SAMSUNG DISPLAY

Product Specification

( ) Preliminary Specification
(√) Approval Specification

Any modification of Spec is not allowed without SDC's permission

CUSTOMER	
DATE OF ISSUE	2013.01.29

MODEL NO.	LTL090CL01
EXTENSION CODE	-W

Customer Approval & Feedback

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SamsungSecret

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REVISION HISTORY

Date.	Rev.No.	Page	Revision Description
01/29/13	A00	All	Initial Release

1. GENERAL DESCRIPTION

DESCRIPTION

The LTL090CL01-001 uses a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFTs as switching components. This model is composed of a TFT LCD panel, a driver circuit, and a backlight unit. This 9.0" model has a resolution of 1920 x 1280 pixels and can display up to 262,144 colors.

FEATURES

PLS Mode Wide viewing angle TFT–LCD
High contrast ratio
WUXGA(1920 x 1280 × RGB pixels) 256dpi resolution
Low power consumption
LED Back Light without LED Driver ; need to external LED Driver
DE (Data enable) only mode
MIPI (**M**obile **I**ndustry **P**rocessor **I**nterface) 6bit 4Lane / without EDID
Including CABC (**C**ontent **A**daptive **B**rightness **C**ontrol) Function
Green product (BFR/CFR/PVC Free)

APPLICATIONS

Tablet PC
If the intent to use this product is for other purpose, please contact Samsung Display.

GENERAL INFORMATION

Item	Specification	Unit	Note
Display area	190.08 (H) x 126.72 (V) (9.0"diagonal)	mm	
Driver element	a-Si TFT active matrix		
Display colors	262,144		6bit
Number of pixel	1920 * 1280	Pixel	
Pixel arrangement	RGB vertical stripe		
Pixel pitch	99.00 x 99.00 (TYP.)	㎛	
Display Mode	Normally black (PLS mode)		
A)Glass Thickness	0.25	㎜	
Surface treatment	Haze 0%, Hard-Coating 2H		Glare

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) Body	-	2.515	2.715	mm	
	Depth (D) Max	-	2.528	2.728	mm	(1)
Weight		-	-	125	g	

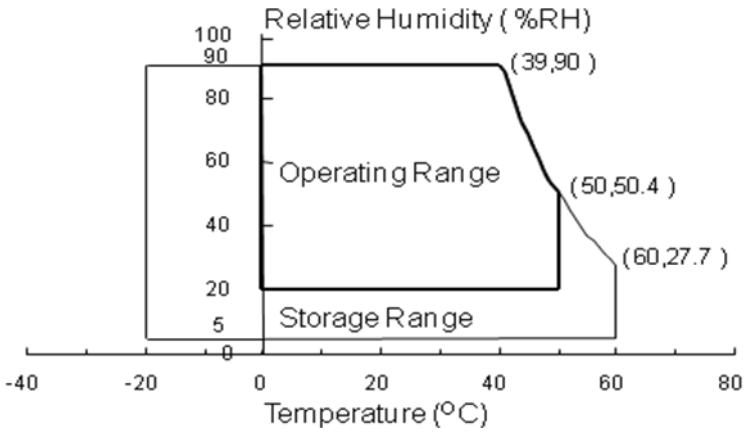
NOTE (1) Thickness Measuring Method
. Measuring force : 150gf with Height Gauge

2. ABSOLUTE MAXIMUM RATINGS

2.1 ENVIRONMENTAL ABSOLTE RATINGS

Item	Symbol	Min.	Max.	Unit	Note
Storage temperate	TSTG	-20	60	°C	(1)
Operating temperature (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) The range of temperature and relative humidity are shown in the graph below 90% RH Max. . (39℃ ≥ Ta) If the temperature is higher than 40 ℃, the maximum temperature of wet–bulb shall be less than 39℃. No condensation



(2) Vibrate ±X, ±Y, and ± Z axis in the shape of the half sine wave one time for 2ms .
(3) Vibrate the X, Y, and Z randomly within a 5 - 500 Hz range for 30min.
(4) When testing a vibration and a shock, the fixture, which holds the module to be tested shall be hard and rigid in order for the the module not to be twisted or bent by the fixture.

2.2 ELECTRICAL ABSOLUTE RATINGS

(1) TFT LCD MODULE

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

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	VDD	VSS - 0.3	VDD + 0.3 (4.0V)	V	(1),(2),(3)
Input Voltage	VIN	VSS - 0.3	VDD + 0.3		
MIPI Differential Input Voltage	I VIDM I	70mV	500 mV		

Note (1) Within Ta (25 ± 2 °C)
(2) Permanent damage to the device may occur if exceed maximum values.
(3) Functional operation should be restricted to the conditions described under normal operating conditions.

2.3 THE OTHERS

(1) STATIC ELECTRICITY PRESSURE RESISTANCE

Item	Test Conditions	Remark
CONTACT DISCHARGE	150pF, 330Ω, ± 8kV, 200points, 1 time/point	Operating
AIR DISCHARGE	150pF, 330Ω, ± 15kV, 200points, 1 time/point	Operating

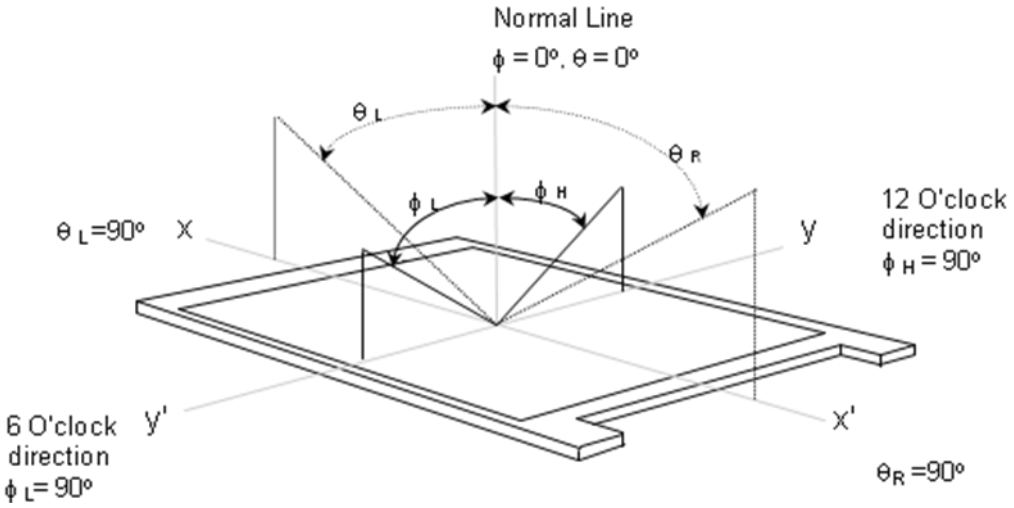
3. OPTICAL CHARACTERISTICS

The following items are measured under the stable conditions.* The optical characteristics should be measured in the dark room or the equivalent environment by the methods shown in the Note (5).
Measuring equipment : TOPCON SR-3

