TO :

Date : 2001. 12. 10.

SAMSUNG TFT-LCD

MODEL NO. : LTM190E1-L01

Note: _____

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Any Modification of Spec is not allowed without SEC's permission.

Samsung Electronics Co . , LTD.

wise view™

SAMSUNG TFT-LCD

Contents

* Description

LTM190E1-L01 is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFTs as a switching devices. This model is composed of a TFT LCD panel, a driver circuit and a back-light system. The resolution of a 19.0" contains 1280 x 1024 pixels and can display up to 16.7 million colors with wide viewing angle of 85° or higher in all directions. (Vertical viewing angle : 170° , Horizontal viewing angle : 170°)

* Features

- High contrast ratio, high aperture structure
- PVA(Patterned Vertical Alignment) mode
- Wide viewing angle
- High speed response
- SXGA(1280 x 1024 pixels) resolution
- Low power consumption
- 2 dual CCFT(Cold Cathode Fluorescent Tube)
- DE only mode
- LVDS(Low Voltage Differential Signaling) interface (2pixel/clock)

* Applications

Workstation & desktop monitors
Display terminals for AV application products
Monitors for industrial machine

* General information

Items	Specification	Unit	Note
Display area	376.32(H) × 301.056(V)	mm	
Driver element	a-Si TFT active matrix		
Display colors	16.7M (true)	colors	
Number of pixels	1280 x 1024	pixel	
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.098(H) × 0.294(V)	mm	
Display mode	Normally Black		
Surface treatment	Haze 44% , Hard-coating (3H)		

* **Mechanical information**

Item		Min.	Typ.	Max.	Note
Module size	Horizontal(H)	404.15	404.2	404.25	mm
	Vertical(V)	329.5	330.0	330.5	mm
	Depth(D)	-	20.0	20.3	mm
Weight		-	-	2,700	g

1. Absolute Maximum Ratings

1.1 Absolute ratings of environment

Item	Symbol	Min.	Max.	Unit	Note
Storage temperature	T$_{STG}$	-20	65	℃	(1)
Operating temperature (Ambient temperature)	T$_{OPR}$	0	50	℃	(1)
Shock (non - operating)	Snop	-	50	G	(2),(4)
Vibration (non - operating)	Vnop	-	1.5	G	(3),(4)

Note (1) Temperature and relative humidity range are shown in the figure below.

　　　90 % RH Max. (40 °C $\geq$ Ta)

　　　Maximum wet-bulb temperature at 39 °C or less. (Ta > 40 °C)　No condensation.

(2)　11ms, sine wave, one time for　±X, ±Y, ±Z axis

(3)　10-300 Hz, Sweep rate 10min, 30min for X,Y,Z axis

(4)　At testing Vibration and Shock, the fixture in holding the Module to be tested have to be hard and rigid enough so that the Module would not be twisted or bent by the fixture.

Relative Humidity (%RH)

Operating Range

Storage Range

Temperature (°C)

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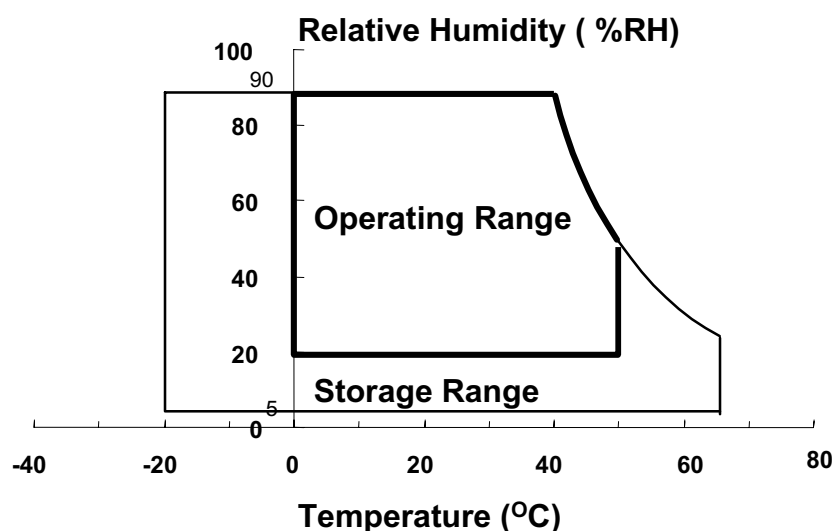
1.2 ELECTRICAL   ABSOLUTE   RATINGS

(1) TFT LCD Module   (Vss = GND = 0 V)

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	VDD	Vss-0.5	6.5	V	(1)

NOTE (1)   Within Ta (25 ± 2 °C)

(2) BACK-LIGHT UNIT   (Ta = 25 ± 2°C)

Item	Symbol	Min.	Max.	Unit.	Note
Lamp Current	IL	2.0	7.0	mArms	(1),(2)
Lamp Frequency	fL	30	80	kHz	(1)

NOTE (1)   Permanent   damage to the device may occur if maximum values are exceeded.
Functional operation should be restricted to the conditions described under Normal
Operating Conditions.

(2)   Specified values are for a single lamp (Refer to the Note (1) in the page 11 for
further information).

2. Optical Characteristics

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (1).

Measuring equipment :   TOPCON BM-5A , BM-7, PHOTO RESEARCH PR650

Eldim EZ-Contrast

(Inverter Freq. : 54kHz)   * Ta = 25 ± 2°C, V_{DD}=5V,   fv= 60Hz, f_{DCLK}=54MHz, I_L = 6.5mArms

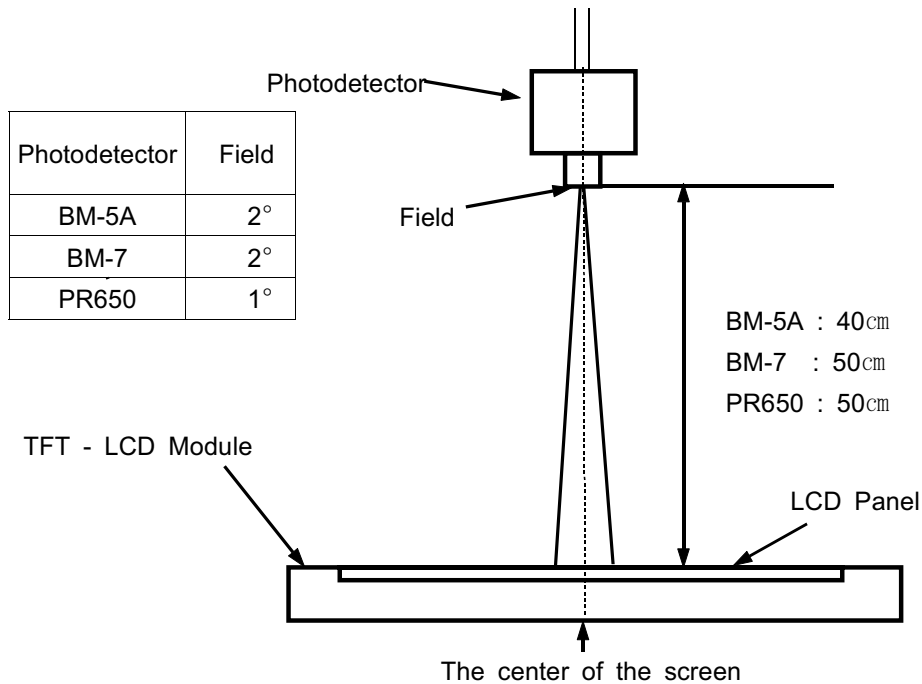| Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio (Center of screen)		C/R		400	500	-		(3) BM-5A
Response Time	Rising	Tr		-	15	20	msec	(4) BM-7
	Falling	Tf		-	10	15		
Luminance of White (Center of screen)		YL	Normal $\phi = 0$ $\theta = 0$ Viewing Angle	220	250	-	cd/m2	(5) BM-5A
Color Chromaticity (CIE 1931)	Red	Rx		TYP. -0.03	0.634	TYP. +0.03		(6) PR650
		Ry			0.354			
	Green	Gx			0.304			
		Gy			0.581			
	Blue	Bx			0.143			
		By			0.102			
	White	Wx			0.310			
		Wy			0.330			
Viewing Angle	Hor.	θ L	CR≥10	70	85	-	Degrees	(7) BM-5A
		θ R		70	85	-		
	Ver.	ϕ H		70	85	-		
		ϕ L		70	85	-		
Brightness Uniformity (9 points)		Buni		-	-	25	%	(8) BM-5A

