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 APOLLO DISPLAY
TECHNOLOGIES



 DISTEC



 DISPLAY
TECHNOLOGY



Datasheet

LG Display

LB315WRM-SVA1

HD-10-160

SPECIFICATION FOR APPROVAL

- () Preliminary specification
- (●) Final specification

Title	31.5" UHD TFT LCD
-------	-------------------

BUYER	General
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LB315WRM
SUFFIX	SVA1

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

APPROVED BY	SIGNATURE DATE
/	_____
/	_____
/	_____

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

APPROVED BY	SIGNATURE DATE
S.H. Lee / G.Manager	_____
REVIEWED BY	
G.J. Han / Manager [C]	_____
Y.H. Hwang / Manager [M]	_____
S.H. Han / Manager [O]	_____
H.S. Kang / Manager [P]	_____
PREPARED BY	
C.Y. Sung / Engineer	_____



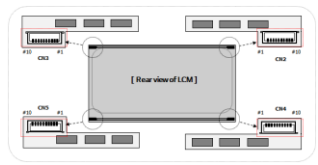
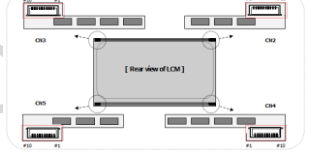
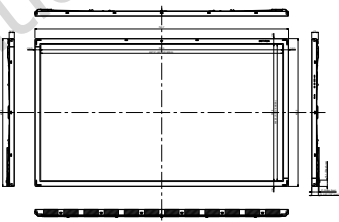
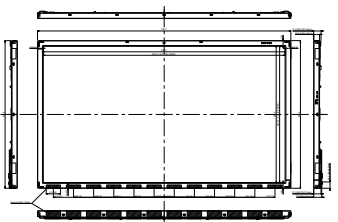
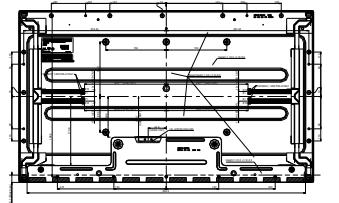
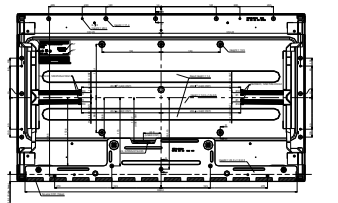
Product engineering dept.
LG Display Co., Ltd

Product specification
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Product specification

Record of revisions

Revision No.	Revision Date	Page	Before	After	Application Date																																																																																																																																				
0.1	Sep.18.2018	-	First Draft, Preliminary Specifications	-	-																																																																																																																																				
0.2	Oct.31.2018	11	<p>CN1 image change (PAD TOP)</p> 	<p>CN1 image change (PAD BOTTOM)</p> 																																																																																																																																					
		14	<p>Connector pin area, CN ref change</p> <table border="1" data-bbox="464 666 778 801"> <thead> <tr> <th>Pin Symbol</th> <th>Pin description (ENL,CMS)</th> <th>Remark</th> <th>Pin Symbol</th> <th>Pin description (ENL,CMS)</th> <th>Remark</th> </tr> </thead> <tbody> <tr><td>X1</td><td>FB1</td><td>Channel0 Current Feedback</td><td>X1</td><td>FB1</td><td>Channel0 Current Feedback</td></tr> <tr><td>X2</td><td>FB2</td><td>Channel0 Current Feedback</td><td>X2</td><td>FB2</td><td>Channel0 Current Feedback</td></tr> <tr><td>X3</td><td>FB3</td><td>Channel0 Current Feedback</td><td>X3</td><td>FB3</td><td>Channel0 Current Feedback</td></tr> <tr><td>X4</td><td>FB4</td><td>Channel0 Current Feedback</td><td>X4</td><td>NC</td><td>NC</td></tr> <tr><td>X5</td><td>V LED</td><td>LED power supply (FB0-FB3) Left side</td><td>X5</td><td>V LED</td><td>LED power supply (FB0-FB3) Right side</td></tr> <tr><td>X6</td><td>V LED</td><td>LED power supply (FB1-FB4) In Front view</td><td>X6</td><td>V LED</td><td>LED power supply (FB1-FB4) In Front view</td></tr> <tr><td>X7</td><td>FB4</td><td>Channel0 Current Feedback</td><td>X7</td><td>FB4</td><td>Channel0 Current Feedback</td></tr> <tr><td>X8</td><td>FB2</td><td>Channel0 Current Feedback</td><td>X8</td><td>FB2</td><td>Channel0 Current Feedback</td></tr> <tr><td>X9</td><td>FB2</td><td>Channel0 Current Feedback</td><td>X9</td><td>FB2</td><td>Channel0 Current Feedback</td></tr> <tr><td>X10</td><td>FB1</td><td>Channel0 Current Feedback</td><td>X10</td><td>FB1</td><td>Channel0 Current Feedback</td></tr> </tbody> </table> 	Pin Symbol	Pin description (ENL,CMS)	Remark	Pin Symbol	Pin description (ENL,CMS)	Remark	X1	FB1	Channel0 Current Feedback	X1	FB1	Channel0 Current Feedback	X2	FB2	Channel0 Current Feedback	X2	FB2	Channel0 Current Feedback	X3	FB3	Channel0 Current Feedback	X3	FB3	Channel0 Current Feedback	X4	FB4	Channel0 Current Feedback	X4	NC	NC	X5	V LED	LED power supply (FB0-FB3) Left side	X5	V LED	LED power supply (FB0-FB3) Right side	X6	V LED	LED power supply (FB1-FB4) In Front view	X6	V LED	LED power supply (FB1-FB4) In Front view	X7	FB4	Channel0 Current Feedback	X7	FB4	Channel0 Current Feedback	X8	FB2	Channel0 Current Feedback	X8	FB2	Channel0 Current Feedback	X9	FB2	Channel0 Current Feedback	X9	FB2	Channel0 Current Feedback	X10	FB1	Channel0 Current Feedback	X10	FB1	Channel0 Current Feedback	<table border="1" data-bbox="835 666 1149 801"> <thead> <tr> <th>Pin Symbol</th> <th>Pin description (ENL,CMS)</th> <th>Remark</th> <th>Pin Symbol</th> <th>Pin description (ENL,CMS)</th> <th>Remark</th> </tr> </thead> <tbody> <tr><td>X1</td><td>FB1</td><td>Channel0 Current Feedback</td><td>X1</td><td>FB1</td><td>Channel0 Current Feedback</td></tr> <tr><td>X2</td><td>FB2</td><td>Channel0 Current Feedback</td><td>X2</td><td>FB2</td><td>Channel0 Current Feedback</td></tr> <tr><td>X3</td><td>FB3</td><td>Channel0 Current Feedback</td><td>X3</td><td>FB3</td><td>Channel0 Current Feedback</td></tr> <tr><td>X4</td><td>FB4</td><td>Channel0 Current Feedback</td><td>X4</td><td>NC</td><td>NC</td></tr> <tr><td>X5</td><td>V LED</td><td>LED power supply (FB1-FB3) Left side</td><td>X5</td><td>V LED</td><td>LED power supply (FB1-FB3) Right side</td></tr> <tr><td>X6</td><td>V LED</td><td>LED power supply (FB2-FB4) In Front view</td><td>X6</td><td>V LED</td><td>LED power supply (FB2-FB4) In Front view</td></tr> <tr><td>X7</td><td>FB4</td><td>Channel0 Current Feedback</td><td>X7</td><td>FB4</td><td>Channel0 Current Feedback</td></tr> <tr><td>X8</td><td>FB2</td><td>Channel0 Current Feedback</td><td>X8</td><td>FB2</td><td>Channel0 Current Feedback</td></tr> <tr><td>X9</td><td>FB2</td><td>Channel0 Current Feedback</td><td>X9</td><td>FB2</td><td>Channel0 Current Feedback</td></tr> <tr><td>X10</td><td>FB1</td><td>Channel0 Current Feedback</td><td>X10</td><td>FB1</td><td>Channel0 Current Feedback</td></tr> </tbody> </table> 	Pin Symbol	Pin description (ENL,CMS)	Remark	Pin Symbol	Pin description (ENL,CMS)	Remark	X1	FB1	Channel0 Current Feedback	X1	FB1	Channel0 Current Feedback	X2	FB2	Channel0 Current Feedback	X2	FB2	Channel0 Current Feedback	X3	FB3	Channel0 Current Feedback	X3	FB3	Channel0 Current Feedback	X4	FB4	Channel0 Current Feedback	X4	NC	NC	X5	V LED	LED power supply (FB1-FB3) Left side	X5	V LED	LED power supply (FB1-FB3) Right side	X6	V LED	LED power supply (FB2-FB4) In Front view	X6	V LED	LED power supply (FB2-FB4) In Front view	X7	FB4	Channel0 Current Feedback	X7	FB4	Channel0 Current Feedback	X8	FB2	Channel0 Current Feedback	X8	FB2	Channel0 Current Feedback	X9	FB2	Channel0 Current Feedback	X9	FB2	Channel0 Current Feedback	X10	FB1	Channel0 Current Feedback	X10	FB1	Channel0 Current Feedback	
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0.3	Dec.27.2018	5, 24	<p>Outline Dimension (D) : 21.0mm Weight : TBD Total (79.3)Watt ((10.5) Watt @V_{LCDr}, (68.8)Watt @Is=(80)mA)</p>	<p>Outline Dimension (D) : 23.0mm Weight : 6,000g (TBD) Total (79.3)Watt ((10.5) Watt @V_{LCDr}, (71.4)Watt @Is=(85)mA)</p>																																																																																																																																					
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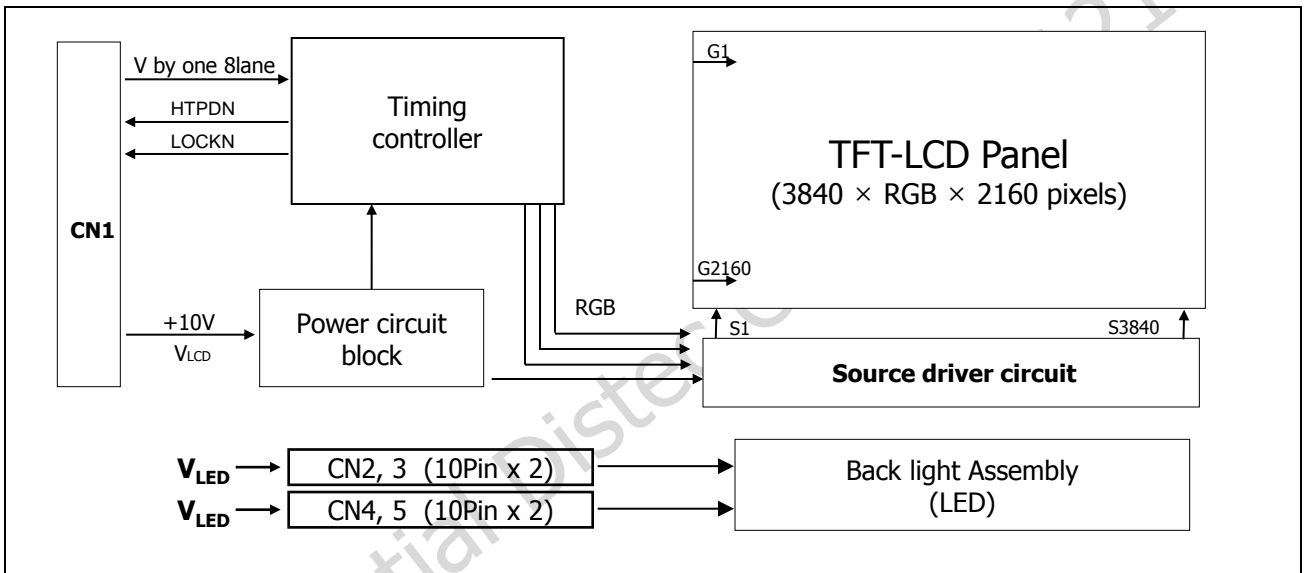
Product specification

