

Customer : General

DATE : 08/Nov/2005

SAMSUNG TFT-LCD
MODEL : LTM150XO-L01

Any Modification of Specification is not allowed without SEC's Permission.

NOTE :

Customer's Approval

SIGNATURE

DATE

PREPARED BY

DATE

24/Oct/'05

APPROVAED BY

DATE

24/Oct/'05

LCD Application Engineering 2, TCS Team

Samsung Electronics Co . , LTD.



SAMSUNG TFT-LCD

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* Revision History

Date	Rev. No	Page	Summary
Nov. 08, 2005	000	all	Approval specification of LTM150XO-L01 model was issued first.

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General Description

Description

LTM150XO-L01 is a color active matrix liquid crystal display (LCD) that uses amorphous silicon TFT(Thin Film Transistor) as switching components. This model is composed of a TFT LCD panel, a driver circuit and a back light unit. The resolution of a 15.0" is 1024 x 768 and this model can display up to 16.2 millions colors.

Features

- RoHS compliance (Pb-free)
- High contrast ratio, high aperture ratio, fast response time
- TN(Twisted Nematic) mode
- 2 CCFTs(Cold Cathode Fluorescent Tube)
- DE(Data Enable) mode
- LVDS (Low Voltage Differential Signaling) interface (1pixel/clock)
- COMPACT SIZE DESIGN

Applications

- Workstation & desktop monitors
 - Display terminals for AV application products
 - Monitors for industrial machine
- * If the module is used to other applications besides the above, please contact SEC in advance.

General Information

Items	Specification	Unit	Note
Pixel Pitch	0.297(H) x 0.297(W)	mm	
Active Display Area	304.128(H) x 228.096(V)	mm	
Surface Treatment	Haze 25%, Hard-coating (3H)		
Display Colors	6 bit - 16.2M	colors	
Number of Pixels	1024 x 768	pixel	
Pixel Arrangement	RGB vertical stripe		
Display Mode	Normally White		
Power Consumption	11.27 Watt (Typ.)		
Luminance of White	250(Typ.)	cd/m ²	

Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal (H)	326.0	326.5	327.0	mm	w/o inverter ass'y
	Vertical (V)	253.0	253.5	254.0	mm	
	Depth (D)	-	-	12.0	mm	
Weight		-	-	1.050	g	LCD module only
		-	-	-	g	w/ Inverter assembly

Note (1) Mechanical tolerance is $\pm 0.5\text{mm}$ unless there is a special comment.

1. Absolute Maximum Ratings

If the condition exceeds maximum ratings, it can cause malfunction or unrecoverable damage to the device.

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	V_{DD}	GND-0.3	4.0	V	(1)
Data Signal	V_{sig}	-	3.3	V	
Storage temperature	T_{STG}	-25	60	°C	(2)
Center of Glass surface temperature (Operation)	T_{OPR}	0	50	°C	(2)
Shock (non - operating)	S_{nop}	-	50	G	(3)
Vibration (non - operating)	V_{nop}	-	1.5	G	(4)

Note (1) $T_a = 25 \pm 2^\circ\text{C}$

- (2) Temperature and relative humidity range are shown in the figure below.
- 90 % RH Max. ($T_a \leq 39^\circ\text{C}$)
 - Maximum wet-bulb temperature at 39°C or less. ($T_a \leq 39^\circ\text{C}$)
 - No condensation
- (3) 11ms, sine wave, one time for $\pm X$, $\pm Y$, $\pm Z$ axis
- (4) 10-300 Hz, Sweep rate 10min, 30min for X,Y,Z axis

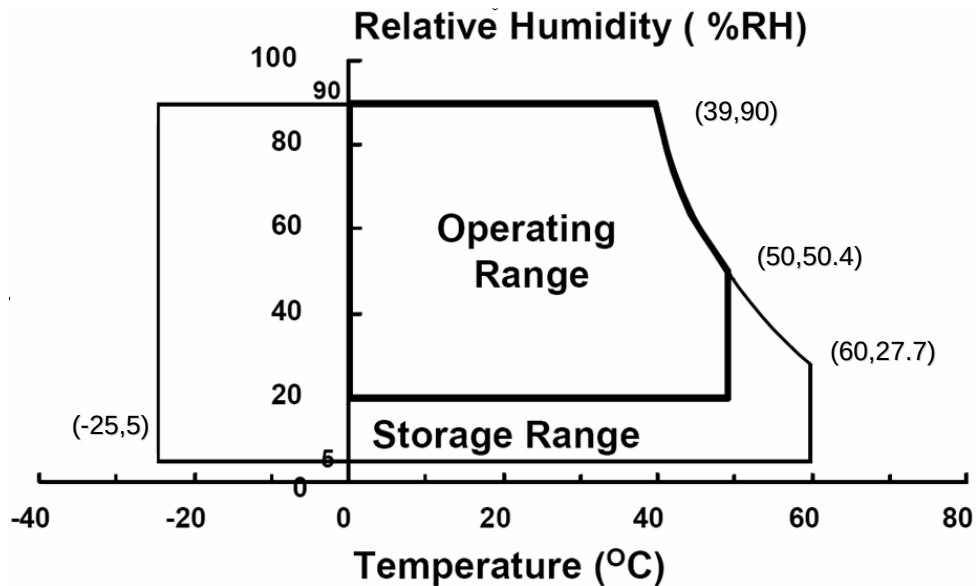


Fig. Temperature and Relative humidity range

2. Optical Characteristics

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The optical characteristics should be measured in a dark room or equivalent.

Measuring equipment : TOPCON BM-7,SPECTRORADIOMETER SR-3

(Ta = 25 ± 2°C, VDD=3.3V, fv= 60Hz, fDCLK=65MHz, IL = 8.0mArms)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio (Center of screen)		C/R	Normal $\theta_{L,R}=0$ $\theta_{U,D}=0$ Viewing Angle	500	700	-		(3) SR-3
Response Time	Rising	Tr		-	2.0	4	msec	(5) BM-7
	Falling	Tf		-	6.0	10		
Luminance of White (Center of screen)		Y _L		200	250	-	cd/m2	(6) SR-3
Color Chromaticity (CIE 1931)	Red	Rx		0.600	0.630	0.660		(7),(8) SR-3
		Ry		0.300	0.330	0.360		
	Green	Gx		0.270	0.300	0.330		
		Gy		0.550	0.580	0.610		
	Blue	Bx		0.120	0.150	0.180		
		By		0.060	0.090	0.120		
	White	Wx		0.283	0.313	0.343		
		Wy		0.299	0.329	0.359		
Color Chromaticity (CIE 1976)	Red	Ru'		-	0.442	-		
		Rv'		-	0.521	-		
	Green	Gu'		-	0.128	-		
		Gv'		-	0.558	-		
	Blue	Bu'		-	0.159	-		
		Bv'		-	0.214	-		
	White	Wu'		-	0.198	-		
		Wv'		-	0.468	-		
Color Gamut		-		-	60	-	%	
Color Temperature		-		-	6,500	-	K	
Viewing Angle	Hor.	θ_L	CR≥10	-	75	-	Degrees	(8) SR-3
		θ_R		-	75	-		
	Ver.	θ_U		-	75	-		
		θ_D		-	60	-		
Brightness Uniformity (9 Points)		B _{uni}		-	-	25	%	(4) SR-3

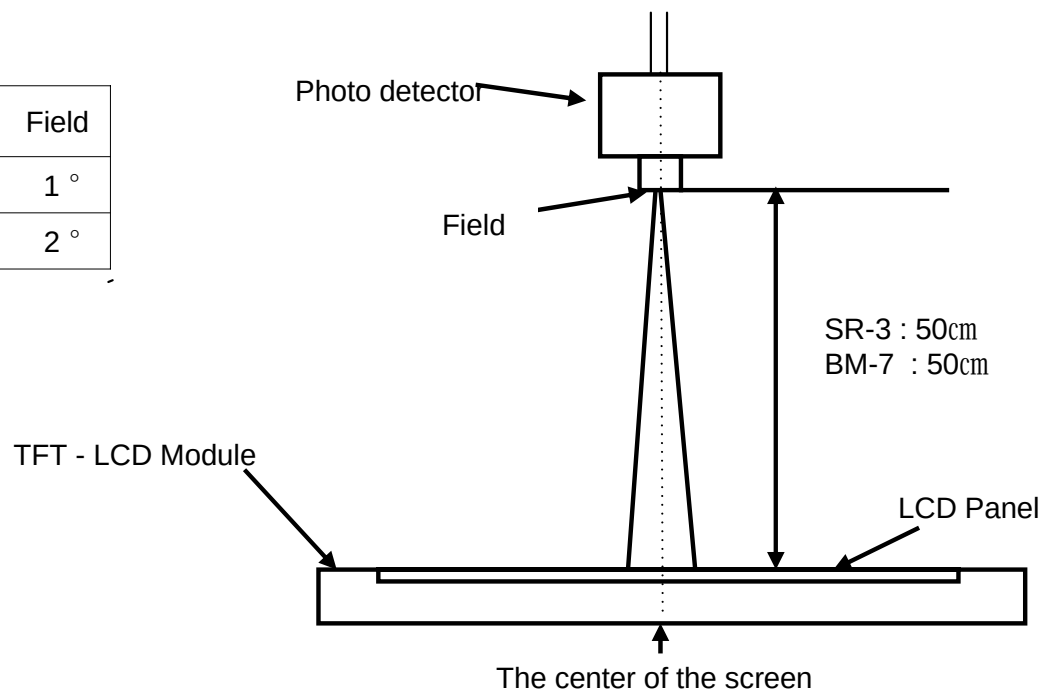
Note (1) Test Equipment Setup

The measurement should be executed in a stable, windless and dark room between 30min after lighting the back light at the given temperature for stabilization of the back light. This should be measured in the center of screen.

