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ELECTRONICS

Preliminary



TO

DATE : Mar. 27, 2008.

SAMSUNG TFT-LCD

MODEL NO. : LTN154AT10

NOTE :

- Extension code [-D] ; LTN154AT10-C
- Surface type [**Glare**]

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

APPROVED BY :

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PREPARED BY : LCD Development Group 1 (Mobile)

SAMSUNG ELECTRONICS CO., LTD.



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REVISION HISTORY

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Date	Revision No.	Page	Summary
Mar. 27. 2008	P00	All	LTN154AT10 Model spec was issued first.

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GENERAL DESCRIPTION**DESCRIPTION**

LTN154AT10 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 and a backlight unit. The resolution of a 15.4" contains 1,280 x 800 pixels and can display up to 262,144 colors. 6 O'clock direction is the Optimum viewing angle.

FEATURES

- High contrast ratio, high aperture structure
- 1280 x 800 pixels resolution
- Low power consumption
- Fast Response
- Single CCFL
- DE(Data enable) only mode
- 3.3V LVDS Interface
- Onboard EEDID chip

APPLICATIONS

- Notebook PC
- 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	331.2(H) x 207.0(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	pixel	16 : 10
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.2588(H) x 0.2588(V) (TYP.)	mm	
Display Mode	Normally white		
Surface treatment	Haze 0, Hard-Coating 3H		

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Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal (H)	343.5	344.0	344.5	mm	w/o inverter ass'y
	Vertical (V)	221.5	222.0	222.5	mm	
	Depth (D)	-	-	6.5	mm	
Weight		-	555	570	g	LCD module only

1. ABSOLUTE MAXIMUM RATINGS

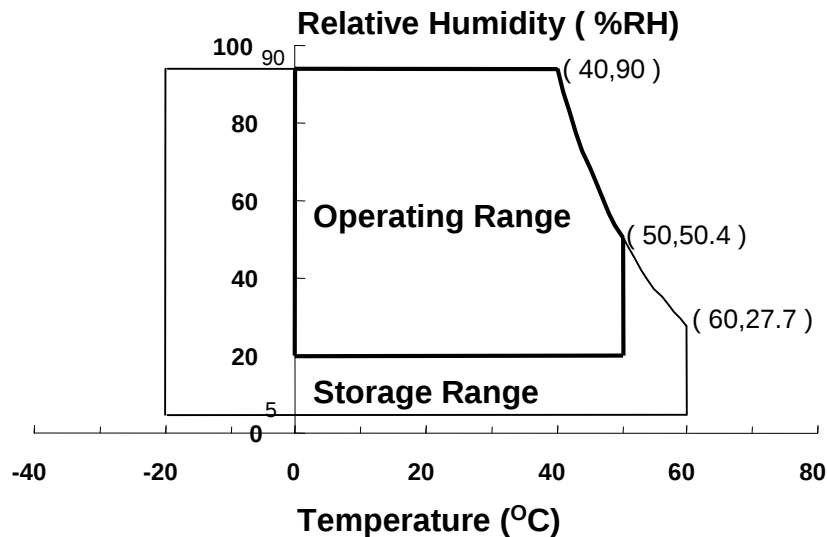
1.1 ENVIRONMENTAL ABSOLUTE RATINGS

Item	Symbol	Min.	Max.	Unit	Note
Storage temperate	TSTG	-20	60	°C	(1),(5)
Operating temperate (Temperature of glass surface)	TOPR	0	50	°C	(1),(5)
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.

95 % RH Max. ($40^{\circ}\text{C} \geq T_a$)

Maximum wet - bulb temperature at 39°C or less. ($T_a > 40^{\circ}\text{C}$) No condensation



(2) 2ms, half sine wave, one time for $\pm X, \pm Y, \pm Z$.

(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.

(5) If product is used for extended time excessively or exposed to high temperatures for extended time, there is a possibility of wide viewing angle film damage which could affect visual characteristics.

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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_{DD}	$V_{DD} - 0.3$	$V_{DD} + 0.3$	V	(1)

Note (1) Within T_a ($25 \pm 2^\circ C$)

(2) BACK-LIGHT UNIT

 $T_a = 25 \pm 2^\circ C$

Item	Symbol	Min.	Max.	Unit	Note
Lamp Current	I_L	3.0	7.0	mA	(1)
Lamp frequency	F_L	45	75	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.

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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 BM-5A and PR-650

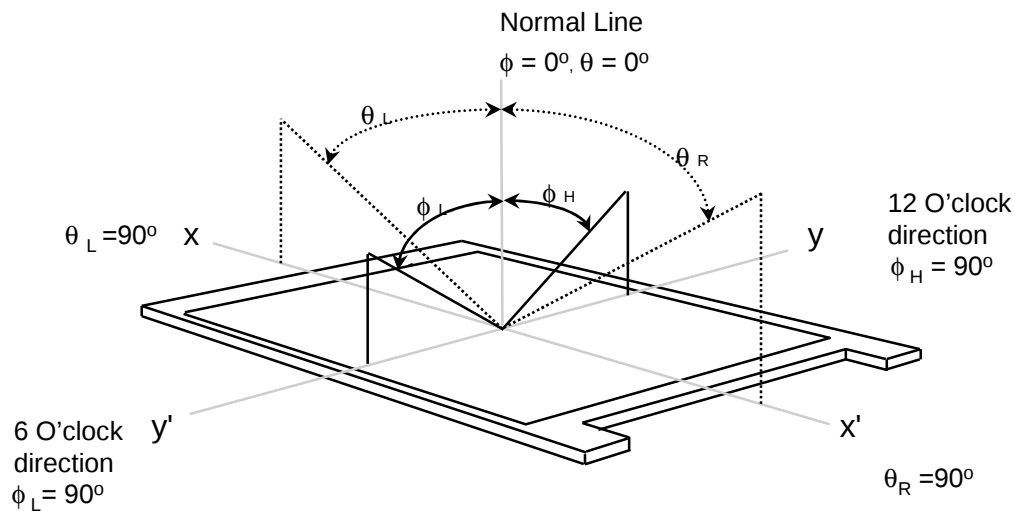
* Ta = 25 ± 2 °C, VDD=3.3V, fv= 60Hz, fDCLK = 71.26MHz, IL = 6.5 mArms

Item		Symbol	Condition	Min.	Typ.	Max	Unit	Note
Contrast Ratio (5 Points)		CR		400	500	-	-	(1), (2), (5)
Response Time at Ta (Rising + Falling)		T _{RT,BW}		-	16	25	msec	(1), (3)
Average Luminance of White (5 Points)		Y _{L,AVE}	Normal Viewing Angle ϕ = 0 θ = 0	190	220	-	cd/m ²	I _L =6.5mA (1), (4)
Color Chromaticity (CIE)	Red	R _X		(0.570)	(0.590)	(0.610)	-	(1), (5) PR-650
		R _Y		(0.320)	(0.340)	(0.360)		
	Green	G _X		(0.310)	(0.330)	(0.350)		
		G _Y		(0.525)	(0.545)	(0.565)		
	Blue	B _X		(0.135)	(0.155)	(0.175)		
		B _Y		(0.115)	(0.135)	(0.155)		
	White	W _X		0.293	0.313	0.333		
		W _Y		0.309	0.329	0.349		
Viewing Angle	Hor.	θ _L		CR ≥ 10	40	-	-	Degrees
		θ _H	40		-	-		
	Ver.	ϕ _H	15		-	-		
		ϕ _L	30		-	-		
13 Points White Variation		δ _L		-	-	1.7	-	(6)

