SAMSUNG
ELECTRONICS

Product Information

ISSUE DATE : 2003-01-27
MODEL : LTM213U4-L01

Note : This Product information is subject to change after 3 months of issuing date

Prepared by AMLCD Application Engineering 2Group

Samsung Electronics Co . , LTD.

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SAMSUNG TFT-LCD

Contents

General Description

* Description

LTM213U4-L01 is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFTs as switching devices. This model is composed of a TFT LCD panel, a driver circuit and a back-light system. The resolution of a 21.3" contains 1600 x 1200 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(± 170°)
- High speed response
- UXGA(1600 x1200)
- Replaceable 2 triple CCFTs (Cold Cathode Fluorescent Tube)
- Low Power consumption
- DE only mode
- Narrow bezel and compact design

* Applications
- Workstation & desktop monitors
- Display terminals for AV application products
- Monitors for industrial machine and medical appliances

* General information

Items	Specification	Unit	Note
Display area	432(H) x 324(V) (21.3inch diagonal)	mm	
Driver element	a-Si TFT active matrix		
Display colors	16.7M (true 8-bit)	colors	
Number of pixels	1600 x 1200	pixel	
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.27(H) x 0.27(W)	mm	
Display mode	Normally Black		
Surface treatment	Haze 25% , Hard - coating (3H)		conduction pol.

* Mechanical information

Item		Min.	Typ.	Max.	Note
Module size	Horizontal(H)	461.5	462.0	462.5	mm
	Vertical(V)	360.5	361.0	361.5	mm
	Depth(D)	-	-	25.0	mm
Weight		-	-	3.9	kg

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 (Surface of panel temperature)	T_{OPR}	0	50	℃	(1)
Shock (non - operating)	Snop	-	50	G	(2),(4)
Vibration (Non - operating)	Vnop	-	1.0	G	(3),(4)

Note (1) Temperature and relative humidity range are shown in the figure below.
      90 % RH Max. (40 °C ≥ Ta)
      Maximum wet-bulb temperature at 39 °C or less. (Ta > 40 °C) No condensation.

  (2) 11ms, sine wave, 1 time for ±X, ±Y, ±Z axis

  (3) 10-300 Hz, Sweep rate 10min, 120min 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)
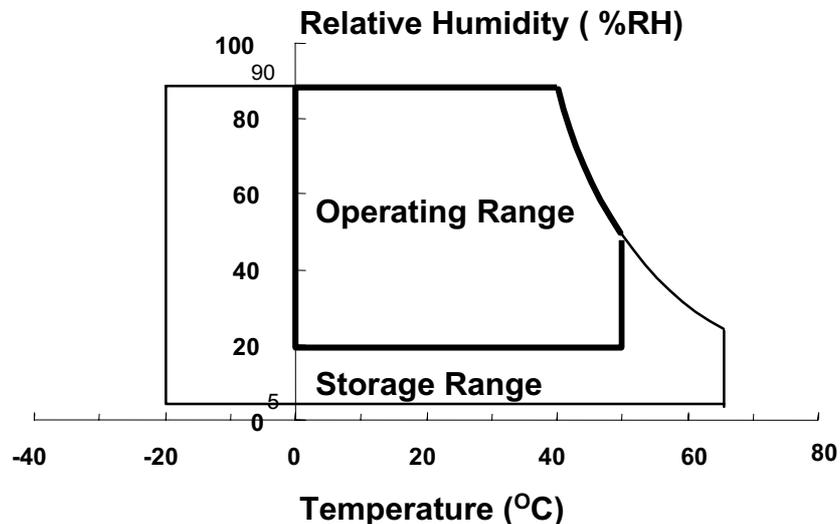
1.2 ELECTRICAL ABSOLUTE RATINGS

(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	I_L	4.0	7.0	mArms	(1),(2)
Lamp Frequency	F_L	40	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 12 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

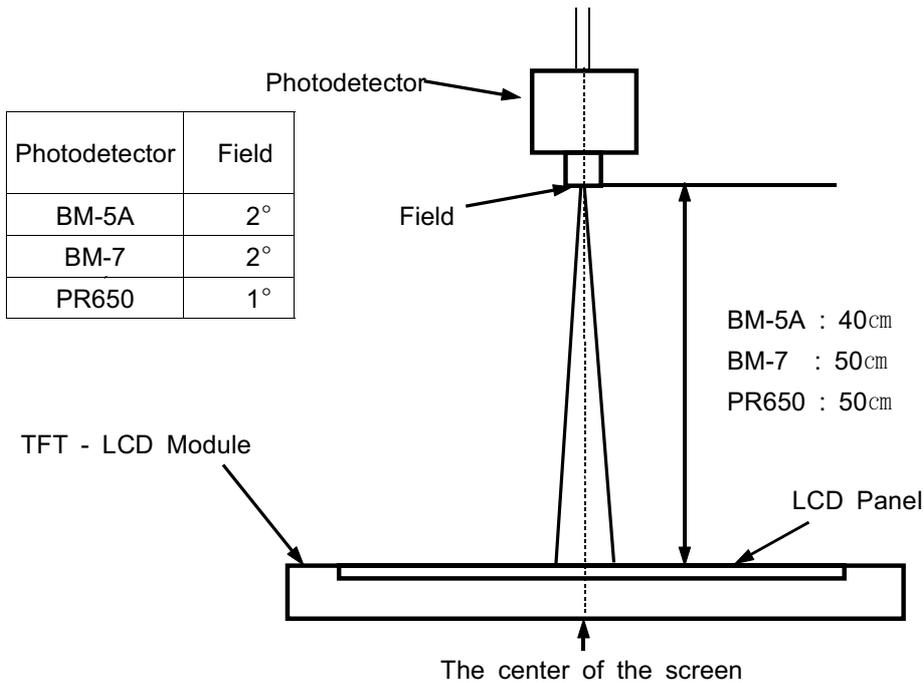(Inverter Freq. : 60kHz) * Ta = 25 ± 2°C , V_{DD}=5V, fv= 60Hz, f_{DCLK}= 90MHz, I_L = 6.5mArms

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio (Center of screen)		C/R		(350)	500	-		(3) BM-5A
Response Time	Rising	Tr		-	15	20	msec	(4)
	Falling	Tf		-	10	15		BM-7
Luminance of White (Center of screen)		YL	Normal $\phi = 0$ $\theta = 0$	(220)	250	-	cd/m2	(5) BM-5A
Color Chromaticity (CIE 1931)	Red	Rx		TYP. -0.03	(0.640)	TYP. +0.03		(6) PR650
		Ry			(0.330)			
	Green	Gx	Viewing Angle		(0.300)			
		Gy			(0.600)			
	Blue	Bx			(0.150)			
		By			(0.060)			
	White	Wx			(0.313)			
		Wy			(0.329)			
Viewing Angle	Hor.	θ L	C/R≥10	-	85	-	Degrees	(7) BM-5A
		θ R		-	85	-		
	Ver.	φ H		-	85	-		
		φ L		-	85	-		
Brightness Uniformity (13 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.

