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ELECTRONICS

Approval



TO :

DATE : Dec.5. 2008

SAMSUNG TFT-LCD

MODEL NO : LTN156AT01-D

NOTE : Extension code [-D]
→ LTN156AT01-D
Surface type [Glare]

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

APPROVED BY :

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PREPARED BY : **Mobile Division, Application Engineering Part**

SAMSUNG ELECTRONICS CO., LTD.



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GENERAL DESCRIPTION

DESCRIPTION

LTN156AT01-D is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as switching devices. This model is composed of a TFT LCD panel, a driver circuit and a backlight system. The resolution of a 15.6" contains 1366 x 768 pixels and can display up to 262,144 colors. 6 O'clock direction is the Optimum viewing angle.

FEATURES

- Thin and light weight
- High contrast ratio, high aperture structure
- 1366 x 768 pixels resolution (16:9)
- Fast Response Time
- Low power consumption
- DE (Data enable) only mode
- 3.3V LVDS Interface
- On board EDID chip
- Pb-free product
- RoHS compliance

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	344.232 (H) x 193.536 (V) (15.6"diagonal)	mm	
Driver element	a-Si TFT active matrix		
Display colors	262,144		
Number of pixel	1366 x 768	pixel	16 : 9
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.252 (H) x 0.252 (V) (TYP.)	mm	
Display Mode	Normally white		
Surface treatment	Haze 0, Hardness 3H		Glare

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Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal (H)	358.8	359.3	359.8	mm	
	Vertical (V)	209.0	209.5	210	mm	
	Depth (D)	-	-	6.2	mm	(1)
Weight		-	500	520	g	

Note (1) Measurement condition of outline dimension

- . Equipment : Vernier Calipers
- . Push Force : 500g · f (minimum)

1. ABSOLUTE MAXIMUM RATINGS

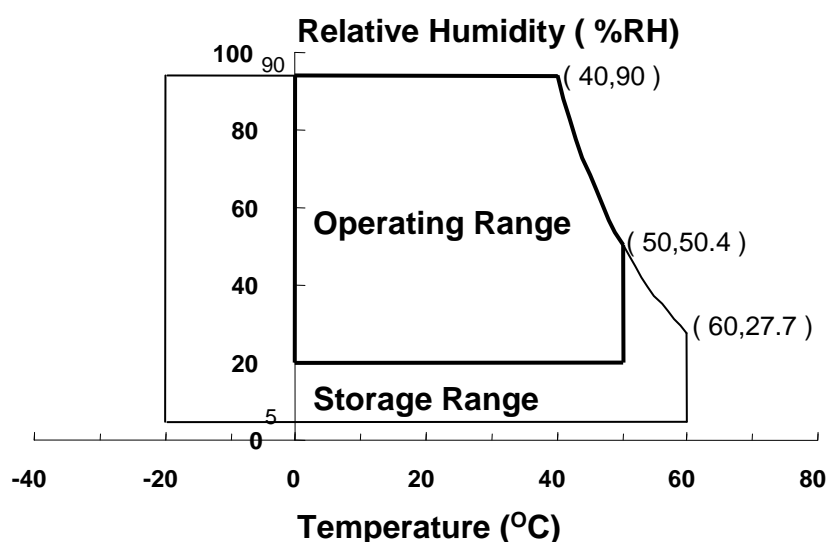
1.1 ENVIRONMENTAL ABSOLUTE RATINGS

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	2.0	6.5	mA	(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.

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2. OPTICAL CHARACTERISTICS

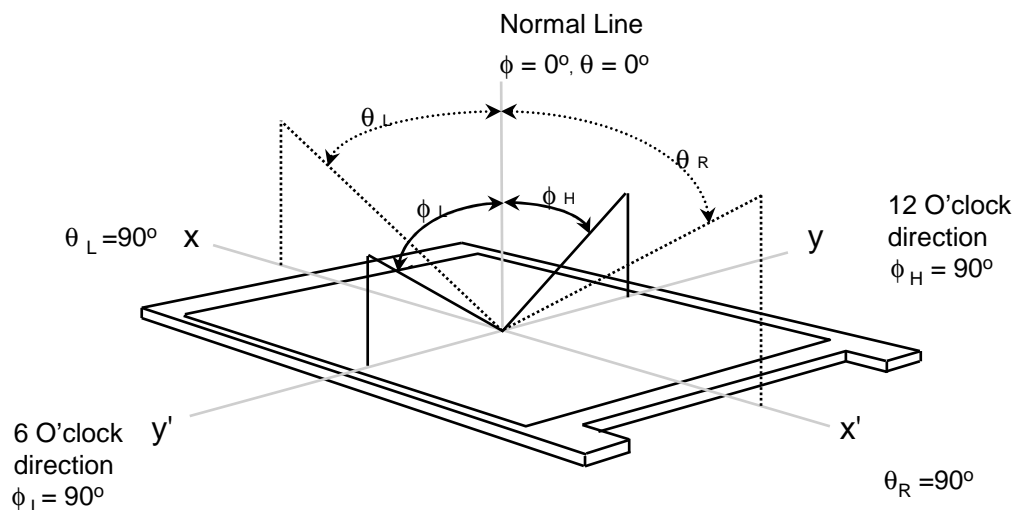
The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (5).
Measuring equipment : TOPCON SR-3

* Ta = 25 ± 2 °C, V_{DD}=3.3V, f_V= 60Hz, f_{DCLK} = 72.33 MHz, I_L = 6.5 mA

Item		Symbol	Condition	Min.	Typ.	Max	Unit	Note
Contrast Ratio (5 Points)		CR	Normal Viewing Angle ϕ = 0 θ = 0	500	600	-	-	(1), (2), (5)
Response Time at Ta (Rising + Falling)		T _{RT}		-	25	35	msec	(1), (3)
Average Luminance of White (5 Points)		Y _{L,AVE}		200	220	-	cd/m ²	I _L =6.0 mA (1), (4)
Color Chromaticity (CIE)	Red	R _X		0.609	0.629	0.649	-	
		R _Y		0.313	0.333	0.353		
	Green	G _X		0.272	0.292	0.312		
		G _Y		0.560	0.580	0.600		
	Blue	B _X		0.140	0.160	0.180		
		B _Y		0.076	0.096	0.116		
	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	(1), (5) SR-3
		θ _R		40	-	-		
	Ver.	ϕ _H		15	-	-		
		ϕ _L		30	-	-		
Color Gamut				-	60	-	%	
13 Points White Variation		δ _L		-	-	1.7	-	(6)