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Note 1) Definition of Viewing Angle : Viewing angle range($10 \leq C/R$, $100 \leq C/R$)

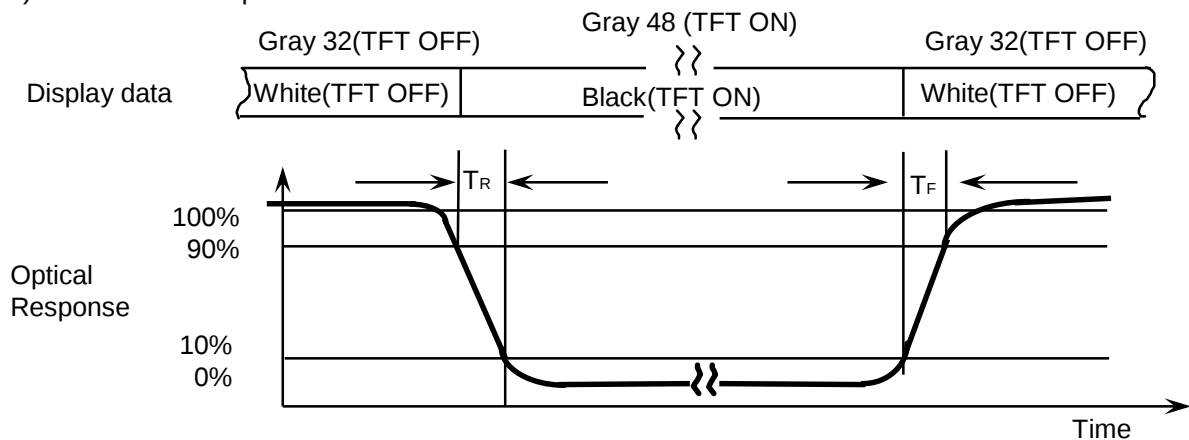


Note 2) Definition of Contrast Ratio (CR) : Ratio of gray max (Gmax), gray min (Gmin) at 5 points(4, 5, 7, 9, 10)

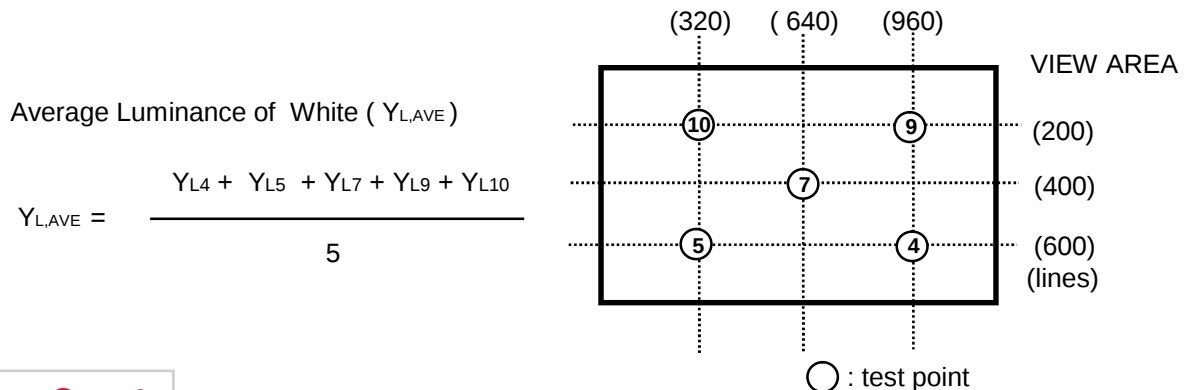
$$CR = \frac{CR(4) + CR(5) + CR(7) + CR(9) + CR(10)}{5}$$

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

Note 3) Definition of Response time :



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

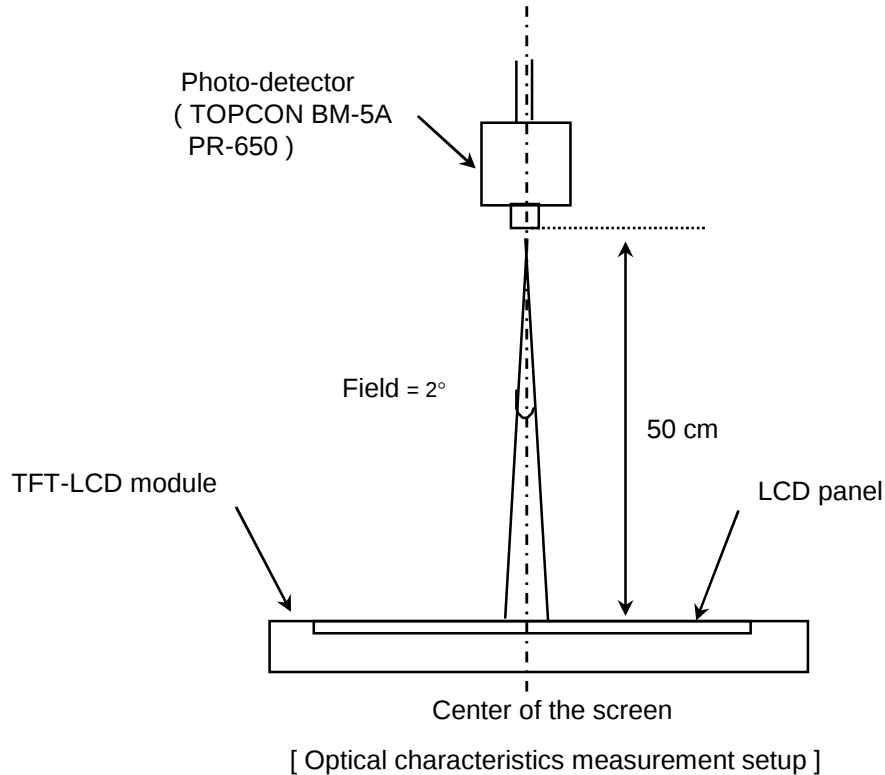


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Note 5) After stabilizing and leaving the panel alone at a given temperature for 30 min , the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30 min after lighting the backlight. This should be measured in the center of screen.