Note 1) Test Equipment Setup

After stabilizing and leaving the panel alone at a given temperature for 30 min , the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30 min after lighting the back-light. This should be measured in the center of screen.
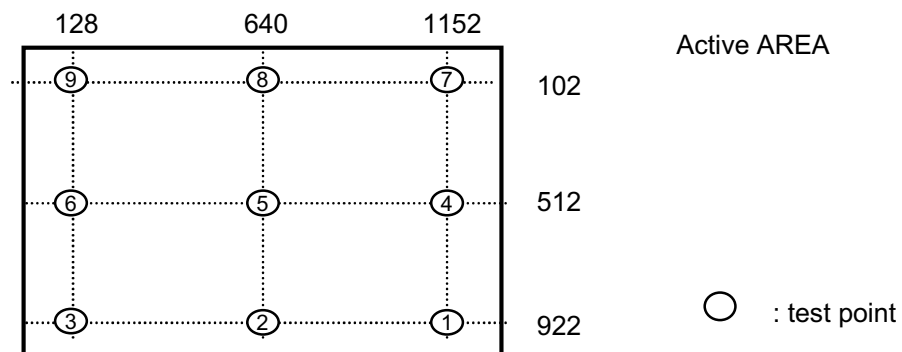
Single lamp current : 6.5mA (Refer to the note(1) in the page 11 for more information.)

Environment condition : Ta = 25 ± 2 °C

Photodetector	Field
BM-5A	2°
BM-7	2°
PR650	1°

Photodetector

Field

BM-5A : 40㎝
BM-7 : 50㎝
PR650 : 50㎝

TFT - LCD Module

LCD Panel

The center of the screen

Optical Measuring Equipment Setup

Note 2) Definition of test point

Active AREA

○ : test point

<table>
<tr><td></td><td>128</td><td>640</td><td>1152</td><td></td></tr>
<tr><td></td><td>⑨</td><td>⑧</td><td>⑦</td><td>102</td></tr>
<tr><td></td><td>⑥</td><td>⑤</td><td>④</td><td>512</td></tr>
<tr><td></td><td>③</td><td>②</td><td>①</td><td>922</td></tr>
</table>

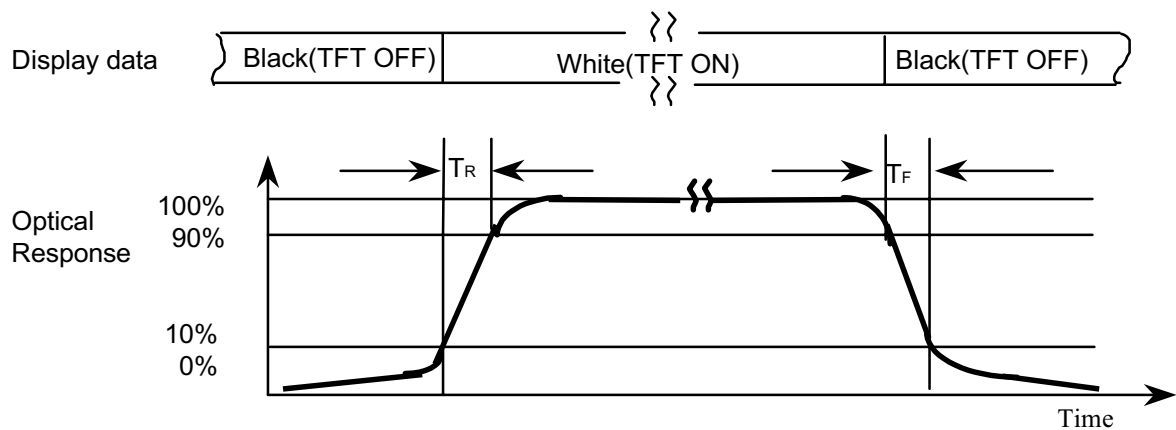| Doc . No	LTM190E1-L01	Page	7 / 26

Note 3) Definition of Contrast Ratio (C/R) : Ratio of gray max (Gmax) & gray min (Gmin)
at the center point(5)   of the panel

$$CR = \frac{G \max}{G \min}$$

Gmax : Luminance with all pixels white

Gmin : Luminance with all pixels black

Note 4) Definition of Response time : Sum of Tr ,Tf

| Display data | Black(TFT OFF) | White(TFT ON) | Black(TFT OFF) |

Optical Response

100%
90%

10%
0%

T_R

T_F

Time

Note 5) Definition of   Luminance of   White : Luminance of white at center point(5).

Note 6) Definition of Color Chromaticity (CIE 1931)
Color coordinate of Red , Green , Blue & White at center point(5).

Note 7) Definition of Viewing Angle :   Viewing angle range (CR $\geq$ 10)

Normal Line
$\phi = 0°, \theta = 0°$

θ_L

θ_R

ϕ_L ϕ_H

$\theta_L = 90°$ x

12 O'clock direction
$\phi_H = 90°$

y

6 O'clock y' direction
$\phi_L = 90°$

x'

$\theta_R = 90°$
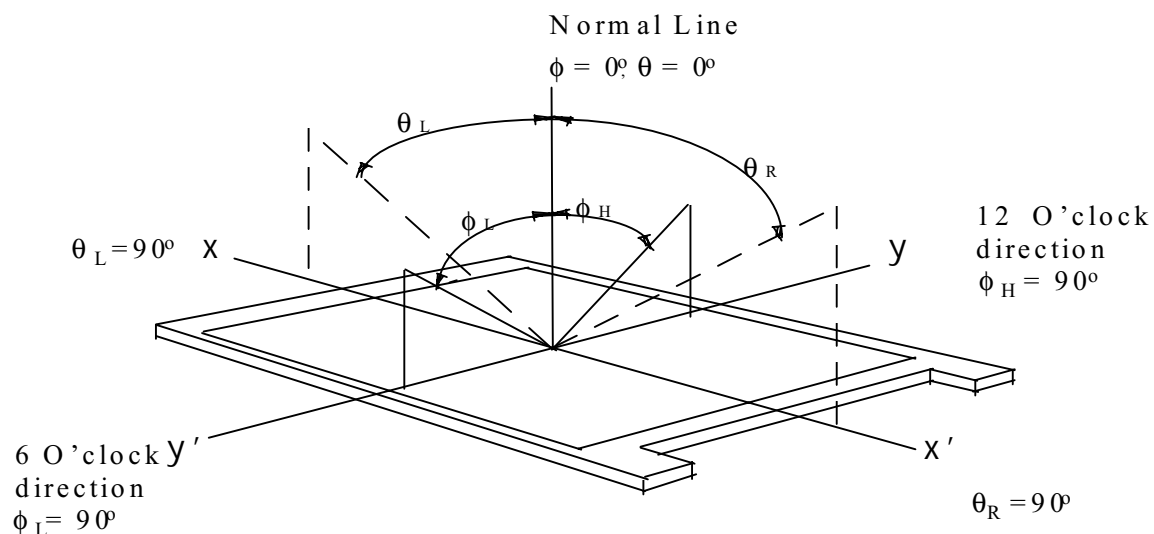
Note 8) Definition of 9 points brightness uniformity

