

TO : General

DATE : Sep. 13, 2002

**SAMSUNG TFT-LCD****MODEL NO. : LTN154X1-L02**

NOTE :

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

APPROVED BY :



PREPARED BY : Application Engineering 1 Group

**SAMSUNG ELECTRONICS CO., LTD.**

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## REVISION HISTORY

PRELIMINARY

Date	Rev.No.	Page	Summary
Jul.25.2002.	P00	ALL	LTN154X1-L02model was first issued

**DESCRIPTION**

LTN154X1 is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching devices. This model is composed of a TFT LCD panel, a driver circuit, a back-light system. The resolution of a 15.4 " contains 1280 x 800 pixels and can display up to 262,144colors. 6 o'clock direction is the optimum viewing angle.

**FEATURES**

- Thin and light weight
- High contrast ratio, high aperture structure
- Super Wide Viewing Angle
- Fast Response Time
- Wide XGA (1280x800 pixels) resolution
- Low power consumption
- Single CCFL
- DE(Data enable) only mode
- 3.3V LVDS Interface
- Onboard EEDID chip

**APPLICATIONS**

- Notebook PC and desktop monitors
- Display terminals for AV application products
- Monitors for Industrial machine
- If the usage of this product is not for PC application, but for others, please contact SEC

**GENERAL INFORMATION**

ITEM	SPECIFICATION	UNIT	NOTE
Display area	331.2max(H) x 207.0max(V) (15.4" diagonal )	mm	
Driver element	a-Si TFT active matrix		
Display colors	262,144		
Number of pixel	1280 X RGB(3) X 800	pixels	
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.25875(H) x 0.25875 (V)	mm	
Display Mode	Normally white		
Surface treatment	HAZE (25), HARD-COATING (3H)		

**Mechanical Information**

ITEM		MIN.	TYP.	MAX.	NOTE
Module size	Horizontal (H)	343.5	344.0	344.5	LCD module only
	Vertical (V)	221.5	222.0	222.5	
	Thickness (T)	-	-	6.5	
Weight (g)		-	-	610	PMMA

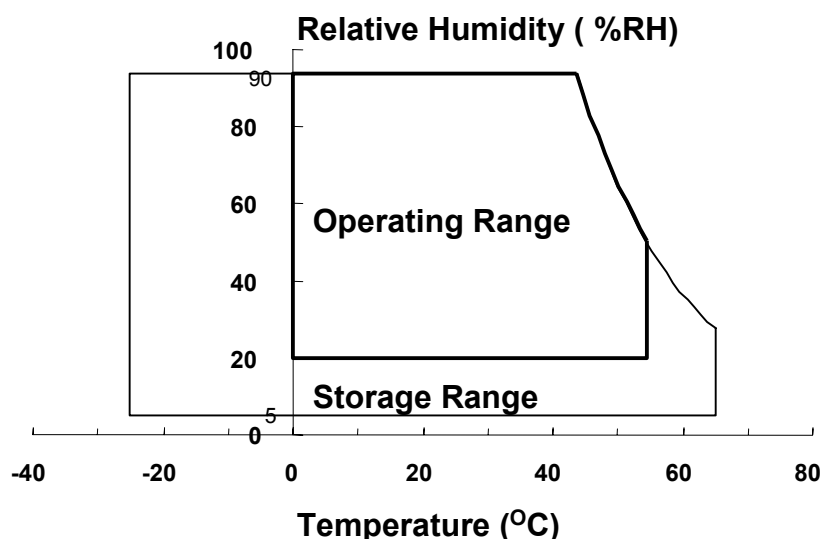
**1. ABSOLUTE MAXIMUM RATINGS****1.1 ENVIRONMENTAL ABSOLUTE RATINGS**

ITEM	SYMBOL	MIN.	MAX.	UNIT	NOTE
Storage temperature	T <sub>STG</sub>	-25	65	°C	(1)
Operating temperature (Temperature of glass surface)	T <sub>OPR</sub>	0	50	°C	(1)
Shock ( Non-operating )	Snop	-	220	G	(2),(4)
Vibration (Non-operating)	Vnop	-	1.5	G	(3),(4)

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

90 % RH Max. ( 40°C ≥ Ta)

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



(2) 220G, 2ms, Half sine wave, one time for ±X, ±Y, ±Z axis

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

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

## 1.2 ELECTRICAL ABSOLUTE RATINGS

### (1) TFT LCD MODULE

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

ITEM	SYMBOL	MIN.	MAX.	UNIT	NOTE
Power Supply Voltage	$V_{DD}$	$V_{SS} - 0.3$	3.8	V	(1)
Logic Input Voltage	$V_{IN}$	$V_{SS} - 0.3$	$V_{DD} + 0.3$	V	(1)

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

### (2) BACK-LIGHT UNIT

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

ITEM	SYMBOL	MIN.	MAX.	UNIT.	NOTE
Lamp current	$I_L$	2.0	7.0	mA <sub>rms</sub>	(1)
Lamp frequency	$F_L$	50	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. OPTICAL CHARACTERISTICS

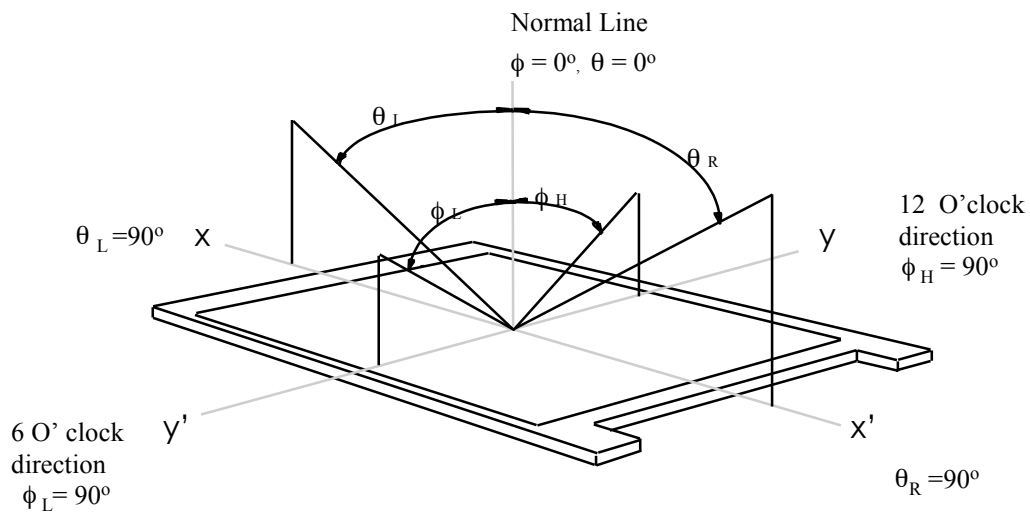
The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (7).

