



ELECTRONICS

# Product Information

**ISSUE DATE : 2000-06-14**

**MODEL : LTM170E4-L01**

Note : This Product information is subject to change after 3 months of issuing date

Prepared by AMLCD Application Engineering Group

**Samsung Electronics Co . , LTD.**

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## General Description

### \* Description

LTM170E4-L01 is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFTs as a switching devices. This model is composed of a TFT LCD panel, a driver circuit and a back-light system. The resolution of a 17.0" contains 1280 x 1024 pixels and can display up to 16.7 million colors with wide viewing angle of 80° or higher in all directions. (Vertical viewing angle : 160° , Horizontal viewing angle : 160°)

### \* Features

- High contrast ratio, high aperture structure
- CE(Coplanar Electrode) mode
- Wide viewing angle
- High speed response
- SXGA(1280 x 1024 pixels) resolution
- Low power consumption
- 2 dual CCFT(Cold Cathode Fluorescent Tube)
- DE only mode
- LVDS(Low Voltage Differential Signaling) interface

### \* Applications

Workstation & desktop monitors

Display terminals for AV application products

Monitors for industrial machine

### \* General information

Items	Specification	Unit	Note
Display area	337.92(H) x 270.336(V)	mm	
Driver element	a-Si TFT active matrix		
Display colors	16.7M	colors	
Number of pixels	1280 x 1024	pixel	
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.264(H) x 0.264(W)	mm	
Display mode	Normally Black		
Surface treatment	Haze 25% , Hard-coating (3H)		

**\* Mechanical information**

Item		Min.	Typ.	Max.	Note
Module size	Horizontal(H)	-	383.5	-	mm
	Vertical(V)	-	306.0	-	mm
	Depth(D)	-	-	22.8	mm
Weight		-	2300	-	g

**1. Absolute Maximum Ratings**

1.1 Absolute ratings of environment

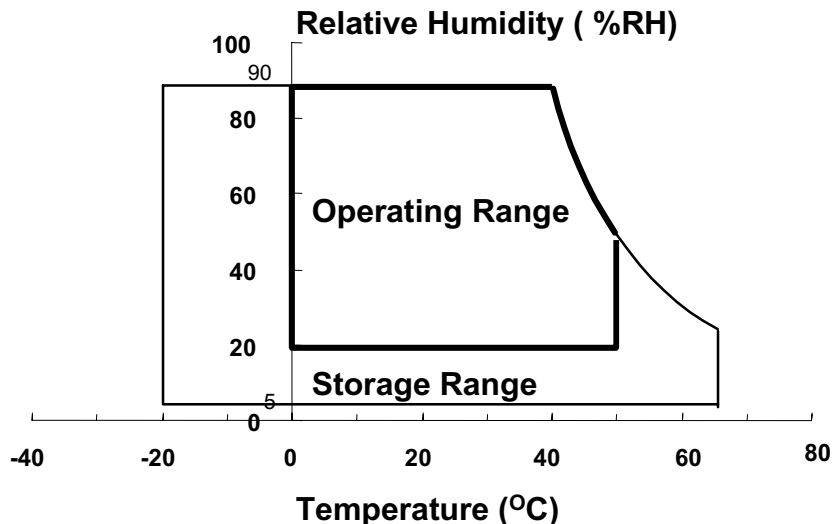
Item	Symbol	Min.	Max.	Unit	Note
Storage temperature	T <sub>STG</sub>	-20	65	°C	(1)
Operating temperature (Ambient temperature)	T <sub>OPR</sub>	0	50	°C	(1)
Shock ( non - operating )	Snop	-	50	G	(2),(4)
Vibration ( non - operating )	Vnop	-	1.5	G	(3),(4)

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) 11ms, sine wave, one time for ±X, ±Y, ±Z axis
- (3) 10-300 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<sub>ss</sub> = GND = 0 V)

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	VDD	V <sub>ss</sub> -0.5	6.5	V	(1)

NOTE (1) Within Ta ( 25 ± 2 °C)

### (2) BACK-LIGHT UNIT

(Ta = 25 ± 2°C)

Item	Symbol	Min.	Max.	Unit.	Note
Lamp Current	IL	2.0	7.0	mArms	(1),(2)
Lamp Frequency	fL	30	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) Specified values are for a single lamp (Refer to the Note (1) in the page 11 for further information).

## 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 (1).

Measuring equipment : TOPCON BM-5A , BM-7, PHOTO RESEARCH PR650

\*  $T_a = 25 \pm 2^\circ\text{C}$  ,  $V_{DD}=5\text{V}$ ,  $f_v= 60\text{Hz}$ ,  $f_{DCLK}=54 \text{ MHz}$ ,  $I_L = 6.5 \text{ mArms}$

