SPECIFICATION
FOR
APPROVAL

( ) **Preliminary Specification**

(●) **Final Specification**

Title	55.0” WUXGA TFT LCD

BUYER	GENERAL
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LD550DUN
SUFFIX	ZMA4(RoHS Verified)

APPROVED BY		SIGNATURE DATE
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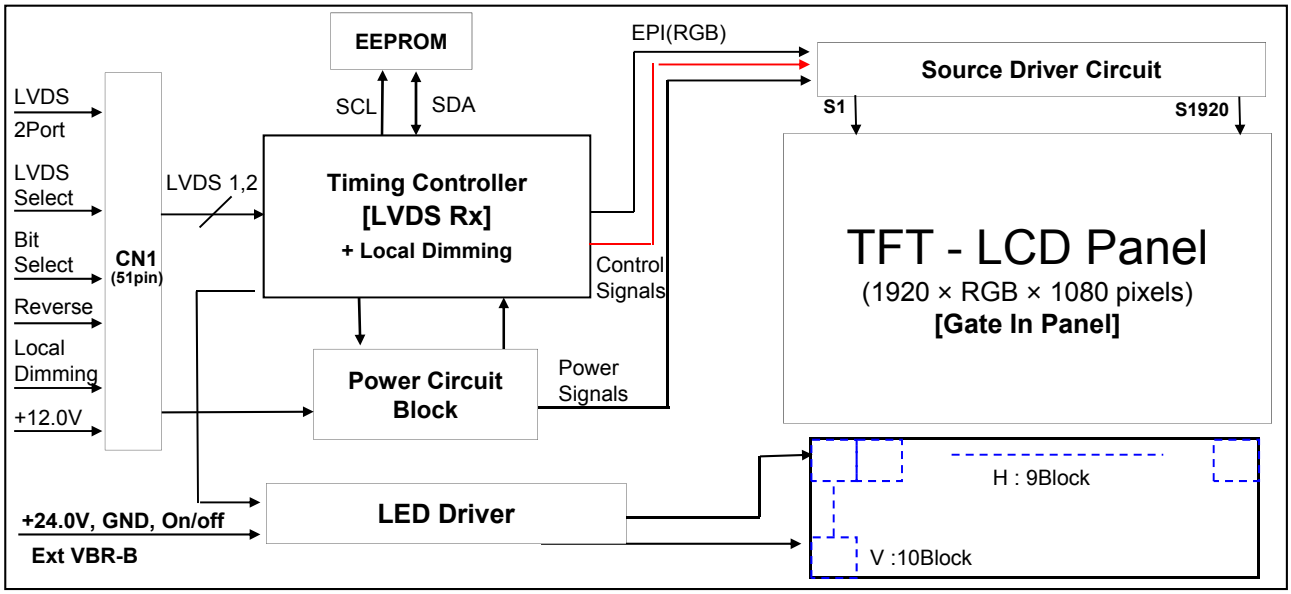
CONTENTS

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	10
3-4	LVDS SIGNAL SPECIFICATIONS	12
3-5	COLOR DATA REFERENCE	15
3-6	POWER SEQUENCE	16
4	OPTICAL SPECIFICATIONS	18
5	MECHANICAL CHARACTERISTICS	22
6	RELIABILITY	25
7	INTERNATIONAL STANDARDS	26
7-1	SAFETY	26
7-2	ENVIRONMENT	26
8	PACKING	27
8-1	INFORMATION OF LCM LABEL	27
8-2	PACKING FORM	27
9	PRECAUTIONS	28
9-1	MOUNTING PRECAUTIONS	28
9-2	OPERATING PRECAUTIONS	28
9-3	ELECTROSTATIC DISCHARGE CONTROL	29
9-4	PRECAUTIONS FOR STRONG LIGHT EXPOSURE	29
9-5	STORAGE	29
9-6	HANDLING PRECAUTIONS FOR PROTECTION FILM	29
9-7	APPROPRIATE CONDITION FOR PUBLIC DISPLAY	29

RECORD OF REVISIONS

Revision No.	Revision Date	Page	Description
0.1	2019.01.22	-	Preliminary Specification(First Draft)
0.2	2019.04.08	16	Power Sequence T5 (1→3)
		4,22	Weight Revision
		4,7	Power Consumption change (Typ, Max)
		23,24	Drawing Update
1.0	2019.07.04	-	Final CAS

The LD550DUN is a Color Active Matrix Liquid Crystal Display with an integral Light Emitting Diode (LED) Local Block 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 54.64 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 1.07Bilion colors.
It has been designed to apply the 10-bit 2-port LVDS interface.
It is intended to support Public 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	54.64 inches(1387.80mm) diagonal
Outline Dimension	1213.4(H) x 684.2(V) x 39.2(B) (Typ.) 57.8mm [mm]
Pixel Pitch	0.630mm X 0.630mm
Pixel Format	1920 horiz. by 1080 vert. Pixels, RGB stripe arrangement
Display Mode	IPS
Color Depth	10bit(D), 1.07Billon colors
Interface	LVDS 2port
Luminance, White	500 cd/m^2 (Center 1point ,Typ.)
BLU Type	Direct type
Viewing Angle (CR>10)	Viewing angle free (R/L 178 (Min.), U/D 178 (Min.))
Power Consumption	Total 124W(Typ.) - Logic= 7.5W(Typ.), 9.8W(Max.) - LED Driver=116.5W (ExtVbr_B=100%)(Typ.), 125.2W(Max.)
Weight	15.1 Kg(Typ.) , 16.5 Kg(Max.)
Display Mode	Transmissive mode, Normally black
Surface Treatment	Hard coating(2H), Anti-glare treatment of the front polarizer(Haze 28%(Typ.))
Possible Display Type	Landscape and Portrait Enabled

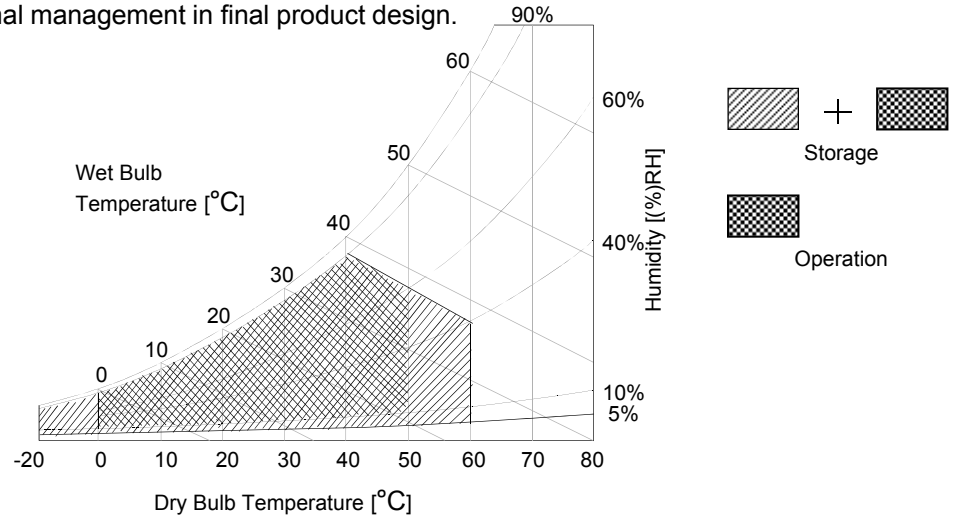
2. Absolute Maximum Ratings

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

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Value		Unit	Note
			Min	Max		
Power Input Voltage	LCD Circuit	V_{LCD}	-0.3	+14.0	V_{DC}	1
	Driver	V_{BL}	-0.3	+ 27.0	V_{DC}	
Driver Control Voltage	ON/OFF	VON/OFF	-0.3	+3.9	V_{DC}	
	Brightness	EXTVBR-B	-0.3	+3.9	V_{DC}	
	Status	Status	-0.3	+3.9	V_{DC}	
T-Con Option Selection Voltage		V_{LOGIC}	-0.3	+4.0	V_{DC}	
Operating Temperature		T_{OP}	0	+50	°C	2
Storage Temperature		T_{ST}	-20	+60	°C	
Panel Front Temperature		T_{SUR}	-	+68	°C	3
Operating Ambient Humidity		H_{OP}	10	90	%RH	2
Storage Humidity		H_{ST}	5	90	%RH	

Note.
1. Ambient temperature condition (Ta = 25 ± 2 °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℃. The range of operating temperature may be degraded in case of improper thermal management in final product design.



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 and LED Driver circuit.

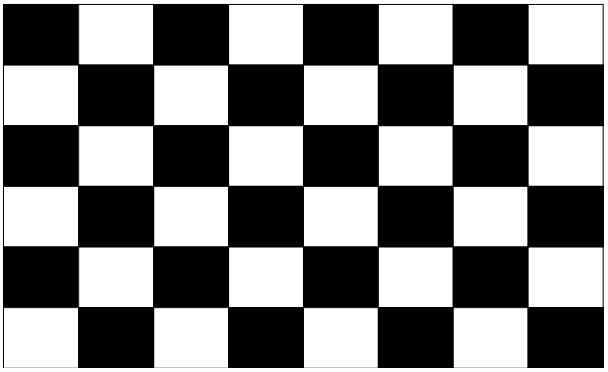
Table 2. ELECTRICAL CHARACTERISTICS

Parameter		Symbol	Value			Unit	Note
			Min	Typ	Max		
Circuit :							
Power Input Voltage		VLCD	10.8	12.0	13.2	VDC	
Power Input Current		ILCD	-	625	810	mA	1
			-	820	1065	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	-	7.5	9.8	Watt	1
			-	9.8	12.7	Watt	2
Rush current		IRUSH	-	-	6	A	3

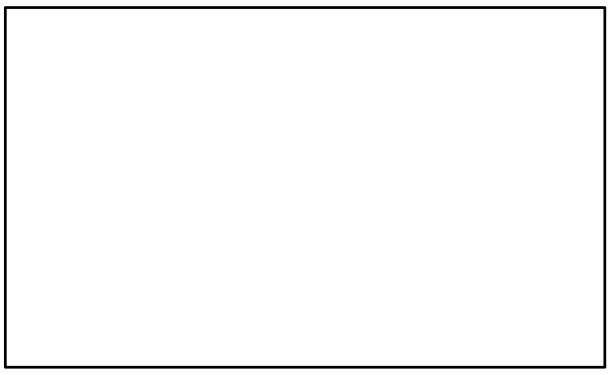
Notes: 1. The specified current and power consumption are under the V_{LCD}=12.0V, 25 ± 2°C, f_V=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
2. The current is specified at maximum current pattern.
3. The duration of rush current is about 2ms and rising time of power input is 0.5ms (min.).
4. Ripple voltage level is recommended under ±5% of typical voltage

.

White : 1023Gray
Black : 0Gray



White : 1023Gray



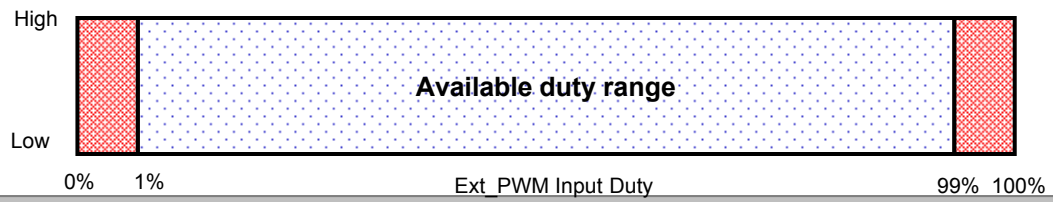
Max Current Pattern

Table 3. ELECTRICAL CHARACTERISTICS (Continue) Normal temperature [25 ±2℃]

Parameter			Symbol	Values			Unit	Notes
				Min	Typ	Max		
LED Driver :								
Power Supply Input Voltage			VBL	21.6	24.0	26.4	Vdc	1
Power Supply Input Current			IBL	-	4.86	5.22	A	Ext V_{BR-B} = 100%
Power Supply Input Current (In-Rush)			In-rush	-	-	8.13	A	V_{BL} = 21.6V Ext V_{BR-B} = 100% 3
Power Consumption			PBL	-	116.5	125.2	W	1 Ext V_{BR-B} = 100%
Input Voltage for Control System Signals	On/Off	On	V on	2.5	-	3.6	Vdc	
		Off	V off	-0.3	0.0	0.7	Vdc	
	Brightness Adjust		ExtV_{BR-B}	1	-	100	%	On Duty, 5
	PWM Frequency for NTSC & PAL		PAL		100		Hz	2
			NTSC		120		Hz	2
	Pulse Duty Level (PWM)		High Level	2.5	-	3.6	Vdc	HIGH : on duty LOW : off duty
			Low Level	0.0	-	0.7	Vdc	
Life Time				50,000	60,000		Hrs	

Notes :

1. Electrical characteristics are determined after the unit has been 'ON' and stable for approximately 60 minutes at 25±2°C. The specified temperature , optical , and power consumption are under the typical supply Input voltage 24V , current & V_{BR} (ExtV_{BR-B} : 100%), it is total power consumption.
2. LGD recommend that the PWM freq. is synchronized with Two times harmonic of V_sync signal of system. Though PWM frequency is over 120Hz (max 252Hz), function of LED Driver is not affected.
3. The duration of rush current is about 200ms. This duration is applied to LED on time.
4. Even though inrush current is over the specified value, there is no problem if I^2T spec of fuse is satisfied.
5. Ext_PWM Signal have to input available duty range.
   Between 99% and 100% ExtV_{BR-B} duty have to be avoided. (99% < ExtV_{BR-B} < 100%)
   But ExtV_{BR-B} 0% and 100% is possible.