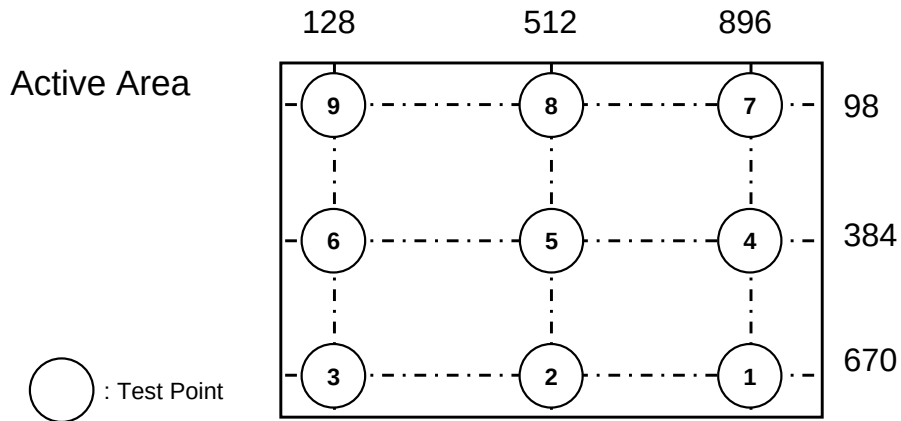
Single lamp current : 8.0mA

Environment condition : $T_a = 25 \pm 2 \text{ }^{\circ}\text{C}$

Photo detector	Field
SR-3	1 °
BM-7	2 °



Note (2) Definition of test point



Note (3) Definition of Contrast Ratio (C/R)

: Ratio of gray max (Gmax) & gray min (Gmin) at the center point⑤ of the panel

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

Gmax : Luminance with all pixels white

Gmin : Luminance with all pixels black

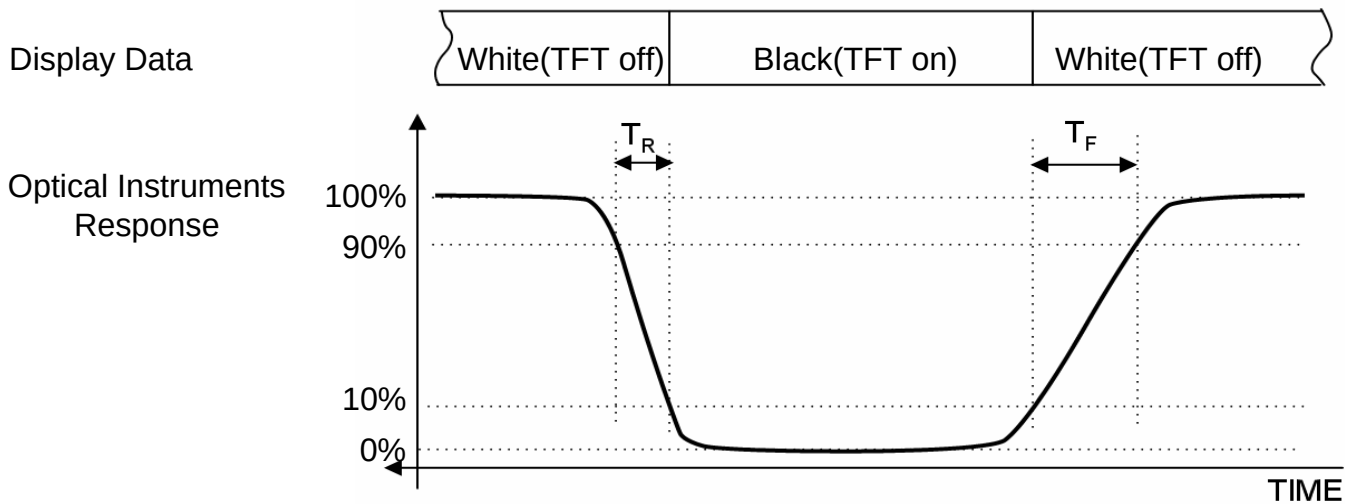
Note (4) Definition of 9 points brightness uniformity

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

Bmax : Maximum brightness

Bmin : Minimum brightness

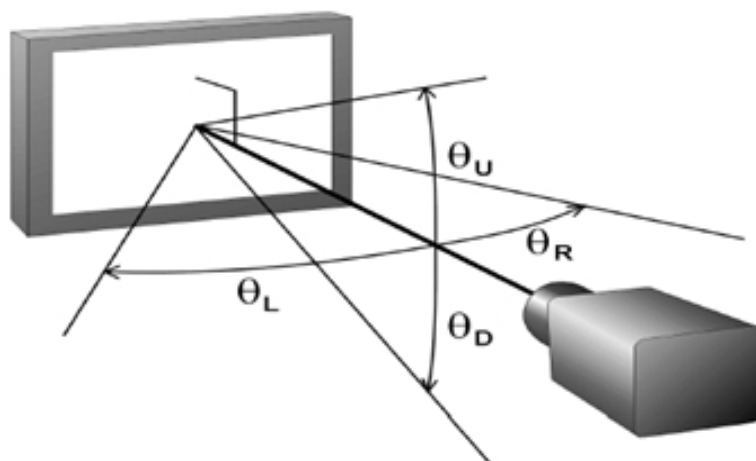
Note (5) Definition of Response time : Sum of Tr, Tf



Note (6) Definition of Luminance of White : Luminance of white at center point⑤

Note (7) Definition of Color Chromaticity (CIE 1931, CIE1976)
Color coordinate of Red, Green, Blue & White at center point⑤

Note (8) Definition of Viewing Angle
: Viewing angle range ($CR \geq 10$)



3. Electrical Characteristics

3.1 TFT LCD Module

The connector for display data & timing signal should be connected.

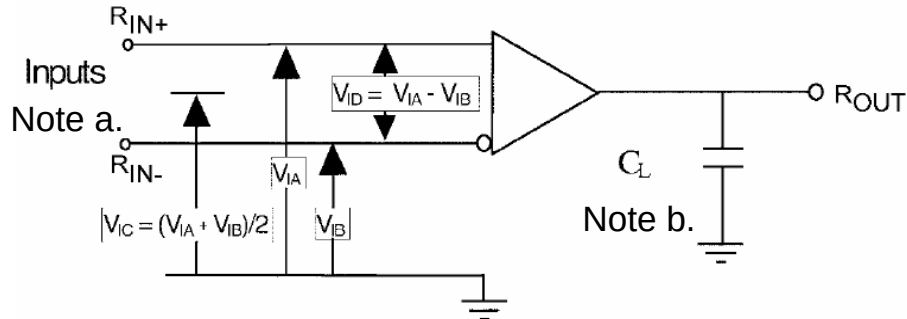
Ta = 25°C

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V_{DD}	3.0	3.3	3.6	V	(1)
LVDS Input Characteristics	Differential Input Voltage for LVDS Receiver Threshold	High	-	-	+100	mV	(2)
		Low	-100	-	-	mV	
	LVDS skew	t_{SKEW}	-380		380	ps	(3)
	Differential input voltage	$ V_{ID} $	200		600	mV	(4)
	Input voltage range (single-ended)	V_{IN}	0		2.4	V	(4)
	Common mode voltage	V_{CM}	0+ $ V_{ID} /2$	1.2	2.4- $ V_{ID} /2$	V	(4)
	Input current	I_{IN}			± 10	μA	(5)
Current of Power Supply	(a) Black	I_{DD}	-	650	-	mA	(6),(7)
	(b) White		-	600	-	mA	
	(c) Dot		-	700	800	mA	
Vsync Frequency		f_V	55	60	77	Hz	
Hsync Frequency		f_H	47.6	48.4	62	kHz	
Main Frequency		f_{DCLK}	50	65	80	MHz	
Rush Current		I_{RUSH}	-	-	3.0	A	(8)

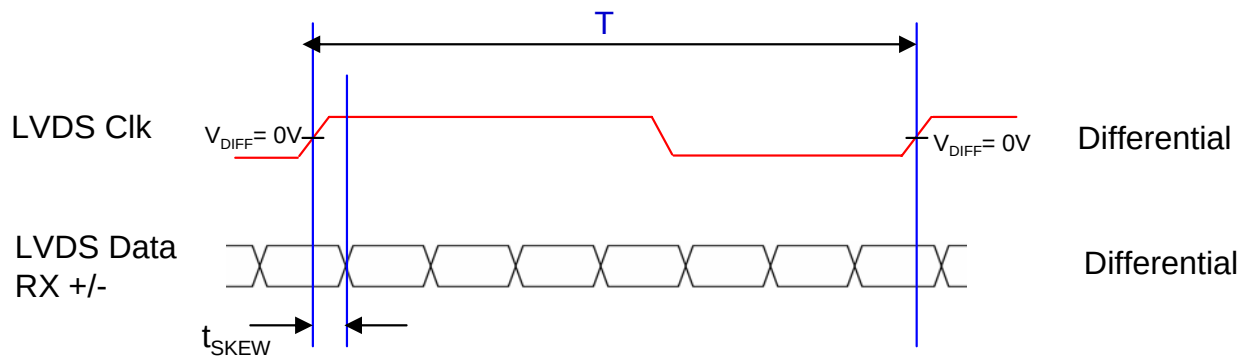
Note (1) The ripple voltage should be controlled under 10% of V_{DD} .

(2) Differential receiver voltage definitions and propagation delay and transition time test circuit

- a. All input pulses have frequency = 10MHz, t_R or $t_F=1ns$
 b. C_L includes all probe and fixture capacitance



(3) LVDS Receiver DC parameters are measured under static and steady conditions which may not be reflective of its performance in the end application.