 A single lamp current : 6.5mA (Refer to the note(1) in the page 12 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

(160) (480) (800) (1120) (1440)

13 ---- 12 ---- 11 --- (120)

10 ---- 9 --- (360)

8 ---- 7 ---- 6 --- (600)

5 ---- 4 --- (840)

3 ---- 2 ---- 1 --- (1080)

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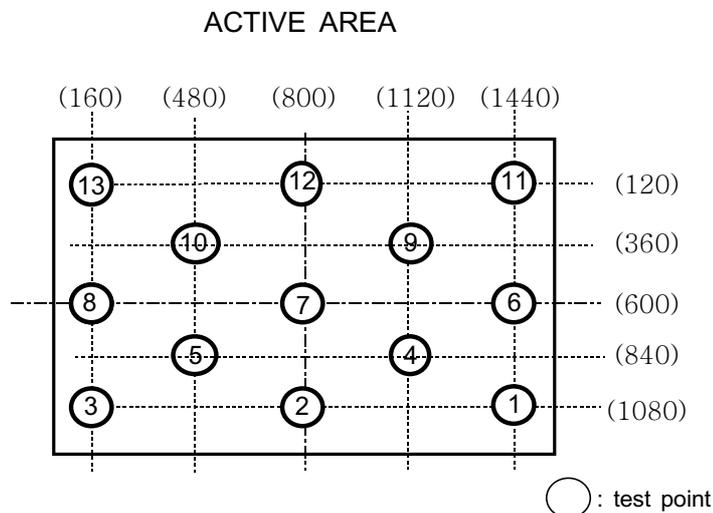
Note 3) Definition of Contrast Ratio (C/R) : Ratio of gray max (Gmax) & gray min (Gmin) at the center point(5) of the panel

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

    Gmax : Luminance with all pixels white

    Gmin : Luminance with all pixels black

Note 4) Definition of Response time : Sum of Tr ,Tf
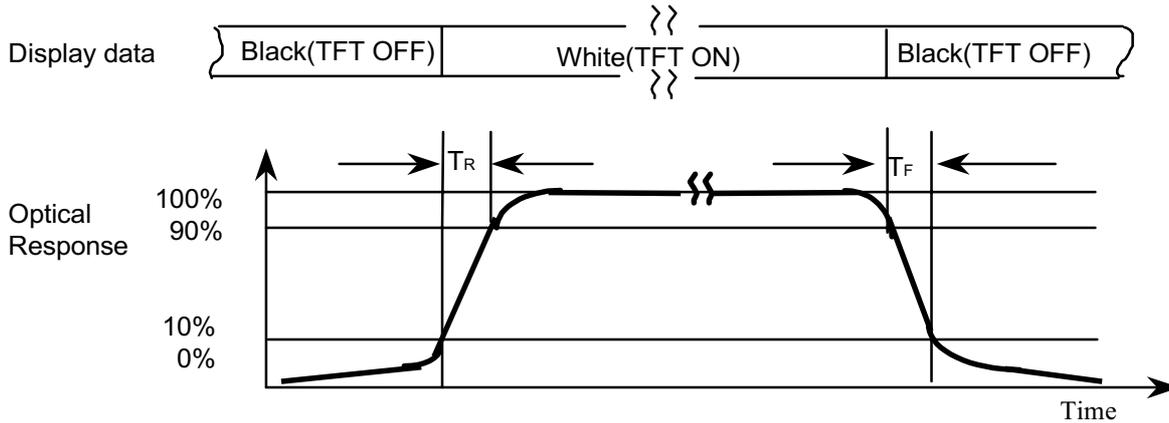
Note 5) Definition of Luminance of White : Luminance of white at center point(5).

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≥ 10)

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

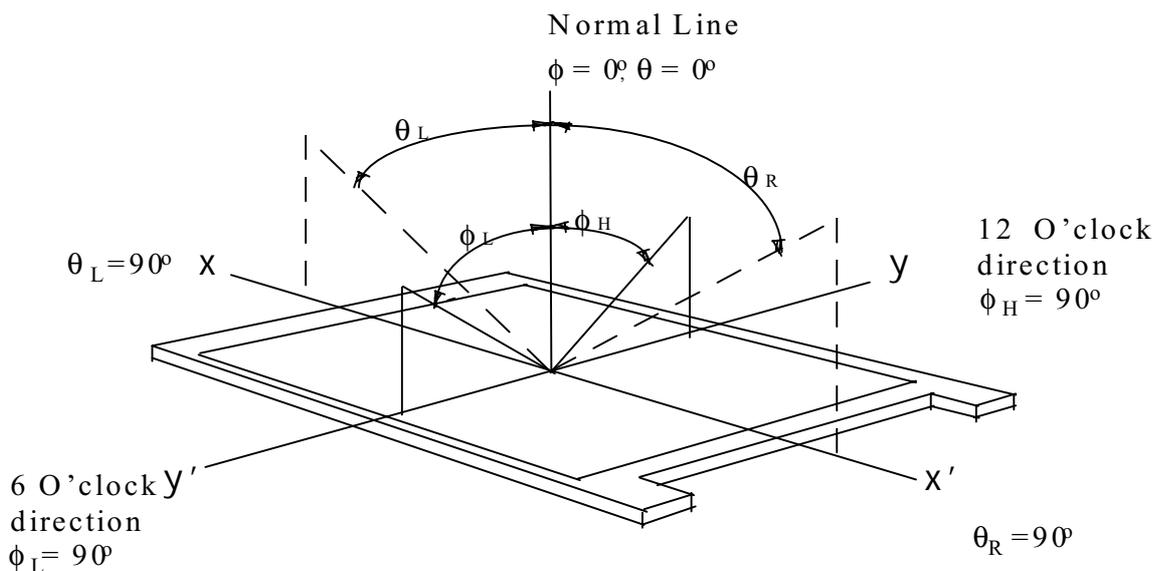| Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V_{DD}	4.5	5.0	5.5	V	(1)
Interface type		LVDS	LCU032420(LVDS Imbeded T-CON)				
Current of Power Supply	(a)Black	I_{DD}	-	(900)	-	mA	(2),(3)
	(b)Mosaic		-	(1000)	-	mA	
	(c)White		-	(1100)	(1300)	mA	
	(d)2Line Vertical		-	(1100)	(1300)	mA	
Vsync Frequency		f_V	(58)	60	(62)	Hz	2pxl/clk
Hsync Frequency		f_H	(70)	75	(77)	kHz	
Main Frequency		f_{DCLK}	(63)	81	(84)	MHz	
Rush Current		I_{RUSH}	-	-	4.0	A	(4)

Note (1) Main pixel clock frequency is the value which is measured at the input of LVDS transmitter.

 (2) f_V=60Hz, f_{DCLK} =81MHz, V_{DD} = 5.0V, DC Current.

