HY-LINE®
COMPUTER COMPONENTS

TFT-Display Datasheet

LG Display
Model: LB156WF1-SPA1

Brief spec.:

Main Feature	Landscape
	White LED Backlight
	Wide Aspect Ratio
Active Screen Area	344.1 x 193.1
Diagonal | Format	15,6" | 16:9
Resolution	1920 X 1080
Colors	6-bit 262 ,144 colors
Backlight	LED
Brightness	400 cd/m²
LED Life Time	50K(h)
Interface	eDP
Viewing Angle	80/80 L/R 80/80
Touchscreen	No
Power Supply	3.3 V
Module Outline	363.8 x 215.9 x 12.85 (mm)
Operation Temperature	- 0 ... +50 °C
Storage Temperature	-20... +60 °C
Surface Treatment	Anti-Glare (haze25% ,3H)

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SPECIFICATION
FOR
APPROVAL

(◆) **Preliminary Specification**
( ) **Final Specification**

Title	15.6" FHD TFT LCD

BUYER	General
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LB156WF1
Suffix	SPA1

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

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

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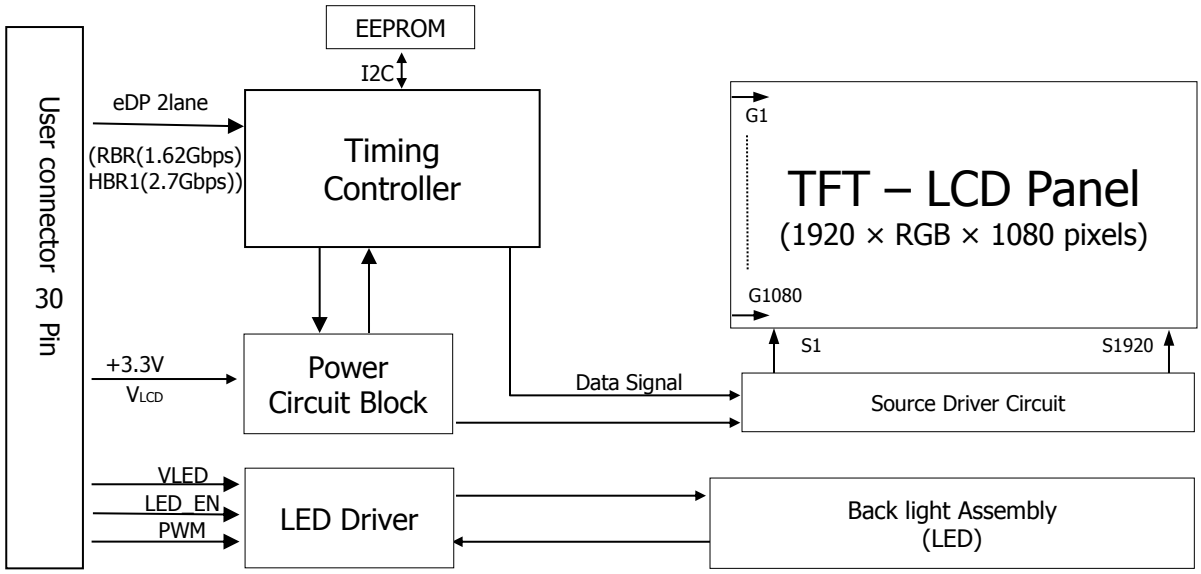
Contents

RECORD OF REVISIONS

Revision No.	Revision Date	Page	Before	After	Application Date
0.0	July. 13. 2017	-	First Draft, Preliminary Specifications	-	-

1. General Description

LB156WF1-SPA1 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 15.6 inch diagonally measured active display area with FHD resolution.(1920 horizontal by 1080 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 6-bit gray scale signal for each dot, thus, presenting a palette of more than 262,144 colors. It has been designed to apply eDP(RBR(1.62Gbps), HBR1(2.7Gbps)) interface. It is intended to support displays where high brightness, wide viewing angle, high color saturation, and high color are important.



[FIG.1] Block diagram

General Features

Active Screen Size	15.6 inches diagonal
Outline Dimension	363.8 (H) x 215.9 (V) x 12.85 mm (Typ.)
Pixel Pitch	0.17925 mm X 0.17925 mm
Pixel Format	1920 horiz. By 1080 vert. Pixels RGB strip arrangement
Color Depth	6-bit, 262,144 colors
Luminance, (@White)	400 cd/m^2 (Center 1Point, Typ.)
Viewing Angle (CR>10)	View Angle (R/L 160(Min.), U/D 160(Min.))
Power Consumption	Total 8.89 W (Typ.) Logic : 1.09 W(Typ. @ Mosaic), B/L : 7.80 W(Typ)
Weight	706 g (Typ.)
Display Operating Mode	Transmissive mode, Normally Black
Panel type	Reverse type
Surface Treatment	Anti-Glare treatment of the front polarizer(Haze25%, 3H)

2. Absolute Maximum Ratings

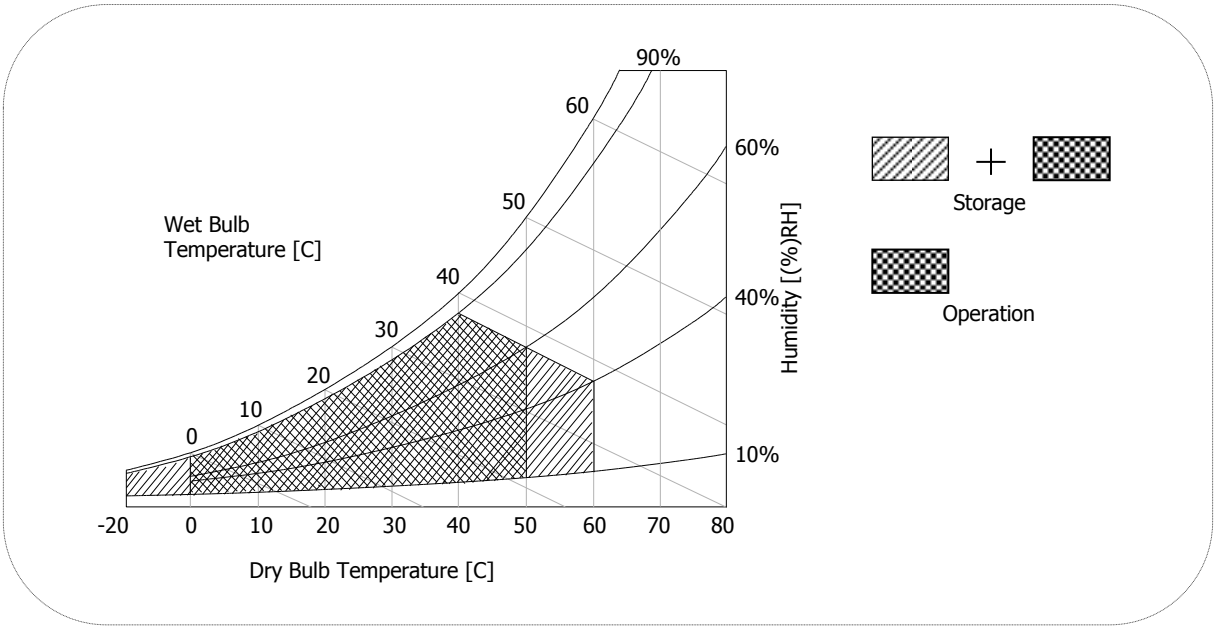
The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Supply Input Voltage	VLCD	-0.3	4.0	V_{DC}	At 25 °C
Operating Temperature	TOP	0	50	°C	1,2,3
Storage Temperature	HST	-20	60	°C	
Operating Ambient Humidity	HOP	10	90	%RH	
Storage Humidity	HST	10	90	%RH	
LCM Surface Temperature (Operation)	$T_{Surface}$	0	65	°C	1, 4

Note : 1. Temperature and relative humidity range are shown in the figure below.
Wet bulb temperature should be 39 °C Max, and no condensation of water.
2. Maximum Storage Humidity is up to 40℃, 70% RH only for 4 corner light leakage Mura.
3. Storage condition is guaranteed under packing condition
4. LCM surface temperature should be measured under the condition of VLCD=3.3V, fv=60Hz, Ta=25℃, no humidity and typical LED string current.
※. Ta= Ambient temperature

FIG. 2 Temperature and relative humidity



3. Electrical Specifications

3-1. LCD 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.