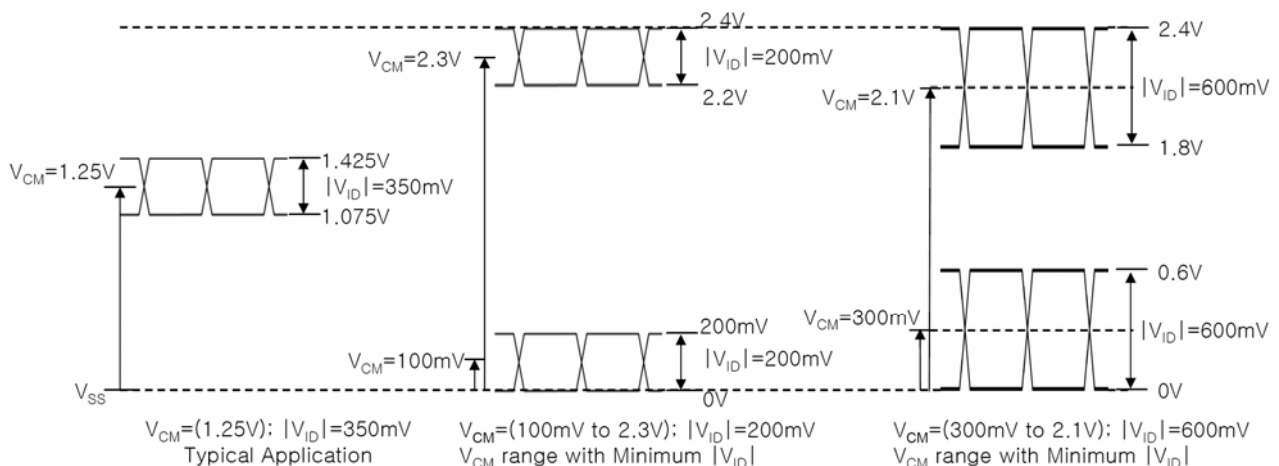


where t_{skew} : skew between LVDS clock & LVDS data,

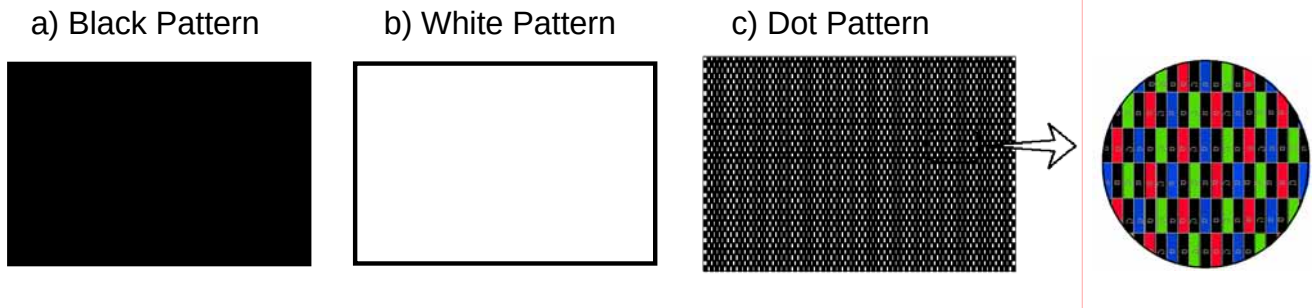
T : 1 period time of LVDS clock

cf) (-/+) of 380psec means LVDS data goes before or after LVDS clock.

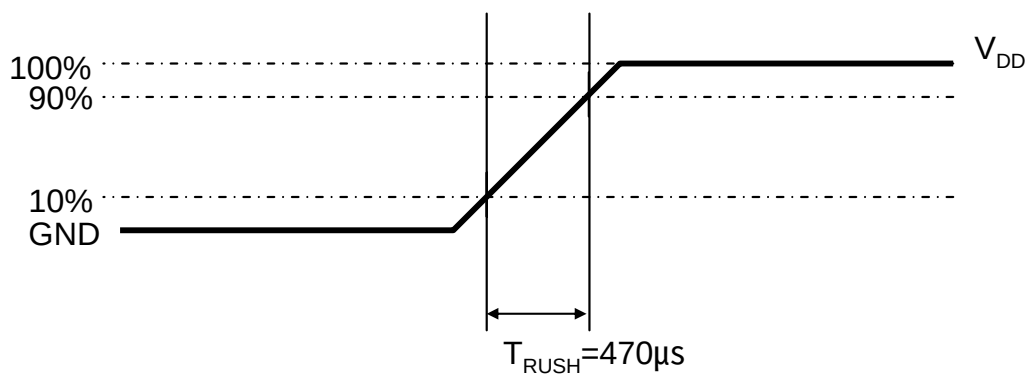
(4) Definition of V_{ID} and V_{CM} using single-end signals



- (5) Measurement Conditions Maximum + 10uA @ $V_{IN}=2.4V$, $V_{DD}=3.6V$,
 - 10uA @ $V_{IN}=0V$, $V_{DD}=3.6V$
- (6) $f_V=60Hz$, $f_{DCLK} = 65MHz$, $V_{DD} = 3.3V$, DC Current.
- (7) Power dissipation check pattern (LCD Module only)



- (8) Measurement Conditions.



Rush Current I_{RUSH} can be measured when T_{RUSH} is 470μs.

3.2 Back Light Unit

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

$T_a = 25 \pm 2^\circ\text{C}$

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Lamp Current		I_L	3.0	8.0	9.0	mArms	(1)
Lamp Current Uniformity		I_{UNI}	-	-	25	%	(2)
Lamp Voltage		V_L	-	560	-	Vrms	
Lamp Frequency		f_L	40	-	60	kHz	(3)
Operating Life Time		Hr	50,000	-	-	Hour	(4)
Inverter waveform	Asymmetry rate	Wasy	-	-	10	%	(5)
	Distortion rate	Wdis	1.2726	1.414	1.5554		
Startup Voltage		V_s	-	-	0°C : 1,400	Vrms	(6)
					25°C: 1,220		

Note (1) Specified values are for a single lamp.

Lamp current is measured with current meter for high frequency as shown below.

Refer to the following block diagram of the back light unit for more information.

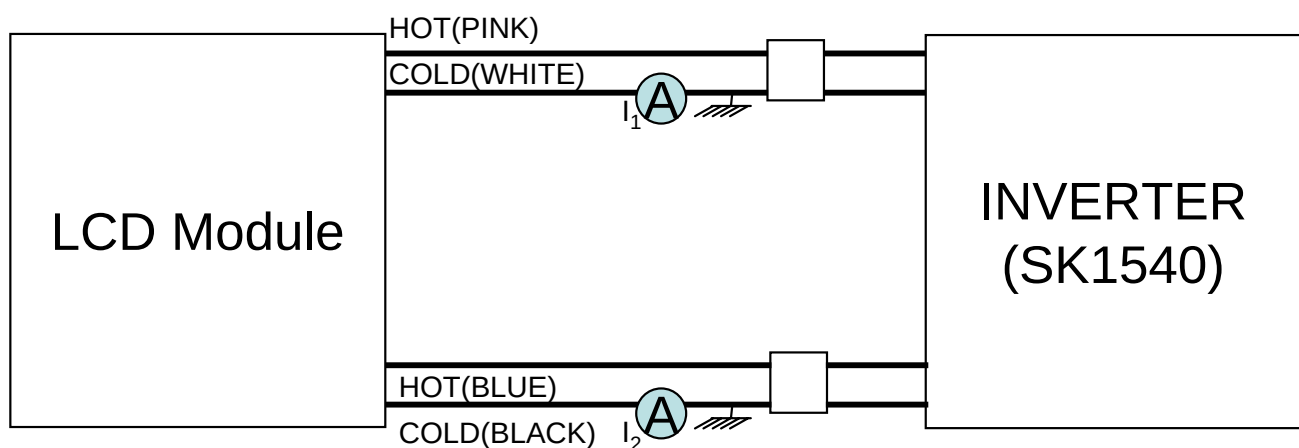


Fig. Measurement point of Lamp Current

(2) Define of Lamp current uniformity : I_{UNI}

$$I_{UNI} = \frac{|I_{Max} - I_{Min}|}{I_{Max}} \times 100$$

I_{max} : Maximum lamp current

I_{min} : Minimum lamp current

Lamp current uniformity I_{UNI} should be less than 25%

(3) Lamp frequency which may produce interference with horizontal synchronous frequency may cause line flow on the display. Therefore lamp frequency should be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.

(4) Life time (Hr) is defined as the time when brightness of a lamp unit itself becomes 50% or less than its original value at the condition of $T_a = 25 \pm 2^\circ\text{C}$ and $I_L = 8\text{mA}_{rms}$

(5) Designing a system inverter intended to have better display performance, power efficiency and lamp reliability.

They would help increase the lamp lifetime and reduce leakage current.

- The measurement should be done at typical lamp current.
 - The asymmetry rate of the inverter waveform should be less than 10%.
 - The distortion rate of the waveform should be $\sqrt{2}$ with $\pm 10\%$ tolerance.
- Inverter output waveform had better be more similar to ideal sine wave.