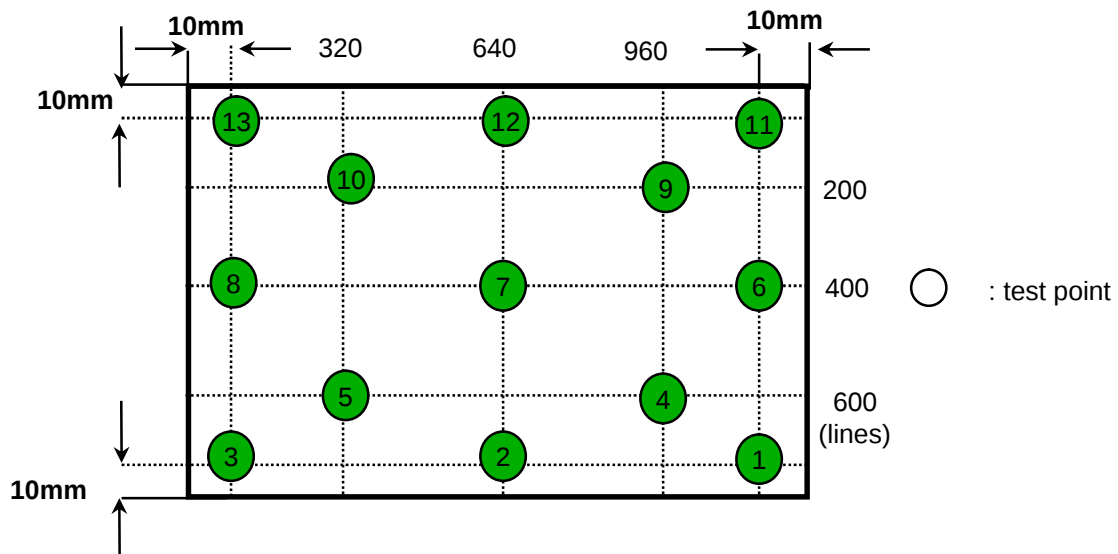
Lamp current : 6.5mA

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



Note 6) Definition of 13 points white variation (δL), CR variation(C_{VER}) [① ~ ⑬]

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



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3. ELECTRICAL CHARACTERISTICS

3.1 TFT LCD MODULE

Ta= 25 ± 2°C

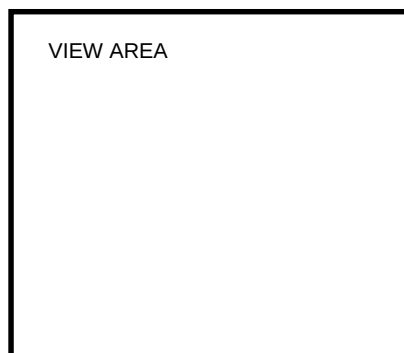
Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V _{DD}	3.0	3.3	3.6	V	
Differential Input Voltage for LVDS Receiver Threshold	High	V _{IH}	-	-	+100	mV	V _{CM} = +1.2V
	Low	V _{IL}	-100	-	-	mV	
Vsync Frequency		f _v	-	60	-	Hz	
Hsync Frequency		f _H	-	48.96	-	KHz	
Main Frequency		f _{DCLK}	-	70.5	-	MHz	
Rush Current		I _{RUSH}	-	-	1.5	A	(4)
Current of Power Supply	White	I _{DD}	-	300	-	mA	(2),(3)*a
	Mosaic		-	310	-	mA	(2),(3)*b
	V. stripe		-	380	500	mA	(2),(3)*c

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

(2) f_v = 60Hz, f_{DCLK} = 70.5MHz, V_{DD} = 3.3V , DC Current.

(3) Power dissipation pattern

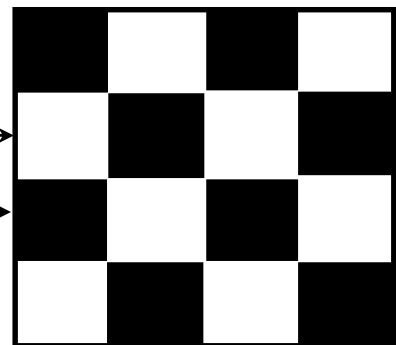
*a) White Pattern



*b) Mosaic Pattern

Display Brightest Gray Level →

Display Darkest Gray Level →

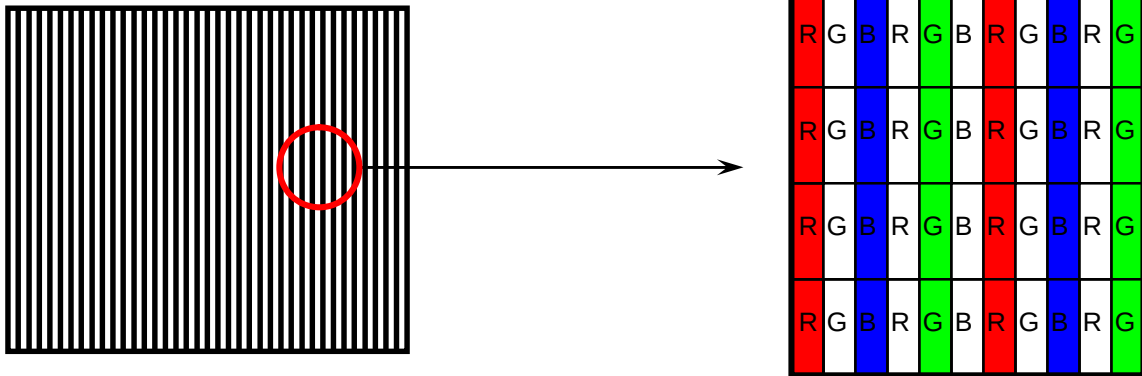


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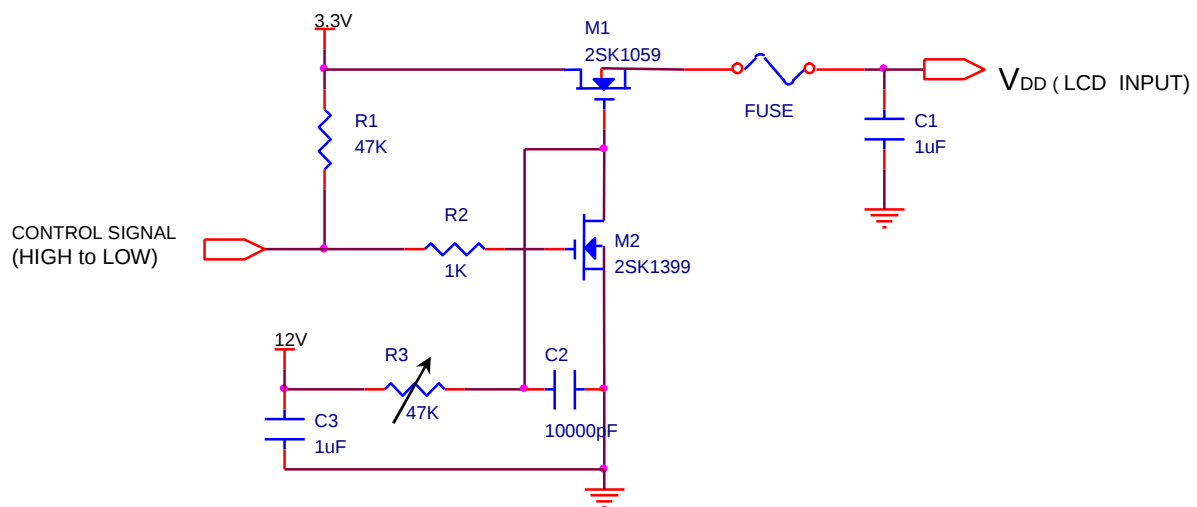
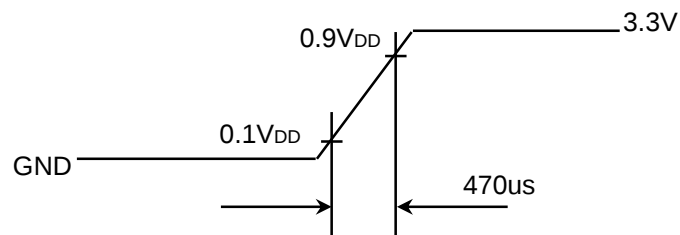
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*c) 1dot Vertical stripe pattern



4) Rush current measurement condition

V_{DD} rising time is 470us

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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 table.