Measuring equipment : TOPCON BM-5A

\* Ta = 25 ± 2°C , VDD=3.3V, fv= 60Hz, fdCLK=68.9MHz, IL = 6.0mA

ITEM	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	NOTE
Contrast Ratio (5 Points)	CR		-	300	-		(1), (2), (7)
Response Time at Ta	Rising	$\phi = 0,$ $\theta = 0$	-	10	15	msec	(1), (3)
	Falling		-	15	20		
Average Luminance of White (5 Points)	Y <sub>L,AVE</sub>		170	185	-	cd/m <sup>2</sup>	(4) at 6.0mA
Color Chromaticity ( CIE )	Red	R <sub>X</sub>	(0.550)	(0.580)	(0.610)		PR650
		R <sub>Y</sub>	(0.310)	(0.340)	(0.370)		
	Green	G <sub>X</sub>	(0.280)	(0.310)	(0.340)		
		G <sub>Y</sub>	(0.520)	(0.550)	(0.580)		
	Blue	B <sub>X</sub>	(0.125)	(0.155)	(0.185)		
		B <sub>Y</sub>	(0.125)	(0.155)	(0.185)		
	White	W <sub>X</sub>	0.283	0.313	0.343		
		W <sub>Y</sub>	0.299	0.329	0.359		
Viewing Angle	Hor.	$\theta_R$	-	65	-	Degrees	(1)
		$\theta_L$	-	65	-		
	Ver.	$\phi_H$	-	50	-		
		$\phi_L$	-	50	-		
13 Points White Variation	$\delta_L$		-	-	1.8		(5),(6),(7)

Note 1) Definition of Viewing Angle :

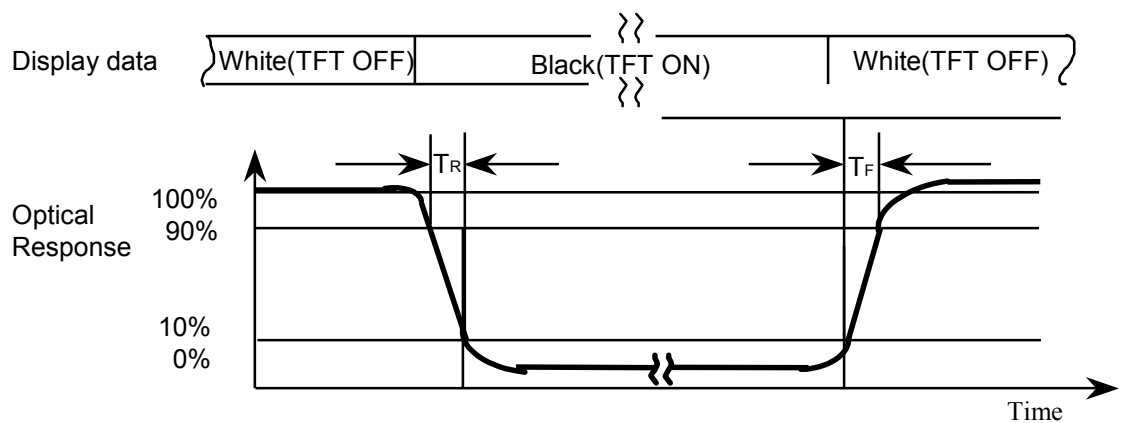


Note 2) Definition of Contrast Ratio (CR) = 
$$\frac{\text{Luminance of all pixel white}}{\text{Luminance of all pixel dark}}$$

$$CR = \frac{CR1 + CR2 + CR3 + CR4 + CR5}{5}$$

POINTS : (1) , (2) , (3) , (4) , (5) at FIGURE OF NOTE 6)

Note 3) Definition of Response time :

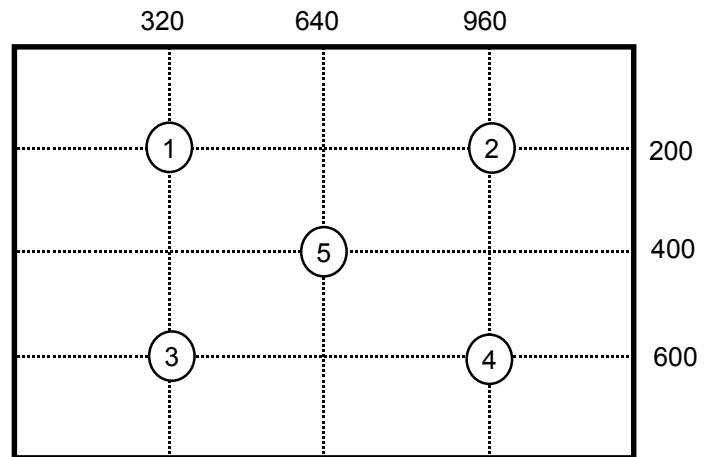




Note 4) Definition of Average Luminance of White : measure the luminance of white at 5 points.

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

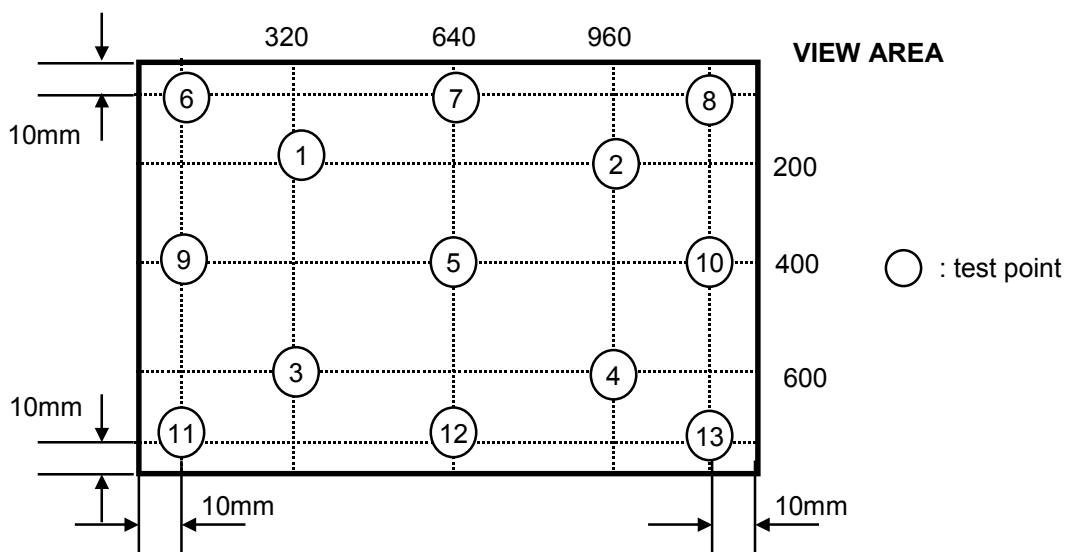
$$Y_{L,AVE} = \frac{Y_{L1} + Y_{L2} + Y_{L3} + Y_{L4} + Y_{L5}}{5}$$



Note 5) The luminance uniformity of 13 points is defined by dividing the maximum luminance values by the minimum test point luminance

$$\text{13 Points Luminance Uniformity} = \frac{\text{Max Luminance (13 pts, 1~13)}}{\text{Min Luminance (13 pts, 1~13)}}$$