Ta = 25 ± 2 °C, V_{LCD_VCC} =3.3V, fv= 60Hz, fDCLK = 155MHz, IF = 20.5mA

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio (5 points)		CR	Normal Viewing Angle $\phi = 0$ $\theta = 0$	600	800	-	-	(1),(2),(5)
Response time (Rising + Falling)		T_{RT}		-	16	24	ms	(1),(3)
Average Luminance of White (5 Points)		$Y_{L,AVE}$		340	400	-	cd/m^2	IF=100% Duty (1),(4)
Color Chromaticity (CIE)	Red	R_X		-0.03	0.598	+0.03		(1),(5) SR-3
		R_Y			0.350			
	Green	G_X			0.340			
		G_Y			0.568			
	Blue	B_X			0.153			
		B_Y			0.109			
	White	W_X			0.313			
		W_Y			0.330			
Viewing Angle	Hor.	θ_L	CR ≥ 10 At center	80	89	-	Degrees	(1),(5)
		θ_H		80	89	-		
	Ver.	ϕ_H		80	89	-		
		ϕ_L		80	89	-		
Color Gamut		CG	-	45	50	-	%	
White variation (13P)		δ_L		60%	-		%	(6)

Note (1) The definition of viewing angle : The range of viewing angle (10 ≤ C/R)

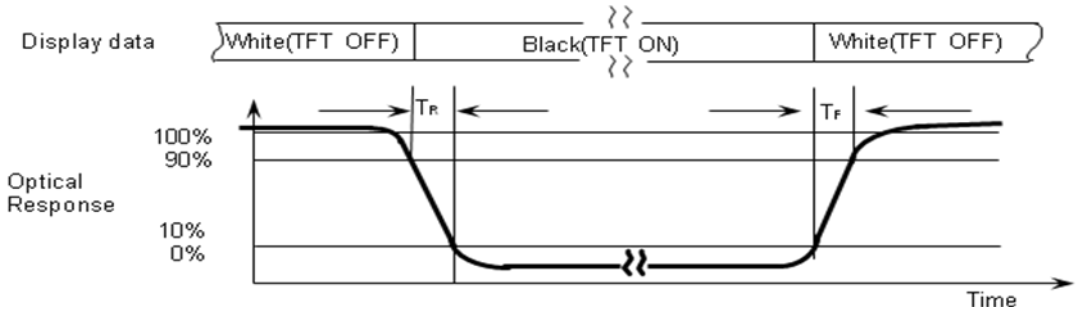


Note (2) The definition of contrast ratio (CR) : The ratio of max. gray and min gray at 5 points (4, 5, 7, 9, and10)

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

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

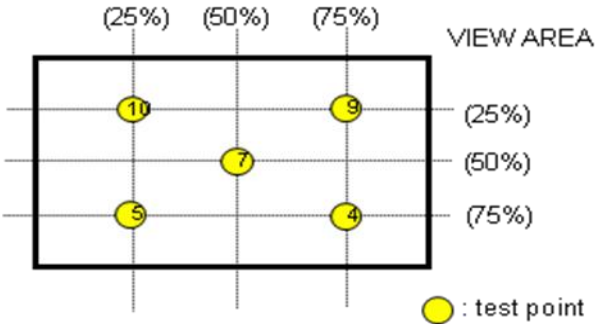
Note (3) The definition of Response time : Subtotal of the time, during which the transmission changes from 10% to 90% when the TFT turns on and off.



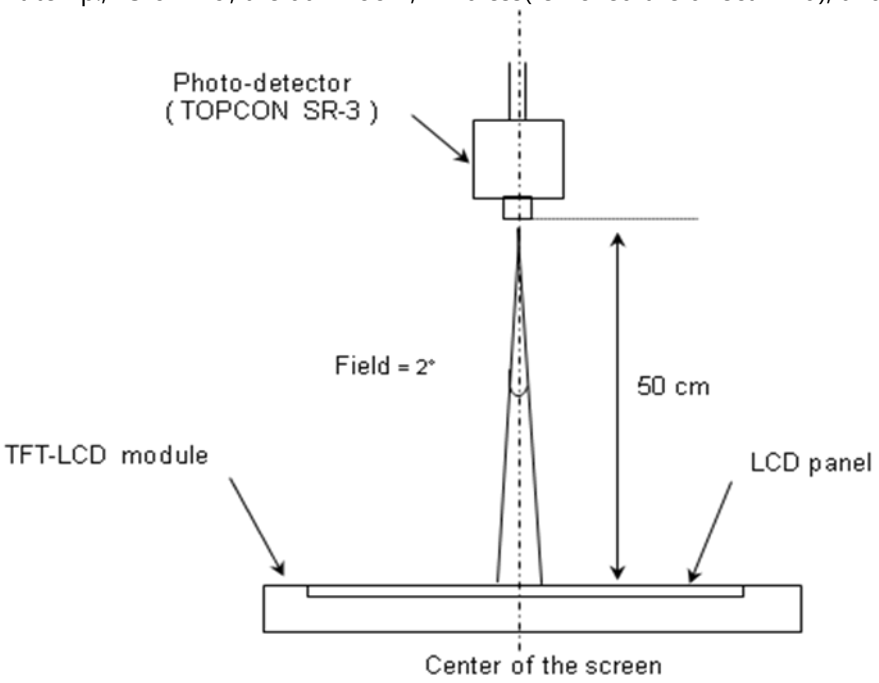
Note (4) The definition of average luminance of white : Measure the luminance of white at 5 points.

Average Luminance of White (Y_{LAVE})

$$Y_{LAVE} = \frac{Y_{L4} + Y_{L5} + Y_{L7} + Y_{L9} + Y_{L10}}{5}$$



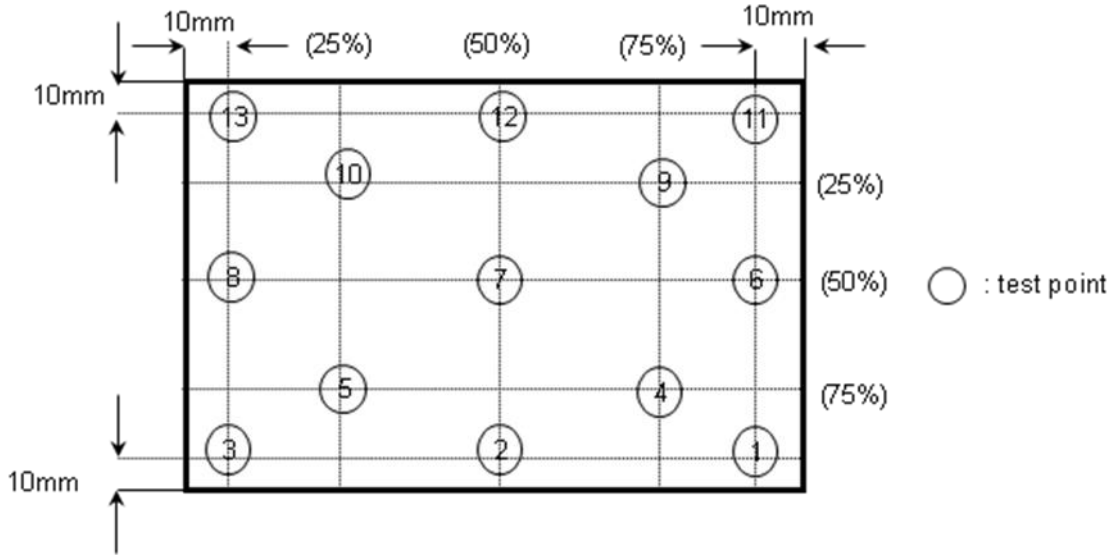
Note (5) Measure the panel, which is left for 30 min. at the normal temp. after leaving it for 30 min with turning the back light on at the rating. The measurement should be executed under the condition including the ambient temp., 25℃±2℃, the dark room, windless(removed the direct wind), and no vibration.