3-2. Interface Connections

This LCD module employs two kinds of interface connection, a 51-pin connector is used for the module electronics and Master 14-pin connectors are used for the integral backlight system.

3-2-1. LCD Module

- LCD Connector(CN1): FI-RE51S-HF (manufactured by JAE) or compatible
- Mating Connector : FI-RE51HL or compatible

Table 4. MODULE CONNECTOR(CN1) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	Reverse	'H' = Enable, 'L' or NC = Disable	27	Bit Select	'H' or NC = 10bit(D), 'L' = 8bit
2	NC	No Connection	28	R2AN	SECOND LVDS Receiver Signal (A-)
3	NC	No Connection	29	R2AP	SECOND LVDS Receiver Signal (A+)
4	NC	No Connection (Reserved for LGD)	30	R2BN	SECOND LVDS Receiver Signal (B-)
5	NC	No Connection (Reserved for LGD)	31	R2BP	SECOND LVDS Receiver Signal (B+)
6	NC	No Connection (Reserved for LGD)	32	R2CN	SECOND LVDS Receiver Signal (C-)
7	LVDS Select	'H' =JEIDA , 'L' = VESA	33	R2CP	SECOND LVDS Receiver Signal (C+)
8	Driver_SCL	Driver SCL	34	GND	Ground
9	Driver_SDA	Driver SDA	35	R2CLKN	SECOND LVDS Receiver Clock Signal(-)
10	Local Dimming	'H' =Enable only	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	GND	Ground
17	R1CP	FIRST LVDS Receiver Signal (C+)	43	GND	Ground
18	GND	Ground	44	GND	Ground
19	R1CLKN	FIRST LVDS Receiver Clock Signal(-)	45	GND	Ground
20	R1CLKP	FIRST LVDS Receiver Clock Signal(+)	46	GND	Ground
21	GND	Ground	47	NC	No connection
22	R1DN	FIRST LVDS Receiver Signal (D-)	48	VLCD	Power Supply +12.0V
23	R1DP	FIRST LVDS Receiver Signal (D+)	49	VLCD	Power Supply +12.0V
24	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	GND	Ground	-	-	-

Notes:
1. All GND(ground) pins should be connected together to the LCD module's metal frame.
2. All VLCD (power input) pins should be connected together.
3. All Input levels of LVDS signals are based on the EIA 644 Standard.
4. #2~#6 NC (No Connection): These pins are used only for LGD (Do not connect)
5. Specific pin No. #44 is used for "No signal detection" of system signal interface.
   It should be GND for NSB(No Signal Black) during the system interface signal is not.
   If this pin is "H" or "NC", LCD Module displays AGP(Auto Generation Pattern).
6. Specially added pins #8 & #9, for LED Driver Defect Detecting (Appendix Ⅴ, Ⅵ, Ⅶ)

3-2-2. Backlight Module

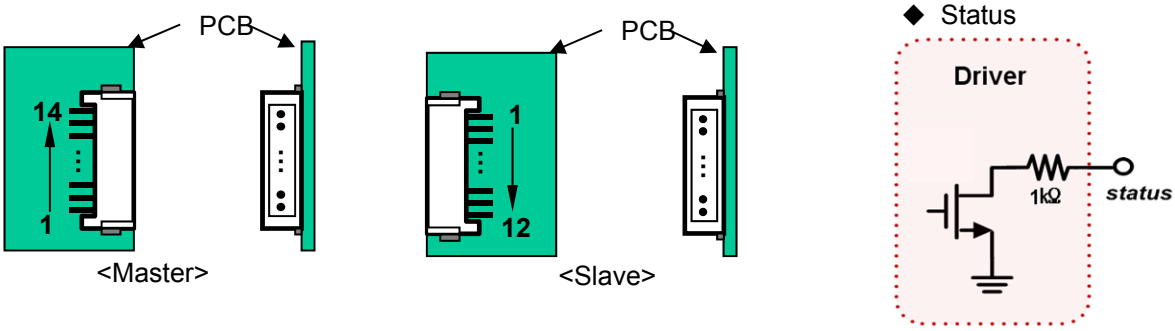
- LED Driver Connector
  : 20022WR - H14B2(Yeonho) or compatible , 20022WR-H12B2(Yeonho) or compatible
- Mating Connector
  : 20022HS-H14B2(Yeonho) or compatible, 20022HS-H12B2(Yeonho) or compatible

Table 5. LED DRIVER CONNECTOR PIN CONFIGULATION

Pin No	Symbol	Description (Master)	Description (Slave)	Note
1	VBL	Power Supply +24.0V	Power Supply +24.0V	
2	VBL	Power Supply +24.0V	Power Supply +24.0V	
3	VBL	Power Supply +24.0V	Power Supply +24.0V	
4	VBL	Power Supply +24.0V	Power Supply +24.0V	
5	VBL	Power Supply +24.0V	Power Supply +24.0V	
6	GND	Backlight Ground	Backlight Ground	
7	GND	Backlight Ground	Backlight Ground	
8	GND	Backlight Ground	Backlight Ground	1
9	GND	Backlight Ground	Backlight Ground	
10	GND	Backlight Ground	Backlight Ground	
11	Status	Status	No Connection	2
12	VON/OFF	Backlight ON/OFF control	No Connection	4
13	EXTVBR-B	External PWM	-	3, 4
14	NC	No Connection	-	

Notes :1. GND should be connected to the LCD module's metal frame.
2. Normal : Low (under 0.7V) / Abnormal :Open
3. High : on duty / Low : off duty, Pin#13 can be opened. (if Pin #13 is open , EXTVBR-B is 100%)
4. Each impedance of pin #12 and #13 is over 50 [KΩ]

◆ Rear view of LCM



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}	960	960	960	tCLK	1920 / 2
	Blank	t_{HB}	100	140	240	tCLK	1
	Total	t_{HP}	1060	1100	1200	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	

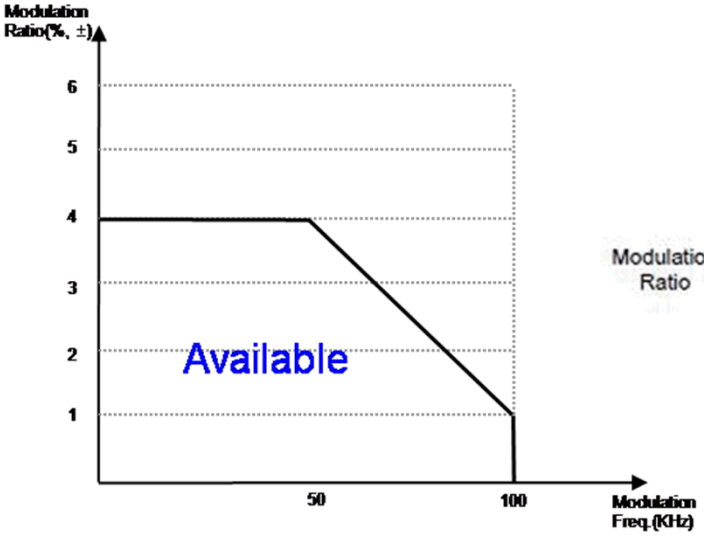
ITEM		Symbol	Min	Typ	Max	Unit	notes
Frequency	DCLK	f_{CLK}	60.00	74.25	78.00	MHz	
	Horizontal	f_H	57.3	67.5	70	KHz	2
	Vertical	f_V	47	60	63	Hz	2

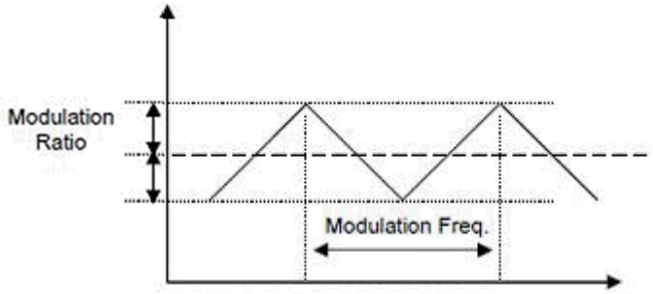
Notes: 1. The input of HSYNC & VSYNC signal does not have an effect on normal operation (DE Only Mode). If you use spread spectrum of EMI, add some additional clock to minimum value for clock margin.

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*Fmod), 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.





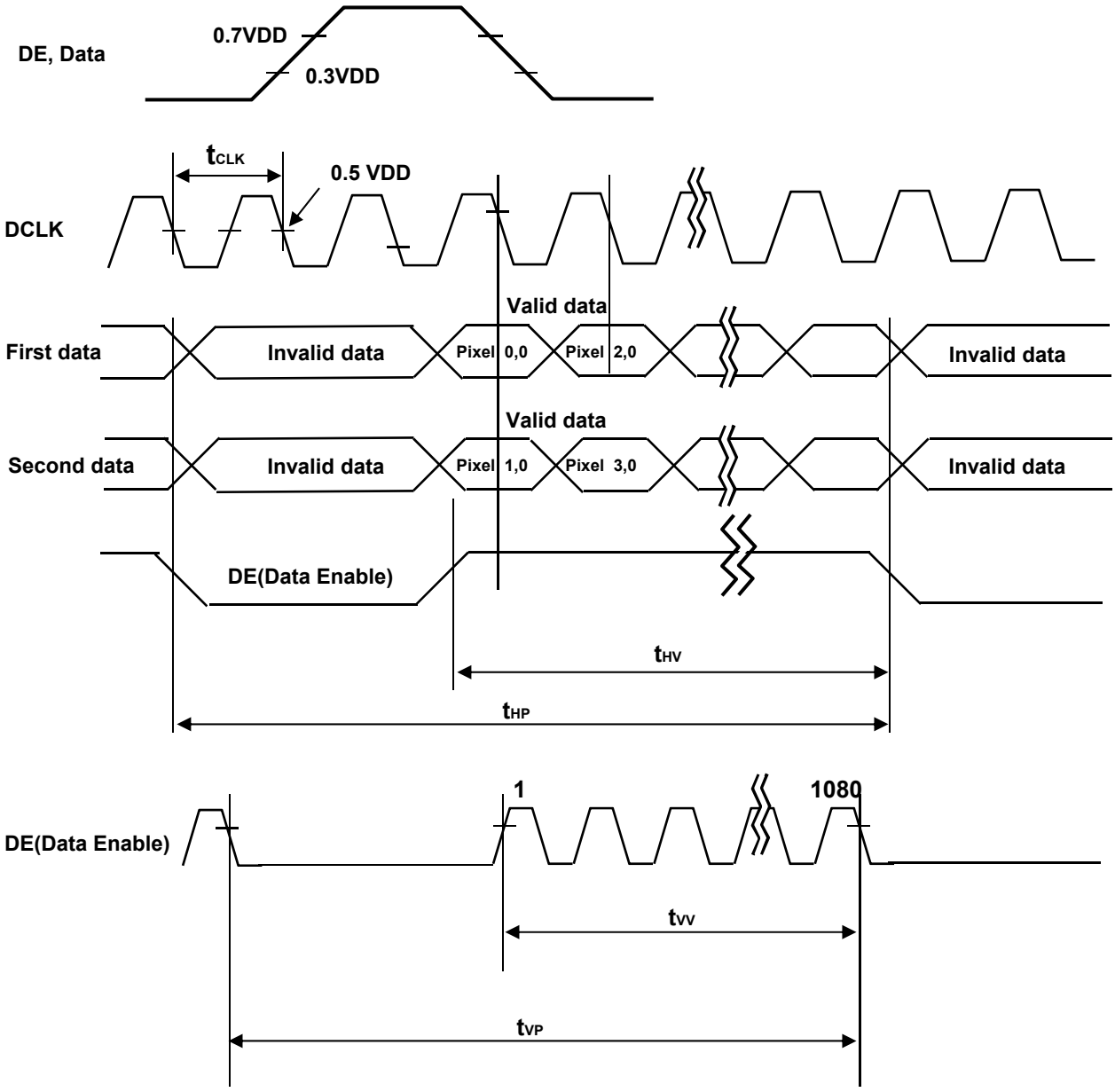
※ Please pay attention to the followings when you set Spread Spectrum Rate(SSR) and Modulation Frequency(FMOD)

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.

