

SPECIFICATION FOR APPROVAL

() Preliminary Specification

(●) Final Specification

Title	65.0" WUXGA TFT LCD
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BUYER	Eunpa
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LD650EUF
SUFFIX	FHB1 (RoHS Verified)

APPROVED BY	SIGNATURE	DATE
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/		

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

APPROVED BY	SIGNATURE	DATE
Hong Sung Song / Team Leader		
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PREPARED BY Dong Uk Lee / Engineer		

TV Product Development Dept.
LG Display Co., Ltd.

Product Specification

CONTENTS

Number	ITEM	Page
	COVER	1
	CONTENTS	2
	RECORD OF REVISIONS	3
1	GENERAL DESCRIPTION	4
2	ABSOLUTE MAXIMUM RATINGS	5
3	ELECTRICAL SPECIFICATIONS	6
3-1	ELECTRICAL CHARACTERISTICS	6
3-2	INTERFACE CONNECTIONS	8
3-3	SIGNAL TIMING SPECIFICATIONS	11
3-4	LVDS SIGNAL SPECIFICATION	13
3-5	COLOR DATA REFERENCE	16
3-6	POWER SEQUENCE	17
4	OPTICAL SPECIFICATIONS	18
5	MECHANICAL CHARACTERISTICS	24
6	Mechanical Dimension	25
7	RELIABILITY	26
8	INTERNATIONAL STANDARDS	27
8-1	SAFETY	27
8-2	ENVIRONMENT	27
9	PACKING	28
9-1	DESIGNATION OF LOT MARK	28
9-2	PACKING FORM	28
10	PRECAUTIONS	29
10-1	MOUNTING PRECAUTIONS	29
10-2	OPERATING PRECAUTIONS	29
10-3	ELECTROSTATIC DISCHARGE CONTROL	30
10-4	PRECAUTIONS FOR STRONG LIGHT EXPOSURE	30
10-5	Storage	30

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Product Specification

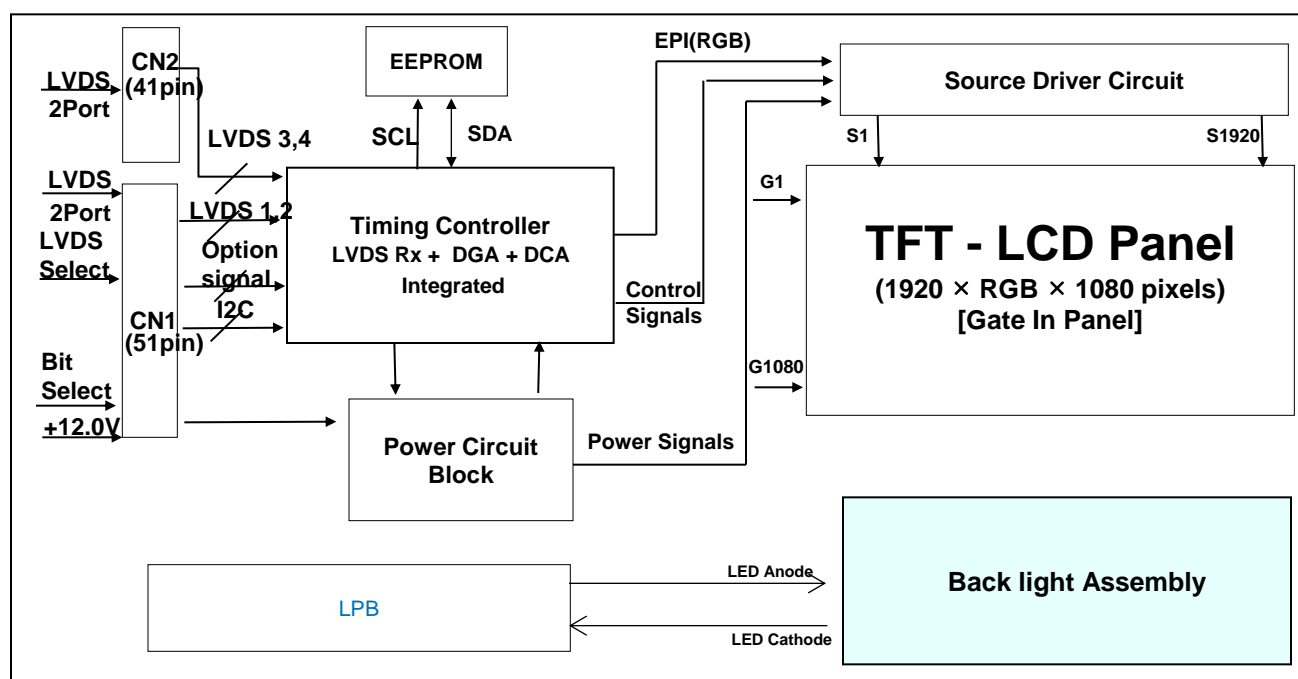
1. General Description

The LD650EUF is a Color Active Matrix Liquid Crystal Display with an integral Light Emitting Diode (LED) backlight system. The matrix employs a-Si Thin Film Transistor as the active element.

It is a transmissive display type which is operating in the normally black mode. It has a 64.53 inch diagonally measured active display area with WUXGA resolution (1080 vertical by 1920 horizontal pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arrayed in vertical stripes. Gray scale or the luminance of the sub-pixel color is determined with a 10-bit gray scale signal for each dot. Therefore, it can present a palette of more than 1.06 Billion colors.

It has been designed to apply the 10-bit 4-port LVDS interface.

It is intended to support Commercial Display where high brightness, super wide viewing angle, high color gamut, high color depth and fast response time are important.



General Features

Active Screen Size	64.53 inches(1639.062mm) diagonal
Outline Dimension	1450.9(H) x 832.0(V) x 16.5(D) mm (Typ.)
Pixel Pitch	0.744 mm x 0.744 mm
Pixel Format	1920 horiz. by 1080 vert. Pixels, RGB stripe arrangement
Color Depth	10bit(D), 1.06 Billion colors
Luminance, White	450 cd/m ² (Center 1point ,Typ.)
Viewing Angle (CR>10)	Viewing angle free (R/L 178 (Min.), U/D 178 (Min.))
Power Consumption	Total 83.81 W (Typ.) [Logic= 3.71 W(Typ) 4.83W(Max), Backlight=80.1W (Typ.) 87.9W(Max)]
Weight	22.3Kg (Typ.), 23 kg (Max.)
Display Mode	Transmissive mode, Normally black
Surface Treatment	Hard coating(3H), Anti-glare treatment of the front polarizer (Haze 1%(Typ.))
Possible Display Type	Landscape and Portrait Enabled

Product Specification

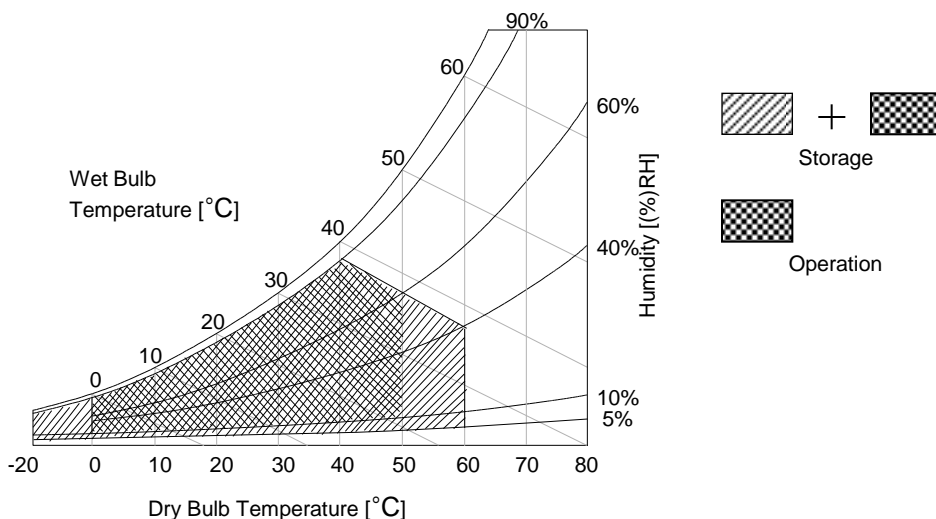
2. Absolute Maximum Ratings

The following items are maximum values which, if exceeded, may cause faulty operation or permanent damage to the LCD module.

Table 1. ABSOLUTE MAXIMUM RATINGS (Only Panel and Circuit Part of LCD Module)

Parameter		Symbol	Value		Unit	Note
			Min	Max		
Power Input Voltage	LCD Circuit	VLCD	-0.3	+14.0	VDC	1
LED Input Voltage	LED Input Voltage 1	VF	-	254.08	VDC	
	LED Input Voltage 2		-	254.08		
T-Con Option Selection Voltage		VLOGIC	-0.3	+4.0	VDC	
Operating Temperature		TOP	0	+50	°C	2,3
Storage Temperature		TST	-20	+60	°C	
Panel Front Temperature		TSUR	-	+68	°C	4
Operating Ambient Humidity		HOP	10	90	%RH	2,3
Storage Humidity		HST	5	90	%RH	

1. Ambient temperature condition ($T_a = 25 \pm 2 \text{ }^\circ\text{C}$)
2. Temperature and relative humidity range are shown in the figure below.
Wet bulb temperature should be Max 39°C, and no condensation of water.
3. Gravity mura can be guaranteed below 40°C condition.
4. The maximum operating temperatures is based on the test condition that the surface temperature of display area is less than or equal to 68°C with LCD module alone in a temperature controlled chamber. Thermal management should be considered in final product design to prevent the surface temperature of display area from being over 68°C. The range of operating temperature may be degraded in case of improper thermal management in final product design.



Product Specification

3. Electrical Specifications

3-1. Electrical Characteristics

It requires two power inputs. One is employed to power for the LCD circuit. The other is used for the LED backlight.

Table 2. ELECTRICAL CHARACTERISTICS

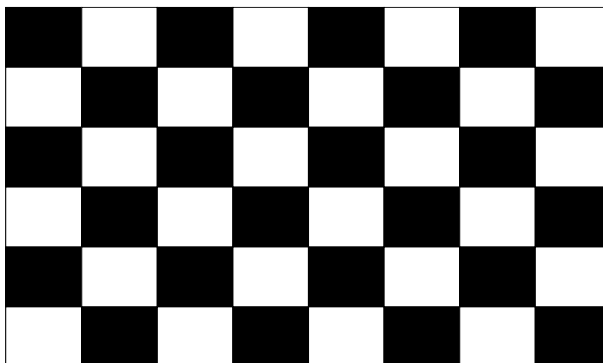
Parameter		Symbol	Value			Unit	Note
			Min	Typ	Max		
Circuit :							
Power Input Voltage		VLCD	10.8	12.0(12.7)	14	VDC	5
Power Input Current		ILCD	-	309(300)	402	mA	1
			-	850(816)	1105	mA	2
T-CON Option Selection Voltage	Input High Voltage	V _{IH}	2.7	-	3.6	VDC	
	Input Low Voltage	V _{IL}	0	-	0.7	VDC	
Power Consumption		PLCD	-	3.71(3.6)	4.83(4.68)	Watt	1
Rush current		IRUSH	-	-	5.0	A	3

notes

1. The specified current and power consumption are under the V_{LCD}=12.0V, Ta=25 ± 2°C, f_V=120Hz condition, and mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
2. The current is specified at the maximum current pattern.
3. The duration of rush current is about 2ms and rising time of power input is 0.5ms (min.).
4. Ripple voltage level is recommended under ±5% of typical voltage.
5. Maximum of Power Input Voltage is included with ripple.