$$Buni = 100 * \frac{(B\max - B\min)}{B\max}$$

Bmax : Maximum brightness
Bmin : Minimum brightness

# 3. Electrical Characteristics

3.1 TFT LCD MODULE

Ta = 25°C

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V_{DD}	4.5	5.0	5.5	V	(1)
Interface type		LVDS	DS90C383/385/387 DS90C386 Pair				
Current of Power Supply	(a)Black	I_{DD}	-	700	900	mA	(2),(3)
	(b)Mosaic		-	700	900	mA	
	(c)2 Line Vertical		-	800	1000	mA	
	(d)White		-	800	1000	mA	
Vsync Frequency		f_V	-	60	60	Hz	
Hsync Frequency		f_H	-	64	64	kHz	
Main Frequency		f_{DCLK}	40	54	54	MHz	
Rush Current		I_{RUSH}	-	-	4.0	A	(4)

Note   (1)   fV=60Hz,   fDCLK =54MHz,   VDD = 5.0V,   DC Current.

          (2)   Main pixel clock frequency is the value which is measured at the input of LVDS transmitter.

          (3)   Power dissipation check pattern(LCD Module only)
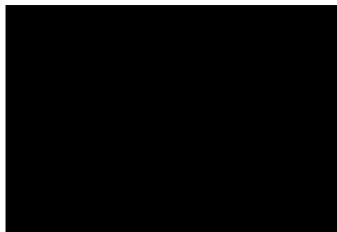
a)Black Pattern   b)Mosaic Pattern   d)White Pattern
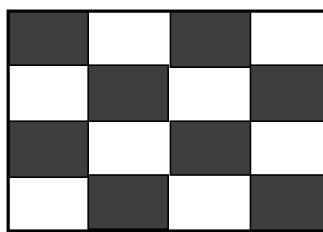
*c) 2line Vertical stripe pattern

(4) Measurement   Conditions

Note : Control Signal : High(+5V) -->Low(Ground)

All Signal lines to panel except for power 5V : Ground

The rising time of supplied voltage is controlled to 470us by R3 and C2 value.

3.2 BACK-LIGHT UNIT

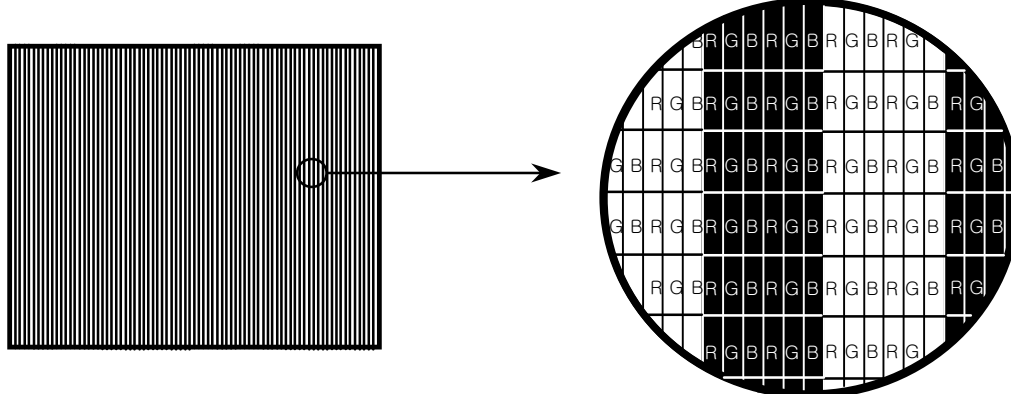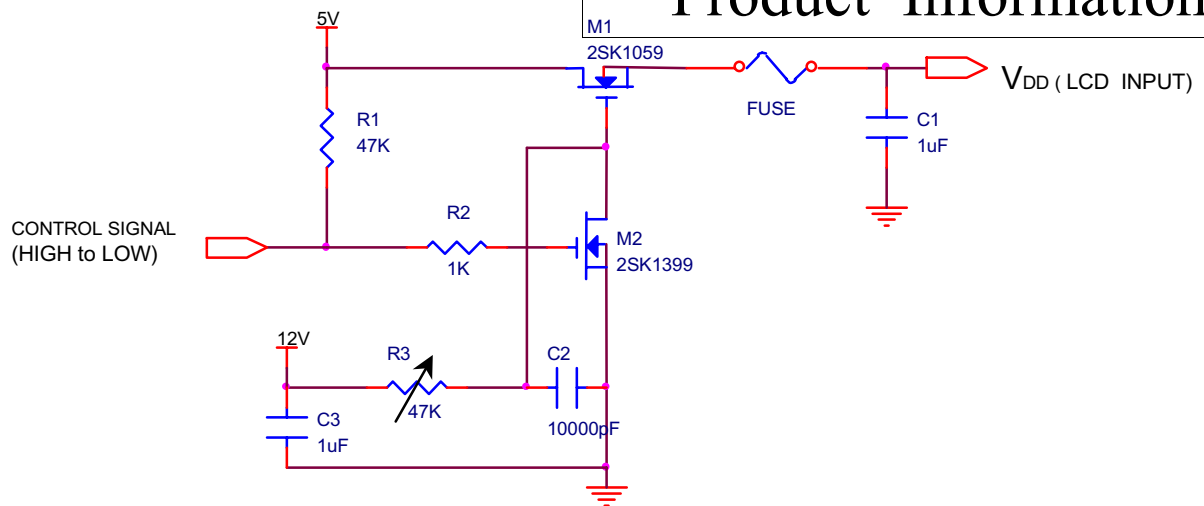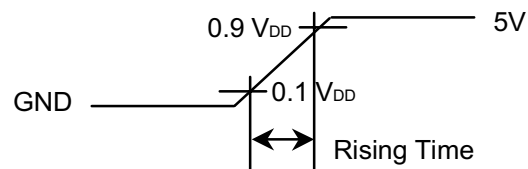The back-light system is an edge - lighting type with 2 dual CCFTs (Cold Cathode Fluorescent Tube) The characteristics of two dual lamps are shown in the following tables.

Ta=25 ± 2°C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Lamp Current	IL	4.0	6.5	6.5	mArms	(1)
Lamp Voltage	VL	-	720	-	Vrms	
Lamp Frequency	fL	40	-	60	kHz	(2)
Startup Voltage	Vs	-	-	1760(25°C)	Vrms	(3)
				1260(0°C)		

Note) The waveform of the inverter output voltage must be area symmetric and the design of the inverter must have specifications for the modularized lamp.

The performance of the back-light, for example life time or brightness, is much influenced by the characteristics of the DC-AC inverter for the lamp. So all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter.

When you design or order the inverter, please make sure that a poor lighting caused by the mismatch of the back-light and the inverter(miss lighting, flicker, etc.) never occur. When you confirm it, the module should be operated in the same condition as it is installed in your instrument.