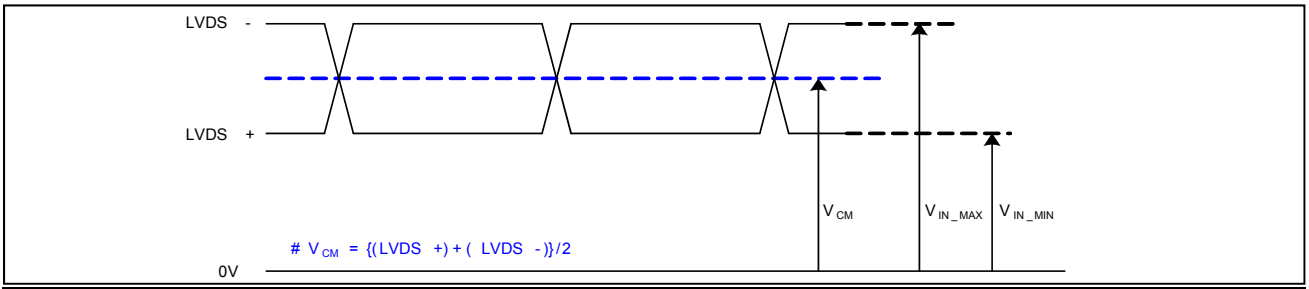
3-4. LVDS Signal Specification

3-4-1. LVDS Input Signal Timing Diagram



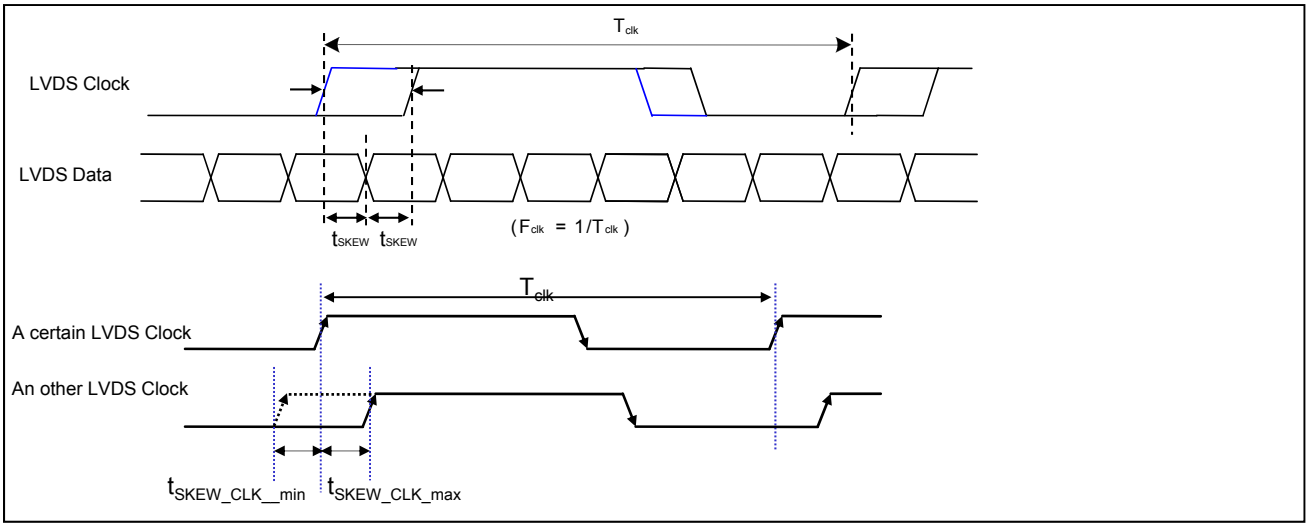
3-4-2. LVDS Input Signal Characteristics

1) DC Specification



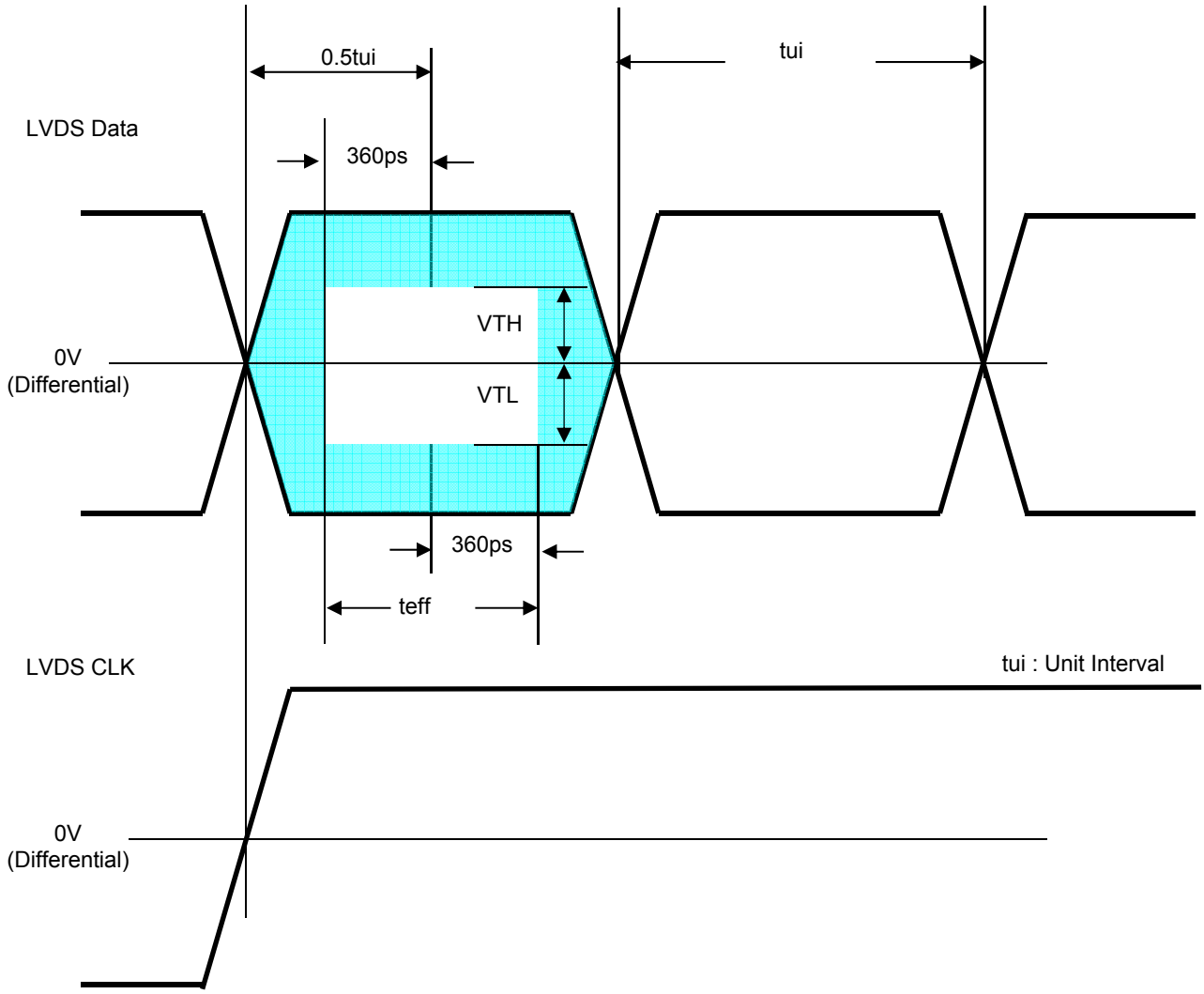
Description	Symbol	Min	Max	Unit	Note
LVDS Common mode Voltage	V_{CM}	1.0	1.5	V	-
LVDS Input Voltage Range	V_{IN}	0.7	1.8	V	-
Change in common mode Voltage	ΔVCM		250	mV	-

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}	-	$\|(0.25*T_{clk})/7\|$	ps	-
Effective time of LVDS	t_{eff}	$\|\pm 360\|$	-	ps	-
LVDS Clock to Clock Skew (Each other)	t_{SKEW_CLK}	-	$\|1/7* T_{clk}\|$	ps	-

notes 1. All Input levels of LVDS signals are based on the EIA 644 Standard.
2. LVDS Differential Voltage is defined within $\mathbf{t_{eff}}$



* This accumulated waveform is tested with differential probe

3-5. Color Data Reference

The brightness of each primary color(red,green,blue) is based on the 10-bit gray scale data input for the color. The higher binary input, the brighter the color. Table 8 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	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	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	1	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	1	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

3-6. Power Sequence

3-6-1. LCD Driving circuit

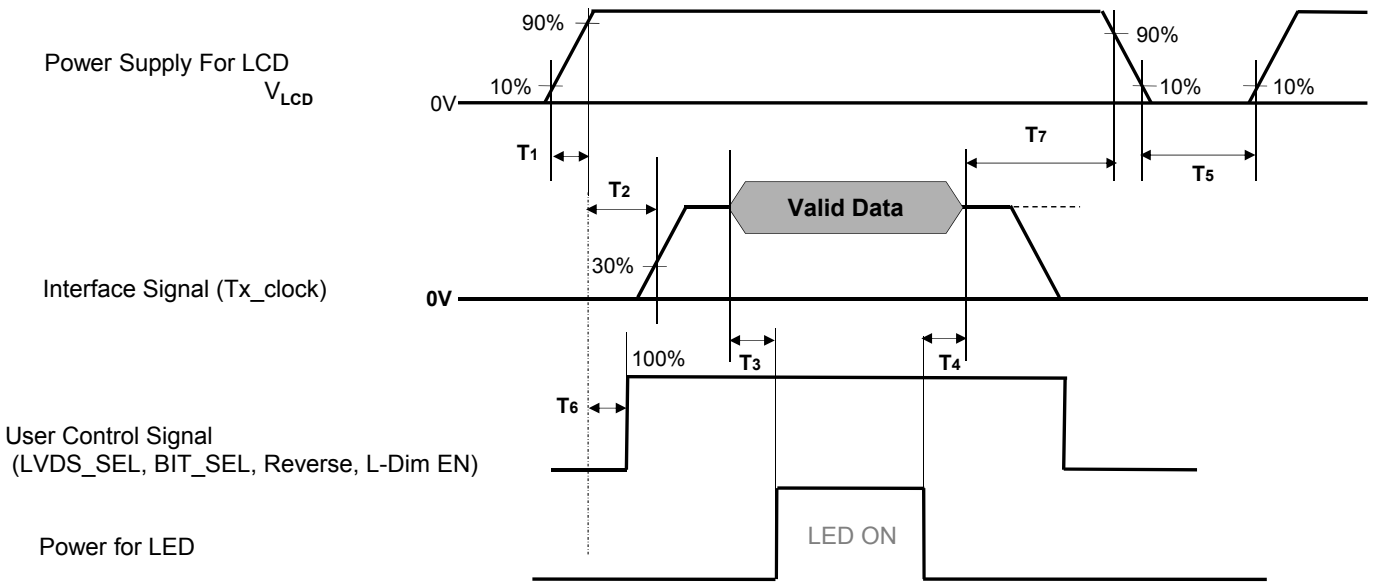


Table 8. POWER SEQUENCE

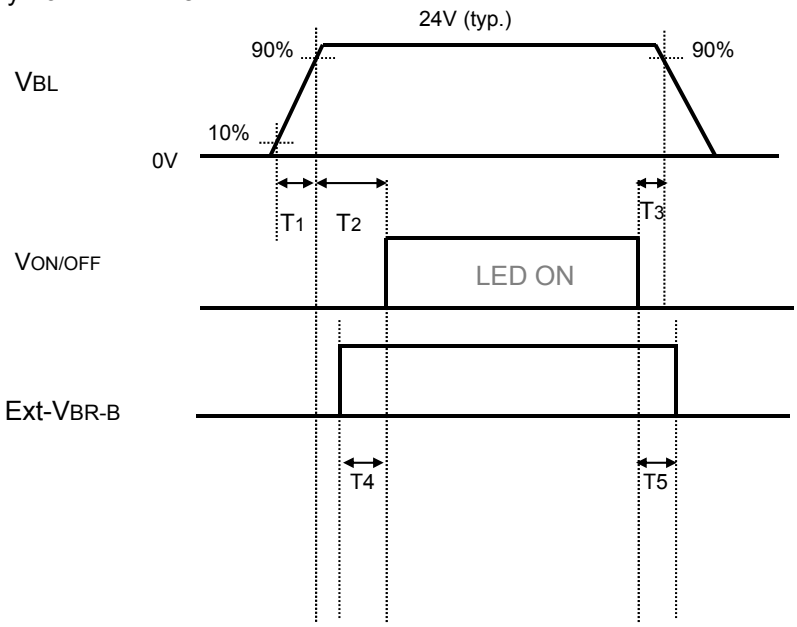
Parameter	Value			Unit	notes
	Min	Typ	Max		
T1	0.5	-	20	ms	1
T2	0	-	400	ms	2
T3	400	-	-	ms	3
T4	100	-	-	ms	3
T5	3.0	-	-	s	4
T6	0	-	T2	ms	5
T7	0	-	-	ms	7

notes :
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.