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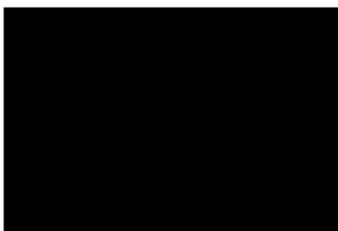
a)Black Pattern   b)Mosaic Pattern   c) White Pattern
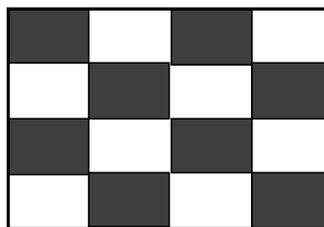
d) 2line Vertical stripe pattern
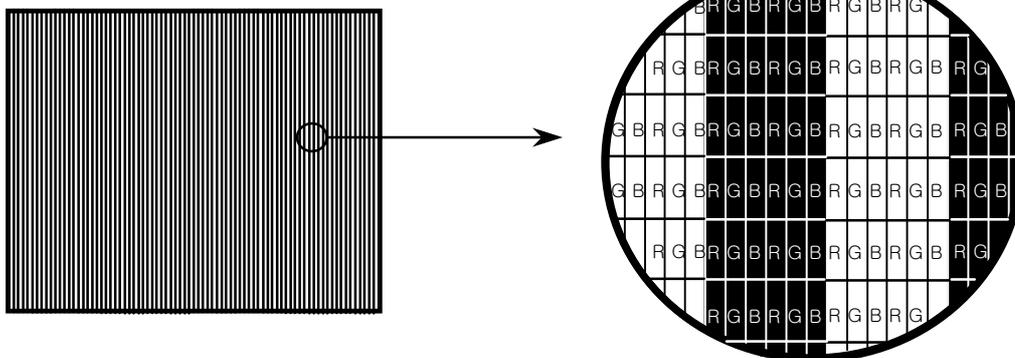
(4) Measurement Conditions

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 triple CCFTs (Cold Cathode Fluorescent Tube). The characteristics of two dual lamps are shown in the following tables.
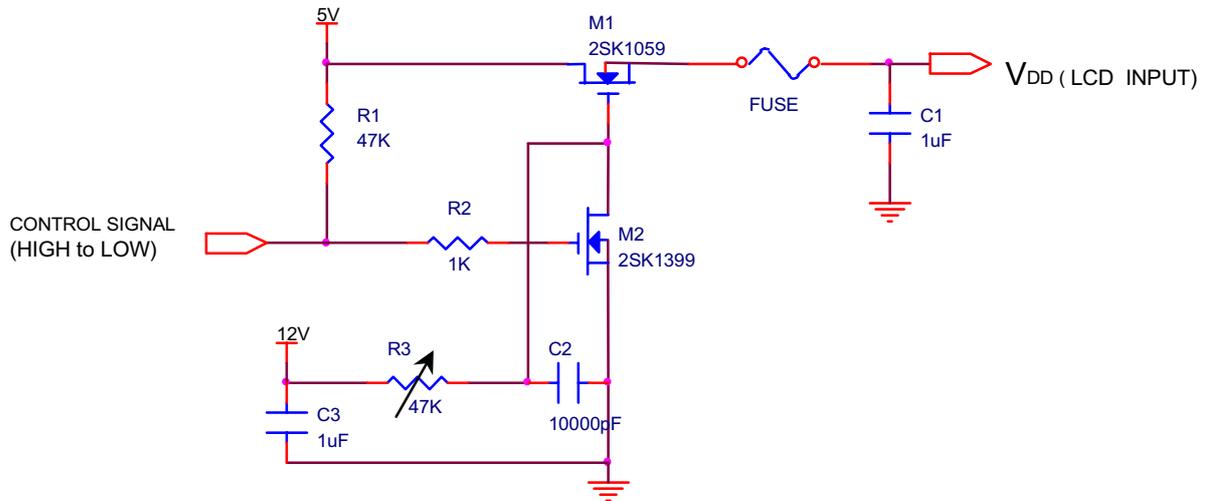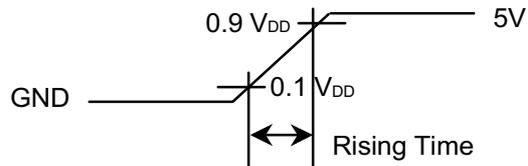
Ta=25 $\pm$ 2°C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Lamp Current	I_L	4.0	6.5	6.5	mArms	(1)
Lamp Voltage	V_L	-	860	-	Vrms	(1)
Lamp Frequency	f_L	40	-	60	kHz	(2)
Start up Voltage	Vs	-	-	0℃:2000 25℃:1548	Vrms	(3)
Operation life time	TL	50,000	-	-	Hr	(4)

Note) The method of measurements inverter should be used PWM(Pulse Width Modulation). 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) Triple 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 triple lamp.
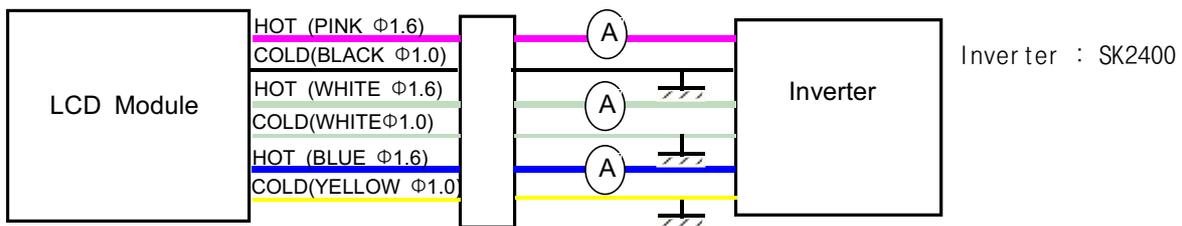
(2) Lamp frequency may produce interference with horizontal synchronous frequency and this may cause line flow on the display. Therefore lamp frequency shall be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.

(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.

(4) Life time (Hr) of a lamp is defined as the time in which it continues to operate under the condition of Ta = 25± 2℃ and I_L = 6.5 mArms until the brightness becomes 50% or lower than it's original value. moreover the operation lifetime is only for the lamp unit at the lamp current 6.5mA, not assembled into the module.

(5) Inverter use high voltage. It should be disconnected power, before Inverter is assembled or disassembled.