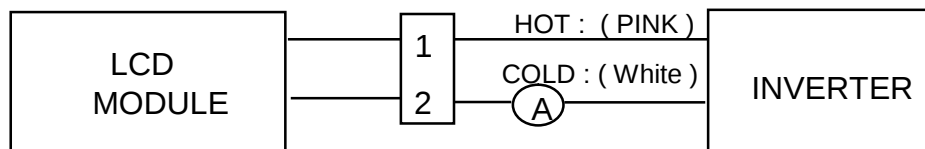
$T_a = 25 \pm 2 \text{ }^{\circ}\text{C}$

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Lamp Current	I_L	3.0	6.5	7.0	mArms	(1)
Lamp Voltage	V_L	-	655	-	Vrms	$I_L = 6.5\text{mA}$
Frequency	f_L	40	60	(85)	KHz	(2)
Power Consumption	P_L	-	4.6	5.0	W	(3) $I_L = 6.5\text{mA}$
Operating Life Time	Hr	15,000	-	-	Hour	(4)
Startup Voltage	V_s	-	-	1250	Vrms	25°C, (5)
				1500	Vrms	0°C, (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 backlight, 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 backlight 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 $T_a = 25 \pm 2 \text{ }^{\circ}\text{C}$ and $I_L = 6.0 \text{ mArms}$ until one of the following event occurs.

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

(5) The inverter open voltage - this voltage should be measured after ballast capacitor- have to be larger than the lamp startup voltage, otherwise backlight may has blinking for a moment after turns on or not be turned on.

If an inverter has shutdown function it should keep its open voltage for longer than 1 second even if lamp connector open.

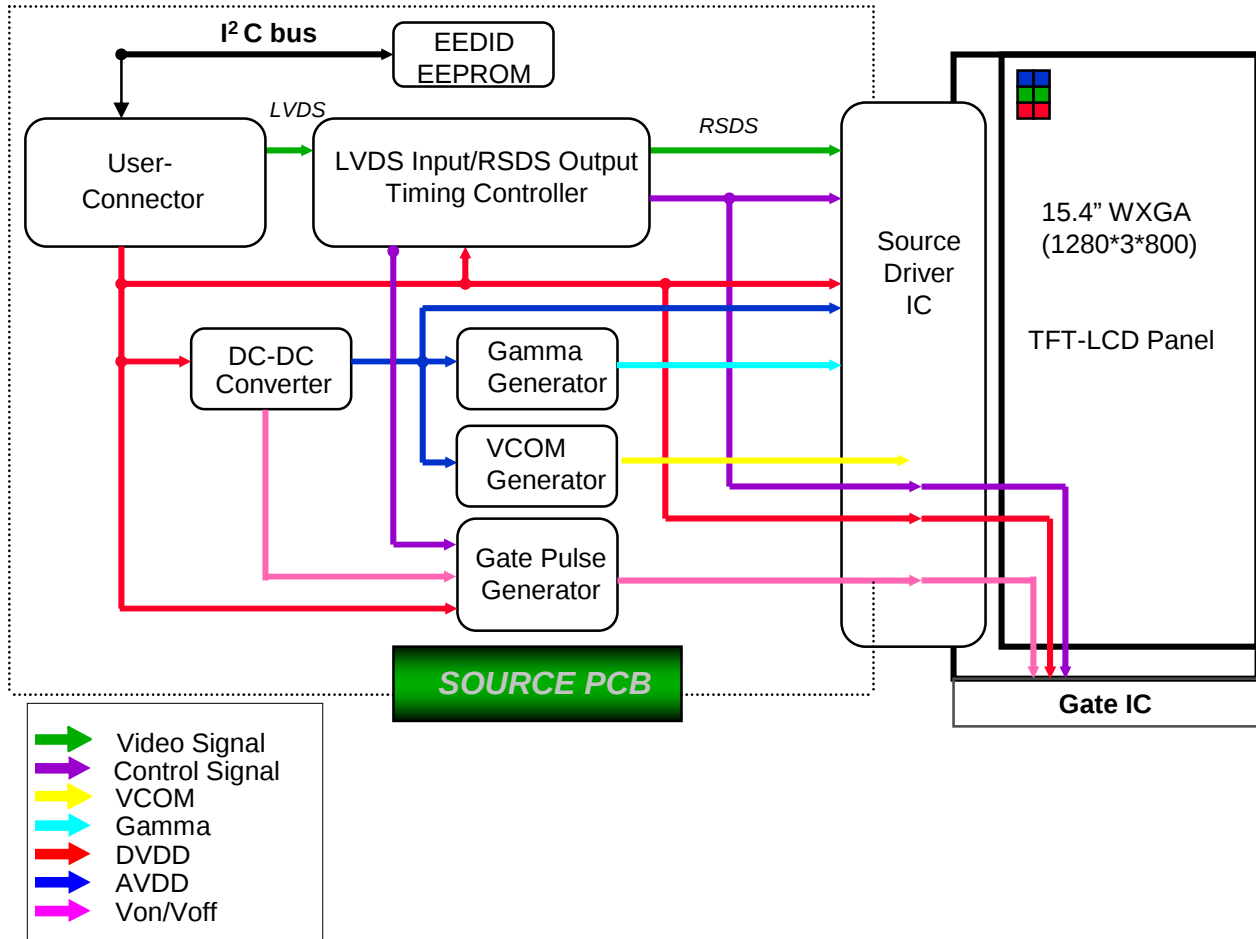
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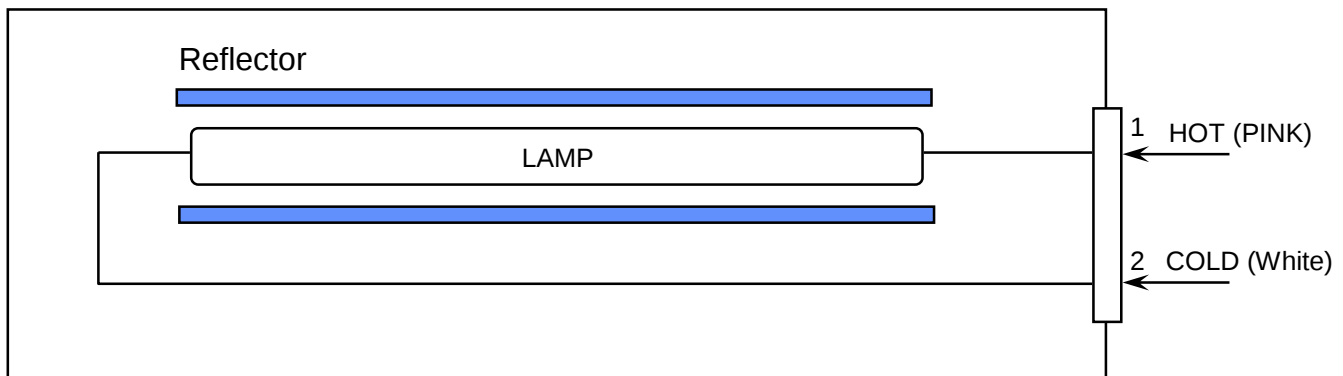
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4. BLOCK DIAGRAM