Note (1) Lamp current is measured with current meter for high frequency as shown below.
Refer to the block diagram of the back-light unit in the next page for more information.
Specified values are for a single lamp.
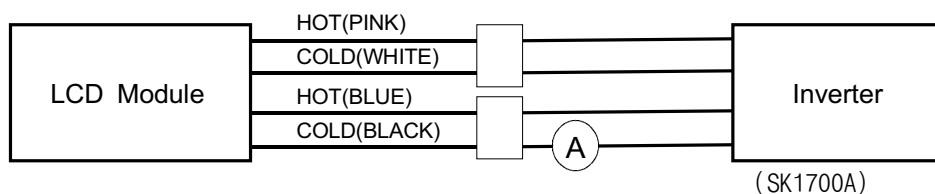
(2) Lamp frequency may produce interference with horizontal synchronous frequency and this may cause line flow on the display. Therefore lamp frequency shall be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.

(3) If an inverter has shutdown function it should keep its output for more than 1 second even if the lamp connector open. Otherwise the lamps may not to be turned on.

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4. Block Diagram

4.1 TFT LCD MODULE

4.2 BACK-LIGHT UNIT

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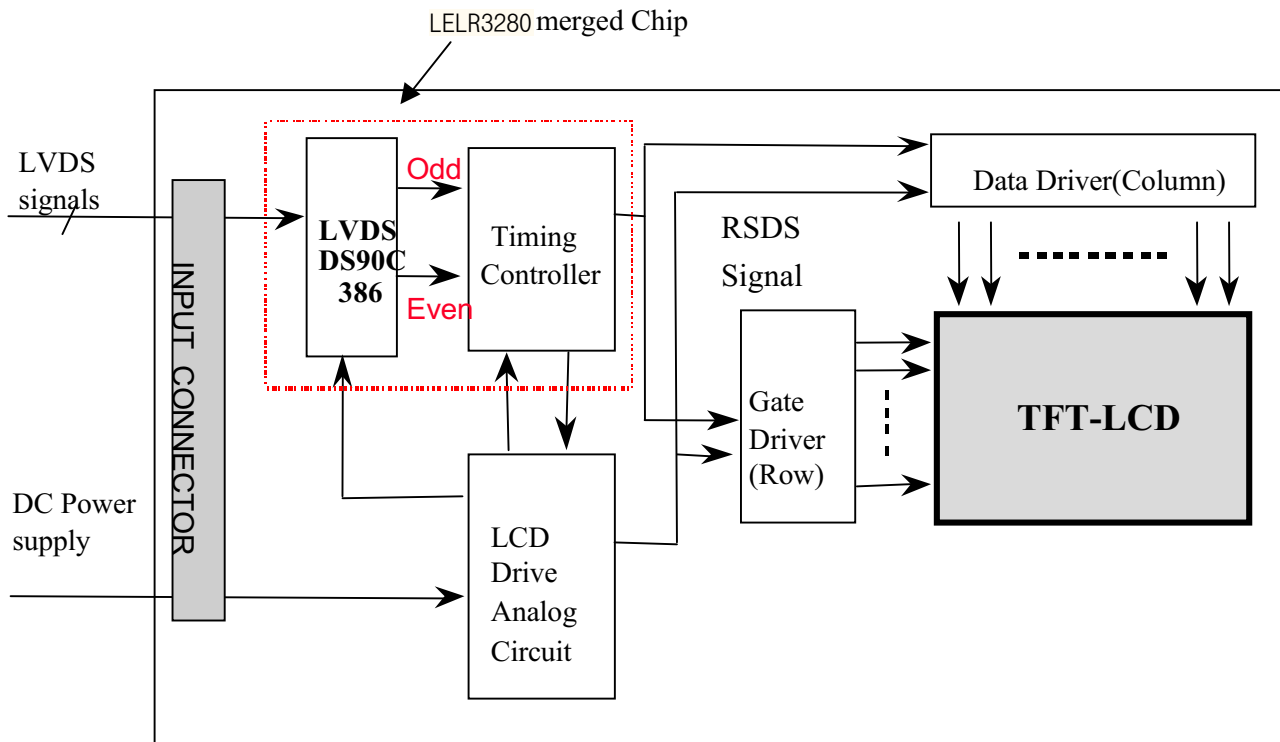
5. Input Terminal Pin Assignment

5.1. Input Signal & Power (Connector : JAE   FI-X30S-HF)

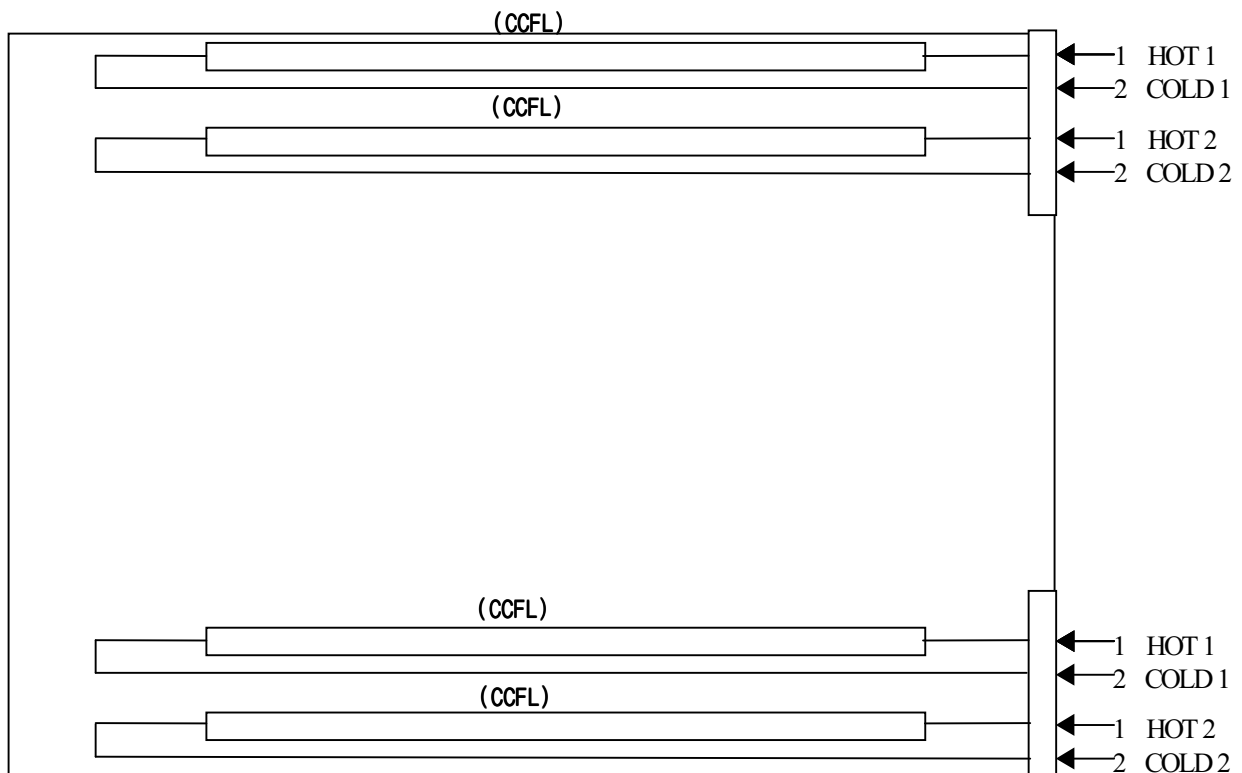| PIN NO	SYMBOL	FUNCTION
1	RXO0-	Negative Transmission Data of Pixel 0 (ODD data)
2	RXO0+	Positive Transmission Data of Pixel 0 (ODD data)
3	RXO1-	Negative Transmission Data of Pixel 1 (ODD data)
4	RXO1+	Positive Transmission Data of Pixel 1 (ODD data)
5	RXO2-	Negative Transmission Data of Pixel 2 (ODD data)
6	RXO2+	Positive Transmission Data of Pixel 2 (ODD data)
7	GND	Power Ground
8	RXOC-	Negative Sampling Clock (ODD data)
9	RXOC+	Positive Sampling Clock (ODD data)
10	RXO3-	Negative Transmission Data of Pixel 3 (ODD data)
11	RXO3+	Positive Transmission Data of Pixel 3 (ODD data)
12	RXE0-	Negative Transmission Data of Pixel 0 (EVEN data)
13	RXE0+	Positive Transmission Data of Pixel 0 (EVEN data)
14	GND	Power Ground
15	RXE1-	Negative Transmission Data of Pixel 1 (EVEN data)
16	RXE1+	Positive Transmission Data of Pixel 1 (EVEN data)
17	GND	Power Ground
18	RXE2-	Negative Transmission Data of Pixel 2 (EVEN data)
19	RXE2+	Positive Transmission Data of Pixel 2 (EVEN data)
20	RXEC-	Negative Sampling Clock (EVEN data)
21	RXEC+	Positive Sampling Clock (EVEN data)
22	RXE3-	Negative Transmission Data of Pixel 3 (EVEN data)
23	RXE3+	Positive Transmission Data of Pixel 3 (EVEN data)
24	GND	Power Ground
25	NC	No Connection
26	DE	DE Out
27	NC	No Connection
28	V_{DD}	Power Supply : +5V
29		
30		