4. Block Diagram

4.1 TFT LCD MODULE
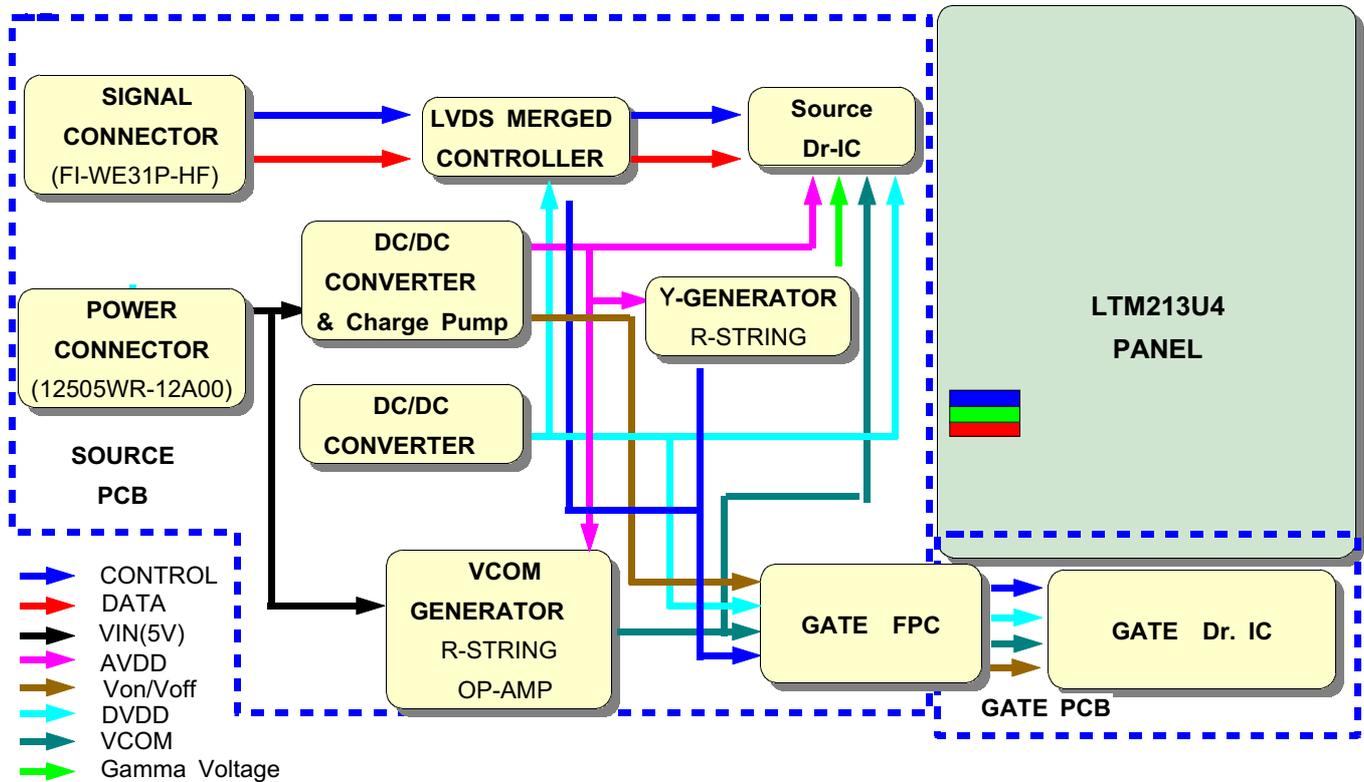
4.2 BACK-LIGHT UNIT

Connector: JST BHR-04VS-1, BHR-03VS-1
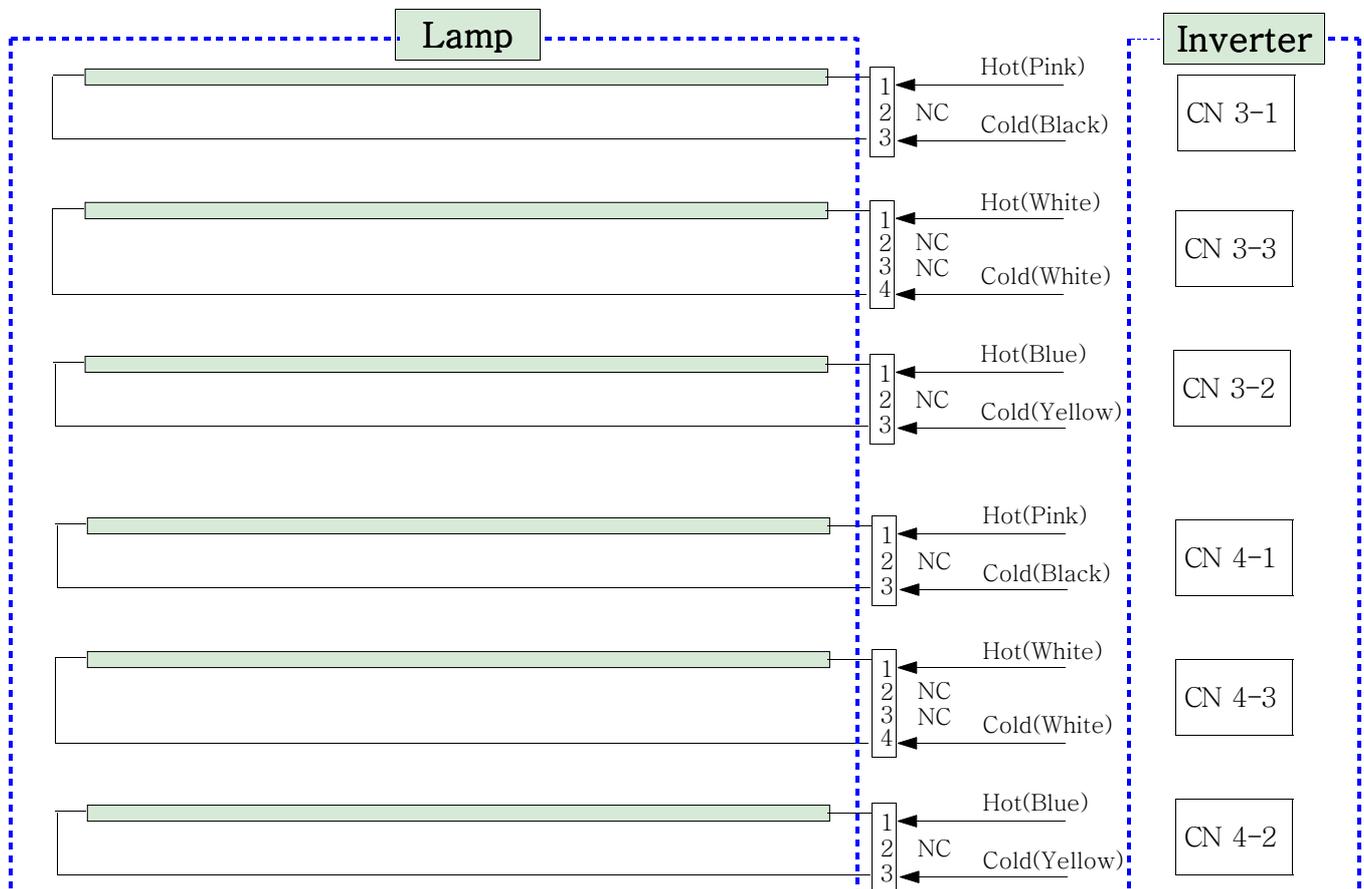
5. Input Terminal Pin Assignment

