TO : B&N

DATE : March 19, 2012

SAMSUNG TFT-LCD

MODEL NO. : LTL090CL01-001

NOTE : Extension code [-001]

→ LTL090CL01-001

Surface type [**Glare**]

The information described in this SPEC is preliminary and can be changed without prior notice.

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PREPARED BY : *Remy Park*

Application engineering group, LCD Division
Samsung Electronics Co., Ltd.

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Preliminary

Date	Revision No.	Page	Summary
March 19, 2011	P00	All	The preliminary specification of LTL090CL01-001 model was issued first.

GENERAL DESCRIPTION

DESCRIPTION

LTL090CL01 is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as switching devices. This model is composed of a TFT LCD panel, a driver circuit and a backlight unit. The resolution of a 9.0" contains 1920 x 1280 pixels and can display up to 262,144 colors. 6 O'clock direction is the optimum viewing angle.

FEATURES

- High contrast ratio, Ultra wide viewing angle
- WUXGA (1920 x 1280 pixels) resolution
- Low power consumption
- LED Back Light with external LED Driver
- DE (Data enable) only mode
- 4 lane 6-bit MIPI input interface / 6bit mini LVDS output interface
- Green product (BFR/CFR/PVC Free)

APPLICATIONS

- Notebook PC or Tablet
- If the usage of this product is not for Note PC or Tablet application, please contact SEC.

GENERAL INFORMATION

Item	Specification	Unit	Note
Display area	200.91(H) x 141.21(V) (9.0" diagonal)	mm	
Driver element	a-Si TFT active matrix		
Display colors	262,144		
Number of pixel	1920 X 1280	pixel	3:2
Pixel arrangement	RGB vertical stripe		
Pixel pitch	33(H) X 99(V) typ	μm	
Display Mode	Normally black (PLS mode)		
Surface treatment	Haze 0, Hard-Coating 3H		

Mechanical Information

	Item	Min.	Typ.	Max.	Unit	Note
Module size	Horizontal (H)	200.71	200.91	201.11	mm	
	Vertical (V)	141.01	141.21	141.41	mm	
	Depth (D)	2.255	2.455	2.655	mm	w/o side tape
Weight		-	-	125	g	w/o TSP

Note (1) Measurement condition of outline dimension
. Equipment : height gauge
. Push Force : 150g·f

1. ABSOLUTE MAXIMUM RATINGS

1.1 ENVIRONMENTAL ABSOLUTE RATINGS

Item	Symbol	Min.	Max.	Unit	Note
Storage temperate	TSTG	-20	60	°C	(1)
Operating temperate (Temperature of glass surface)	TOPR	0	50	°C	(1)
Shock (non-operating)	Snop	-	240	G	(2),(4)
Vibration (non-operating)	Vnop	-	2.41	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

Relative Humidity (%RH)

(40,90)
Operating Range
(50,50.4)
(60,27.7)
Storage Range

Temperature (°C)
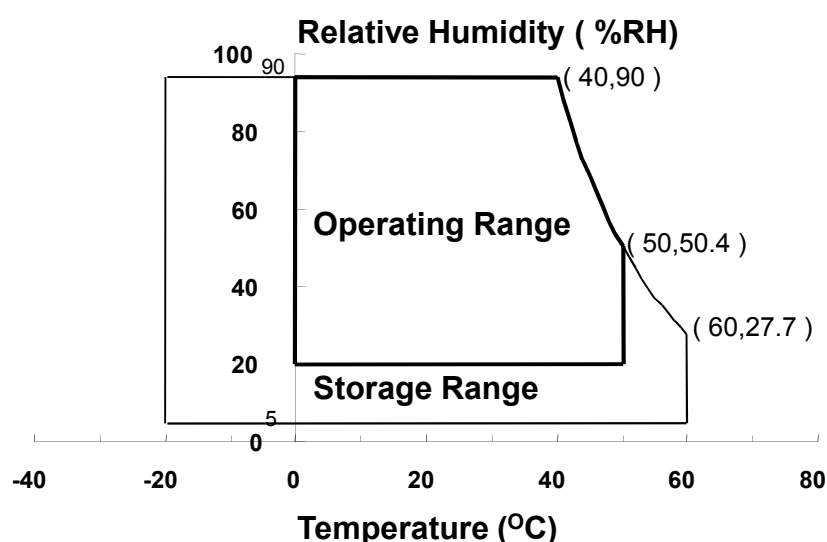
(2) 2ms, half sine wave, one time for ±X, ±Y, ± Z.
(3) 5 - 500 Hz, random vibration, 30min for X, Y, Z.
(4) At testing Vibration and Shock, the fixture in holding the Module to be tested have to be hard and rigid enough so that the Module would not be twisted or bent by the fixture.

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1.2 ELECTRICAL ABSOLUTE RATINGS

(1) TFT LCD MODULE

V_{DD} =3.3V, V_{SS} = GND = 0V

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	V_{DD}	V_{DD} - 0.3	V_{DD} + 0.3	V	(1)
Logic Input Voltage	V_{IN}	V_{DD} - 0.3	V_{DD} + 0.3	V	(1)

Note (1) Within Ta (25 $\pm$ 2 °C)
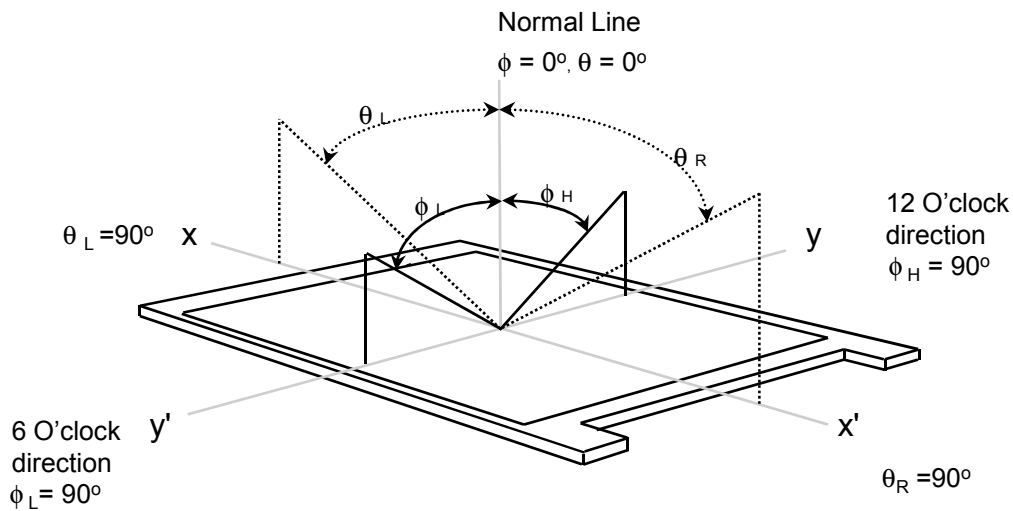
2. OPTICAL CHARACTERISTICS

