SPECIFICATION
FOR
APPROVAL

(   )   **Preliminary Specification**

(◆)   **Final Specification**

Title	15.4" WUXGA TFT LCD

Customer	General
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LP154WU1
Suffix	TLA2

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

APPROVED BY	SIGNATURE
/	
/	
/	

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

APPROVED BY	SIGNATURE
K.J. Kwon / G.Manager	
REVIEWED BY	
G.J. Han / Manager / Manager	
PREPARED BY	
K.Y. Kwon / Engineer / Engineer	

**Products Engineering Dept.
LG Display Co., Ltd**

Contents

RECORD OF REVISIONS

| Revision No	Revision Date	Page	Description	EDID ver
1.0	June. 4. 2008	-	Final Specification	

Product Specification

1. General Description

The LP154WU1 is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Lamp (CCFL) backlight system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally white mode. This TFT-LCD has 15.4 inches diagonally measured active display area with WUXGA resolution(1200 vertical by 1920 horizontal pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 6-bit gray scale signal for each dot, thus, presenting a palette of more than 262,144 colors.

The LP154WU1 has been designed to apply the interface method that enables low power, high speed, low EMI.

The LP154WU1 is intended to support applications where thin thickness, low power are critical factors and graphic displays are important. In combination with the vertical arrangement of the sub-pixels, the LP154WU1 characteristics provide an excellent flat display for office automation products such as Notebook PC.
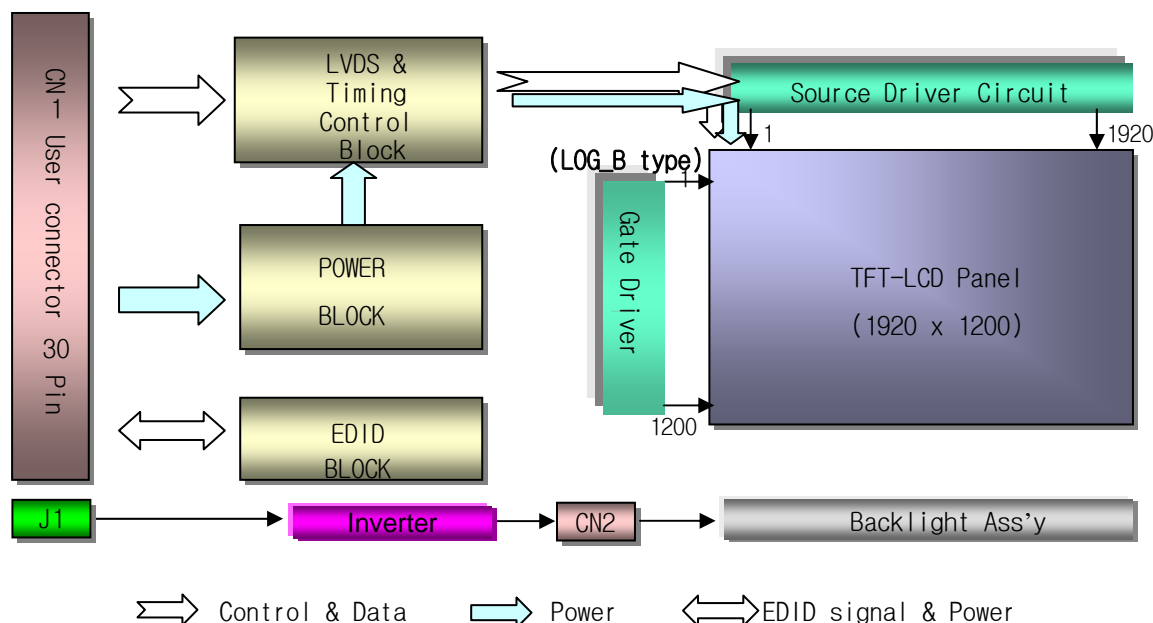
General Features

|	
Active Screen Size	15.4 inches diagonal
Outline Dimension	344.0 (H) × 222.0 (V) × 6.5(D, max) mm
Pixel Pitch	0.1725 mm × 0. 1725 mm
Pixel Format	1920 horiz. by 1200 vert. Pixels RGB strip arrangement
Color Depth	6-bit, 262,144 colors
Luminance, White	220 cd/m^2(Typ.) , 5 point
Power Consumption	Total 5.91 Watt(Typ.) @ LCM circuit 1.49 Watt(Typ.), B/L input 4.42 Watt(Typ.)
Weight	560 g (Max.) without inverter & bracket
Display Operating Mode	Transmissive mode, normally white
Surface Treatment	Glare treatment of the front polarizer
RoHS Comply	Yes

2. Absolute Maximum Ratings

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

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	VCC	-0.3	4.0	Vdc	at 25 $\pm$ 5°C
Operating Temperature	TOP	0	50	°C	1
Storage Temperature	HST	-20	60	°C	1
Operating Ambient Humidity	HOP	10	90	%RH	1
Storage Humidity	HST	10	90	%RH	1

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.

Dry Bulb Temperature [℃]

LG Display

Product Specification
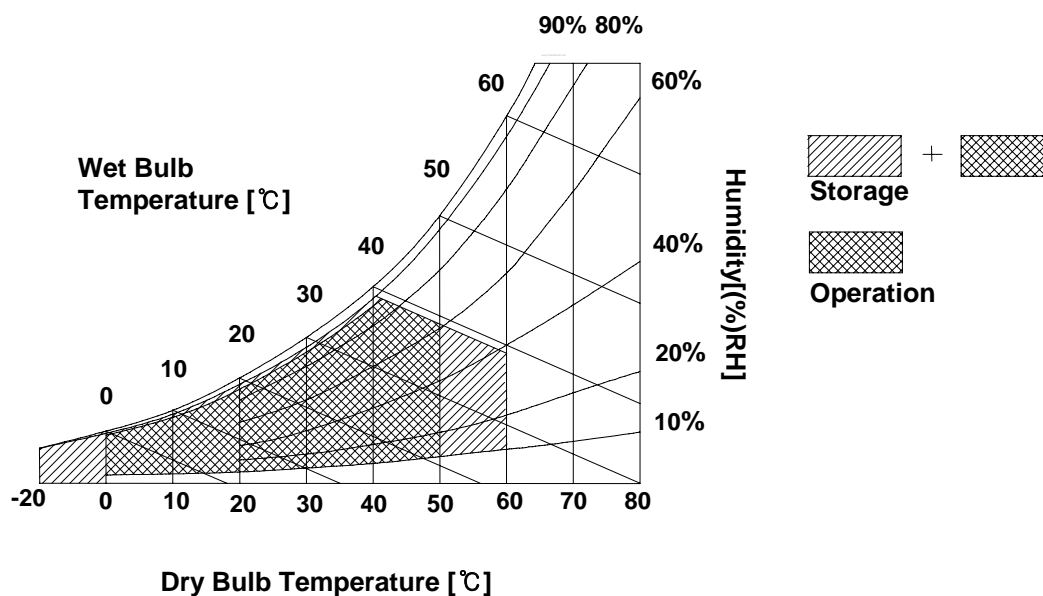
## 3. Electrical Specifications

3-1. Electrical Characteristics

The LP154WU1 requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input which powers the CCFL, is typically generated by an inverter. The inverter is an external unit to the LCD.