5.1. Input Signal (Connector : JAE WE31P-HF)

(Mating Connector :JAE F1-WE31S-HF)

Pin No	Symbol	Function
1	GND	Ground
2		
3	A0M	Negative LVDS differential data output
4	A0P	Positive LVDS differential data output
5	A1M	Negative LVDS differential data output
6	A1P	Positive LVDS differential data output
7	A2M	Negative LVDS differential data output
8	A2P	Positive LVDS differential data output
9	GND	Ground
10		
11	CLKM	Negative LVDS differential clock output
12	CLKP	Positive LVDS differential clock output
13	A3M	Negative LVDS differential data output
14	A3P	Positive LVDS differential data output
15	GND	Ground
16		
17	A4M	Negative LVDS differential data output
18	A4P	Positive LVDS differential data output
19	A5M	Negative LVDS differential data output
20	A5P	Positive LVDS differential data output
21	A6M	Negative LVDS differential data output
22	A6P	Positive LVDS differential data output
23	GND	Ground
24		
25	A7M	Negative LVDS differential data output
26	A7P	Positive LVDS differential data output
27	N.C	Reserved
28	N.C	Reserved
29	N.C	Reserved
30	N.C	Reserved
31	N.C	Reserved

5.2 LVDS Interface (1)

5.2.1 Odd pixel data (1st pixel data)

1st LVDS Transmitter (*DS90C385*) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM213U4 Interface (CN101)	
No	Symbol	Symbol	Function		Terminal	Symbol
51	TXIN0	RO0	Red Odd Pixel Data (LSB)	TXOUT0- TXOUT0+	No. 3 No. 4	A0M A0P
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. 13 No. 14	A3M A3P
3	TXIN6	RO5	Red Odd Pixel Data	TXOUT0- TXOUT0+	No. 3 No. 4	A0M A0P
4	TXIN7	GO0	Green Odd Pixel Data (LSB)			
6	TXIN8	GO1	Green Odd Pixel Data	TXOUT1- TXOUT1+	No. 5 No. 6	A1M A1P
7	TXIN9	GO2	Green Odd Pixel Data			
8	TXIN10	GO6	Green Odd Pixel Data	TXOUT3- TXOUT3+	No. 13 No. 14	A3M A3P
10	TXIN11	GO7	Green Odd Pixel Data (MSB)			
11	TXIN12	GO3	Green Odd Pixel Data	TXOUT1- TXOUT1+	No. 5 No. 6	A1M A1P
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. 13 No. 14	A3M A3P
18	TXIN17	BO7	Blue Odd Pixel Data (MSB)			
19	TXIN18	BO1	Blue Odd Pixel Data	TXOUT1- TXOUT1+	No. 5 No. 6	A1M A1P
20	TXIN19	BO2	Blue Odd Pixel Data	TXOUT2- TXOUT2+	No. 7 No. 8	A2M A2P
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. 13 No. 14	A3M A3P

5.2.2 Even pixel data (2nd pixel data)

2nd LVDS Transmitter (*DS90C385*) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM213U4 Interface (CN101)	
No	Symbol	Symbol	Function		Terminal	Symbol
51	TXIN0	RE0	Red Even Pixel Data (LSB)	TXOUT0- TXOUT0+	No. 17 No. 18	A4M A4P
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. 25 No. 26	A7M A7P
3	TXIN6	RE5	Red Even Pixel Data	TXOUT0- TXOUT0+	No. 17 No. 18	A4M A4P
4	TXIN7	GE0	Green Even Pixel Data (LSB)			
6	TXIN8	GE1	Green Even Pixel Data	TXOUT1- TXOUT1+	No. 19 No. 20	A5M A5P
7	TXIN9	GE2	Green Even Pixel Data			
8	TXIN10	GE6	Green Even Pixel Data	TXOUT3- TXOUT3+	No. 25 No. 26	A7M A7P
10	TXIN11	GE7	Green Even Pixel Data (MSB)			
11	TXIN12	GE3	Green Even Pixel Data	TXOUT1- TXOUT1+	No. 19 No. 20	A5M A5P
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. 25 No. 26	A7M A7P
18	TXIN17	BE7	Blue Even Pixel Data (MSB)			
19	TXIN18	BE1	Blue Even Pixel Data	TXOUT1- TXOUT1+	No. 19 No. 20	A5M A5P
20	TXIN19	BE2	Blue Even Pixel Data	TXOUT2- TXOUT2+	No. 21 No. 22	A6M A6P
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. 25 No. 26	A7M A7P

LVDS Interface (2)

5.2.3 Odd pixel data (1st pixel data)

LVDS Transmitter (*DS90C387*) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM213U4 Interface (CN101)	
No	Symbol	Symbol	Function		Terminal	Symbol
10	R10	RO0	Red Odd Pixel Data (LSB)	A0M A0P	No. 3	A0M
9	R11	RO1	Red Odd Pixel Data		No. 4	A0P
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. 13	A3M
					No. 14	A3P
5	R15	RO5	Red Odd Pixel Data	A0M A0P	No. 3	A0M
2	G10	GO0	Green Odd Pixel Data (LSB)		No. 4	A0P
1	G11	GO1	Green Odd Pixel Data	A1M A1P	No. 5	A1M
100	G12	GO2	Green Odd Pixel Data		No. 6	A1P
94	G16	GO6	Green Odd Pixel Data	A3M A3P	No. 13	A3M
93	G17	GO7	Green Odd Pixel Data (MSB)		No. 14	A3P
99	G13	GO3	Green Odd Pixel Data	A1M A1P	No. 5	A1M
96	G14	GO4	Green Odd Pixel Data		No. 6	A1P
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. 13	A3M
85	B17	BO7	Blue Odd Pixel Data (MSB)		No. 14	A3P
91	B11	BO1	Blue Odd Pixel Data	A1M A1P	No. 5	A1M
					No. 6	A1P
90	B12	BO2	Blue Odd Pixel Data	A2M A2P		
89	B13	BO3	Blue Odd Pixel Data		No. 7	A2M
88	B14	BO4	Blue Odd Pixel Data		No. 8	A2P
87	B15	BO5	Blue Odd Pixel Data			
4	R16	RO6	Red Odd Pixel Data	A3M A3P	No. 13	A3M
					No. 14	A3P