5.2   LVDS   Interface(1)

5.2.1 Odd pixel data (1st pixel data)

1st LVDS Transmitter (*DS90C383, DS90C385*) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM190E1 Interface (CN101)	
No	Symbol	Symbol	Function		Terminal	Symbol
51	TXIN0	RO0	Red Odd Pixel Data (LSB)	TXOUT0- TXOUT0+	No. 1 No. 2	RXO0- RXO0+
52	TXIN1	RO1	Red Odd Pixel Data			
54	TXIN2	RO2	Red Odd Pixel Data			
55	TXIN3	RO3	Red Odd Pixel Data			
56	TXIN4	RO4	Red Odd Pixel Data			
2	TXIN5	RO7	Red Odd Pixel Data (MSB)	TXOUT3- TXOUT3+	No. 10 No. 11	RXO3- RXO3+
3	TXIN6	RO5	Red Odd Pixel Data	TXOUT0- TXOUT0+	No. 1 No. 2	RXO0- RXO0+
4	TXIN7	GO0	Green Odd Pixel Data (LSB)			
6	TXIN8	GO1	Green Odd Pixel Data	TXOUT1- TXOUT1+	No. 3 No. 4	RXO1- RXO1+
7	TXIN9	GO2	Green Odd Pixel Data			
8	TXIN10	GO6	Green Odd Pixel Data	TXOUT3- TXOUT3+	No. 10 No. 11	RXO3- RXO3+
10	TXIN11	GO7	Green Odd Pixel Data (MSB)			
11	TXIN12	GO3	Green Odd Pixel Data	TXOUT1- TXOUT1+	No. 3 No. 4	RXO1- RXO1+
12	TXIN13	GO4	Green Odd Pixel Data			
14	TXIN14	GO5	Green Odd Pixel Data			
15	TXIN15	BO0	Blue Odd Pixel Data (LSB)			
16	TXIN16	BO6	Blue Odd Pixel Data	TXOUT3- TXOUT3+	No. 10 No. 11	RXO3- RXO3+
18	TXIN17	BO7	Blue Odd Pixel Data (MSB)			
19	TXIN18	BO1	Blue Odd Pixel Data	TXOUT1- TXOUT1+	No. 3 No. 4	RXO1- RXO1+
20	TXIN19	BO2	Blue Odd Pixel Data	TXOUT2- TXOUT2+	No. 5 No. 6	RXO2- RXO2+
22	TXIN20	BO3	Blue Odd Pixel Data			
23	TXIN21	BO4	Blue Odd Pixel Data			
24	TXIN22	BO5	Blue Odd Pixel Data			
50	TXIN27	RO6	Red Odd Pixel Data	TXOUT3- TXOUT3+	No. 10 No. 11	RXO3- RXO3+

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5.2.2 Even pixel data (2nd pixel data)

2nd LVDS Transmitter (*DS90C383, DS90C385*) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM190E1 Interface (CN101)	
No	Symbol	Symbol	Function		Terminal	Symbol
51	TXIN0	RE0	Red Even Pixel Data (LSB)	TXOUT0- TXOUT0+	No. 12 No. 13	RXE0- RXE0+
52	TXIN1	RE1	Red Even Pixel Data			
54	TXIN2	RE2	Red Even Pixel Data			
55	TXIN3	RE3	Red Even Pixel Data			
56	TXIN4	RE4	Red Even Pixel Data			
2	TXIN5	RE7	Red Even Pixel Data (MSB)	TXOUT3- TXOUT3+	No. 22 No. 23	RXE3- RXE3+
3	TXIN6	RE5	Red Even Pixel Data	TXOUT0- TXOUT0+	No. 12 No. 13	RXE0- RXE0+
4	TXIN7	GE0	Green Even Pixel Data (LSB)			
6	TXIN8	GE1	Green Even Pixel Data	TXOUT1- TXOUT1+	No. 15 No. 16	RXE1- RXE1+
7	TXIN9	GE2	Green Even Pixel Data			
8	TXIN10	GE6	Green Even Pixel Data	TXOUT3- TXOUT3+	No. 22 No. 23	RXE3- RXE3+
10	TXIN11	GE7	Green Even Pixel Data (MSB)			
11	TXIN12	GE3	Green Even Pixel Data	TXOUT1- TXOUT1+	No. 15 No. 16	RXE1- RXE1+
12	TXIN13	GE4	Green Even Pixel Data			
14	TXIN14	GE5	Green Even Pixel Data			
15	TXIN15	BE0	Blue Even Pixel Data (LSB)			
16	TXIN16	BE6	Blue Even Pixel Data	TXOUT3- TXOUT3+	No. 22 No. 23	RXE3- RXE3+
18	TXIN17	BE7	Blue Even Pixel Data (MSB)			
19	TXIN18	BE1	Blue Even Pixel Data	TXOUT1- TXOUT1+	No. 15 No. 16	RXE1- RXE1+
20	TXIN19	BE2	Blue Even Pixel Data	TXOUT2- TXOUT2+	No. 18 No. 19	RXE2- RXE2+
22	TXIN20	BE3	Blue Even Pixel Data			
23	TXIN21	BE4	Blue Even Pixel Data			
24	TXIN22	BE5	Blue Even Pixel Data			
50	TXIN27	RE6	Red Even Pixel Data	TXOUT3- TXOUT3+	No. 22 No. 23	RXE3- RXE3+