4.1 TFT LCD Module



4.2 BACKLIGHT UNIT



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

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5. INPUT TERMINAL PIN ASSIGNMENT

5.1. Input Signal & Power (LVDS, Connector : JAE FI-XB30SRL-HF11 or compatible)
Mating Connector : JAE FI-XB20Sx-HFxx or compatible)

No.	Symbol	Function	Polarity	Remarks
1	VSS	Ground		
2	VDD	POWER SUPPLY +3.3V		
3	VDD	POWER SUPPLY +3.3V		
4	VEEDID	DDC 3.3V Power		
5	BIST	Panel BIST enable		
6	CLKEDID	DDC Clock		
7	DATAEDID	DDC data		
8	RxIN0-	LVDS Differential Data INPUT (R0-R5,G0)	Negative	
9	RxIN0+	LVDS Differential Data INPUT (R0-R5,G0)	Positive	
10	GND	Ground		
11	RxIN1-	LVDS Differential Data INPUT (G1-G5,B0-B1)	Negative	
12	RxIN1+	LVDS Differential Data INPUT (G1-G5,B0-B1)	Positive	
13	GND	Ground		
14	RxIN2-	LVDS Differential Data INPUT (B2-B5,Sync,DE)	Negative	
15	RxIN2+	LVDS Differential Data INPUT (B2-B5,Sync,DE)	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		

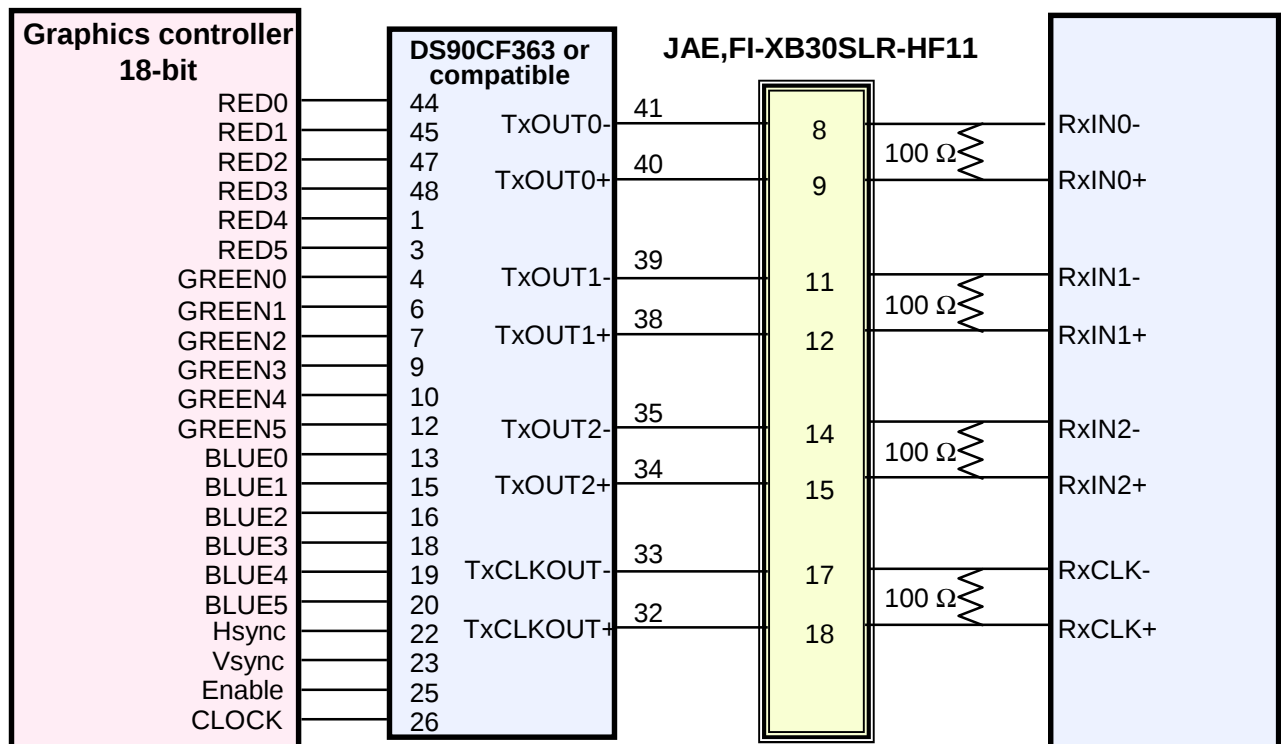
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5.2 LVDS Interface : Transmitter DS90CF363 or Compatible

LVDS

Pin No.	Name	RGB Signal	Pin No.	Name	RGB Signal
44	TxIN0	RO0	12	TxIN11	GO5
45	TxIN1	RO1	13	TxIN12	BO0
47	TxIN2	RO2	15	TxIN13	BO1
48	TxIN3	RO3	16	TxIN14	BO2
1	TxIN4	RO4	18	TxIN15	BO3
3	TxIN5	RO5	19	TxIN16	BO4
4	TxIN6	GO0	20	TxIN17	BO5
6	TxIN7	GO1	22	TxIN18	Hsync
7	TxIN8	GO2	23	TxIN19	Vsync
9	TxIN9	GO3	25	TxIN20	DE
10	TxIN10	GO4	26	TxCLK IN	Clock