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

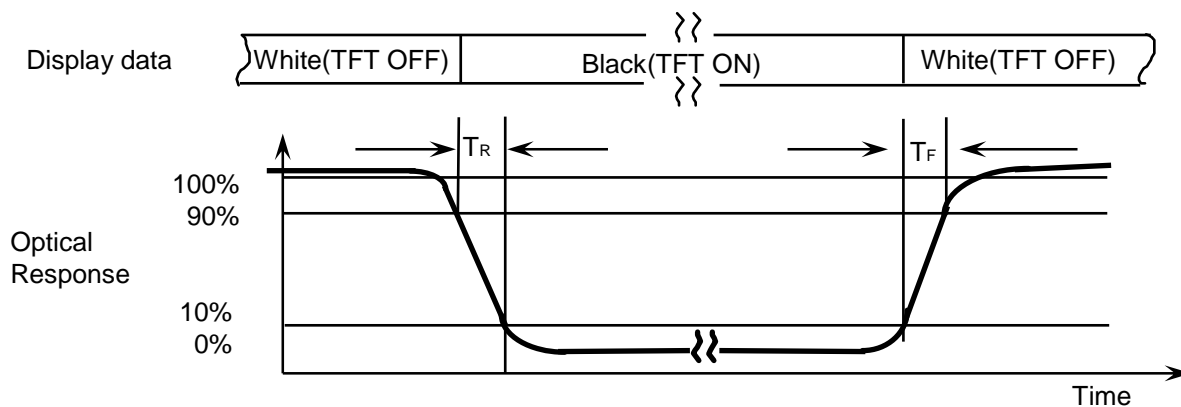


Note 2) Definition of Contrast Ratio (CR) : Ratio of gray max (Gmax), gray min (Gmin) at 5 points(4, 5, 7, 9, 10)

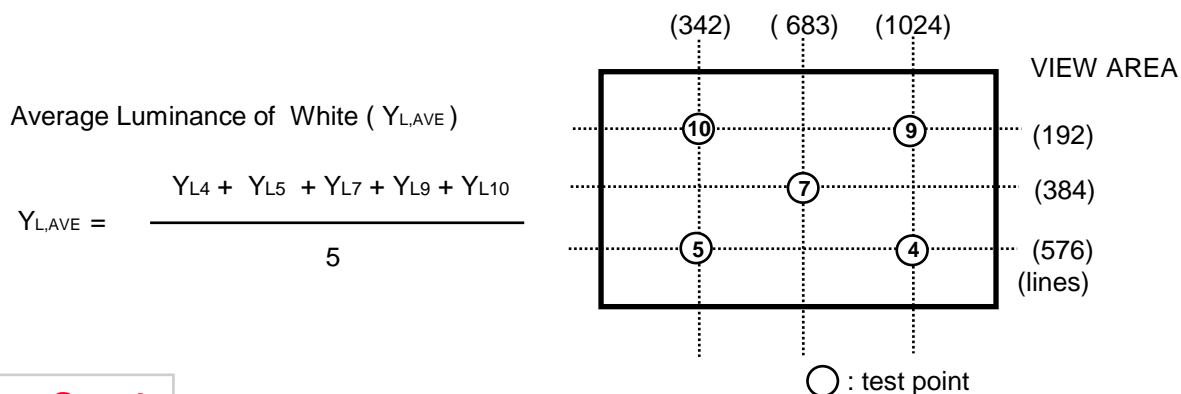
$$CR = \frac{CR(4) + CR(5) + CR(7) + CR(9) + CR(10)}{5}$$

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

Note 3) Definition of Response time :

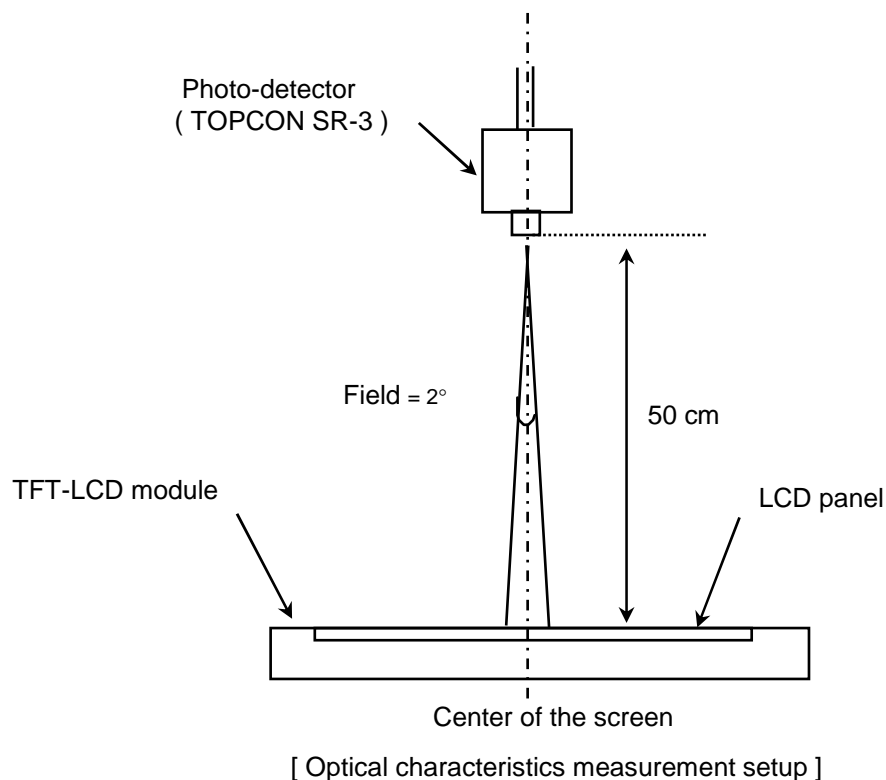


Note 4) Definition of Average Luminance of White : measure the luminance of white at 5 points.



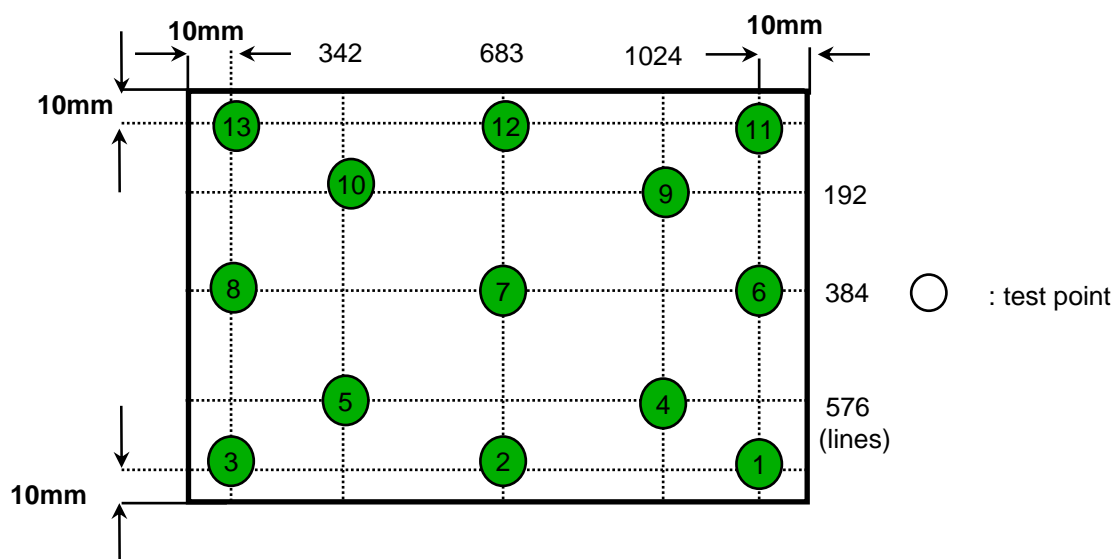
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Note 5) After stabilizing and leaving the panel alone at a given temperature for 30 min , the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30 min after lighting the backlight. This should be measured in the center of screen.
 Lamp current : 6.5 mA (Inverter : SI1700)
 Environment condition : $T_a = 25 \pm 2 \text{ }^{\circ}\text{C}$