White : 255 Gray

Black : 0 Gray



Mosaic Pattern(8 x 6)

Product Specification

Table 3. ELECTRICAL CHARACTERISTICS (Continue) :

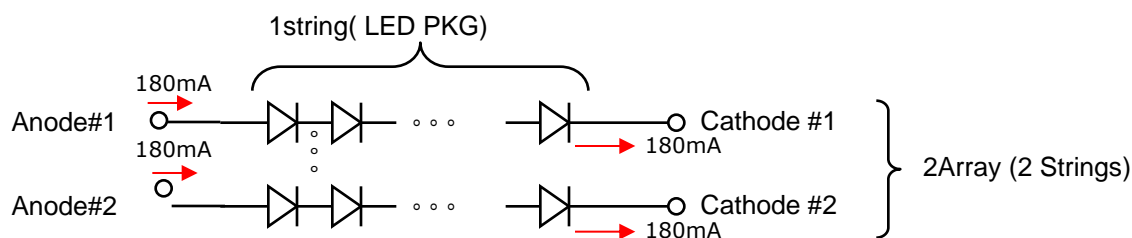
Parameter		Symbol	Values			Unit	Note
			Min	Typ	Max		
Backlight Assembly :							
Forward Current (one array)	Anode	I _{F (anode)}	-	180	-	mAdc	±5% 2, 3
Forward Voltage		V _F	220.32	222.5	244.08	Vdc	4
Forward Voltage Variation		△V _F	- -	- -	5.5	Vdc	5
Power Consumption		P _{BL}	-	80.1	87.9	W	6
Burst Dimming Duty		On duty	1		100	%	
Burst Dimming Frequency		1/T	95		182	Hz	8
LED Array :							
Life Time			30,000	50,000		Hrs	7

Notes :

The design of the LED driver must have specifications for the LED array in LCD Assembly. The electrical characteristics of LED driver are based on Constant Current driving type. The performance of the LED in LCM, for example life time or brightness, is extremely influenced by the characteristics of the LED Driver. So, all the parameters of an LED driver should be carefully designed. When you design or order the LED driver, please make sure unwanted lighting caused by the mismatch of the LED and the driver (no lighting, flicker, etc) has never been occurred. When you confirm it, the LCD-Assembly should be operated in the same condition as installed in your instrument.

1. Electrical characteristics are based on LED Array specification.
2. Specified values are defined for a Backlight Assembly. (2LED array/LCM)
3. Each LED array has 1 anode terminal and 1 cathode terminal

The forward current(I_F) of the anode terminal is 180mA and it supplies 180mA into 2 strings, respectively



4. The forward voltage(V_F) of LED array depends on ambient temperature
 5. ΔV_F means Max string V_F – Min string V_F in one Backlight. So V_F variation in a Backlight isn't over Max. 5.5V
 6. Maximum level of power consumption is measured at initial turn on.
Typical level of power consumption is measured after 1hrs aging at $25 \pm 2^\circ\text{C}$.
 7. The life time(MTTF) is determined as the time at which brightness of the LED is 50% compared to that of initial value at the typical LED current on condition of continuous operating at $25 \pm 2^\circ\text{C}$, based on duty 100%.
 8. The reference method of burst dimming duty ratio.
- It is recommended to use synchronous V-sync frequency to prevent waterfall ($V_{\text{sync}} \times 1 = \text{Burst Frequency}$)
Though PWM frequency is over 182Hz (max252Hz), function of backlight is not affected.

Product Specification

3-2. Interface Connections

This LCD module employs two kinds of interface connection, 51-pin connector and 41-pin connector are used for the module electronics and 13-pin connector is used for the integral backlight system.

3-2-1. LCD Module

- LCD Connector(CN1): FI-RXE51S-HF(manufactured by JAE)
- GT05S-51S-H38(manufactured by LSM)
- IS050-C51B-C39-C(manufactured by UJU)

Table 4. MODULE CONNECTOR(CN1) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	NC	No Connection (notes 4)	27	Bit Select	'H' or NC= 10bit(D) , 'L' = 8bit
2	NC	No Connection (notes 4)	28	R2AN	SECOND LVDS Receiver Signal (A-)
3	NC	No Connection (notes 4)	29	R2AP	SECOND LVDS Receiver Signal (A+)
4	NC	No Connection (notes 4)	30	R2BN	SECOND LVDS Receiver Signal (B-)
5	NC	No Connection (notes 4)	31	R2BP	SECOND LVDS Receiver Signal (B+)
6	NC	No Connection (notes 4)	32	R2CN	SECOND LVDS Receiver Signal (C-)
7	LVDS Select	'H' =JEIDA , 'L' or NC = VESA	33	R2CP	SECOND LVDS Receiver Signal (C+)
8	NC	No Connection (notes 4)	34	GND	Ground
9	NC	No Connection (notes 4)	35	R2CLKN	SECOND LVDS Receiver Clock Signal(-)
10	NC	No Connection (notes 4)	36	R2CLKP	SECOND LVDS Receiver Clock Signal(+)
11	GND	Ground	37	GND	Ground
12	R1AN	FIRST LVDS Receiver Signal (A-)	38	R2DN	SECOND LVDS Receiver Signal (D-)
13	R1AP	FIRST LVDS Receiver Signal (A+)	39	R2DP	SECOND LVDS Receiver Signal (D+)
14	R1BN	FIRST LVDS Receiver Signal (B-)	40	R2EN	SECOND LVDS Receiver Signal (E-)
15	R1BP	FIRST LVDS Receiver Signal (B+)	41	R2EP	SECOND LVDS Receiver Signal (E+)
16	R1CN	FIRST LVDS Receiver Signal (C-)	42	NC or GND	No Connection or Ground
17	R1CP	FIRST LVDS Receiver Signal (C+)	43	NC or GND	No Connection or Ground
18	GND	Ground	44	GND	Ground (notes 6)
19	R1CLKN	FIRST LVDS Receiver Clock Signal(-)	45	GND	Ground
20	R1CLKP	FIRST LVDS Receiver Clock Signal(+)	46	GND	Ground
21	GND	Ground	47	NC	No connection
22	R1DN	FIRST LVDS Receiver Signal (D-)	48	VLCD	Power Supply +12.0V
23	R1DP	FIRST LVDS Receiver Signal (D+)	49	VLCD	Power Supply +12.0V
24	R1EN	FIRST LVDS Receiver Signal (E-)	50	VLCD	Power Supply +12.0V
25	R1EP	FIRST LVDS Receiver Signal (E+)	51	VLCD	Power Supply +12.0V
26	NC or GND	No Connection or Ground	-	-	-

notes

1. All GND (ground) pins should be connected together to the LCD module's metal frame.
2. All V_{LCD} (power input) pins should be connected together.
3. All Input levels of LVDS signals are based on the **EIA 644** Standard.
4. #1~#6 & #8~#10 NC (No Connection): These pins are used only for LGD (Do not connect)
5. LVDS pin (pin No. **#24,25,40,41**) are used for 10Bit(D) of the LCD module.
If used for 8Bit(R), these pins are no connection.
6. Specific pin No. **#44** is used for "No signal detection" of system signal interface.
It should be GND for NSB (No Signal Black) while the system interface signal is not.
If this pin is "H", LCD Module displays AGP (Auto Generation Pattern).

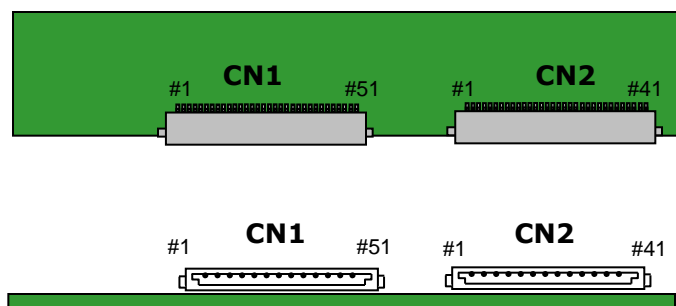
Product Specification

- LCD Connector(CN2): FI-RX41S-HF(manufactured by JAE)
 GT05S-41S-H38(manufactured by LSM)
 IS050-C41B-C39-C(manufactured by UJU)

Table 4-2. MODULE CONNECTOR(CN2) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	NC	No connection	22	RE3N	THIRD LVDS Receiver Signal (E-)
2	NC	No connection	23	RE3P	THIRD LVDS Receiver Signal (E+)
3	NC	No connection	24	GND	Ground
4	NC	No connection	25	GND	Ground
5	NC	No connection	26	RA4N	FORTH LVDS Receiver Signal (A-)
6	NC	No connection	27	RA4P	FORTH LVDS Receiver Signal (A+)
7	NC	No connection	28	RB4N	FORTH LVDS Receiver Signal (B-)
8	NC	No connection	29	RB4P	FORTH LVDS Receiver Signal (B+)
9	GND	Ground	30	RC4N	FORTH LVDS Receiver Signal (C-)
10	RA3N	THIRD LVDS Receiver Signal (A-)	31	RC4P	FORTH LVDS Receiver Signal (C+)
11	RA3P	THIRD LVDS Receiver Signal (A+)	32	GND	Ground
12	RB3N	THIRD LVDS Receiver Signal (B-)	33	RCLK4N	FORTH LVDS Receiver Clock Signal(-)
13	RB3P	THIRD LVDS Receiver Signal (B+)	34	RCLK4P	FORTH LVDS Receiver Clock Signal(+)
14	RC3N	THIRD LVDS Receiver Signal (C-)	35	GND	Ground
15	RC3P	THIRD LVDS Receiver Signal (C+)	36	RD4N	FORTH LVDS Receiver Signal (D-)
16	GND	Ground	37	RD4P	FORTH LVDS Receiver Signal (D+)
17	RCLK3N	THIRD LVDS Receiver Clock Signal(-)	38	RE4N	FORTH LVDS Receiver Signal (E-)
18	RCLK3P	THIRD LVDS Receiver Clock Signal(+)	39	RE4P	FORTH LVDS Receiver Signal (E+)
19	GND	Ground	40	GND	Ground
20	RD3N	THIRD LVDS Receiver Signal (D-)	41	GND	Ground
21	RD3P	THIRD LVDS Receiver Signal (D+)	-		

- Note : 1. All GND (ground) pins should be connected together to the LCD module's metal frame.
 2. LVDS pin (**pin No. #22,23,38,39**) are used for 10Bit(D) of the LCD module.
 If used for 8Bit(R), these pins are no connection.