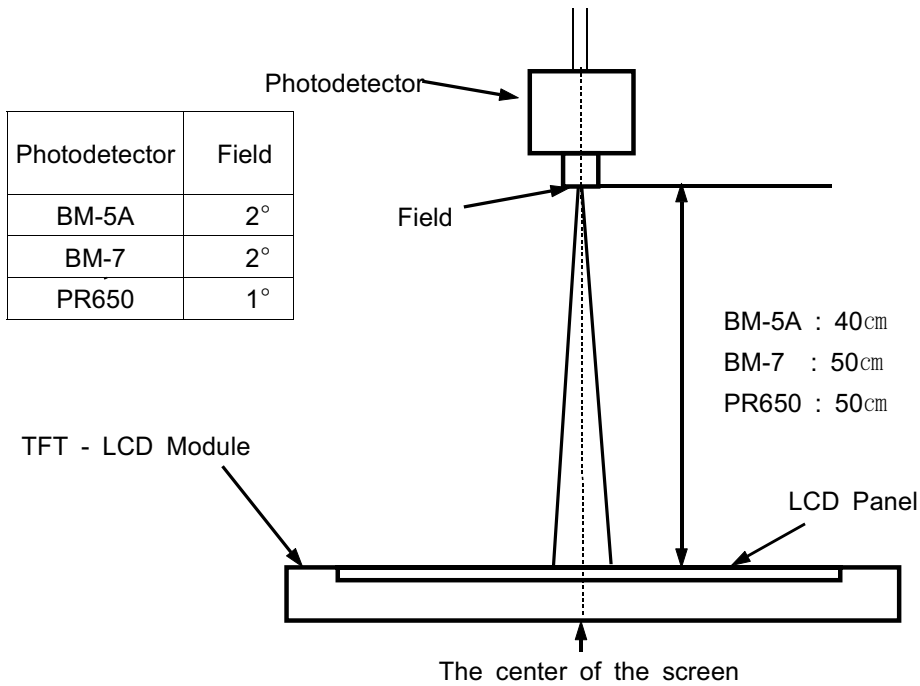
Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio (Center of screen)		C/R	Normal $\phi = 0$ $\theta = 0$	-	300	-		(3) BM-5A
Response Time	Rising	Tr		-	20	-	msec	(4)
	Falling	Tf		-	15	-		BM-7
Luminance of White (Center of screen)		YL		-	200	-	cd/m <sup>2</sup>	(5) BM-5A
Color Chromaticity (CIE 1931)	Red	Rx		Viewing Angle	-	TBD	-	
		Ry						
	Green	Gx						
		Gy						
	Blue	Bx						
		By						
White	Wx	TBD (0.312)						
	Wy	TBD (0.335)						
Viewing Angle	Hor.	$\theta_L$	$CR \geq 10$	-	80	-	Degrees	(7) BM-5A
		$\theta_R$		-	80	-		
	Ver.	$\phi_H$		-	80	-		
		$\phi_L$		-	80	-		

Note 1) Test Equipment Setup

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 back-light. This should be measured in the center of screen.

Single lamp current : 6.5mA (Refer to the note(1) in the page 11 for more information.)

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



Optical Measuring Equipment Setup

Note 2) Definition of test point



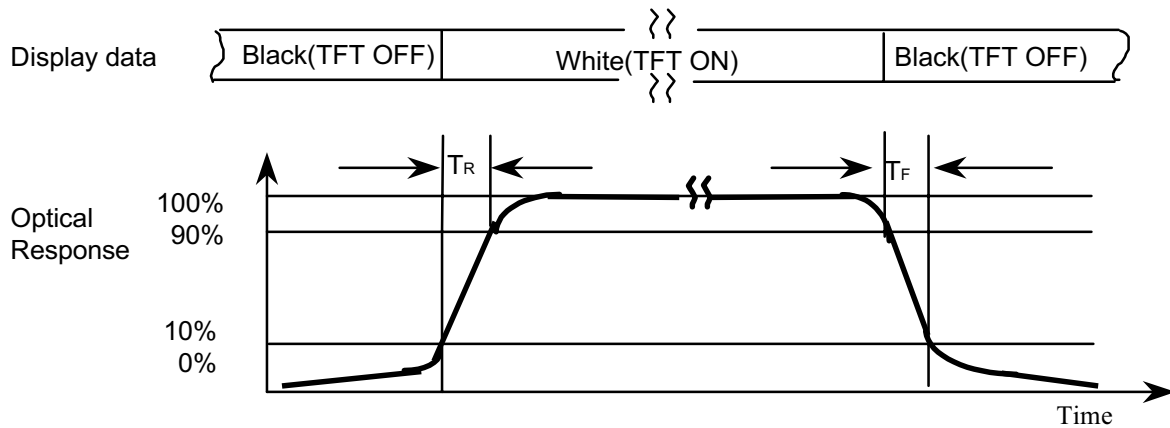
Note 3) Definition of Contrast Ratio (C/R) : Ratio of gray max (Gmax) & gray min (Gmin) at the center point(5) of the panel

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

Gmax : Luminance with all pixels white

Gmin : Luminance with all pixels black

Note 4) Definition of Response time : Sum of  $T_r$ ,  $T_f$

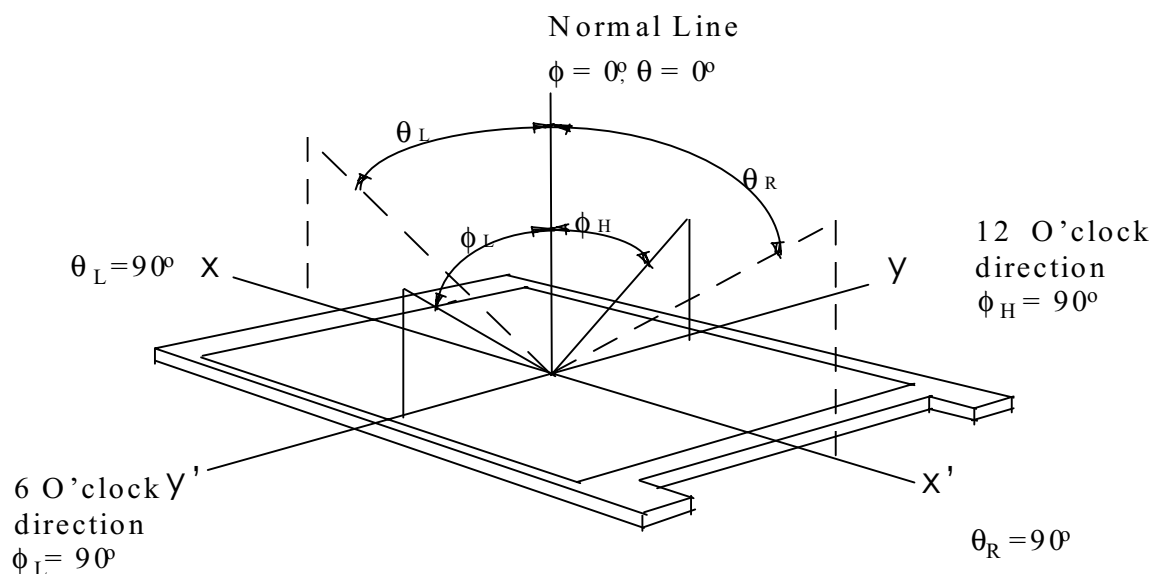


Note 5) Definition of Luminance of White : Luminance of white at center point(5).