Table 2. LCD ELECTRICAL CHARACTERISTICS

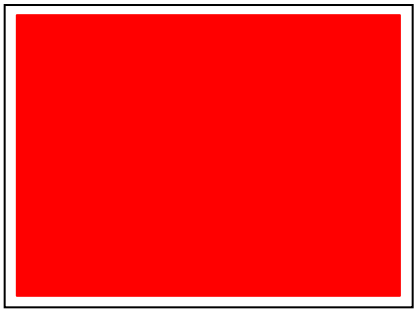
Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
Power Supply Input Voltage	VLCD	3.0	3.3	3.6	V	4
Permissive Power Supply Input Ripple	VLCDrp	-	-	100	mV_{p-p}	1
Power Supply Input Current	I_{CC_TYP}	-	330	410	mA	2
	I_{CC_MAX}	-	450	560	mA	
Power Consumption	P_{CC_TYP}	-	1.09	1.35	W	
	P_{CC_TYP}	-	1.49	1.85	W	
Power Supply Inrush Current	I_{CC_P}	-	-	1.5	A	3

Note :

1. Permissive power ripple should be measured under the condition of V_{LCD}=3.3V, 25°C,*fv=max.
   Refer to page 7 for the pattern and more information.
2. The specified current and power consumption can be measured under the V_{LCD}=3.3V, 25°C, f_V=60Hz and the pattern should be changed according to the typical or maximum power condition.
   The Max current can be measured only with the maximum power pattern.
   See the page 7 for details.
3. Maximum Condition of Inrush current :
   The duration of rush current is about 5ms and rising time of power Input is 500us ± 20%. (min.).
4. V_{LCD} level must be measured between two points on PCB of LCM (V_{LCD} (test point) ~ LCM Ground)
   (Test condition : maximum power pattern, 25°C, f_V=60Hz)

*fv=frame frequency

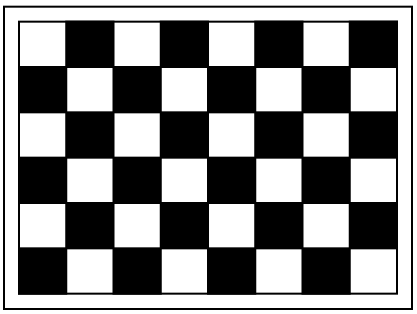
• Permissive Power input ripple (V_{LCD} =3.3V, 25°C, fv (frame frequency)=MAX condition)



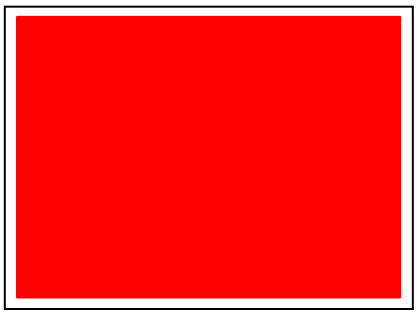
Red 63 pattern

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

• Power consumption (V_{LCD} =3.3V, 25°C, fv (frame frequency=60Hz condition)



Typical power Pattern



Maximum power Pattern

FIG. 3 Mosaic pattern & Red 63 Pattern for power consumption measurement

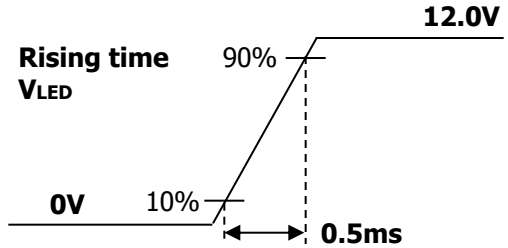
3-2. LED Backlight Electrical Characteristics

Table 3. LED B/L ELECTRICAL CHARACTERISTICS

Parameter		Symbol	Values			Unit	Notes
			Min	Typ	Max		
LED Power Input Voltage		V_{LED}	11.5	12.0	12.5	V	1
LED Power Input Current		I_{LED}	-	650	715	mA	2
LED Power Consumption		P_{LED}	-	7.80	8.58	W	
LED Power Inrush Current		I_{LED_P}	-	-	3.0	A	3
PWM Duty Ratio			5	-	100	%	4
PWM Jitter			0	-	0.2	%	5
PWM Frequency		F_{PWM}	200	-	1000	Hz	6
PWM	High Level Voltage	V_{PWM_H}	2.5	-	3.6	V	
	Low Level Voltage	V_{PWM_L}	0	-	0.3	V	
LED_EN	High Voltage	$V_{LED\_EN\_H}$	2.5	-	3.6	V	
	Low Voltage	$V_{LED\_EN\_L}$	0	-	0.3	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℃.
2. The current and power consumption with LED Driver are under the V_{LED} = 12.0V , 25℃, 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 T13 at Power on sequence.



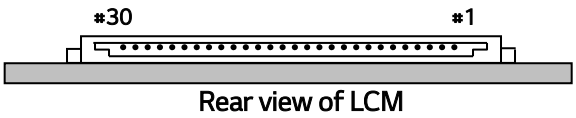
4. The operation of LED Driver below minimum dimming ratio may cause flickering or reliability issue.
5. If Jitter of PWM is bigger than maximum, it may induce flickering.
6. This Spec. is not effective at 100% dimming ratio as an exception because it has DC level equivalent to 0Hz. In spite of acceptable 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.

3-3. Interface Connections

Table 4. MODULE CONNECTOR PIN CONFIGURATION (CN1)

No	Symbol	Description	No	Symbol	Description
1	NC Reserved	Reserved for LCD manufacturer's use	16	GND	LCD logic and driver ground
2	GND	High Speed Ground	17	HPD	HPD signal pin
3	Lane1_N	Complement Signal Link Lane 1	18	BL_GND	LED Backlight ground
4	Lane1_P	True Signal Link Lane 1	19	BL_GND	LED Backlight ground
5	GND	High Speed Ground	20	BL_GND	LED Backlight ground
6	Lane0_N	Complement Signal Link Lane 0	21	BL_GND	LED Backlight ground
7	Lane0_P	True Signal Link Lane 0	22	LED EN	LED Backlight control on/off control
8	GND	High Speed Ground	23	BL PWM	System PWM signal input for dimming
9	AUX_CH_P	True Signal Auxiliary Channel	24	SCL	I2C Serial interface
10	AUX_CH_N	Complement Signal Auxiliary Channel	25	SDA	I2C Serial interface
11	GND	High Speed Ground	26	VLED	LED Backlight power (12V Typical)
12	VLCD	LCD logic and driver power	27	VLED	LED Backlight power (12V Typical)
13	VLCD	LCD logic and driver power	28	VLED	LED Backlight power (12V Typical)
14	NC Reserved	LCD Panel Self Test Enable (Optional)	29	VLED	LED Backlight power (12V Typical)
15	GND	LCD logic and driver ground	30	NC Reserved	Reserved for LCD manufacture's use

Note: 1. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.
2. All VLCD (power input) pins should be connected together.