Table 2. ELECTRICAL CHARACTERISTICS

Parameter	Symbol		Values Min	Values Typ	Values Max	Unit	Notes
MODULE :							
Power Supply Input Voltage	VCC		3.0	3.3	3.6	V_{DC}	
Power Supply Input Current	I_{CC}	Mosaic	-	450	518	mA	1
Power Consumption	Pc		-	1.49	1.71	Watt	1
Differential Impedance	Zm		90	100	110	Ohm	2
LAMP :							
Operating Voltage	V_{BL}		665(7.0mA)	680(6.5mA)	835(3.0mA)	V_{RMS}	
Operating Current	I_{BL}		3.0	6.5	7.0	mA_{RMS}	3
Power Consumption	P_{BL}		-	4.42	4.7		
Operating Frequency	f_{BL}		45	60	80	kHz	
Discharge Stabilization Time	Ts		-	-	3	Min	4
Life Time			15,000	-	-	Hrs	5
Established Starting Voltage at 25℃ at 0 ℃	Vs				1170 1400	V_{RMS} V_{RMS}	

Note)
1. The specified current and power consumption are under the Vcc = 3.3V , 25℃, fv = 60Hz condition whereas Mosaic pattern is displayed and fv is the frame frequency.
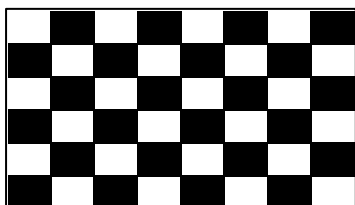

2. This impedance value is needed to proper display and measured form LVDS Tx to the mating connector.
3. The typical operating current is for the typical surface luminance (L_{WH}) in optical characteristics.
4. Define the brightness of the lamp after being lighted for 5 minutes as 100%, Ts is the time required for the brightness of the center of the lamp to be not less than 95%.
5. The life time is determined as the time at which brightness of lamp is 50% compare to that of initial value at the typical lamp current.

Product Specification

Note)
6. The output of the inverter must have symmetrical(negative and positive) voltage waveform and symmetrical current waveform.(Asymmetrical ratio is less than 10%) Please do not use the inverter which has asymmetrical voltage and asymmetrical current and spike wave.
   Lamp frequency may produce interface with horizontal synchronous frequency and as a result this may cause beat on the display. Therefore lamp frequency shall be as away possible from the horizontal synchronous frequency and from its harmonics in order to prevent interference.
7. It is defined the brightness of the lamp after being lighted for 5 minutes as 100%.
   T_S is the time required for the brightness of the center of the lamp to be not less than 95%.
8. The lamp power consumption shown above does not include loss of external inverter.
   The applied lamp current is a typical one.
9. Requirements for a system inverter design, which is intended to have a better display performance, a better power efficiency and a more reliable lamp, are following.
   It shall help increase the lamp lifetime and reduce leakage current.
         a. The asymmetry rate of the inverter waveform should be less than 10%.
         b. The distortion rate of the waveform should be within $\sqrt{2} \pm 10\%$.
            * Inverter output waveform had better be more similar to ideal sine wave.
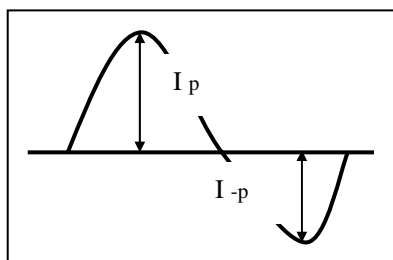

* Asymmetry rate:

$$| I_p - I_{-p} | / I_{rms} * 100\%$$

* Distortion rate

$$I_p \text{ (or } I_{-p}) / I_{rms}$$

10. Inverter open voltage must be more than lamp voltage for more than 1 second for start-up.
    Otherwise, the lamps may not be turned on.
    ※ Do not attach a conducting tape to lamp connecting wire.
       If the lamp wire attach to a conducting tape, TFT-LCD Module has a low luminance and the inverter has abnormal action. Because leakage current is occurred between lamp wire and conducting tape.
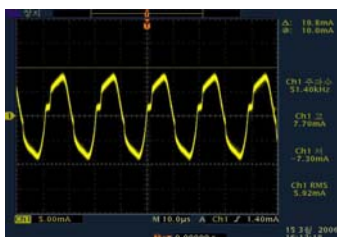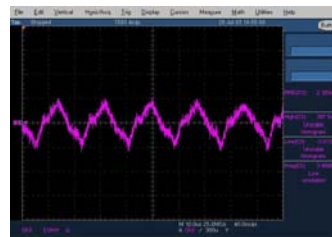
Ex of current wave)
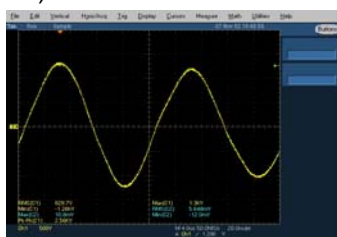
Normal current wave - Standard
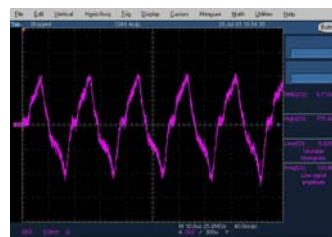
Abnormal current wave - Bad

Abnormal current wave - Bad

Abnormal current wave - Bad
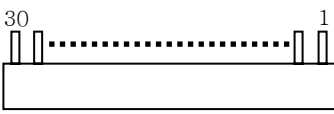
3-2. Interface Connections

This LCD employs two interface connections, a 30 pin connector is used for the module electronics interface and the other connector is used for the integral backlight system.
The electronics interface connector is a model GT101-30S-HR11 manufactured by LSC.