LVDS Interface

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

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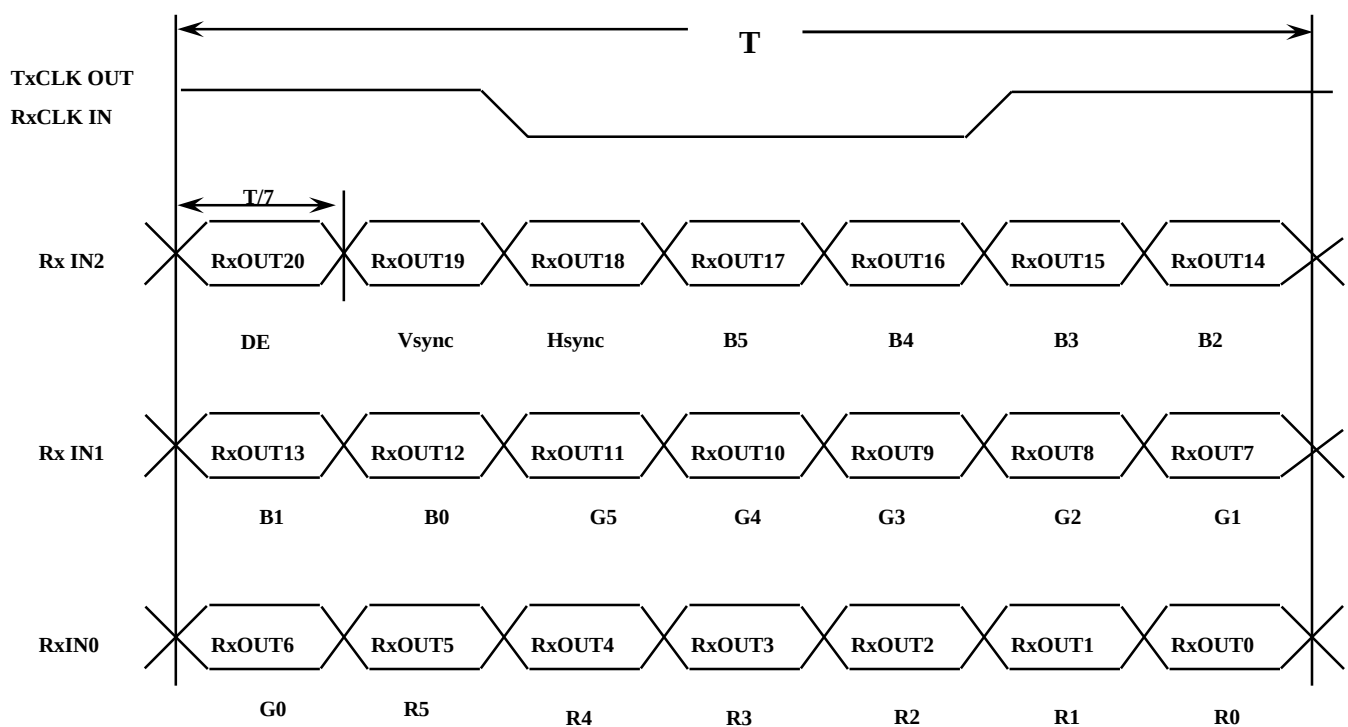
5.3 BACK LIGHT UNIT

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

Pin NO.	Symbol	Color	Function
1	HOT	Pink	High Voltage
2	COLD	White	Low Voltage

5.4 Timing Diagrams of LVDS For Transmission

LVDS Receiver : Integrated T-CON



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5.5 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)

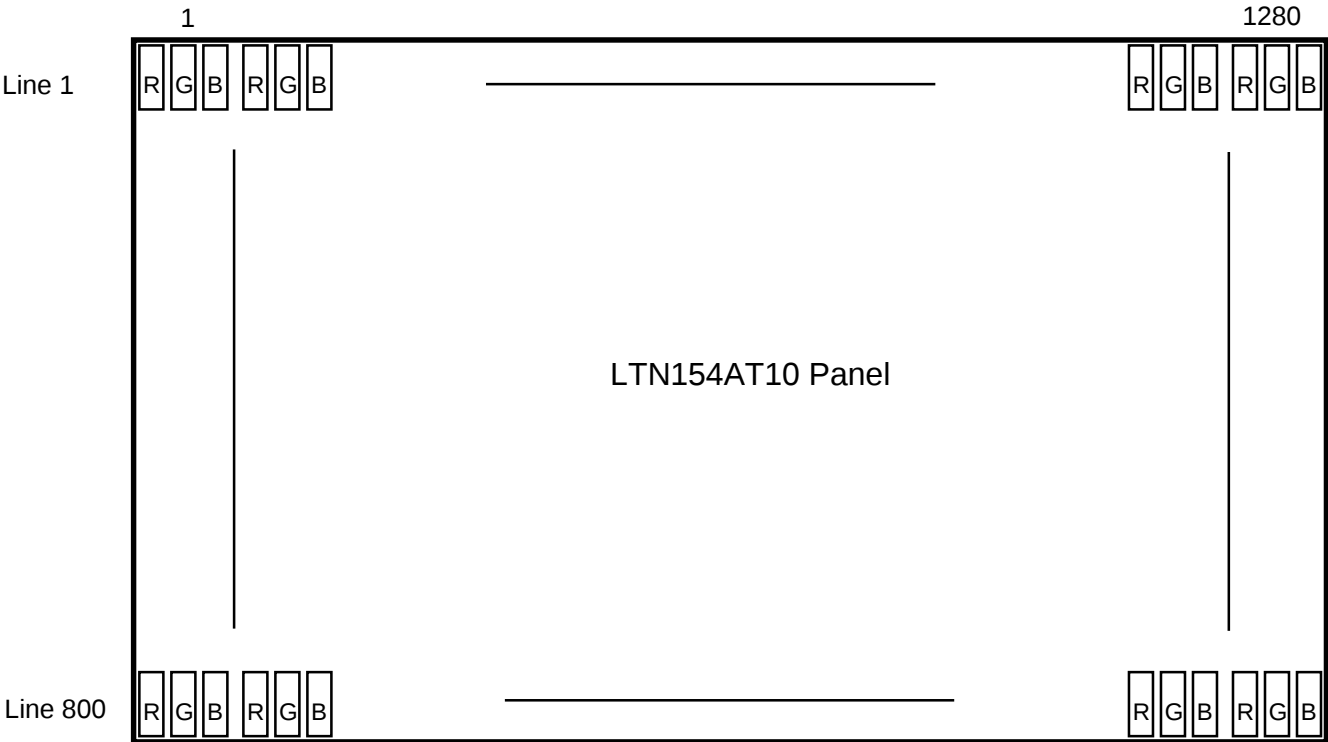
Note 2) Input signal: 0 =Low level voltage, 1=High level voltage

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Preliminary

5.6 Pixel Format in the display



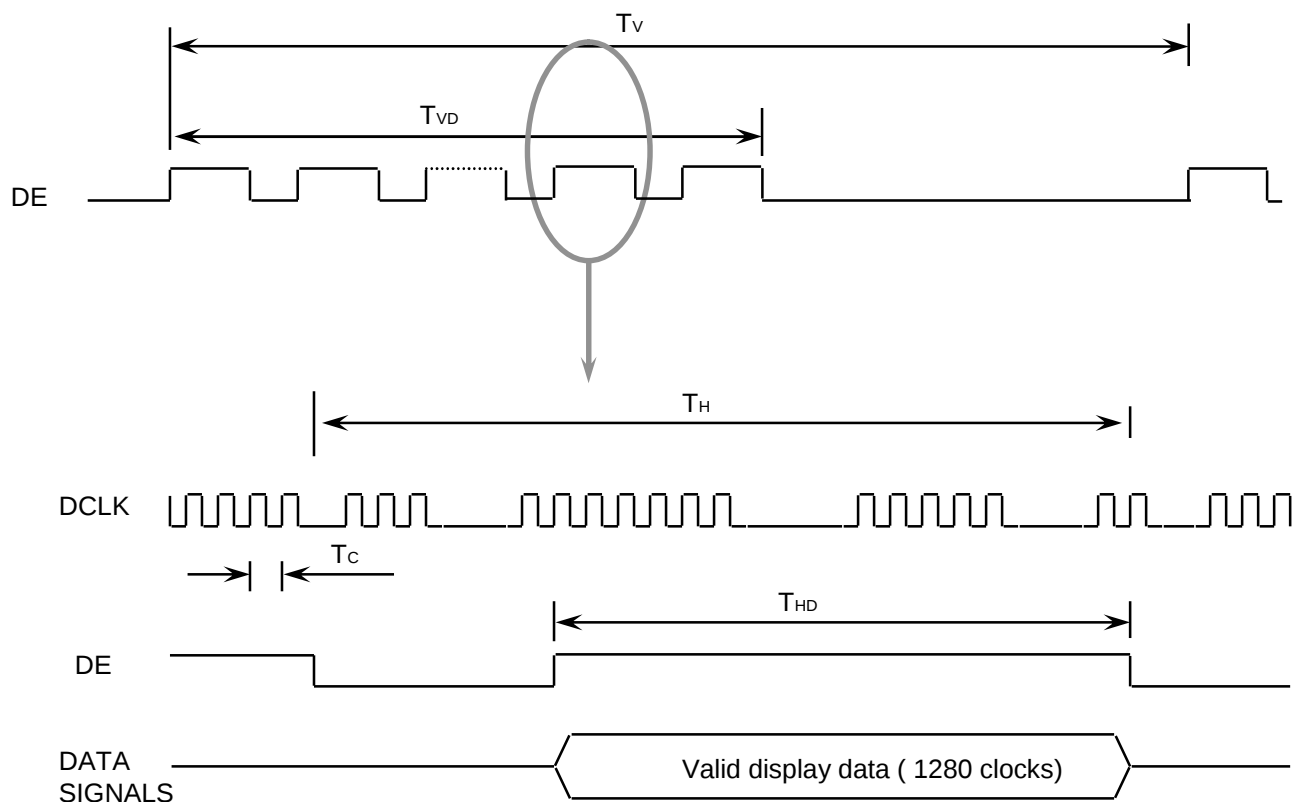
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6. INTERFACE TIMING