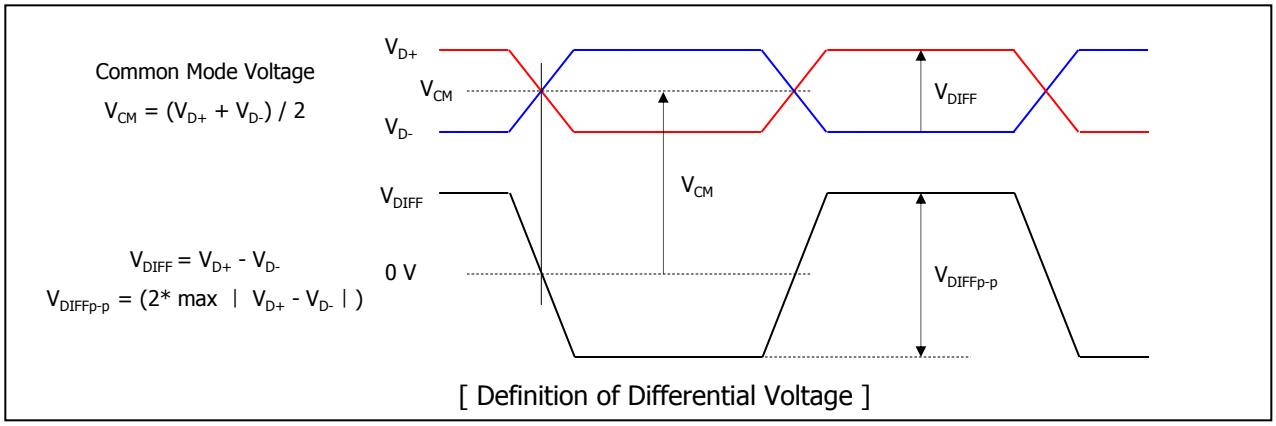


- LCD Connector(CN1) : GT05Q-30S-H10-MN (LSMtron) or Equivalent

[그림.5] Connector diagram

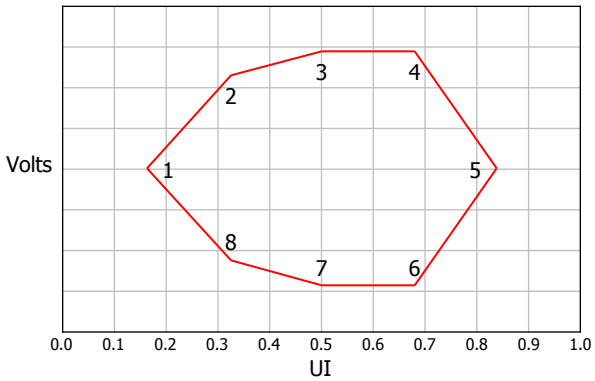
3-4. eDP Signal Timing Specifications

3-4-1. Definition of Differential Voltage

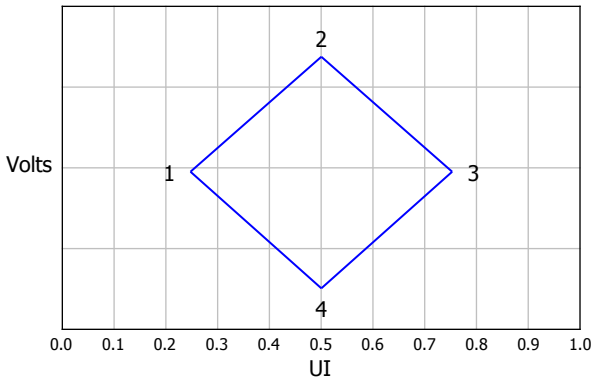


[Definition of Differential Voltage]

3-4-2. Main Link EYE Diagram



[EYE Mask at Source Connector Pins]



[EYE Mask at Sink Connector Pins]

Point	Reduced Bit Rate		High Bit Rate	
	Time(UI)	Voltage(V)	Time(UI)	Voltage(V)
1	0.127	0.000	0.210	0.000
2	0.291	0.160	0.355	0.140
3	0.500	0.200	0.500	0.175
4	0.709	0.200	0.645	0.175
5	0.873	0.000	0.790	0.000
6	0.709	-0.200	0.645	-0.175
7	0.500	-0.200	0.500	-0.175
8	0.291	-0.160	0.355	-0.140

[EYE Mask Vertices at Source Connector Pins]

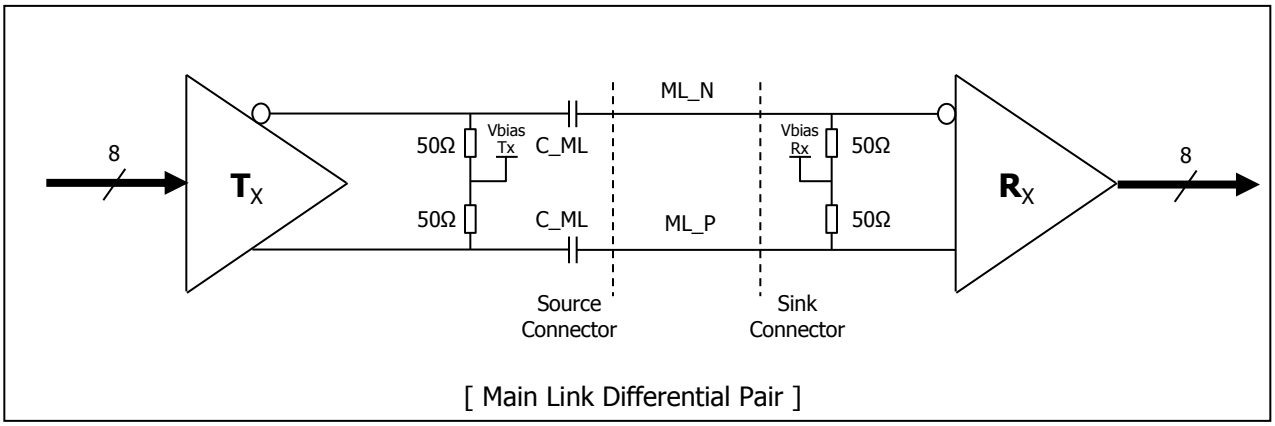
Point	Reduced Bit Rate		High Bit Rate	
	Time(UI)	Voltage(V)	Time(UI)	Voltage(V)
1	0.375	0.000	0.246	0.000
2	0.500	0.023	0.500	0.075
3	0.625	0.000	0.755	0.000
4	0.500	-0.023	0.500	-0.075

[EYE Mask Vertices at Sink Connector Pins]

Point	Reduced Bit Rate		High Bit Rate	
	Time(UI)	Voltage(V)	Time(UI)	Voltage(V)
1	0.270	0.000	0.246	0.000
2	0.500	0.068	0.500	0.075
3	0.731	0.000	0.755	0.000
4	0.500	-0.068	0.500	-0.075

[EYE Mask Vertices at embedded DP Sink Connector Pins]

3-4-3. eDP Main Link Signal

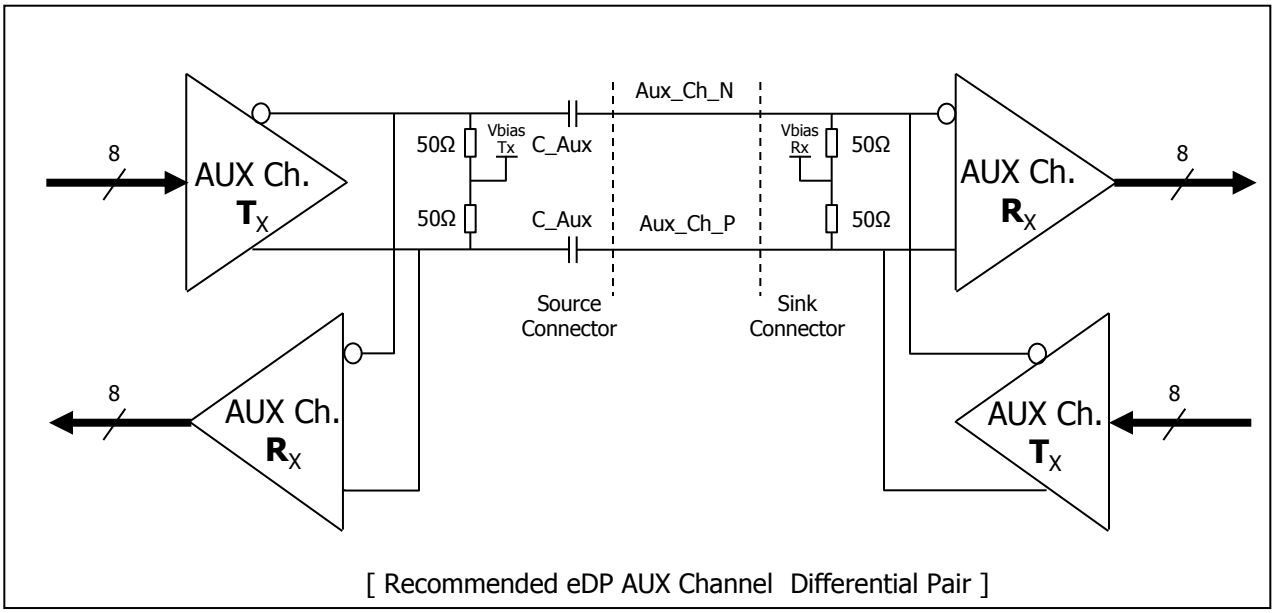


[Main Link Differential Pair]