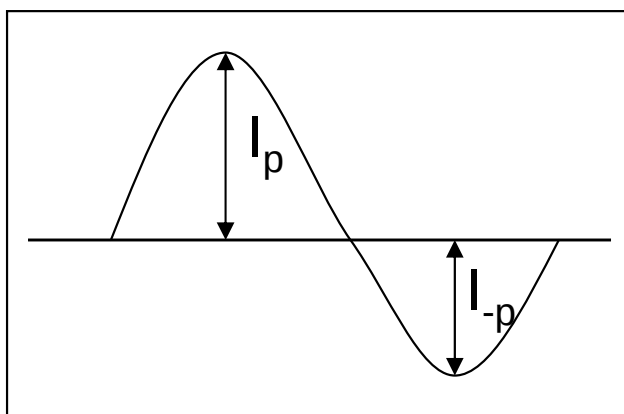


Fig. Wave form of the inverter

▪ Asymmetry rate

$$\frac{|I_p - I_{-p}|}{I_{rms}} \times 100$$

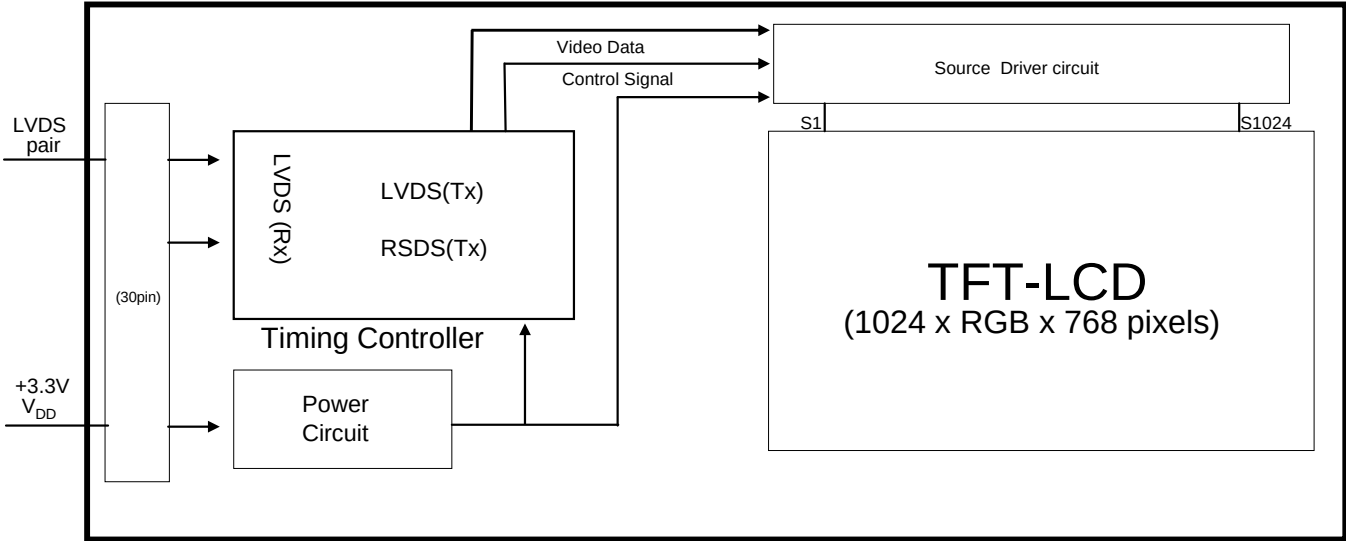
▪ Distortion rate

$$\left| \frac{I_p}{I_{rms}} \right| \text{ or } \left| \frac{I_{-p}}{I_{rms}} \right|$$

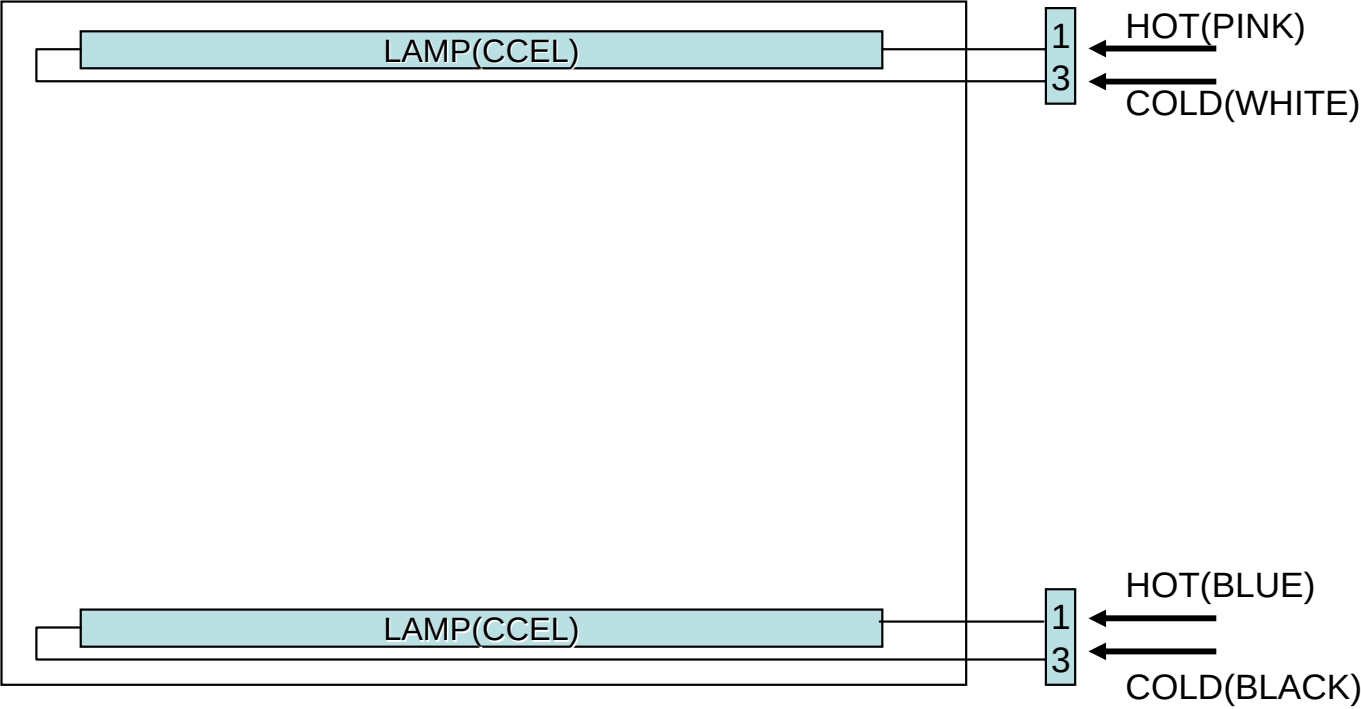
(6) If an inverter has shutdown function, it should keep its output for over 1 second even if the lamp connector is open. Otherwise the lamps may not be turned on.

4. BLOCK DIAGRAM

4.1 TFT LCD Module



4.2 Back Light Unit



5. Input Terminal Pin Assignment

5.1. Input Signal & Power (Connector : Hirose DF14H-20P-1.25H or equivalent)

Pin No.	Symbol	Function	Remark
1	VDD	Power Supply 3.3V	
2	VDD	Power Supply 3.3V	
3	GND	Ground	
4	GND	Ground	
5	OD-RX0-	ODD Receiver Signal(-)	
6	OD-RX0+	ODD Receiver Signal(+)	
7	GND	Ground	
8	OD-RX1-	ODD Receiver Signal(-)	
9	OD-RX1+	ODD Receiver Signal(+)	
10	GND	Ground	
11	OD-RX2-	ODD Receiver Signal(-)	
12	OD-RX2+	ODD Receiver Signal(+)	
13	GND	Ground	
14	OD-RXCLK-	ODD Receiver Clock Signal(-)	
15	OD-RXCLK+	ODD Receiver Clock Signal(+)	
16	GND	Ground	
17	OD-RX3-	ODD Receiver Signal(-)	
18	OD-RX3+	ODD Receiver Signal(+)	
19	*CE	For LCD internal use only. Do not Connect.	
20	*CTL	For LCD internal use only. Do not Connect.	

* If the system already uses the 19, 20pins, it should keep under GND level
The voltage applied to those pins should not exceed -200mV.