**Rear view of LCM**

Product Specification

3-2-2. Backlight Module

1) BLU Connector (Plug)

: SMH200-H07M (manufactured by YeonHo)

Table 5. BACKLIGHT CONNECTOR PIN CONFIGURATION

Pin No	Symbol	Description
1	L Cathode	LED Output Current L
2	N.C	
3	Anode L	LED Input Current For L
4	N.C	
5	R Cathode	LED Output Current R
6	N.C	
7	Anode R	LED Input Current For R

Product Specification

3-3. Signal Timing Specifications

Table 6 shows the signal timing required at the input of the LVDS transmitter. All of the interface signal timings should be satisfied with the following specification for normal operation.

Table 6. TIMING TABLE for NTSC & PAL(DE Only Mode)

ITEM		Symbol	Min	Typ	Max	Unit	notes
Horizontal	Display Period	t _{HV}	480	480	480	tCLK	1920 / 4
	Blank	t _{HB}	50	70	200	tCLK	1
	Total	t _{HP}	520	550	680	tCLK	
Vertical	Display Period	t _{VV}	1080	1080	1080	Lines	
	Blank	t _{VB}	20	45	300	Lines	1
	Total	t _{VP}	1100	1125	1380	Lines	

ITEM		Symbol	Min	Typ	Max	Unit	notes
Frequency	DCLK	f _{CLK}	60.00	74.25	78.00	MHz	
	Horizontal	f _H	121.8	135	140	KHz	2
	Vertical	f _V	95	120	122	Hz	2

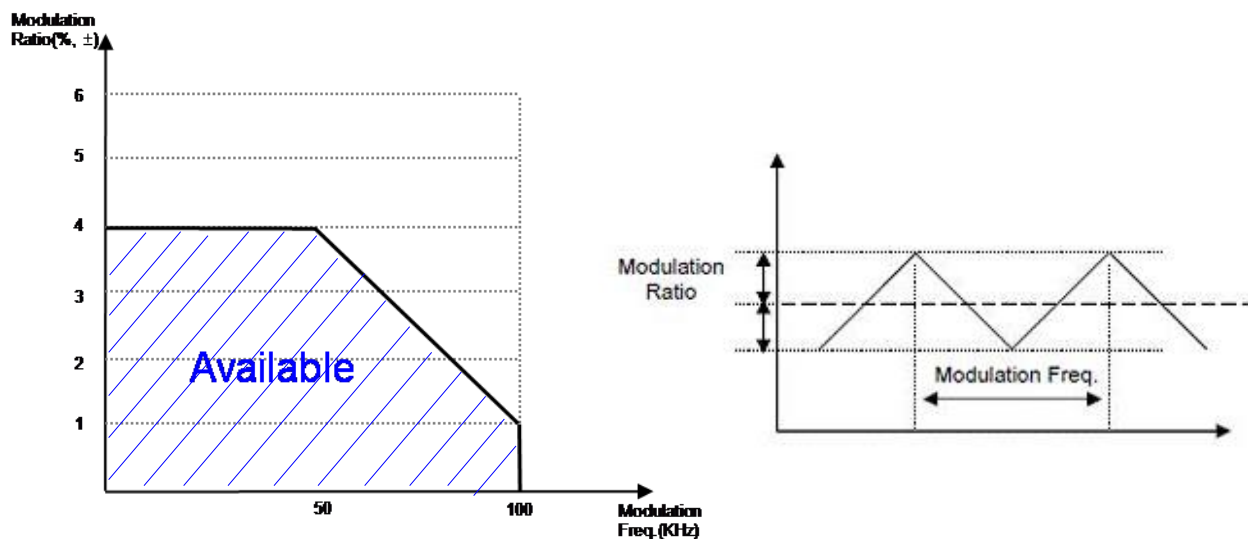
notes: 1. The input of HSYNC & VSYNC signal does not have an effect on normal operation (DE Only Mode).
If you use spread spectrum of EMI, add some additional clock to minimum value for clock margin.

2. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rate and the horizontal frequency

3. Spread Spectrum Rate (SSR) for 50KHz ~ 100kHz Modulation Frequency(FMOD) is calculated by $(7 - 0.06 \cdot F_{mod})$, where Modulation Frequency (FMOD) unit is KHz.
LVDS Receiver Spread spectrum Clock is defined as below figure

※ Timing should be set based on clock frequency.

Product Specification



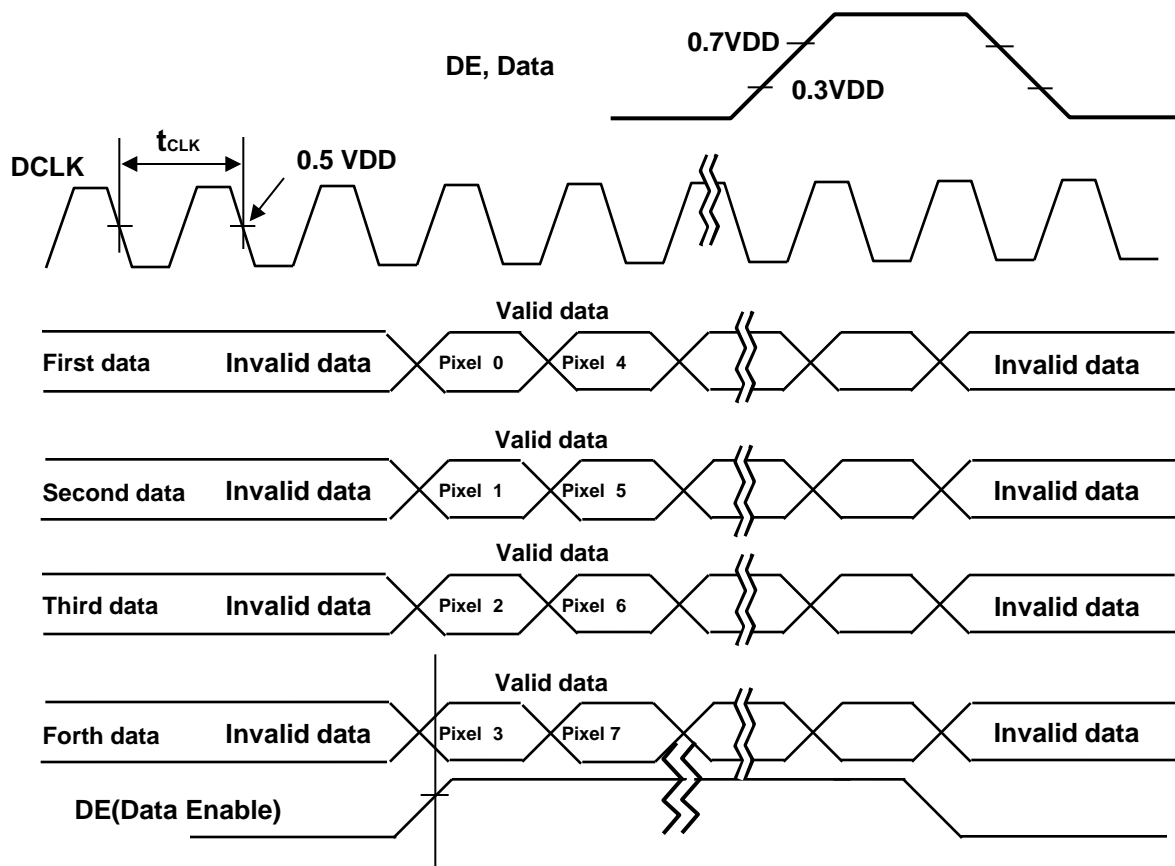
※ Please pay attention to the followings when you set Spread Spectrum Rate(SSR) and Modulation Frequency(FMOD)

1. Please set proper Spread Spectrum Rate(SSR) and Modulation Frequency (FMOD) of TV system LVDS output.
2. Please check FOS after you set Spread Spectrum Rate(SSR) and Modulation Frequency(FMOD) to avoid abnormal display. Especially, harmonic noise can appear when you use Spread Spectrum under FMOD 30 KHz.

Product Specification

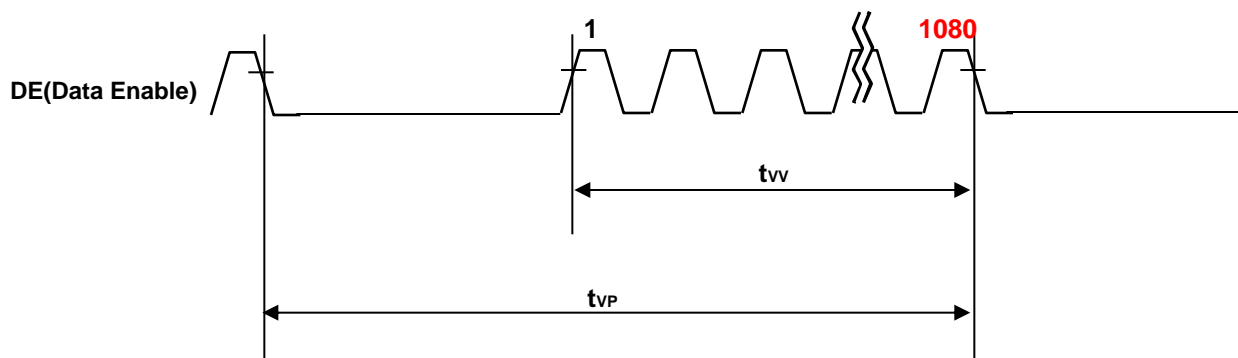
3-4. LVDS Signal Specification

3-4-1. LVDS Input Signal Timing Diagram



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

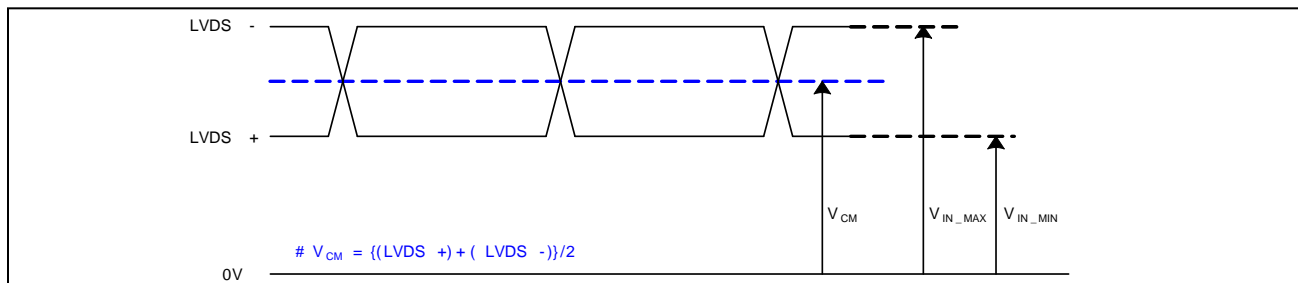
$$* t_{VB} = t_{VFP} + t_{WV} + t_{VBP}$$