Table 3. MODULE CONNECTOR PIN CONFIGURATION (CN1)

Pin	Symbol	Description	Notes
1	GND	Ground	
2	VCC	Power Supply, 3.3V Typ.	
3	VCC	Power Supply, 3.3V Typ.	
4	V EEDID	DDC 3.3V power	1, Interface chips
5	NC	Reserved for supplier test point	Siw, 2port LVDS Receiver
6	Clk EEDID	DDC Clock	
7	DATA EEDID	DDC Data	
8	$R_{IN}0-$	Odd channel differential data input	2. Connector
9	$R_{IN}0+$	Odd channel differential data input	2.1 LCD : FI-XB30SRL-HF11 (JAE)
10	GND	Ground	or
11	$R_{IN}1-$	Odd channel differential data input	its compatibles
12	$R_{IN}1+$	Odd channel differential data input	2.2 Mating : FI-X30M or equivalent.
13	GND	Ground	2.3 Connector pin arrangement
14	$R_{IN}2-$	Odd channel differential data input	
15	$R_{IN}2+$	Odd channel differential data input	
16	GND	Ground	
17	CLKIN−	Odd channel differential clock input	
18	CLKIN+	Odd channel differential clock input	[LCD Module Rear View]
19	GND	Ground	
20	RA2−	Even channel differential data input	
21	RA2+	Even channel differential data input	
22	GND	Ground	
23	RB2−	Even channel differential data input	
24	RB2+	Even channel differential data input	
25	GND	Ground	
26	RC2−	Even channel differential data input	
27	RC2+	Even channel differential data input	
28	GND	Ground	
29	RCLK2−	Even channel differential clock input	
30	RCLK2+	Even channel differential clock input	

The backlight interface connector is a model BHSR-02VS-1, manufactured by JST or Compatible.
The mating connector part number is SM02B-BHSS-1 or equivalent.
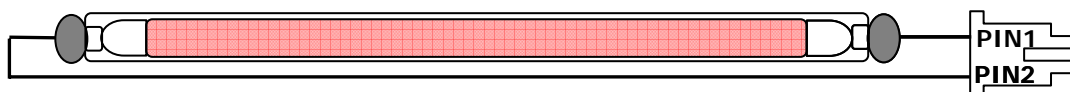
Table 4. BACKLIGHT CONNECTOR PIN CONFIGURATION (J3)

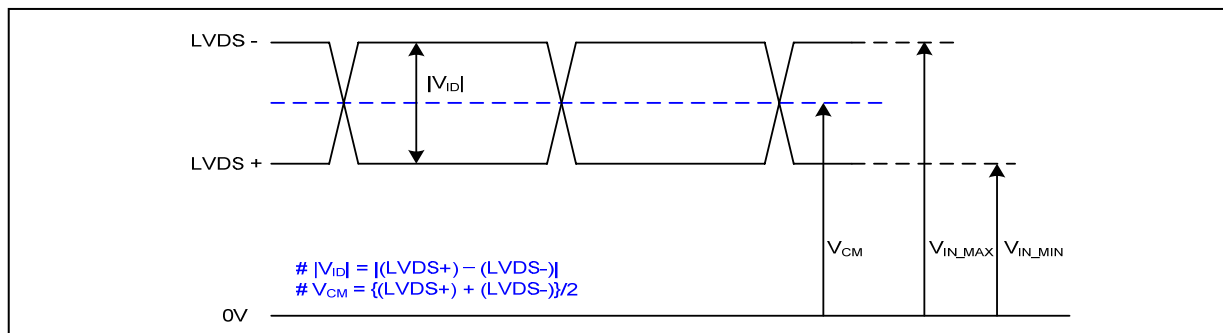| Pin	Symbol	Description	Notes
1	HV	Power supply for lamp (High voltage side)	1
2	LV	Power supply for lamp (Low voltage side)	1

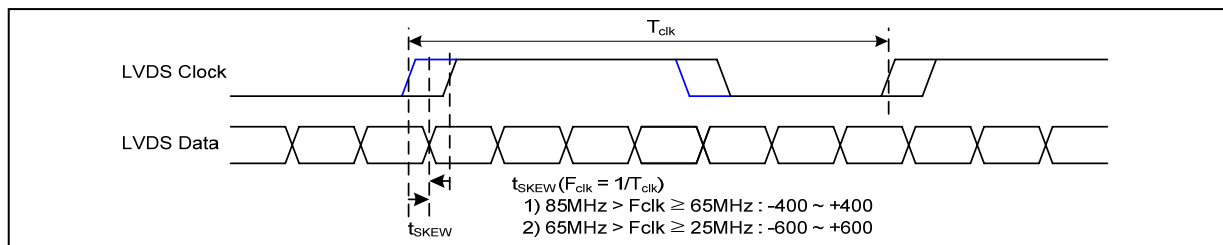Notes : 1. The high voltage side terminal is colored white and the low voltage side terminal is black.

3-3. LVDS Signal Timing Specifications

3-3-1. DC Specification

$|V_{ID}|$ = |(LVDS+) − (LVDS−)|
V_{CM} = {(LVDS+) + (LVDS−)}/2

Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$|V_{ID}|$	100	600	mV	-
LVDS Common mode Voltage	V_{CM}	0.6	1.8	V	-
LVDS Input Voltage Range	V_{IN}	0.3	2.1	V	-

3-3-2. AC Specification

$t_{SKEW} (F_{clk} = 1/T_{clk})$
1) 85MHz > Fclk ≥ 65MHz : −400 ~ +400
2) 65MHz > Fclk ≥ 25MHz : −600 ~ +600

Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	- 400	+ 400	ps	85MHz > Fclk ≥ 65MHz
	t_{SKEW}	- 600	+ 600	ps	65MHz > Fclk ≥ 25MHz
LVDS Clock to Clock Skew Margin (Even to Odd)	t_{SKEW_EO}	- 1/7	+ 1/7	T_{clk}	-
Maximum deviation of input clock frequency during SSC	F_{DEV}	-	± 3	%	-
Maximum modulation frequency of input clock during SSC	F_{MOD}	-	200	KHz	-