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0.5	Apr. 23, 2019	18	<p>Power sequence spec</p> <p>Table 4. POWER SEQUENCE</p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Unit</th> <th>Typ</th> <th>Max</th> <th>Unit</th> <th>Note</th> </tr> </thead> <tbody> <tr> <td>T1</td> <td>s</td> <td>-</td> <td>20</td> <td>ms</td> <td>1</td> </tr> <tr> <td>T2</td> <td>s</td> <td>-</td> <td>-</td> <td>ms</td> <td>2</td> </tr> <tr> <td>T3</td> <td>ms</td> <td>400</td> <td>-</td> <td>ms</td> <td>3</td> </tr> <tr> <td>T4</td> <td>ms</td> <td>100</td> <td>-</td> <td>ms</td> <td>3</td> </tr> <tr> <td>T5</td> <td>s</td> <td>-</td> <td>-</td> <td>s</td> <td>4</td> </tr> <tr> <td>T6</td> <td>s</td> <td>-</td> <td>T2</td> <td>ms</td> <td>5</td> </tr> <tr> <td>T7</td> <td>s</td> <td>-</td> <td>-</td> <td>ms</td> <td>6</td> </tr> </tbody> </table> <p>Note: 1. Even though T1 is normally specified, when there is no operation, LED spec. after a specified time. 2. T2 is specified with specification after recovery by one cycle, when there is no problem. 3. The T3, T4 is recommended value, the user should take to meet a minimum specification, abnormal delay should be shown. There is no stability problem. 4. It should be measured after the module has been fully discharged between power-off and on period. 5. If the on time of power (Interface signal and user control signal) precedes the on time of Power (Vcc), it will be measured according to the time T4. For details, T4 should be measured. 6. It is recommended to specify the user to meet a minimum value. 7. Please specify the date of interface signal at initial period. 8. When the power supply for LED (LED) is off, the user should observe the LED and module data to be.</p>	Parameter	Unit	Typ	Max	Unit	Note	T1	s	-	20	ms	1	T2	s	-	-	ms	2	T3	ms	400	-	ms	3	T4	ms	100	-	ms	3	T5	s	-	-	s	4	T6	s	-	T2	ms	5	T7	s	-	-	ms	6	<p>Update power sequence spec</p> <p>Table 4. POWER SEQUENCE</p> <table border="1"> <thead> <tr> <th>Parameter</th> <th>Unit</th> <th>Typ</th> <th>Max</th> <th>Unit</th> <th>Note</th> </tr> </thead> <tbody> <tr> <td>T1</td> <td>s</td> <td>-</td> <td>20</td> <td>ms</td> <td>1</td> </tr> <tr> <td>T2</td> <td>s</td> <td>-</td> <td>-</td> <td>ms</td> <td>2</td> </tr> <tr> <td>T3</td> <td>ms</td> <td>400</td> <td>-</td> <td>ms</td> <td>3</td> </tr> <tr> <td>T4</td> <td>ms</td> <td>100</td> <td>-</td> <td>ms</td> <td>3</td> </tr> <tr> <td>T5</td> <td>s</td> <td>-</td> <td>-</td> <td>s</td> <td>4</td> </tr> <tr> <td>T6</td> <td>s</td> <td>-</td> <td>T2</td> <td>ms</td> <td>5</td> </tr> <tr> <td>T7</td> <td>s</td> <td>-</td> <td>-</td> <td>ms</td> <td>6</td> </tr> </tbody> </table> <p>Note: 1. Even though T1 is normally specified, when there is no operation, LED spec. after a specified time. 2. T2 is specified with specification after recovery by one cycle, when there is no problem. 3. The T3, T4 is recommended value, the user should take to meet a minimum specification, abnormal delay should be shown. There is no stability problem. 4. It should be measured after the module has been fully discharged between power-off and on period. 5. If the on time of power (Interface signal and user control signal) precedes the on time of Power (Vcc), it will be measured according to the time T4. For details, T4 should be measured. 6. It is recommended to specify the user to meet a minimum value. 7. Please specify the date of interface signal at initial period. 8. When the power supply for LED (LED) is off, the user should observe the LED and module data to be.</p>	Parameter	Unit	Typ	Max	Unit	Note	T1	s	-	20	ms	1	T2	s	-	-	ms	2	T3	ms	400	-	ms	3	T4	ms	100	-	ms	3	T5	s	-	-	s	4	T6	s	-	T2	ms	5	T7	s	-	-	ms	6	Apr.23.2019																
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Blue							0.060																																																																																																														
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1.0	Sep.19.2019	28	<p>1) Update safety, Environment spec</p> <p>7. International standards</p> <p>7-1. Safety</p> <p>① IEC 60950-1, Underwriters Laboratories Inc. Information Technology Equipment - Safety - Part 1 : General Requirements.</p> <p>② IEC 60950-2-2, No. 60950-2-2, Canadian Standards Association. Information Technology Equipment - Safety - Part 1 : General Requirements.</p> <p>③ IEC 60950-2, European Committee for Electrotechnical Standardization (CENELEC). Information Technology Equipment - Safety Requirements.</p> <p>④ IEC 60950-2, European Committee for Electrotechnical Standardization (CENELEC). Information Technology Equipment - Safety - Part 1 : General Requirements.</p> <p>⑤ IEC 60950-2, The International Electrotechnical Commission (IEC). Information Technology Equipment - Safety - Part 1 : General Requirements.</p>	<p>7-1. Safety</p> <p>① IEC 60950-1, The International Electrotechnical Commission (IEC). Information Technology Equipment - Safety - Safety Requirements.</p> <p>② IEC 60950-2, European Committee for Electrotechnical Standardization (CENELEC). Information Technology Equipment - Safety Requirements.</p> <p>③ IEC 60950-2-2, IEC. Information Technology Equipment - Safety Requirements.</p> <p>④ IEC 60950-2, No. 60950-2, Canadian Standards Association (CSA). Information Technology Equipment - Safety Requirements.</p> <p>⑤ IEC 60950-2, The International Electrotechnical Commission (IEC). Information Technology Equipment - Safety - Part 1 : General Requirements.</p>	Sep.19.2019																																																																																																																
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Product specification
1. General description