[Optical characteristics measurement setup]

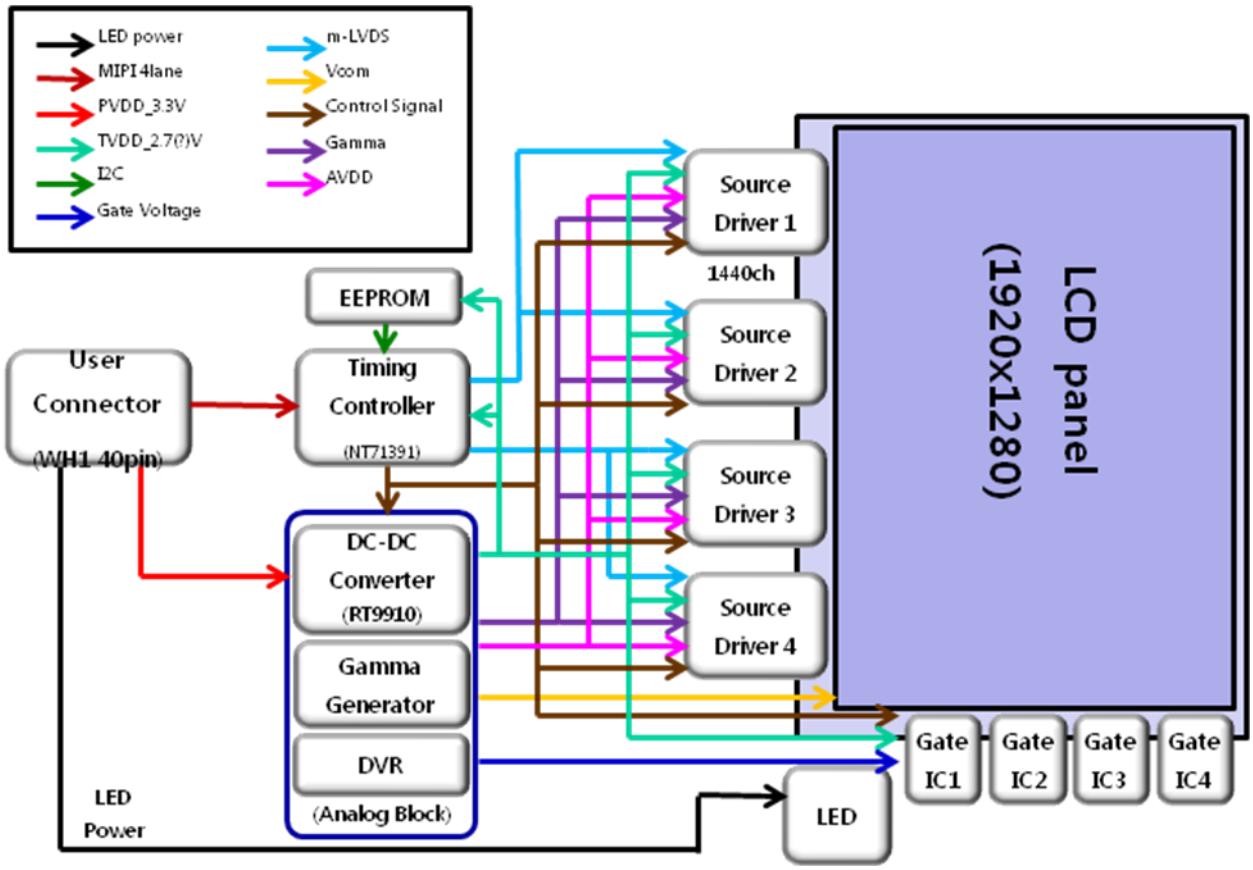
Note (6) The definition of white variation at 13 points (δ L)

$$\delta_L = \frac{\text{Maximum luminance of 13 points}}{\text{Minimum luminance of 13 points}}$$



4. BLOCK DIAGRAM

4.1 TFT LCD MODULE



4.2 THE STRUCTURE OF LED PLACEMENT

TBD

5. ELECTRICAL CHARACTERISTICS

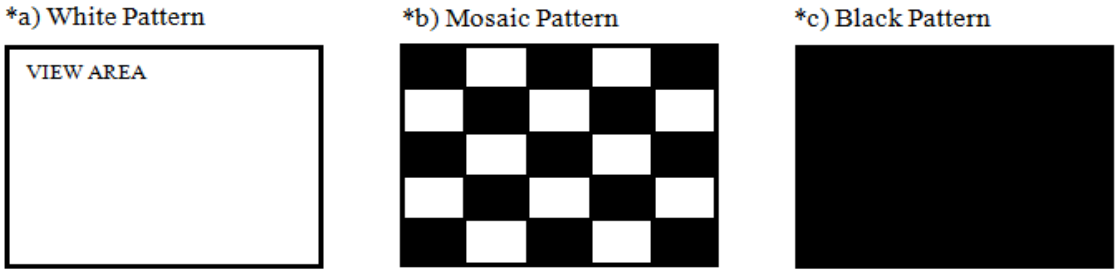
5.1 TFT LCD MODULE

* Ta = 25 ± 2 °C

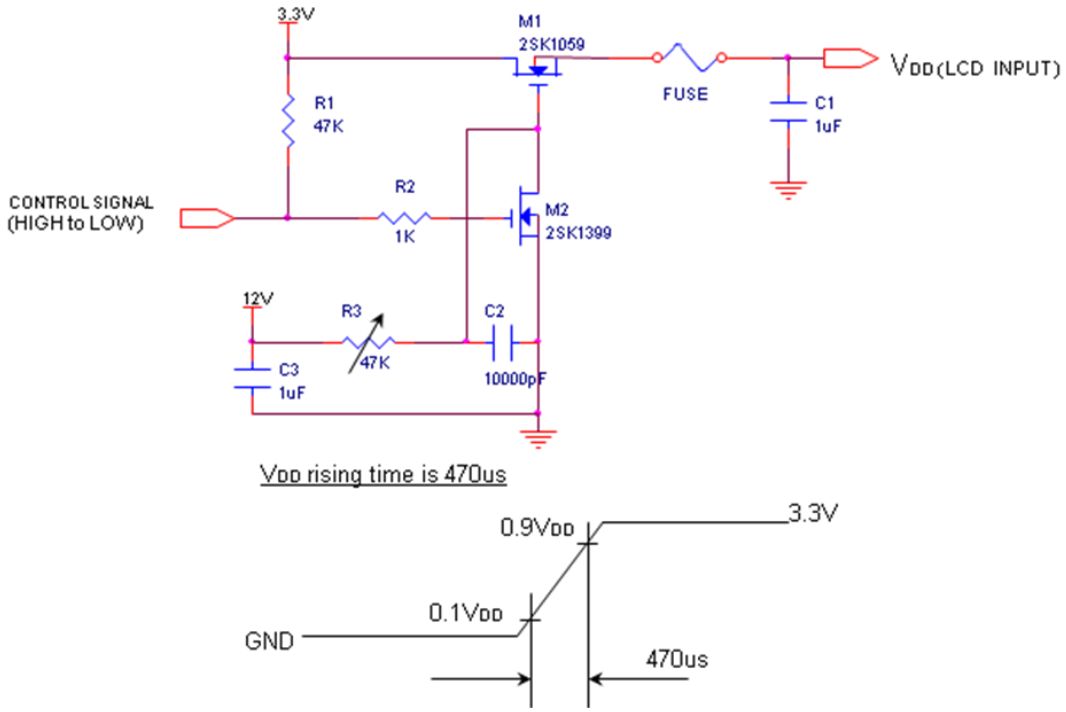
Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		VDD	3.0	3.3	3.6	V	
Differential Input Voltage for MIPI Receiver Threshold	High	VIH	-	-	+100	mV	-
	Low	VIL	-100	-	-	mV	
Vsync Frequency	60 Hz	fv	-	60	-	Hz	-
Hsync Frequency	60Hz	fH	-	78	-	kHz	-
Main Frequency	60 Hz	fDCLK	-	155	-	MHz	-
Rush Current		IRUSH	-	-	1.5	A	(4)
Current of Power Supply	White	IDD	-	215	250	mA	(2),(3)*a
	Mosaic		-	215	250	mA	(2),(3)*b
	Black		-	210	240	mA	(2),(3)*c
Content Adaptive Brightness Control		CABC_EN	1.6	-	3.6	V	Enable
			-	-	0.8	V	Disable
Color Management Enable		CM_EN	1.6	-	3.6	V	Enable
			-	-	0.8	V	Disable
PWM IN			VIL	VIH	Vmax	V	(5)
			0.5	1.8	3.6		
PWM OUT			VIL	VIH	Vmax	V	(5)
			0.4	2.1	-		