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 (5). Measuring equipment : TOPCON SR-3

＊Ta = 25 ± 2 °C, V_{DD}=3.3V, fv= 60Hz, f_{DCLK} = TBD, IF = 20.0mA

Item		Symbol	Condition	Min.	Typ.	Max	Unit	Note
Contrast Ratio (5 Points)		CR		-	900	-	-	(1), (2), (5)
Response Time at Ta (Rising + Falling)		T_{RT}		-	16	-	msec	(1), (3)
Average Luminance of White (5 Points)		$Y_{L,AVE}$		400	450	-	cd/m^2	IF=20mA 5 points (1), (4)
Color Chromaticity (CIE)	Red	R_X	Normal Viewing Angle $\phi = 0$ $\theta = 0$	TBD	TBD	TBD	-	(1), (5) SR-3
		R_Y		TBD	TBD	TBD		
	Green	G_X		TBD	TBD	TBD		
		G_Y		TBD	TBD	TBD		
	Blue	B_X		TBD	TBD	TBD		
		B_Y		TBD	TBD	TBD		
	White	W_X		0.283	0.313	0.343		
		W_Y		0.299	0.329	0.359		
Viewing Angle	Hor.	θ_L	CR ≥ 10 At center	-	85	-	Degrees	(1), (5) SR-3
		θ_R		-	85	-		
	Ver.	ϕ_H		-	85	-		
		ϕ_L		-	85	-		
13 Points White Variation		δ_L		-	1.4	1.6	-	(6)

Note 1) Definition of Viewing Angle : Viewing angle range(10 ≤ C/R)

Normal Line
$\phi = 0^o, \theta = 0^o$

θ_L

θ_R

ϕ_L ϕ_H

$\theta_L = 90^o$ x   y   12 O'clock direction
$\phi_H = 90^o$

6 O'clock direction   y'   x'
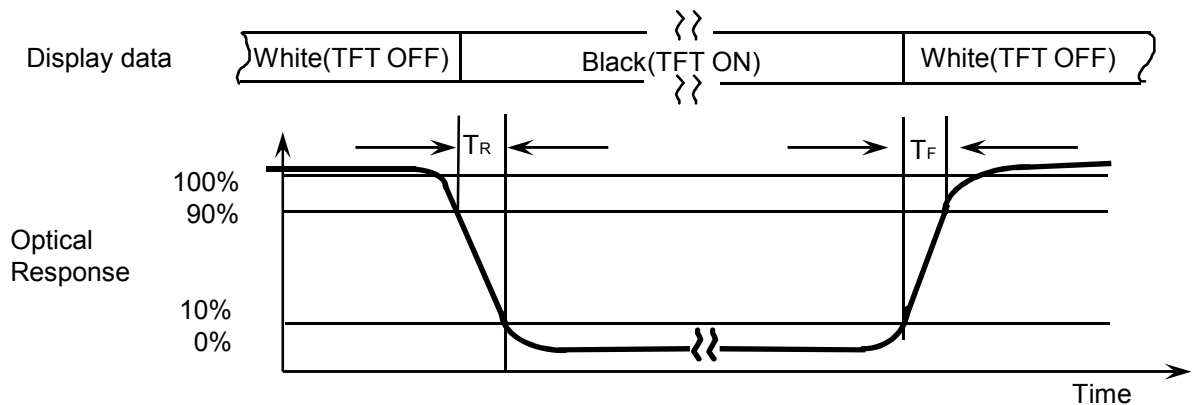$\phi_L = 90^o$

$\theta_R = 90^o$

Note 2) Definition of Contrast Ratio (CR) : Ratio of gray max (Gmax) ,gray min (Gmin) at 5 points(4, 5, 7, 9, 10)

$$CR = \frac{CR(4) + CR(5) + CR(7) + CR(9) + CR(10)}{5}$$

Points : ④ , ⑤ , ⑦ , ⑨ , ⑩   at the figure of Note (6).

Note 3) Definition of Response time :

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

T_R T_F

Optical Response

100%
90%

10%
0%

Time

Note 4) Definition of Average Luminance of White : measure the luminance of white at 5 points.

480   960   1440

VIEW AREA

Average Luminance of White ($Y_{L,AVE}$)

⑩   ⑨   320

$$Y_{L,AVE} = \frac{Y_{L4} + Y_{L5} + Y_{L7} + Y_{L9} + Y_{L10}}{5}$$

⑦   640

⑤   ④   960
(lines)