Note 6) Definition of Color Chromaticity (CIE 1931)

Color coordinate of Red , Green , Blue & White at center point(5).

Note 7) Definition of Viewing Angle : Viewing angle range ( $CR \geq 10$  )





### 3. Electrical Characteristics

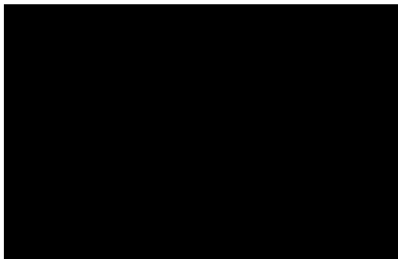
#### 3.1 TFT LCD MODULE

Ta = 25°C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply	VDD	4.5	5.0	5.5	V	
Current of Power Supply	Black	-	600	-	mA	(1) (3)
	2 line V stripe	-	900	-	mA	
	White	-	1100	-	mA	
Vsync Frequency	fV	-	-	60	Hz	(2)
Hsync Frequency	fH	-	-	64	kHz	
Main Frequency	fDCLK	-	-	54	MHz	
Rush Current	Irush	-	-	4.0	A	(4)

- Note
- (1) fV=60Hz, fDCLK =54MHZ, VDD = 5.0V, DC Current.
  - (2) Main pixel clock frequency is the value which is measured at the input of LVDS transmitter.
  - (3) Power dissipation check pattern(LCD Module only)

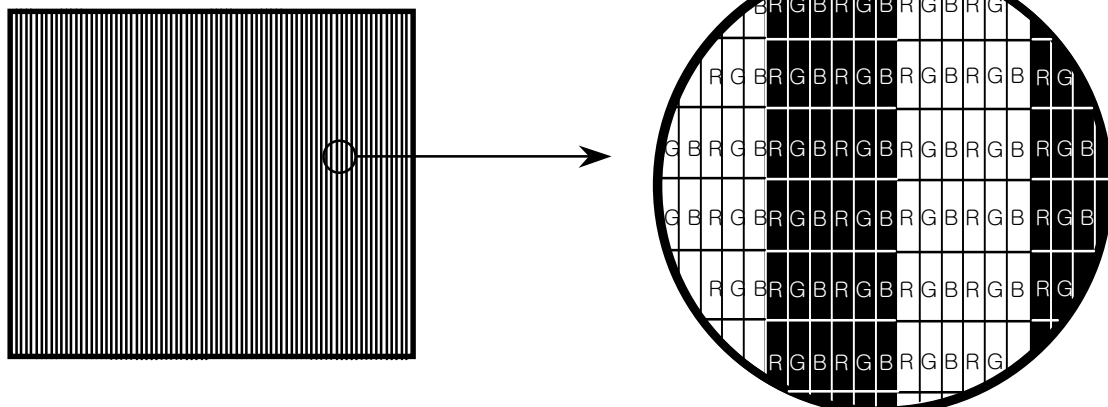
\*a) Black pattern



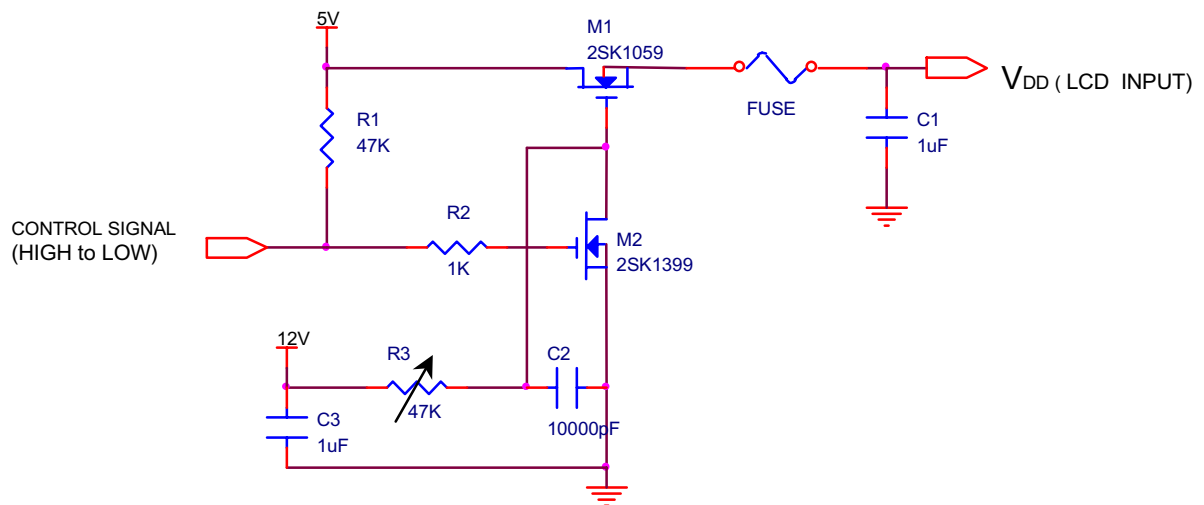
\*b) White pattern



\*c) 2line Vertical stripe pattern



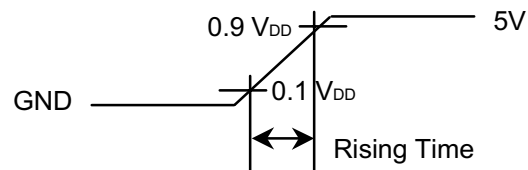
#### (4) Measurement Conditions



Note : Control Signal : High(+5V) -->Low(Ground)

All Signal lines to panel except for power 5V : Ground

The rising time of supplied voltage is controlled to 470us by R3 and C2 value.



### 3.2 BACK-LIGHT UNIT

The back-light system is an edge - lighting type with 2 dual CCFTs ( Cold Cathode Fluorescent Tube )

The characteristics of two dual lamps are shown in the following tables.