Product Specification

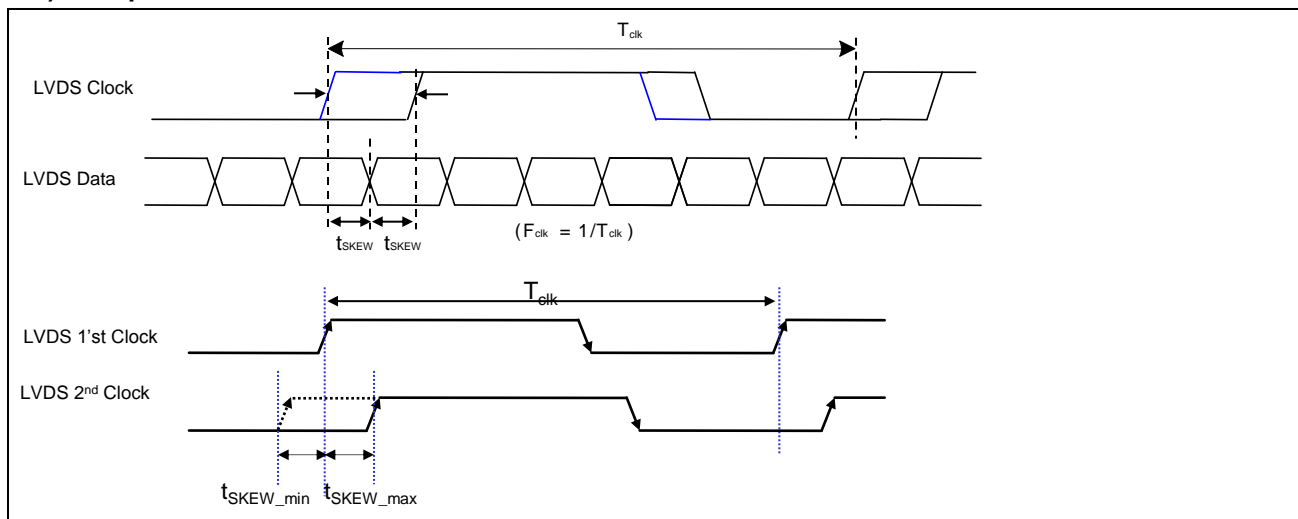
3-4-2. LVDS Input Signal Characteristics

1) DC Specification



Description	Symbol	Min	Max	Unit	notes
LVDS Common mode Voltage	V_{CM}	1.0	1.5	V	-
LVDS Input Voltage Range	V_{IN}	0.7	1.8	V	-
Change in common mode Voltage	ΔV_{CM}	-	250	mV	-

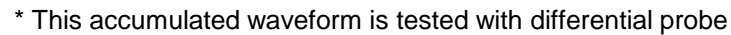
2) AC Specification



Description	Symbol	Min	Max	Unit	notes
LVDS Differential Voltage	V_{TH}	100	600	mV	Tested with Differential Probe 2
	V_{TL}	-600	-100	mV	
LVDS Clock to Data Skew	t_{SKEW}	-	$ (0.2 \cdot T_{clk})/7 $	ps	-
Effective time of LVDS	t_{eff}	$ \pm 360 $	-	ps	-
LVDS Clock to Clock Skew (Even to Odd)	t_{SKEW_EO}	-	$ 1/7 \cdot T_{clk} $	ps	-

notes 1. All Input levels of LVDS signals are based on the EIA 644 Standard.

2. LVDS Differential Voltage is defined within t_{eff}



Product Specification

3-5. Color Data Reference

The brightness of each primary color (red, green, blue) is based on the 10bit gray scale data input for the color. The higher binary input, the brighter the color. Table 7 provides a reference for color versus data input.

Table 7. COLOR DATA REFERENCE

Color		Input Color Data																															
		RED										GREEN										BLUE											
		MSB					LSB					MSB					LSB					MSB						LSB					
		R9	R8	R7	R6	R5	R4	R3	R2	R1	R0	G9	G8	G7	G6	G5	G4	G3	G2	G1	G0	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0		
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Red (1023)	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	Green (1023)	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0		
	Blue (1023)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1		
	Cyan	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
	Magenta	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1		
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0		
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
RED	RED (0000)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	RED (0001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
											
	RED (1022)	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	RED (1023)	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
GREEN	GREEN (0000)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	GREEN (0001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
											
	GREEN (1022)	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0		
	GREEN (1023)	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0		
BLUE	BLUE (0000)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	BLUE (0001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
											
	BLUE (1022)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0		
	BLUE (1023)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1		

Product Specification

3-6. Power Sequence

3-6-1. LCD Driving circuit

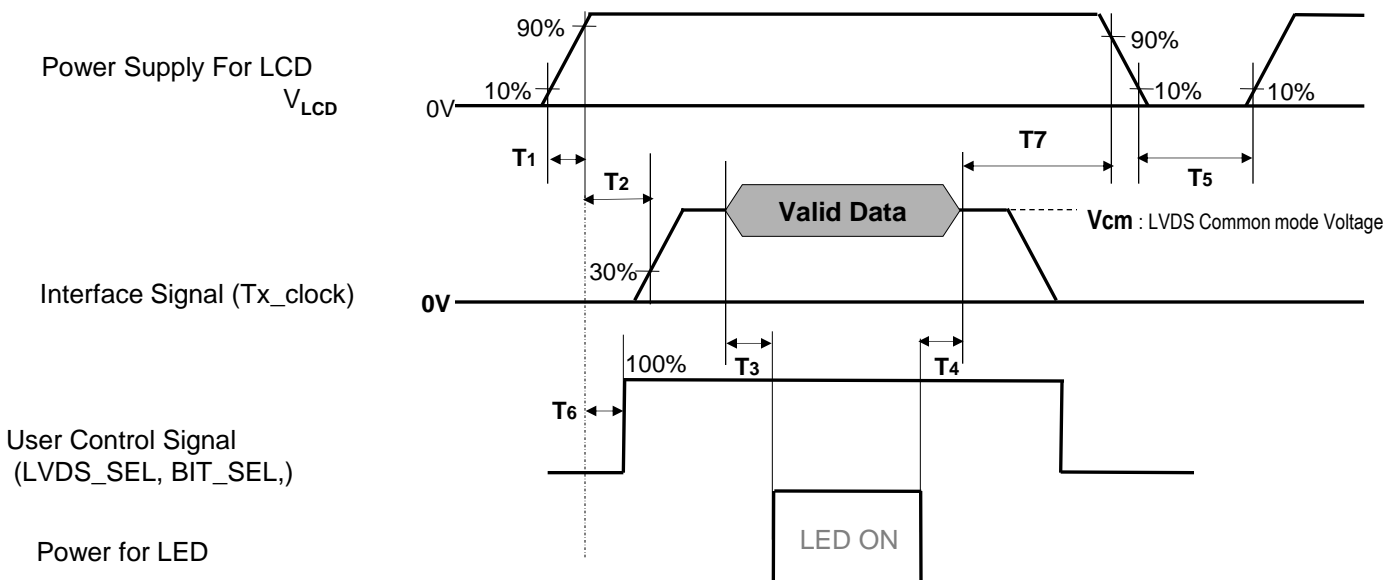


Table 8. POWER SEQUENCE

Parameter	Value			Unit	Notes
	Min	Typ	Max		
T1	0.5	-	20	ms	1
T2	0	-	-	ms	2
T3	400	-	-	ms	3
T4	100	-	-	ms	3
T5	1.0	-	-	s	4
T6	0	-	T2	ms	5
T7	0	-	-	ms	6

- 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 LVDS 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. If the on time of signals (Interface signal and user control signals) precedes the on time of Power (V_{LCD}), it will be happened abnormal display. When T6 is NC status, T6 doesn't need to be measured.
 6. It is recommendation specification that T7 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.

Product Specification

4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' and stable in a dark environment at $25 \pm 2^\circ\text{C}$. The values are specified at 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0° .

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

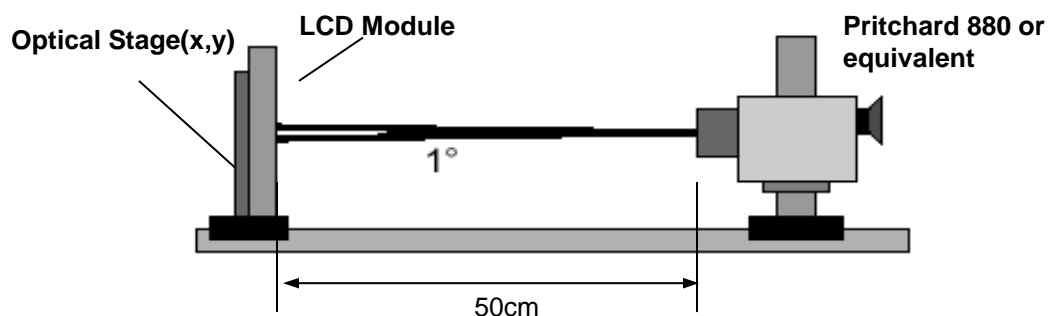


FIG. 1 Optical Characteristic Measurement Equipment and Method

Table 10. OPTICAL CHARACTERISTICS

$T_a = 25 \pm 2^\circ\text{C}$, $V_{\text{LCD}} = 12.0\text{V}$, $f_v = 120\text{Hz}$, $D_{\text{clk}} = 74.25\text{MHz}$,
Refer to Table3. Typ. If

Parameter			Symbol		Value			Unit	Note
					Min	Typ	Max		
Contrast Ratio			CR		800	1300	-		1
Surface Luminance, white			L _{WH}		360	450	-	cd/m ²	2
Luminance Variation			δ _{WHITE}	9P	65	-	-	%	3
Response Time		Gray to Gray	G to G BW			10	14	ms	4
Color Coordinates [CIE1931]		RED	Rx		Typ -0.03	0.647	Typ +0.03		5
			Ry			0.332			
		GREEN	Gx			0.311			
			Gy			0.589			
		BLUE	Bx			0.151			
			By			0.055			
		WHITE	Wx		-0.035	0.281	+0.030		6
			Wy			0.288			
Color Temperature						10000		K	
Color Gamut						68		%	
Viewing Angle	2D (CR>10)	right(φ=0°)	θ _r (x axis)		89	-	-	degree	7
		left (φ=180°)	θ _l (x axis)		89	-	-		
		up (φ=90°)	θ _u (y axis)		89	-	-		
		down (φ=270°)	θ _d (y axis)		89	-	-		
Gray Scale					-	2.2	-		8

Product Specification

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

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

It is measured at center 1-point.