Product Specification
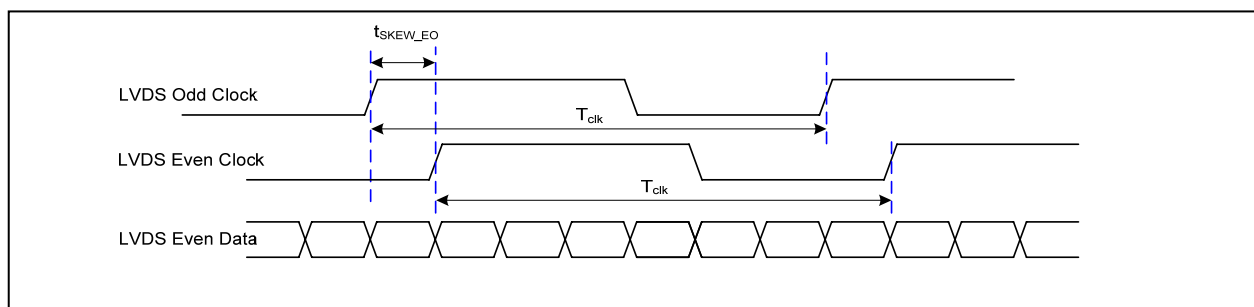
< Clock skew margin between channel >
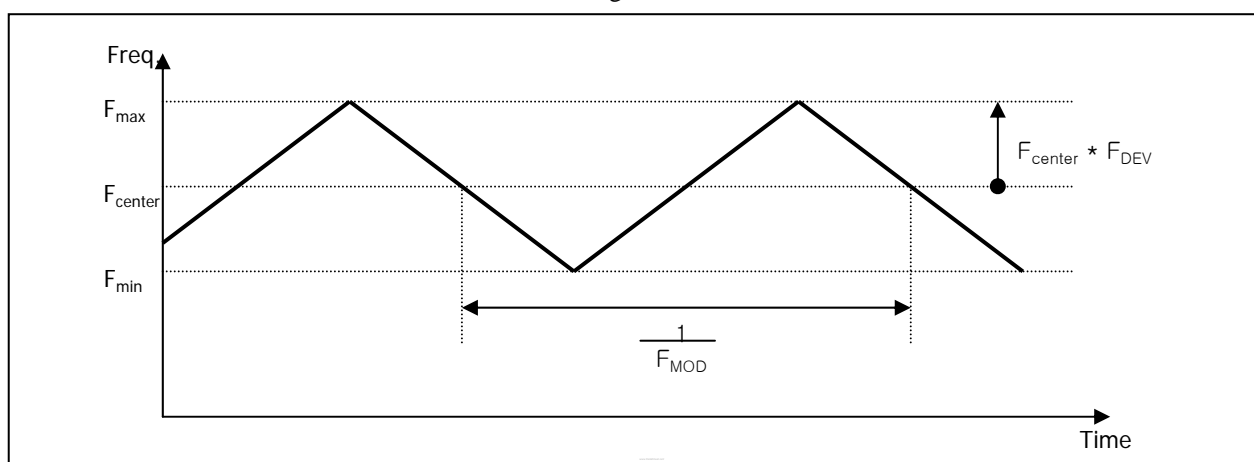
< Spread Spectrum >

3-3-3. Data Format

1) LVDS 2 Port

< LVDS Data Format >

2) LVDS 1 Port

RCLK+														
RA+/-	R3	R2	R1	R0	G0	R5	R4	R3	R2	R1	R0	G0	R5	R4
RB+/-	G4	G3	G2	G1	B1	B0	G5	G4	G3	G2	G1	B1	B0	G5
RC+/-	B5	B4	B3	B2	DE	VSYNC	HSYNC	B5	B4	B3	B2	DE	VSYNC	HSYNC
RD+/-	G7	G6	R7	R6	X	B7	B6	G7	G6	R7	R6	X	B7	B6

—— Previous (N-1)th Cycle ——✕—— Current (Nth) Cycle ——✕— Next (N+1)th Cycle —
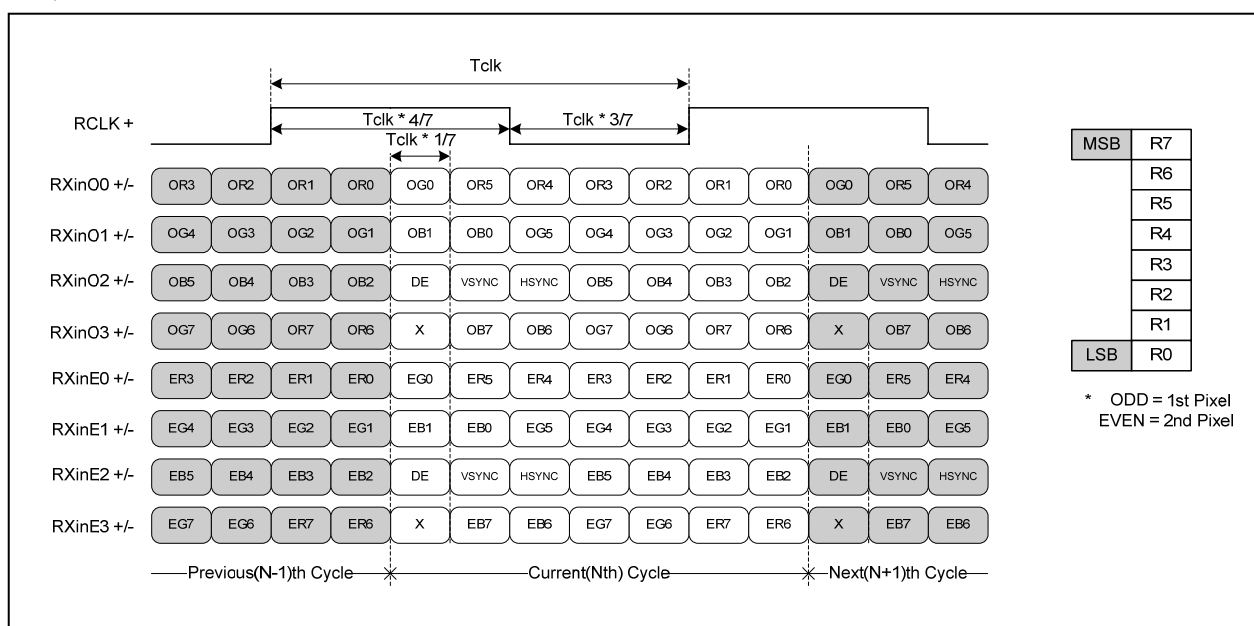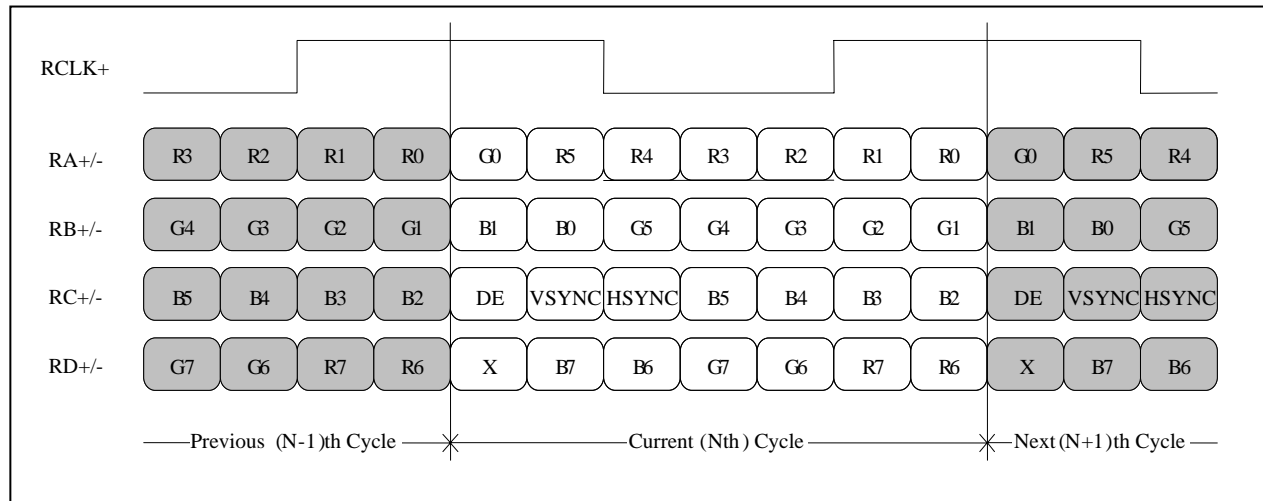
3-4. Signal Timing Specifications

This is the signal timing required at the input of the User connector. All of the interface signal timing should be satisfied with the following specifications and specifications of LVDS Tx/Rx for its proper operation.