6.1 Timing Parameters

Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
Frame Frequency	Cycle	TV	804	816	1000	Lines	
Vertical Active Display Term	Display Period	T _{VD}	-	800	-	Lines	
One Line Scanning Time	Cycle	TH	1350	1400	1550	Clocks	
Horizontal Active Display Term	Display Period	THD	-	1280	-	Clocks	

6.2 Timing diagrams of interface signal

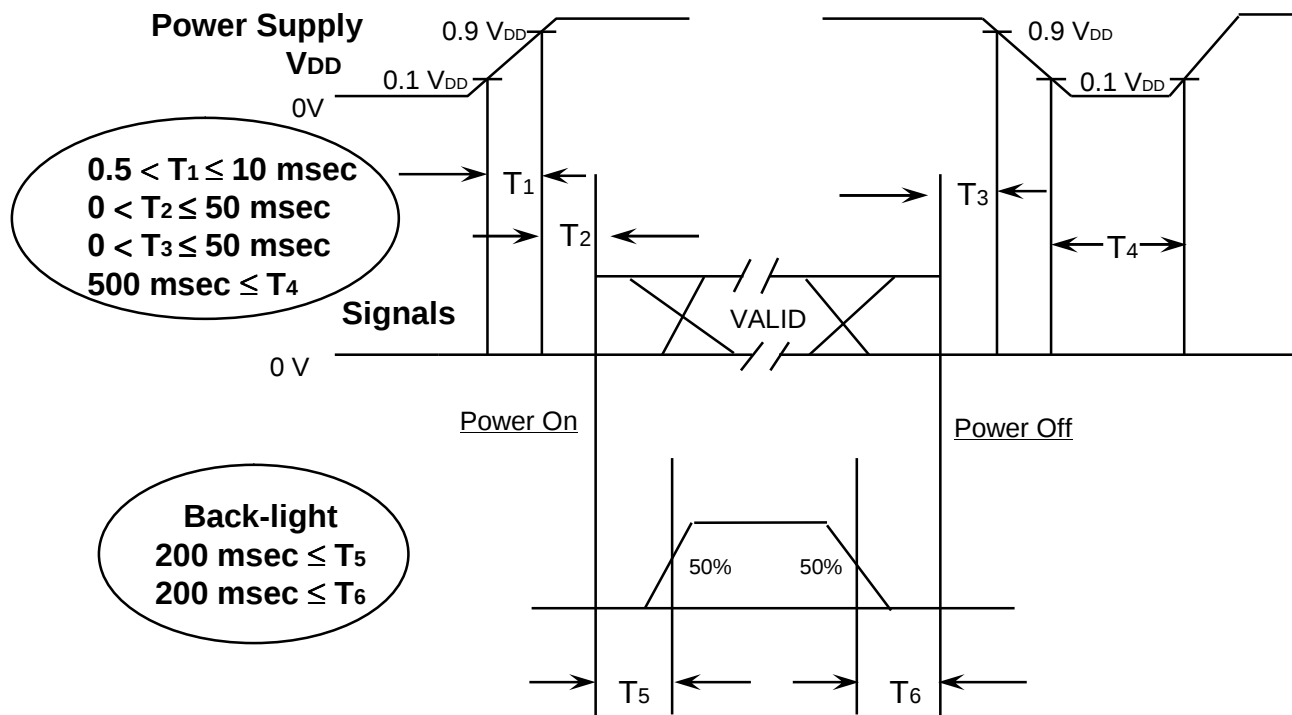


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6.3 Power ON/OFF Sequence

Preliminary

: 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_{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.

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7. Mechanical Outline Dimension

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It will be attached with PDF file

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Preliminary

This page will be replaced with the outline drawing after producing PDF file.

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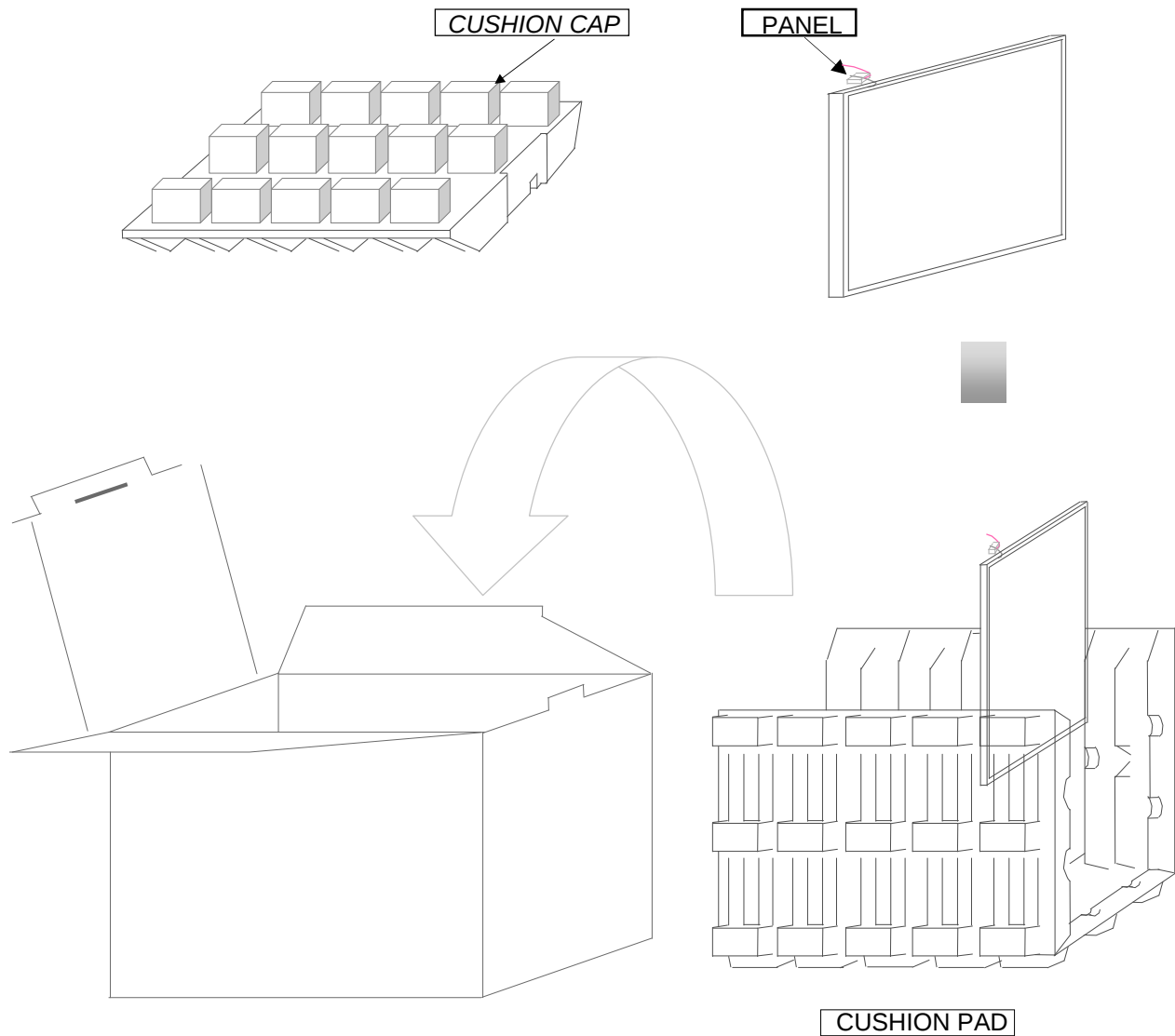
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8. PACKING