Note 6) Definition of 13 points white variation (δL), [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

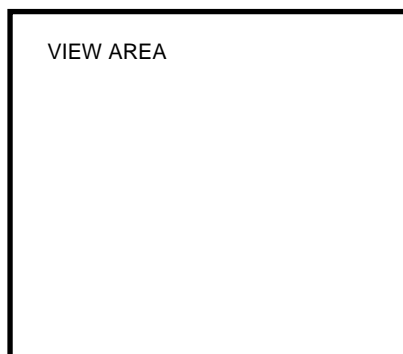
Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V _{DD}	3.0	3.3	3.6	V	
Differential Input Voltage for LVDS Receiver Threshold	High	V _{IH}	-	-	+100	mV	V _{CM} = +1.2V
	Low	V _{IL}	-100	-	-	mV	
Vsync Frequency		f _V	-	60	-	Hz	
Hsync Frequency		f _H	-	47.4	-	KHz	
Main Frequency		f _{DCLK}	67.5	72.33	80	MHz	
Rush Current		I _{RUSH}	-	-	1.5	A	(4)
Current of Power Supply	White	I _{DD}	-	360	-	mA	(2),(3)*a
	Mosaic		-	420	-	mA	(2),(3)*b
	V. Stripe		-	530	600	mA	(2),(3)*c

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

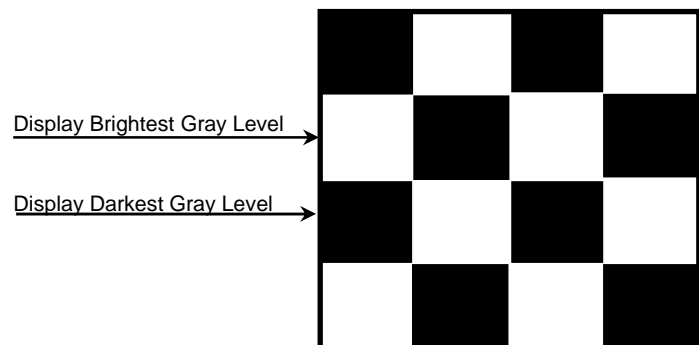
(2) f_V = 60Hz, f_{DCLK} = 72.33 MHz, V_{DD} = 3.3V , DC Current.

(3) Power dissipation pattern

*a) White Pattern

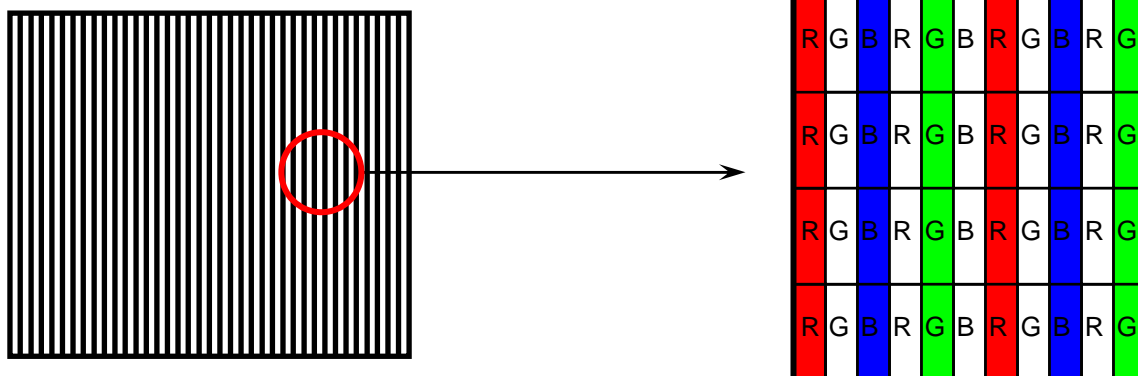


*b) Mosaic Pattern

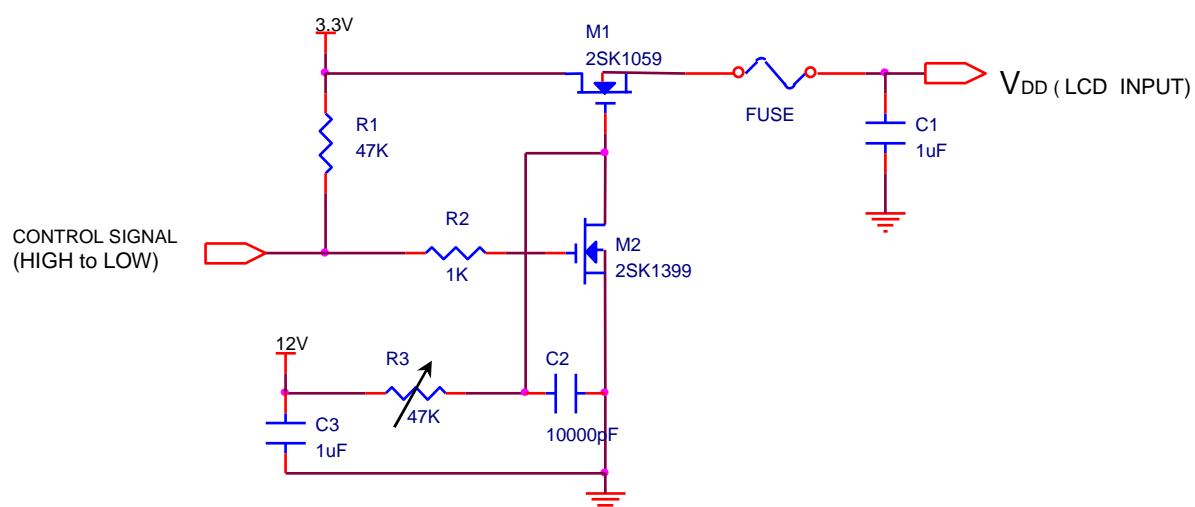


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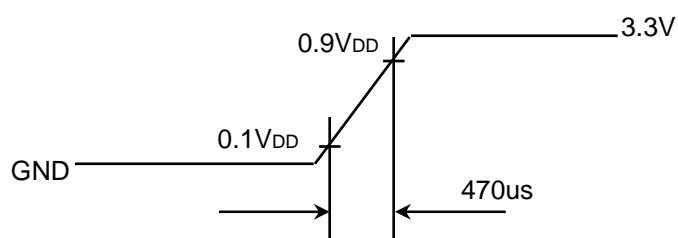
*c) 1dot Vertical stripe pattern



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 CCFL (Cold Cathode Fluorescent Lamp).
The characteristics of a single lamp are shown in the following tables.