Note) Pin number starts from Right side

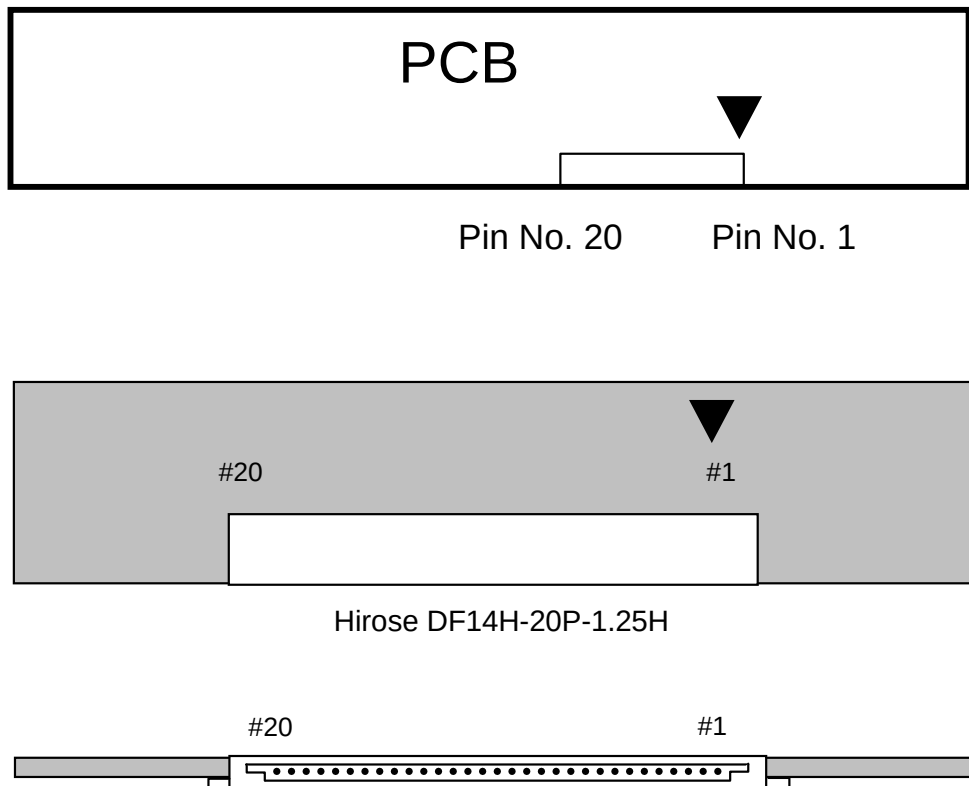
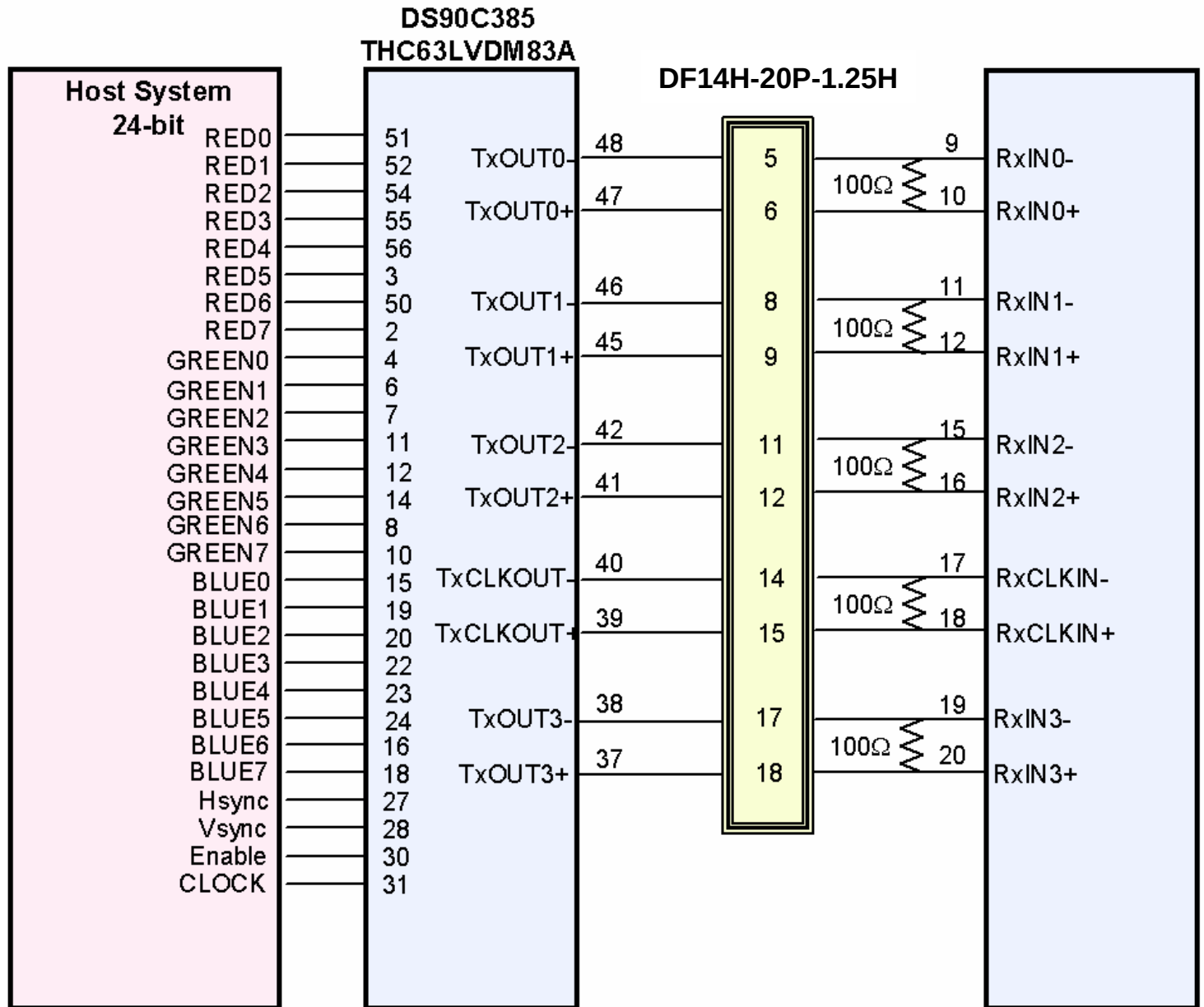


Fig. Connector diagram

- a. All GND pins should be connected together and also be connected to the LCD's metal chassis.
- b. All power input pins should be connected together.
- c. All NC pins should be separated from other signal or power.

5.2 LVDS Interface

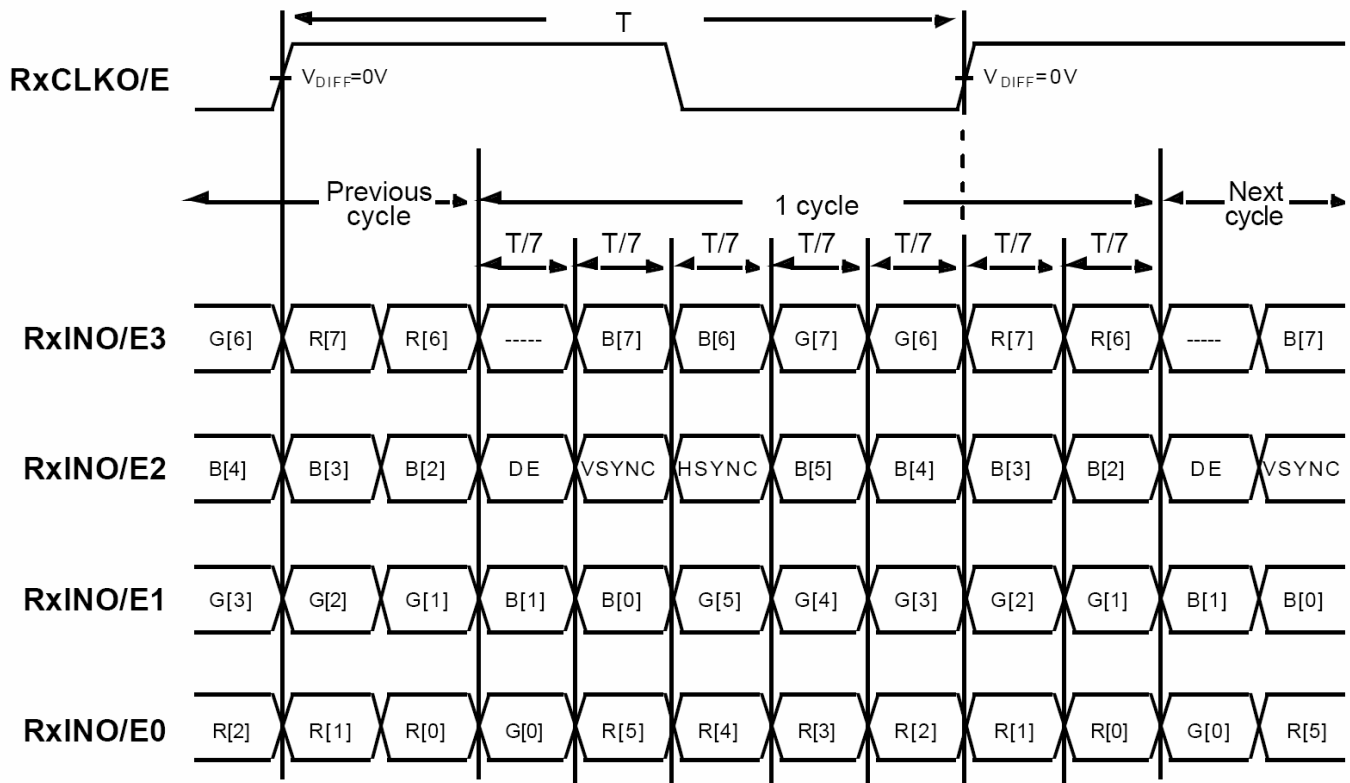
5.2.1 Pixel data



Note :

The LCD Module uses a 100ohm resistor between positive and negative lines of each receiver input.

5.2.2 Timing Diagrams of LVDS For Transmitting LVDS Receiver : Integrated T-CON



5.3 Back Light Unit

Pin No.	Input	Color	Function
1	Hot1	Pink(U), Blue(D)	High Voltage
2	NC	-	No connection
3	Cold1	White(U), Black(D)	Ground
Connector Part No.	JST BHR-03VS-1 or equivalent		

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

COLO R	DISPLAY (8bit)	DATA SIGNAL																										GRAY SCALE LEVEL
		RED								GREEN								BLUE										
		R0	R1	R2	R3	R4	R5	R6	R7	G0	G 1	G 2	G3	G 4	G 5	G6	G 7	B0	B1	B2	B3	B4	B5	B6	B7			
BASIC COLO R	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	
	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	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	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	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	0	-	
	MAGENTA A	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	-	
	YELLOW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	-	
	WHITE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	
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	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	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	0	R2	
		:	:	:	:	:	:			:	:	:	:	:	:	:		:	:	:	:	:	:				R3~ R252	
		:	:	:	:	:	:			:	:	:	:	:	:	:		:	:	:	:	:	:					
	↓ LIGHT	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R252	
		0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R252	
	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	0	R252	
GRAY SCALE OF GREE N	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	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	0	G2	
		:	:	:	:	:	:			:	:	:	:	:	:	:		:	:	:	:	:	:				G3~ G252	
		:	:	:	:	:	:			:	:	:	:	:	:	:		:	:	:	:	:	:					
	↓ LIGHT	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	G252	
		0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	G252	
	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	0	G252	
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	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	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	0	B2	
		:	:	:	:	:	:			:	:	:	:	:	:	:		:	:	:	:	:	:	:			B3~ B252	
		:	:	:	:	:	:			:	:	:	:	:	:	:		:	:	:	:	:	:	:				
	↓ LIGHT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	B252	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	B252	
	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	1	B252	