Note (1) The data pins for display and signal pins for timing should be connected.(GND= 0V)
(2) fV = 60Hz, fDCLK = 155 MHZ, V_{LCD_VCC} = 3.3V , DC Current.

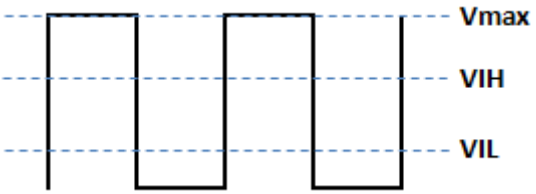
Note (3) The dissipation pattern for power



Note (4) The condition for measurement for rush current



Note (5) VIH : Enable Voltage Level, VIL : Disable Voltage Level



5.2 BACK LIGHT UNIT

Ta = 25 ± 2 °C

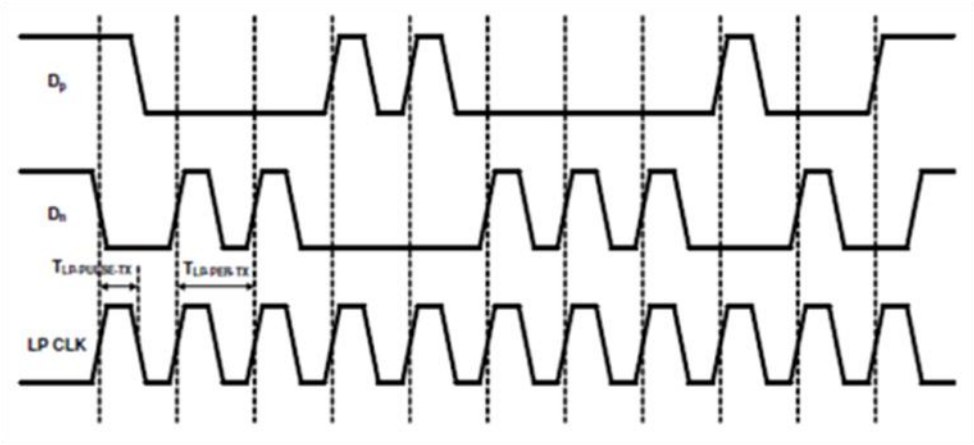
Item	Symbol	Min.	Typ.	Max.	Unit	Note
LED Forward Current	IF	-	20.5	-	mA	
LED Forward Voltage	VF	2.8	2.9	3.0	V	IF = 20.5mA
LED Array Voltage	VP	-	20.3	-	V	VF X 7LEDs
Power Consumption	P	-	-	2.15	W	IF X VF X 35LEDs
Operating Life Time	Hr	12,000	-	-	Hour	(1)
LED Counts	Q	-	35	-	EA	

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 °C and IF = 20.5 mA until one of the following event occurs.
When the brightness becomes 50% or lower than the original.