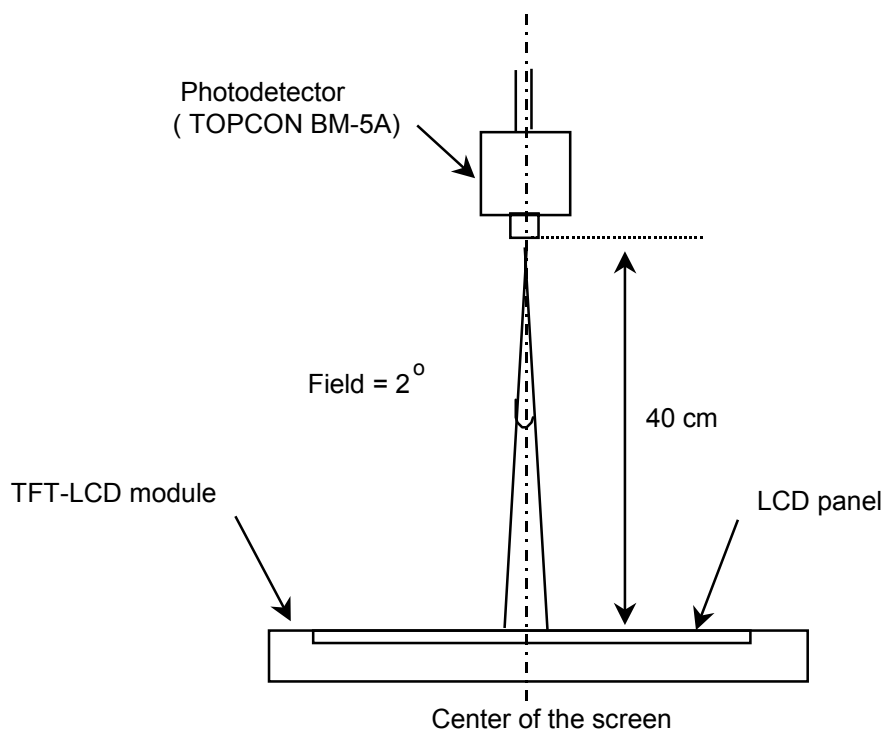
Note 6) Luminance uniformity measurement performed at the 13 points and 5 points as defined in the drawing below.



Note 7) After stabilizing and leaving the panel alone at a given temperature for 30 minutes, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30 minutes after lighting the back-light. This should be measured in the center of screen.

Lamp current : 6.0 mA

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



Optical characteristics measurement setup

### 3. ELECTRICAL CHARACTERISTICS

PRELIMINARY

#### 3.1 TFT LCD MODULE

Ta = 25 ± 2 °C

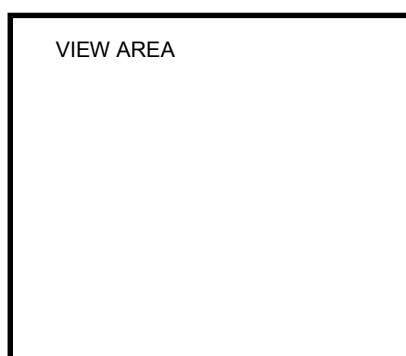
ITEM		SYMBOL	MIN	TYP	MAX	UNIT	NOTE
Voltage of Power Supply		V <sub>DD</sub>	3.0	3.3	3.6	V	
Differential Input Voltage for LVDS Receiver Threshold	High	V <sub>IH</sub>	-	-	+100	mV	(1)
	Low	V <sub>IL</sub>	-100	-	-	mV	
Vsync Frequency		f <sub>v</sub>	-	60	-	Hz	
Hsync Frequency		f <sub>H</sub>	-	48.96	-	KHz	
Main Frequency		f <sub>DCLK</sub>	-	68.9	-	MHz	
Rush Current		I <sub>RUSH</sub>	-	-	(1.5)	A	(4)
Electric Circuit Power Consumption	White	I <sub>DD</sub>	-	TBD	-	mA	(2),(3)*a
	Mosaic		-	TBD	-	mA	(2),(3)*b
	Maximum Pattern		-	TBD	TBD	mA	(2),(3)*c

Note (1) Condition : V<sub>CM</sub>=+1.2V(Common mode Voltage)

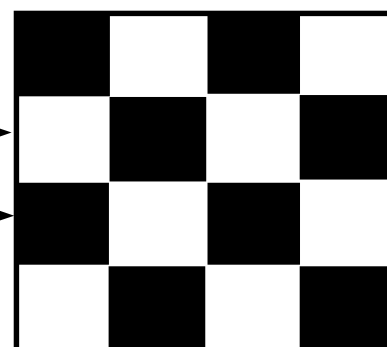
(2) f<sub>v</sub>=60Hz, f<sub>DCLK</sub> = 68.9 MHz, V<sub>dd</sub> = 3.3V , DC Current.