5.3 LVDS Interface (2)

5.3.1 Odd pixel data (1st pixel data)

LVDS Transmitter (*DS90C387*) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM190E1 Interface (CN101)	
No	Symbol	Symbol	Function		Terminal	Symbol
10	R10	RO0	Red Odd Pixel Data (LSB)	A0M A0P	No. 1 No. 2	RXO0- RXO0+
9	R11	RO1	Red Odd Pixel Data			
8	R12	RO2	Red Odd Pixel Data			
7	R13	RO3	Red Odd Pixel Data			
6	R14	RO4	Red Odd Pixel Data			
3	R17	RO7	Red Odd Pixel Data (MSB)	A3M A3P	No. 10 No. 11	RXO3- RXO3+
5	R15	RO5	Red Odd Pixel Data	A0M A0P	No. 1 No. 2	RXO0- RXO0+
2	G10	GO0	Green Odd Pixel Data (LSB)			
1	G11	GO1	Green Odd Pixel Data	A1M A1P	No. 3 No. 4	RXO1- RXO1+
100	G12	GO2	Green Odd Pixel Data			
94	G16	GO6	Green Odd Pixel Data	A3M A3P	No. 10 No. 11	RXO3- RXO3+
93	G17	GO7	Green Odd Pixel Data (MSB)			
99	G13	GO3	Green Odd Pixel Data	A1M A1P	No. 3 No. 4	RXO1- RXO1+
96	G14	GO4	Green Odd Pixel Data			
95	G15	GO5	Green Odd Pixel Data			
92	B10	BO0	Blue Odd Pixel Data (LSB)			
86	B16	BO6	Blue Odd Pixel Data	A3M A3P	No. 10 No. 11	RXO3- RXO3+
85	B17	BO7	Blue Odd Pixel Data (MSB)			
91	B11	BO1	Blue Odd Pixel Data	A1M A1P	No. 3 No. 4	RXO1- RXO1+
90	B12	BO2	Blue Odd Pixel Data	A2M A2P	No. 5 No. 6	RXO2- RXO2+
89	B13	BO3	Blue Odd Pixel Data			
88	B14	BO4	Blue Odd Pixel Data			
87	B15	BO5	Blue Odd Pixel Data			
4	R16	RO6	Red Odd Pixel Data	A3M A3P	No. 10 No. 11	RXO3- RXO3+

5.3.2 Even pixel data (2nd pixel data)

LVDS Transmitter (*DS90C387*) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM190E1 Interface (CN101)	
No	Symbol	Symbol	Function		Terminal	Symbol
84	R20	RE0	Red Even Pixel Data (LSB)	A4M A4P	No. 12 No. 13	RXE0- RXE0+
81	R21	RE1	Red Even Pixel Data			
80	R22	RE2	Red Even Pixel Data			
79	R23	RE3	Red Even Pixel Data			
78	R24	RE4	Red Even Pixel Data			
75	R27	RE7	Red Even Pixel Data (MSB)	A7M A7P	No. 22 No. 23	RXE3- RXE3+
77	R25	RE5	Red Even Pixel Data	A4M A4P	No. 12 No. 13	RXE0- RXE0+
74	G20	GE0	Green Even Pixel Data (LSB)			
73	G21	GE1	Green Even Pixel Data	A5M A5P	No. 15 No. 16	RXE1- RXE1+
72	G22	GE2	Green Even Pixel Data			
66	G26	GE6	Green Even Pixel Data	A7M A7P	No. 22 No. 23	RXE3- RXE3+
65	G27	GE7	Green Even Pixel Data (MSB)			
71	G23	GE3	Green Even Pixel Data	A5M A5P	No. 15 No. 16	RXE1- RXE1+
70	G24	GE4	Green Even Pixel Data			
69	G25	GE5	Green Even Pixel Data			
64	B20	BE0	Blue Even Pixel Data (LSB)			
58	B26	BE6	Blue Even Pixel Data	A7M A7P	No. 22 No. 23	RXE3- RXE3+
57	B27	BE7	Blue Even Pixel Data (MSB)			
63	B21	BE1	Blue Even Pixel Data	A5M A5P	No. 15 No. 16	RXE1- RXE1+
62	B22	BE2	Blue Even Pixel Data	A6M A6P	No. 18 No. 19	RXE2- RXE2+
61	B23	BE3	Blue Even Pixel Data			
60	B24	BE4	Blue Even Pixel Data			
59	B25	BE5	Blue Even Pixel Data			
76	R26	RE6	Red Even Pixel Data	A7M A7P	No. 22 No. 23	RXE3- RXE3+

5.4 BACK-LIGHT UNIT

Pin No.	Input [ch1] ,[ch2]	Color	Fucnction
1	Hot1	Pink	High Voltage
2	Cold1	White	Ground
3	Hot2	Blue	High Voltage
4	Cold2	Black	Ground
Connector Part No.	JST BHSR-02VS-1		

5.5 Input Signal, Basic Display Colors and Gray Scale of Each Colors

COLOR	DISPLAY	\multicolumn{24}{DATA SIGNAL}																							GRAY SCALE LEVEL

COLOR	DISPLAY	RED								GREEN								BLUE								GRAY SCALE
		R0	R1	R2	R3	R4	R5	R6	R7	G0	G1	G2	G3	G4	G5	G6	G7	B0	B1	B2	B3	B4	B5	B6	B7	LEVEL
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	−
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	−
	GREEN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	−
	CYAN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	−
	RED	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−
	MAGENTA	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	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	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	−
GRAY SCALE OF RED	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	R0
	DARK	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R1
	↑	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R2
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	R3~R252
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R253
	LIGHT	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R254
	RED	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R255
GRAY SCALE OF GREEN	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	G0
	DARK	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G1
	↑	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G2
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	G3~G252
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	G253
	LIGHT	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	G254
	GREEN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	G255
GRAY SCALE OF BLUE	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	B0
	DARK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	B1
	↑	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	B2
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	B3~B252
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	B253
	LIGHT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	B254
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	B255

Note) Definition of Gray :

Rn : Red Gray, Gn : Green Gray, Bn : Blue Gray (n = Gray level)

Input Signal : 0 = Low level voltage, 1 = High level voltage

6. Interface Timing

6.1 Timing Parameters (DE only mode)

Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
Clock	Frequency	1/T$_C$	40	-	54	MHz	(2)
	Hgh Time	T$_{CH}$	4	-	-	nsec	
	Low Time	T$_{CL}$	4	-	-	nsec	
Data	Setup Time	T$_{DS}$	4	-	-	nsec	
	Hold Time	T$_{DH}$	4	-	-	nsec	
Data Enable	Setup Time	T$_{ES}$	4	-	-	nsec	(1)
Frame Frequency	Cycle	T$_V$	-	16.7	16.7	msec	
			1032	1066	1066	lines	
Vertical Active Disply Term	Display Period	T$_{VD}$	1024	1024	1024	lines	
	Verticle Blank Period	T$_{VB}$	8	-	-	lines	
One Line Scanning Time	Cycle	T$_H$	672	-	844	clocks	
Horizontal Active Display Term	Display Period	T$_{HD}$	640	640	640	clocks	