Table 6. TIMING TABLE

ITEM	Symbol		Min	Typ	Max	Unit	Note
DCLK	Frequency	f_{CLK}	-	82.45	-	MHz	
Hsync	Period	Thp	990	1005	1040	tCLK	
	Width	t_{WH}	10	15	50		
	Width-Active	t_{WHA}	960	960	960		
Vsync	Period	t_{VP}	1207	1250	1400	tHP	
	Width	t_{WV}	1	3	25		
	Width-Active	t_{WVA}	1200	1200	1200		
Data Enable	Horizontal back porch	t_{HBP}	10	-	-	tCLK	
	Horizontal front porch	t_{HFP}	10	-	-		
	Vertical back porch	t_{VBP}	5	-	-	tHP	
	Vertical front porch	t_{VFP}	1	-	-		

3-5. Signal Timing Waveforms

Condition : VCC =3.3V

Data Enable, Hsync, Vsync

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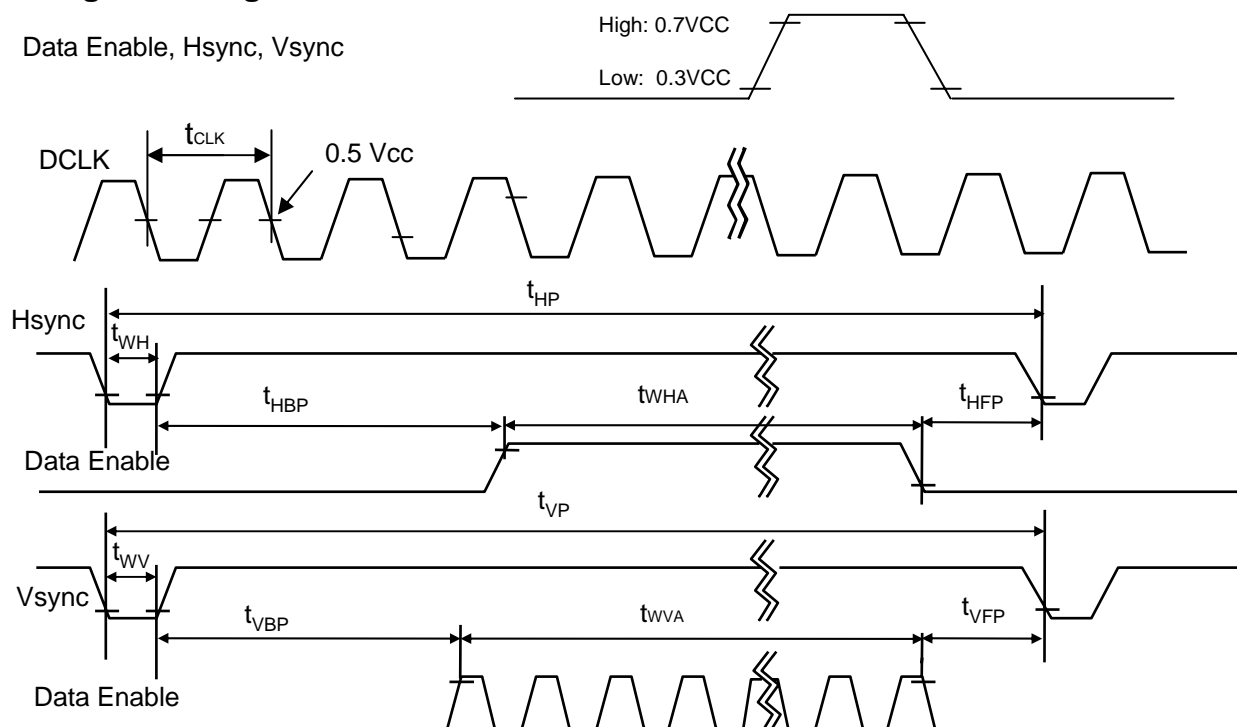
3-6. Color Input Data Reference

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 7. COLOR DATA REFERENCE

Color		Input Color Data																			
		RED						GREEN						BLUE					
		MSB					LSB	MSB					LSB	MSB					LSB
		R 5	R 4	R 3	R 2	R 1	R 0	G 5	G 4	G 3	G 2	G 1	G 0	B 5	B 4	B 3	B 2	B 1	B 0
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

3-7. Power Sequence
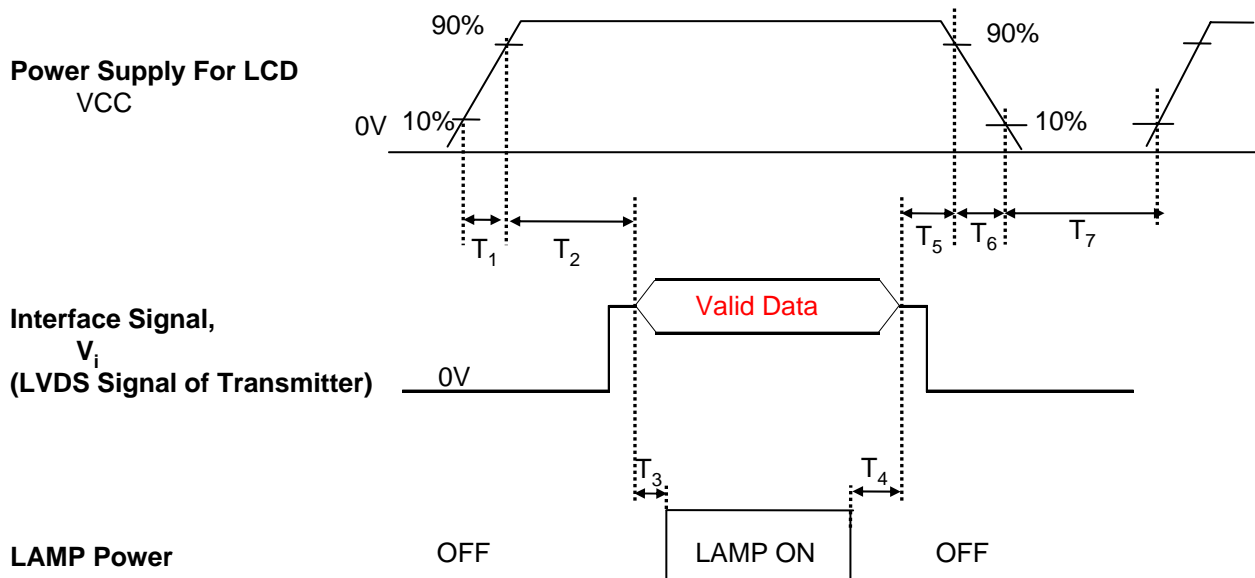
Table 8. POWER SEQUENCE TABLE