Ta=25 ± 2°C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Lamp Current	IL	3.0	6.5	6.5	mArms	(1)
Lamp Voltage	VL	-	690	-	Vrms	
Lamp Frequency	fL	40	-	60	kHz	(2)
Startup Voltage	Vs	-	-	880(25°C)	Vrms	(3)
				1450(0°C)		

**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.**

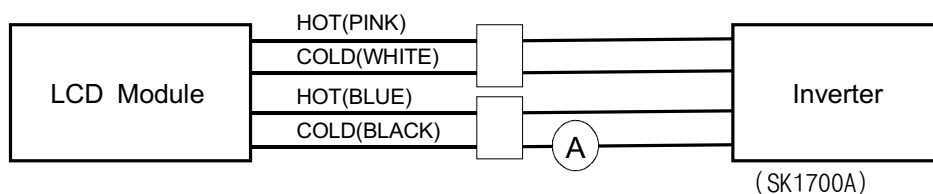
The performance of the back-light, for example life time or brightness, is much influenced by the characteristics of the DC-AC inverter for the lamp. So all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter.

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 current meter for high frequency as shown below.

Refer to the block diagram of the back-light unit in the next page for more information.

Specified values are for a single lamp.

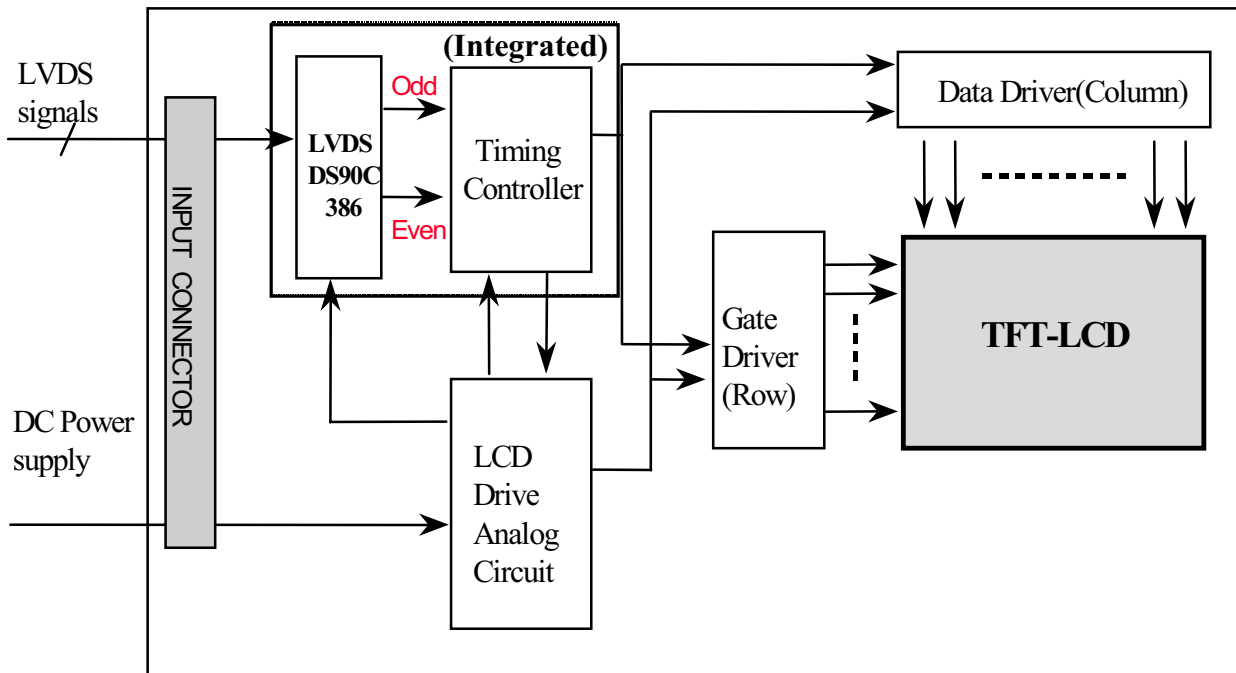


(2) Lamp frequency may produce interference with horizontal synchronous frequency and this may cause line flow on the display. Therefore lamp frequency shall be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.