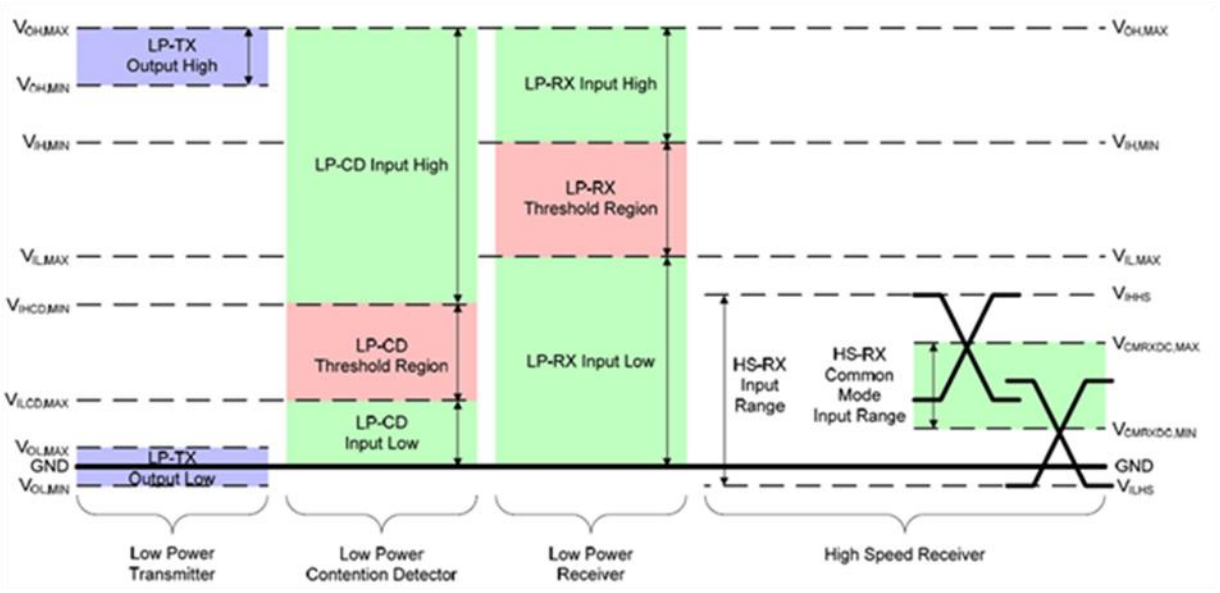
5.4 MIPI INTERFACE

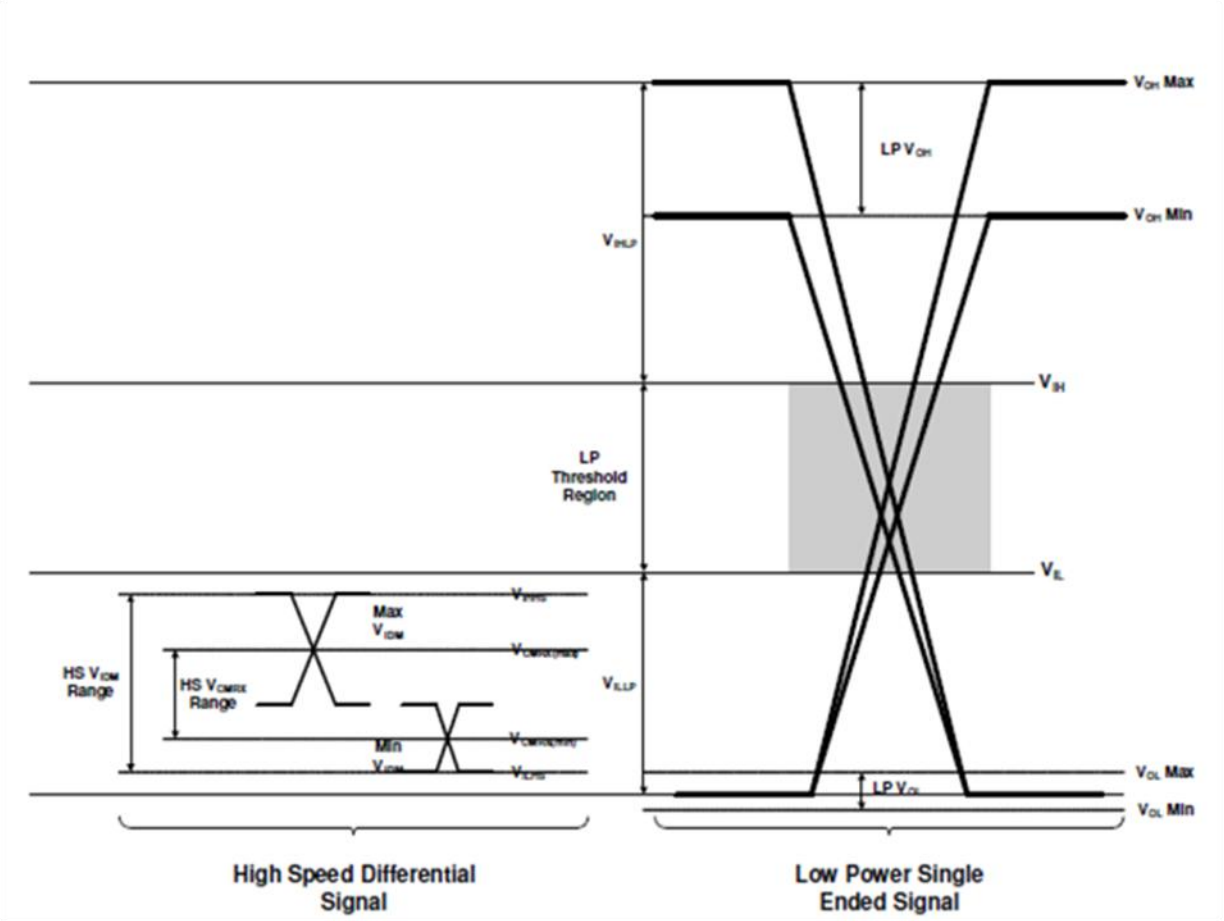
MIPI DC Specifications					
Characteristics	**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Single-end input high voltage (HS Rx mode)	V_{IHHS}	-	-	460	mV
Single-end input low voltage (HS Rx mode)	V_{ILHS}	-40	-	-	mV
Low power input voltage Logic1 (LP Rx mode)	V_{IHLP}	880	-	-	mV
Low power input voltage Logic2 (LP Rx mode)	V_{ILLP}	-	-	550	mV
Differential input high threshold voltage	V_{IDTH}	-	-	70	mV
Output high level (LP Tx mode)	V_{OH}	1.08	1.2	1.32	V
Output low level (LP Tx mode)	V_{OL}	-50	-	50	mV
Differential input low threshold voltage	V_{IDTL}	-70	-	-	mV
Differential input voltage	$\|V_{IDM}\|$	70	-	500	mV
Common mode voltage	V_{CMRX}	70	-	330	mV

MIPI AC Specifications						
Characteristics		**Symbol**	**Min**	**Typ**	**Max**	**Unit**
Minimum pulse width response		T_{MIN-RX}	50	-	-	ns
Data to clock setup time (SETUP)		T_{SETUP}	0.15	-	-	UI
Data to clock setup time (HOLD)		T_{HOLD}	0.15	-	-	UI
Pulse width of the LP exclusive-OR clock		$T_{LP-PULSE-TX}$	50	55	58	ns
Period of the LP exclusive-OR clock		$T_{LP-PER-TX}$	90	-	-	ns
Rise time and fall time	LP	T_{RLP}/T_{FLP}	-	-	25	ns
	EOT	T_{REOT}	-	-	35	ns



< Definition of Exclusive-OR Clock in LP Mode>





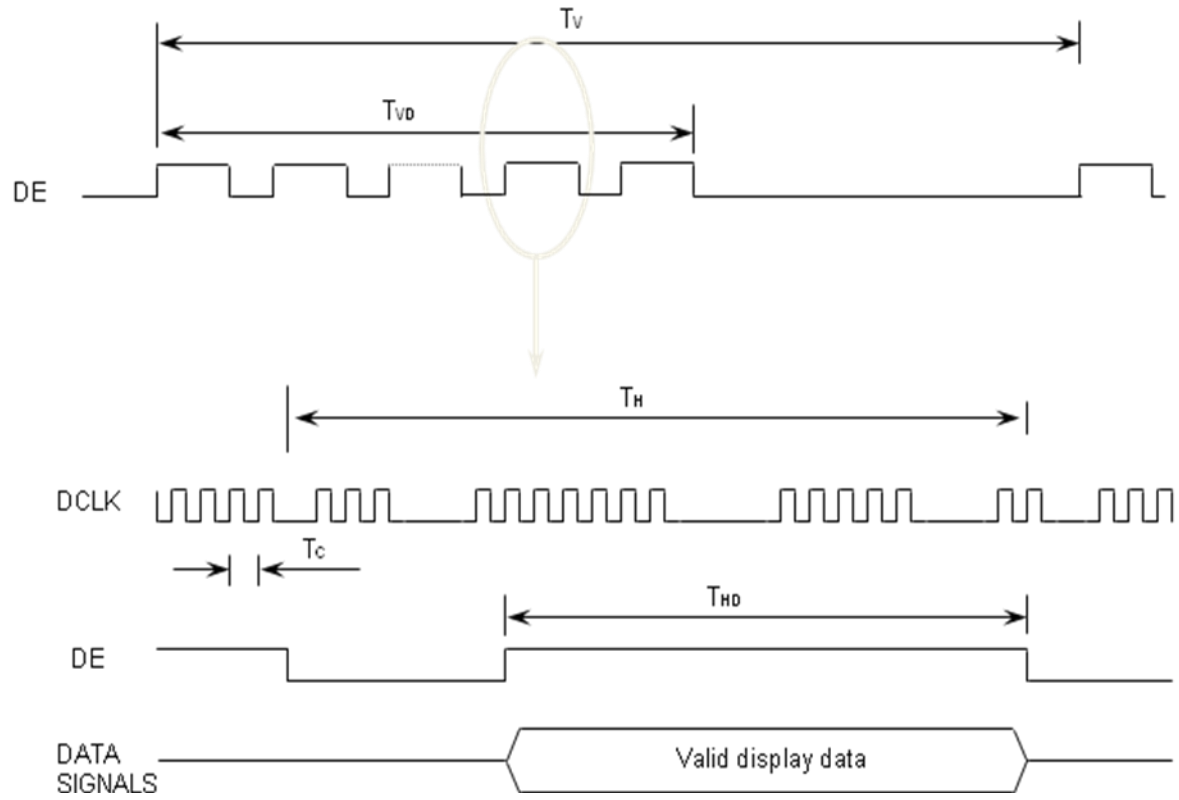
< Definition of MIPI Signal Level>

5.5 INTERFACE TIMING

5.5.1 TIMING PARAMETERS

Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
Frame Frequency	Cycle	TV		60		Hz	
Vertical Active Display Term	Display Period	TVD	-	1280	-	Lines	
One Line Scanning Time	Cycle	TH	-	1984	-	Clocks	
Horizontal Active Display Term	Display Period	THD	-	1920	-	Clocks	