- INVERTER : (SEM SI 1700)

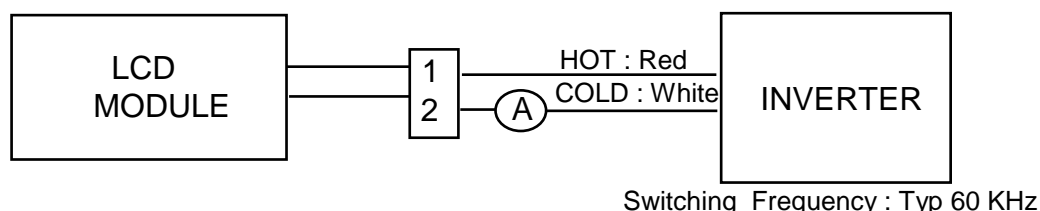
Ta= 25 ± 2 °C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Lamp Current	I _L	3.0	6.0	6.5	mArms	(1)
Lamp Voltage	V _L	-	705	-	Vrms	I _L =6.0mA
Frequency	f _L	48	60	65	KHz	(2)
Power Consumption	P _L	-	4.5	-	W	(3) I _L =6.0mA
Operating Life Time	Hr	15,000	-	-	Hour	(4)
Startup Voltage	V _s	-	-	1300	Vrms	25°C, (5)
				1480	Vrms	0°C, (5)
Lamp startup time		-	-	1.0	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 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.



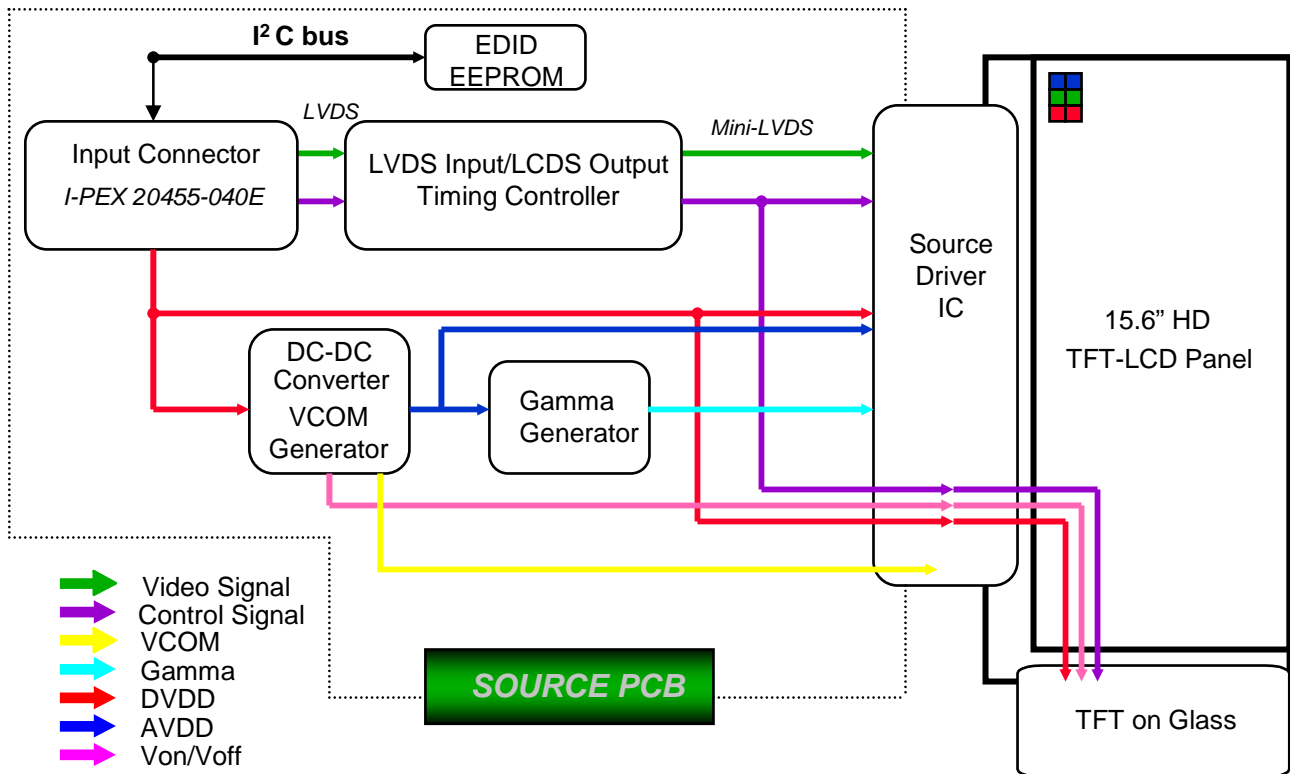
- (2) Lamp frequency may produce interference with horizontal synchronous frequency and this may cause line flow on the display. Therefore lamp frequency should be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.
- (3) Refer to I_L × 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 Ta= 25 ± 2 °C and I_L = 6.5 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.)
- (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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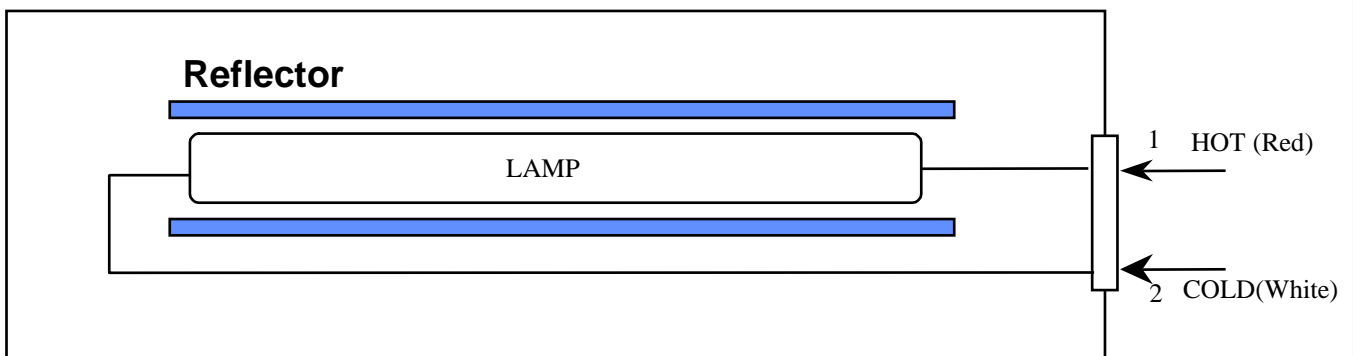
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4. BLOCK DIAGRAM

4.1 TFT LCD Module



4.2 BACK-LIGHT 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 : UJU IS100-L30R-C15 or compatible)
Mating Connector : JAE FI-X30M or compatible)