(3) Power dissipation check pattern

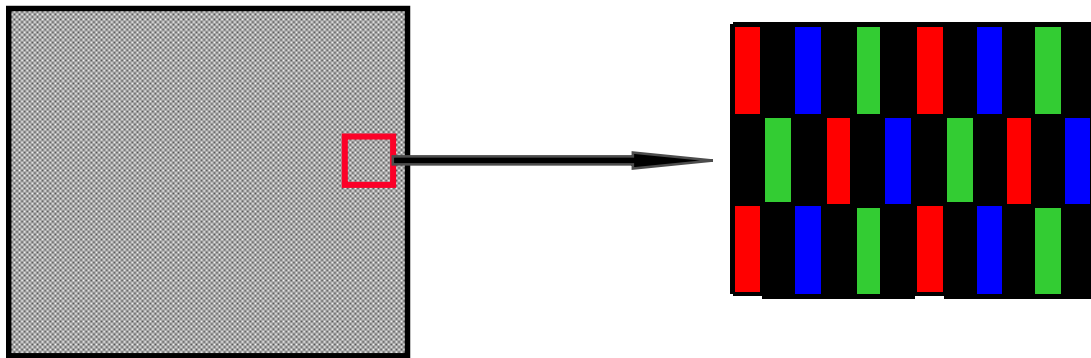
\*a) White Pattern



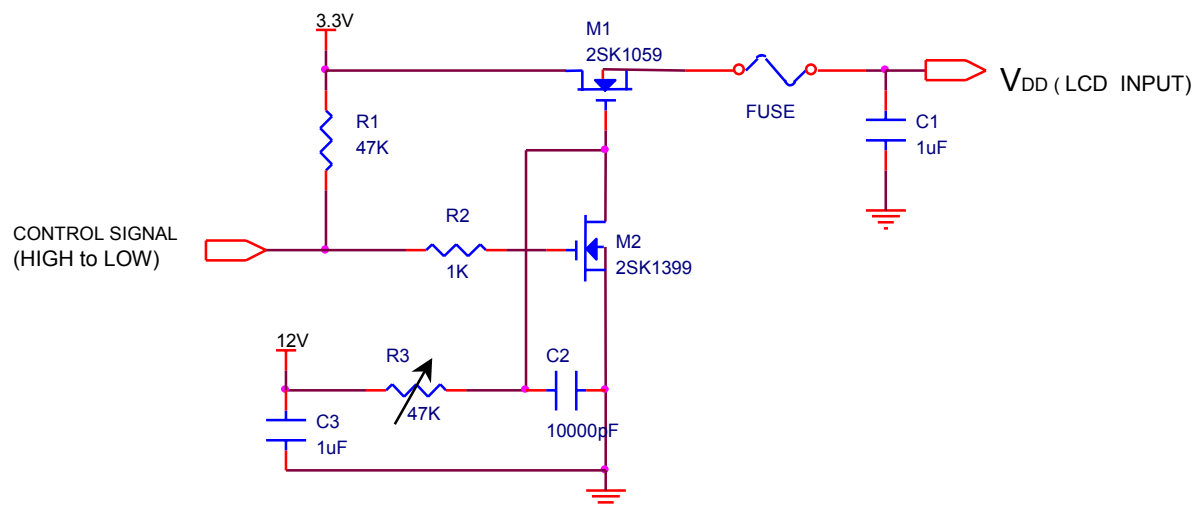
\*b)Mosaic Pattern



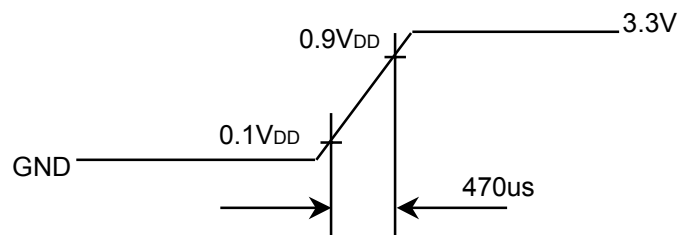
\*c) Maximum Power pattern : 1dot inversion



(4) Rush current measurement condition



V<sub>DD</sub> rising time is 470us



### 3.2 BACK-LIGHT UNIT

The backlight system is an edge - lighting type with a single CCFT ( Cold Cathode Fluorescent Tube ). The characteristics of a single lamp are shown in the following tables.

INVERTER : SIC 130T(SEMCO,  $f_L=60\text{KHz}$ )

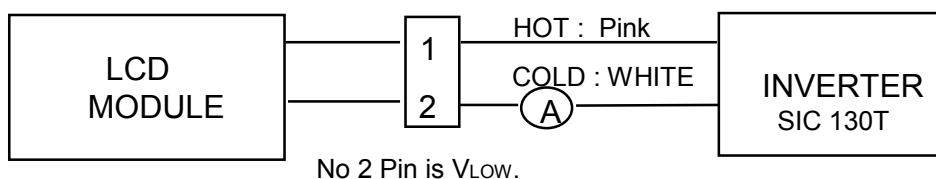
$T_a = 25 \pm 2^\circ\text{C}$

ITEM	SYMB	MIN	TYP	MAX	UNIT	NOTE
Lamp Current	$I_L$	(3.0)	-	(6.0)	mArms	(1)
Lamp Voltage	$V_L$	-	TBD	-	Vrms	$I_L=6.0\text{mA}$
Frequency	$f_L$	(50)	(60)	(65)	KHz	(2)
Power Consumption	$P_L$	-	TBD	-	W	(3) $I_L=6.0\text{mA}$
Operating Life Time	Hr	TBD	-	-	Hr	(4)
Startup Voltage	$V_s$	-	-	TBD	Vrms	$25^\circ\text{C}$
		-	-	TBD	Vrms	$0^\circ\text{C}$
Lamp Startup Time	$V_s$	-	-	1	sec	(5)

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

The performance of the back-light, for example life time or brightness, is much influenced by the characteristics of the DC-AC inverter for the lamp. So all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter. When you design or order the inverter, please make sure that a poor lighting caused by the mismatch of the back-light and the inverter(miss lighting, flicker, etc.) never occur. When you confirm it, the module should be operated in the same condition as it is installed in your instrument.

Note (1) Lamp current is measured with a high frequency current meter as shown below.



(2) Lamp frequency may produce interference with horizontal synchronous frequency and this 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.

(3) refer to  $I_L \times V_L$  to calculate.

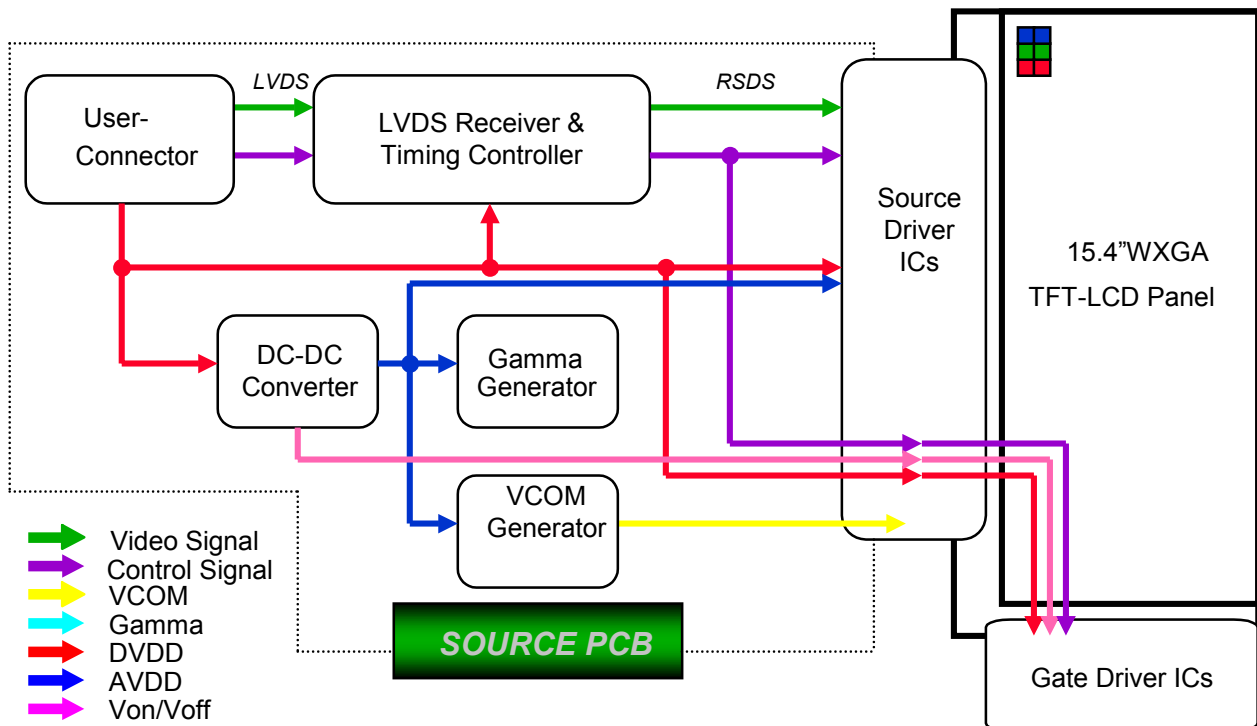
(4) Life time (Hr) of a lamp can be defined as the time in which it continues to operate under the condition  $T_a = 25 \pm 2^\circ\text{C}$  and  $I_L = 6.0 \text{ mArms}$  until one of the following event occurs.