3-6-2. Sequence for Inverter

Power Supply For LED Driver



3-6-3. Deep condition for Inverter

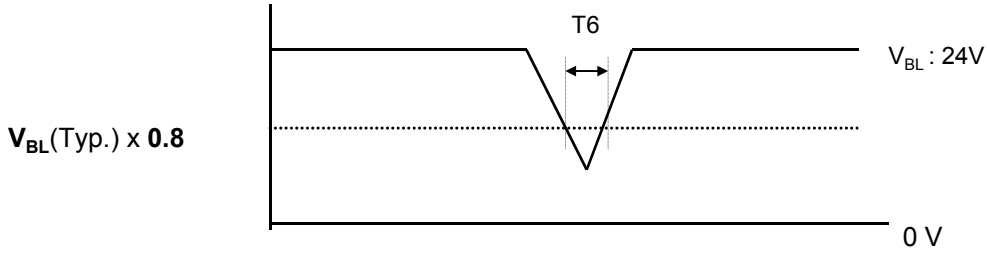


Table 9. Power Sequence for LED DRIVER

Parameter	Values			Units	Remarks
	Min	Typ	Max		
T1	20	-	-	ms	1
T2	500	-	-	ms	
T3	10		-	ms	
T4	0	-	-	ms	
T5	0	-	-	ms	
T6	-	-	10	ms	**V_{BL}**(Typ) x **0.8**

Notes : 1. T1 describes rising time of 0V to 24V and this parameter does not applied at restarting time.
Even though T1 is over the specified value, there is no problem if I^2T spec of fuse is satisfied.

4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' and stable 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 °.
FIG. 1 shows additional information concerning the measurement equipment and method.

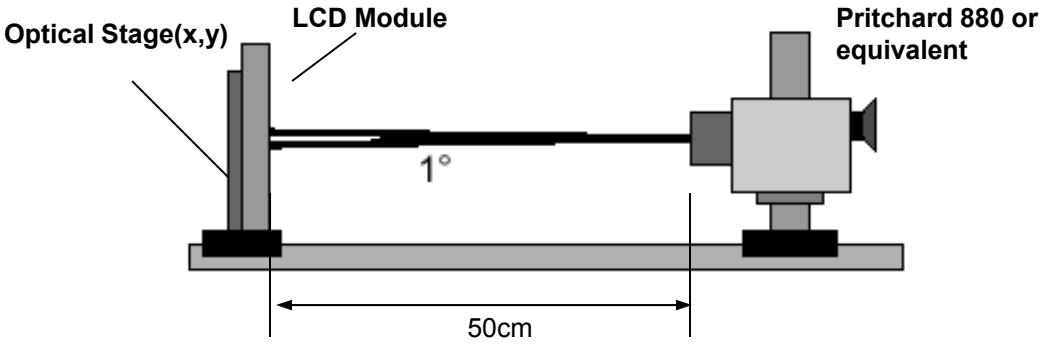


FIG. 1 Optical Characteristic Measurement Equipment and Method

Ta= 25±2°C, V_{LCD}=12.0V, fv=60Hz, Dclk=74.25MHz, ExtVBR-B=100%

Table 10. OPTICAL CHARACTERISTICS

Parameter		Symbol	Value			Unit	Note
			Min	Typ	Max		
Contrast Ratio		CR	900	1200	-		1
Surface Luminance, white		L_{WH}	400	500	-	cd/m²	2
Luminance Variation		δ_{WHITE} 13P	80	90	-		3
Response Time	Gray-to-Gray	G to G	-	8	12	ms	4
Color Coordinates [CIE1931]	RED	Rx	Typ -0.03	0.647	Typ +0.03		
		Ry		0.334			
	GREEN	Gx		0.313			
		Gy		0.615			
	BLUE	Bx		0.152			
		By		0.051			
	WHITE	Wx	Typ -0.02	0.279	Typ +0.02		
		Wy		0.292			
Color Temperature				10,000		K	
Color Gamut (NTSC)				72		%	
Viewing Angle (CR>10)							
	x axis, right(ϕ=0°)	θr	89	-	-	degree	5
	x axis, left (ϕ=180°)	θl	89	-	-		
	y axis, up (ϕ=90°)	θu	89	-	-		
	y axis, down (ϕ=270°)	θd	89	-	-		
Gray Scale			-	-	-		6

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

CR(Contrast Ratio) = Maximum CRn (n=1, 2, 3, 4, 5)

$$CRn = \frac{\text{Surface Luminance at position n with all white pixels}}{\text{Surface Luminance at position n with all black pixels}}$$

n = the Position number(1, 2, 3, 4, 5). For more information, see FIG 2-1.

. 2.Optical Characteristics is determined after the unit has been 'ON' and 1 Hour after lighting the backlight in a dark environment at 25±2°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. 2-1.

3. δ WHITE(13P) = Minimum(Lon1,Lon2, Lon3,…, Lon12, Lon13)
/ Maximum(Lon1,Lon2, Lon3,…, Lon12, Lon13)*100(%)
Where Lon1 to Lon13 are the luminance with all pixels displaying white at 13 locations .
For more information, see the FIG. 2-2.

4. Response time is the time required for the display to transition from G(N) to G(M) (Rise Time, Tr_R) and from G(M) to G(N) (Decay Time, Tr_D). For additional information see the FIG. 3. (N<M)
※ G to G Spec is average of measured time (N, M = 0 (Black) ~ 1023(White), 128 gray step).

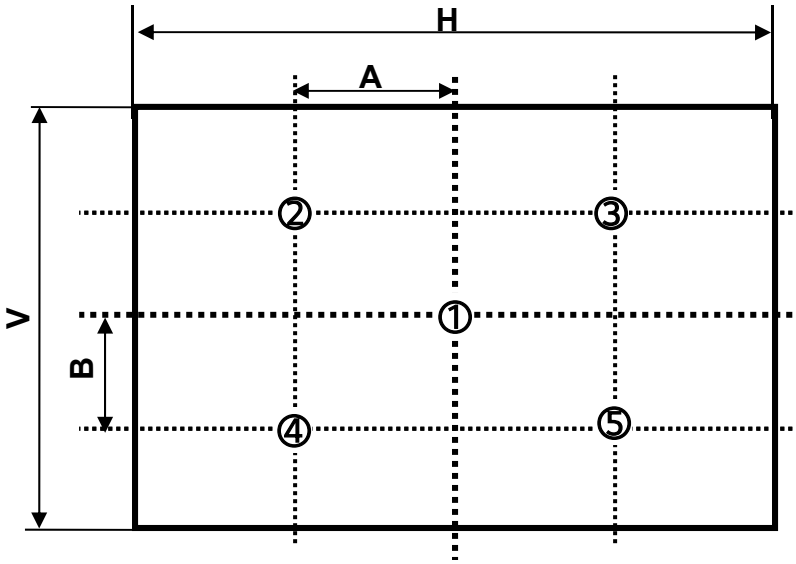
5. Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD module surface. For more information, see the FIG. 4.

6. Gray scale specification
Gamma Value is approximately 2.2. For more information, see the Table 11.

Table 11. GRAY SCALE SPECIFICATION

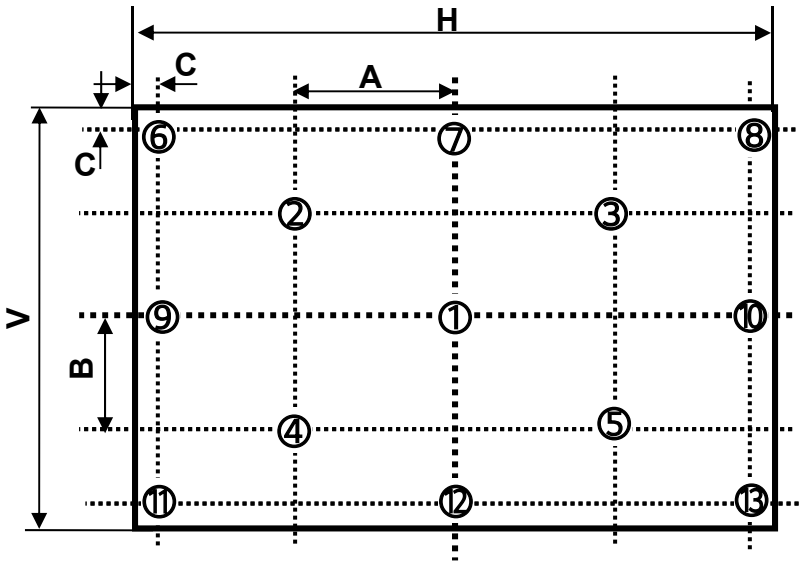
Gray Level	Luminance [%] (Typ.)
L0	0.083
L63	0.27
L127	1.04
L191	2.49
L255	4.68
L319	7.66
L383	11.5
L447	16.1
L511	21.6
L575	28.1
L639	35.4
L703	43.7
L767	53.0
L831	63.2
L895	74.5
L959	86.7
L1023	100

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



A : H / 4 mm
B : V / 4 mm
@ H,V : Active Area

FIG. 2-1 5 Points for Contrast Ratio Measure



A : H / 4 mm
B : V / 4 mm
C : 25 mm
@ H,V : Active Area

FIG. 2-2 13 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 "Gray(M)".