○ : test point

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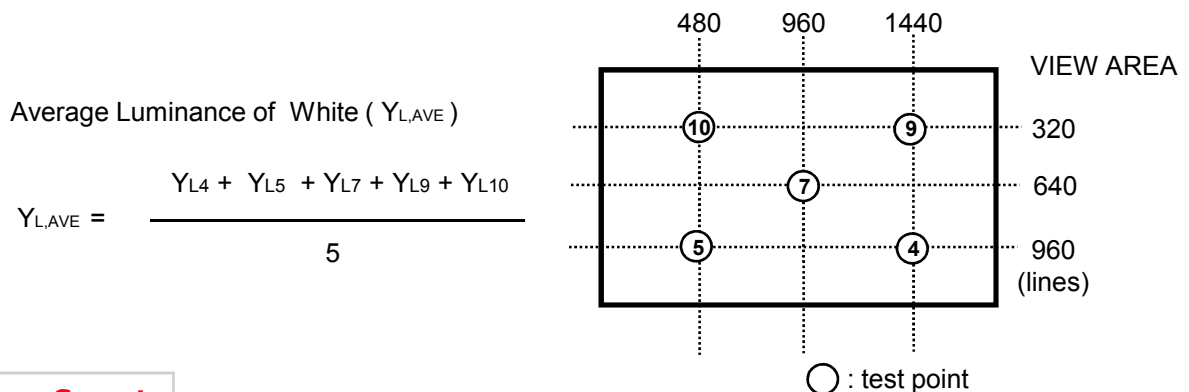
Note 5) After stabilizing and leaving the panel alone at a given temperature for 30min, the measurement should be executed. Measurement should be executed in a stable, windless,and dark room. 30 min after lighting the backlight. This should be measured in the center of screen.
IF current : 20.0mA
Environment condition : Ta = 25 $\pm$ 2 °C

Photo-detector
(TOPCON SR-3)

Field = 2°

50 cm

TFT-LCD module

LCD panel

Center of the screen

[Optical characteristics measurement setup]
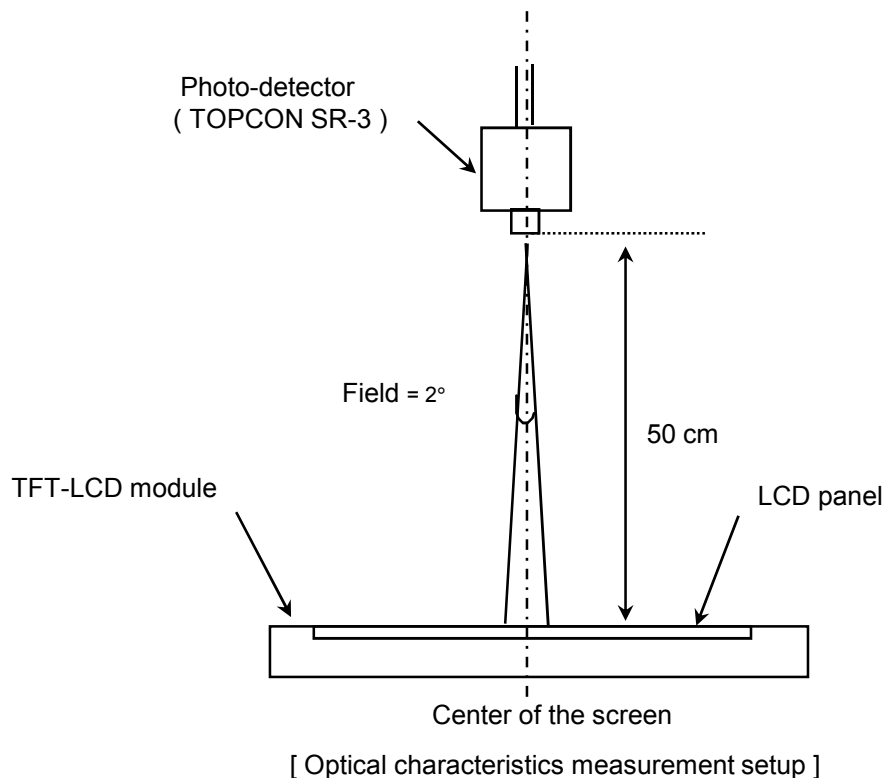
Note 6) Definition of 13 points white variation (δ L), CR variation(CVER) [(1) ~ (13)]
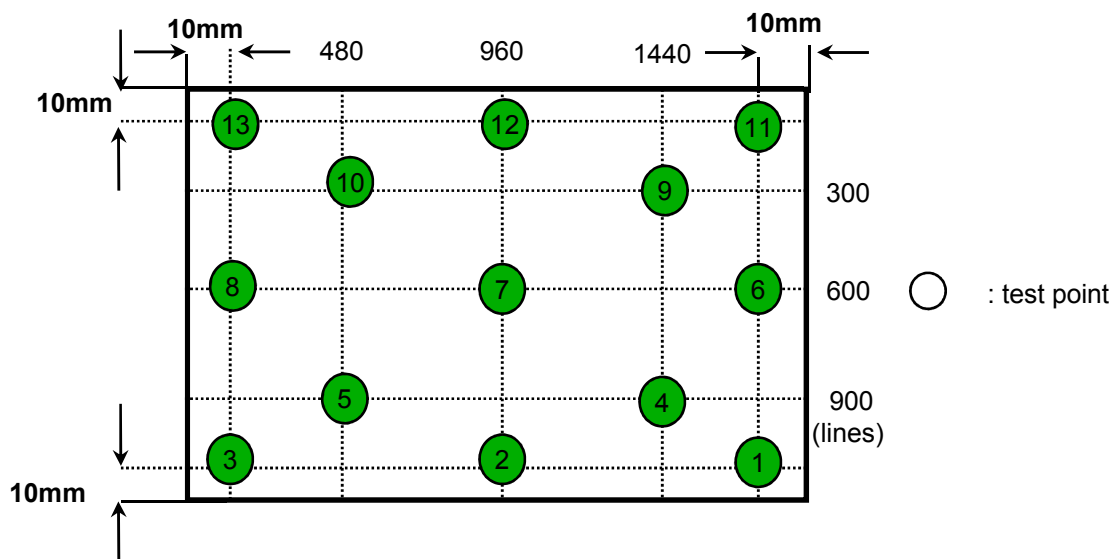
$$\delta \, L \ = \ \frac{\text{Maximum luminance of 13 points}}{\text{Minimum luminance of 13 points}}$$

10mm   480   960   1440   **10mm**

10mm

13   12   11

10   9   300

8   7   6   600   ◯ : test point

5   4   900
(lines)

3   2   1

10mm

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3. ELECTRICAL CHARACTERISTICS

3.1 TFT LCD MODULE

Ta= 25 $\pm$ 2°C

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V_{DD}	3.0	3.3	3.6	V	
Vsync Frequency		f_V	-	60	-	Hz	
Hsync Frequency		f_H	-	TBD	-	KHz	
Main Frequency		f_{DCLK}	-	TBD	-	MHz	
Rush Current		I_{RUSH}	-	-	TBD	A	(4)
Current of Power Supply	White	I_{DD}	-	TBD	TBD	mA	(2),(3)*a
	Mosaic		-	0.75	0.83	mA	(2),(3)*b

Note (1) Display data pins and timing signal pins should be connected.(GND = 0V)

(2) f_V = 60Hz, f_{DCLK} = TBD, V_{DD} = 3.3V, DC Current.