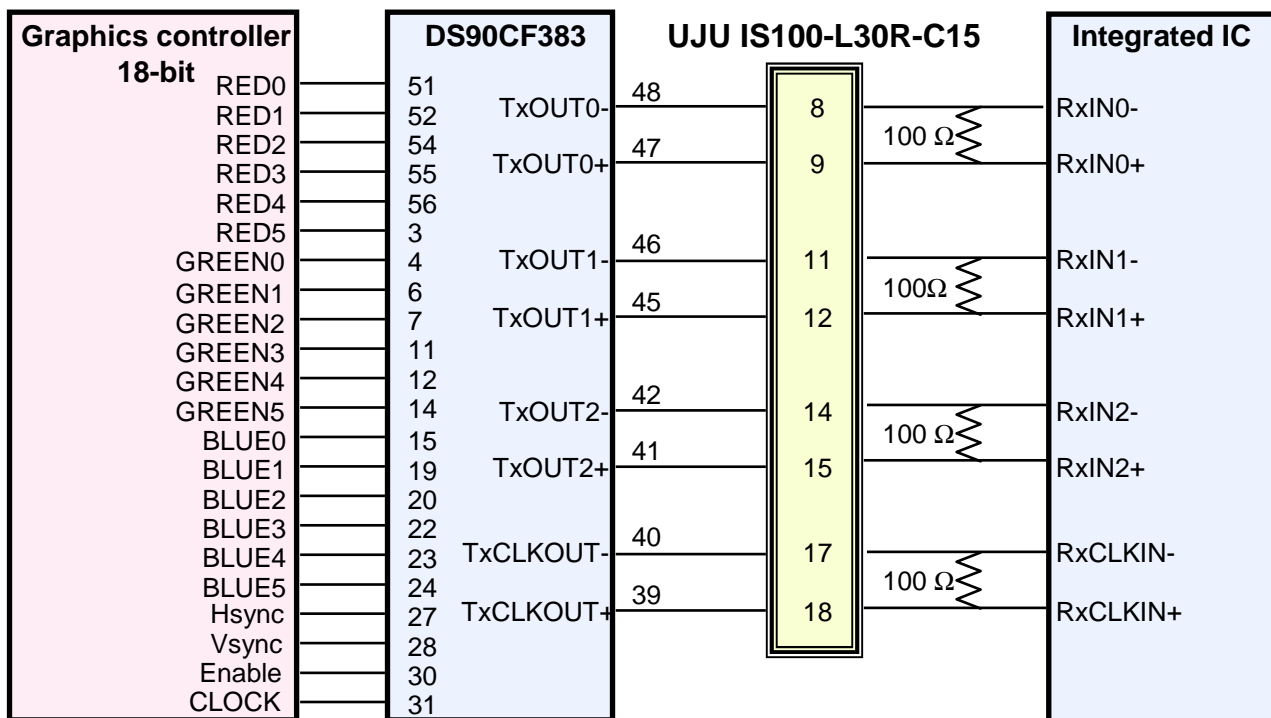
PIN NO	SYMBOL	FUNCTION	POLARITY	REMARK
1	VSS	Ground		
2	VDD	POWER SUPPLY +3.3V		
3	VDD	POWER SUPPLY +3.3V		
4	VEEDID	DDC 3.3V Power		
5	TEST	Panel Self Test		
6	CLKEDID	DDC Clock		
7	DATAEDID	DDC data		
8	RxIN0-	LVDS Differential Data INPUT (R0-R5,G0)	Negative	
9	RxIN0+	LVDS Differential Data INPUT (R0-R5,G0)	Positive	
10	VSS	Ground		
11	RxIN1-	LVDS Differential Data INPUT (G1-G5,B0-B1)	Negative	
12	RxIN1+	LVDS Differential Data INPUT (G1-G5,B0-B1)	Positive	
13	VSS	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	RxCLK-	LVDS Differential Data INPUT (Clock)	Negative	
18	RxCLK+	LVDS Differential Data INPUT (Clock)	Positive	
19	VSS	Ground		
20	NC	No Connection		
21	NC	No Connection		
22	NC	No Connection		
23	NC	No Connection		
24	NC	No Connection		
25	NC	No Connection		
26	NC	No Connection		
27	NC	No Connection		
28	NC	No Connection		
29	NC	No Connection		
30	NC	No Connection		

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5.2 LVDS Interface : Transmitter DS90CF363 or Compatible

Pin No.	Name	RGB Signal	Pin No.	Name	RGB Signal
51	TxIN0	R0	14	TxIN14	G5
52	TxIN1	R1	15	TxIN15	B0
54	TxIN2	R2	19	TxIN18	B1
55	TxIN3	R3	20	TxIN19	B2
56	TxIN4	R4	22	TxIN20	B3
3	TxIN6	R5	23	TxIN21	B4
4	TxIN7	G0	24	TxIN22	B5
6	TxIN8	G1	27	TxIN24	Hsync
7	TxIN9	G2	28	TxIN25	Vsync
11	TxIN12	G3	30	TxIN26	DE
12	TxIN13	G4	31	TxCLKIN	Clock

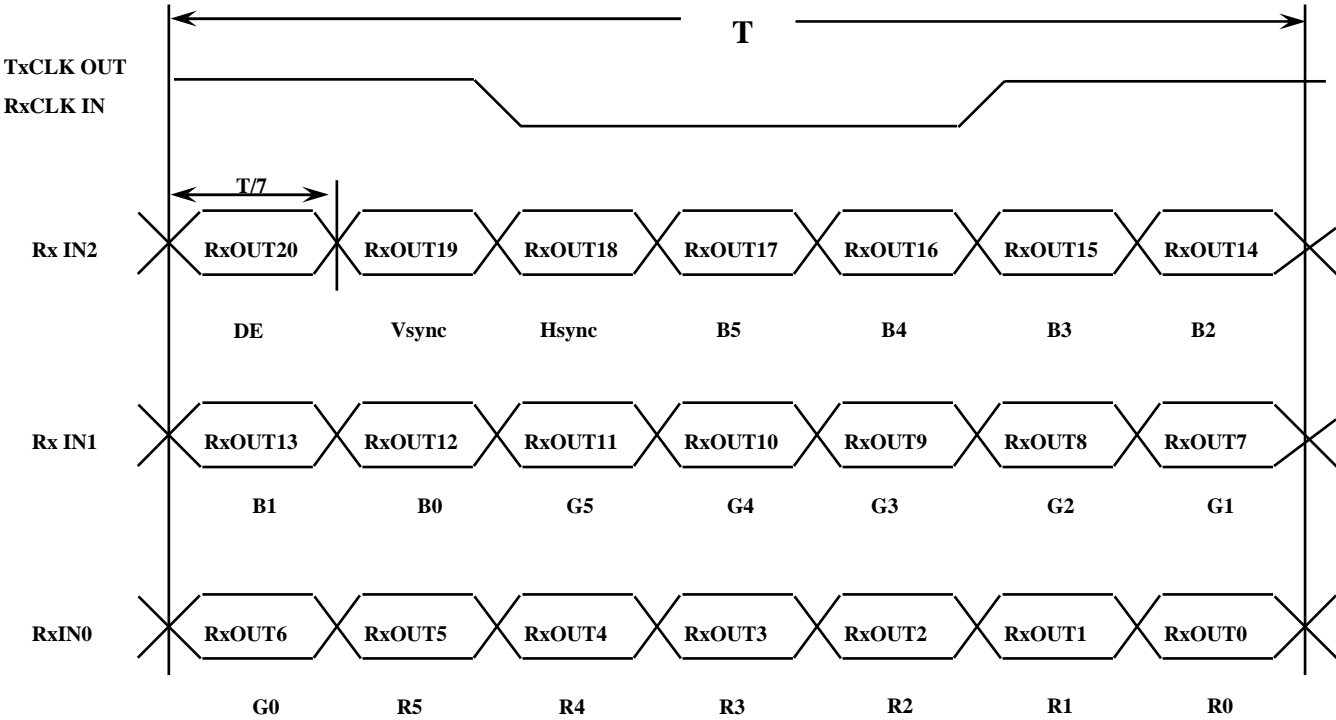
LVDS INTERFACE

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

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5.3 Timing Diagrams of LVDS For Transmission

LVDS Receiver : Integrated T-CON



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5.4 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