LB315WRM-SVA1 is a color active matrix liquid crystal display with a light emitting diode (WLED) 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 31.5 inch diagonally measured active display area with UHD resolution.(3840 horizontal by 2160 vertical pixels array) Each pixel is divided into red, green and blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 10-bit gray scale signal for each dot, thus, presenting a palette of more than 1.07Billion colors. It has been designed to apply 10-bit 8 Lane V by one 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	31.5 inches(80.0051cm) (Aspect ratio 16:9)
Outline dimension	730.7 (H) x 425.2 (V) x 23.0 (D) mm (Typ.)
Pixel pitch	0.18159(H)mm x 0.18159(V)mm
Pixel format	3840(H) x 2160(V) Pixels. RGB stripes arrangement
Color depth	1.07Billion colors
Color Gamut (CIE.1931)	sRGB Typ.100% Supporting (Cover ratio) , sRGB Typ. 115% (Area)
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 (81.9)Watt ((10.5) Watt @V _{LCDr} , (71.4)Watt @Is=(85)mA)
Weight	6000g (Typ.)
Display operating mode	Transmissive mode, normally black
Panel type	Reverse type
Surface treatment	Anti-glare treatment of the front polarizer (Haze 25%, 3H)

Product specification

2. Absolute maximum ratings

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

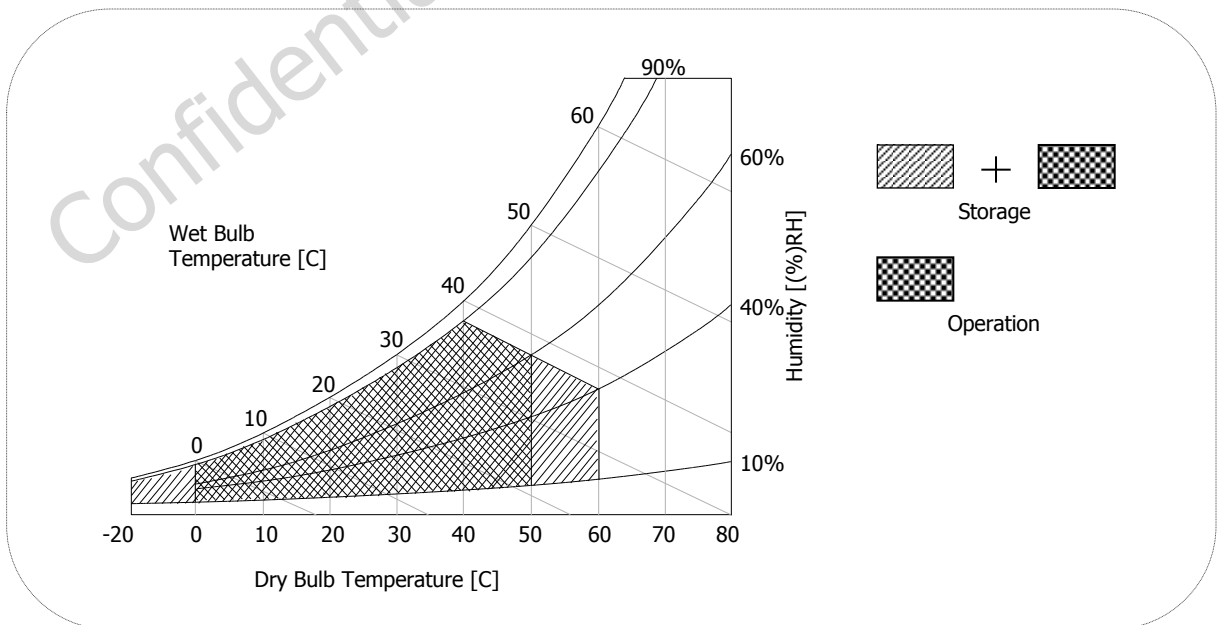
Table 1. Absolute maximum ratings

Parameter	Symbol	Values		Units	Notes
		Min.	Max.		
Power supply input voltage	V_{LCD}	-0.3	12	V_{DC}	At 25°C
Operating temperature	T_{OP}	0	50	°C	1,2,3
Storage temperature	T_{ST}	-20	60	°C	
Operating ambient humidity	H_{OP}	10	90	%RH	
Storage humidity	H_{ST}	10	90	%RH	
LCM surface temperature (Operation)	$T_{Surface}$	0	65	°C	1, 4

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 $V_{LCD}=10.0V$, $f_v=60Hz$, $T_a=25°C$, 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}	9.5	10.0	10.5	V	4
Permissive power input ripple	V_{ripple}			400	mVp-p	1
Power supply input current	I_{LCD} Typ.	-	1.05	1.31	A	2
	I_{LCD} Max.	-	1.5	1.87	A	
Power consumption	P_c Typ.	-	10.5	13.1	Watt	
	P_c Max.	-	15	18.7	Watt	
Rush current	I_{RUSH}	-		3.0	A	3

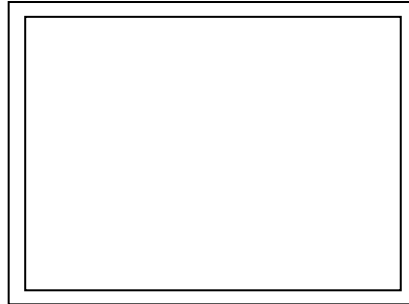
Notes :

- Permissive power ripple should be measured under the condition of $V_{LCD}=10.0V$, $25^{\circ}C$, $*f_v=\max$. Refer to page 7 for the pattern and more information.
- The specified current and power consumption can be measured under the $V_{LCD}=10.0V$, $25^{\circ}C$, $f_v=60Hz$ and the pattern should be changed according to the typical or maximum power condition. The max. current can be measured only with the maximum power pattern. See the page 7 for details.
- 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

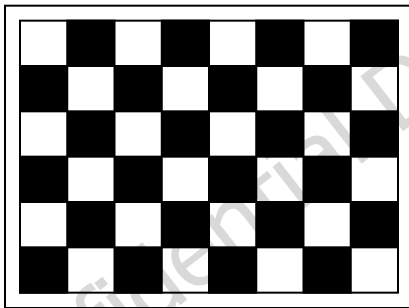
- **Permissive power input ripple** ($V_{LCD} = 10.0V$, $25^{\circ}C$, f_v (frame frequency)=Max. condition)



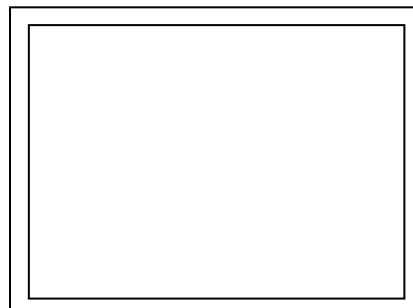
White pattern

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

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



Typical power pattern



Maximum power pattern

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

Product specification

Table 2-2. Electrical characteristics of LED bar in normal operating condition

Parameter	Symbol	Values			Units	Notes
		Min.	Typ.	Max.		
LED string current	Is	-	85	90	mA	1, 2
LED string voltage	Vs	27.0	28.0	29.0	V	1, 3
Power consumption	PBar	-	71.4	74.0	Watt	1, 2, 5
LED life time	LED_LT	30,000	-	-	Hour	4

Notes : The LED bar consists of 150 LED packages, 15 strings parallel x 5 packages serial x 2bar

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

Product specification

3-2. Interface connections
3-2-1. LCD Module

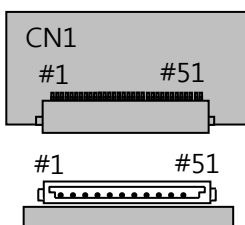
- LCD Connector(CN1) : GT05S-51S-H38(LS) or Equivalent

Table 3-1. Module connector (CN1) pin configuration

No	Symbol	Description	No	Symbol	Description
1	VLCD	Power Supply +10.0V	27	GND	Ground
2	VLCD	Power Supply +10.0V	28	RX0N	V-by-One HS Data Lane 0
3	VLCD	Power Supply +10.0V	29	RX0P	V-by-One HS Data Lane 0
4	VLCD	Power Supply +10.0V	30	GND	Ground
5	VLCD	Power Supply +10.0V	31	RX1N	V-by-One HS Data Lane 1
6	VLCD	Power Supply +10.0V	32	RX1P	V-by-One HS Data Lane 1
7	VLCD	Power Supply +10.0V	33	GND	Ground
8	VLCD	Power Supply +10.0V	34	RX2N	V-by-One HS Data Lane 2
9	NC	No Connection	35	RX2P	V-by-One HS Data Lane 2
10	GND	Ground	36	GND	Ground
11	GND	Ground	37	RX3N	V-by-One HS Data Lane 3
12	GND	Ground	38	RX3P	V-by-One HS Data Lane 3
13	GND	Ground	39	GND	Ground
14	GND	Ground	40	RX4N	V-by-One HS Data Lane 4
15	NC	No Connection	41	RX4P	V-by-One HS Data Lane 4
16	NC	No Connection	42	GND	Ground
17	NC	No Connection	43	RX5N	V-by-One HS Data Lane 5
18	NC	No Connection	44	RX5P	V-by-One HS Data Lane 5
19	NC	No Connection	45	GND	Ground
20	NC	No Connection	46	RX6N	V-by-One HS Data Lane 6
21	NC	No Connection	47	RX6P	V-by-One HS Data Lane 6
22	NC	No Connection	48	GND	Ground
23	NC	No Connection	49	RX7N	V-by-One HS Data Lane 7
24	NC	No Connection	50	RX7P	V-by-One HS Data Lane 7
25	HTPDN	Hot plug detect output, Open drain	51	GND	Ground
26	LOCKN	Lock detect output, Open drain	-	-	-

Notes :

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



- [CN1]
- Part/No. : GT05S-51S-H38(LS) or Equivalent
 - Mating connector : FI-RE51HL(Manufactured by JAE)