5.2.4 Even pixel data (2nd pixel data)

LVDS Transmitter (*DS90C387*) Signal Interface						
Device Input Pin		Device Input Signal		Output Signal	To LTM213U4 Interface (CN101)	
No	Symbol	Symbol	Function		Terminal	Symbol
84	R20	RE0	Red Even Pixel Data (LSB)	A4M A4P	No. 17	A4M
81	R21	RE1	Red Even Pixel Data		No. 18	A4P
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. 25	A7M
					No. 26	A7P
77	R25	RE5	Red Even Pixel Data	A4M A4P	No. 17	A4M
74	G20	GE0	Green Even Pixel Data (LSB)		No. 18	A4P
73	G21	GE1	Green Even Pixel Data	A5M A5P	No. 19	A5M
72	G22	GE2	Green Even Pixel Data		No. 20	A5P
66	G26	GE6	Green Even Pixel Data	A7M A7P	No. 25	A7M
65	G27	GE7	Green Even Pixel Data (MSB)		No. 26	A7P
71	G23	GE3	Green Even Pixel Data	A5M A5P	No. 19	A5M
70	G24	GE4	Green Even Pixel Data		No. 20	A5P
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. 25	A7M
57	B27	BE7	Blue Even Pixel Data (MSB)		No. 26	A7P
63	B21	BE1	Blue Even Pixel Data	A5M A5P	No. 19	A5M
					No. 20	A5P
62	B22	BE2	Blue Even Pixel Data	A6M A6P		
61	B23	BE3	Blue Even Pixel Data		No. 21	A6M
60	B24	BE4	Blue Even Pixel Data		No. 22	A6P
59	B25	BE5	Blue Even Pixel Data			
76	R26	RE6	Red Even Pixel Data	A7M A7P	No. 25	A7M
					No. 26	A7P

NOTE

DS90C387 LVDS Transmitter에서 24th BAL pin은 Low로 23th DUAL pin은 High로 고정할 것

5.3 Input Power (Connector : Molex 53261-1290 (Matching Socket : 51021-1200))

Pin No	Symbol	Function
1	+5V	Module Input Vcc
2		
3		
4		
5		
6		
7	GND	Power Ground
8		
9		
10		
11		
12		

5.4 Back-light Unit (Connector: JST BHR-04VS-1, BHR-03VS-1)

Pin No	Input [ch1],[ch2]	Color	Function
3-1-1	HOT	Pink	High Voltage
3-1-2	N.C	-	-
3-1-3	Cold	Black	Ground
3-2-1	HOT	Blue	High Voltage
3-2-2	N.C		
3-2-3	Cold	Yellow	Ground
3-3-1	HOT	White	High Voltage
3-3-2	N.C	-	-
3-3-3			
3-3-4	Cold	White	Ground
4-1-1	HOT	Pink	High Voltage
4-1-2	N.C		
4-1-3	Cold	Black	Ground
4-2-1	HOT	Blue	High Voltage
4-2-2	N.C	-	-
4-2-3	Cold	Yellow	Ground
4-3-1	HOT	White	High Voltage
4-3-2	N.C	-	-
4-3-3			
4-3-4	Cold	White	Ground
Connector Part No	JST BHR-03VS-1, JST BHR-04VS-1		

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

COLOR	DISPLAY	RED								GREEN								BLUE								GRAY SCALE LEVEL
		R0	R1	R2	R3	R4	R5	R6	R7	G0	G1	G2	G3	G4	G5	G6	G7	B0	B1	B2	B3	B4	B5	B6	B7	
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	(63)	81	(84.5)	MHz	(2)
	Hgh Time	T_{CH}	1.6	-	-	nsec	
	Low Time	T_{CL}	1.6	-	-	nsec	
Data	Setup Time	T_{DS}	2	-	-	nsec	
	Hold Time	T_{DH}	2	-	-	nsec	
Data Enable	Setup Time	T_{ES}	2	-	-	nsec	
Frame Frequency	Cycle	T_V	(17.2)	16.7	(16.1)	msec	
			1208	1250	1250	lines	
Vertical Active Disply Term	Display Period	T_{VD}	1200	1200	1200	lines	
	Verticle Blank Period	T_{VB}	8	-	50	lines	
One Line Scanning Time	Cycle	T_H	900	1080	1090	clocks	2pixel/clock
Horizontal Active Display Term	Display Period	T_{HD}	800	800	800	clocks	

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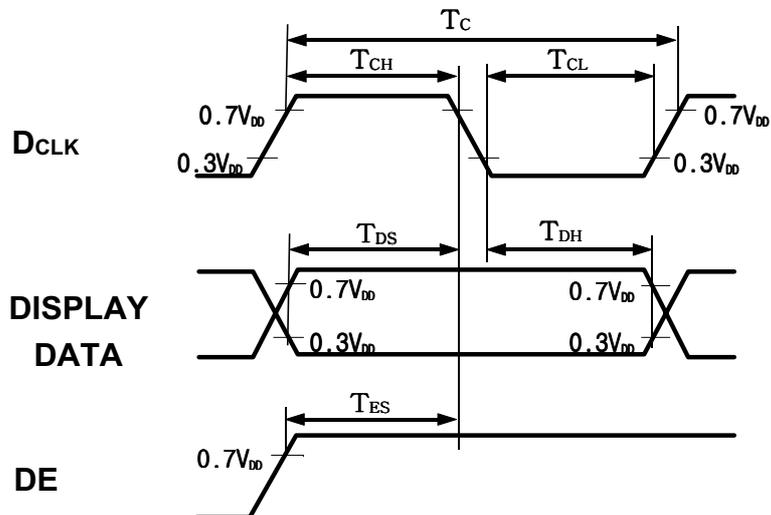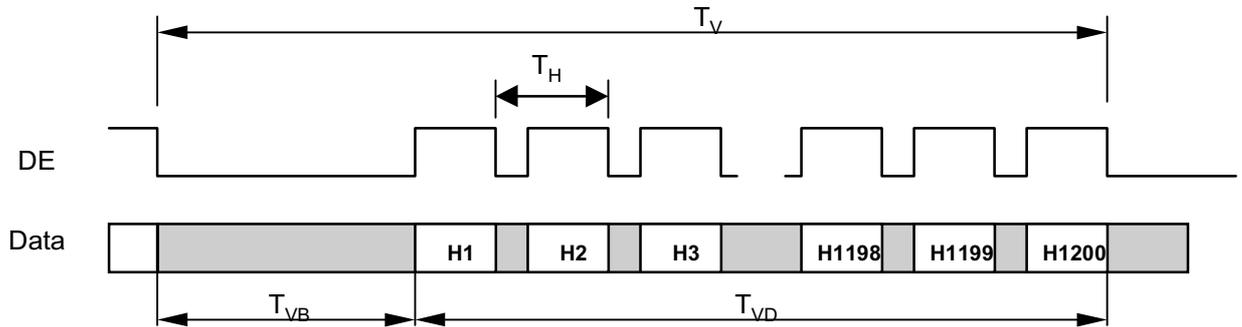2) Internal Vcc = 3.3V