(3) Power dissipation pattern

*a) White Pattern

VIEW AREA
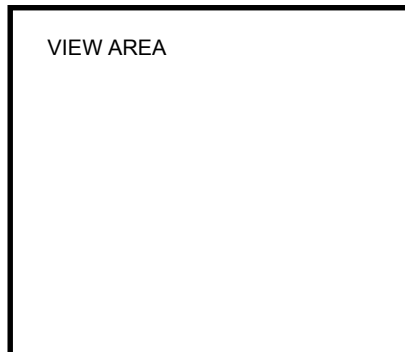
*b) Mosaic Pattern

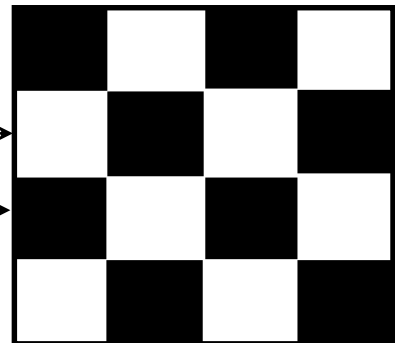Display Brightest Gray Level

Display Darkest Gray Level

4) Rush current measurement condition
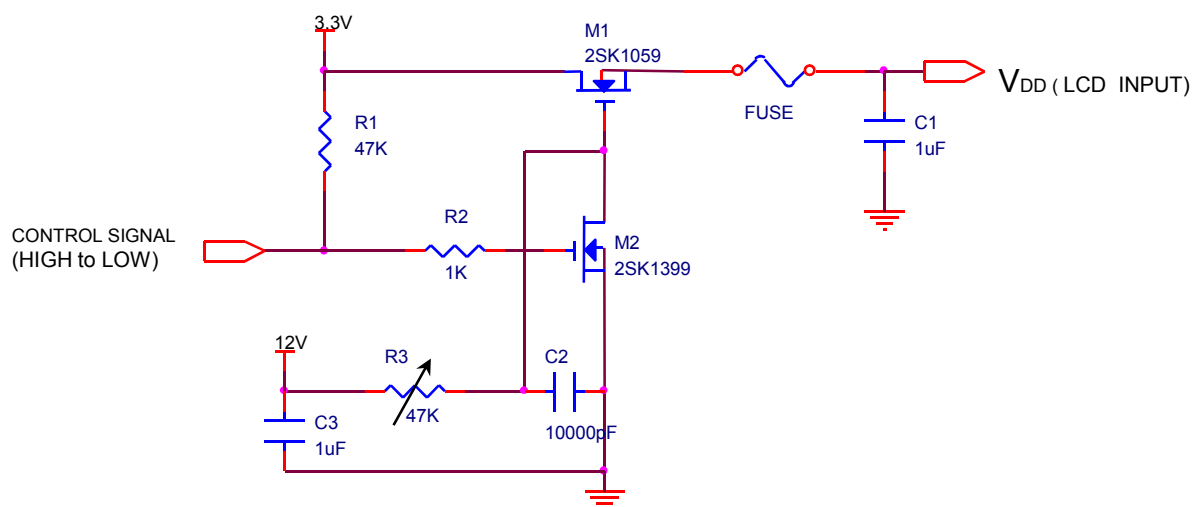
V_DD rising time is 470us
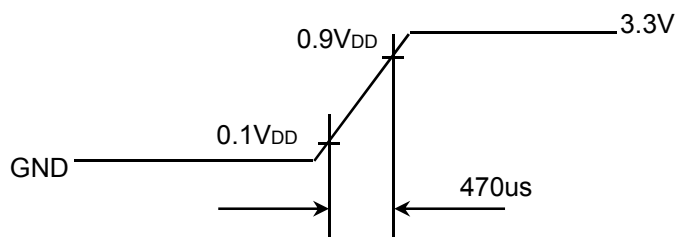
3.2 BACK-LIGHT UNIT

Ta= 25 ± 2 ℃

Item	Symbol	Min.	Typ.	Max.	Unit	Note
LED Forward Current	IF	-	20.5	-	mA	
LED Forward Voltage	VF	-	3.0	-	V	
LED Array Voltage	VP	-	21.0	-	V	VF X 7LEDs
Power Consumption	P	-	2.15	-	W	IF X VF X 35LEDs (w/o driver)
Operating Life Time	Hr	12,000	-	-	Hour	(1)

Note (1) Life time (Hr) of LEDs can be defined as the time in which it continues to operate under the condition Ta= 25 ± 2 ℃ and IF = 20.0mA until one of the following event occurs.
　　　　1. When the brightness becomes 50% or lower than the original.