5.5.2 TIMING DIAGRAMS OF INTERFACE SIGNAL



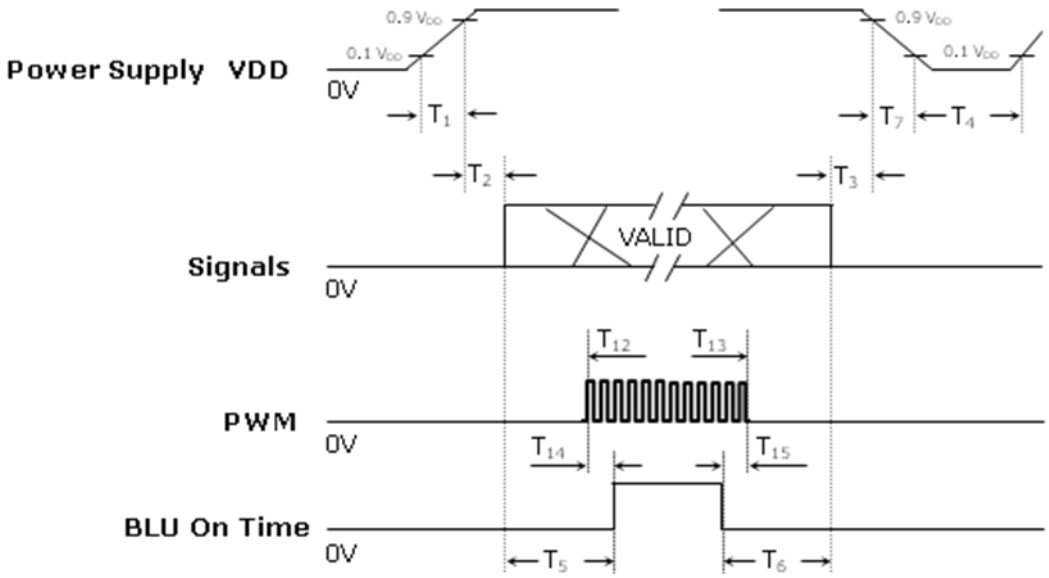
5.6 INPUT COLOR DATA MAPPING

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	B4	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

5.7 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.



Timing (ms)	Remarks
0.5 < T_1≤10	V_{DD} rising time from 10% to 90%
90 < T_2 ≤120	Delay from V_{DD} to valid data at power ON
0 < T_3 ≤50	Delay from valid data OFF to V_{DD} OFF at power Off
500 ≤T_4	V_{DD} OFF time for Windows restart
200 ≤T_5	Delay from valid data to B/L enable at power ON
200 ≤T_6	Delay from valid data off to B/L disable at power Off
0 < T_7 ≤10	V_{DD} falling time from 90% to 10%
10 < T_8	Delay from valid data on to LED driver Vin rising time 10%
10 < T_9	Delay from LED driver Vin falling time 10% to valid data Off
0.5 < T_{10}≤10	LED V_{in} rising time from 10% to 90%
0.5 < T_{11}≤10	LED V_{in} falling time from 90% to 10%
0 < T_{12}	Delay from LED driver Vin rising time 90% to PWM ON
0 < T_{13}	Delay from PWM Off to LED driver Vin falling time 10%
0 ≤ T_{14}	Delay from PWM ON to B/L Enable ON
0 ≤ T_{15}	Delay from B/L Enable Off to PWM Off

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 white.

(3) In case of VDD = off level, please keep the level of input signals on the low or keep a high impedance.

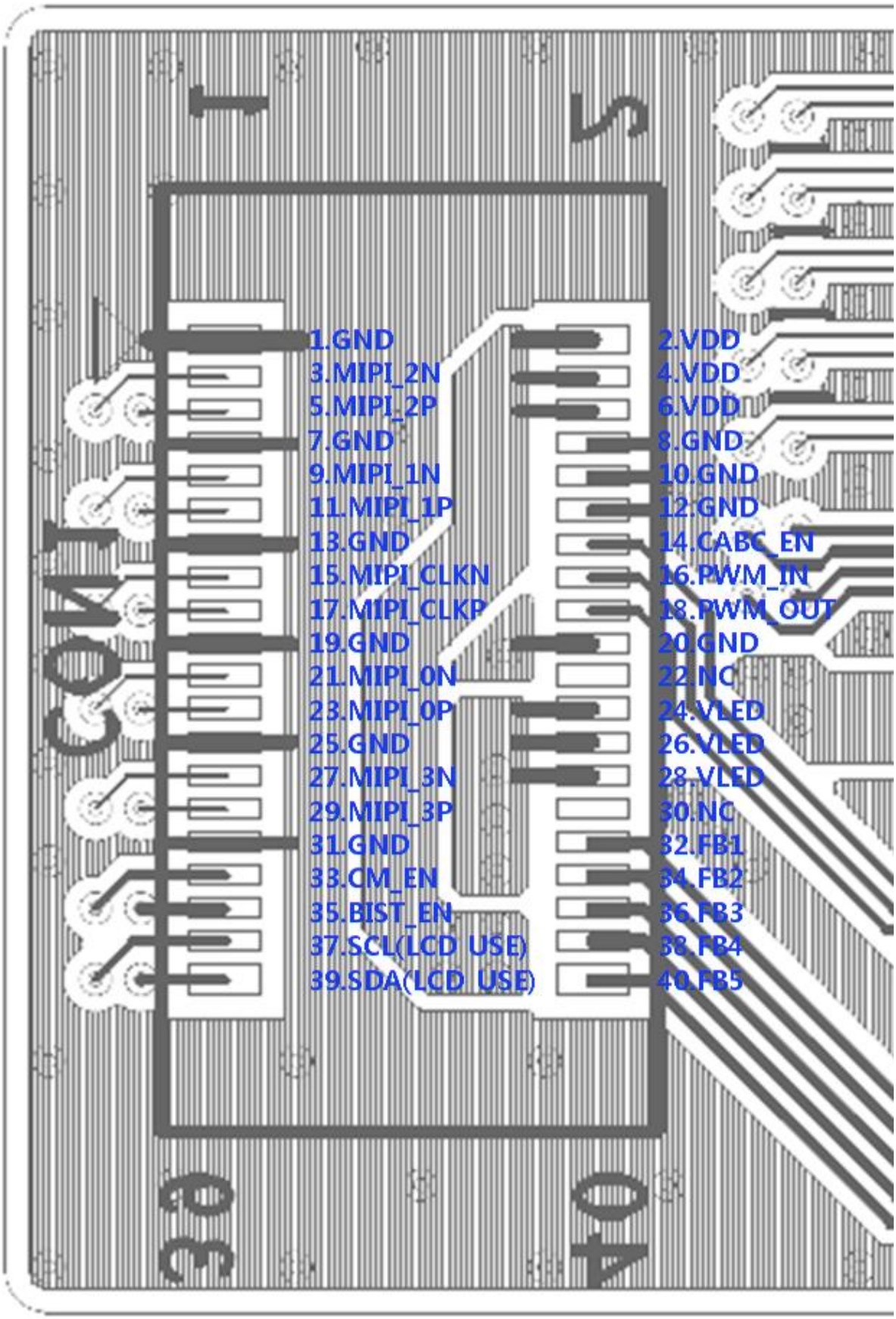
(4) T4 should be measured after the module has been fully discharged between power off and on period.