2. Surface luminance is determined after the unit has been 'ON' and 1 Hour after lighting the backlight in a dark environment at $25 \pm 2^\circ\text{C}$. Surface luminance is the luminance value at center 1-point across the LCD surface 50cm from the surface with all pixels displaying white. For more information see the FIG. 3.
3. The variation in surface luminance, δ WHITE is defined as :
 $\delta \text{ WHITE}(9\text{P}) = \text{Minimum (Lon1, Lon2~ Lon8, Lon9)} / \text{Maximum (Lon1, Lon2~ Lon8, Lon9)} * 100$
 Where Lon1 to Lon9 are the luminance with all pixels displaying white at 9 locations .
 For more information, see the FIG. 3.
4. Response time is the time required for the display to transit from any gray to white (Rise Time, Tr_R) and from any gray to black (Decay time, Tr_D). For additional information see the FIG. 4.
 ※ G to G_{BW} Spec stands for average value of all measured points.
 Photo Detector : RD-80S / Field : 2°
5. White, Red, Green, Blue Color Coordinates are measured at gray level 255(100IRE)
6. White color coordinates tolerance is 0.035, In the case of more than Wx typical target and Wy typical target + 0.01, in the case of less than Wx typical target and Wy typical target - 0.01, in the remaining area is 0.03, see the FIG. 2.
7. 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 module surface. For more information, see the FIG. 5.
8. Gray scale specification
 Gamma Value is approximately 2.2. For more information, see the Table 11

Product Specification

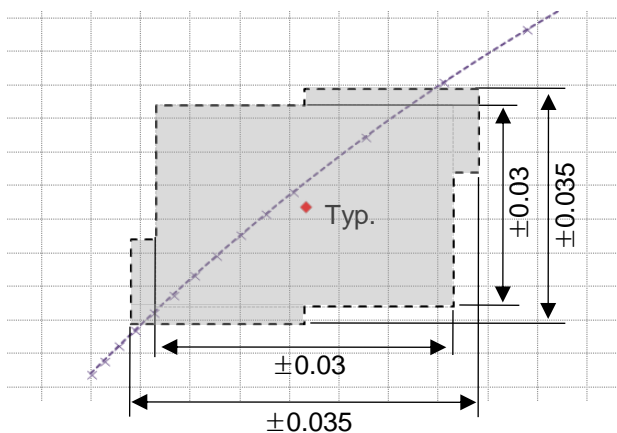


FIG. 2 Tolerance of White color coordinates

Table 11. Gray scale specification

Gray Level	Luminance [%] (Typ)
L0	0.07
L15	0.27
L31	1.04
L47	2.49
L63	4.68
L79	7.66
L95	11.5
L111	16.1
L127	21.6
L143	28.1
L159	35.4
L175	43.7
L191	53.0
L207	63.2
L223	74.5
L239	86.7
L255	100

Product Specification

Measuring point for surface luminance & measuring point for luminance variation.

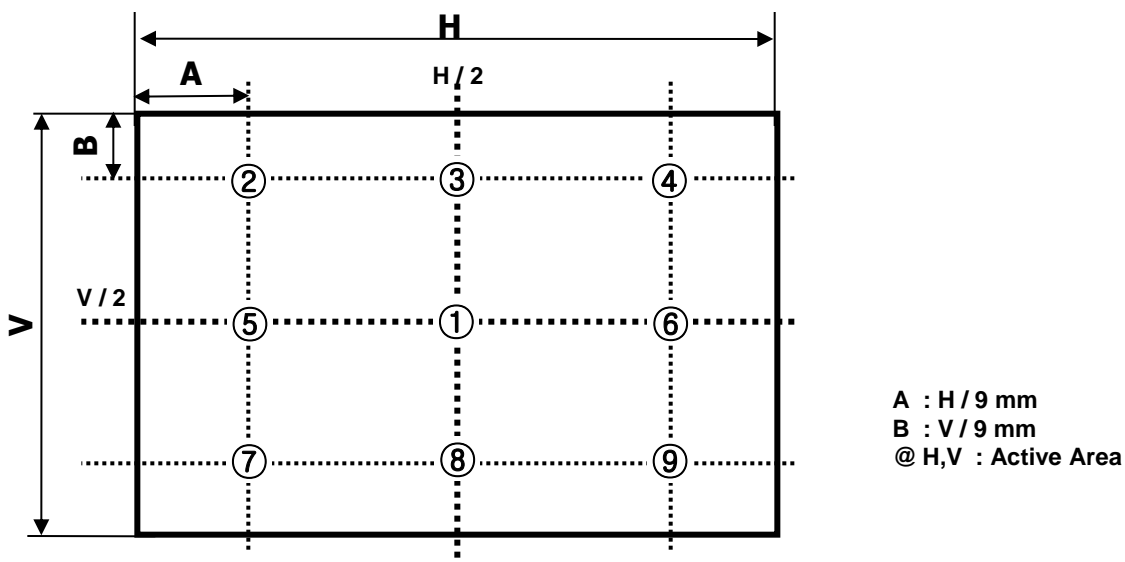


FIG. 3 9 Points for Luminance Measure

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

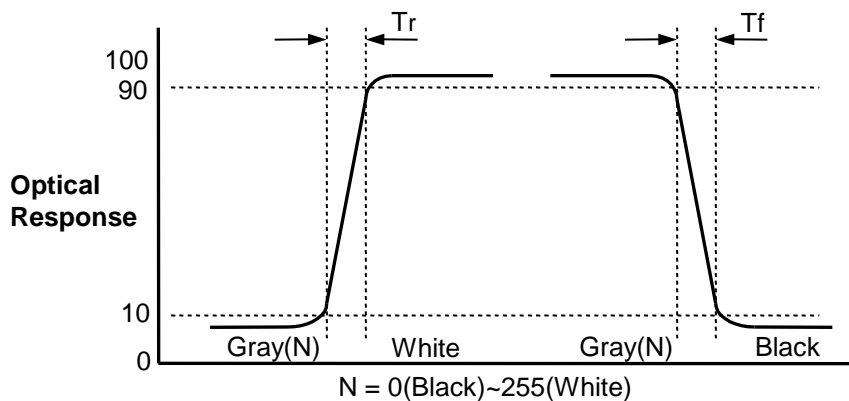


FIG. 4 Response Time

Product Specification

Dimension of viewing angle range

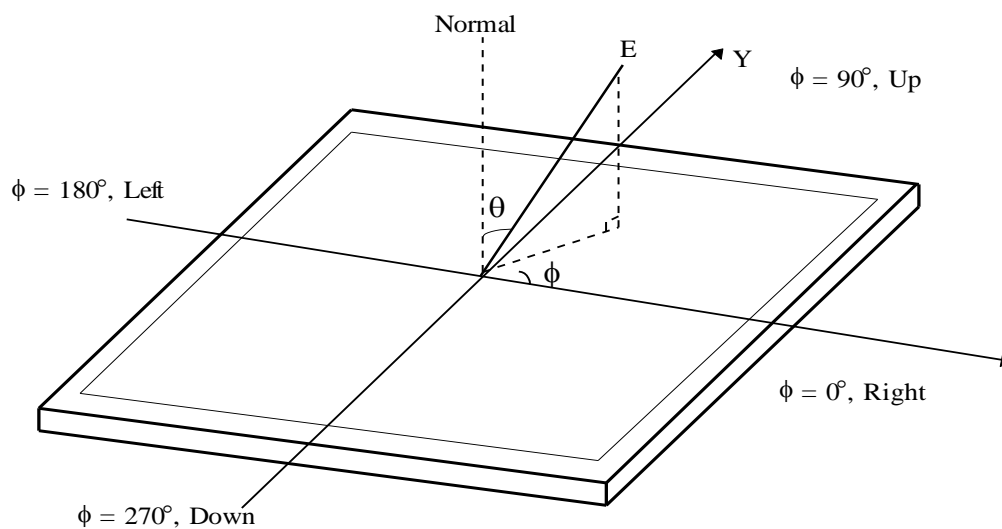


FIG. 6 Viewing Angle

Product Specification

5. Mechanical Characteristics

Table 12 provides general mechanical characteristics.

Table 12. MECHANICAL CHARACTERISTICS

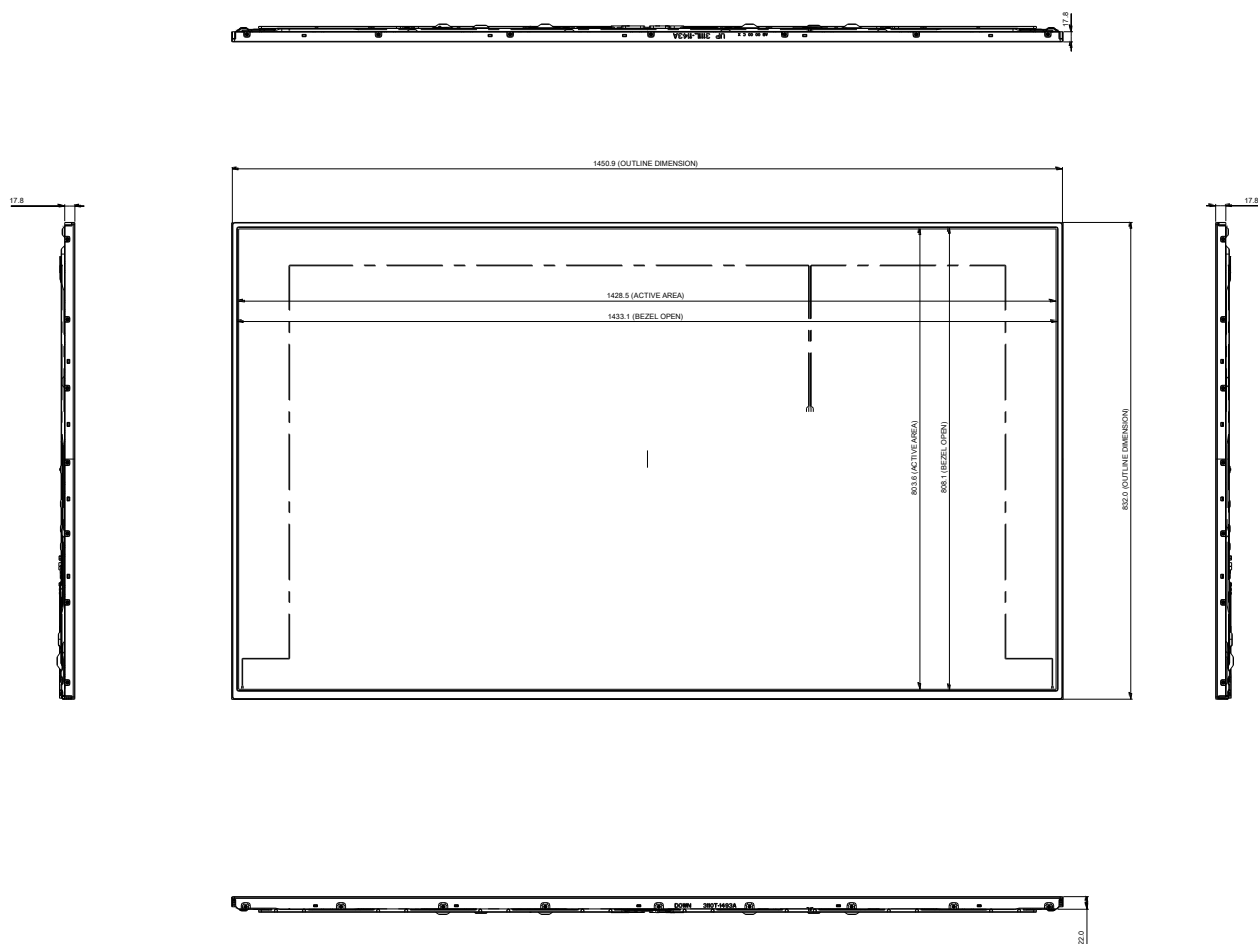
Item	Value	
Outline Dimension	Horizontal	1450.9mm
	Vertical	832.0 mm
	Depth	16.5 mm
Bezel Area	Horizontal	1433.1mm
	Vertical	808.1 mm
Active Display Area	Horizontal	1428.5 mm
	Vertical	803.5 mm
Case Top	Material	EGI PCM 0.8T
	Color	Black
	Manufactory	Hansung
Weight	22.3Kg (Typ.), 23 kg (Max.)	