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Unit Interval for high bit rate (2.7Gbps / lane)	UI_HBR	-	370	-	ps	
Unit Interval for reduced bit rate (1.62Gbps / lane)	UI_RBR	-	617	-	ps	
Link Clock Down Spreading	Amplitude	0	-	0.5	%	
	Frequency	30		33	kHz	
Differential peak-to-peak voltage at Source side connector	$V_{TX-DIFFp-p}$	350	-	-	mV	For HBR(2.7Gbps)
		400	-	-		For RBR(1.62Gbps)
EYE width at Source side connector	$T_{TX-EYE-CONN}$	0.58	-	-	UI	For HBR(2.7Gbps)
		0.75	-	-	UI	For RBR(1.62Gbps)
Differential peak-to-peak voltage at Sink side connector	$V_{RX-DIFFp-p}$	150	-	-	mV	For HBR(2.7Gbps)
		136	-	-		For RBR(1.62Gbps)
EYE width at Sink side connector	$T_{RX-EYE-CONN}$	0.51	-	-	UI	For HBR(2.7Gbps)
		0.46	-	-	UI	For RBR(1.62Gbps)
Rx DC common mode voltage	$V_{RX\ CM}$	0	-	1.0	V	
AC Coupling Capacitor	$C_{SOURCE-ML}$	75		200	nF	Source side

Note)
1. Termination resistor is typically integrated into the transmitter and receiver implementations.
2. In cabled embedded system, it is recommended the system designer ensure that EYE width and voltage are met at the sink side connector pins.
3. Mismatched common mode voltage will occur abnormal display.
4. All eDP electrical spec is measured at sink connector side.
5. eDP cable Impedance should be 100ohm ± 10%.
6. At sink side main link cap. are for protection ESD/EOS damage.

3-4-4. eDP AUX Channel Signal

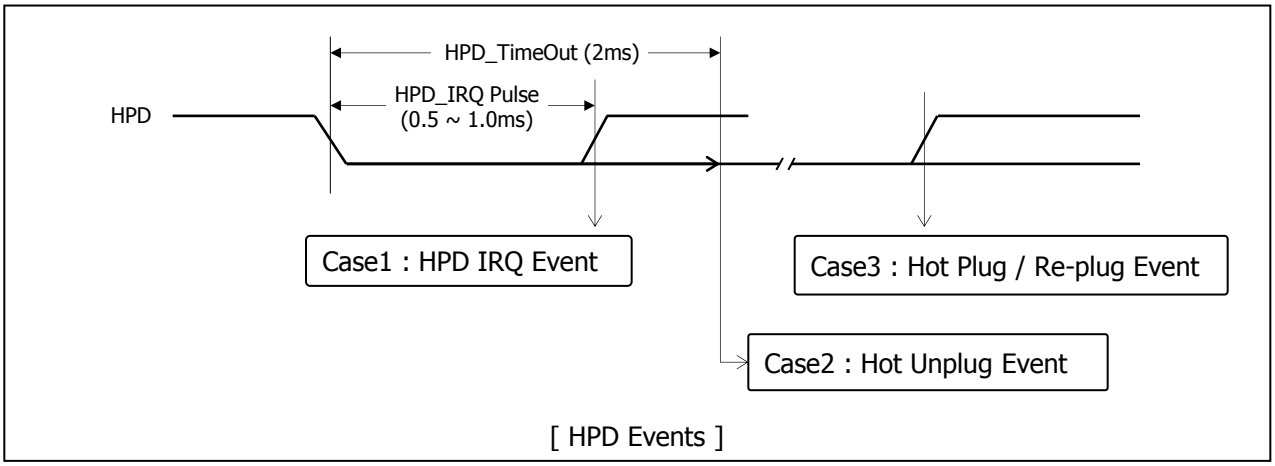


[Recommended eDP AUX Channel Differential Pair]

Parameter	Symbol	Min	Typ	Max	Unit	Notes
AUX Unit Interval	UI	0.4	-	0.6	us	
AUX Jitter at Tx IC Package Pins	T_{jitter}	-	-	0.04	UI	Equal to 24ns
AUX Jitter at Rx IC Package Pins		-	-	0.05	UI	Equal to 30ns
AUX Peak-to-peak voltage at Connector Pins of Receiving	$V_{AUX-DIFFp-p}$	0.32	-	1.36	V	
AUX Peak-to-peak voltage at Connector Pins of Transmitting		0.39	-	1.38	V	
AUX EYE width at Connector Pins of Tx and Rx		0.98	-	-	UI	
AUX DC common mode voltage	V_{AUX-CM}	0	-	1.0	V	
AUX AC Coupling Capacitor	$C_{SOURCE-AUX}$	75		200	nF	Source side

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

3-4-5. eDP HPD Signal



[HPD Events]

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

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

3-5. Signal Timing Specifications

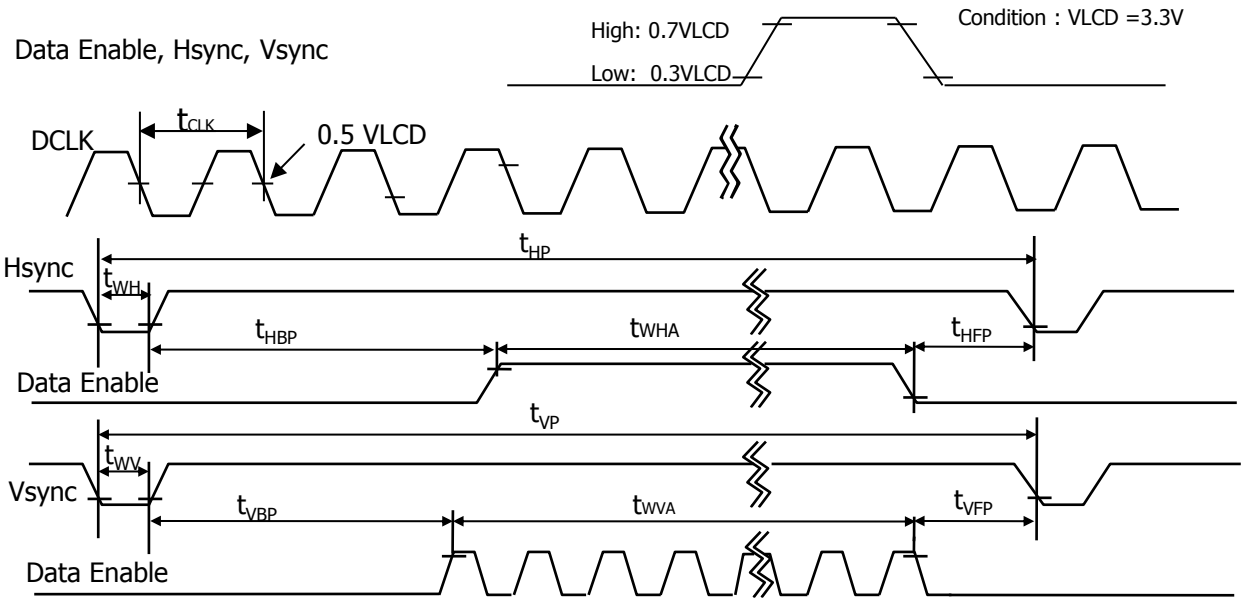
This is the signal timing requirement from the signal transmitter. All of the interface signal timing should satisfy the following specifications of its proper operation.

Table 5. TIMING TABLE

ITEM	Symbol		Min	Typ	Max	Unit	Note
DCLK	Frequency	f_{CLK}	-	138.7	-	MHz	
Hsync	Period	t_{HP}	2072	2080	2088	t_{CLK}	
	Width	t_{WH}	32	32	32		
	Width-Active	t_{WHA}		1920			
Vsync	Period	t_{VP}	1108	1111	1114	t_{HP}	
	Width	t_{WV}	5	5	5		
	Width-Active	t_{WVA}		1080			
Data Enable	Horizontal back porch	t_{HBP}	72	80	88	t_{CLK}	
	Horizontal front porch	t_{HFP}	48	48	48		
	Vertical back porch	t_{VBP}	20	23	24	t_{HP}	
	Vertical front porch	t_{VFP}	3	3	5		

Notice. All Reliabilities are specified for timing specification based on refresh rate of 60Hz.