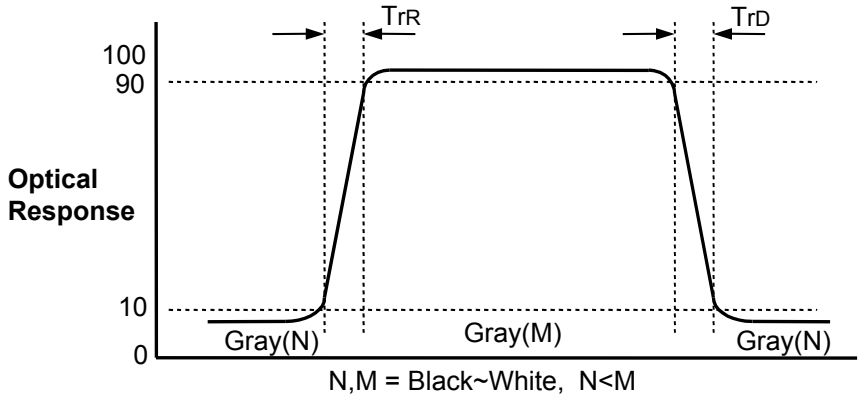


FIG. 3 Response Time

Dimension of viewing angle range

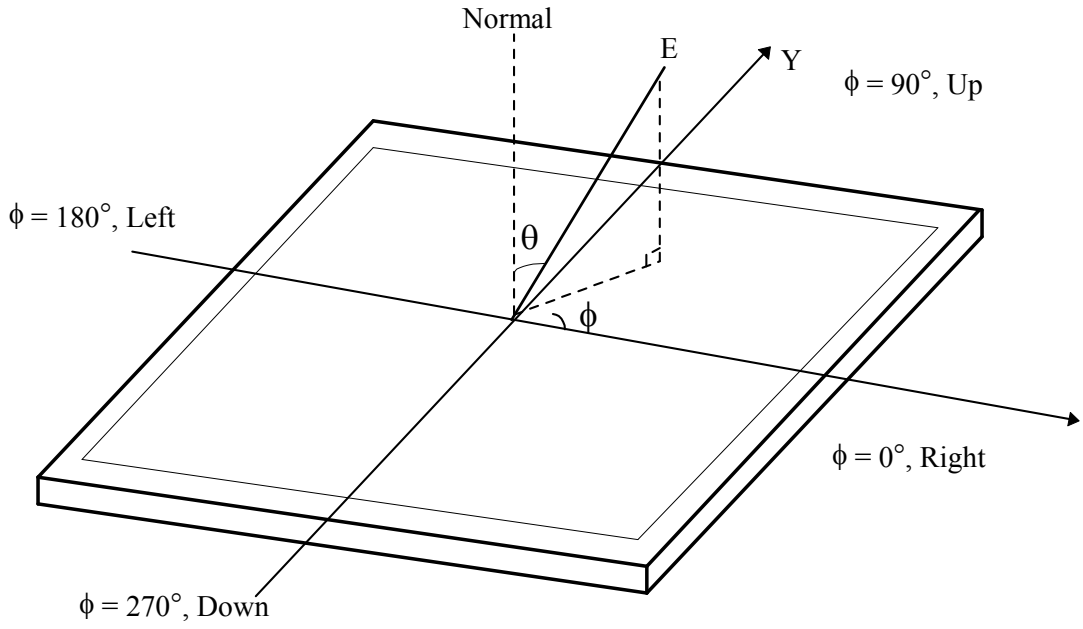


FIG. 4 Viewing Angle

5. Mechanical Characteristics

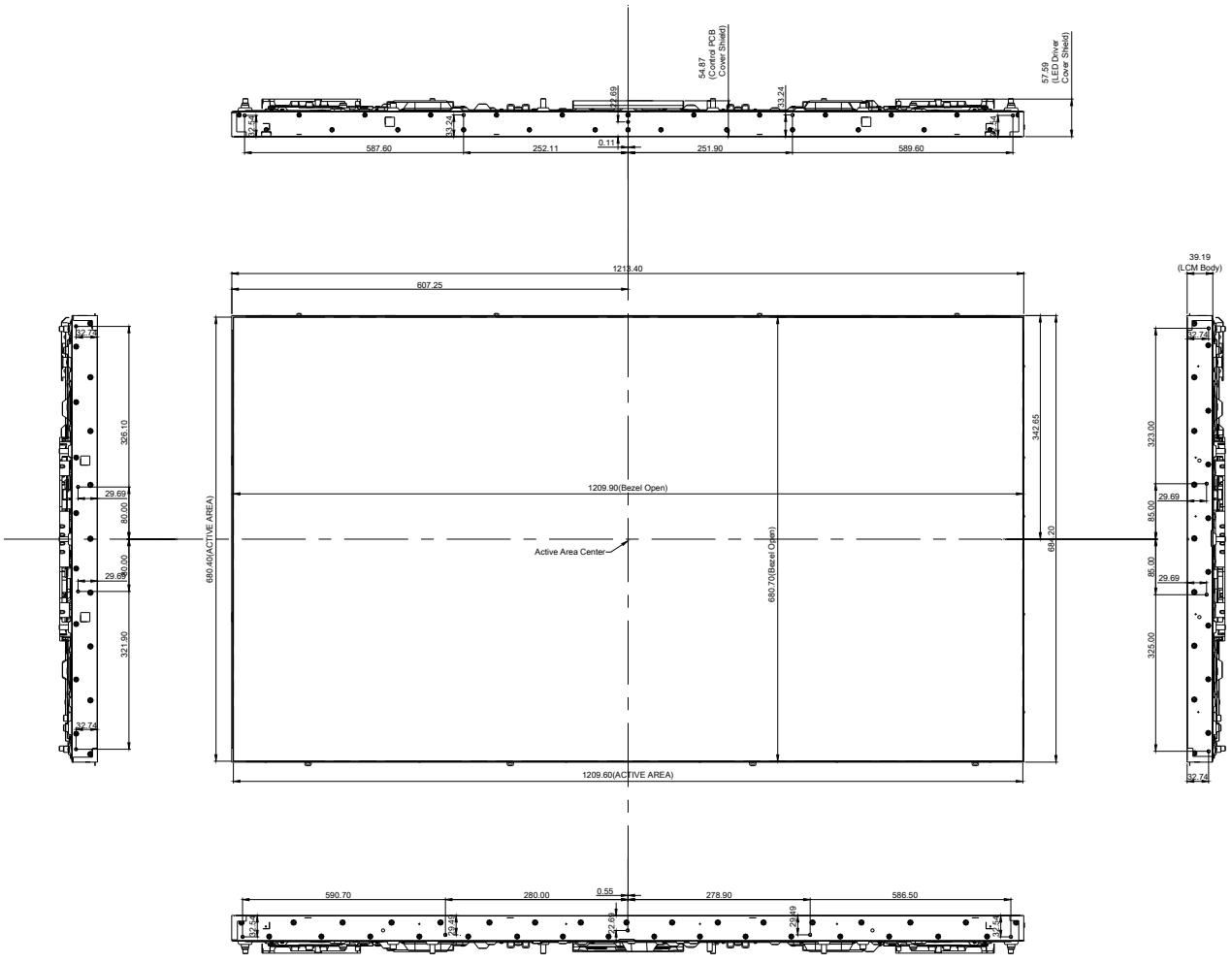
Table 12 provides general mechanical characteristics.

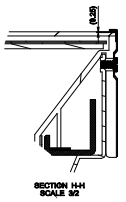
Table 12. MECHANICAL CHARACTERISTICS

Item	Value	
Outline Dimension	Horizontal	1213.4 mm
	Vertical	684.2 mm
	Depth	39.2 mm
Bezel Area	Horizontal	1209.9 mm
	Vertical	680.7 mm
Active Display Area	Horizontal	1209.6 mm
	Vertical	680.4 mm
Weight	15.1 Kg(Typ.), 16.5Kg(Max.)	

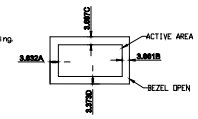
Note : Please refer to a mechanic drawing in terms of tolerance at the next page.

<FRONT VIEW>

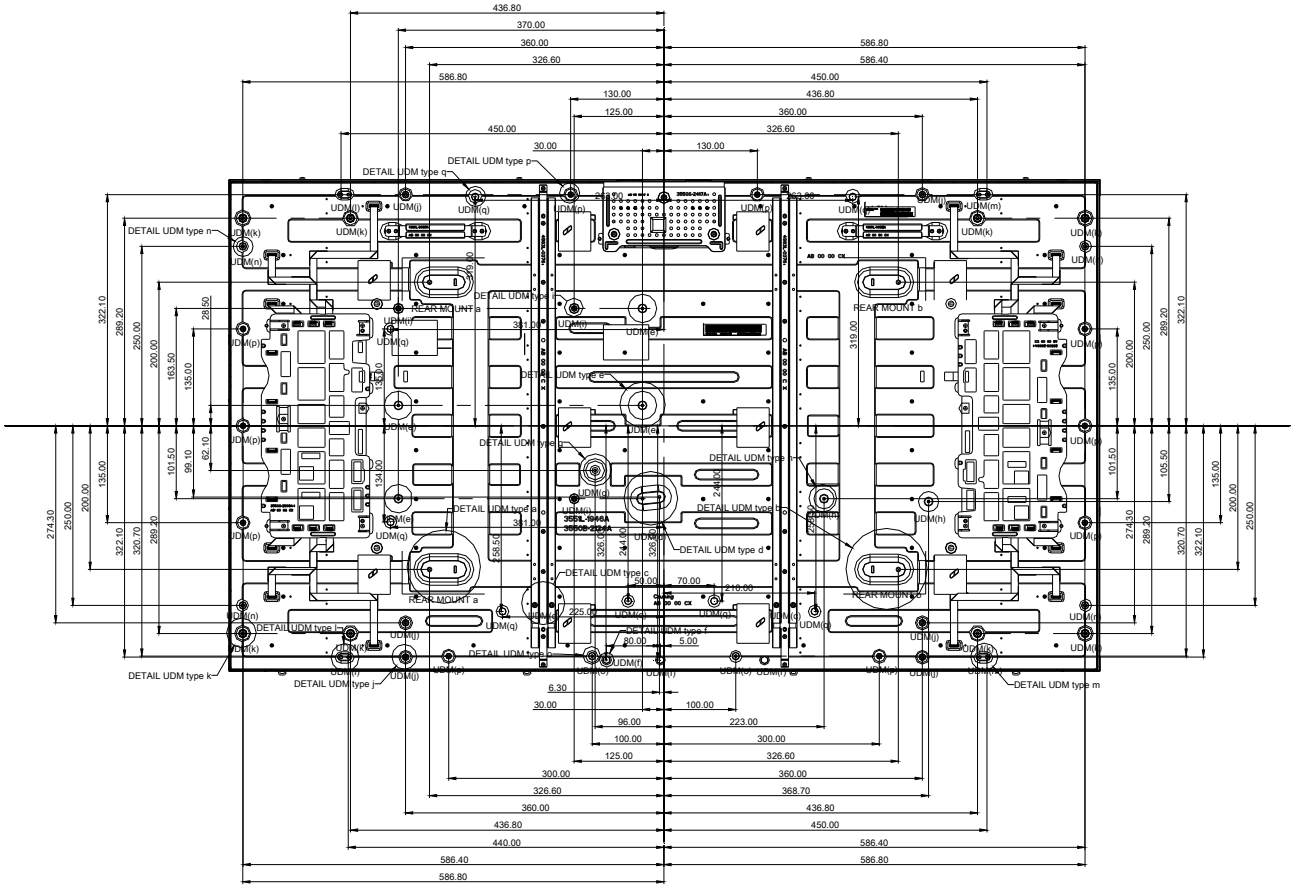




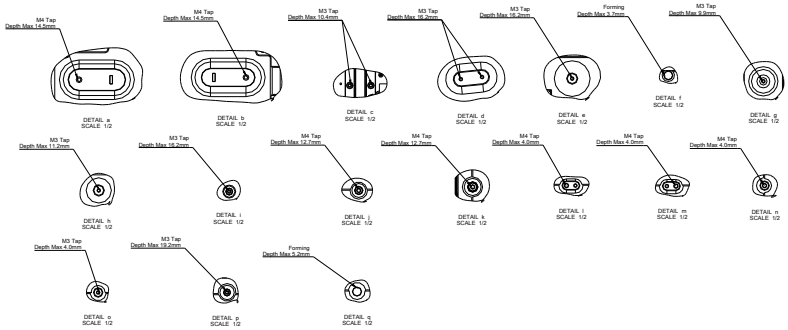
Note
1. Unspecified tolerance is 1.0mm
2. Tilt and partial disposition tolerance of display area as following.
   (a) Y-Direction : |A-B| = 1.0 or |A-B| <1.0
   (b) X-Direction : |C-D| = 1.0 or |C-D| <1.0
3. Max Torque : refer to table
4. Max Depth : refer to table
5. The same figure means the same dimension.
6. Designer's approval is required before mass-pro.



<REAR VIEW>



Item	Type	Tap	Max. Depth (mm)	Torque (Kgf cm)	Notes
Rear mount	a	M4	14.5		2ea
	b	M4	14.5		2ea
UDM	c	M3	10.4		2ea
	d	M3	16.2		1ea
	e	M3	16.2		4ea
	f	-	3.7		Forming, 2ea
	g	M3	9.9		1ea
	h	M3	11.2		2ea
	i	M3	16.2		Pem-nut, 3ea
	j	M4	12.7		Pem-nut, 6ea
	k	M4	12.7		Pem-nut, 8ea
	l	M4	4.0		2ea
	m	M4	4.0		2ea
	n	M4	4.0		4ea
	o	M3	4.0		2ea
	p	M3	19.2		Pem-nut, 10ea
	q	-	5.2	-	Forming, 8ea



6. 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)	6kgf (note2)

Note : 1. Before and after Reliability test, LCM should be operated with normal function.
2. Guarantee panel crack less than 6kgf

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 Electrotechnical Standardization (CENELEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.
d) IEC 60950-1, The International Electrotechnical 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. 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)
D : YEAR
E : MONTH
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 : 10 pcs

b) Pallet Assy Size : 1440mm(W) X 1140mm(D) X 950mm(H)

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 specified mounting holes (Details refer to the drawings).
(2) You should consider the mounting structure so that uneven force (ex. Twisted stress, Concentrated 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 benzine. 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) Touching the LED Driver might cause an electric shock and damage to LED Driver. Please always use antistatic tools when handling the LED Driver.

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 lower 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 can causes conductive particles and deal LCM a fatal blow)
(9) Please do not set LCD on its edge.
(10) The conductive material and signal cables are kept away from LED driver inductor to prevent abnormal display, sound noise and temperature rising.

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.
(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.

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.

9-7. 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℃
- 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.

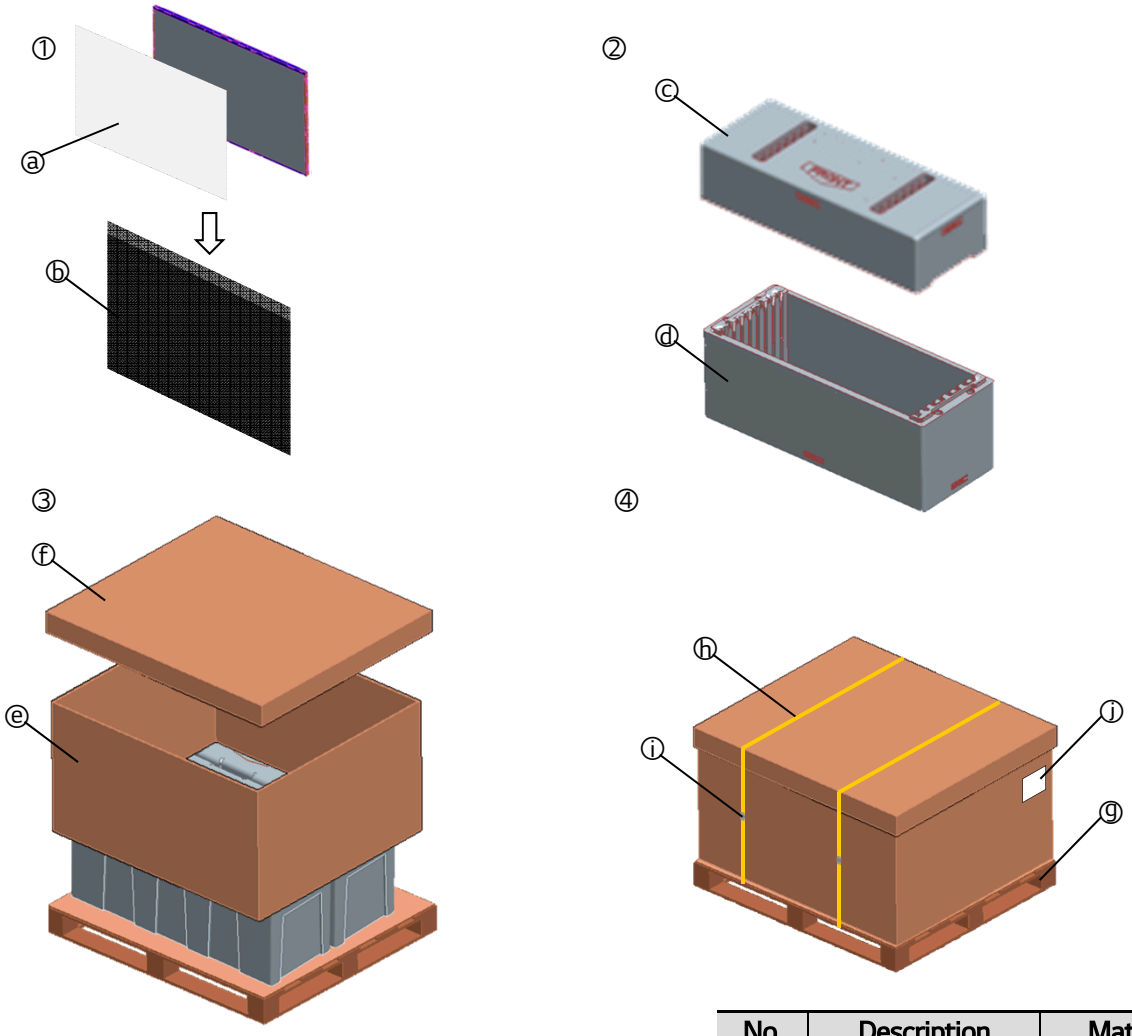
3. Operating usages to protect against image sticking due to long-term static display
   a. Suitable operating time: under 24 hours a day.
      (* The moving picture can be allowed for 24 hours a day)
   b. Static information display recommended to use with moving image.
      - Cycling display between 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 clockwise based on front view when used in portrait mode.