Note (1) 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)

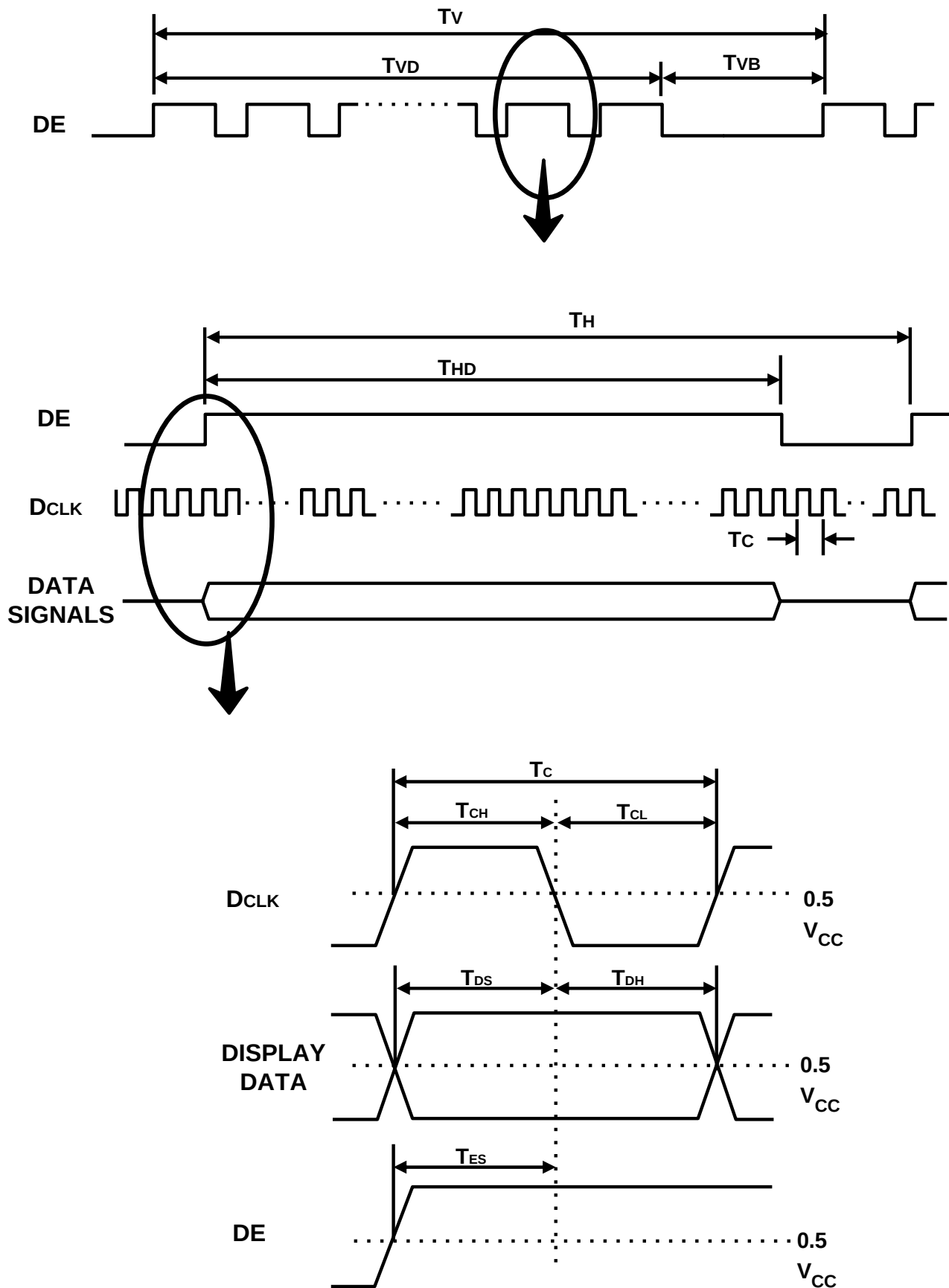
SIGNAL	ITEM	SYMBOL	MIN.	TYP.	MAX.	Unit	NOTE
Clock	Frequency	$1/T_C$	50	65	80	MHz	-
Hsync		F_H	47.6	48.4	62	KHz	-
Vsync		F_V	55	60	77	Hz	-
Vertical Display Term	Active Display Period	T_{VD}	-	768	-	lines	-
	Vertical Total	T_{VB}	772	806	870	lines	-
Horizontal Display Term	Active Display Period	T_{HD}	1024	1024	1024	clocks	Clocks
	Horizontal Total	T_H	1244	1344	1494	clocks	Clocks

Note (1) This product is DE only mode. The input of Hsync & Vsync signal does not have an effect on normal operation.

(2) Test Point : TTL control signal and CLK at LVDS Tx input terminal in system

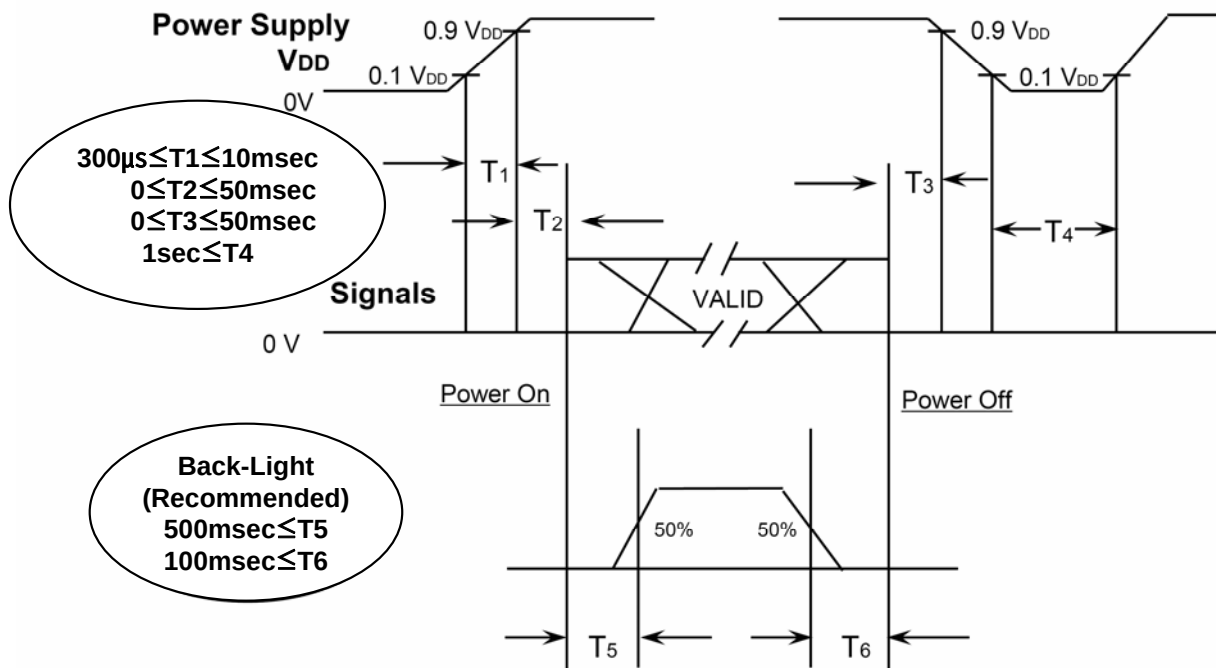
(3) Internal Vcc = 3.3V

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.



T_1 : V_{DD} rising time from 10% to 90%

T_2 : The time from V_{DD} to valid data at power ON.

T_3 : The time from valid data off to V_{DD} off at power Off.

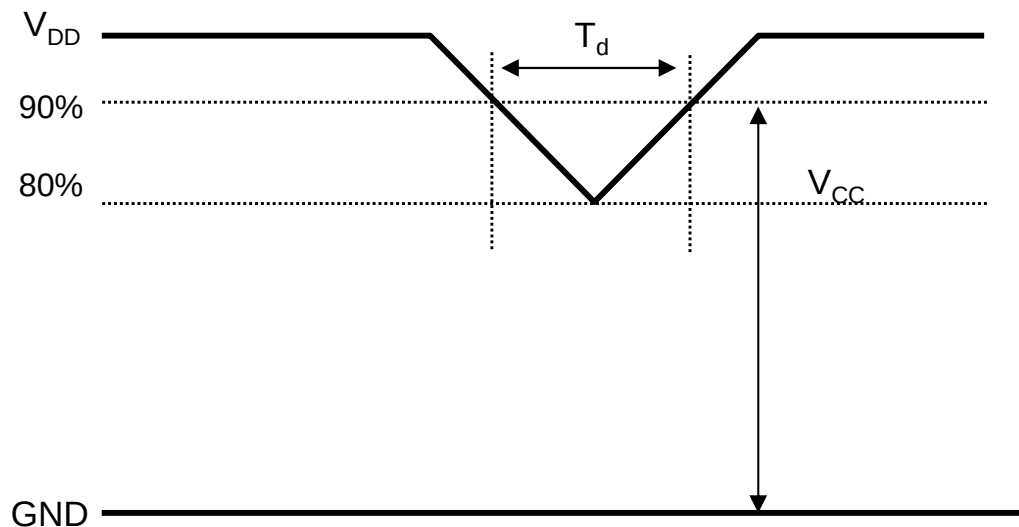
T_4 : V_{DD} off time for Windows restart

T_5 : The time from valid data to B/L enable at power ON.

T_6 : The time from valid data off to B/L disable at power Off.

- The supply voltage of the external system for the Module input should be the same as the definition of V_{DD} .
- 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 show abnormal screen.
- In case of V_{DD} = off level, please keep the level of input signals low or keep a high impedance.
- T_4 should be measured after the Module has been fully discharged between power off and on period.
- Interface signal should not be kept at high impedance when the power is on.

