Angle Cover	Paper(SW)
(j)	BAND	PP
(k)	Wrap	-
(l)	Pallet	Plywood

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 soaks with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
- (8) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
- (9) Do not open the case because inside circuits do not have sufficient strength.

9-2. Operating precautions

- (1) Response time depends on the temperature. (In lower temperature, it becomes longer.)
- (2) 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.
- (3) 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.
- (4) When fixed patterns are displayed for a long time, remnant image is likely to occur.
- (5) 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.
- (6) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
- (7) 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)
- (8) Please do not set LCD on its edge.
- (9) When LCMs are used for public display, defects such as Yogore & image sticking can not be guaranteed.
- (10) LCM cannot support "Interlaced scan method"
- (11) When this reverse model is used as a forward-type model (PCB on top side), LGD can not guarantee any defects of LCM.
- (12) 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.