APPENDIX- I-1

■ Pallet Ass'y

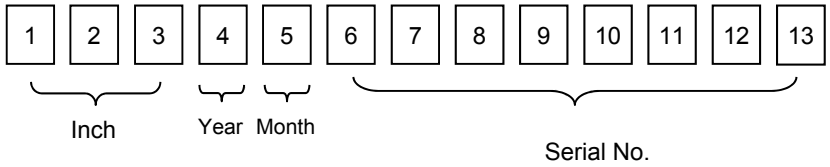


No.	Description	Material
ⓐ	Protect Film	PE
ⓑ	BAG	AL
ⓒ	Packing Top	EPS
ⓓ	Packing Bottom	EPS
ⓔ	Angle Packing	Double Wall
ⓕ	Angle Cover	Single Wall
ⓖ	Pallet	Plywood
ⓗ	Band	PP
ⓘ	Clip	Steel
Ⓙ	Label	Paper

APPENDIX-I-2

■ LCM Label

■ Serial No. (See CAS page 27 for more information)

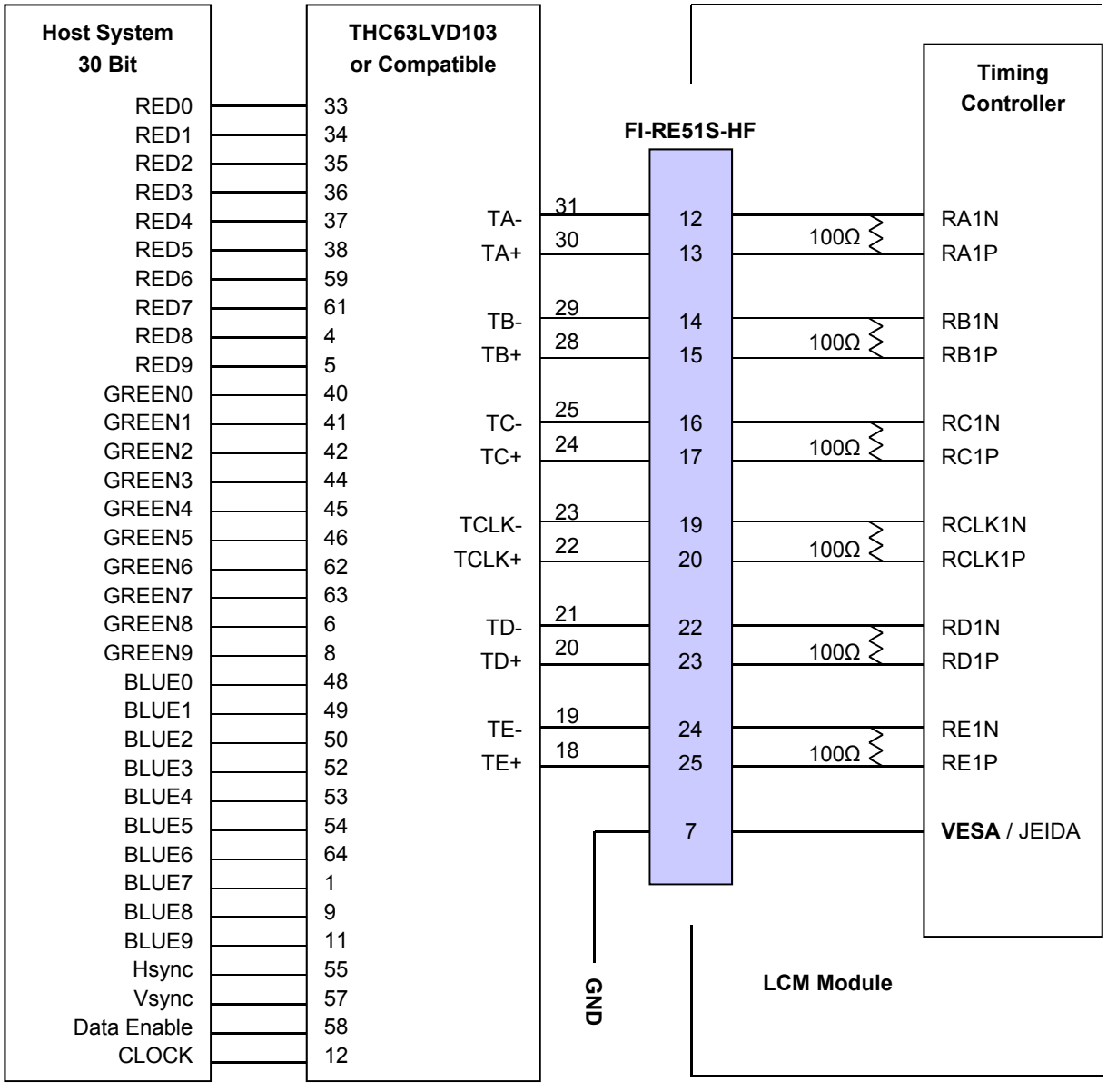


APPENDIX- I-3

■ Pallet Label

APPENDIX-II-1

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

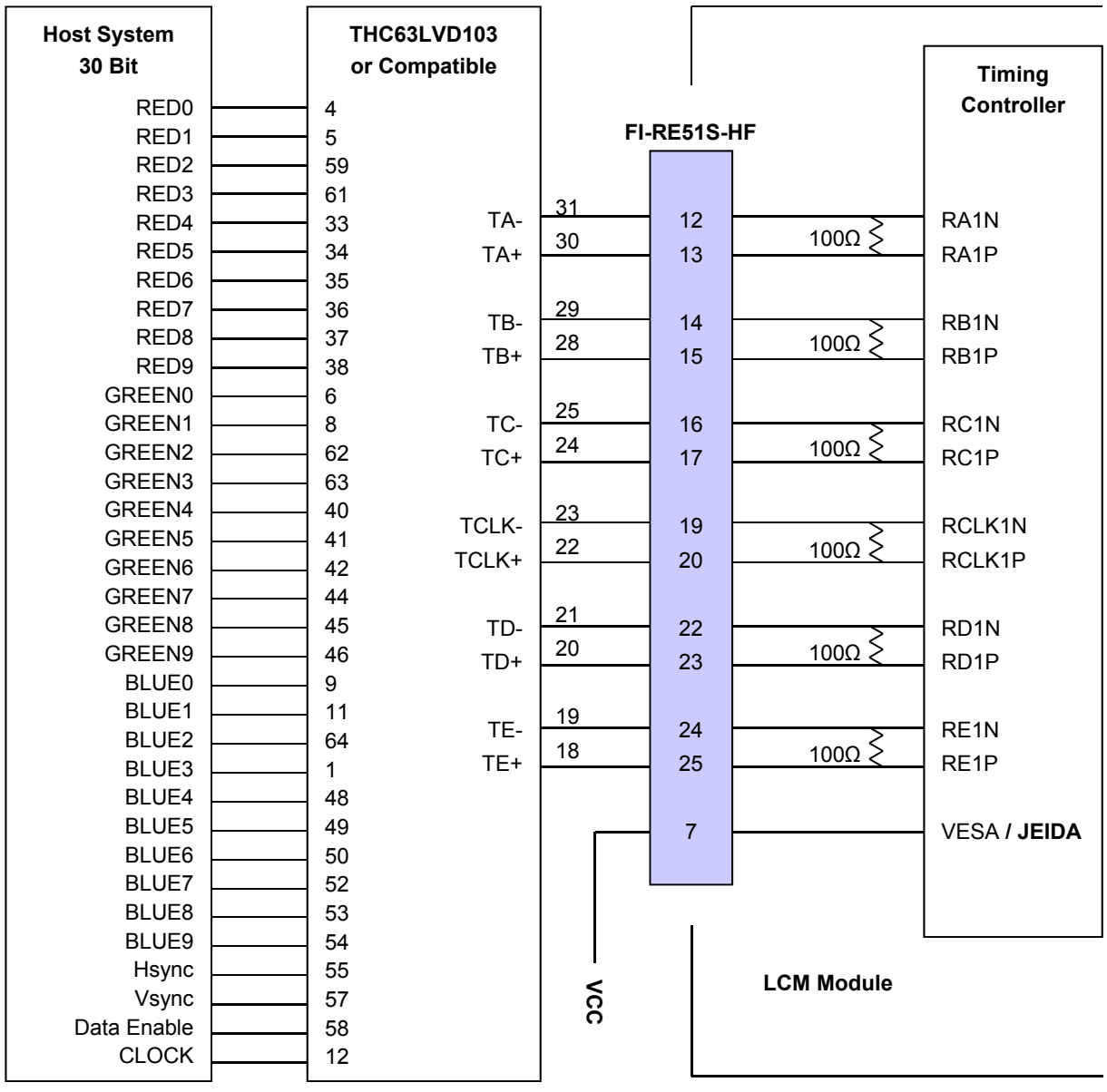


Notes:

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.

APPENDIX-II-2

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



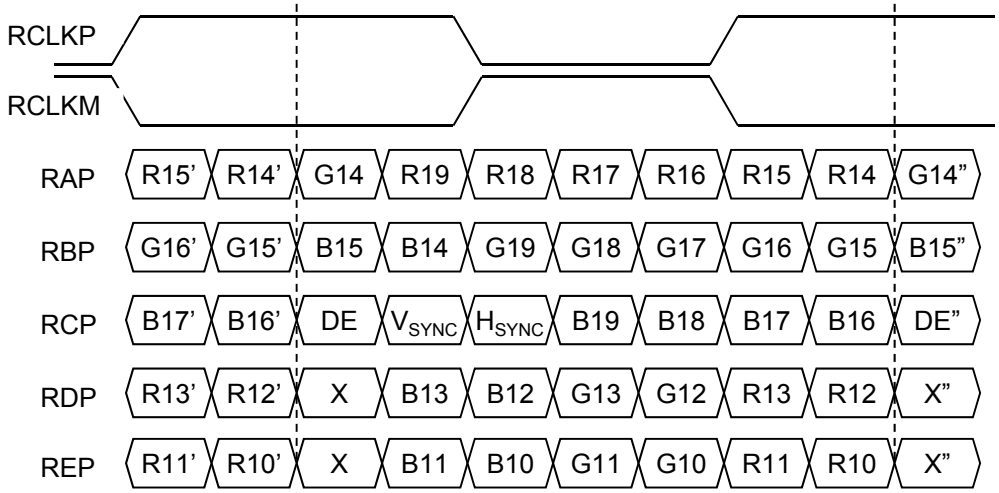
Notes:

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.