1. When the brightness becomes 50% or lower than it's original.
2. When the Effective ignition length becomes 80% or lower than it's original value.  
(Effective ignition length is defined as an area that has less than 70% brightness compared to the brightness in the center point.)

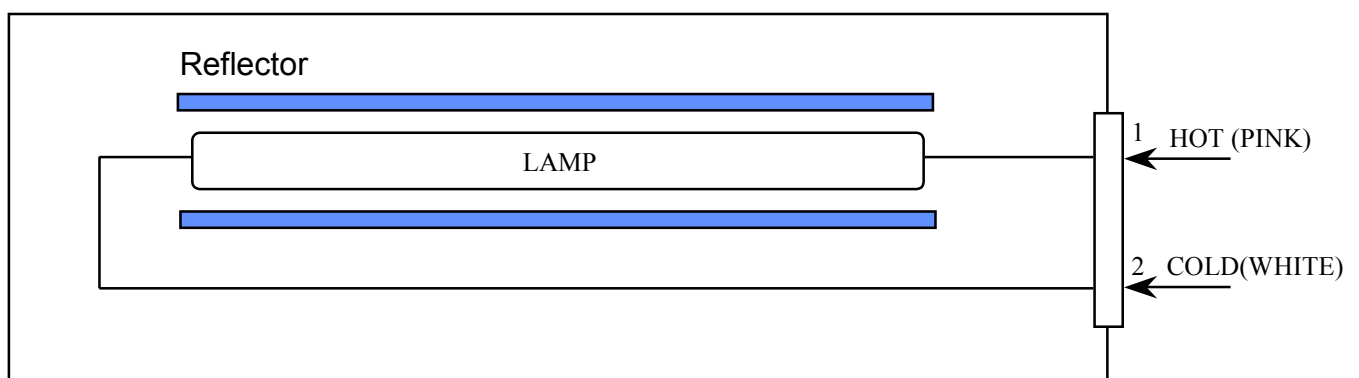
(5) The voltage above this value should be applied to the lamp for more than 1 second to startup. Otherwise the lamp may not be turned on.

## 4. BLOCK DIAGRAM

### 4.1 TFT LCD Module



### 4.2 BACKLIGHT UNIT



Note) The output of the inverter may change according to the material of the reflector.

## 5. INPUT TERMINAL PIN ASSIGNMENT

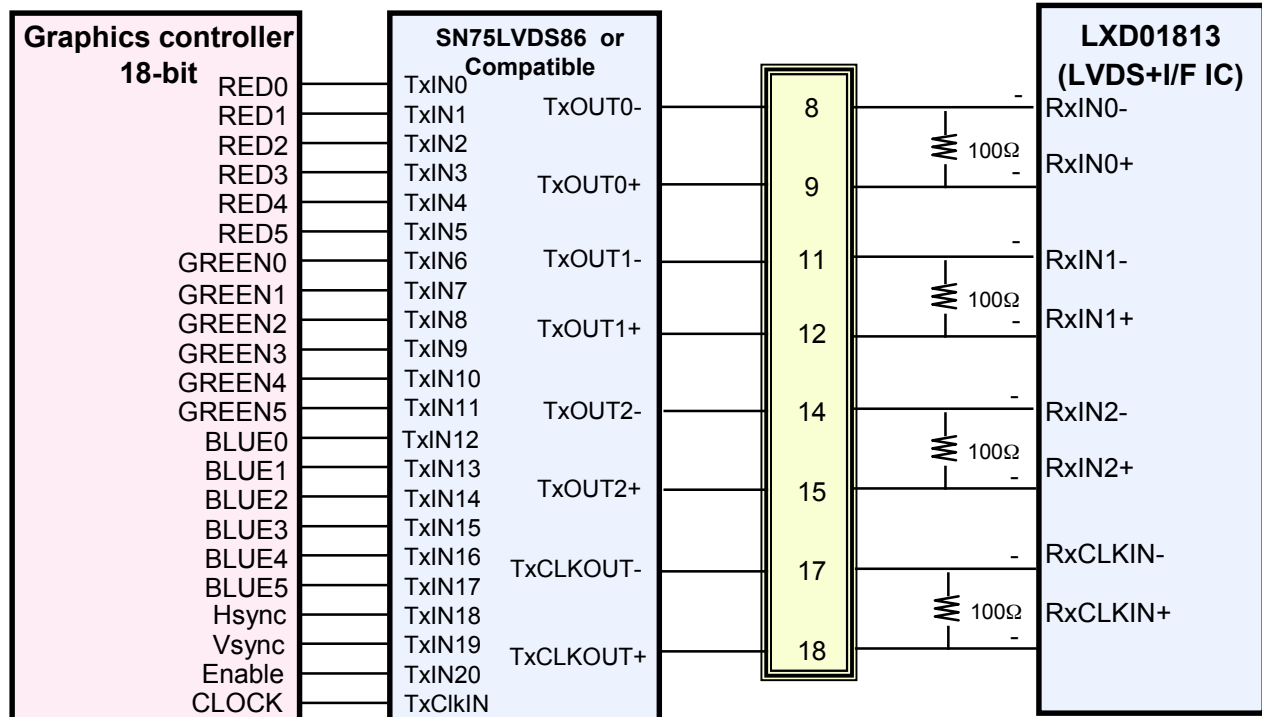
### 5.1. Input Display Signal & Power (Input Connector : JAE, FI-XB30SL-HF10)

PIN#	SYMBOL	FUNCTION	POLARITY	REMARK
1	VSS	Ground		
2	VDD	Power Supply, 3.3 V (typical )		
3	VDD	Power Supply, 3.3 V (typical)		
4	V EEDID	DDC 3.3V power		
5	NC	No connect		
6	Clk EEDID	DDC Clock		
7	DATA EEDID	DDC Data		
8	RxIN0-	LVDS differential data input	Negative	R0-R5, G0
9	RxIN0+	LVDS differential data input	Positive	
10	VSS	Ground		
11	RxIN1-	LVDS differential data input	Negative	G1-G5, B0-B1
12	RxIN1+	LVDS differential data input	Positive	
13	VSS	Ground		
14	RxIN2-	LVDS differential data input	Negative	B2-B5, HS,VS,DE
15	RxIN2+	LVDS differential data input	Positive	
16	VSS	Ground		
17	ClkIN-	LVDS differential clock input	Negative	
18	ClkIN+	LVDS differential clock input	Positive	
19	VSS	Ground		
20	NC	No connect		
21	NC	No connect		
22	NC	No connect		
23	NC	No connect		
24	NC	No connect		
25	NC	No connect		
26	NC	No connect		
27	NC	No connect		
28	NC	No connect		
29	NC	No connect		
30	NC	No connect		