[FIG. 4] Connector diagram

Product specification

3-2-2. V by One input signal Characteristics

1. V by One input signal timing diagram

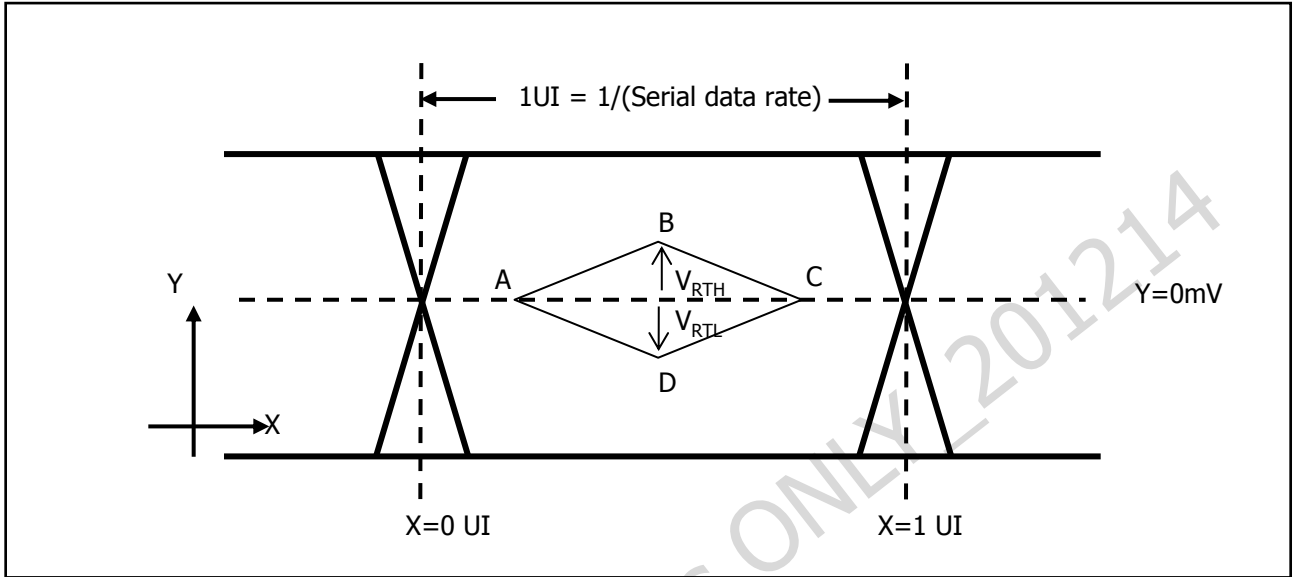


Table 3-2. Eye Mask Specification

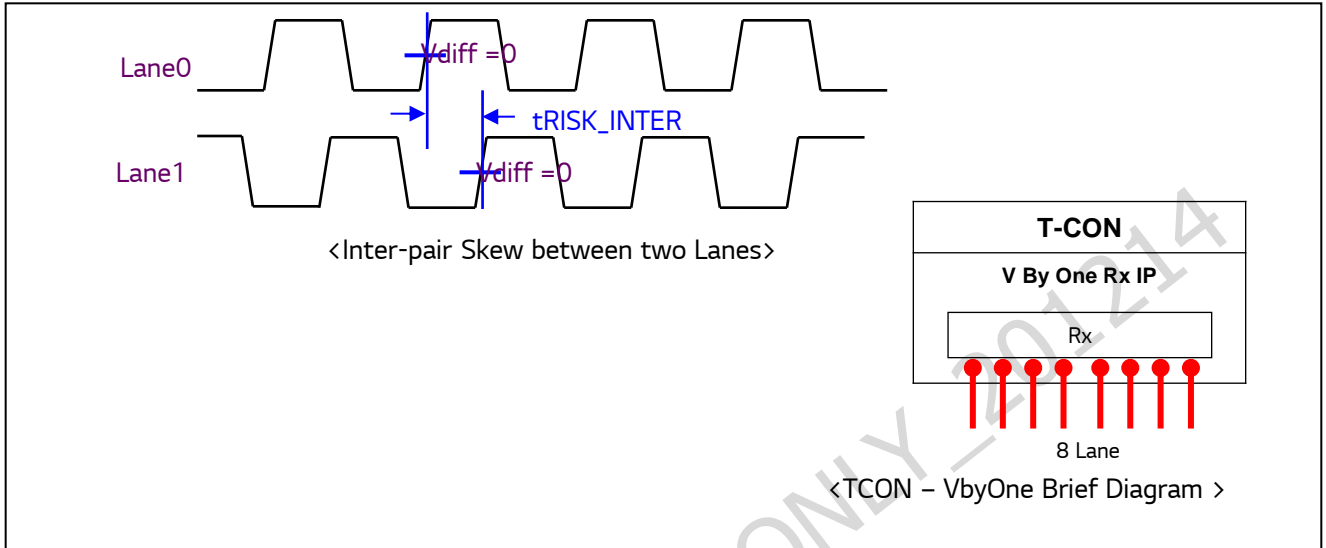
Symbol	X[UI]	Y[mV]	Note
A	0.25 (max)	0	-
B	0.5	50 (min)	V_{RTH}
C	0.75 (min)	0	-
D	0.5	-50 (min)	V_{RTL}

Notes

- All Input levels of V by One signals are based on the V by One HS Standard Ver. 1.4
- The eye diagram is measured by the oscilloscope and receiver CDR characteristic must be emulated.
 - PLL Type : Second Order
 - PLL bandwidth : 15MHz
 - Damping Factor : 1

Product specification

2. V by One input signal characteristics



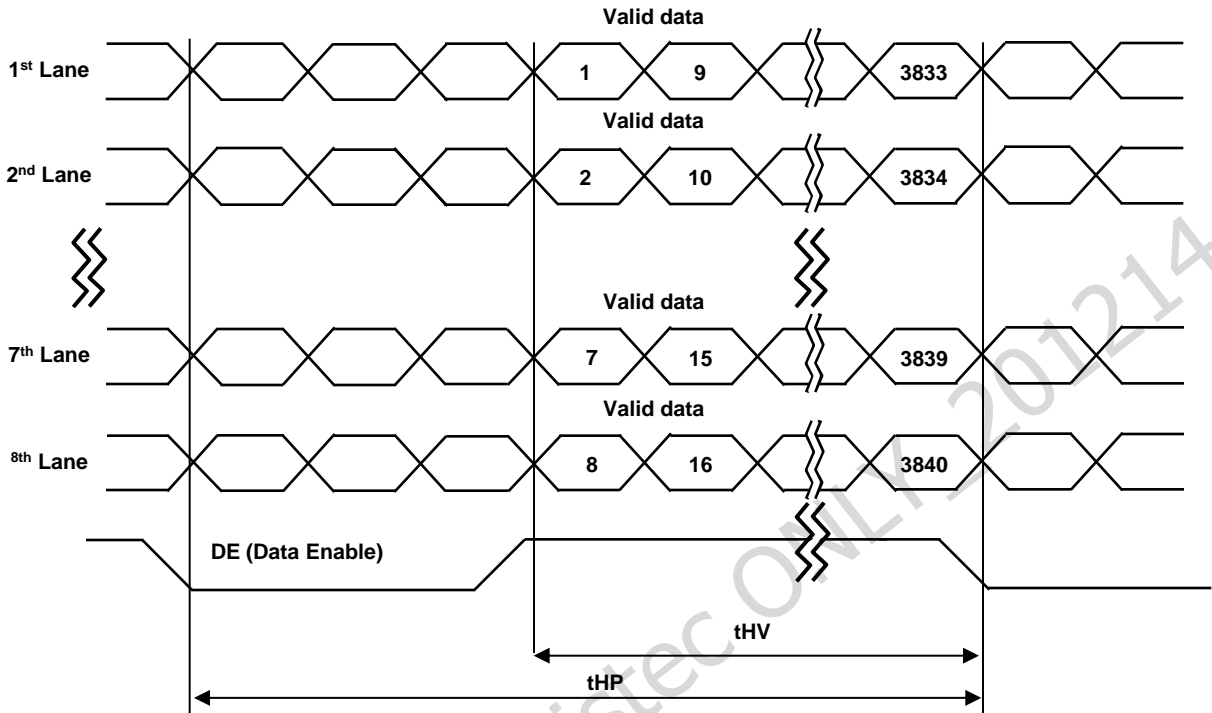
Description	Symbol	Min	Max	Unit	notes
Allowable inter-pair skew between lanes	tRISK_INTER	-	5	UI	1,2

Notes

1. $1UI = 1/\text{serial data rate}$
2. It is the time difference of the differential voltage between any two lanes in one sub block.