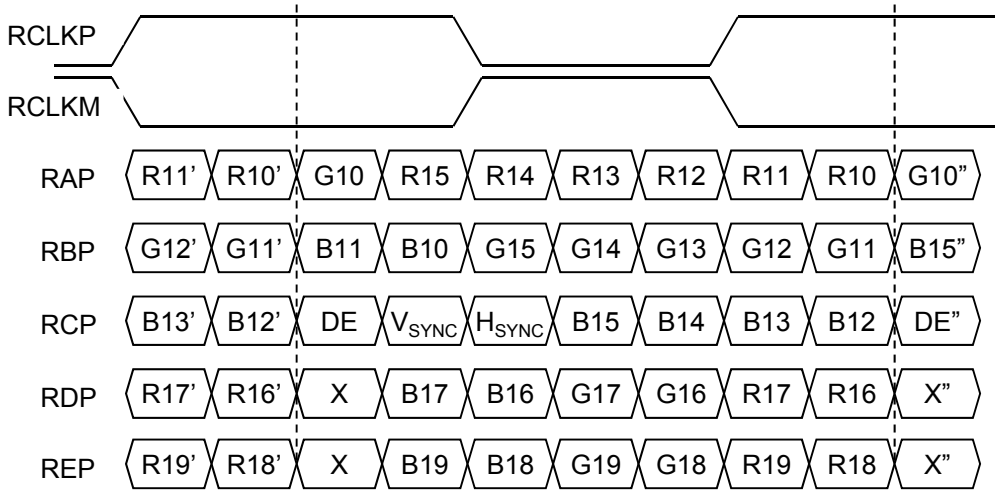
 # APPENDIX- III-1

LVDS Data-Mapping info. (10bit)

■ LVDS Select : “H” Data-Mapping (JEIDA format)



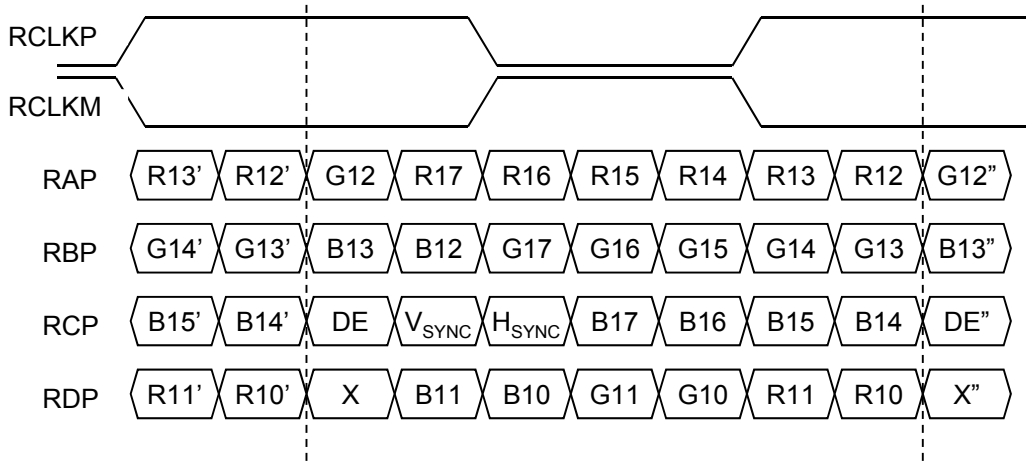
■ LVDS Select : “L” Data-Mapping (VESA format)



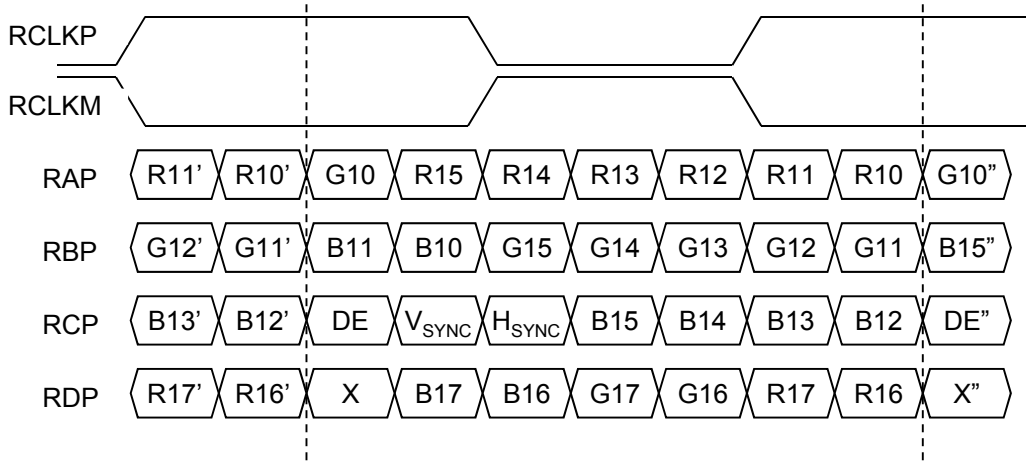
 # APPENDIX-III-2

LVDS Data-Mapping info. (8bit)

■ LVDS Select : “H” Data-Mapping (JEIDA format)



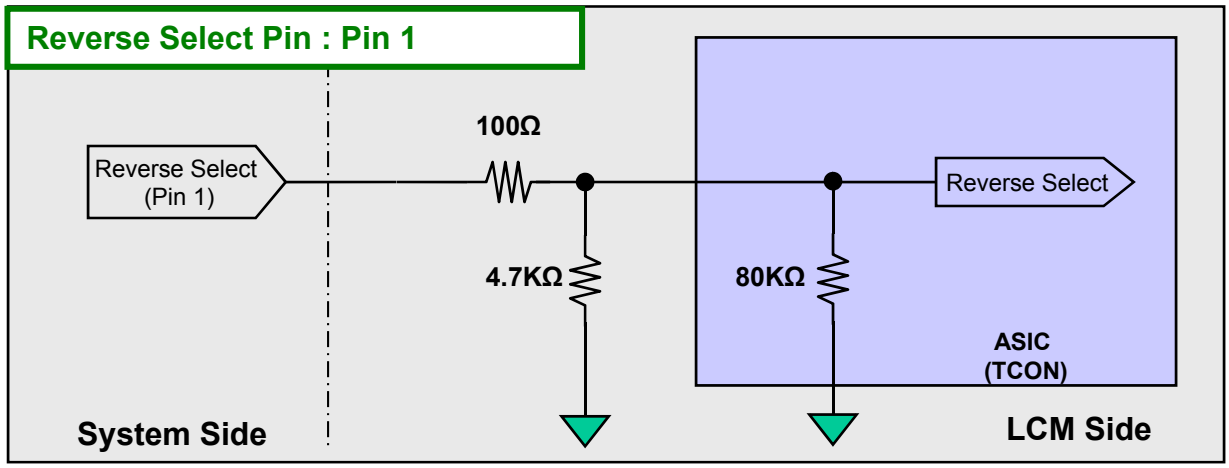
■ LVDS Select : “L” Data-Mapping (VESA format)



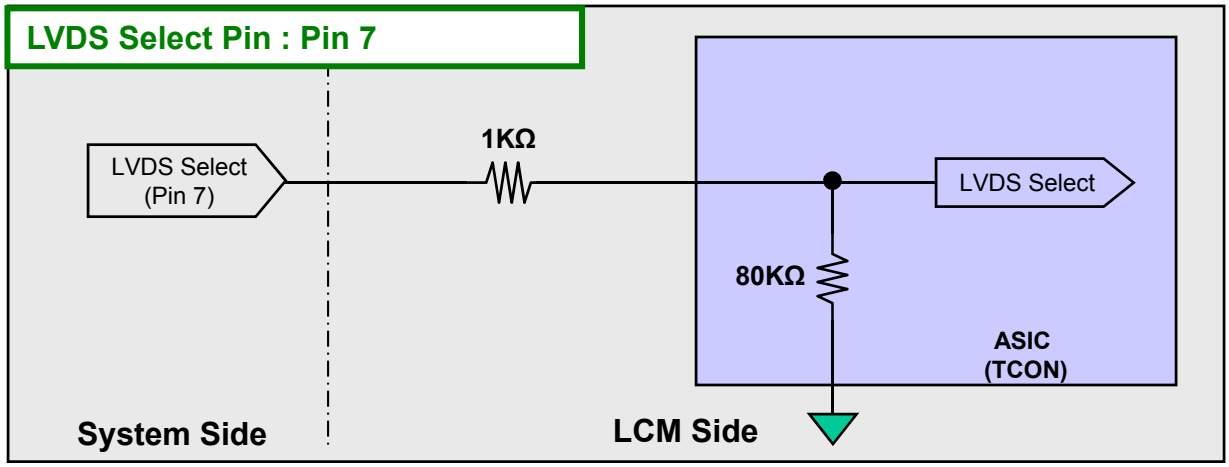
APPENDIX-IV

■ **Option Pin** Circuit Block Diagram

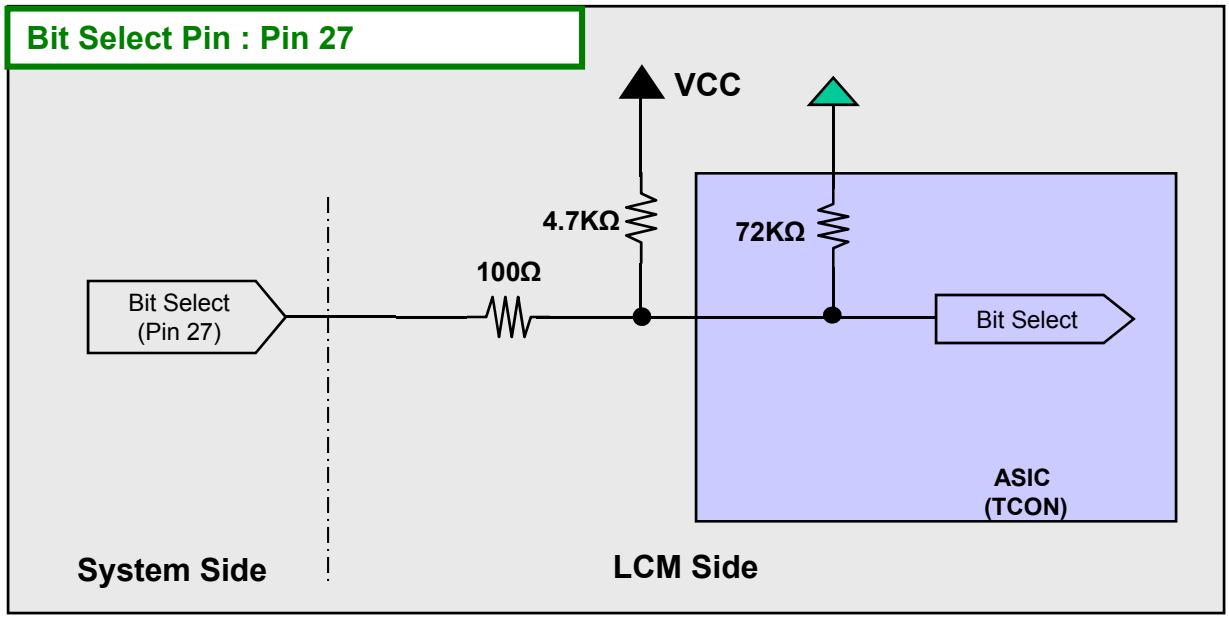
1) Circuit Block Diagram of **Reverse** pin



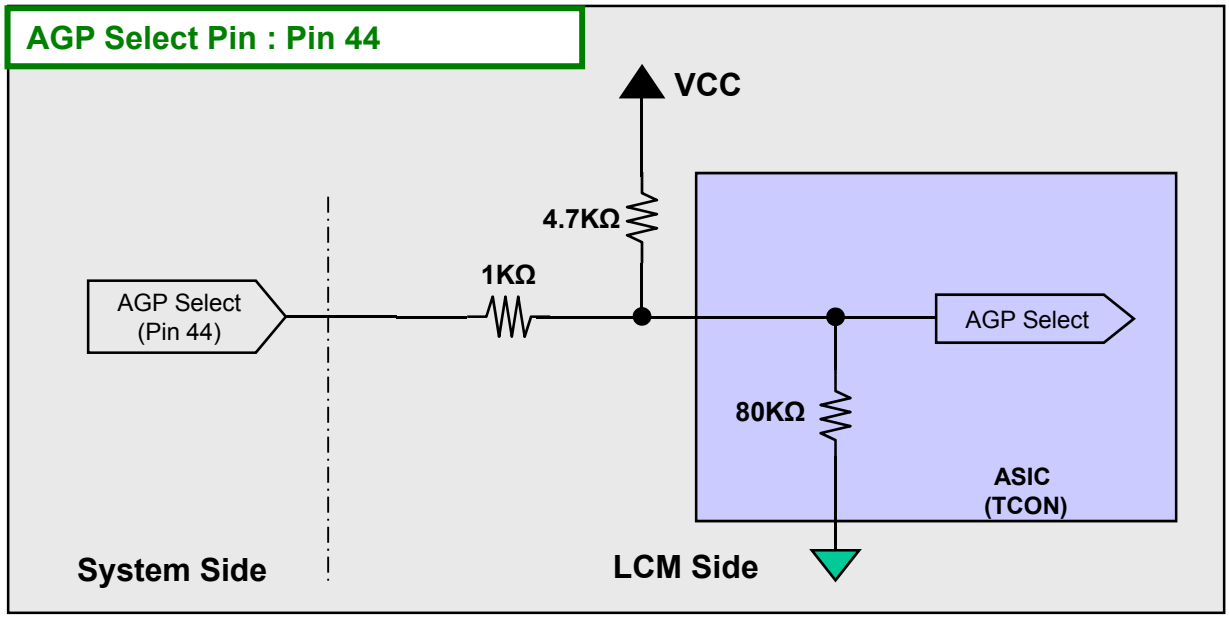
2) Circuit Block Diagram of **LVDS Format** Selection pin