6.4 VDD Power Dip Condition



$$3.0V \leq V_{DD} \leq 3.6V$$

$$\text{If } V_{DD}(\text{typ.}) \times 80\% \leq V_{CC} \leq V_{DD}(\text{typ}) \times 90\%$$

$$\text{Then, } 0 < T_d \leq 20\text{msec}$$

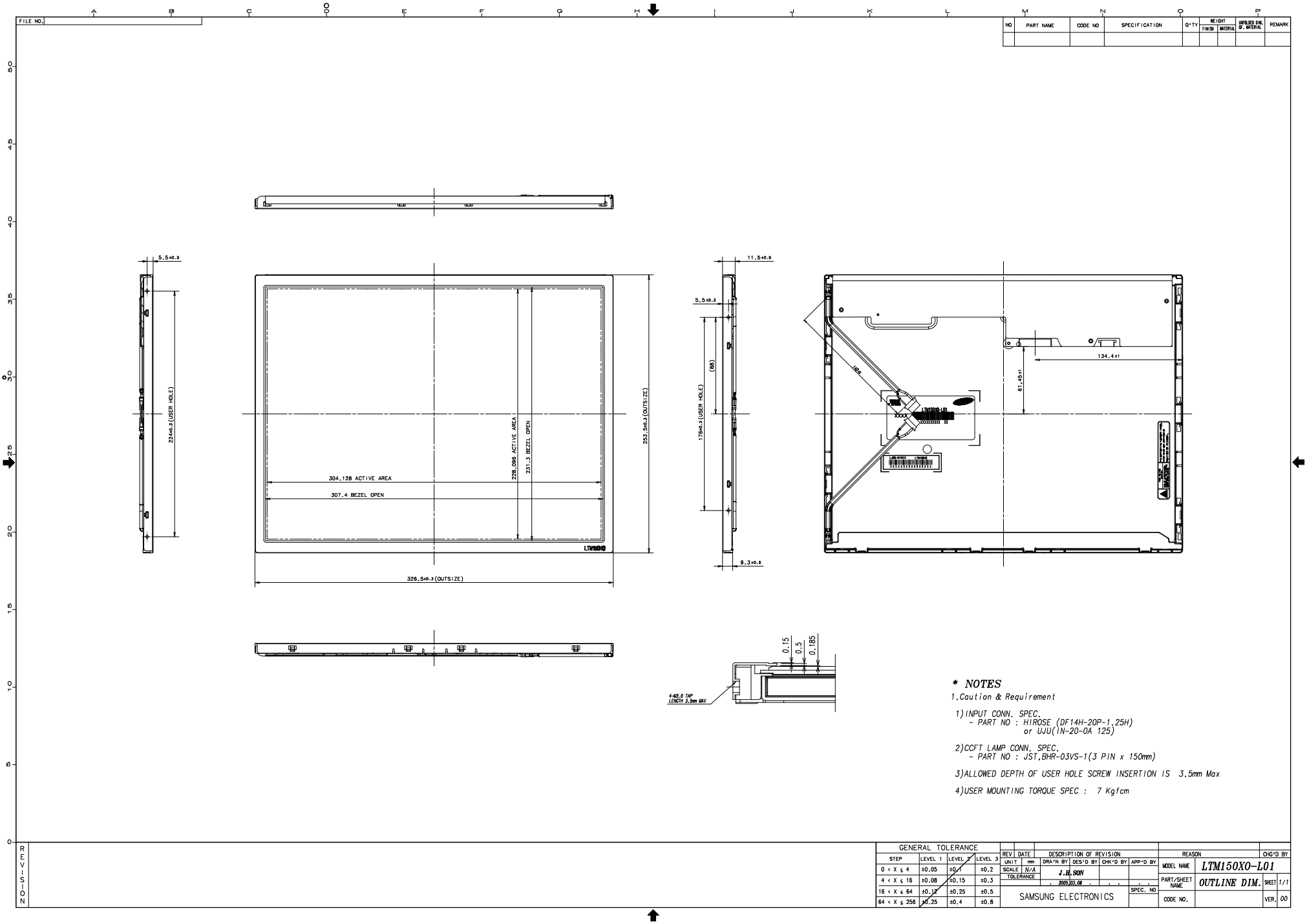
- Note (1) The above conditions are for the glitch of the input voltage.
 (2) For stable operation of an LCD Module power, please follow them.
 i.e., if $\text{typ } V_{DD} \times 80\% \leq V_{CC} \leq \text{typ } V_{DD} \times 90\%$, then T_d should be less than 20ms.

7. Outline Dimension

[Refer to the next page]

Approval Specification

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NO	PART NAME	CODE NO	SPECIFICATION	Q'TY	WEIGHT	UNIT	APPROVED	REMARK

- * NOTES**
- 1.Caution & Requirement
- 1)INPUT CONN. SPEC.
- PART NO : HIROSE (DF14H-20P-1.25H)
or UJU(1N-20-0A 12S)
- 2)CCFT LAMP CONN. SPEC.
- PART NO : JST,BHR-03VS-1(3 PIN x 150mm)
- 3)ALLOWED DEPTH OF USER HOLE SCREW INSERTION IS 3.5mm Max
- 4)USER MOUNTING TORQUE SPEC : 7 Kg/cm

GENERAL TOLERANCE				DESCRIPTION OF REVISION				REASON		CHK'D BY
STEP	LEVEL 1	LEVEL 2	LEVEL 3	REV	DATE	BY	DATE	BY	DATE	
0 < X ≤ 4	±0.05	±0.1	±0.2	SCALE	N/A	J.B.SUN				LTM150X0-L01
4 < X ≤ 16	±0.08	±0.15	±0.3	TOLERANCE		2008.03.08				OUTLINE DIM. SHEET 1/1
16 < X ≤ 64	±0.12	±0.25	±0.5							
64 < X ≤ 256	±0.25	±0.4	±0.8							

SAMSUNG ELECTRONICS

CODE NO.

VER. 00

8. Reliability Test

Approval Specification

Test Items		Conditions	Time/Cycle	Sample
HTOL*		50°C , Bias	500 hrs	12
LTOL*		0°C , Bias	500 hrs	5
THB**		40°C / 95% , Bias	500 hrs	5
HTS***		70°C , No Bias	500 hrs	5
LTS***		-30°C , No Bias	500 hrs	5
Thermal Cycle		-20°C/30min ~ +60°C/30min , No bias	100 cycle	5
Box Drop		1 angle , 3 edge , 6 side , 66 cm		5
Shock (Non-operating)		50G , 11msec Sine wave , ± x/y/z axis	1 time/axis	3
Vibration (Non-operating)		1.5G , 10~300 Hz x/y/z axis , sweep rate : 10 min	30min/axis	3
ESD	Non-Operating	CDM : 150pF, 330Ω, 9point, 3 times/point	± 10kV	3
	Operating	Contact : 150pF, 330Ω, 100point, once/point	± 8kV	3
		Air(non-contact) : 150pF, 330Ω, 100point, once/point	± 15kV	3
Altitude		Operating : 0~10,000ft	72hrs	3
		Non-operating : 0~50,000ft		3

[Result Evaluation Criteria]

Under the display quality test conditions with normal operation state, these should be no change which may affect practical display functions.

* HTOL/ LTOL : High/Low Temperature Operating Life

** THB : Temperature Humidity Bias

*** HTS/LTS : High/Low Temperature Storage

9. PACKING

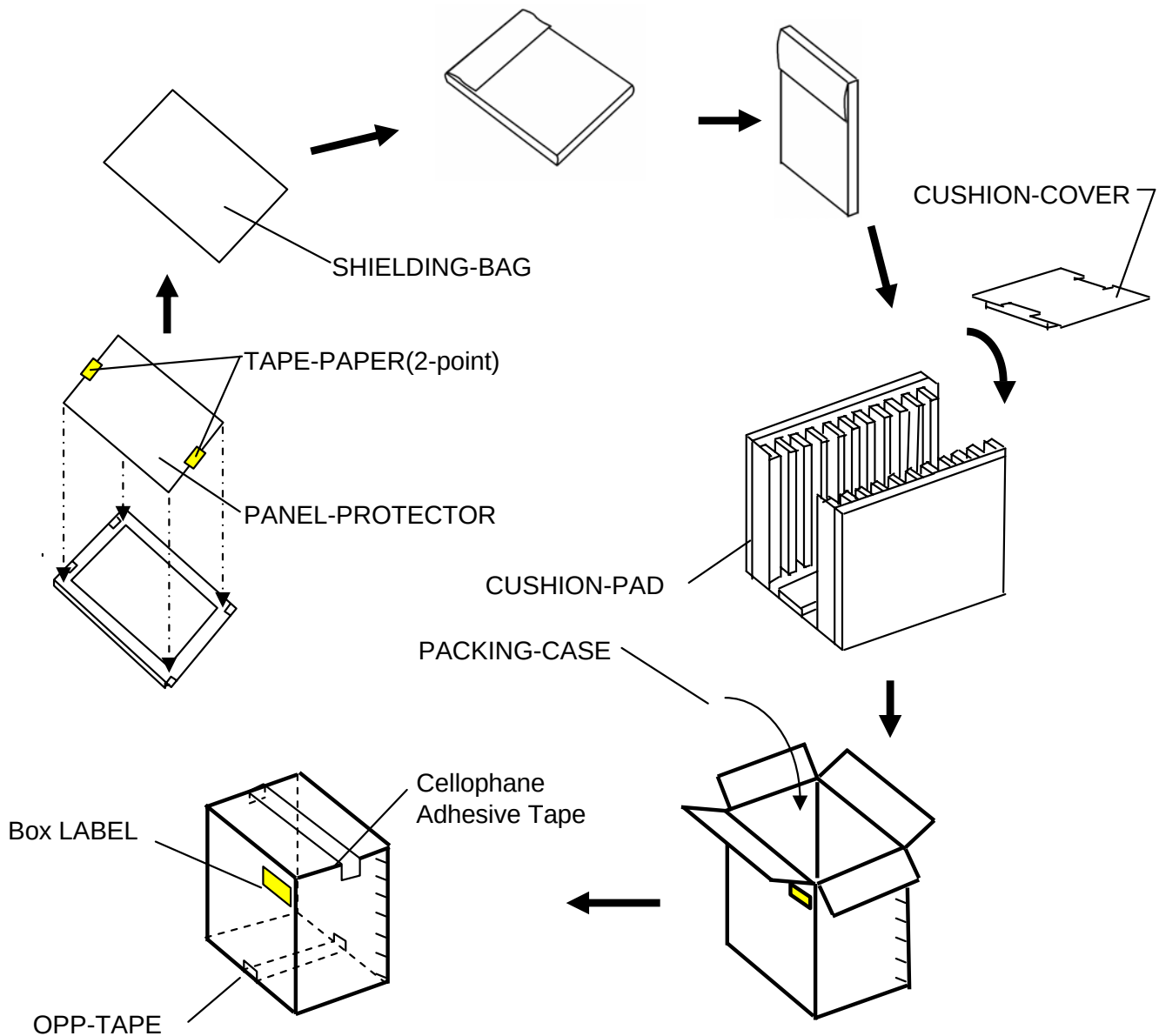
9.1 CARTON (Internal Package)