Product specification

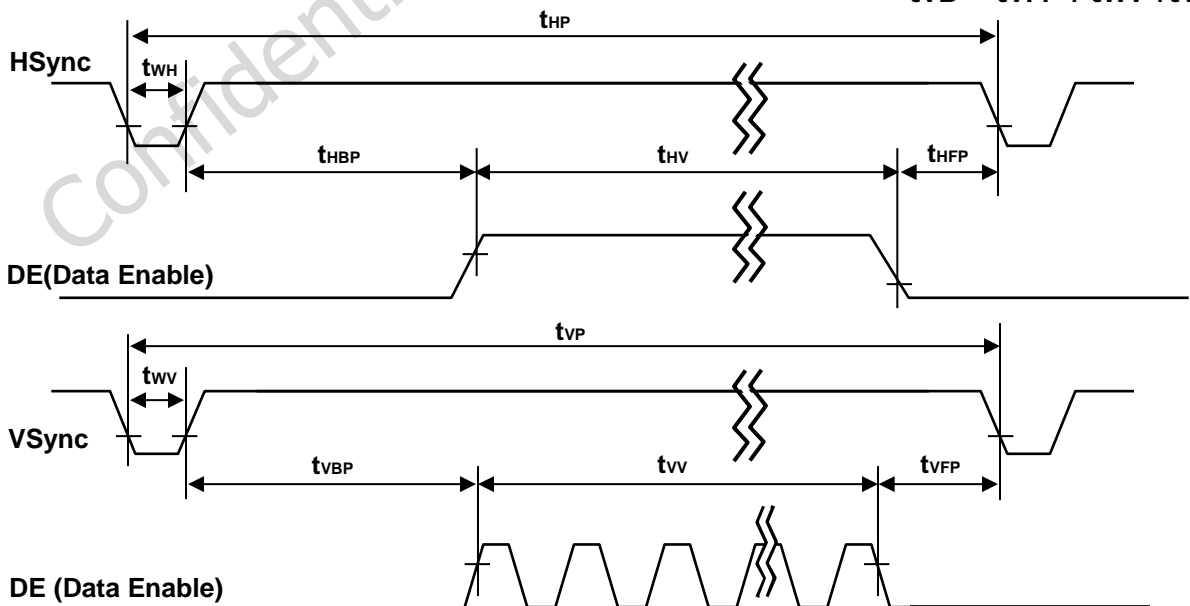
2. V by One input signal characteristics



* Reference : Sync. Relation

* $t_{HB} = t_{HFP} + t_{WH} + t_{HBP}$

* $t_{VB} = t_{VFP} + t_{VW} + t_{VBP}$



Product specification

3-2-3. Backlight connector pin configuration

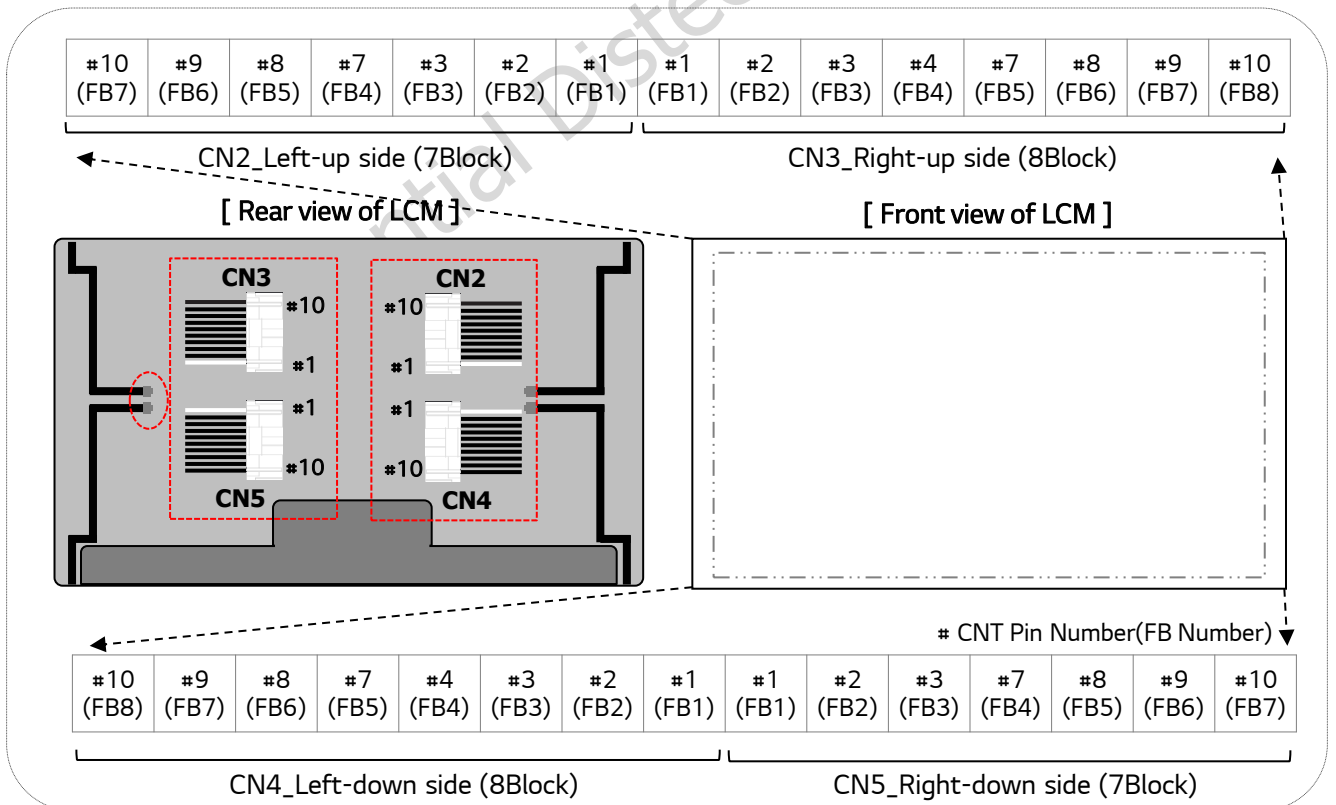
Table 4. Backlight connector pin configuration(CN2 ~ CN5)

The LED wire cable connector is a model 12507HS-H10G1 Manufactured by Yeonho.

The mating connector is a 12507WR-H10G.

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

Pin	Symbol	Pin-description (CN3, CN4)	Remark	Pin	Symbol	Pin-description (CN2, CN5)	Remark
#1	FB1	Channel1 Current Feedback	Left-down side(CN4) & Right-up Side(CN3) in front view	#1	FB1	Channel1 Current Feedback	Right-down side(CN5) & Left-up Side(CN2) in front view
#2	FB2	Channel2 Current Feedback		#2	FB2	Channel2 Current Feedback	
#3	FB3	Channel3 Current Feedback		#3	FB3	Channel3 Current Feedback	
#4	FB4	Channel4 Current Feedback		#4	NC	NC	
#5	V LED	LED power supply (FB1~FB4)		#5	V LED	LED power supply (FB1~FB3)	
#6	V LED	LED power supply (FB5~FB8)		#6	V LED	LED power supply (FB4~FB7)	
#7	FB5	Channel5 Current Feedback		#7	FB4	Channel4 Current Feedback	
#8	FB6	Channel6 Current Feedback		#8	FB5	Channel5 Current Feedback	
#9	FB7	Channel7 Current Feedback		#9	FB6	Channel6 Current Feedback	
#10	FB8	Channel8 Current Feedback		#10	FB7	Channel7 Current Feedback	



[FIG. 5] Backlight connector view

Product specification
3-3. Signal timing specifications

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

Table 5. Timing table

ITEM		Symbol	Min	Typ	Max	Unit	Note
Horizontal	Display Period	tHV	480	480	480	tCLK	3840/8
	Blank	tHB	60	70	120	tCLK	1
	Total	tHP	540	550	600	tCLK	
Vertical	Display Period	tVV	2160	2160	2160	Lines	
	Blank	tVB	40	90	600	Lines	1
	Total	tVP	2200	2250	2760	Lines	

ITEM		Symbol	Min	Typ	Max	Unit	Note
Frequency	DCLK	fCLK	67	74.25	78.00	MHz	594/8
	Horizontal	fH	121.8	135	140	KHz	2
	Vertical	fV	50	60	63	Hz	2

Notes

- The input of HSYNC & VSYNC signal does not have an effect on normal operation (DE Only Mode).
If you use spread spectrum of EMI, add some additional clock to minimum value for clock margin.
 - The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rate and the horizontal frequency
 - Spread Spectrum Rate (SSR) is limited to $\pm 0.5\%$ center spread at 30KHz
- ※ Timing should be set based on clock frequency.

Product specification

3-4. Color input data reference

The brightness of each primary color(red,green,blue) is based on the 10-bit gray scale data input for the color; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