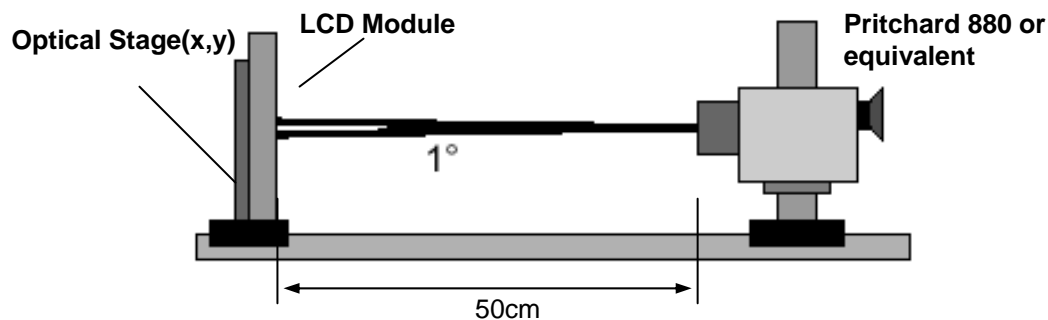| Parameter	Value			Units
	Min.	Typ.	Max.	
T_1	0	-	10	(ms)
T_2	0	-	50	(ms)
T_3	200	-	-	(ms)
T_4	200	-	-	(ms)
T_5	0	-	50	(ms)
T_6	0	-	10	(ms)
T_7	400	-	-	(ms)

Note)
1. Valid Data is Data to meet "3-3. LVDS Signal Timing Specifications"
2. Please avoid floating state of interface signal at invalid period.
3. When the interface signal is invalid, be sure to pull down the power supply for LCD VCC to 0V.
4. Lamp power must be turn on after power supply for LCD and interface signal are valid.

LG Display

4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' and stable for approximately 30 minutes in a dark environment at 25°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°.
FIG. 1 presents additional information concerning the measurement equipment and method.

FIG. 1 Optical Characteristic Measurement Equipment and Method

Table 9. OPTICAL CHARACTERISTICS

Ta=25°C, VCC=3.3V, f$_V$=60Hz, f$_{CLK}$= 150.75MHz, F$_{BL}$ = 60KHz , I$_{BL}$= 6.5mA

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	500	-	-		1
Surface Luminance, white		L$_{WH}$	200	220	-	cd/m^2	2
Luminance Variation		δ WHITE	-	-	2.0		3
Response Time		Tr$_R$ $_+$Tr$_D$	-	16	30	ms	4
Color Coordinates							±0.03
	RED	RX	0.566	0.596	0.626		
		RY	0.321	0.351	0.381		
	GREEN	GX	0.293	0.323	0.353		
		GY	0.519	0.549	0.579		
	BLUE	BX	0.128	0.158	0.188		
		BY	0.118	0.148	0.178		
	WHITE	WX	0.283	0.313	0.343		
		WY	0.299	0.329	0.359		
Viewing Angle							5
	x axis, right(Φ=0°)	Θr	60	-	-	degree	
	x axis, left (Φ=180°)	Θl	60	-	-	degree	
	y axis, up (Φ=90°)	Θu	40	-	-	degree	
	y axis, down (Φ=270°)	Θd	50	-	-	degree	
Gray Scale							

Product Specification

Note)
1. Contrast Ratio(CR) is defined mathematically as

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

2. Surface luminance is the average of 5 point across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 1.

$$L_{WH} = \text{Average}(L_1, L_2, \ldots L_5)$$

3. The variation in surface luminance , The panel total variation (δ_{WHITE}) is determined by measuring L_N at each test position 1 through 13 and then defined as followed numerical formula. For more information see FIG 2.

$$\delta_{WHITE} = \frac{\text{Maximum}(L_1, L_2, \ldots L_{13})}{\text{Minimum}(L_1, L_2, \ldots L_{13})}$$

4. Response time is the time required for the display to transition from white to black (rise time, Tr_R) and from black to white(Decay Time, Tr_D). For additional information see FIG 3.

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 4.
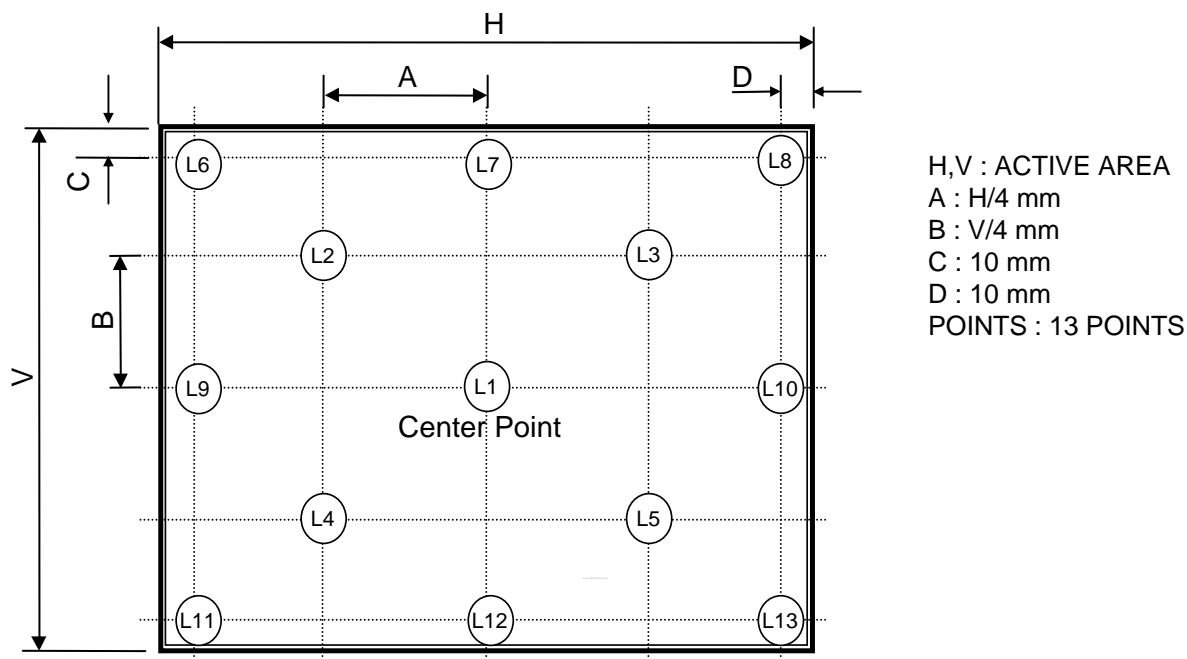
6. Gray scale specification   * f_V = 60Hz