(1) Packing Form

Corrugated fiberboard box and corrugated cardboard as shock absorber

(2) Packing Method

a. Without Inverter



Note a. Total weight : Approx. 11Kg

b. Acceptance number of pilling : 10 Sets

c. Carton size : 326(M) X 376(D) X 412(H)

d. Max accumulation quantity : 5 cartons

(3) Packing Material

No	Part name	Quality
1	Static electric protective sack	10
2	Packing case(Inner box) included shock absorber	1 set
3	Pictorial marking	2 pics
4	Carton	1 set

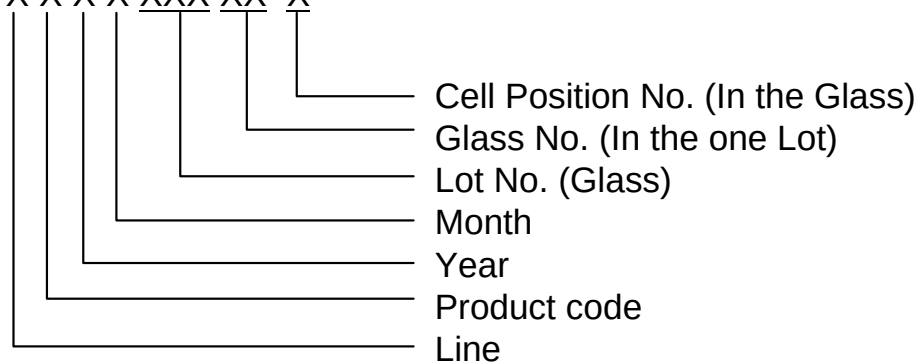
10. MARKING & OTHERS

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

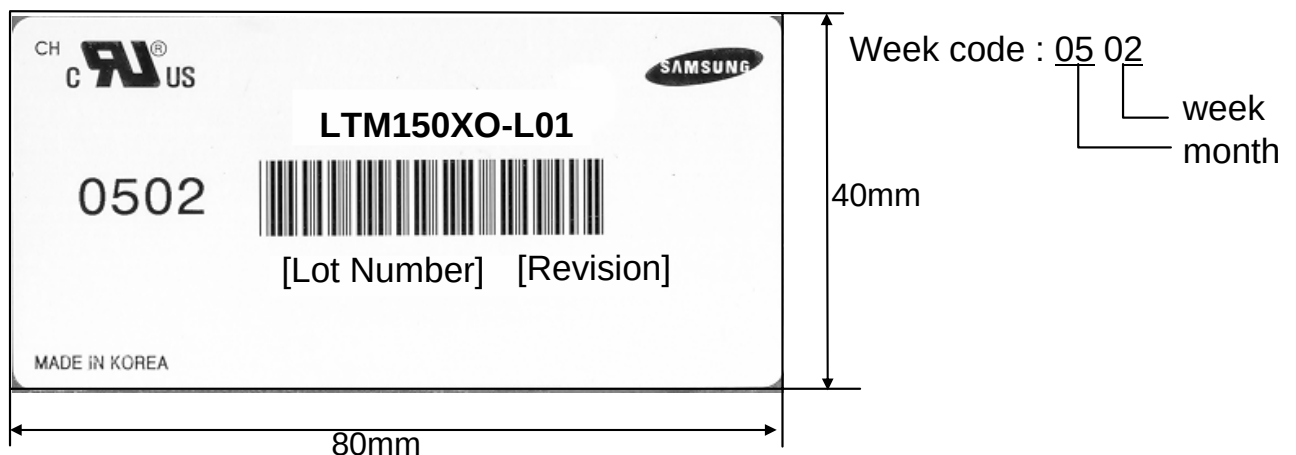
(1) Parts number : LTM150XO-L01

(2) Revision: Three letters

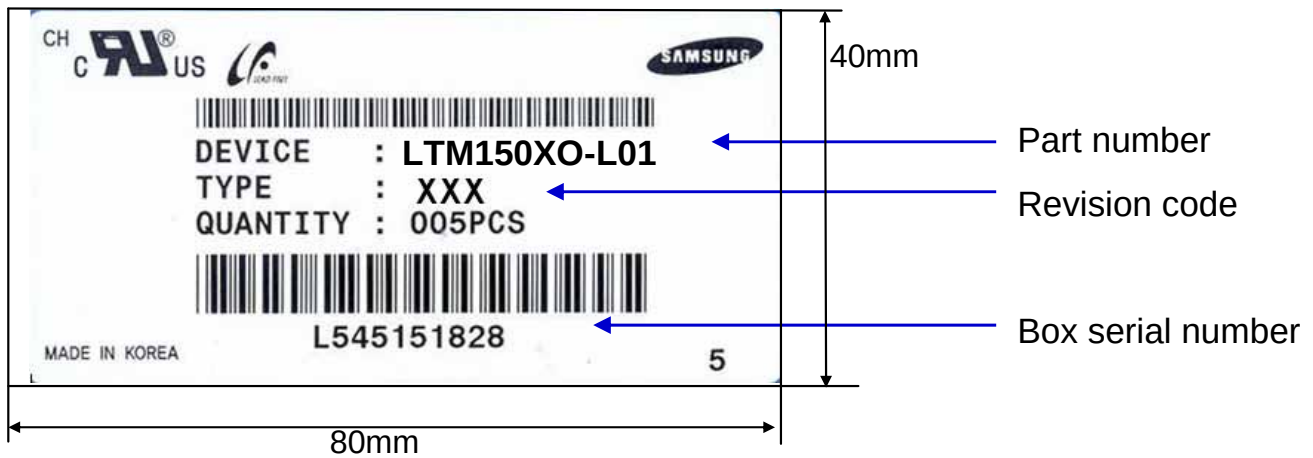
(3) Lot number : X X X X XXX XX X



(4) Nameplate Indication



(5) Packing box attach



(6) Others

a. After service part

Lamps cannot be replaced because of the narrow bezel structure.

11. General Precautions

11.1 Handling

- (a) When the module is assembled, it should be attached to the system firmly using all mounting holes. Be careful not to twist and bend the module.
- (b) Because the inverter uses high voltages, it should be disconnected from power source before it is assembled or disassembled.
- (c) Refrain from strong mechanical shock and / or any force to the module.
In addition to damage, it may cause improper operation or damage to the module and CCFT back light.
- (d) Note that polarizer films are very fragile and could be damaged easily.
Do not press or scratch the surface harder than a HB pencil lead.
- (e) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, staining or discoloration may occur.
- (f) If the surface of the polarizer is dirty, clean it using absorbent cotton or soft cloth.
- (g) 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 cause permanent damage to the polarizer due to chemical reaction.
- (h) 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 with soap thoroughly.
- (i) Protect the Module from static, or the CMOS Gate Array IC would be damaged.
- (j) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
- (k) Do not disassemble the Module.
- (l) Do not pull or fold the lamp wire.
- (m) Do not adjust the variable resistor located on the Module.
- (n) Protection film for polarizer on the Module should be slowly peeled off just before use so that the electrostatic charge can be minimized.
- (o) Pins of I/F connector should not be touched directly with bare hands.

11.2 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 35°C 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 in storing.

11.3 Operation

- (a) Do not connect or 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 be connected directly with a minimized length. A longer cable between the back light and the inverter may cause lower luminance of lamp(CCFT) and may require higher startup voltage(Vs).

11.4 Operation Condition Guide

- (a) The LCD product should be operated under normal conditions.
Normal condition is defined as below;
 - Temperature : $20 \pm 15^{\circ}\text{C}$
 - Humidity : $65 \pm 20\%$
 - Display pattern : continually changing pattern (Not stationary)
- (b) If the product will be used in extreme conditions such as high temperature, humidity, display patterns or operation time etc., It is strongly recommended to contact SEC for Application engineering advice. Otherwise, its reliability and function may not be guaranteed. Extreme conditions are commonly found at Airports, Transit Stations, Banks, Stock market, and Controlling systems.

11.5 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. (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 keeps displaying the same pattern for a long period of time, the image may be "sticked" to the screen.
To avoid image sticking, it is recommended to use a screen saver.
- (e) This Module has its circuitry PCB's on the rear side and should be handled carefully in order not to be stressed.
- (f) Please contact SEC in advance when you display the same pattern for a long time.