4. BLOCK DIAGRAM

4.1 TFT LCD Module

Legend:
- → LED power
- → MIPI 4lane
- → PVDD
- → TVDD
- → I2C
- → Gate Voltage
- → m-LVDS
- → Vcom
- → Control Signal
- → Gamma
- → AVDD

Blocks:
- User Connector (31pin), 12V
- EEPROM
- Timing Controller (NT71391)
- DC-DC Converter (RT9910)
- Gamma Generator
- DVR
- (Analog Block)
- Source Driver 1, 2, 3, 4 — 1440ch
- LCD panel (1920x1280)
- Gate IC1, Gate IC2, Gate IC3, Gate IC4
- LED

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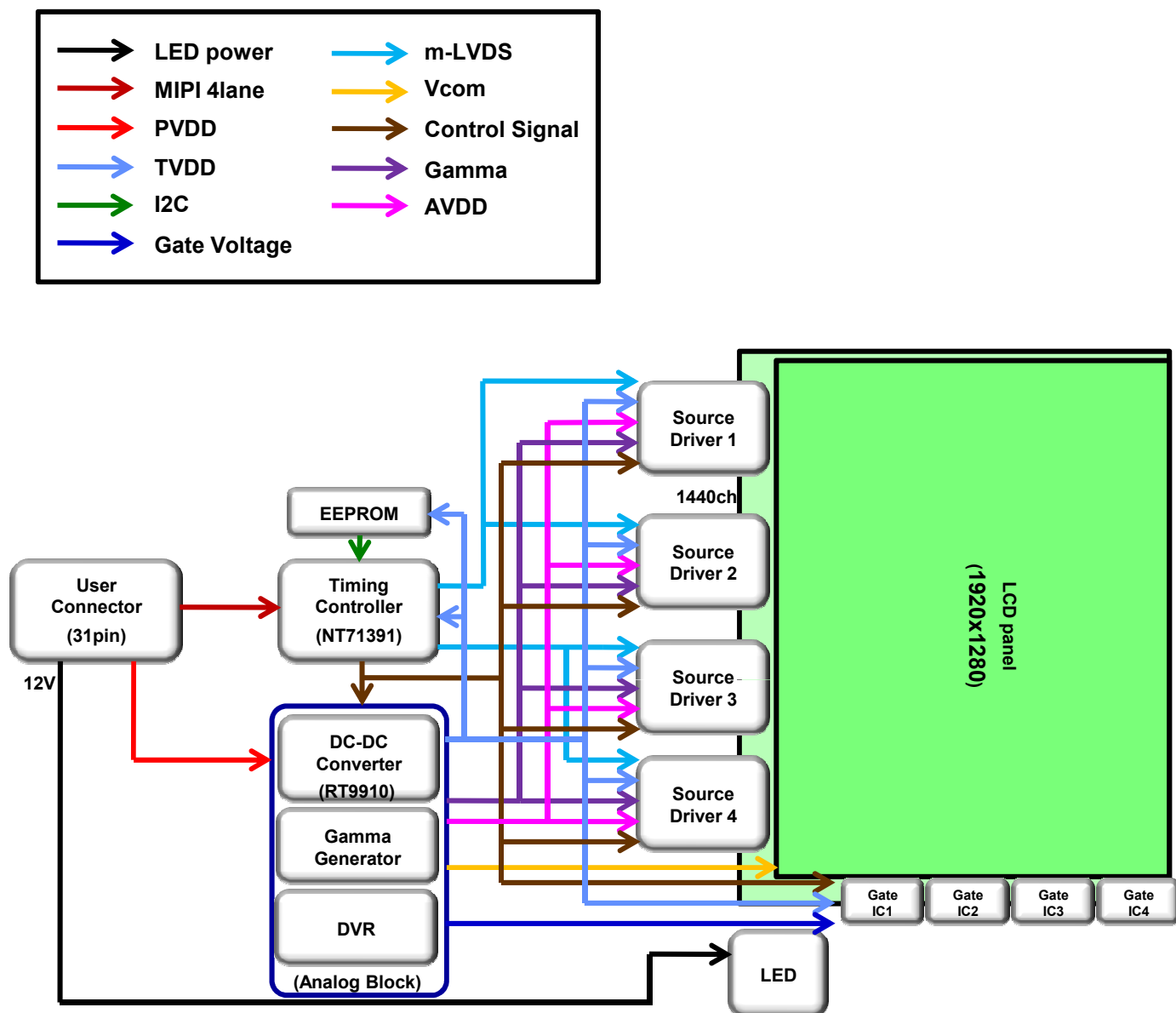
5. INPUT TERMINAL PIN ASSIGNMENT

5.1. Input Signal & Power (Connector : JAE WH1 40pin, TCON: NT71391QG-001)

No.	Symbol	Function
1	GND	Ground
2	VDD	Input Power (3.3V)
3	MIPI_D2_N	DSI Lane 2 Neg
4	VDD	Input Power (3.3V)
5	MIPI_D2_P	DSI Lane 2 Pos
6	VDD	Input Power (3.3V)
7	GND	Ground
8	GND	Ground
9	MIPI_D1_N	DSI Lane 1 Neg
10	GND	Ground
11	MIPI_D1_P	DSI Lane 1 Pos
12	GND	Ground
13	GND	Ground
14	CABC_EN	CABC Enable
15	MIPI_CLK_N	DSI CLK Neg
16	PWM_IN	BL PWM Input to LCM
17	MIPI_CLK_P	DSI CLK Pos
18	PWM_OUT	BL PWM Output from LCM
19	GND	Ground
20	GND	Ground
21	MIPI_D0_N	DSI Lane 0 Neg
22	NC	True NC
23	MIPI_D0_P	DSI Lane 0 Pos
24	LED_VDD	LED Anode VDD
25	GND	Ground
26	LED_VDD	LED Anode VDD
27	MIPI_D3_N	DSI Lane 3 Neg
28	LED_VDD	LED Anode VDD
29	MIPI_D3_P	DSI Lane 3 Pos
30	NC	True NC
31	GND	Ground
32	LED_FB0	LED Cathode String0
33	CM_EN	CM Enable
34	LED_FB1	LED Cathode String1
35	NC	NC (LCM USE)
36	LED_FB2	LED Cathode String2
37	NC	SCL (LCM USE)
38	LED_FB3	LED Cathode String3
39	NC	SDA (LCM USE)
40	LED_FB4	LED Cathode String4