Note : Please refer to a mechanical drawing in terms of tolerance at the next page.

Product Specification

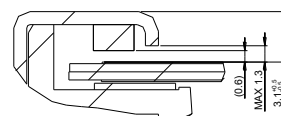
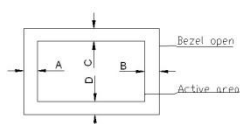
6. Mechanical Dimension

[FRONT VIEW]



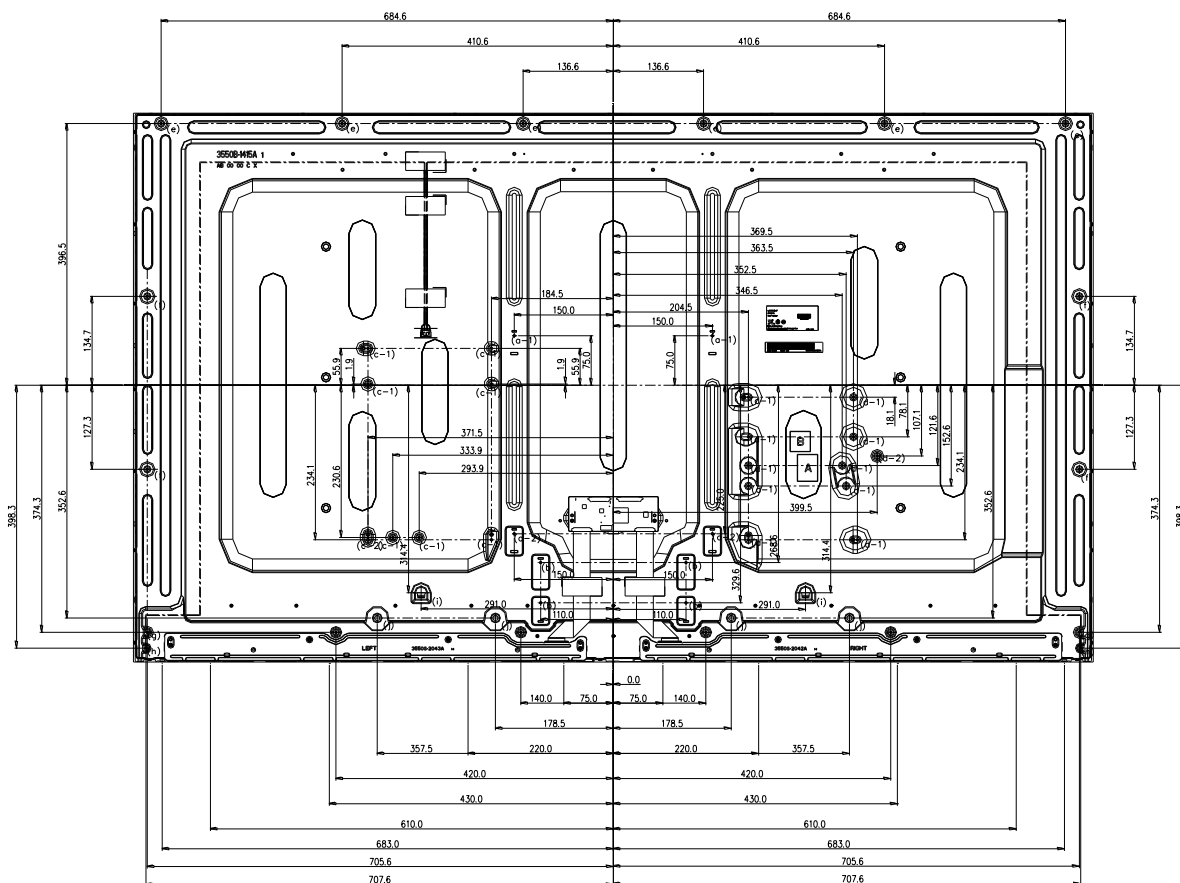
Date	Version
Nov. 23. 2014	V1.0
Jan. 8. 2015	V2.0

- NOTES.
1. UNSPECIFIED TOLERANCE IS $\pm 1.0\text{mm}$
 2. MAX TORQUE : REFER TO TABLE
 3. MAX DEPTH (SCREW) : REFER TO TABLE
 4. THE SAME FEATURE MEANS THE SAME DIMENSION
 5. TILT AND PARTIAL DISPOSITION TOLERANCE OF DISPLAY AREA IS AS FOLLOWING
 - (1) X-DIRECTION : $IA-BI \leq 2.0$
 - (2) Y-DIRECTION : $IC-DI \leq 2.0$



Product Specification

[REAR VIEW]



Item	Tap	Height (mm)	Max. Torque (kgf.cm)	Note
a-1	M3	7.5	Max 5.0	VESA
a-2	M3	9.0	Max 5.0	STAND
(b)	M3	9.0	Max 5.0	STAND
c-1	M3	4.0	Max 5.0	PSU
c-2	M4	4.0	Max 5.0	PSU
d-1	M3	8.8	Max 5.0	Main
d-2	M3	3.6	Max 5.0	Main
(e)	M3	5.8	Max 5.0	BACK COVER
(f)	M3	6.8	Max 5.0	BACK COVER
(g)	M3	8.5	Max 5.0	-
(h)	M3	7.5	Max 5.0	-
(i)	-	12.6	-	SPEAKER
(j)	26.0	14.6	-	SPEAKER

Product Specification

7. Reliability

Table 13. ENVIRONMENT TEST CONDITION

No.	Test Item	Condition
1	High temperature storage test	Ta= 60°C 90% 240h
2	Low temperature storage test	Ta= -20°C 240h
3	High temperature operation test	Ta= 50°C 50%RH 500h
4	Low temperature operation test	Ta= 0°C 500h
5	Humidity condition Operation	Ta= 40 °C, 90%RH
6	Altitude operating storage / shipment	0 – 16,400 ft 0 - 40,000 ft
7	Panel Push Test (Module Condition)	Max 6kgf

Note : 1. Before and after Reliability test, LCM should be operated with normal function.

2. These conditions are for LGD's internal test. Please refer to Absolute Maximum Ratings (Table1) for guaranteed condition.

8. International Standards

7-1. Safety

- a) UL 60065, Underwriters Laboratories Inc.
Audio, Video and Similar Electronic Apparatus - Safety Requirements.
- b) CAN/CSA C22.2 No.60065:03, Canadian Standards Association.
Audio, Video and Similar Electronic Apparatus - Safety Requirements.
- c) EN 60065, European Committee for Electrotechnical Standardization (CENELEC).
Audio, Video and Similar Electronic Apparatus - Safety Requirements.
- d) IEC 60065, The International Electrotechnical Commission (IEC).
Audio, Video and Similar Electronic Apparatus - Safety Requirements.

7-2. Environment

- a) RoHS, Directive 2011/65/EU of the European Parliament and of the council of 8 June 2011

Product Specification

9. Packing**9-1. Information of LCM Label**

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.

9-2. Packing Form

a) Package quantity in one Pallet : 18 pcs(TBD)

b) Pallet Size : 1700 mm(W) X 1140 mm(D) X 1090 mm(H) (TBD)

Product Specification

10. Precautions

Please pay attention to the followings when you use this TFT LCD module.

10-1. Mounting Precautions

- (1) You must mount a module using specified mounting holes (Details refer to the drawings).
- (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.

10-2. Operating Precautions

- (1) Response time depends on the temperature. (In lower temperature, it becomes longer.)
- (2) Brightness depends on the temperature. (In lower 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 can cause conductive particles and deal LCM a fatal blow)
- (8) Please do not set LCD on its edge.
- (9) The conductive material and signal cables are kept away from LED driver inductor to prevent abnormal display, sound noise and temperature rising.

10-3. 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.

10-4. Precautions for Strong Light Exposure

Strong light exposure causes degradation of polarizer and color filter.

10-5. 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.
- (3) Storage condition is guaranteed under packing conditions.
- (4) The phase transition of Liquid Crystal in the condition of the low or high storage temperature will be recovered when the LCD module returns to the normal condition.

10-6. 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.

10-7. Appropriate Condition for Commercial Display

- Generally large-sized LCD modules are designed for consumer applications (TV).
Accordingly, a long-term display like in Commercial Display application, can cause uneven display including image sticking. To optimize module's lifetime and function, several operating usages are required.

1. Normal operating condition

- Temperature: 0 ~ 40°C
- Operating Ambient Humidity : 10 ~ 90 %
- Display pattern: dynamic pattern (Real display)
- Note) Long-term static display can cause image sticking.

2. Operating usages under abnormal condition

a. Ambient condition

- Well-ventilated place is recommended to set up Commercial Display system.

b. Power and screen save

- Periodical power-off or screen save is needed after long-term display.