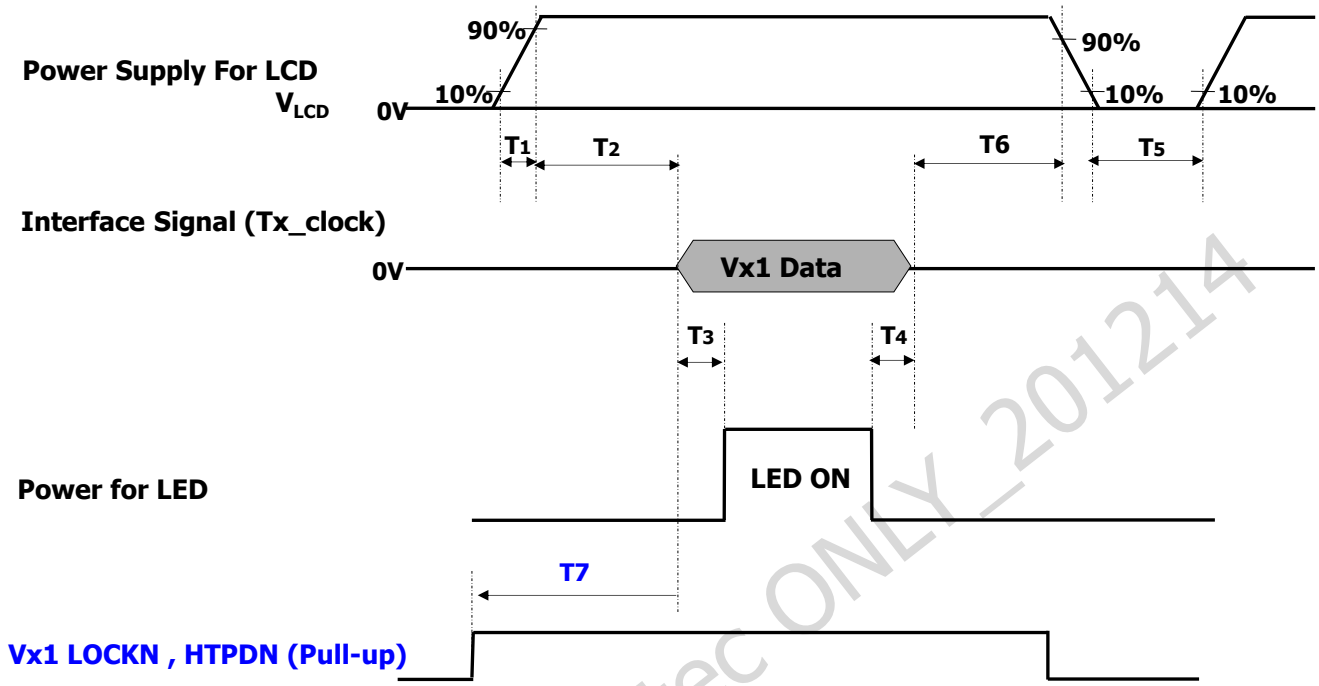
Table 6. Color data reference

Packer input & Unpacker output		30bpp RGB (10bit)	24bpp RGB (8bit)
Byte0	D[0]	R[2]	R[0]
	D[1]	R[3]	R[1]
	D[2]	R[4]	R[2]
	D[3]	R[5]	R[3]
	D[4]	R[6]	R[4]
	D[5]	R[7]	R[5]
	D[6]	R[8]	R[6]
	D[7]	R[9]	R[7]
Byte1	D[8]	G[2]	G[0]
	D[9]	G[3]	G[1]
	D[10]	G[4]	G[2]
	D[11]	G[5]	G[3]
	D[12]	G[6]	G[4]
	D[13]	G[7]	G[5]
	D[14]	G[8]	G[6]
	D[15]	G[9]	G[7]
Byte2	D[16]	B[2]	B[0]
	D[17]	B[3]	B[1]
	D[18]	B[4]	B[2]
	D[19]	B[5]	B[3]
	D[20]	B[6]	B[4]
	D[21]	B[7]	B[5]
	D[22]	B[8]	B[6]
	D[23]	B[9]	B[7]
Byte3	D[24]	Don't care	
	D[25]	Don't care	
	D[26]	B[0]	
	D[27]	B[1]	
	D[28]	G[0]	
	D[29]	G[1]	
	D[30]	R[0]	
	D[31]	R[1]	

Notes 1. 30bpp RGB (10bit) is 4 byte mode, otherwise (24bpp RGB) 3byte mode

Product specification

3-5. Power sequence

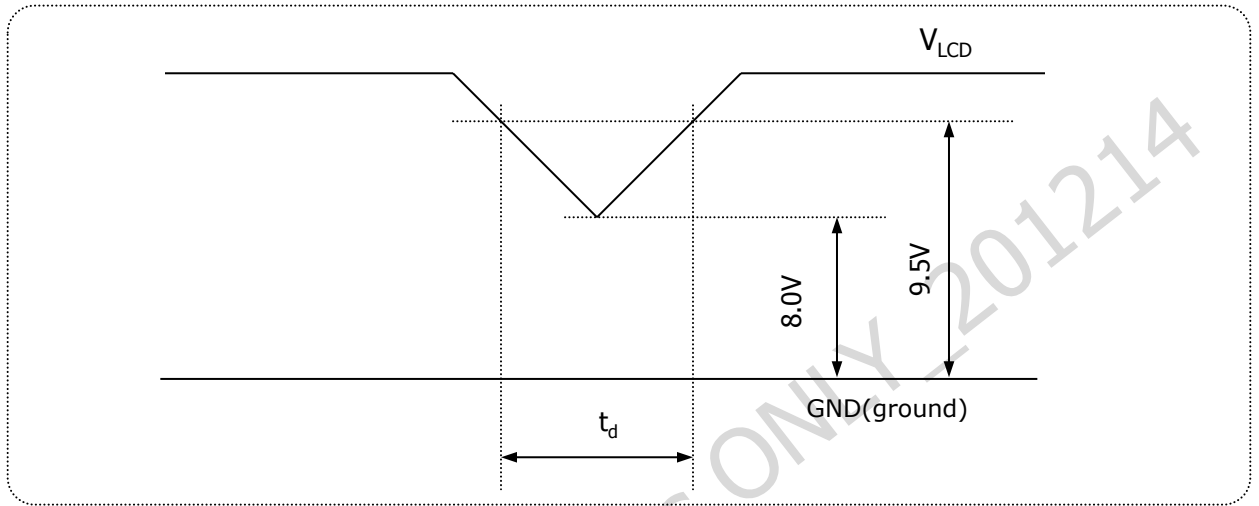


Parameter	Value			Unit	Note
	Min	Typ	Max		
T1	0.5	-	20	ms	1
T2	5	-	-	ms	2
T3	400	-	-	ms	3
T4	100	-	-	ms	3
T5	1000	-	-	ms	4
T6	0	-	-	ms	5
T7	0	-	-	ms	

Note :

1. Even though T1 is over the specified value, there is no problem if I2T spec of fuse is satisfied.
2. If T2 is satisfied with specification after removing V by one Cable, there is no problem.
3. The T3 / T4 is recommended value, the case when failed to meet a minimum specification, abnormal display would be shown. There is no reliability problem.
4. T5 should be measured after the Module has been fully discharged between power off and on period.
5. It is recommendation specification that T6 has to be 0ms as a minimum value.
 - ※ Please avoid floating state of interface signal at invalid period.
 - ※ When the power supply for LCD (VLCD) is off, be sure to pull down the valid and invalid data to 0V.

3-6. 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.

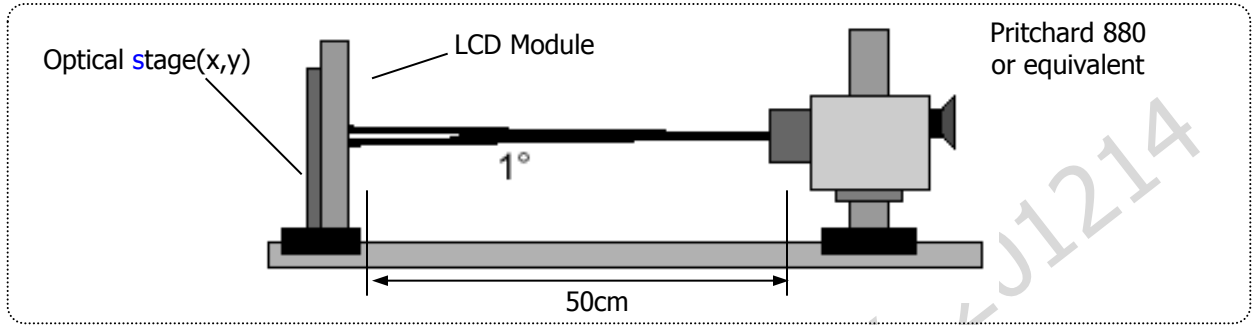
1) Dip condition

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

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 8. Optical characteristics ($T_a=25^\circ\text{C}$, $V_{\text{LCD}}=10.0\text{V}$, $f_v=60\text{Hz}$ $D_{\text{clk}}=74.25\text{MHz}$, $I_s=85\text{mA}$)

Parameter	Symbol	Values			Units	Notes	
		Min.	Typ.	Max.			
Contrast Ratio	CR	910	1300	-		1	
Surface luminance, white	L_{WH}	800	1000	-	cd/m^2	2	
Luminance variation	δ_{WHITE}	75	-	-	%	3	
Response time	Gray To Gray	$T_{\text{GTG_AVR}}$	14	25	ms	4	
Color gamut (CIE1931)	sRGB	95		-	%		
Color coordinates [CIE1931] (By PR650)	Red	Rx	Typ. -0.03	0.660	Typ. +0.03		
		Ry		0.327			
	Green	Gx		0.295			
		Gy		0.645			
	Blue	Bx		0.150			
		By		0.060			
	White	Wx		0.313			
		Wy		0.329			
Color temperature	-	-	6500	-	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)**