Note (1) Test Point : TTL control signal and CLK at LVDS Tx input terminal in system
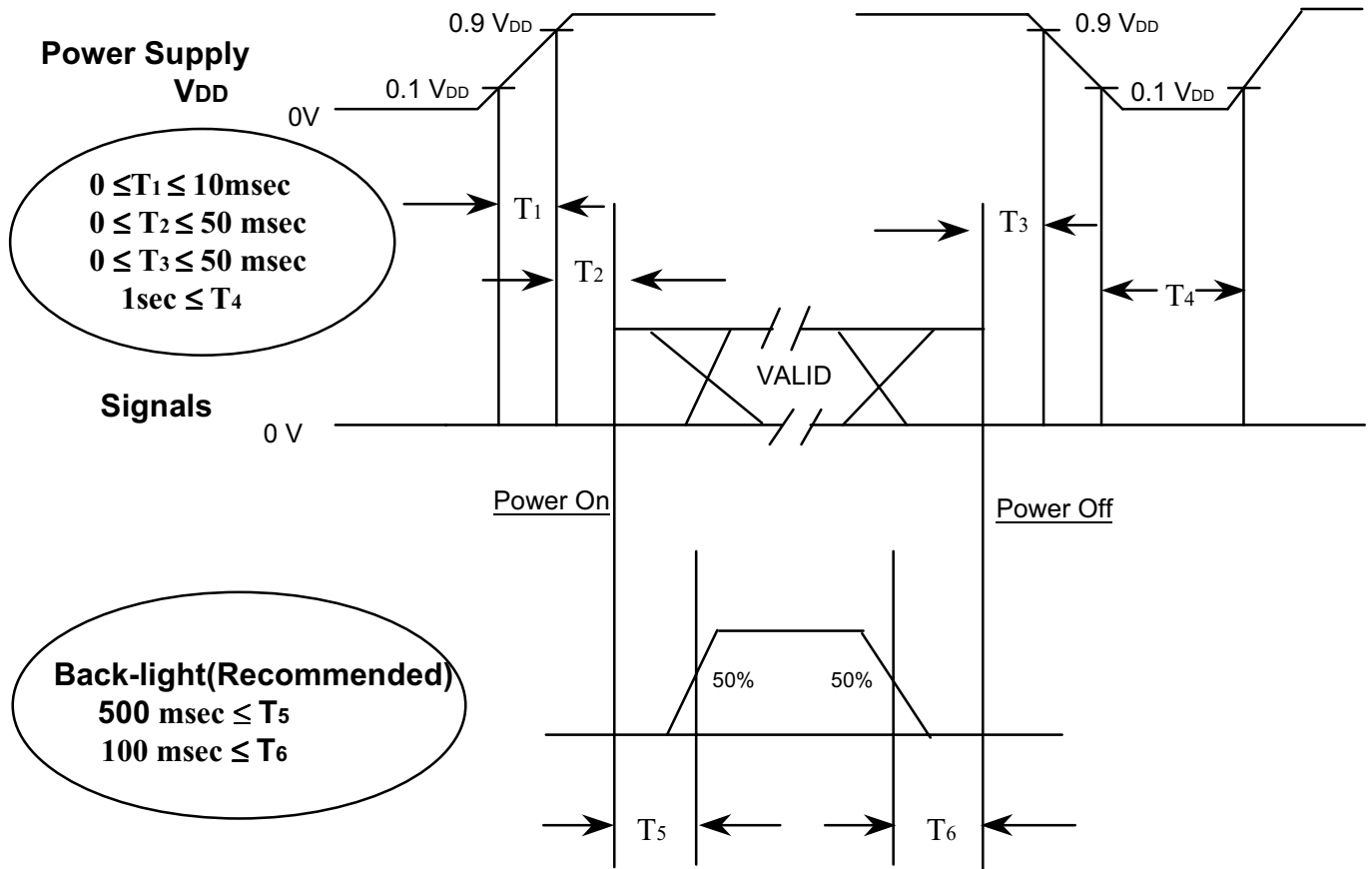   (2) Internal Vcc = 3.3V

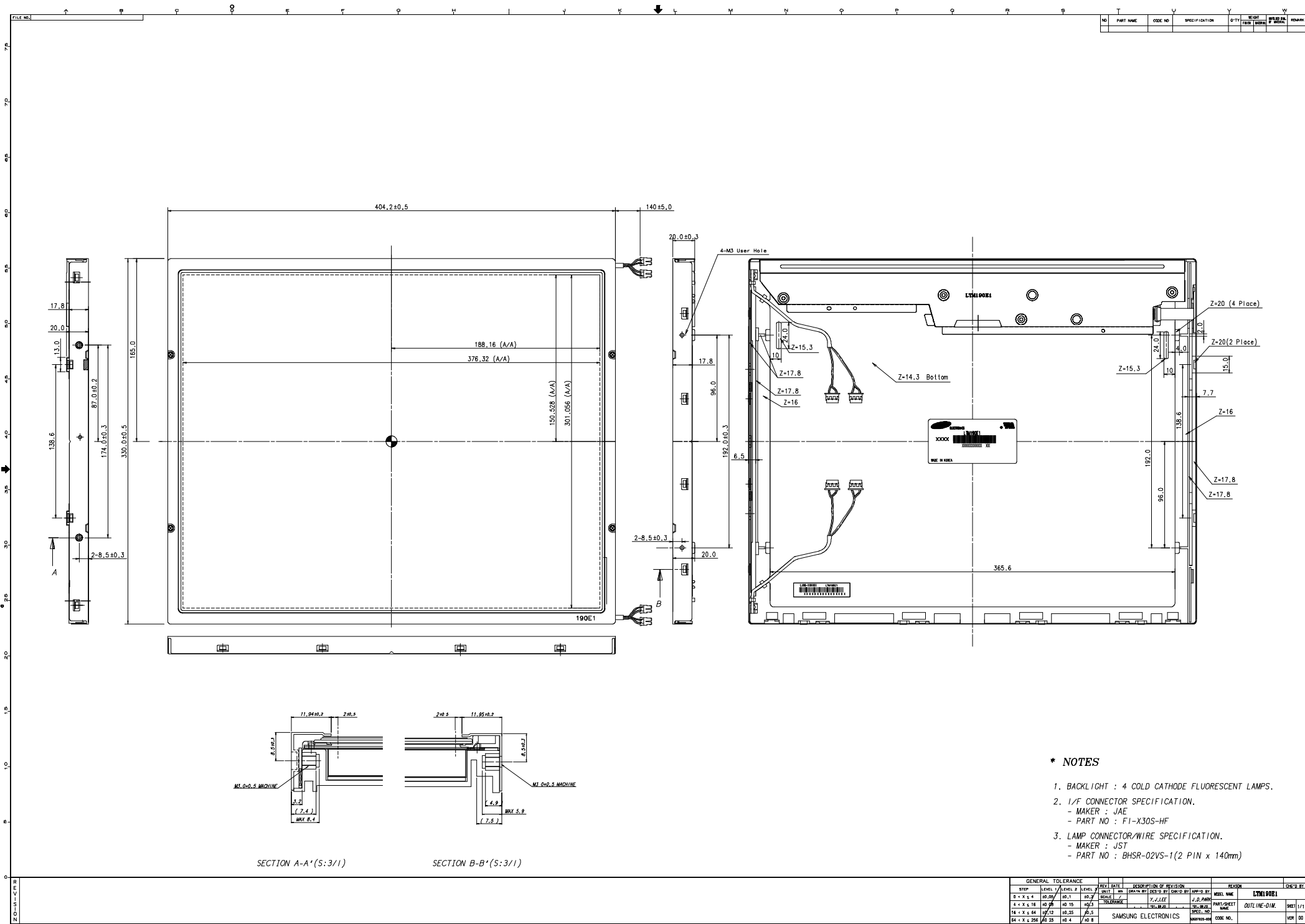6.2 Timing diagrams of interface signal (DE only mode)
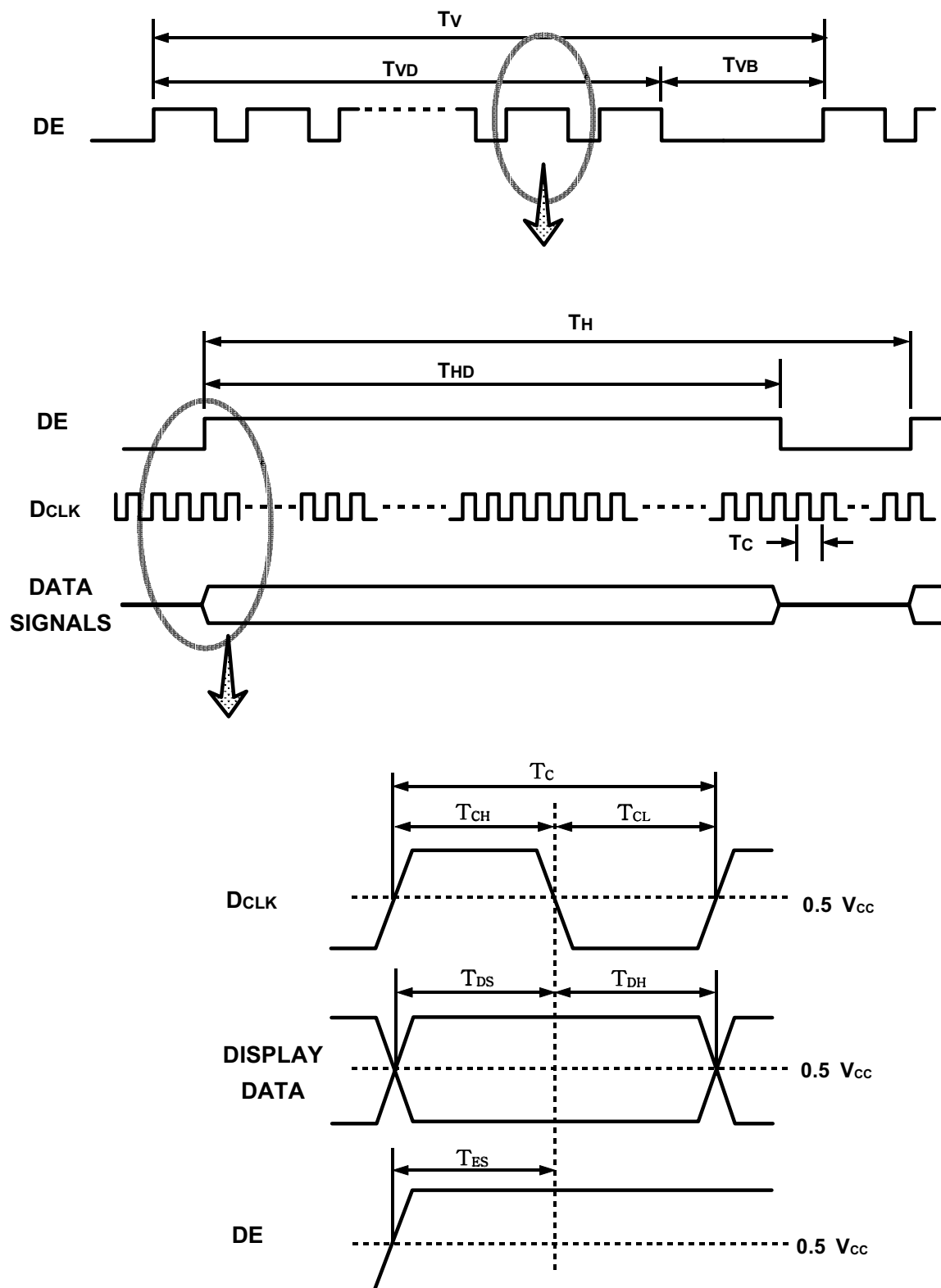
6.3 Power ON/OFF Sequence