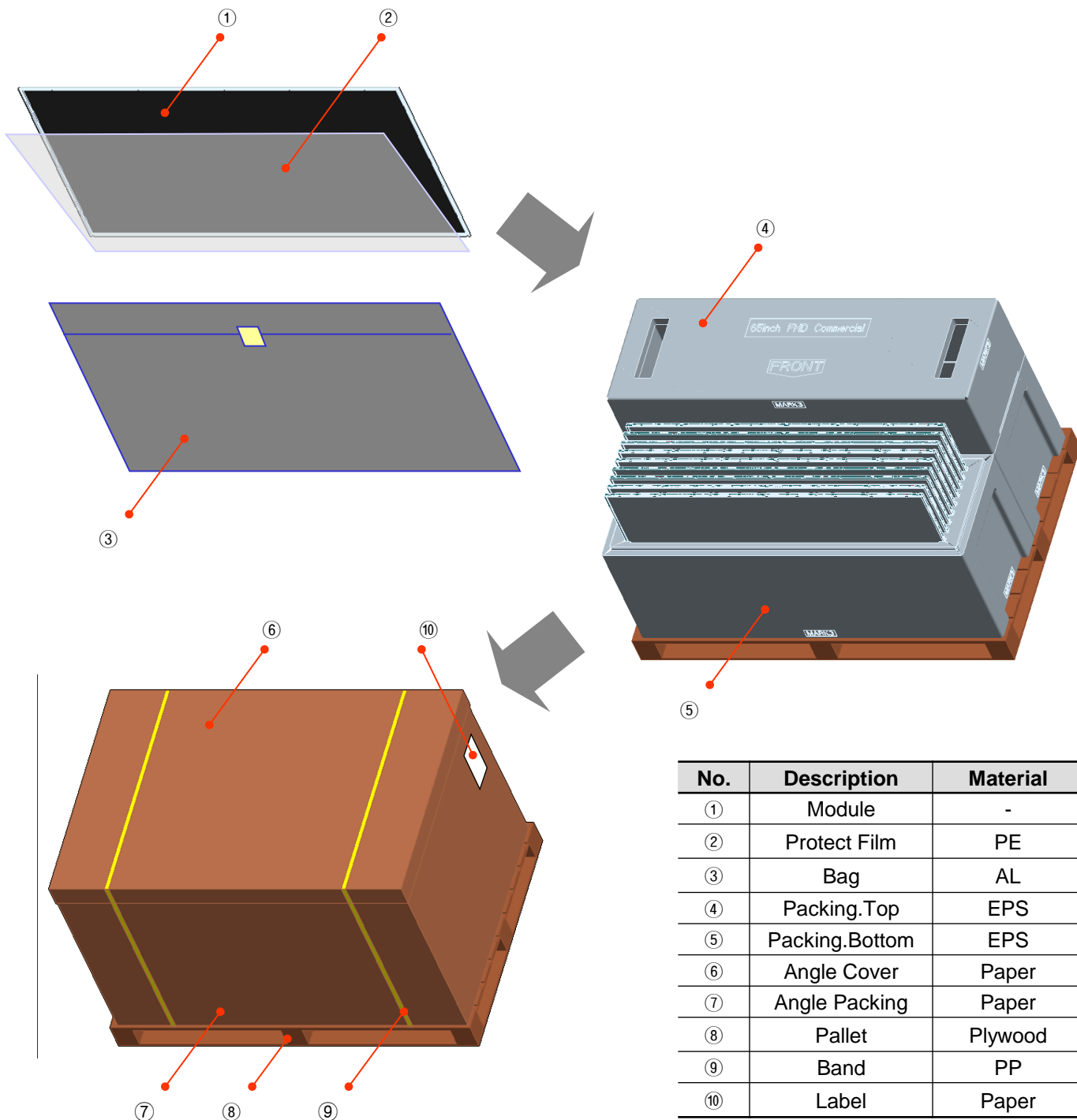
Product Specification

3. Operating usages to protect against image sticking due to long-term static display
 - a. Suitable operating time: under 24 hours a day.
 - (* The moving picture can be allowed for 24 hours a day)
 - b. Static information display recommended to use with moving image.
 - Cycling display between 5 minutes' information(static) display and 10 seconds' moving image.
 - c. Background and character (image) color change
 - Use different colors for background and character, respectively.
 - Change colors themselves periodically.
 - d. Avoid combination of background and character with large different luminance.
- 1) Abnormal condition just means conditions except normal condition.
- 2) Black image or moving image is strongly recommended as a screen save.
4. Lifetime in this spec. is guaranteed only when Commercial Display is used according to operating usages.
5. Module should be turned counter-clockwise based on front view when used in portrait mode.

Product Specification

APPENDIX-I

■ Pallet Ass'y



Product Specification

APPENDIX- II-1

■ LCM Label



■ Production site


– LG Display (Guangzhou) Co., LTD

Note 1. The origin of LCM Label will be changed according to the production site.

Product Specification

APPENDIX- II-2

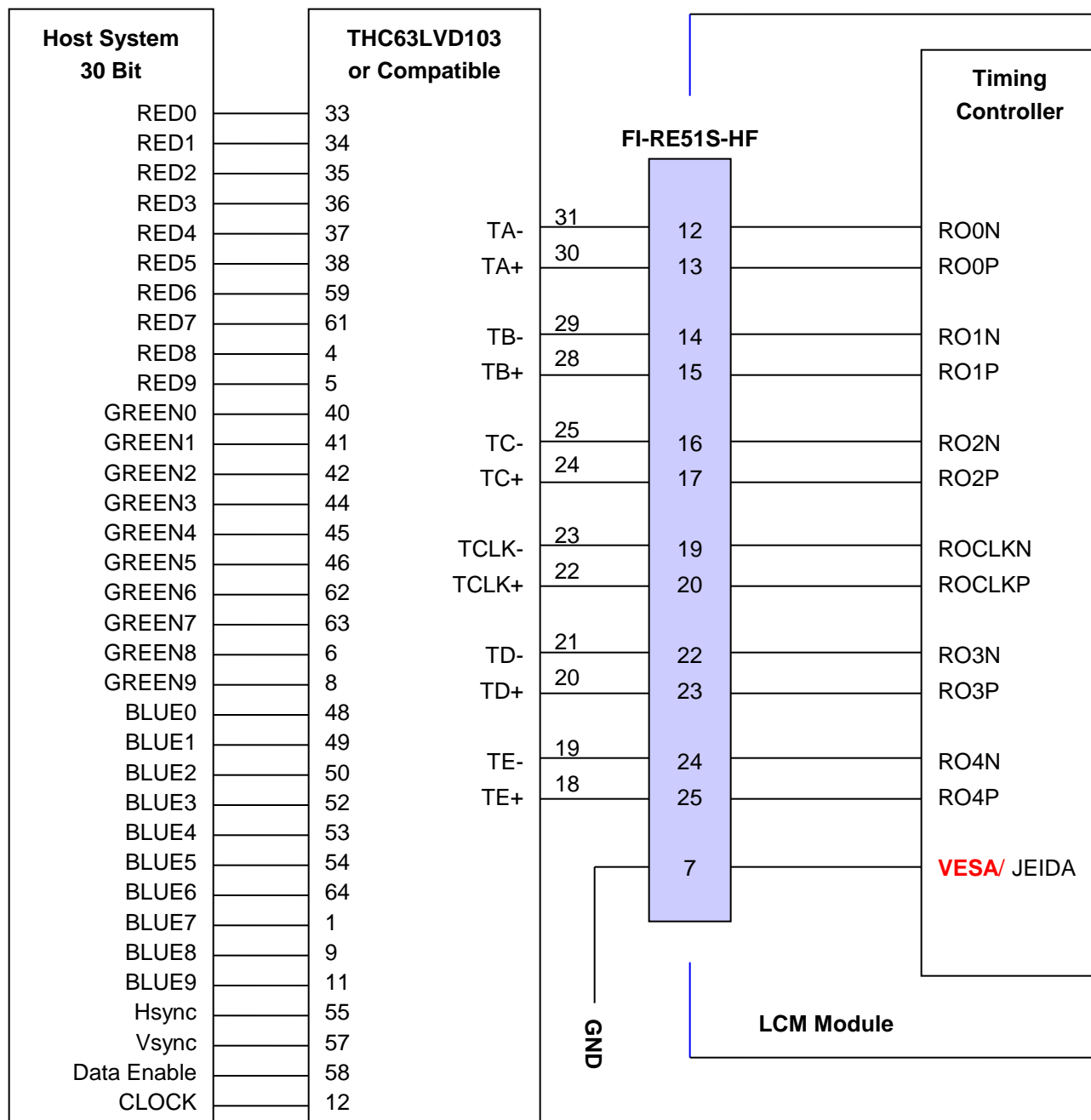
■ Pallet Label

LD650EUE		FHB1
EAJ63329501		
18 PCS	LOT/MM-DD	
MADE IN CHINA		RoHS Verified HF
 *****		

Product Specification

APPENDIX- III-1

■ Required signal assignment for Flat Link (Thine : THC63LVD103) Transmitter(Pin7= **"L"** or **"NC"**)



Note: 1. The LCD module uses a 100 Ohm[Ω] resistor between positive and negative lines of each receiver input.

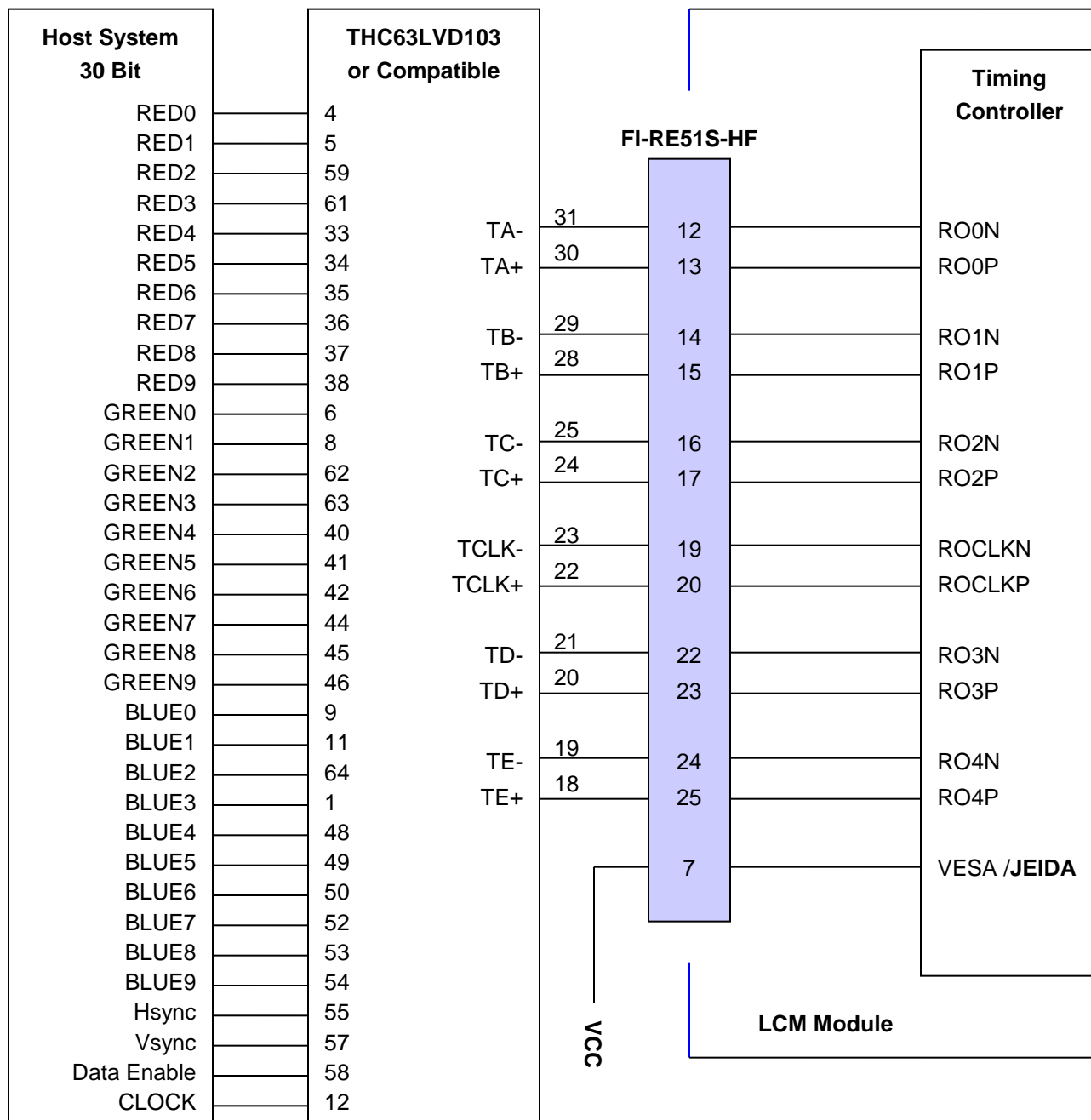
2. Refer to LVDS Transmitter Data Sheet for detail descriptions. (THC63LVD103 or Compatible)

3. '9' means MSB and '0' means LSB at R,G,B pixel data.