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

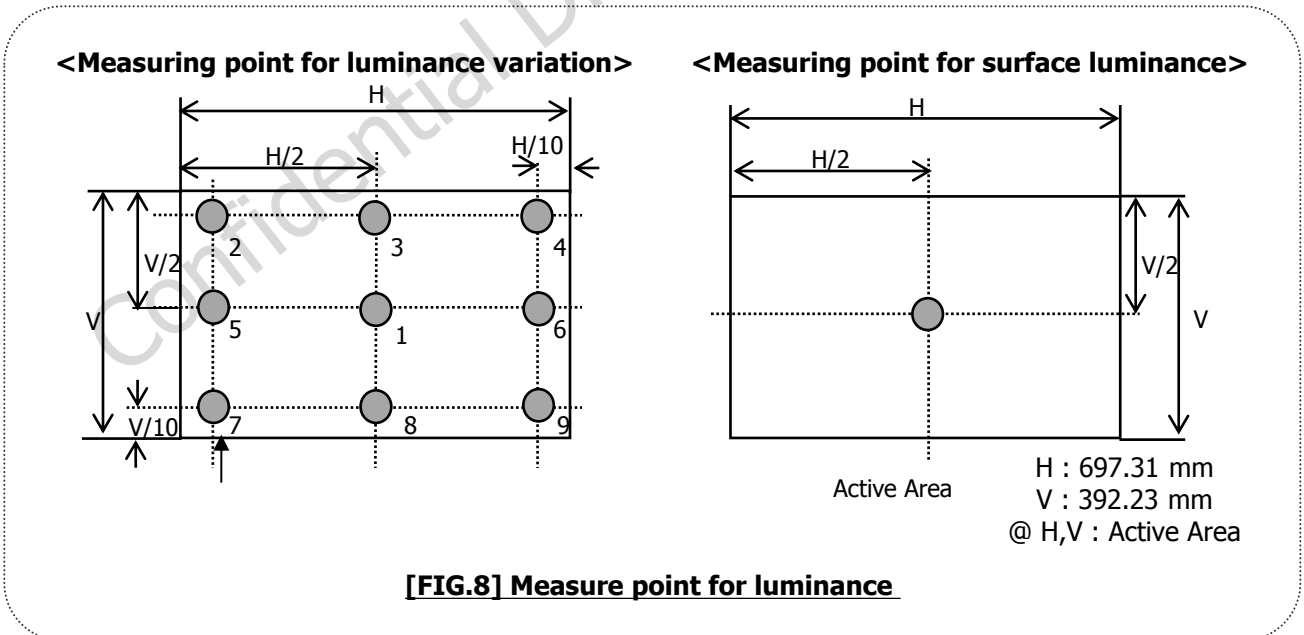
It is measured at center point(Location P1)

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



[FIG.8] Measure point for luminance

Product specification

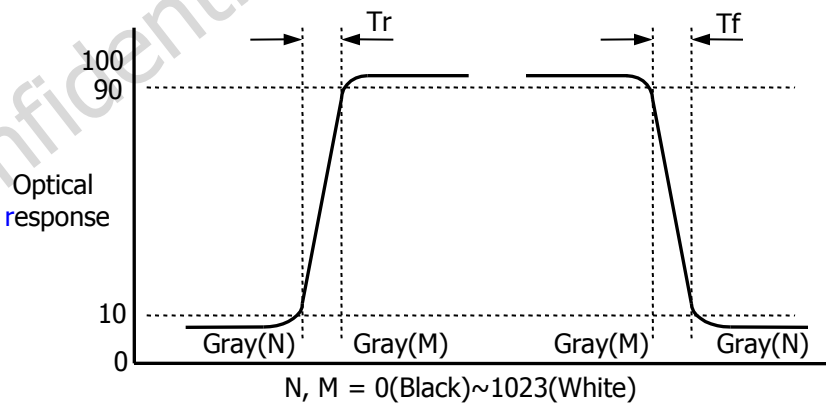
4. The Gray To Gray response time is defined as the following figure and shall be measured by switching the input signal for "Gray To Gray".

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

Table 9. GTG Gray table

Gray To Gray		Rising time				
		G1023	G767	G511	G255	G0
Falling time	G1023					
	G767					
	G511					
	G255					
	G0					

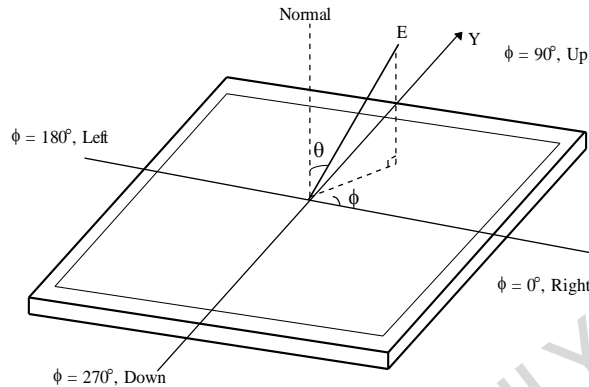
Response time is defined as the following figure and shall be measured by switching the input signal for "Gray(N)" and "Gray(M)".



[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 10. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.11
127	1.08
255	4.72
383	11.49
511	21.66
639	35.45
767	53.00
895	74.48
1023	100

Product specification
5. Mechanical characteristics

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

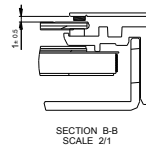
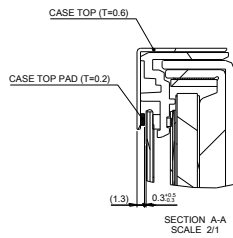
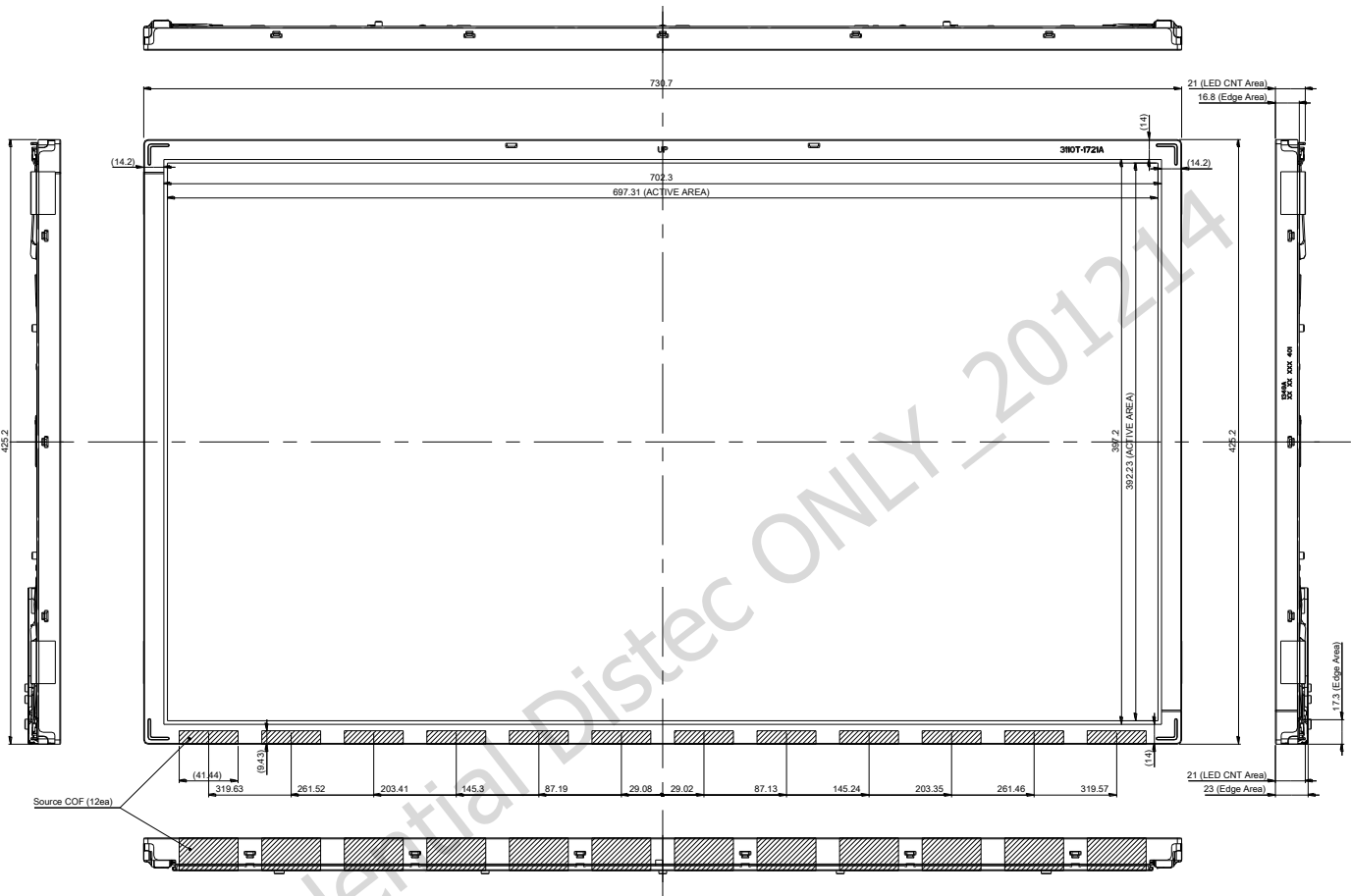
Outline dimension	Horizontal	730.7 mm
	Vertical	425.2 mm
	Depth	23.0 mm
Bezel area	Horizontal	702.3mm
	Vertical	397.2mm
Active display area	Horizontal	697.31 mm
	Vertical	392.23 mm
Weight	Typ. : 6,000g, Max. : 6,300g	
Surface treatment	Hard coating(3H) Anti-glare treatment of the front polarizer	

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

Outline dimensions (horizontal, vertical and outside depth) are measured by using vernier calipers.
 The inside depth dimensions are measured by using height gauge, when LCM is put face down onto a flat surface.