3-6. Signal Timing Waveforms



3-7. Color Input Data Reference

The brightness of each primary color (red, green and blue) is based on the 6-bit gray scale data input for the color ; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 6. COLOR DATA REFERENCE

Color		Input Color Data																	
		RED						GREEN						BLUE					
		MSB					LSB	MSB					LSB	MSB					LSB
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	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
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	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
RED	RED (00)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (01)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	...	...						...						...					
	RED (62)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN (00)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (01)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	...	...						...						...					
	GREEN (62)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	GREEN (63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
BLUE	BLUE (00)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BLUE (01)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	...	...						...						...					
	BLUE (62)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	BLUE (63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

3-8. Power Sequence

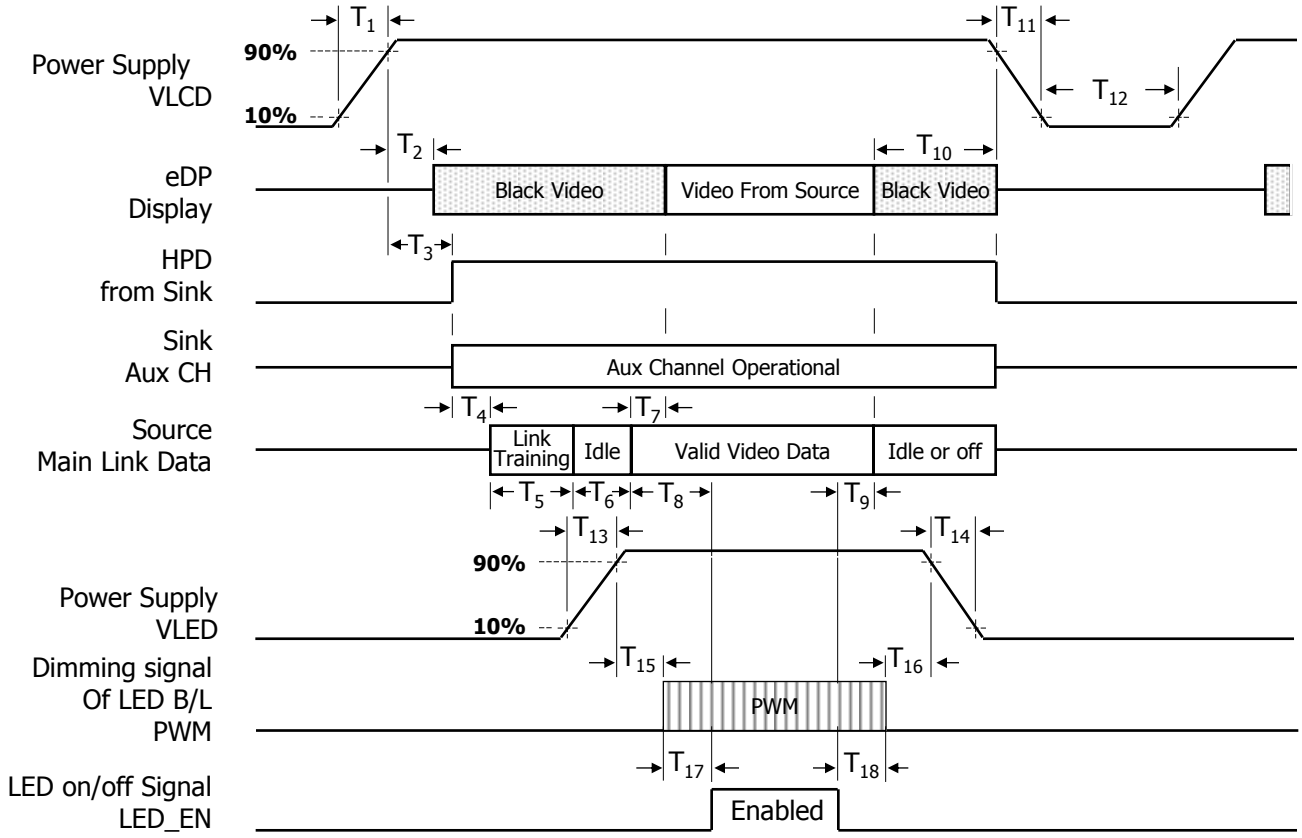


Table 7. POWER SEQUENCE TABLE

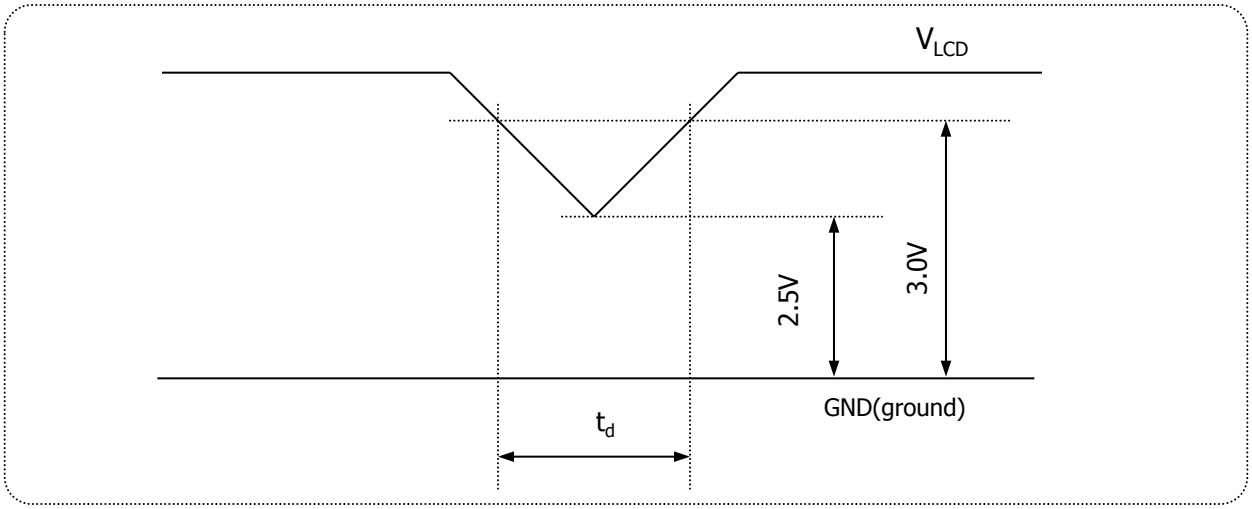
Symbol	Required By	Limits		Units	Notes
		Min	Max		
T_1	Source	0.5	10	ms	-
T_2	Sink	10	200	ms	-
T_3	Sink	15	200	ms	-
T_4	Source	-	-	ms	-
T_5	Source	-	-	ms	-
T_6	Source	-	100	ms	-
T_7	Sink	0	50	ms	-
T_8	Source	200	-	ms	
T_9	Source	200	-	ms	

Symbol	Required By	Limits		Units	Notes
		Min	Max		
T_{10}	Source	0	500	ms	-
T_{11}	Source	-	10	ms	-
T_{12}	Source	1000	-	ms	
T_{13}	Source	0.5	10	ms	-
T_{14}	Source	0.5	10	ms	-
T_{15}	Source	10	-	ms	-
T_{16}	Source	10	-	ms	-
T_{17}	Source	0	-	ms	-
T_{18}	Source	0	-	ms	-

Note:

1. 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.
2. Please avoid floating state of interface signal during signal invalid period.
3. When the interface signal is invalid, be sure to pull down the VLCD.(0V)
4. Please turn off the power supply for LED when the level of V_{LCD} changes to prevent noise issue.
5. Link training duration is dependent on the customer's system.

3-9. V_{LCD} Power Dip Condition



For proper operation, stable power supply of V_{LCD} is necessary and power dip is allowed only in below condition. Except this condition, power on/off should follow power sequence specification in page 17 exactly.

1) Dip condition

$2.5V \leq V_{LCD} < 3.0V$, $t_d \leq 20ms$

4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at 25±2°C.

The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0 ° and aperture 1 degree.

FIG. 1 presents additional information concerning the measurement equipment and method.