Product Specification

APPENDIX- III-2

■ Required signal assignment for Flat Link (Thine : THC63LVD103) Transmitter(Pin7= "H")



Note :1. The LCD module uses a 100 Ohm[Ω] resistor between positive and negative lines of each receiver input.

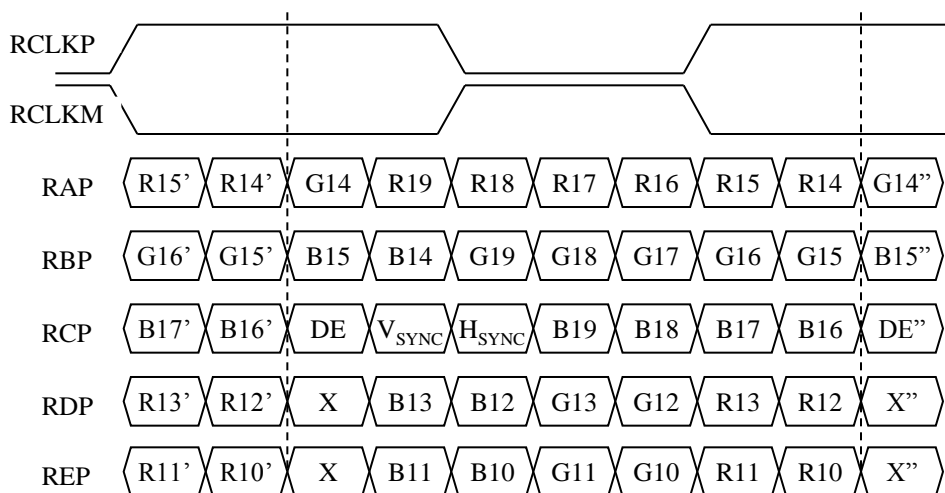
2. Refer to LVDS Transmitter Data Sheet for detail descriptions. (THC63LVD103 or Compatible)

3. '0' means MSB and '0' means LSB at R,G,B pixel data.

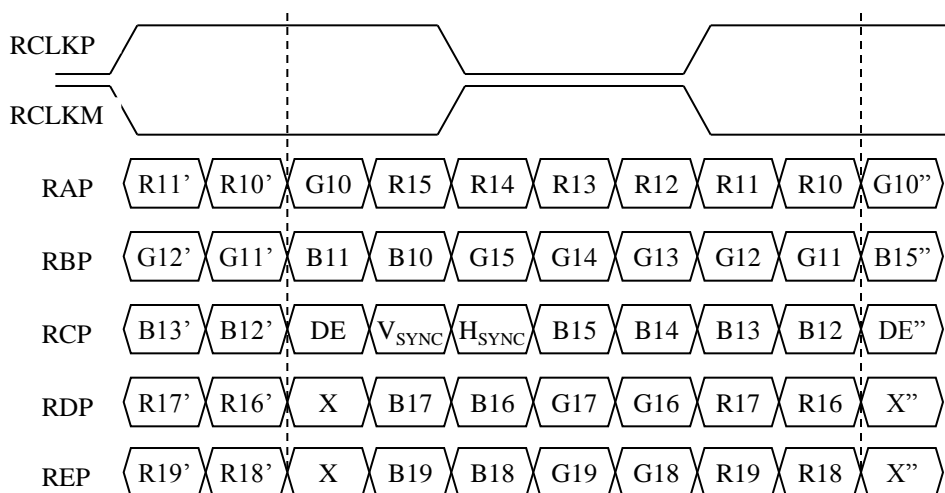
APPENDIX- IV-1

■ LVDS Data-Mapping Information (10 Bit)

1) LVDS Select : "H" Data-Mapping (JEIDA format)



2) LVDS Select : "L" Data-Mapping (VESA format)

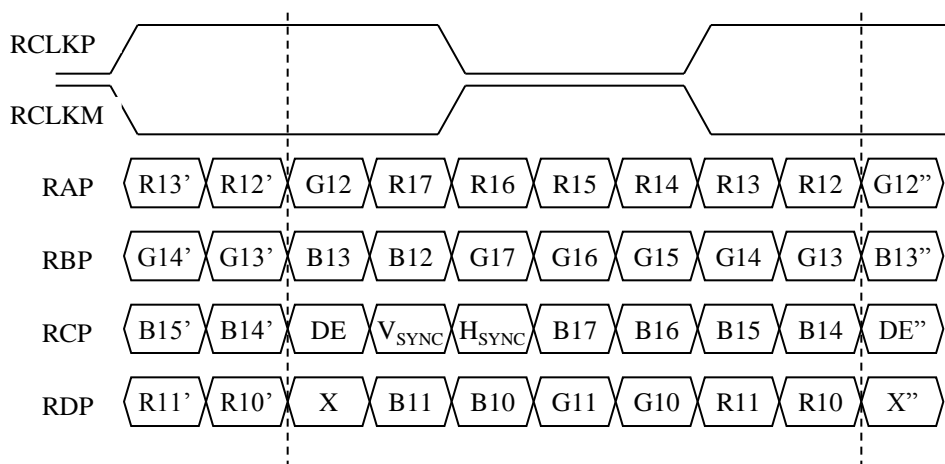


Product Specification

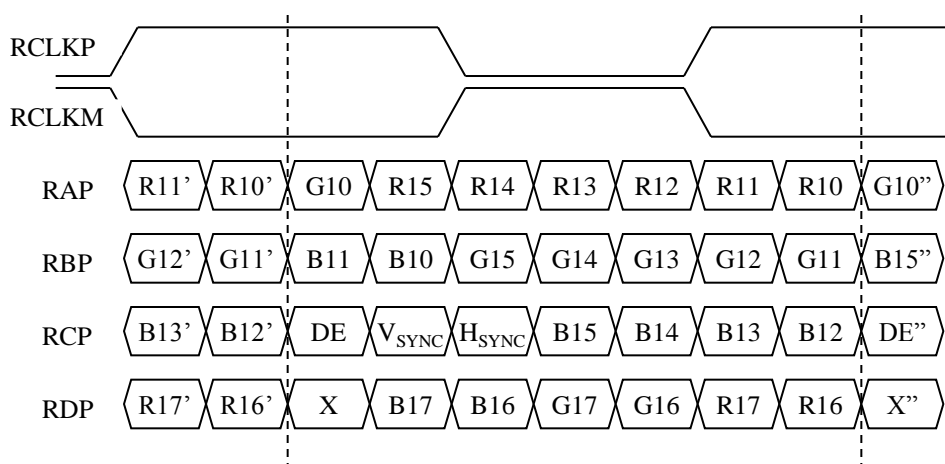
APPENDIX- IV-2

■ LVDS Data-Mapping Information (8 Bit)

1) LVDS Select : "H" Data-Mapping (JEIDA format)

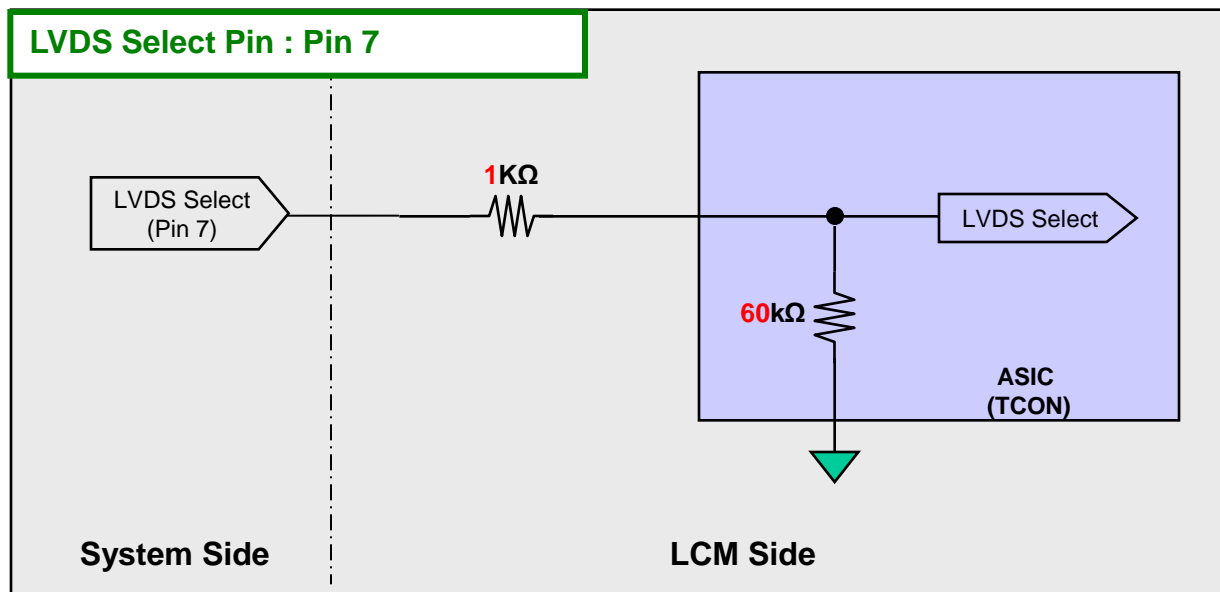


2) LVDS Select : "L" Data-Mapping (VESA format)



APPENDIX- V

■ Option Pin Circuit Block Diagram

1) Circuit Block Diagram of **LVDS Format** Selection pin2) Circuit Block Diagram of **Bit** Selection pin