## 5.2 LVDS Interface

Transmitter SN75LVDS86 or Compatible

Pin No.	Name	RGB Signal	Pin No.	Name	RGB Signal
44	TxIN0	R0	12	TxIN11	G5
45	TxIN1	R1	13	TxIN12	B0
47	TxIN2	R2	15	TxIN13	B1
48	TxIN3	R3	16	TxIN14	B2
1	TxIN4	R4	18	TxIN15	B3
3	TxIN5	R5	19	TxIN16	B4
4	TxIN6	G0	20	TxIN17	B5
6	TxIN7	G1	22	TxIN18	Hsync
7	TxIN8	G2	23	TxIN19	Vsync
9	TxIN9	G3	25	TxIN20	DE
10	TxIN10	G4	26	TxCLK IN	Clock



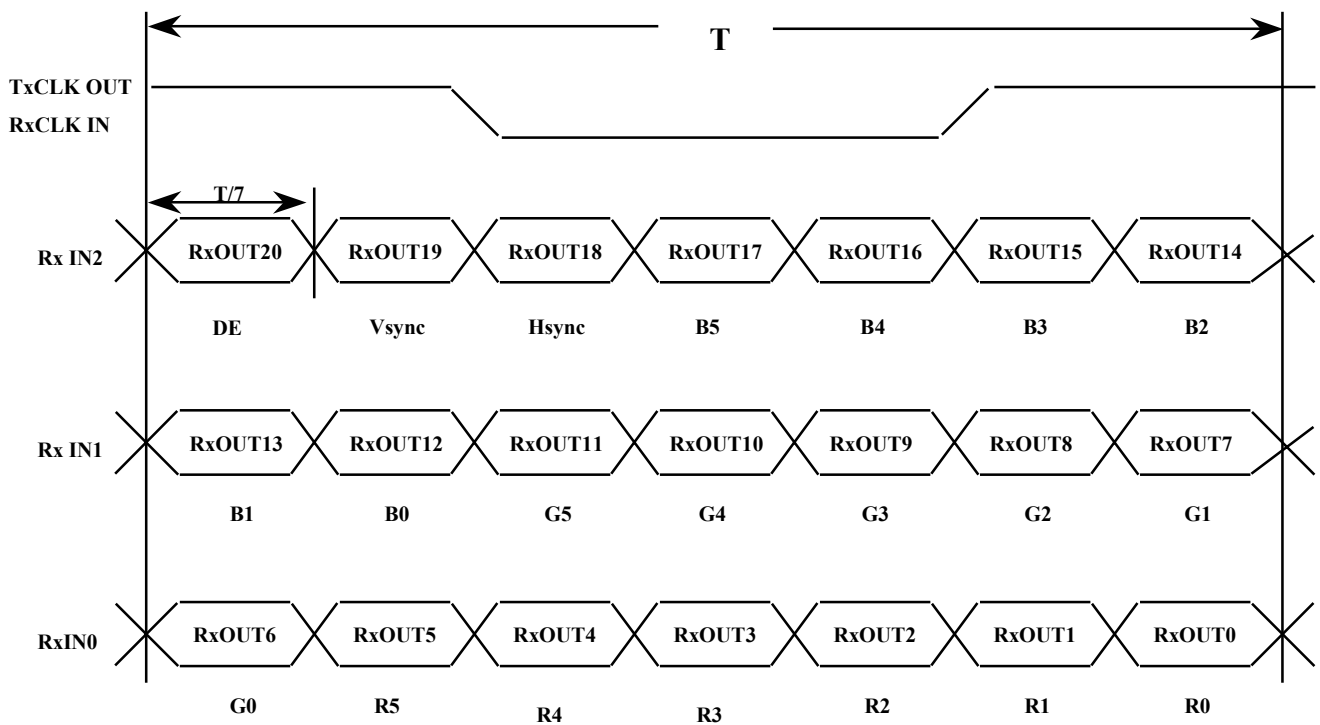


### 5.3 BACK LIGHT UNIT

Connector : JST BHSR - 02VS -1  
Mating Connector : JST SM02B-BHSS-1

Pin NO.	Symbol	Color	Function
1	HOT	PINK	High Voltage
2	COLD	WHITE	Low Voltage

### 5.4 Timing Diagrams of LVDS For Transmission



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

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 COLOR	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
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓ LIGHT	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R61
		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
	GRAY SCALE OF GREEN	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
↓ LIGHT		0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0	G61
		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
GRAY SCALE OF BLUE		BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓ LIGHT	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	B61
		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