5.2 Input Signals, Basic Display Colors and Gray Scale of Each Color

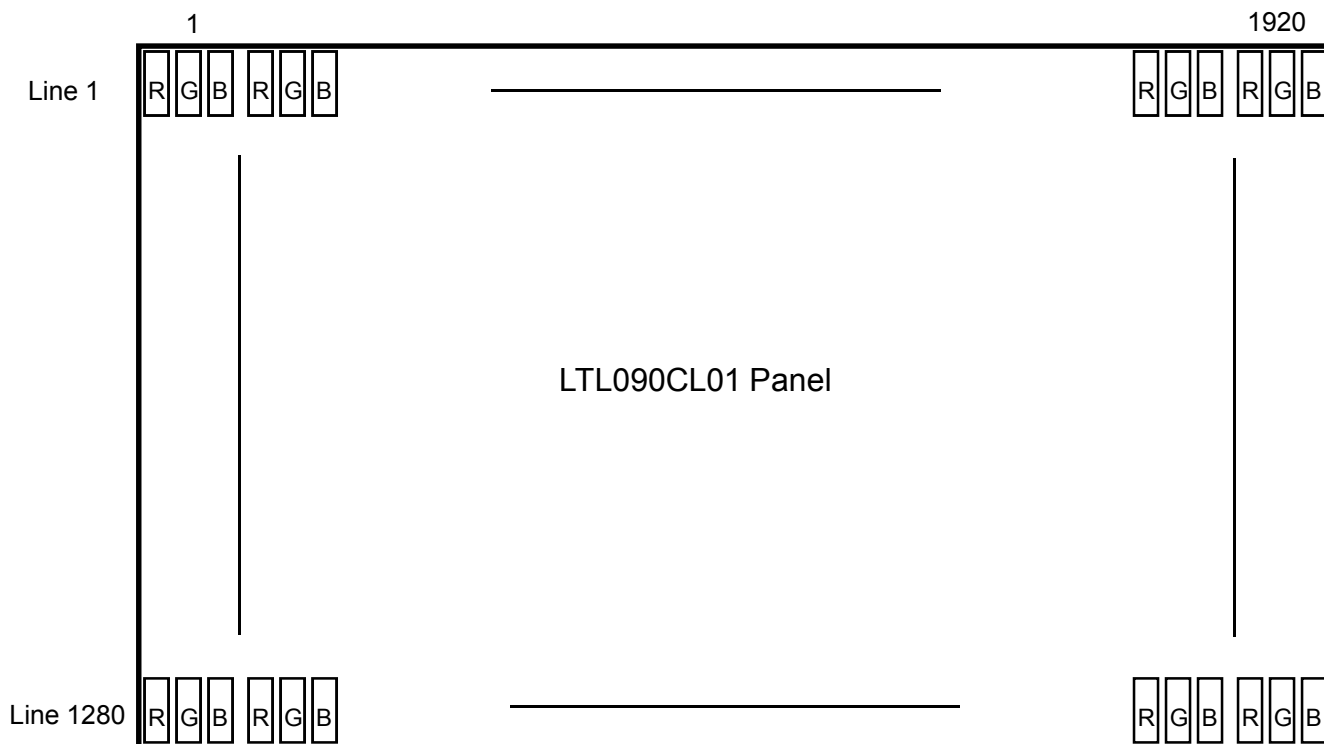| Color	Display	Data Signal																		Gray Scale Level
		Red						Green						Blue						
		R0	R1	R2	R3	R4	R5	G0	G1	G2	G3	G4	G5	B0	B1	B2	B3	45	B5	
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	-
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	-
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	-
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	-
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	-
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	-
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
Gray Scale Of Red	Black	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	R1
	↑	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	R3~R60
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R61
	Light	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R62
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R63
Gray Scale Of Green	Black	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	1	0	0	0	0	0	0	0	0	0	0	0	G1
	↑	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	G2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	G3~G60
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0	G61
	Light	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	G62
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	G63
Gray Scale Of Blue	Black	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	1	0	0	0	0	0	B1
	↑	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	B2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	B3~B60
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	B61
	Light	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	B62
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	B63

Note 1) Definition of gray :
    Rn: Red gray, Gn: Green gray, Bn: Blue gray (n=gray level)
Note 2)Input signal: 0 =Low level voltage, 1=High level voltage
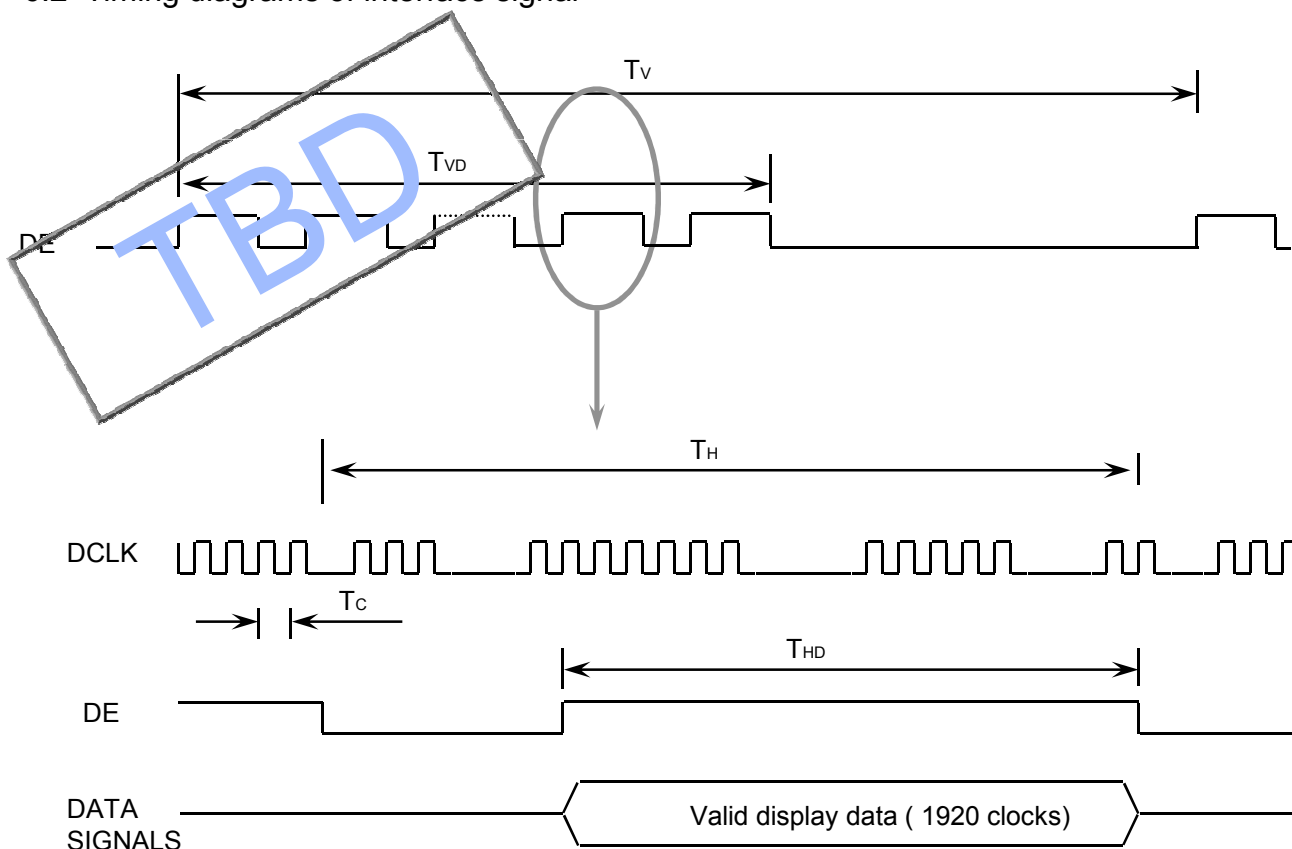
5.3 Pixel Format in the display