FIG. 1 Optical Characteristic Measurement Equipment and Method

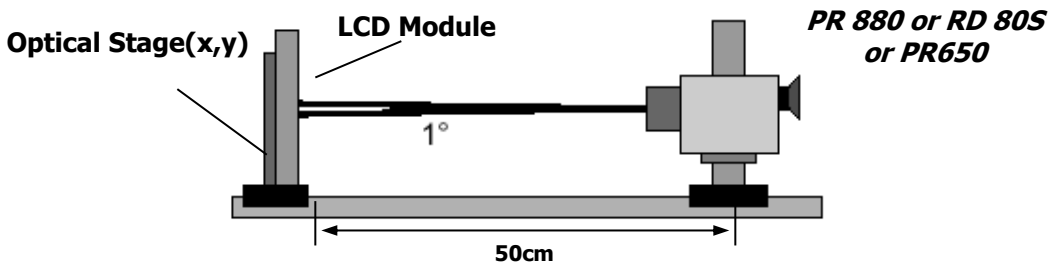


Table 7. OPTICAL CHARACTERISTICS

Ta=25°C, VLCD=3.3V, fv=60Hz, Dclk=138.7MHz

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	600	700	-		1
Surface Luminance, white		L_{WH}	320	400	-	cd/m^2	2
Luminance Variation		δ_{WHITE}	75	-	-	%	3
Response Time		Tr + Tf	-	25	35	ms	4
Color Coordinates	RED	Rx	Typical - 0.03	0.636	Typical + 0.03		
		Ry		0.352			
	GREEN	Gx		0.295			
		Gy		0.647			
	BLUE	Bx		0.158			
		By		0.058			
	WHITE	Wx		0.313			
		Wy		0.329			
Viewing Angle	x axis, right(Φ=0°)	Θr	80	-	-	Degree	5
	x axis, left (Φ=180°)	Θl	80	-	-		
	y axis, up (Φ=90°)	Θu	80	-	-		
	y axis, down (Φ=270°)	Θd	80	-	-		
Gray Scale				-			6
Color Gamut			-	72	-	%	

Notes :

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

   It is measured at center point (1)

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

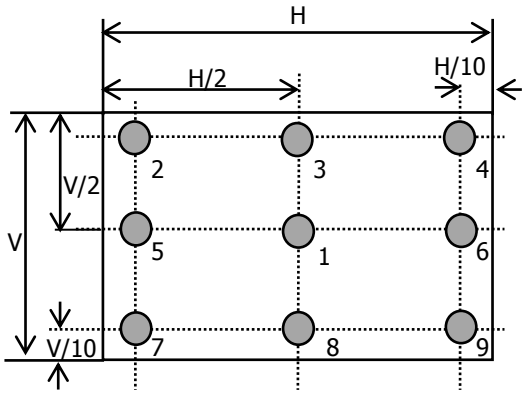
2. **Surface luminance** is the luminance value at center 1 point (1) across the LCD surface 50cm from the surface with all pixels displaying white.
   For more information see Figure 1.

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

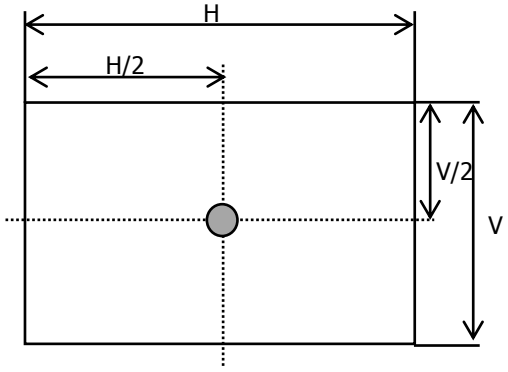
$$\delta_{WHITE} = \frac{\text{Minimum (P1,P2, ..., P9)}}{\text{Maximum (P1,P2, ..., P9)}} \times 100\ (\%)$$

   For more information see Figure 1.

FIG.2 Luminance measuring point



@ H,V : Active Area



<Measuring point for luminance variation> **<Measuring point for surface luminance>**

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

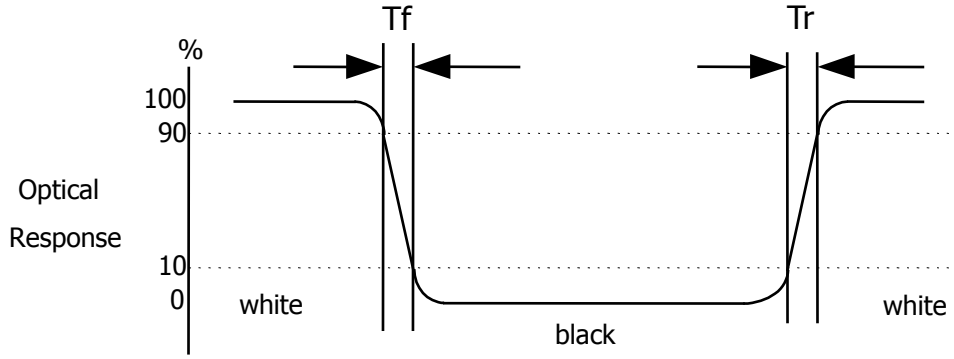


Figure 3. Response Time

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 4 .

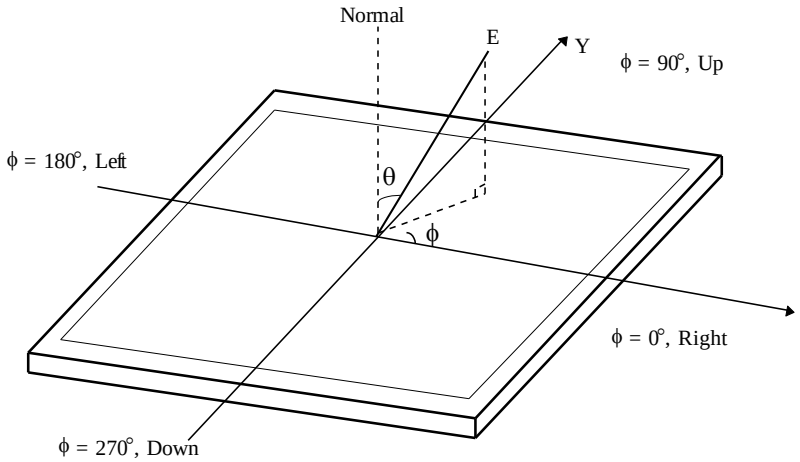


FIG.4 Viewing Angle

6. **Gray scale** specification

Table 8. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.10
3	0.20
7	0.70
11	1.80
15	3.60
19	6.20
23	11.3
27	16.5
31	23
35	29.5
39	36.7
43	44
47	53.2
51	62
55	73.5
59	85.5
63	100