Gray Level	Luminance [%] (Typ)
L0	0.1
L7	2.0
L15	7.6
L23	15.7
L31	25.6
L39	39.0
L47	55.6
L55	76.2
L63	100

FIG. 2 Luminance

<measuring point for surface luminance & measuring point for luminance variation>

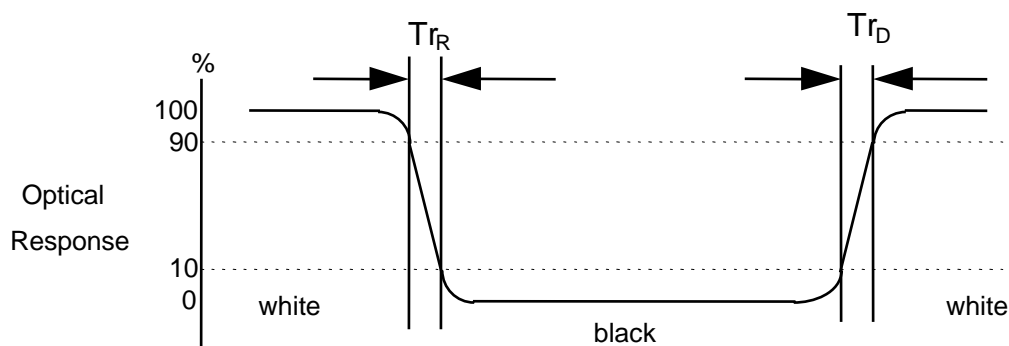H,V : ACTIVE AREA
A : H/4 mm
B : V/4 mm
C : 10 mm
D : 10 mm
POINTS : 13 POINTS

FIG. 3 Response Time

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

5. Mechanical Characteristics

The contents provide general mechanical characteristics for the model LP154WU1. In addition the figures in the next page are detailed mechanical drawing of the LCD.

|		
Outline Dimension	Horizontal	344.0 $\pm$ 0.5mm
	Vertical	222.0 $\pm$ 0.5mm
	Depth	6.2(typ) $\pm$ 0.3mm
Bezel Area	Horizontal	335.0 $\pm$ 0.5mm
	Vertical	210.7 $\pm$ 0.5mm
Active Display Area	Horizontal	331.2 mm
	Vertical	207.0 mm
Weight	560 g (Max.) without inverter & bracket	
Surface Treatment	Glare treatment of the front polarizer	