1   1920

Line 1 |R|G|B| |R|G|B| |R|G|B| |R|G|B|

LTL090CL01 Panel

Line 1280 |R|G|B| |R|G|B| |R|G|B| |R|G|B|

6. INTERFACE TIMING

6.1 Timing Parameters

Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
Frame Frequency	Cycle	TV	1210	1280	1300	Lines	
Vertical Active Display Term	Display Period	TVD	-	1280	-	Lines	
One Line Scanning Time	Cycle	TH	2052	2194	2400	Clocks	
Horizontal Active Display Term	Display Period	THD	-	1920	-	Clocks	

6.2 Timing diagrams of interface signal

DATA SIGNALS — Valid display data (1920 clocks)

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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

$0.5 < T_1 \leq 10$ msec
$0 < T_2 \leq 50$ msec
$0 < T_3 \leq 50$ msec
500 msec $\leq T_4$

T_1

T_2 T_3

T_4

Signals

VALID

0 V

Power On   Power Off

Back-light
200 msec $\leq T_5$
200 msec $\leq T_6$

50%   50%

T_5 T_6
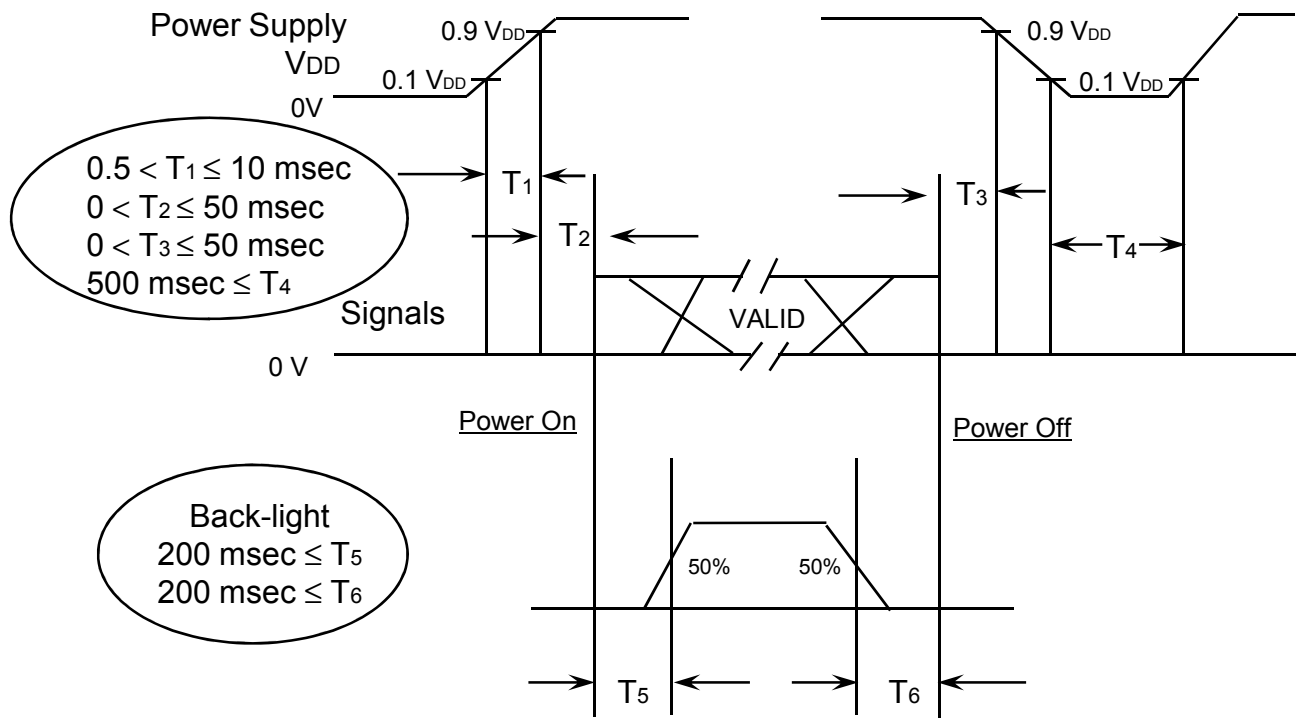
Power ON/OFF Sequence

T1 : Vdd rising time from 10% to 90%
T2 : The time from Vdd to valid data at power ON.
T3 : The time from valid data off to Vdd off at power Off.
T4 : Vdd off time for Windows restart
T5 : The time from valid data to B/L enable at power ON.
T6 : The time from valid data off to B/L disable at power Off.

NOTE.

  (1) The supply voltage of the external system for the module input should be the same as the definition of V_{DD}.

  (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 white.