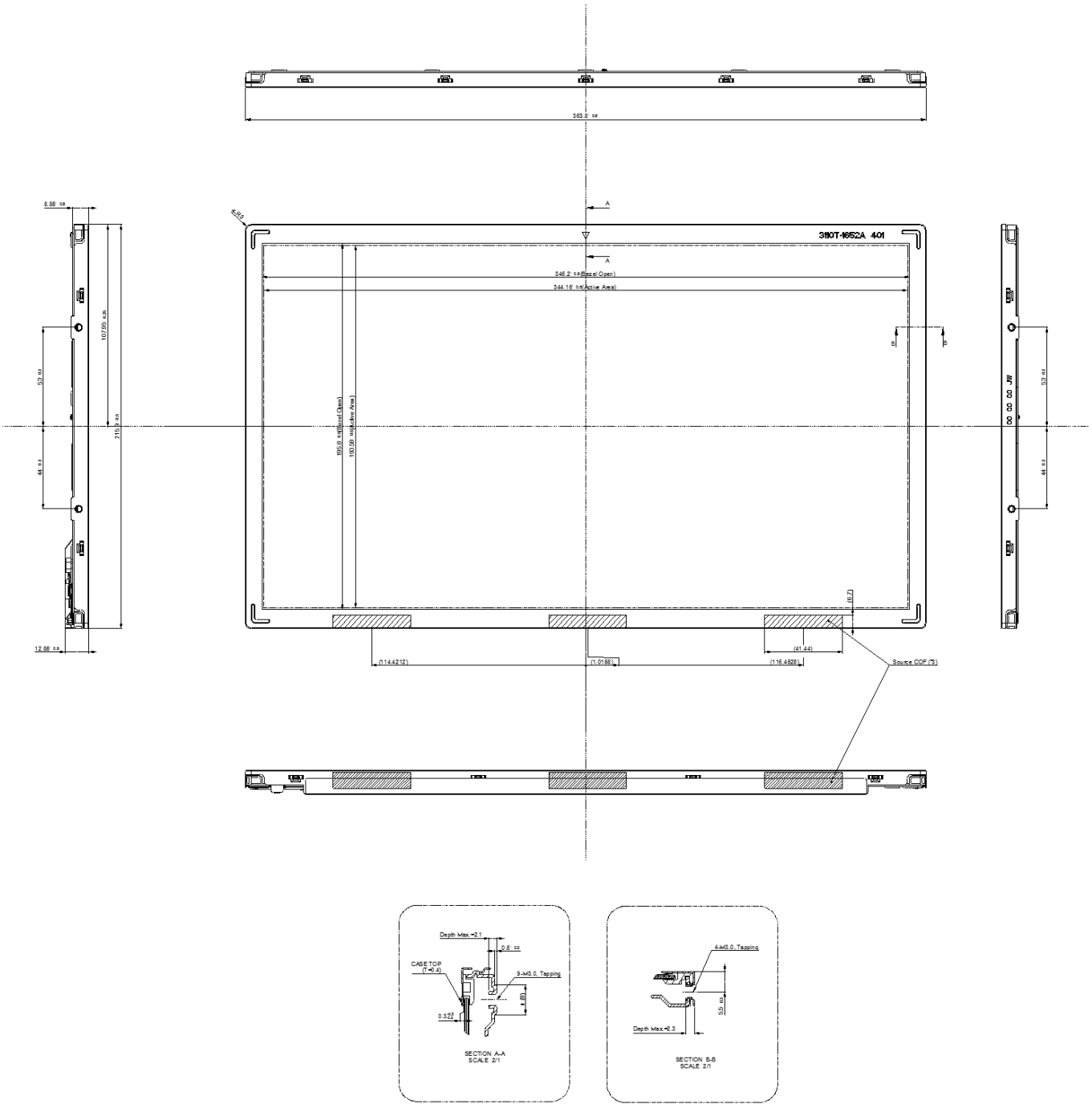
5. Mechanical Characteristics

The contents provide general mechanical characteristics for the model LB156WF1. In addition the figures in the next page are detailed mechanical drawing of the LCD.

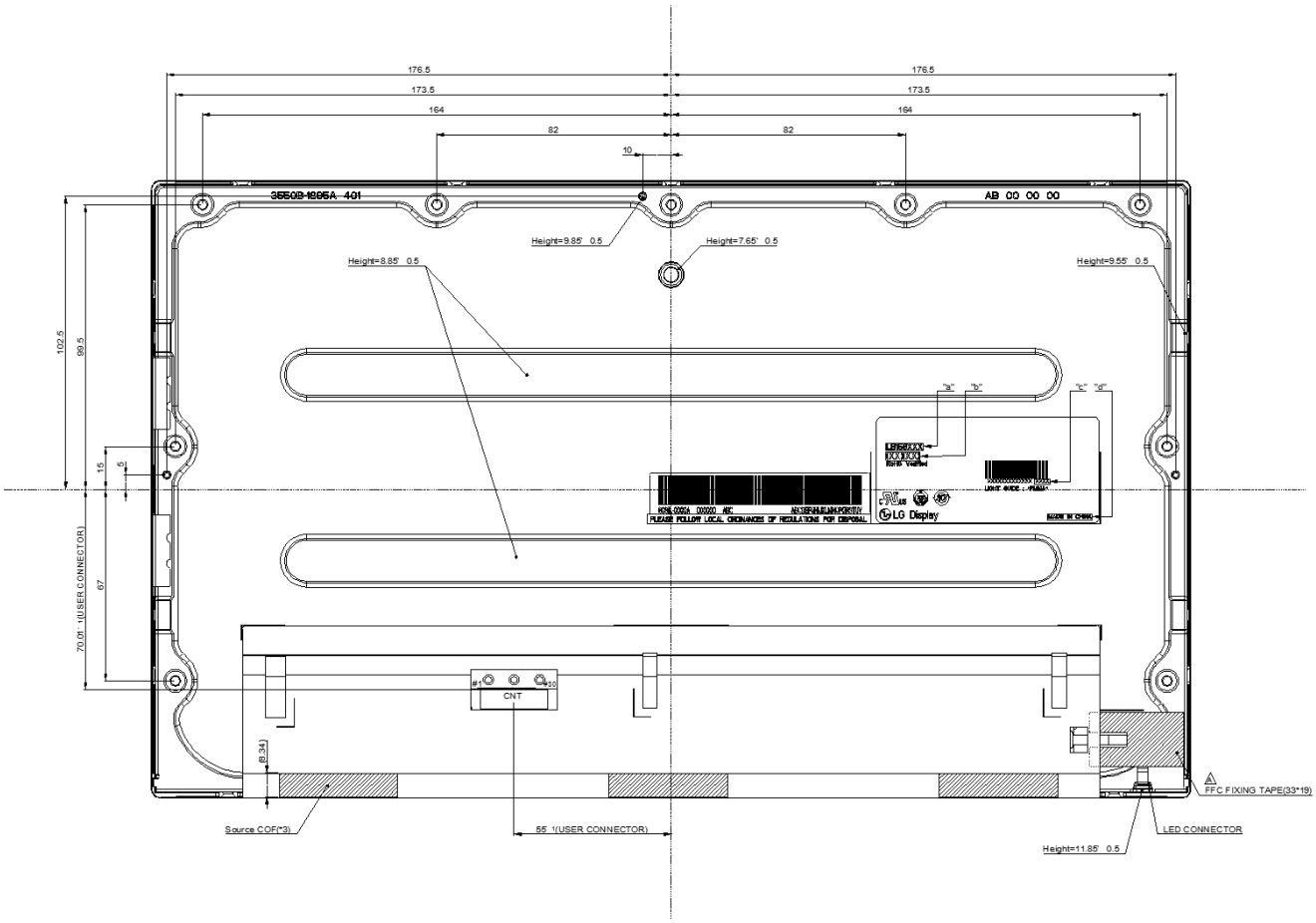
Outline Dimension	Horizontal	363.80 mm
	Vertical	215.90 mm
	Thickness	12.85 mm (Typ)
Bezel Area	Horizontal	346.20 mm
	Vertical	195.60 mm
Active Display Area	Horizontal	344.16 mm
	Vertical	193.59 mm
Weight	706 g (Max.) / 740 g(Typ.)	
Surface Treatment	Anti-Glare treatment of the front polarizer	

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

<FRONT VIEW>

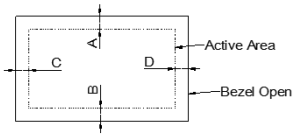

363.0 ±0.5
8.88 ±0.5
107.95 ±0.5
215.9 ±0.5
52 ±0.3
44 ±0.3
12.88 ±0.5
3MI0T-16952A 401
346.2 ±0.5(Bezel Open)
344.16 ±0.5(Active Area)
195.6 ±0.5(Bezel Open)
193.59 (Active Area)
(114.4212)
(1.0158)
(41.44)
(116.4628)
Source COF (3)
Depth Max.=2.1
0.6 ±0.2
CASE TOP
(T=0.4)
9-M3.0 Tapping
4.85
0.3±0.2
SECTION A-A
SCALE 2/1
4-M3.0 Tapping
5.5 ±0.2
Depth Max.=6.3
SECTION B-B
SCALE 2/1

<REAR VIEW>



Notes
1. Unspecified tolerances are to be ` 0.3
2. Tilt and partial disposition tolerance of display area are as following.

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



3. Torque SPEC of Mounting : 3.0~4.0kgf.cm
4. I/F Connector Specification : KN38B-30S-0.5H or Compatible.
5. The LCM warp(warpage) is less than 1.0mm on the surface plate.
6. The COF area is weak and sensitive, so please don't press the COF area.
7. Unspecified height should follow 3D modeling data.