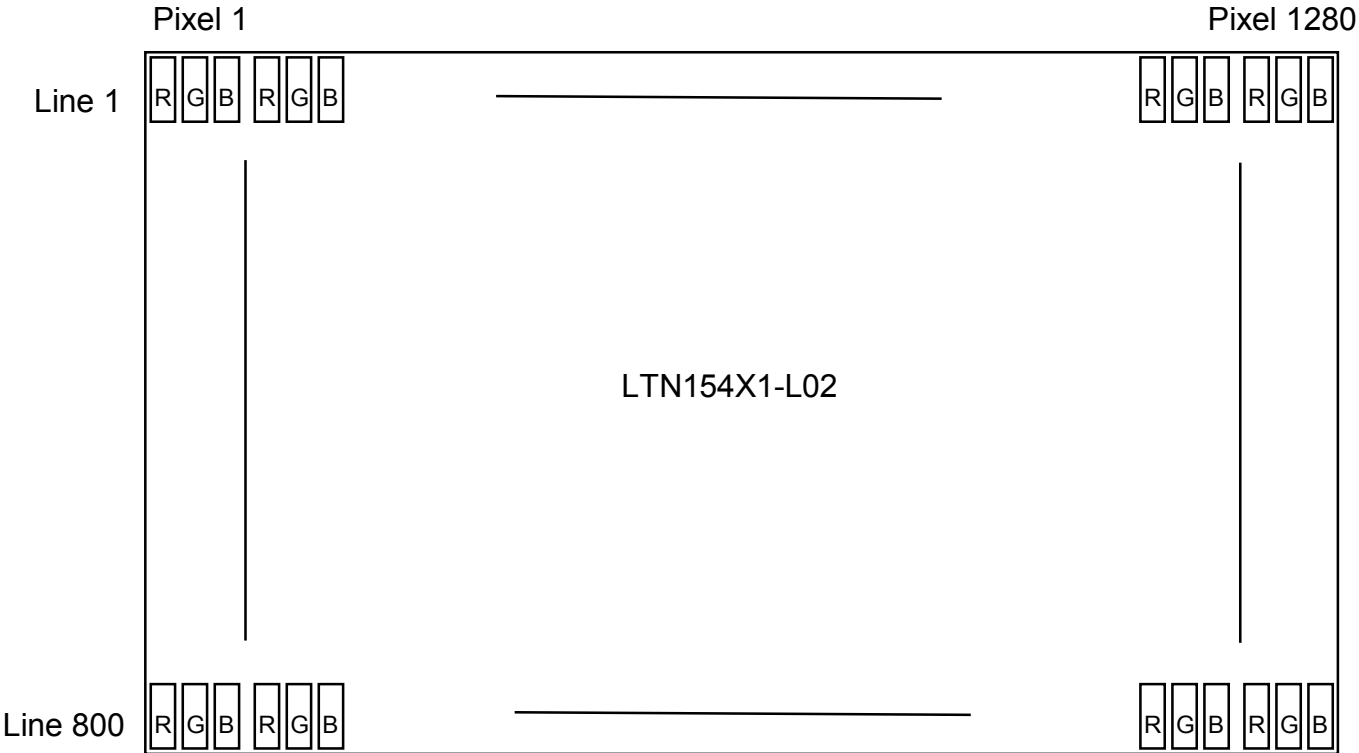
#### Note

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

(2) Input Signal : 0 = Low level voltage, 1 = High level voltage

5.6 PIXEL FORMAT

PRELIMINARY

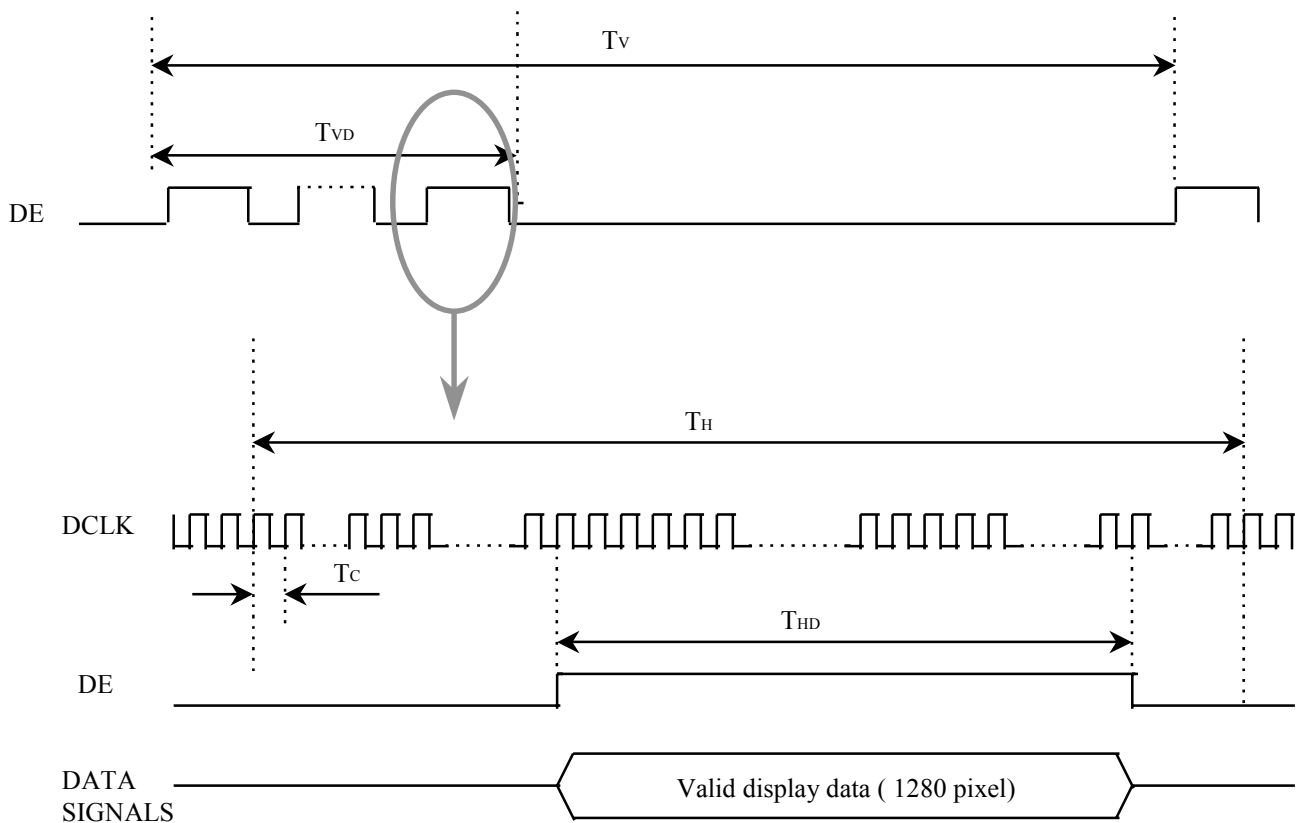


## 6. INTERFACE TIMING

### 6.1 Timing Parameters

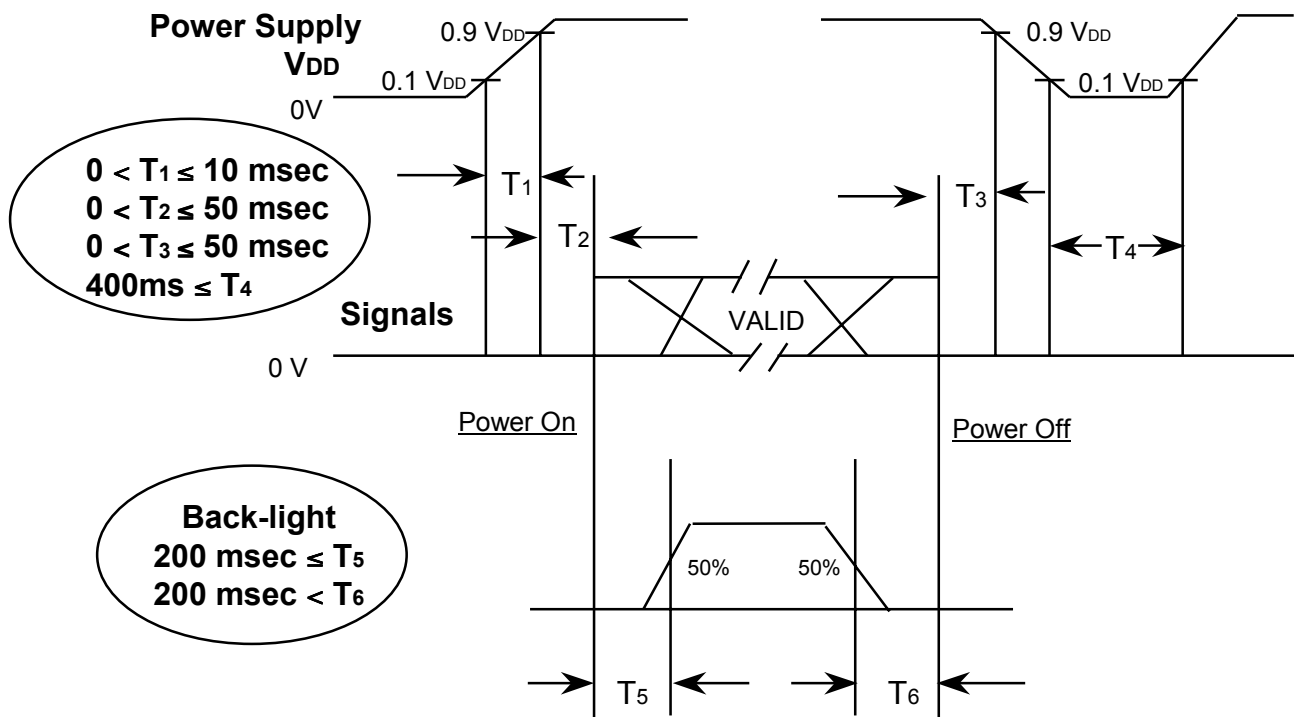
Signal	Item	Symbol	Min	Typ	Max	Unit
Frame Frequency	Cycle	$T_V$	(804)	816	(900)	lines
Vertical Active Display Term	Display Period	$T_{VD}$	-	800	-	lines
One Line Scanning Time	Cycle	$T_H$	(1368)	1408	(1800)	clocks
Horizontal Active Display Term	Display Period	$T_{HD}$	-	1280	-	clocks