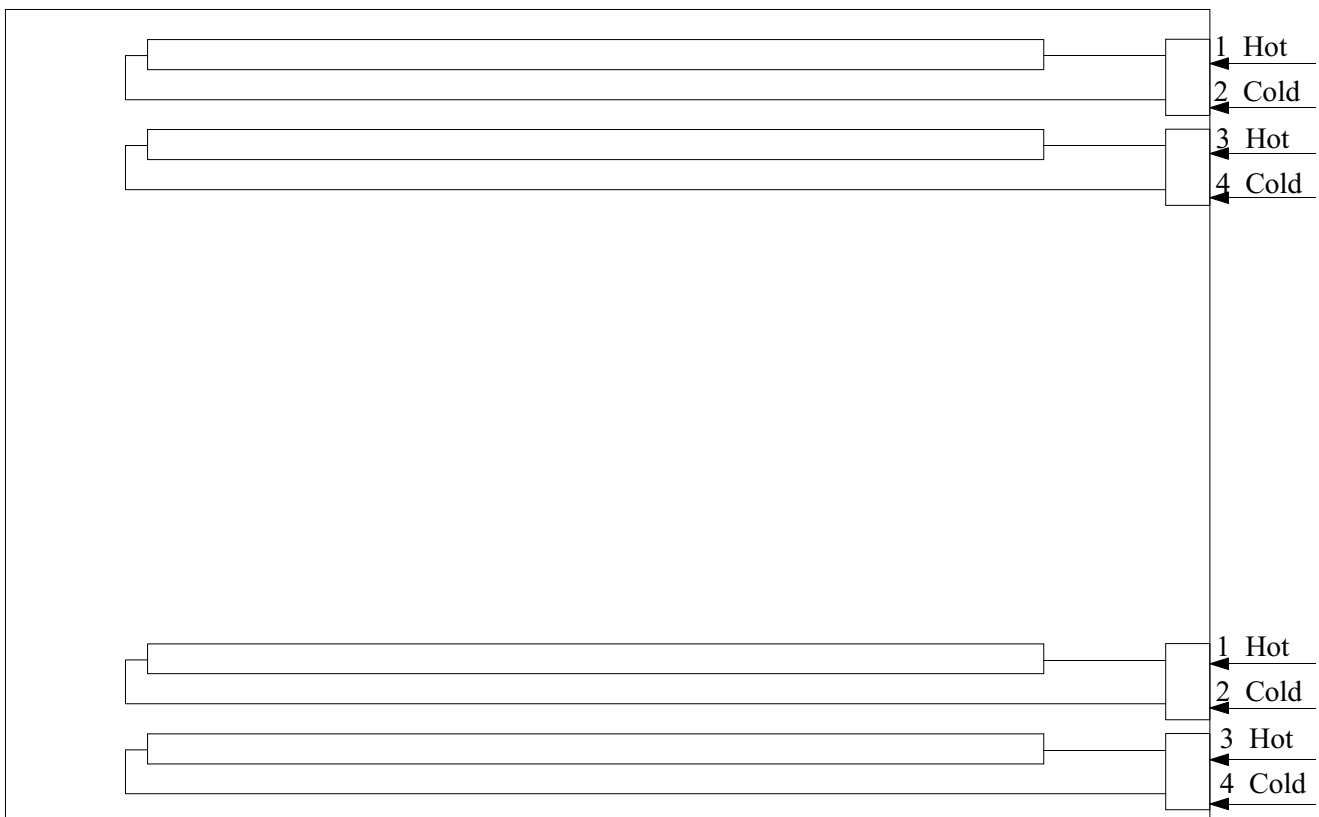
(3) If an inverter has shutdown function it should keep its output for more than 1 second even if the lamp connector open. Otherwise the lamps may not to be turned on.

## 4. Block Diagram

### 4.1 TFT LCD MODULE



### 4.2 BACK-LIGHT UNIT



## 5. Input Terminal Pin Assignment

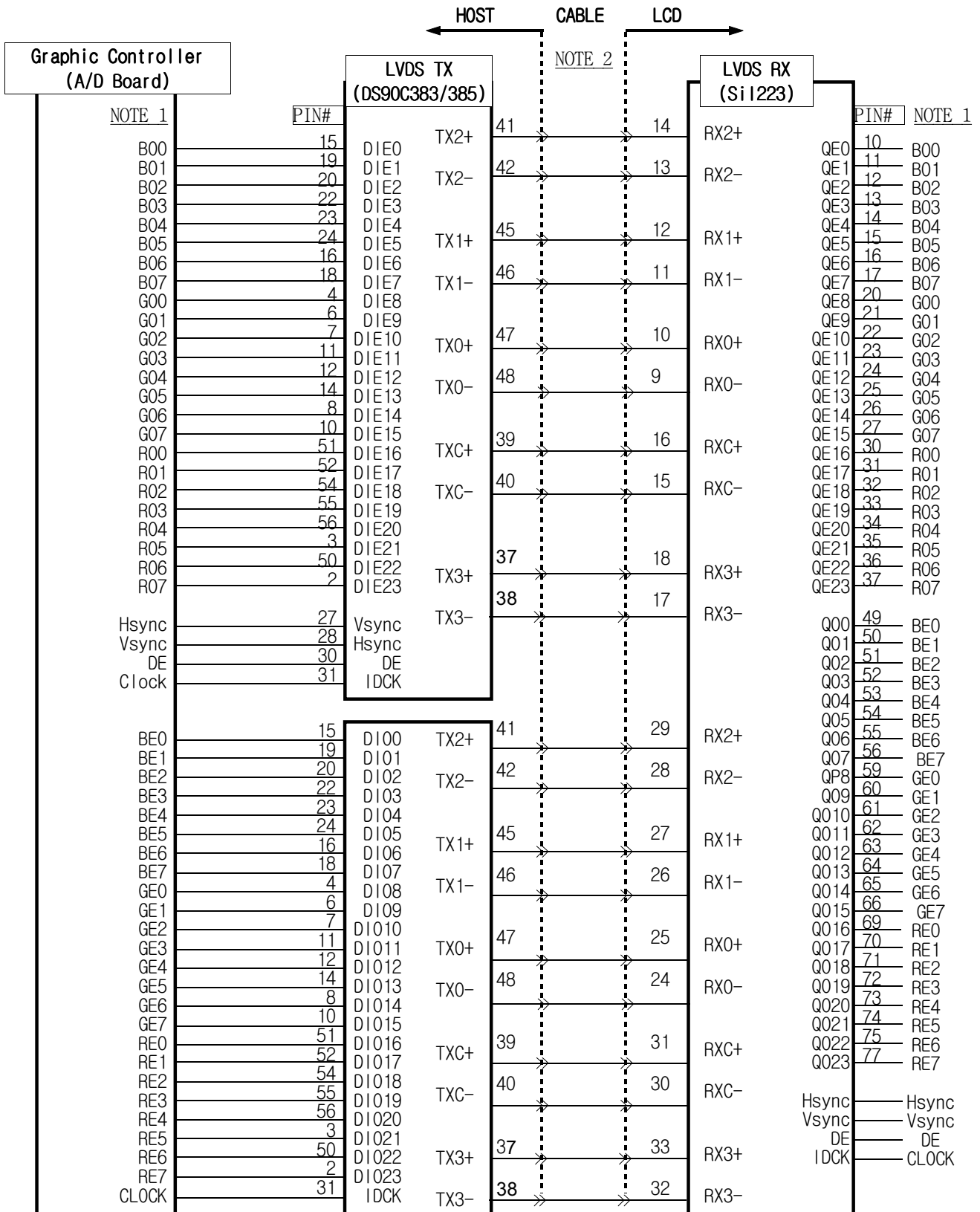
5.1. Input Signal & Power ( Connector : JAE FI-X30S-HF )