6. Reliability

Environment test condition

No.	Test Item	Conditions
1	High temperature storage test	Ta= 60°C, 240h
2	Low temperature storage test	Ta= -10°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 : 1.00G RMS Bandwidth : 10-300Hz Duration : ±X, ±Y, ±Z, 30 min One time each direction
6	Shock test (non-operating)	Shock level : 120G Waveform : half sine wave, 2ms Direction : ±X, ±Y, ±Z One time each direction
7	Humidity condition Operation	Ta= 40 °C ,90%RH
8	Altitude operating storage / shipment	0 ~ 10,000 feet (3,048m) 24Hr 0 ~ 40,000 feet (12,192m) 24Hr

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 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

8. Packing

8-1. Designation of Lot Mark

a) Lot Mark

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

A,B,C : SIZE(INCH)
E : MONTH
D : YEAR
F ~ M : SERIAL NO.

Note

1. YEAR

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mark	A	B	C	D	E	F	G	H	J	K

2. MONTH

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	A	B	C

b) Location of Lot Mark

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

8-2. Packing Form

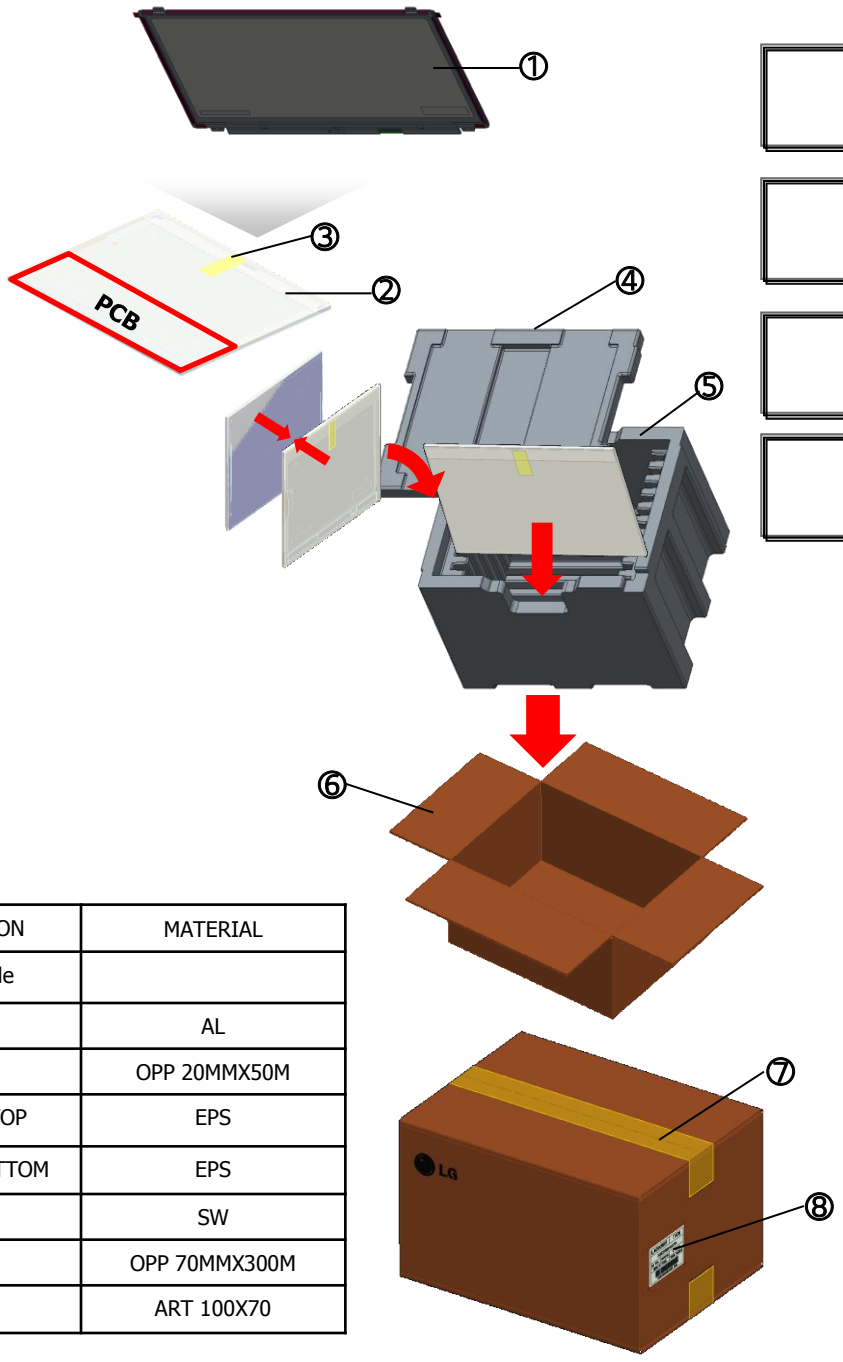
a) Package quantity in one box : 14 pcs

b) Box Size : 478 x 365 x 288

8-2. Packing Assembly

a) Package quantity in one box : 14 pcs

b) Box Size : 478 x 365 x 288



1 LCM / 1 Bag

2 LCM / 1 Slot

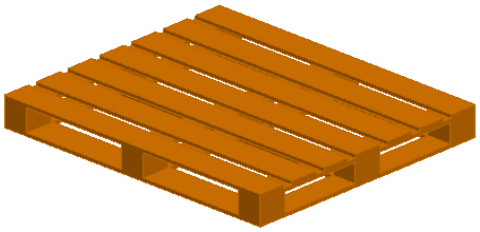
14LCM/Box = 7 Slot

No silica gel in the box

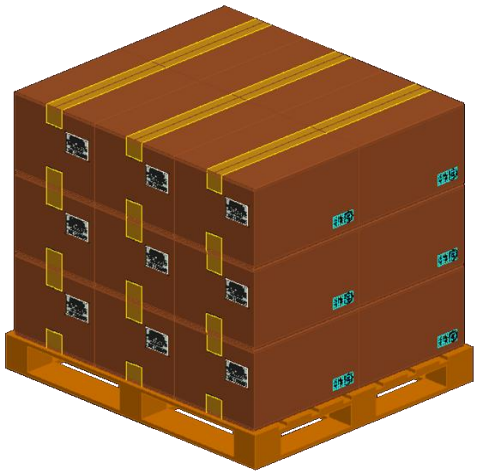
NO.	DESCRIPTION	MATERIAL
1	LCD Module	
2	BAG	AL
3	TAPE	OPP 20MMX50M
4	PACKING, TOP	EPS
5	PACKING, BOTTOM	EPS
6	BOX	SW
7	TAPE	OPP 70MMX300M
8	LABEL	ART 100X70

8-3. Pallet Assembly

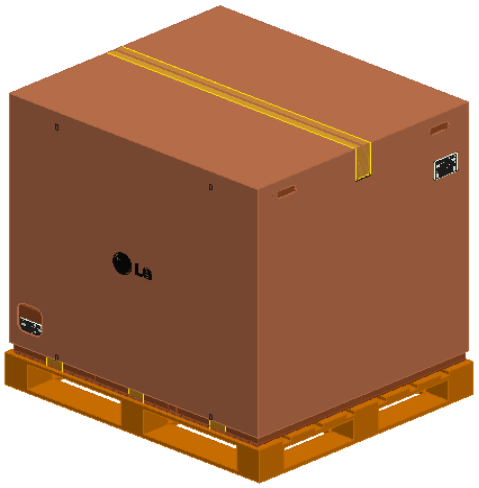
1. Pallet Ready



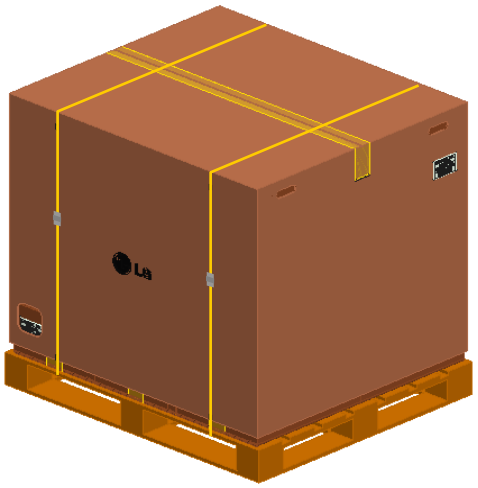
2. 3 x 2 x 3 Box Pattern



3. Angle Packing & Taping



4. Banding



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 Full White PTN 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.