6.2 Timing diagrams of interface signal (DE only mode)
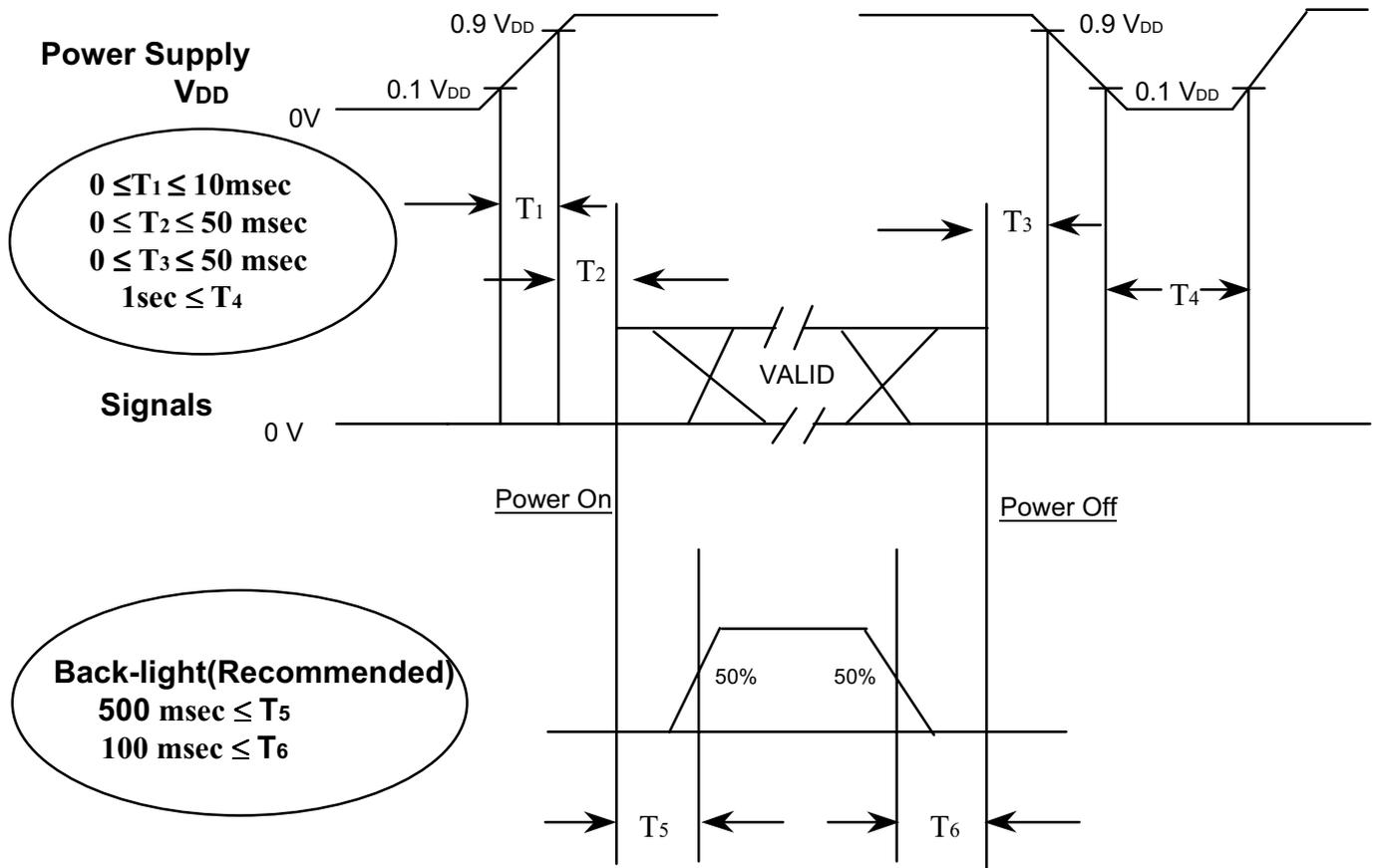
[Horizontal Timing]
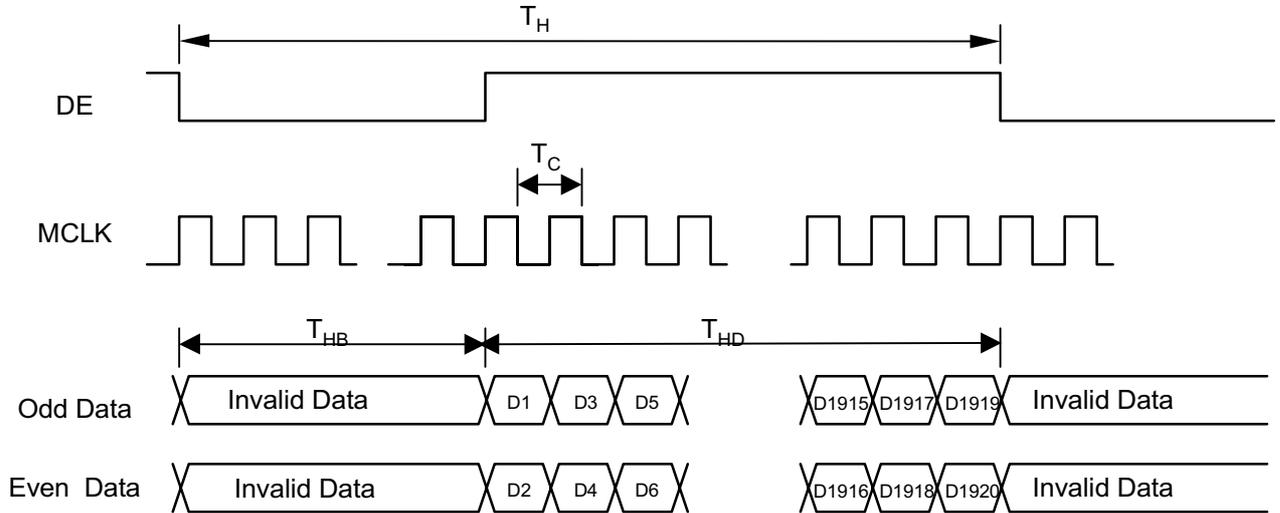
[Vertical Timing]