( Matching Socket : JAE FI-X30H )

PIN NO	SYMBOL	FUNCTION	POLARITY	OutPin# * Transmitter : DS90C383/385 ×2	OutPin# * Transmitter : DS90C387 ×1
1	RX00-	LVDS ODD 0 - Signal	Negative	②#48	#50
2	RX00+	LVDS ODD 0 + Signal	Positive	②#47	#49
3	RX01-	LVDS ODD 1 - Signal	Negative	②#46	#47
4	RX01+	LVDS ODD 1 + Signal	Positive	②#45	#46
5	RX02-	LVDS ODD 2 - Signal	Negative	②#42	#45
6	RX02+	LVDS ODD 2 + Signal	Positive	②#41	#44
7	GND	Power Ground			
8	RXOC-	LVDS ODD Clock - Signal	Negative	②#40	#42
9	RXOC+	LVDS ODD Clock + Signal	Positive	②#39	#41
10	RX03-	LVDS ODD 3 - Signal	Negative	②#38	#39
11	RX03+	LVDS ODD 3 + Signal	Positive	②#37	#38
12	RXE0-	LVDS EVEN 0 - Signal	Negative	①#48	#37
13	RXE0+	LVDS EVEN 0 + Signal	Positive	①#47	#36
14	GND	Power Ground			
15	RXE1-	LVDS EVEN 1 - Signal	Negative	①#46	#34
16	RXE1+	LVDS EVEN 1 + Signal	Positive	①#45	#33
17	GND	Power Ground			
18	RXE2-	LVDS EVEN 2 - Signal	Negative	①#42	#32
19	RXE2+	LVDS EVEN 2 + Signal	Positive	①#41	#31
20	RXEC-	LVDS EVEN Clock - Signal	Negative	①#40	#27
21	RXEC+	LVDS EVEN Clock + Signal	Positive	①#39	#26
22	RXE3-	LVDS EVEN 3 - Signal	Negative	①#38	#29
23	RXE3+	LVDS EVEN 3 + Signal	Positive	①#37	#28
24	GND	Power Ground			
25	NC	No Connection			
26	DE	DE Out			
27	NC	No Connection			
28	V <sub>DD</sub>	Power Supply (+5V)			
29	V <sub>DD</sub>				
30	V <sub>DD</sub>				

5.2 LVDS Interface (1)

- LVDS Receiver : Silicon Image SiI223



**NOTE 1 : SIGNAL CONFIGURATION**[Graphic Controller(A/D Converter) Output]

ODD DATA(ROx, BOx, GOx : 1'st, 3'rd, 5'th .... data)

EVEN DATA(REx, GEx, BEx : 2'nd, 4'th, 6'th .... data)

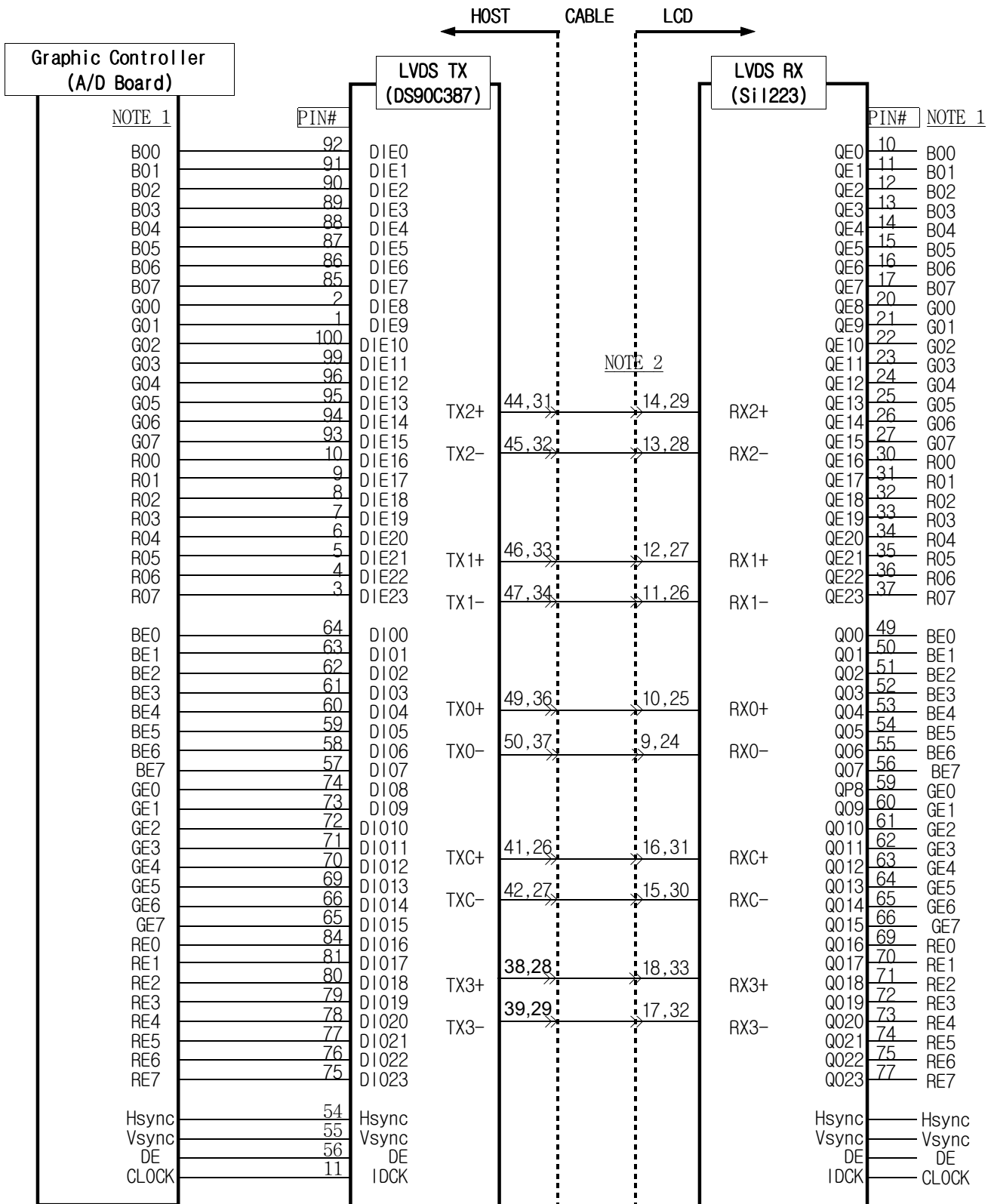
**NOTE 2 : Use FI-X30S-HF JAE Connector on the TFT module side**