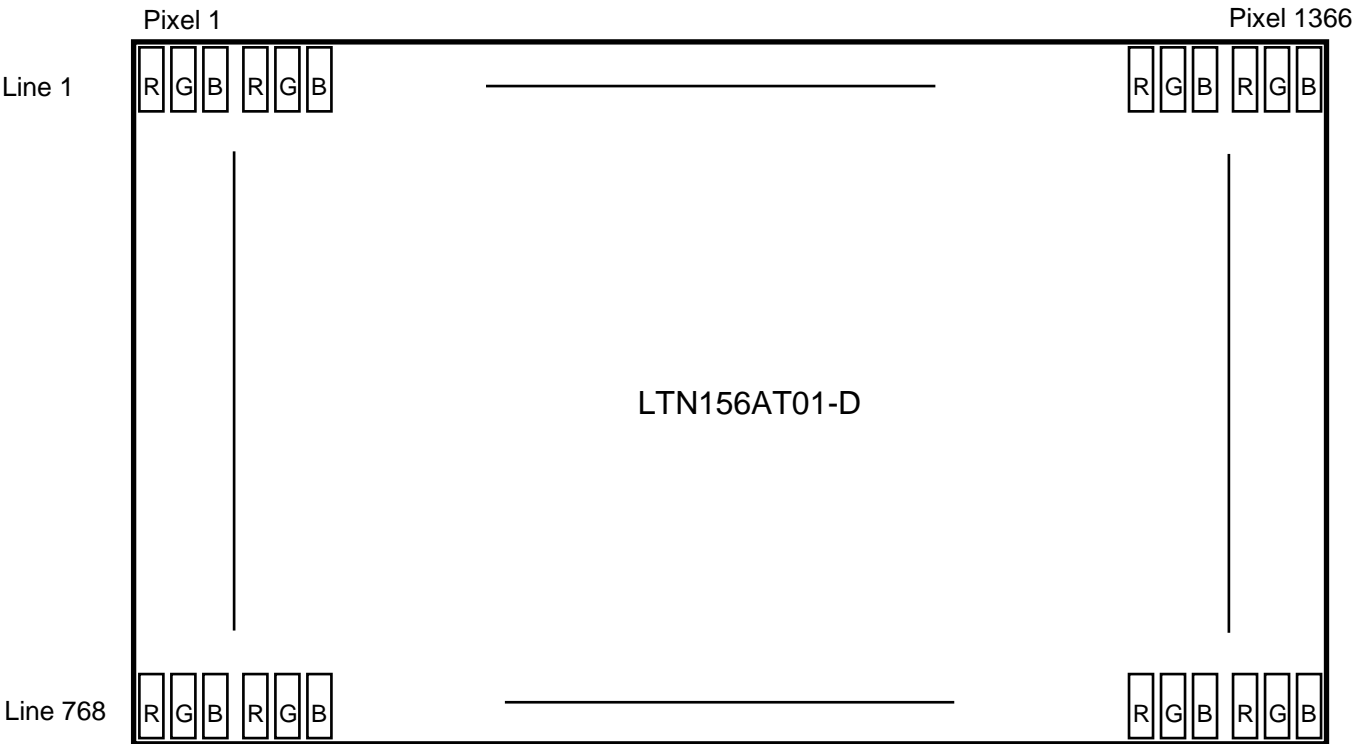
Note 1) Definition of gray :

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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5.5 Pixel Format in the display



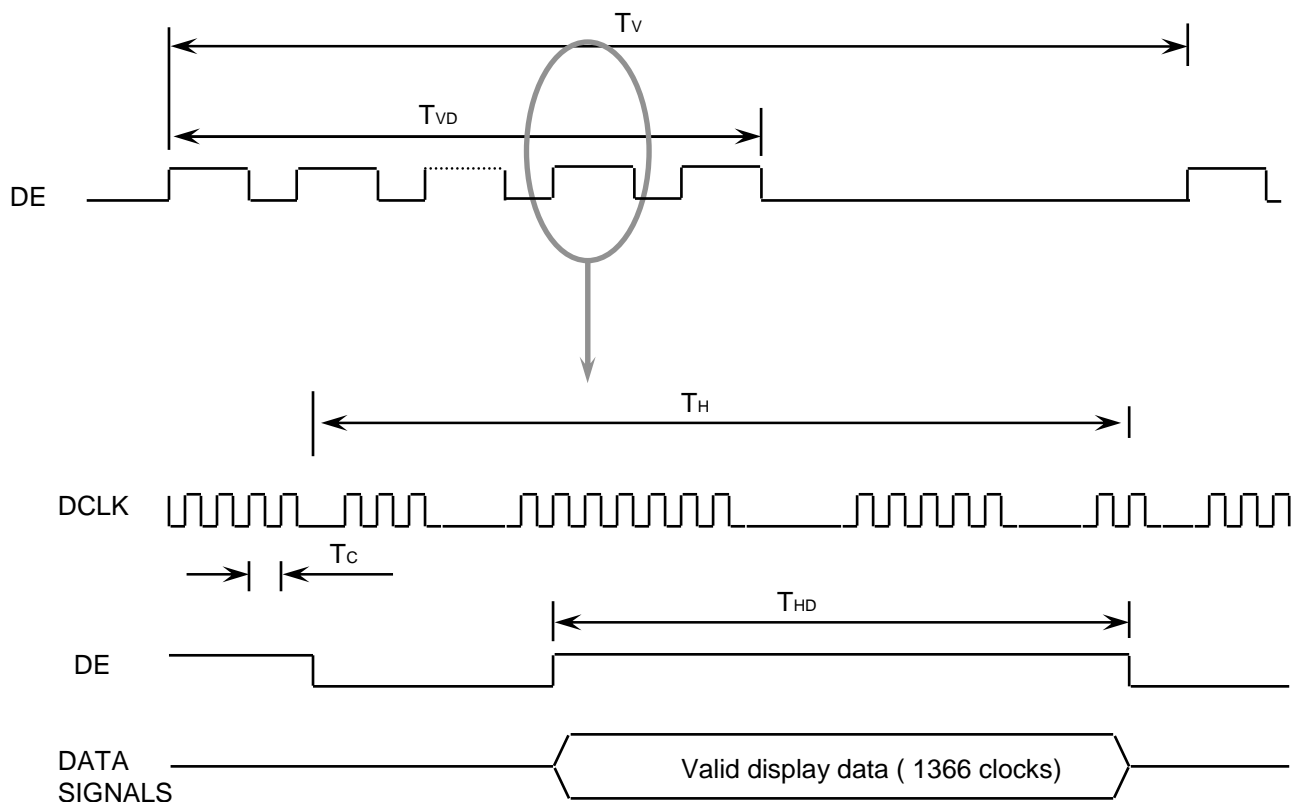
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6. INTERFACE TIMING

6.1 Timing Parameters

Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
Frame Frequency	Cycle	TV	773	790	1000	Lines	-
Vertical Active Display Term	Display Period	TVD	-	768	-	Lines	-
One Line Scanning Time	Cycle	TH	1406	1526	1750	Clocks	-
Horizontal Active Display Term	Display Period	THD	-	1366	-	Clocks	-