3) Circuit Block Diagram of **Bit selection** pin



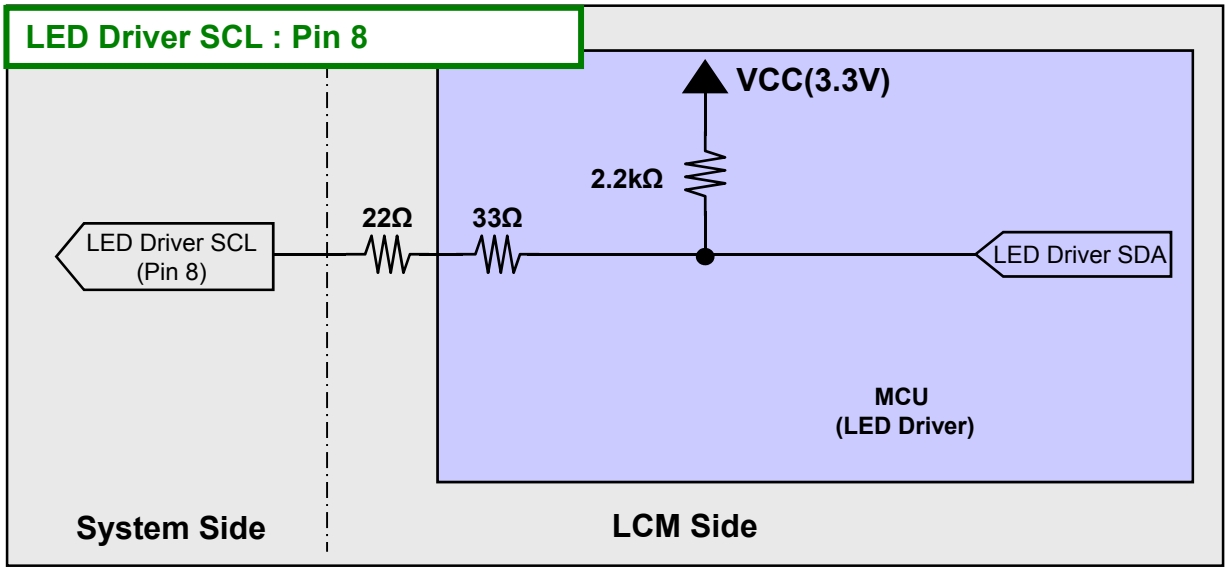
4) Circuit Block Diagram of **AGP Option** pin



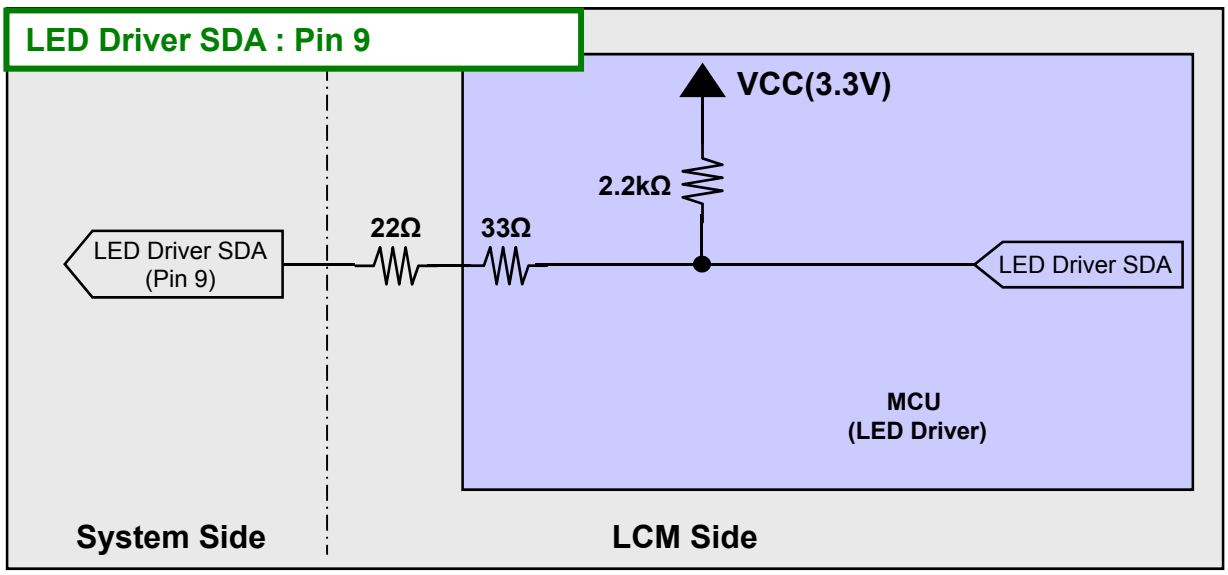
APPENDIX-V

■ LED Driver **SCL, SDA Pin** Circuit Diagram

1) Circuit Block Diagram of **LED Driver SCL** pin



1) Circuit Block Diagram of **LED Driver SDA** pin



APPENDIX- VI

■ **EXTV**BR-B & **Local Dimming** Design Guide

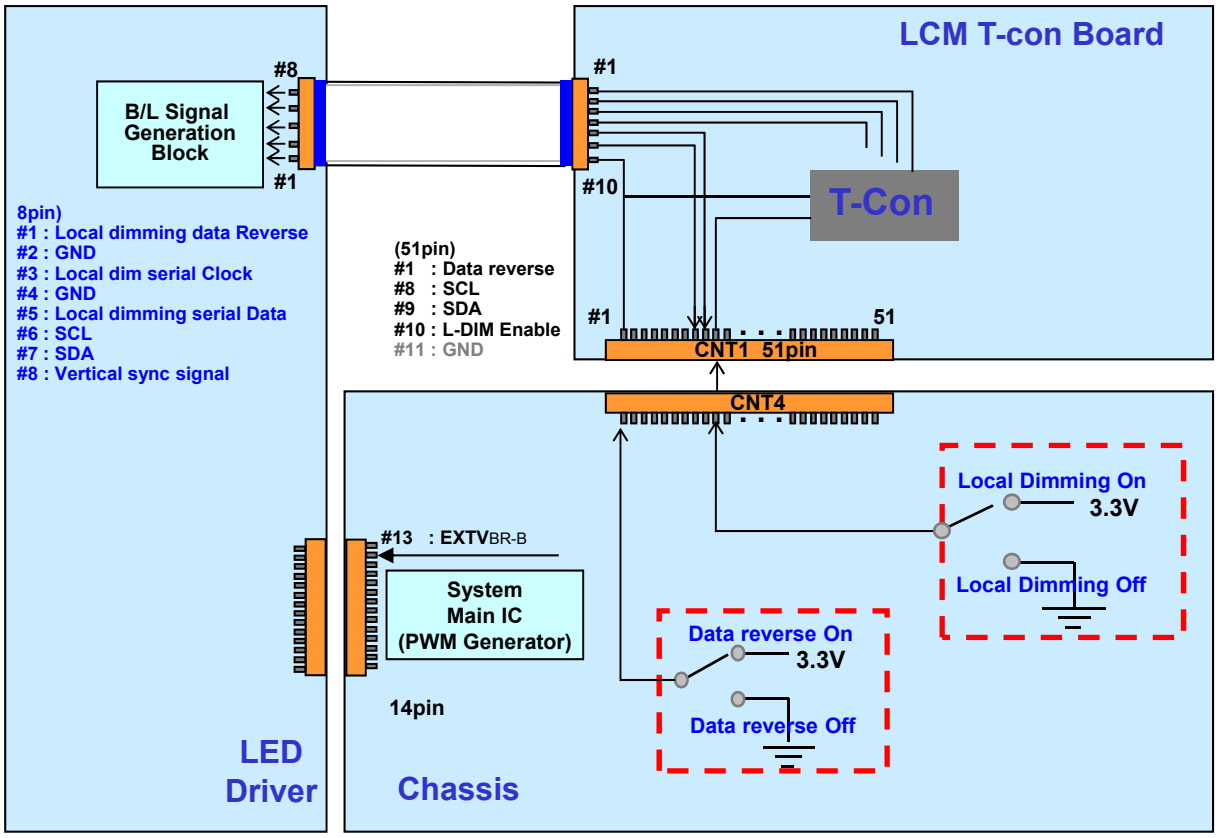
1) When L-Dim Enable is “L", Vertical Sync Signal = System Dimming with 100Hz or 120Hz frequency.

2) Local Dimming signals are synchronized with V-Sync Freq. of System in T-Con Board.

3) EXTVBR-B Specification (VCC = 3.3V) @ Local Dimming , Reverse Specification

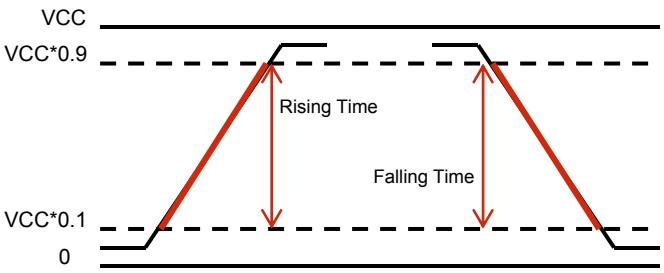
a) High Voltage Range : 2.5 V ~ 3.6 V

b) Low Voltage Range : 0.0 V ~ 0.7 V



<With Driver Model>

EXTVBR-B Frequency	100 Hz for PAL 120 Hz for NTSC
Rising Time	MAX 10.0 μs
Falling Time	MAX 10.0 μs



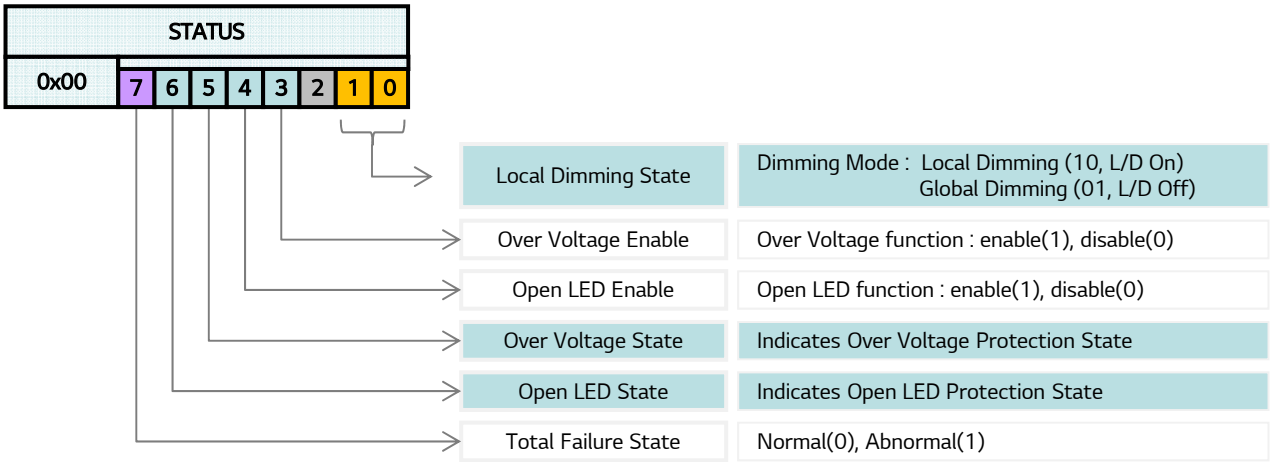
APPENDIX- VII

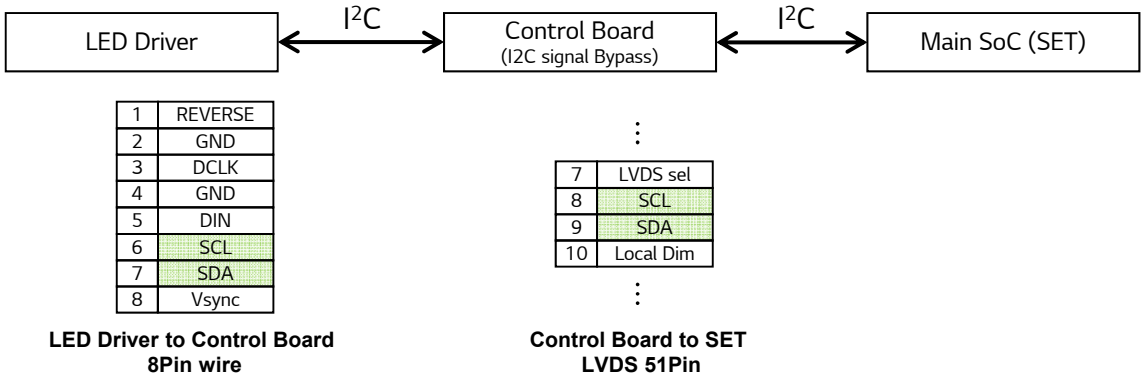
■ Defect Detecting Mode (LED Driver)

1) It is possible to get defect information by I²C when LCM is defected

2) Failure mode that can be detected
- Open LED, Over Voltage
- Protection Operation status, Local Dimming Operation status

▶ I²C Data format (2Byte)





LED Driver to Control Board 8Pin wire

Control Board to SET LVDS 51Pin