**Use Twisted Differential Cable(Impedence:100Ω )**

**SiI223 pin polarity configuration (ODD,EVEN)**

## 5.2 LVDS Interface (2)

- LVDS Receiver : Silicon Image SiI223



**NOTE 1 : SIGNAL CONFIGURATION**[Graphic Controller(A/D Converter) Output]

ODD DATA(ROx, BOx, GOx : 1'st, 3'rd, 5'th .... data)

EVEN DATA(REx, GEx, BEx : 2'nd, 4'th, 6'th .... data)

**NOTE 2 : Use FI-X30S-HF JAE Connector on the TFT module side**

**Use Twisted Differential Cable(Impedance:100Ω)**

**DS90C387/SiI223 pin polarity configuration (ODD,EVEN)**

### 5.3 BACK-LIGHT UNIT

Pin No.	Input [ch1][ch2], [ch3][ch4]	Color	Fucntion
1	Hot	Pink	High Voltage
2	Cold	White	Ground
3	Hot	Blue	High Voltage
4	Cold	Black	Ground
Connector Part No.	JST BHSR - 02VS - 1		
Matching Connector	SM02B - BHSS -1-TB		



### 5.4 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	R6	R7	G0	G1	G2	G3	G4	G5	G6	G7	B0	B1	B2	B3	B4	B5	B6	B7	
BASIC COLOR	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	-
	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	-
	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	-
	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	-
	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	-
	MAGENTA	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	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	-
	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	-
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	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	R1	
		0	1	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	R253	
		0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R254	
		1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R255	
	GRAY SCALE OF GREEN	BLACK	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	G1	
		0	0	0	0	0	0	0	0	0	1	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	G253	
		0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	G254	
		0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	G255	
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	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	B1	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	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	B253	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	B254	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	B255	