(5) Interface signal shall not be kept at high impedance when the power is on.

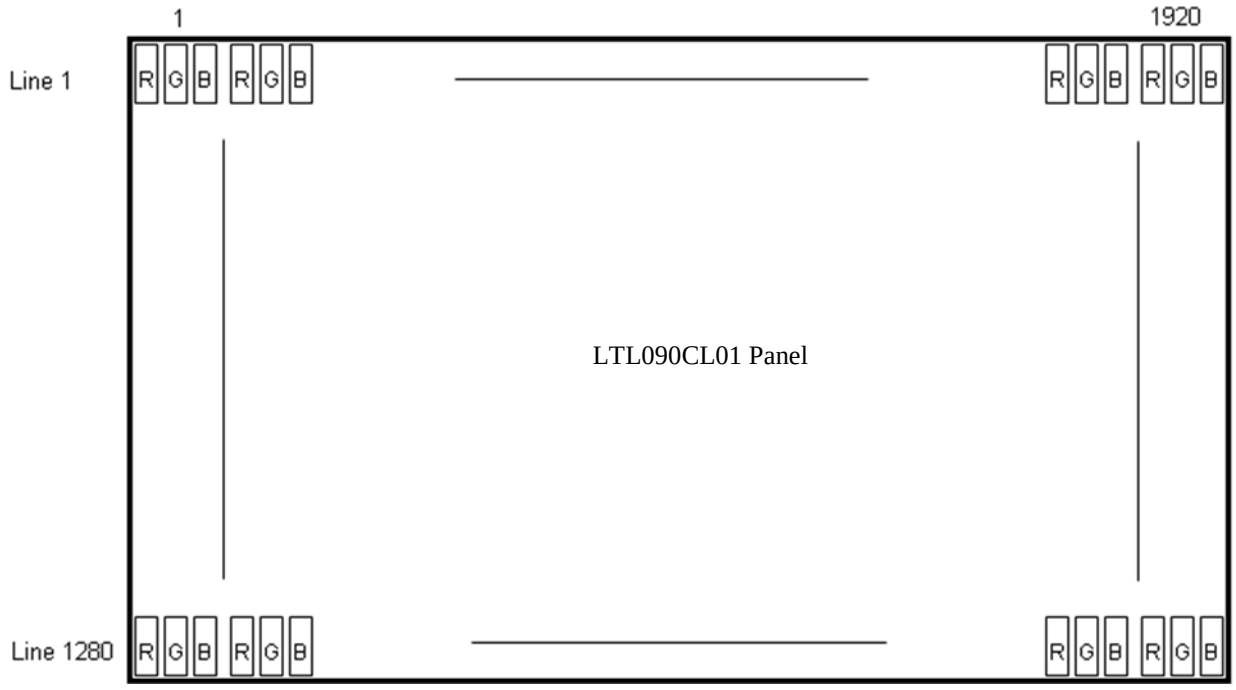
5.8 INPUT TERMINAL PIN ASSIGNMENT

5.8.1 INPUT SIGNAL & POWER (Connector : JAE WH1 40Pin)

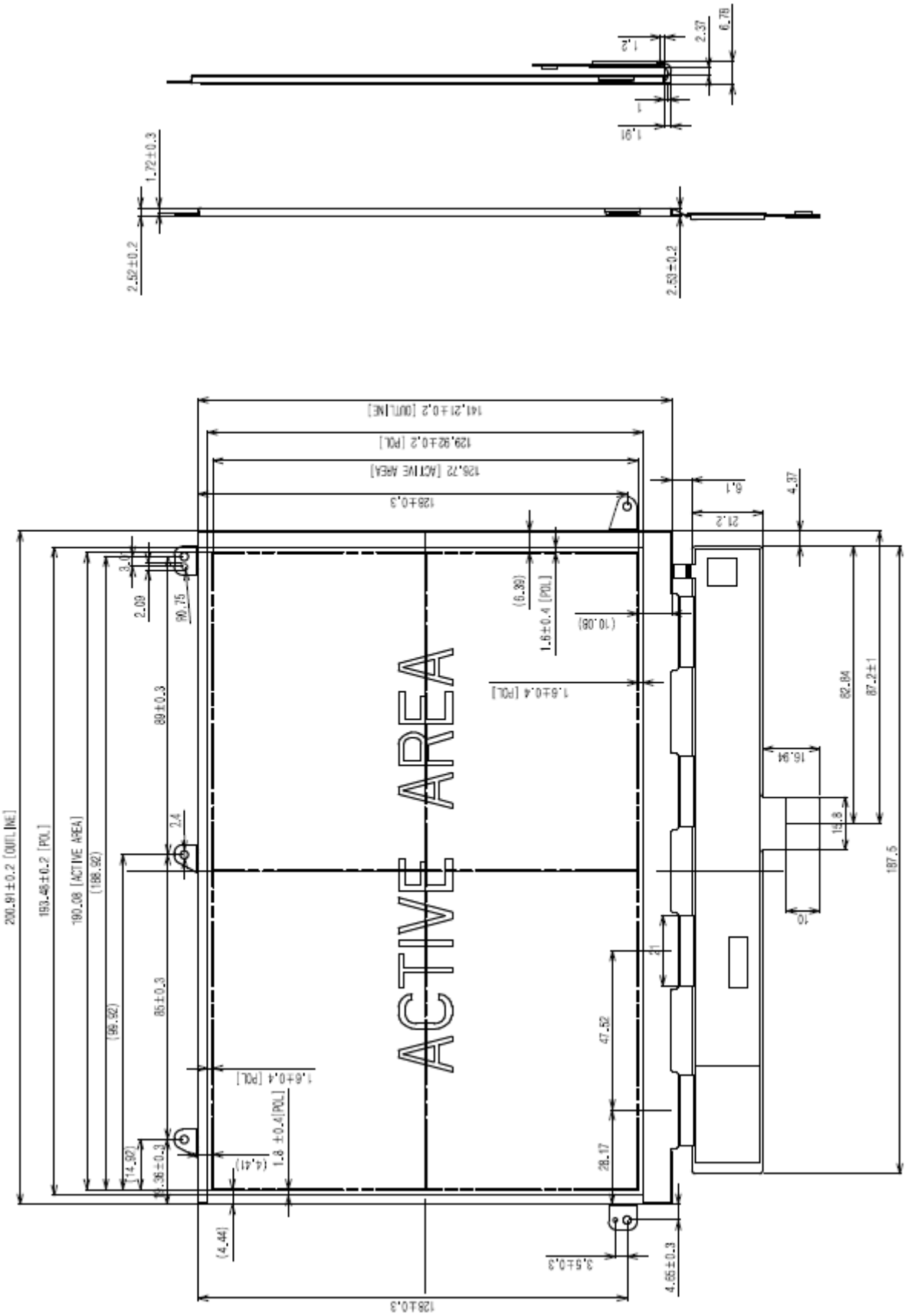
Pin	Symbol	Function
1	GND	Ground
2	VDD	Input Power (3.3V)
3	MIPI_D2_N	DSI Lane 2 Neg
4	VDD	Input Power (3.3V)
5	MIPI_D2_P	DSI Lane 2 Pos
6	VDD	Input Power (3.3V)
7	GND	Ground
8	GND	Ground
9	MIPI_D1_N	DSI Lane 1 Neg
10	GND	Ground
11	MIPI_D1_P	DSI Lane 1 Pos
12	GND	Ground
13	GND	Ground
14	CABC_EN	CABC 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
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_FB1	LED Cathode String1
33	CM_EN	CM Enable
34	LED_FB2	LED Cathode String2
35	WPN	WPN, LCM Use
36	LED_FB3	LED Cathode String3
37	SCL	SCL, LCM Use
38	LED_FB4	LED Cathode String4
39	SDA	SDA, LCM
40	LED_FB5	LED Cathode String5