### 6.2 Timing diagrams of interface signal



### 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.

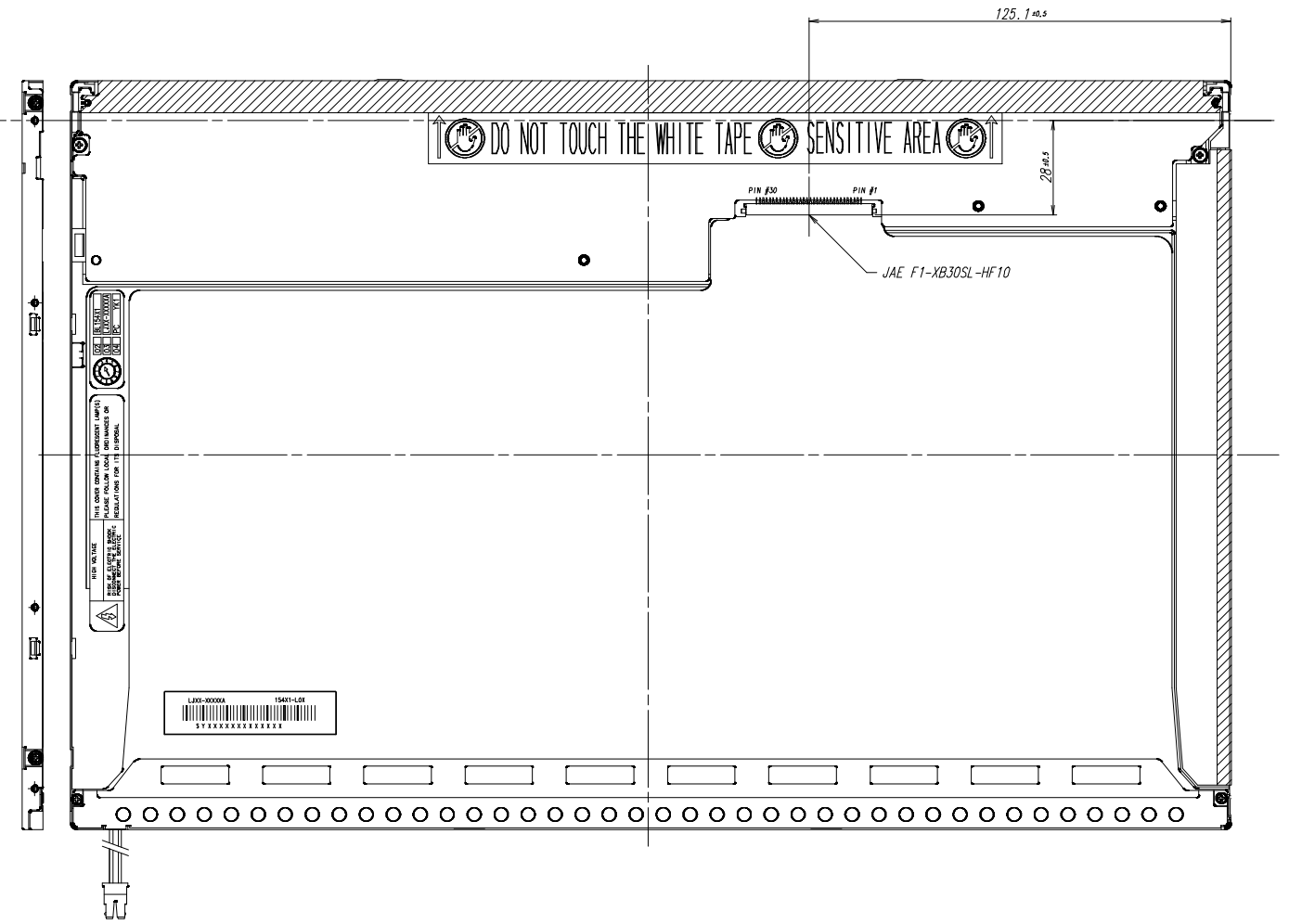
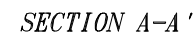


#### Power ON/OFF Sequence

- 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<sub>DD</sub>.
- (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<sub>DD</sub> = 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.



1. SIGNAL INTERFACE CONNECTOR TO BE SPECIFIED AS BELOW.
  - MAKER : JAE OR COMPATIBLE
  - INPUT CONNECTOR : JAE FI-XB30SL-HF10
2. CCFT CONNECTOR FOR BACKLIGHT TO BE SPECIFIED AS BELOW.
  - MAKER : JST
  - PART NO : BHSR-02VS-1
3. ALLOWED DEPTH OF USERHOLE SCREW INSERTION IS MAX 2.5mm
4. Number of pixels : 1280 X 3(R,G,B) X 800.

R E V I S I O N												GENERAL TOLERANCE				REV. DATE		DESCRIPTION OF REVISION				REASON		CHG'D BY	
	STEP	LEVEL 1	LEVEL 2	LEVEL 3	UNIT	mm	DRAW'N BY	DES'N BY	CHK'D BY	APP'D BY	MODEL NAME	LTN154X1-LOX													
	0 < X ≤ 4	±0.05	±0.1	±0.2	SCALE	1/1		Y.J.LEE	D.C.KIM	Y.B.CHU	PART/SHEET NAME	OUTLINE DIMENSION				SHEET	1/1								
	4 < X ≤ 16	±0.08	±0.15	±0.3	TOLERANCE																				
	16 < X ≤ 64	±0.12	±0.25	±0.5	LEVEL 3																				
	64 < X ≤ 256	±0.25	±0.4	±0.8	SAMSUNG ELECTRONICS											SPEC. NO									
												CODE NO.			VER.	000									

## 8. 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 and CCFT back-light.
- (c) Note that polarizers are very fragile and could be easily damaged. Do not press or scratch the surface harder than a HB pencil lead.
- (d) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, Staining and discoloration may occur.
- (e) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.
- (f) The desirable cleaners are water, IPA(Isopropyl Alcohol) or Hexane.  
Do not use Ketone type materials(ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.
- (g) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contact with hands, legs or clothes, it must be washed away thoroughly with soap.
- (h) Protect the module from static, it may cause damage to the 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 lamp wire.
- (l) Do not adjust the variable resistor 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.

## 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 shall be stored in a dark place. It is prohibited to apply sunlight or fluorescent light during the store.

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

## 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.