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$_{DD}$

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

0.1 V$_{DD}$　　　　　　　　　　　　　0.1 V$_{DD}$

0V

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

T$_1$　　　　　　　　T$_3$

T$_2$　　　　　　　　T$_4$

Signals

0 V

VALID

Power On　　　　　　　　Power Off

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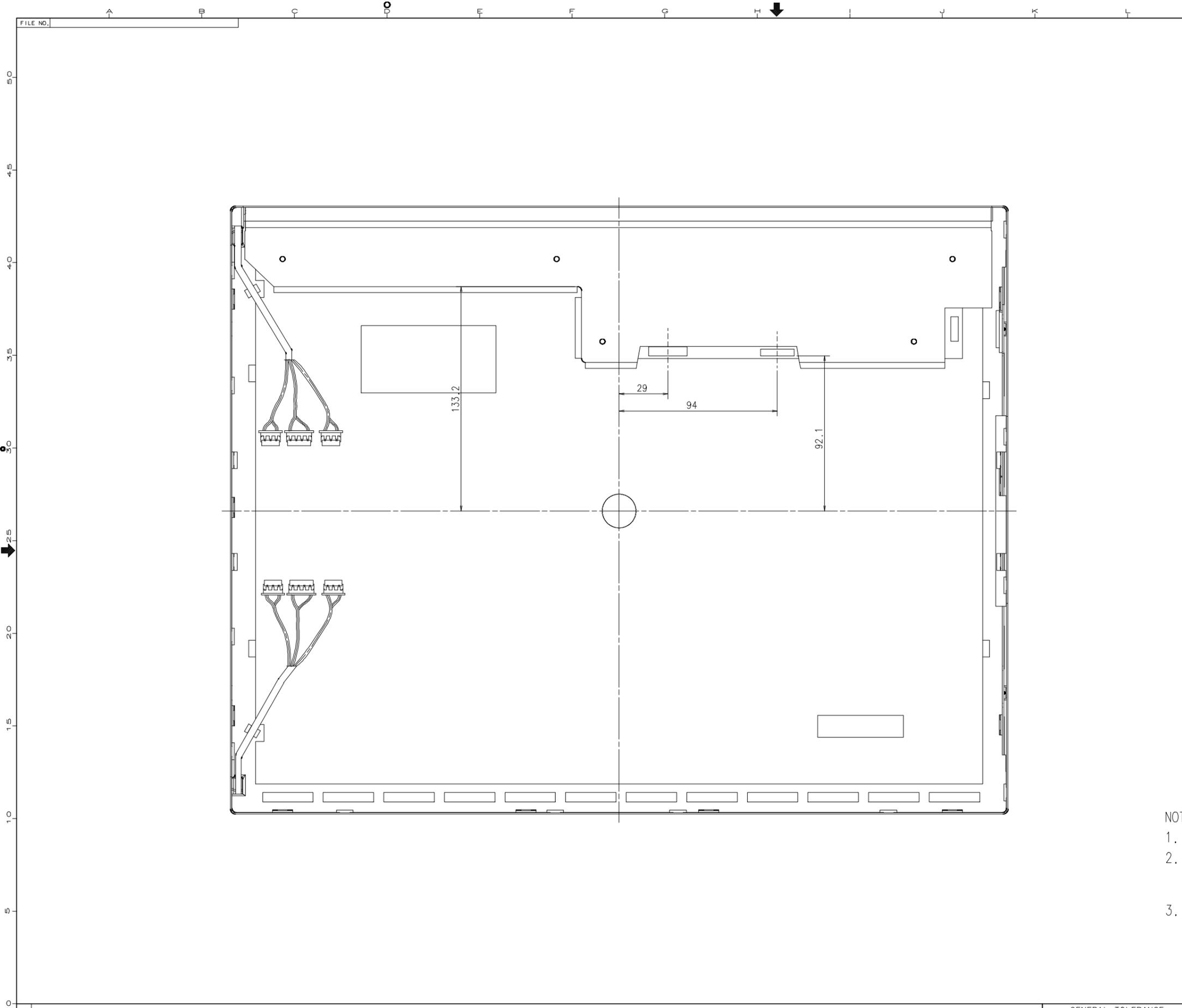100 msec $\leq$ T$_6$

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.

7. Outline Dimension
(Refer to the next page)

NOTES

1. BACKLIGHT : 6 COLD CATHODE FLUORESCENT LAMPS.

2. I/F CONNECTOR SPECIFICATION.
   - MAKER : JAE
   - PART NO : FI-WE31P-HF

3. LAMP CONNECTOR/WIRE SPECIFICATION.
   - MAKER : JST
   - PART NO : BHSR-04VS-1(4 PIN x 140mm): 1 EA
              BHSR-03VS-1(3 PIN x 140mm): 2 EA

SECTION A-A'

SECTION B-B'

M3.0*0.5 MACHINE

MIN 6.9

25 MAX

462.0±0.5

216 (A/A)
432 (A/A)

162 (A/A)
324 (A/A)

361.0±0.5
328

436

8-ø4.5
4-8.5
18.35
99 ±0.3
59.1 ±0.3
21
59.1 ±0.3
18.35
99 ±0.3
23

17.1
21.65
21.5
4-8.5
89 ±0.3
64.1 ±0.3
18.35
64.1 ±0.3
89 ±0.3
18.35
18.65

GENERAL TOLERANCE				REV	DATE	DESCRIPTION OF REVISION				REASON		CHG'D BY
STEP	LEVEL 1	LEVEL 2	LEVEL 3	UNIT	mm	DRA'N BY	DES'D BY	CHK'D BY	APP'D BY	MODEL NAME	LTM213U4	
0 < X ≤ 4	±0.05	±0.1	±0.2	SCALE	/		G.H.CHA		J.D.PARK			
4 < X ≤ 16	±0.08	±0.15	±0.3	TOLERANCE		.	03.01.08	. .	03.01.08	PART/SHEET NAME	OUTLINE-DIM.(FRONT)	SHEET 1/2
16 < X ≤ 64	±0.12	±0.25	±0.5					SPEC. NO				
64 < X ≤ 256	±0.25	±0.4	±0.8	SAMSUNG ELECTRONICS				CODE NO.			VER.	

NOTES

1. BACKLIGHT : 6 COLD CATHODE FLUORESCENT LAMPS.

2. I/F CONNECTOR SPECIFICATION.
   - MAKER : JAE
   - PART NO : FI-WE31P-HF

3. LAMP CONNECTOR/WIRE SPECIFICATION.
   - MAKER : JST
   - PART NO : BHSR-04VS-1(4 PIN x 140mm): 1 EA
               BHSR-03VS-1(3 PIN x 140mm): 2 EA

NO	PART NAME	CODE NO	SPECIFICATION	Q'TY	WEIGHT FINISH	MATERIAL	UNFOLDED DIM. OF. MATERIAL	REMARK

REV	DATE	DESCRIPTION OF REVISION			REASON		CHG'D BY
UNIT	mm	DRA'N BY	DES'D BY	CHK'D BY	APP'D BY	MODEL NAME	LTM213U4
SCALE	/		G.H.CHA		J.D.PARK		
TOLERANCE		.	03.01.08	.	03.01.08	PART/SHEET NAME	OUTLINE-DIM.(REAR)
						SPEC. NO	
SAMSUNG ELECTRONICS						CODE NO.	VER.

SHEET 2/2

8. General Precautions

8.1 Handling

(a) When the module is assembled, it should be attached to the system firmly using every mounting hole. 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 damage to the polarizer permanently due to chemical reaction.

(g) The liquid crystal material leaked from the panel 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 which 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 of the polarizer on the module should be slowly peeled off just before use in order to minimize the electrostatic charge.

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

8.2 Storage

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

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

(c) The module should 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 should 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 should
have 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
require higher startup voltage(Vs).

8.4 Others

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

(b) Avoid condensation of water which 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,
the situation when the image "Sticks" to the screen could happen.

(e) This module with its circuitry PCB's on the rear side should be handled
carefully in order to avoid the stress to the PCB.