6.2 Timing diagrams of interface signal

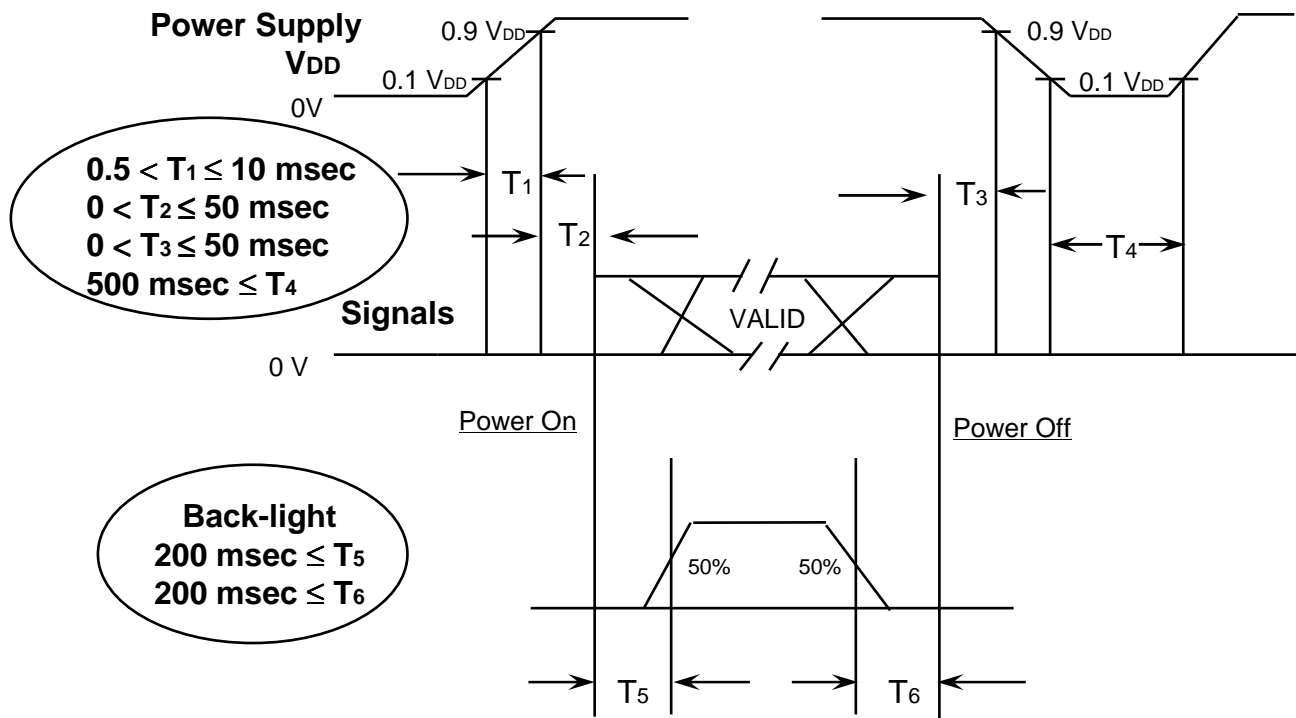


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6.3 Power ON/OFF Sequence

Approval

: 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 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.

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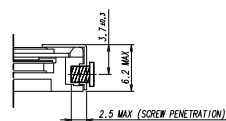
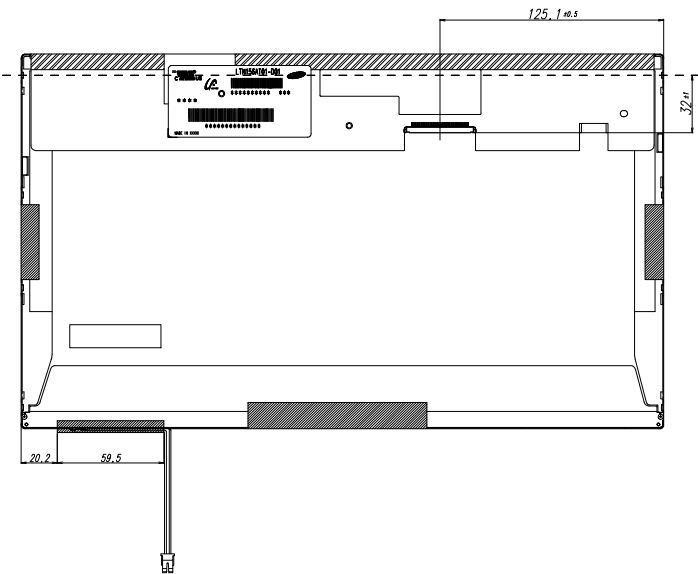
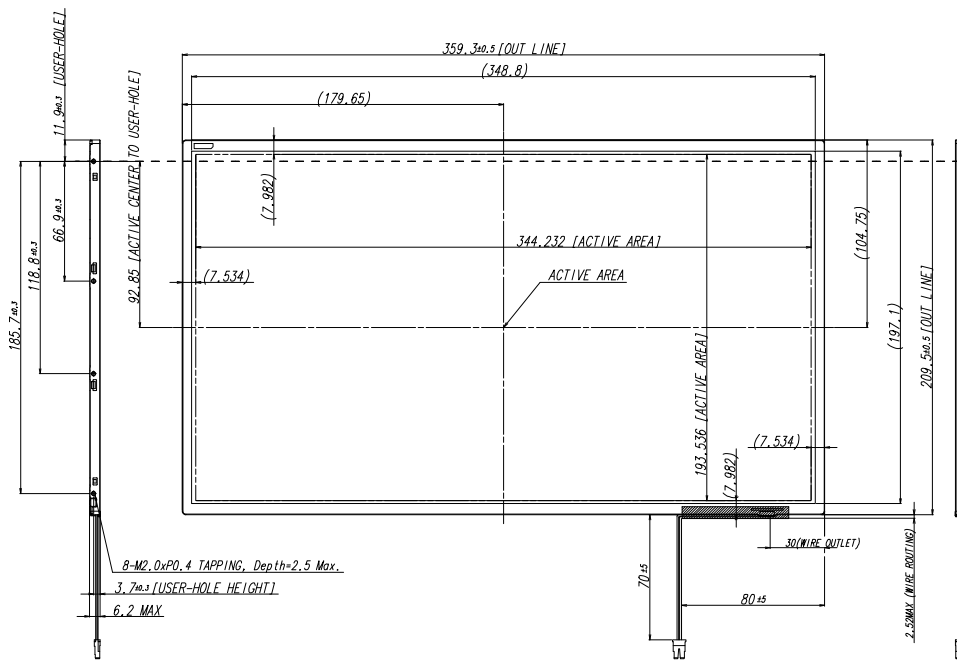
7. MECHANICAL OUTLINE DIMENSION

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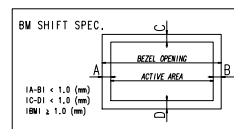
Please refer to the next page.