Preliminary

1. CARTON(Internal Package)**(1) Packing Form**

Corrugated Cardboard box and Corrupad form as shock absorber

(2) Packing Method

Note 1) Total Weight : Approximately 10 kg

2) Acceptance number of piling : 10 sets

3) Carton size : 408(W) X 325(D) X 295(H)

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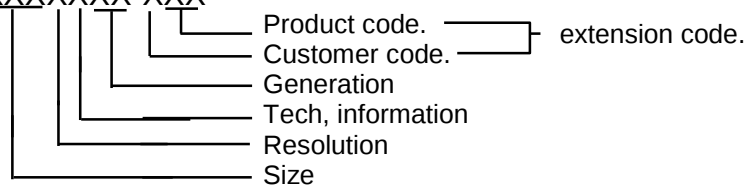
Preliminary

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

9. MARKINGS & OTHERS

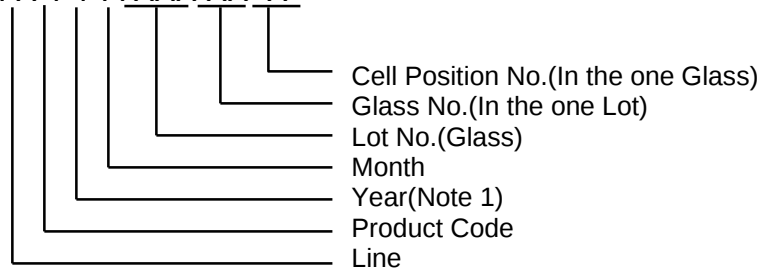
A nameplate bearing followed by is affixed to a shipped product at the specified location on each product.

(1) Parts number : LTNXXXXXXXX-XXX



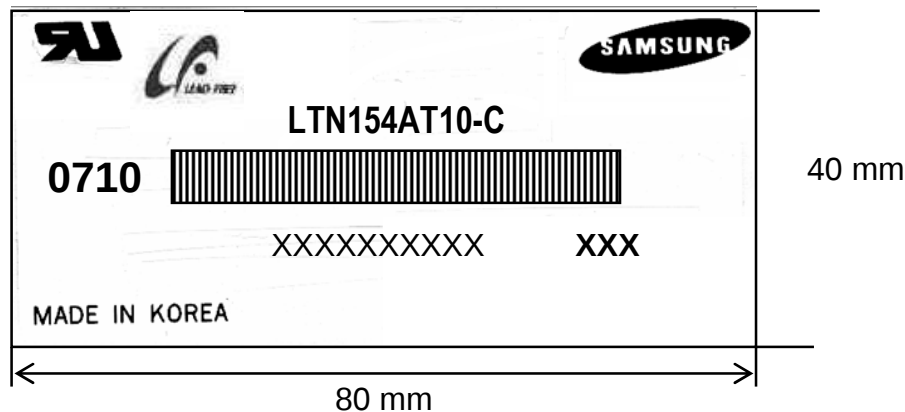
(2) Revision : Three letters

(3) Lot number : X Y 7 A XXX XX X



NOTE 1). This code indicating year is omitted in the products of KIHENG site.

(5) Nameplate Indication(Following example is only for reference)



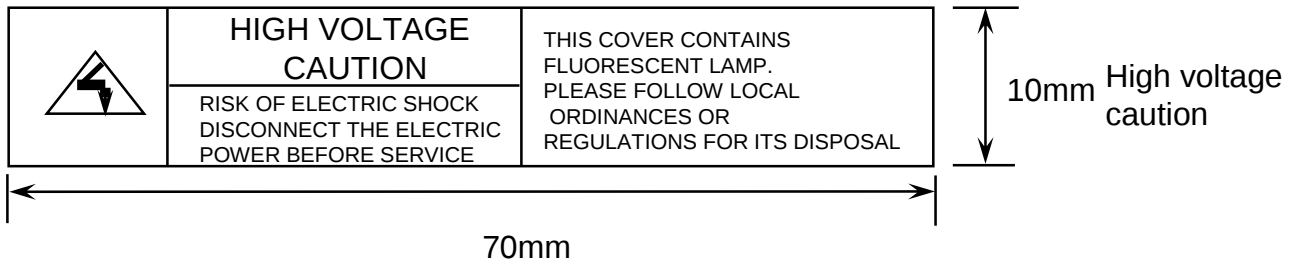
Parts name : LTN154AT10-C
Lot number : XXXXXXXXXXXX
Inspected work week : 0710(2007 year 10th week)
Product Revision Code : XXX

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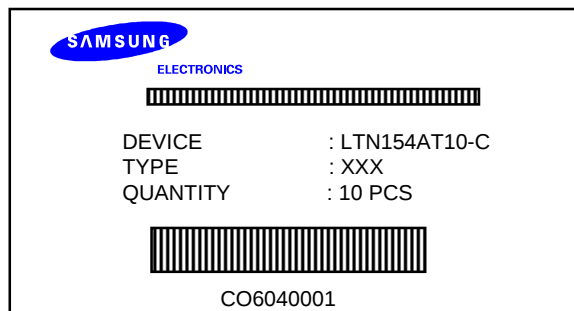
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Preliminary

This HIGH VOLTAGE CAUTION is carved in mold frame



(6) Packing box attach



(7) Packing box Marking : Samsung TFT-LCD Brand Name



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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 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 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.

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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 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).
- (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.

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.

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