  (3) In case of V_{DD} = 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. Mechanical Outline Dimension

Refer to the next page

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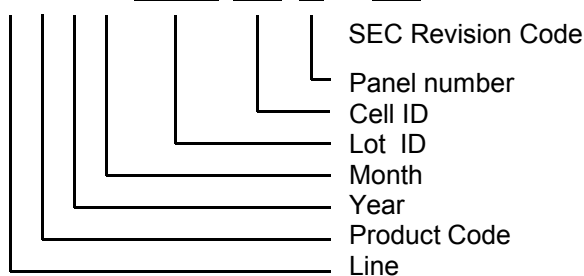| Doc.No. | LTL090CL01-001 | Rev.No | | 04-P00-S-120319 | | Page | 21 / 26 |

TBD

9. MARKINGS & OTHERS

A nameplate bearing followed by is affixed to a shipped product at the specified location on each product.

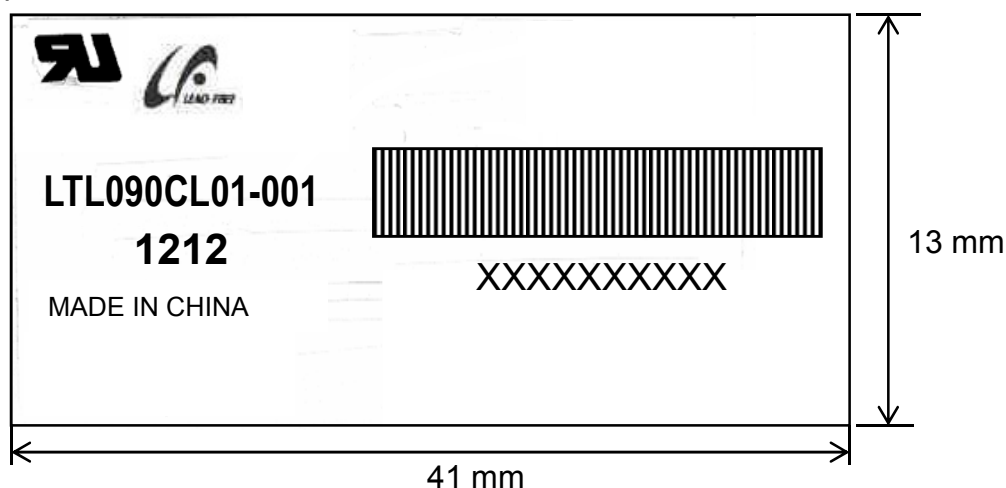(1)Parts number : LTL090CL01
(2)Revision code : 3 letters
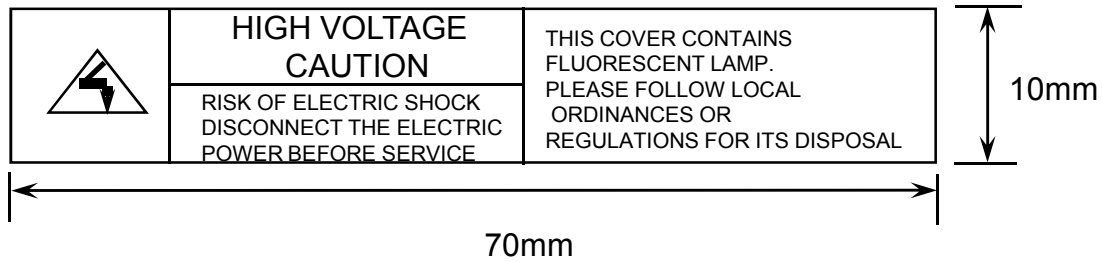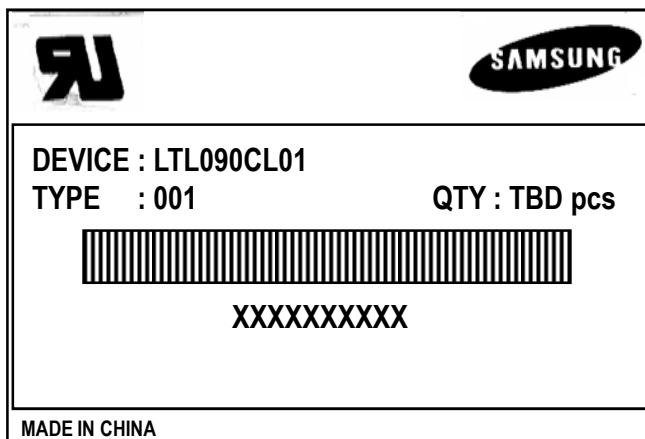(3)Lot number   : X X X X XXX XX X   **XXX**

- SEC Revision Code
- Panel number
- Cell ID
- Lot ID
- Month
- Year
- Product Code
- Line

(4) Nameplate Indication

LTL090CL01-001
1212
MADE IN CHINA

XXXXXXXXXX

13 mm

41 mm

Parts name   : LTL090CL01
Cell ID   : XXXXXXXXXX
Inspected work week   : 12 (2012 year 12th week)
Product Revision Code : 001

(5) High voltage caution notice

⚡	HIGH VOLTAGE CAUTION RISK OF ELECTRIC SHOCK DISCONNECT THE ELECTRIC POWER BEFORE SERVICE	THIS COVER CONTAINS FLUORESCENT LAMP. PLEASE FOLLOW LOCAL ORDINANCES OR REGULATIONS FOR ITS DISPOSAL

10mm

70mm

(6) Packing small box attach

UL **SAMSUNG**

DEVICE : LTL090CL01
TYPE   : 001   **QTY : TBD pcs**

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MADE IN CHINA

10. GENERAL PRECAUTIONS

Preliminary

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.

(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. They might cause 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 C-MOS Gate Array IC.

(i) Use fingerstalls 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 adjust the variable resistor which is located on the back side.

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

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

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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 5 to 40 °C and relative humidity of less than 70%.

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

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

(d) Storage period is recommended not to exceed 1 year.

3. OPERATION

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

(b) Power supply should always be turned on/off according to the following 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 standard limited warranty is only applicable when the module is used for general notebook applications. If used for purposes other than as specified, SEC is not to be held reliable for the defective operations. It is strongly recommended to contact SEC to find out fitness for a particular purpose.

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, 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 let it stressed.

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