Note) 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

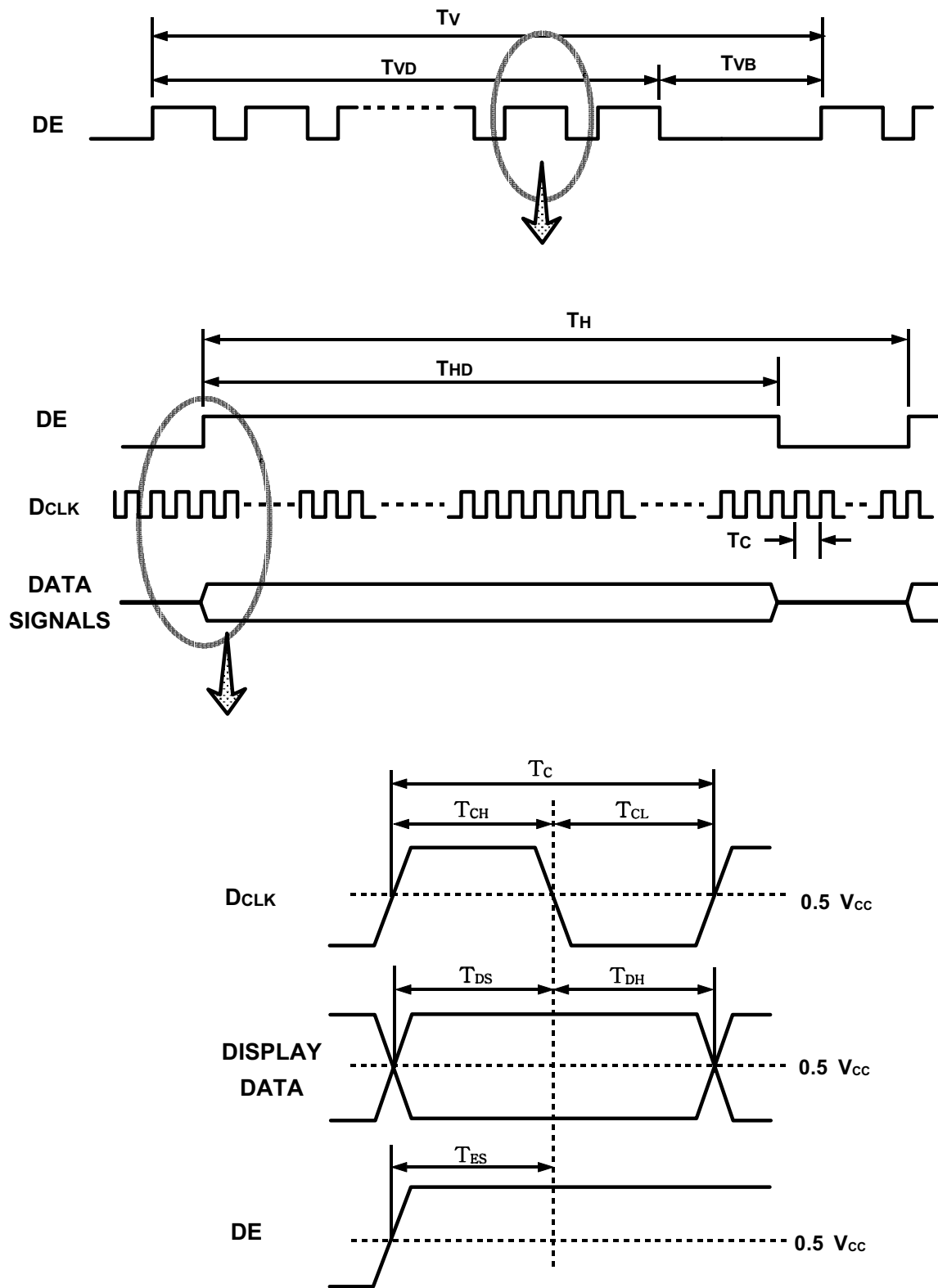
## 6. Interface Timing

### 6.1 Timing Parameters ( DE only mode )

Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
Clock	Frequency	1/TC	-	-	54	MHz	
	Hgh Time	TCH	5	-	-	nsec	
	Low Time	TCL	5	-	-	nsec	
Data	Setup Time	TDS	4	-	-	nsec	
	Hold Time	TDH	4	-	-	nsec	
Data Enable	Setup Time	TES	4	-	-	nsec	(1)
Frame Frequency	Cycle	TV	-	16.7	16.7	msec	
			1032	1066	1066	lines	
Vertical Active Disply Term	Display Period	TVD	1024	1024	1024	lines	
	Verticle Blank Period	TVB	8	38	38	lines	
One Line Scanning Time	Cycle	TH	672	844	844	clocks	
Horizontal Active Display Term	Display Period	THD	640	640	640	clocks	

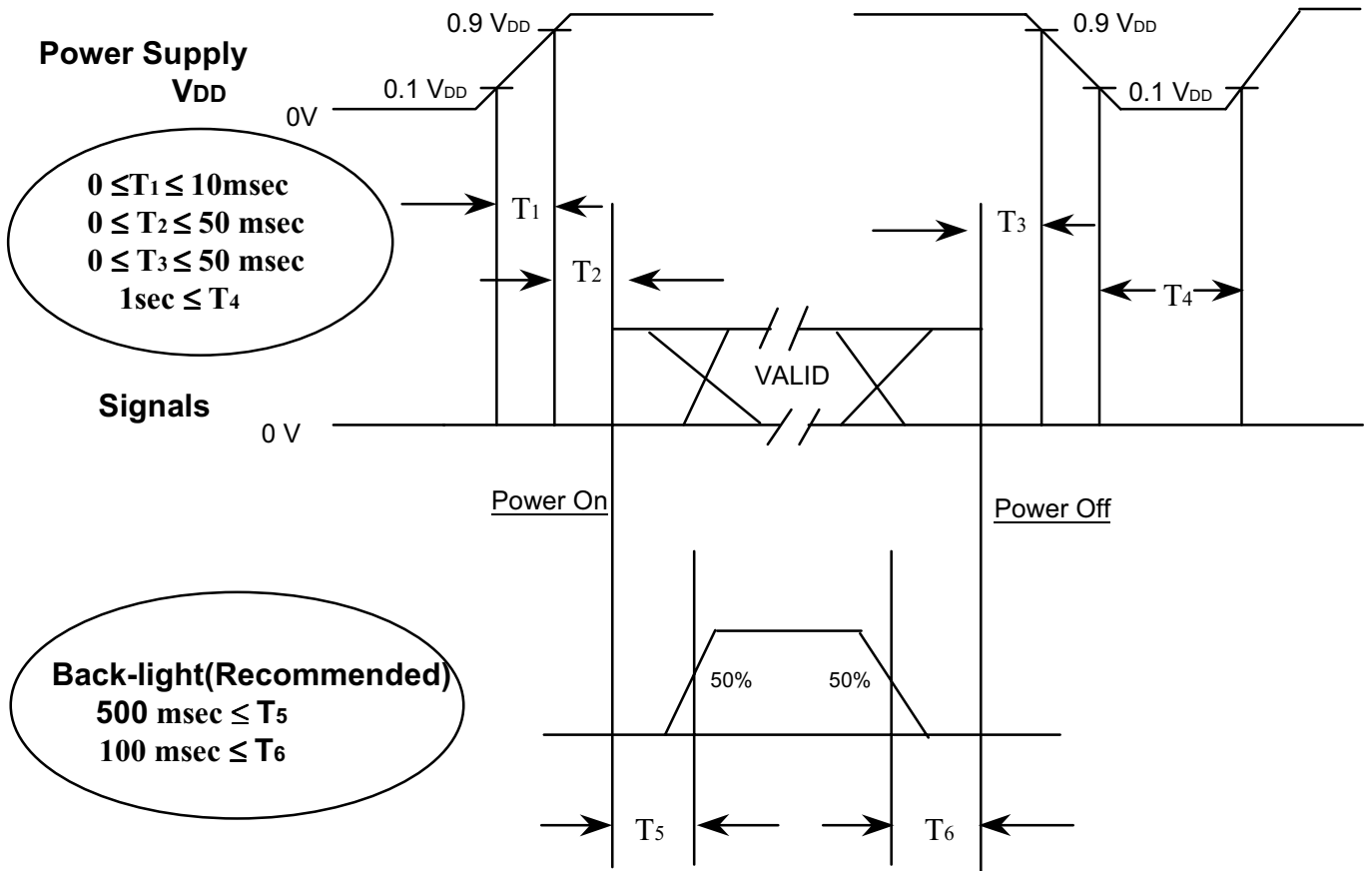
Note (1) When LTM170E4-L01 model is operated by DE only mode, Hsync and Vsync input signals should be fixed to low for stable operation. Otherwise, the module could operate abnormally.

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.



Power ON/OFF Sequence

**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 abnormal screen.
- (3) In case of VDD = off level, please keep the level of input signals on the low or keep a high impedance.
- (4) T<sub>4</sub> 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.



## 8. General Precautions

### 8.1 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 CMOS Gate Array IC.
- (i) Use finger-stalls 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 module.
- (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.

## 8.2 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 35C 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.

## 8.3 Operation

- (a) Do not connect,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 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).

## 8.4 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, and 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.