Product Specification

<FRONT VIEW>

Note) Unit:[mm], General tolerance: ± 0.5mm

Product Specification
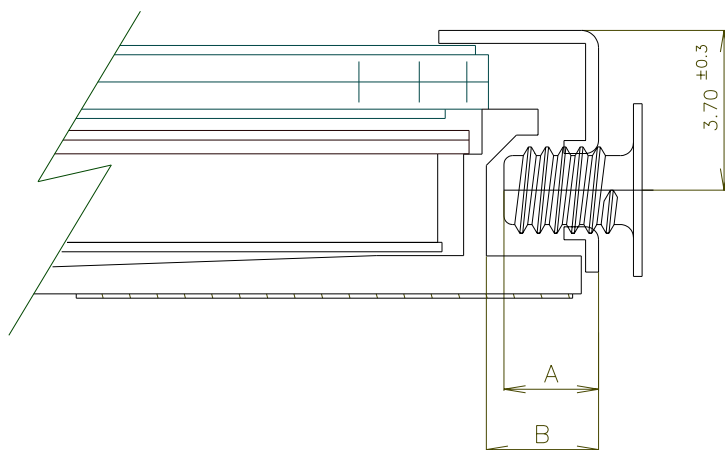
<REAR VIEW>
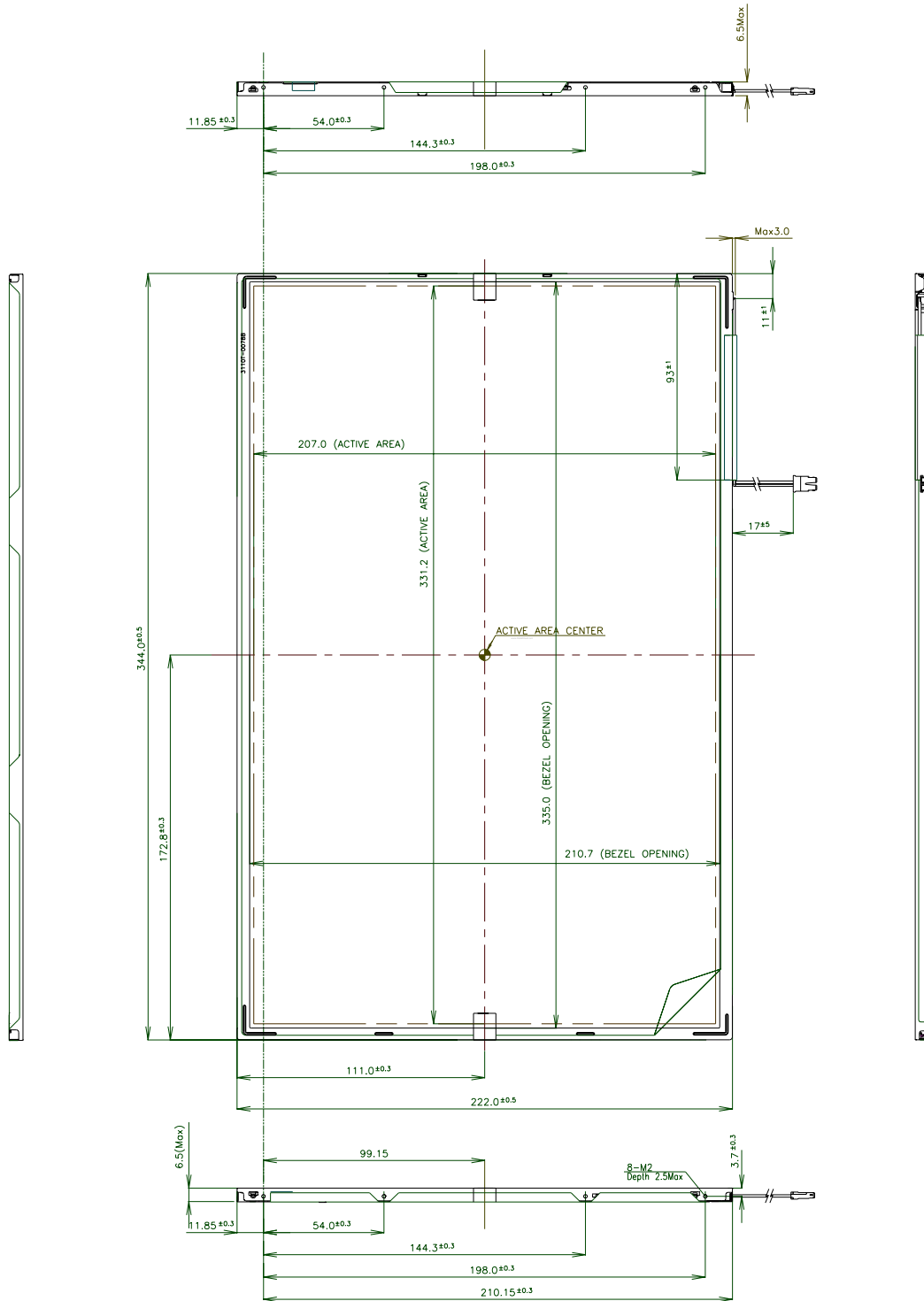
Note) Unit:[mm], General tolerance: ± 0.5mm
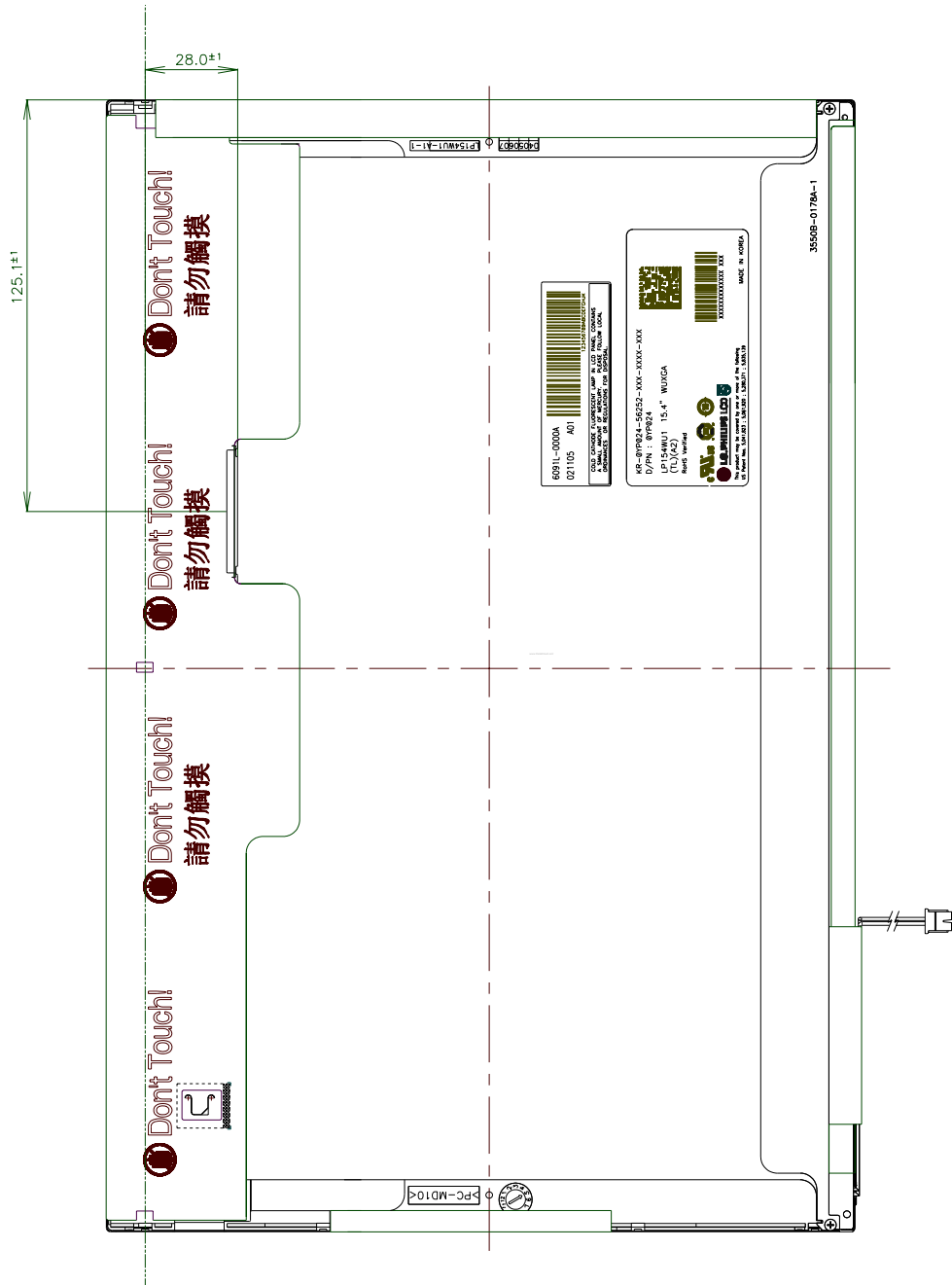
Product Specification

[DETAIL DESCRIPTION OF SIDE MOUNTING SCREW]

* Mounting Screw Length (A)
    = 2.0(Min) / 2.5(Max)
* Mounting Screw Hole Depth (B)
    = 2.5(Min)
* Mounting hole location : 3.7(typ.)
* Torque : 2.5 kgf.cm(Max)
  (Measurement gauge : torque meter)

Notes : 1. Screw plated through the method of non-electrolytic nickel plating is preferred
           to reduce possibility that results in vertical and/or horizontal line defect due to
           the conductive particles from screw surface.

[DETAIL INFORMATION OF PPID LABEL AND REVISION CODE]
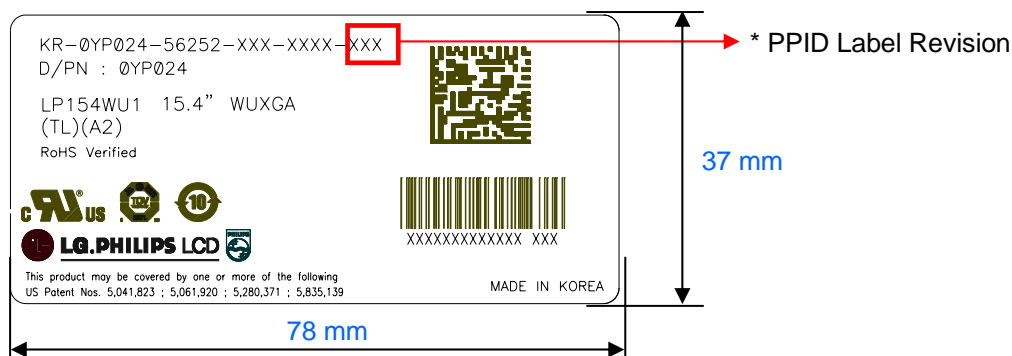
* PPID Label Revision :
   It is subject to change with Dell event. Please refer to the below table for detail.

Classification	No Change	1st Revision	2nd Revision	…	9th Revision	…
SST(WS)	X00	X01	X02	…	A09	…
PT(ES)	X10	X11	X12	…	A19	…
ST(CS)	X20	X21	X22	…	A29	…
XB(MP)	A00	A01	A02	…	A09	…