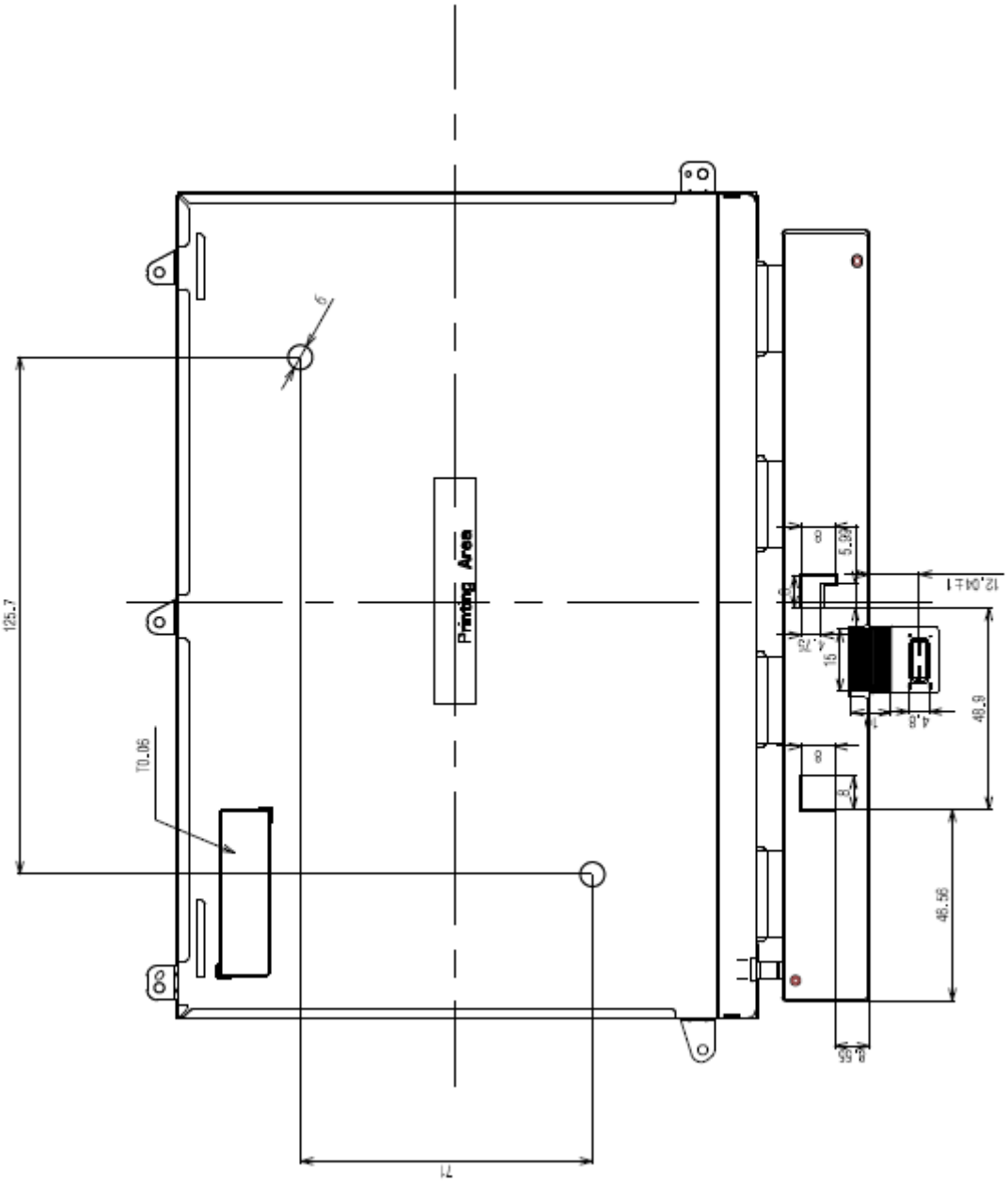

1.GND
2.VDD
3.MIPI_2N
4.VDD
5.MIPI_2P
6.VDD
7.GND
8.GND
9.MIPI_1N
10.GND
11.MIPI_1P
12.GND
13.GND
14.CABC_EN
15.MIPI_CLKN
16.PWM_IN
17.MIPI_CLKP
18.PWM_OUT
19.GND
20.GND
21.MIPI_0N
22.NC
23.MIPI_0P
24.VLED
25.GND
26.VLED
27.MIPI_3N
28.VLED
29.MIPI_3P
30.NC
31.GND
32.FB1
33.CM_EN
34.FB2
35.BIST_EN
36.FB3
37.SCL(LCD USE)
38.FB4
39.SDA(LCD USE)
40.FB5

6. PIXEL FORMAT



7. OUTLINE DIMENSION





GENERAL TOLERANCE			
STEP	LEVEL 1	LEVEL 2	LEVEL 3
0 < X ≦ 4	±0.05	±0.1	±0.2
4 < X ≦ 16	±0.08	±0.15	±0.3
16 < X ≦ 64	±0.12	±0.25	±0.5
64 < X ≦ 256	±0.25	±0.4	±0.8

8. PACKING

8.1 CARTON

TBD

8.2 MARKING

TBD

9. GENERAL PRECAUTIONS

9.1 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 (Isoprophyl 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 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 pull or fold the LED FPC.

(l) Do not touch any component which is located on the back side.

(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.

(o) Do not twist or pull the MIPI connector.

9.2 STORAGE

We highly recommend to comply with the criteria in the table below.

ITEM	Unit	Min.	Max.
Storage Temperature	(℃)	5	40
Storage Humidity	(%rH)	35	75
Storage Life	12 months		
Storage Condition	- The storage room should be equipped with a good ventilation facility, which has a temperature controlling system. - Products should be placed on the pallet, which is away from the wall not on the floor. - Prevent products from being exposed to the direct sunlight, moisture, and water.; Be cautious not to pile the products up. - Avoid storing products in the environment, which other hazardous material is placed. - If products are delivered or kept in the storage facility more than 3 months,we recommend you to leave products under the condition including a 20℃ temperature and a humidity of 50% for 24 hours. - If you store semi-manufactured products for more than 3 months, bake the products under the condition including the 50℃ temp. and the 10% humidity for 24hrs after being used.		

9.3 OPERATION

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

(b) Power supply should always be turned on/off by 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 FPC cable between the LED chips and its converter power supply shall be a minimized length and be connected directly .The longer cable between the back-light and the converter may cause lower luminance of light source (LED).

(e) 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.

9.4 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 be stressed.