Product specification

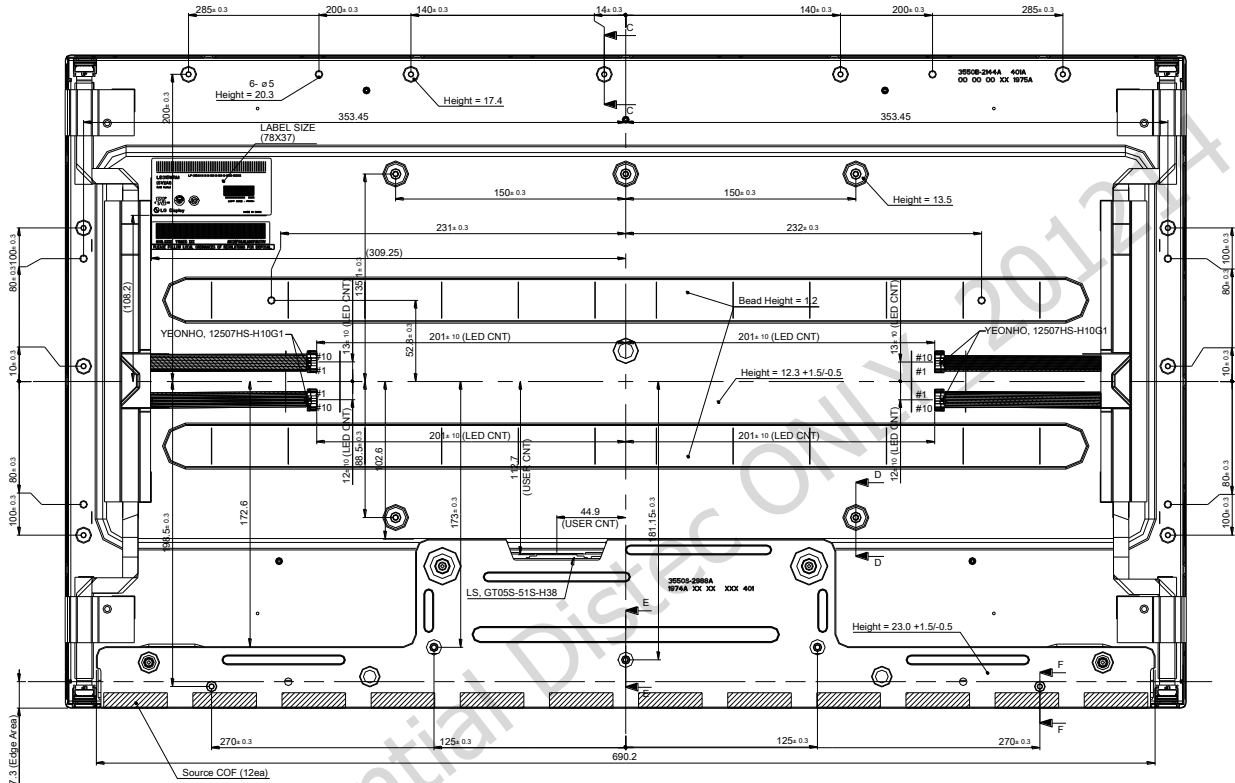
<FRONT VIEW>



Product specification

<REAR VIEW>

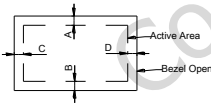
* Reverse Panel



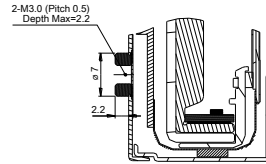
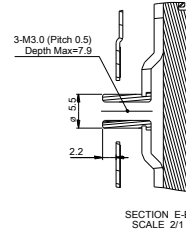
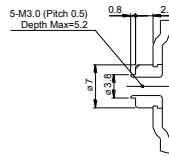
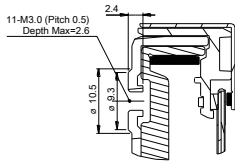
Notes

- Unspecified tolerances are to be ± 0.5mm.
- 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



- Torque SPEC of Mounting : 3.0 ~ 4.0kgf.cm, M3.0 Machine Screw
- IF Connector Specification : LS, GT05S-51S-H38
- LED Connector Specification : YEONHO, 12507HS-H10G1
- The COF area is weak & sensitive, so please don't press the COF area
- The LCM warp (warpage) is less than 1.0 on the surface plate
- Undefined height should follow the 3D Modeling data



Product specification
6. Reliability

Environment test condition

No	Test Item	Condition	Notes
1	High temperature storage test	$T_a = 60^\circ\text{C}$, 240h	1
2	Low temperature storage test	$T_a = -20^\circ\text{C}$, 240h	1
3	High temperature operation test	$T_a = 50^\circ\text{C}$, 50%RH, 240h	1
4	Low temperature operation test	$T_a = 0^\circ\text{C}$, 240h	1
5	Humidity condition operation	$T_a = 40^\circ\text{C}$, 90%RH	1
6	Vibration test (non-operating)	Wave form : Random Vibration level : 1.0G RMS Bandwidth : 10-300Hz Duration : X,Y,Z, 10min One time each direction	
7	Shock test (non-operating)	Shock level : 100G RMS Waveform : Half sine wave, 2ms Direction : $\pm X$, $\pm Y$, $\pm Z$ One time each direction	
8	Altitude Operating Storage / Shipment	0 - 10,000 feet (3,048m) 0 - 40,000 feet (12,192m)	
9	Maximum storage humidity for 4 corner light leakage Mura.	Max 70%RH , $T_a = 40^\circ\text{C}$	

Note 1) Result Evaluation Criteria:

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

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

 * T_a = Ambient Temperature

Product specification**7. International Standards****7-1. Safety**

- a) IEC 62368-1, The International Electro-technical Commission(IEC).
Audio/video, Information and Communication Technology Equipment - Safety - Safety Requirements.
- b) EN 62368-1, European Committee for Electro-technical Standardization (CENELEC)
Audio/video, Information and Communication Technology Equipment - Safety Requirements
- c) UL 62368-1, UL LLC.
Audio/video, Information and Communication Technology Equipment - Safety Requirements
- d) CAN/CSA C22.2 No.62368-1, Canadian Standards Association (CSA).
Audio/video, Information and Communication Technology Equipment - Safety Requirements
- e) IEC 60950-1, The International Electro technical Commission (IEC).
Information Technology Equipment - Safety - Part 1 : General Requirements

7-2. Environment

- a) RoHS, Commission Delegated Directive (EU) 2015/863 of 31 March 2015 amending Annex II to Directive 2011/65/EU of the European Parliament and of the Council

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 packing : 10ea/Box

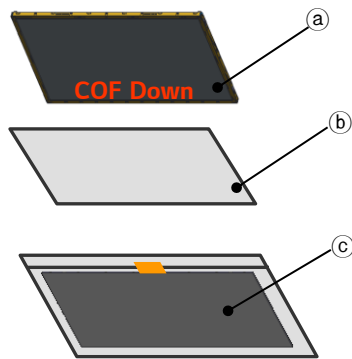
Package quantity in one Pallet : 20ea/Pallet

b) Packing Size : 814mm X 543mm X 509mm

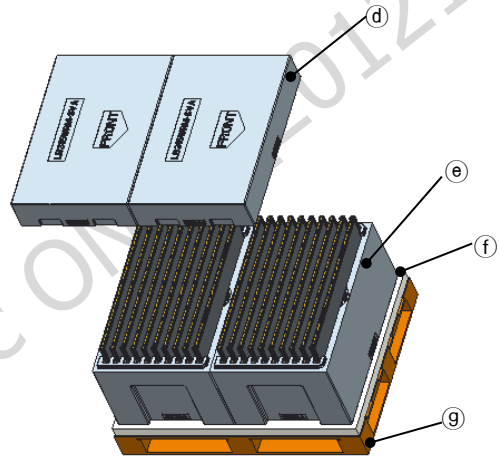
c) Pallet Ass'y Size: 1140mmX870mmX682mm

* LCM Direction(insert to Bottom Packing) : COF Down

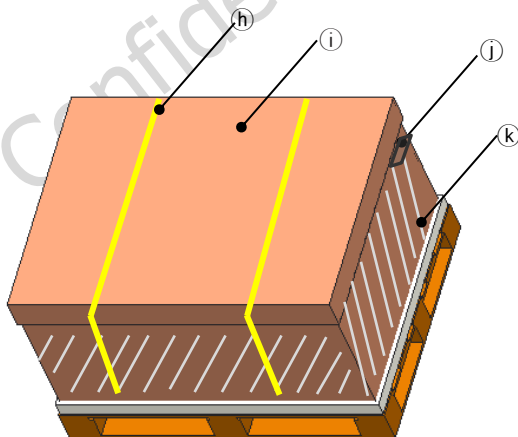
1.



2.



3.



No.	Description	Material
(a)	LCM	-
(b)	Protect film	PP+PE
(c)	AL-Bag	AL
(d)	Packing,Top	EPS
(e)	Packing,Bottom	EPS
(f)	Cushion	EPE
(g)	Pallet	Plywood
(h)	BAND	PP
(i)	Angle Packing	Paper(SW)
(j)	LABEL	YUPO PAPER
(k)	Wrap	-

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 and hazardous materials exposure

Strong light exposure causes degradation of polarizer and color filter.

The LCM should be avoided direct contact with Hazardous materials such as sulfur, acetic acid, chlorine, etc. These materials may cause chemical reaction such as sulfurization, corrosion, discoloration, etc.

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.

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