: To prevent a latch-up or DC operation of the LCD module, the power on/off sequence
   should be as the diagram below.

Power Supply
V$_{DD}$

$0 \leq T_1 \leq 10msec$
$0 \leq T_2 \leq 50\ msec$
$0 \leq T_3 \leq 50\ msec$
$1sec \leq T_4$

Signals

0.9 V$_{DD}$
0.1 V$_{DD}$
0V

T_1
T_2

VALID

0 V

Power On

0.9 V$_{DD}$
0.1 V$_{DD}$

T_3
T_4

Power Off

Back-light(Recommended)
500 msec $\leq$ T$_5$
100 msec $\leq$ T$_6$

50%   50%

T_5 T_6

Power ON/OFF Sequence

NOTE.

   (1)The supply voltage of the external system for the module input should be the
       same as the definition of VDD.
   (2) Apply the lamp voltage within the LCD operation range. When the back-light turns
       on before the LCD operation or the LCD turns off before the back-light turns off,
       the display may momentarily become abnormal screen.
   (3) In case of VDD = off level, please keep the level of input signals on the low or
       keep a high impedance.
   (4) T4 should be measured after the module has been fully discharged between
       power off and on period.
   (5) Interface signal shall not be kept at high impedance when the power is on.

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SECTION A-A'(S:3/1)   SECTION B-B'(S:3/1)

* NOTES

1. BACKLIGHT : 4 COLD CATHODE FLUORESCENT LAMPS.

2. I/F CONNECTOR SPECIFICATION.
   - MAKER : JAE
   - PART NO : FI-X30S-HF

3. LAMP CONNECTOR/WIRE SPECIFICATION.
   - MAKER : JST
   - PART NO : BHSR-02VS-1(2 PIN x 140mm)

SAMSUNG ELECTRONICS

MODEL NAME: LTM190E1
OUTLINE-DIM.

8. General Precautions

8.1 Handling

(a) When the module is assembled, It should be attached to the system firmly using every mounting holes. Be careful not to twist and bend the modules.

(b) Refrain from strong mechanical shock and / or any force to the module. In addition to damage, this may cause improper operation or damage to the module and CCFT back-light.

(c) Note that polarizers are very fragile and could be easily damaged. Do not press or scratch the surface harder than a HB pencil lead.

(d) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, Staining and discoloration may occur.

(e) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.

(f) The desirable cleaners are water, IPA(Isopropyl Alcohol) or Hexane.
Do not use Ketone type materials(ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.

(g) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth . In case of contact with hands, legs or clothes, it must be washed away thoroughly with soap.

(h) Protect the module from static , it may cause damage to the CMOS Gate Array IC.

(i) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.

(j) Do not disassemble the module.

(k) Do not pull or fold the lamp wire.

(l) Do not adjust the variable resistor which is located on the module.

(m) Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.

(n) Pins of I/F connector shall not be touched directly with bare hands.

8.2 Storage

(a) Do not leave the module in high temperature, and high humidity for a long time.
It is highly recommended to store the module with temperature from 0 to 35C
and relative humidity of less than 70%.

(b) Do not store the TFT-LCD module in direct sunlight.

(c) The module shall be stored in a dark place. It is prohibited to apply sunlight or
fluorescent light   during the store.

8.3 Operation

(a) Do not connect,disconnect the module in the "Power On" condition.

(b) Power supply should always be turned on/off by the item 6.3
"Power on/off sequence"

(c) 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.

(d) The cable between the back-light connector and its inverter power supply shall
be a minimized length and be connected directly . The longer cable between
the back-light and the inverter may cause lower luminance of lamp(CCFT) and
may require higher startup voltage(Vs).

8.4 Others

(a) Ultra-violet ray filter is necessary for outdoor operation.

(b) Avoid condensation of water. It may result in improper operation or disconnection
of electrode.

(c) Do not exceed the absolute maximum rating value. (the supply voltage variation,
input voltage variation, variation in part contents and environmental temperature,
and so on) Otherwise the module may be damaged.

(d) If the module displays the same pattern continuously for a long period of time,it
can be the situation when the image "Sticks" to the screen.

(e) This module has its circuitry PCB's on the rear side and should be handled
carefully in order not to be stressed.