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<USER HOLE SCREW PENETRATION DEPTH>



* NOTE

1. SIGNAL INTERFACE CONNECTOR TO BE SPECIFIED AS BELOW.
- MAKER : UJU OR COMPATIBLE
- INPUT CONNECTOR : UJU IS100-L30R-L15
2. LAMP CONNECTOR FOR BACKLIGHT TO BE SPECIFIED AS BELOW.
- MAKER : JST (TBD)
- PART NO : BHSR-02VS-1 (TBD)
- LAMP DIAMETER : $\phi 2.0$
3. ALLOWED DEPTH OF USERHOLE SCREW INSERTION IS MAX 2.5mm
4. TORQUE SPEC : MAX 2.5 Kgf-cm (5TIMES)
5. CALIFERS MEASURING FORCE : 750 150 gf
6. WEIGHT : TYP 500, MAX 520 g (TBD)

Approval

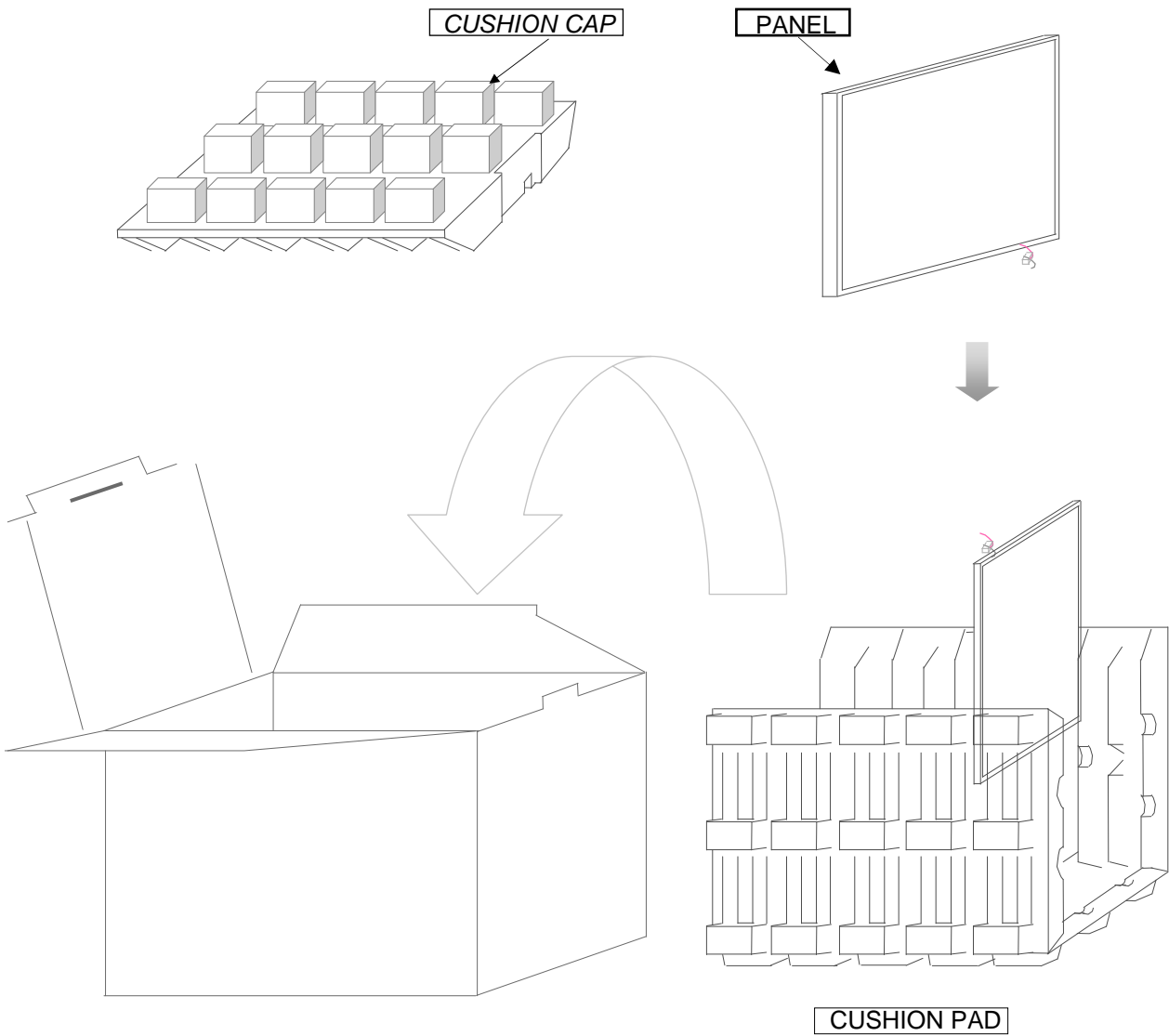
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003	10/10/2008	DESIGN CHANGE		
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8. PACKING

Approval

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 : 20 sets
3) Carton size : 344(W) x 432(D) x 329(H)

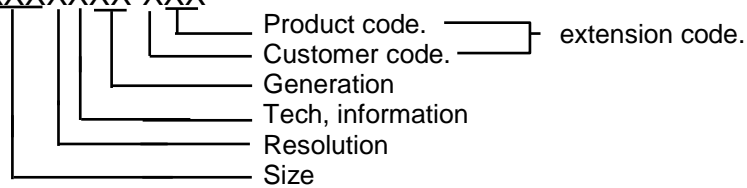
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No	Part name	Quantity
1	Static electric protective sack	20
2	Packing case (Inner box) included shock absorber	1 set
3	Pictorial marking	2 pcs
4	Carton	1 set

9. MARKINGS & OTHERS

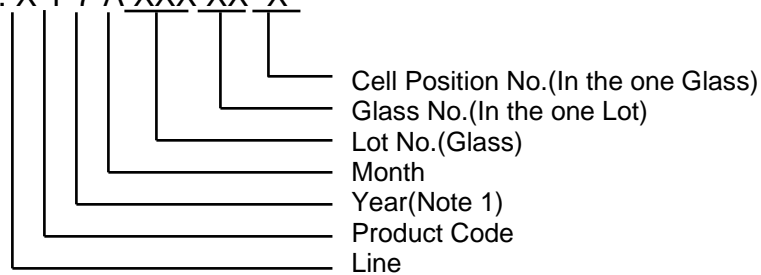
A nameplate bearing followed by is affixed to a shipped product at the specified location on each product.

(1) Parts number : LTNXXXXXXXX-XXX



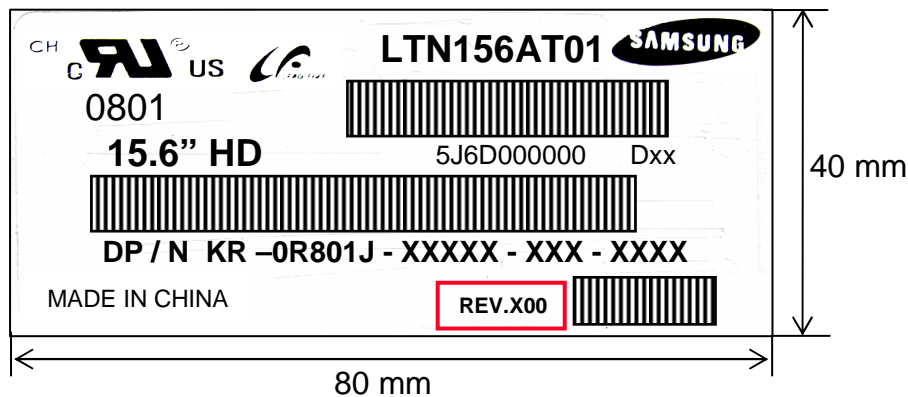
(2) Revision : Three letters

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



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

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



Parts name : LTN156AT01-D
Lot number : 5J6D000000
Inspected work week : 0801 Number ("0R801J" is for 156AT01-D)
DP/N : Part Number for other customer
REV.X00 : Product Revision Code

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