Product Information

ISSUE DATE : 99-09-14
MODEL : LTM150XS-T01

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

LTM150XS-T01 is a color active matrix TFT (Thin Film Transistor) liquid crystal display that uses amorphous silicon TFT switching devices. This model is composed of a TFT LCD panel, a driver circuit and a back-light system. The resolution of 15.0- inch contains 1,024 x 768 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
- Wide viewing angle
- High-speed response
- XGA(1024x768 pixels) resolution
- Low power consumption
- 2 CCFTs (Cold Cathode Fluorescent Tube)
- Sync & DE Mode or DE Only Mode
- TTL Interface with 2pixels / clock

APPLICATIONS

- Desktop monitors
- Display terminals for AV application products
- Monitors for Industrial machine

GENERAL SPECIFICATIONS

ITEM	SPECIFICATION	UNIT	NOTE
Active area	304.128(H) x228.096(V) (15 inch diagonal)	mm	
Driver element	a-Si TFT active matrix		
Display colors	262,144		
Number of pixel	1024 x 768	pixel	
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.297(H) x 0.297(W)	mm	
Display Mode	Normally white		
Surface treatment	Haze 12 , Anti-glare Hard - Coating (3H)		

Mechanical Information

ITEM		MIN.	TYP.	MAX.	NOTE
Module size	Horizontal (H)	-	331.3	-	mm
	Vertical (V)	-	257.9	-	mm
	Depth (D)	-	15.9	16.4	mm
Weight		-	-	1300	g

1. ELECTRICAL ABSOLUTE RATINGS

1.1 TFT LCD MODULE

(Vss =GND= 0 V)

ITEM	SYMBOL	MIN.	MAX.	UNIT	NOTE
Power Supply Voltage	V_{DD}	Vss-0.3	4.0	V	(1)

NOTE (1) Within Ta (25 ± 2 ˚C)

1.2 BACK-LIGHT UNIT

Ta = 25 ± 2 ˚C

ITEM	SYMBOL	MIN.	MAX.	UNIT.	NOTE
Lamp current	I_L	2.5	6.5	mA_{rms}	(1)
Lamp frequency	f_L	20	70	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.

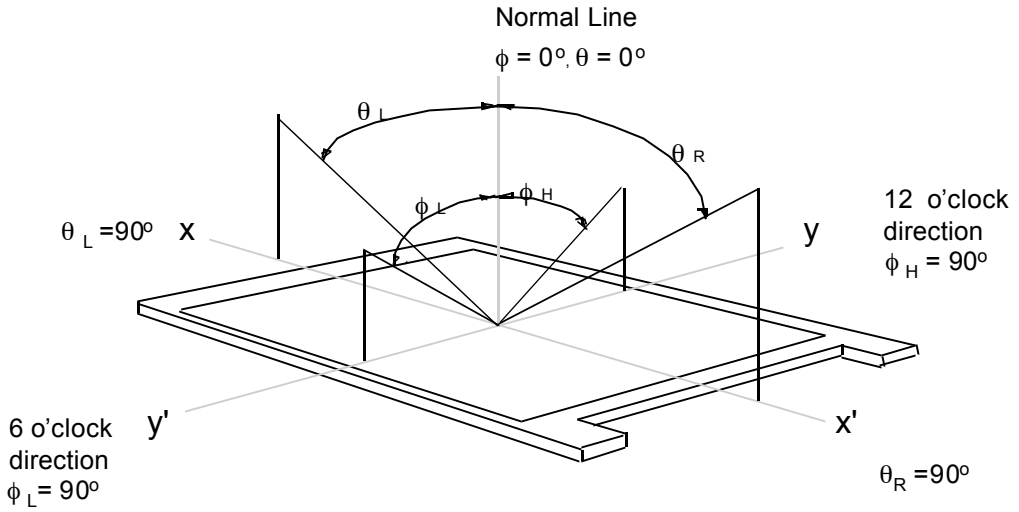
2. OPTICAL CHARACTERISTICS

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 (4).
Measuring equipment : TOPCON BM-5A

* Ta = 25 ± 2 °C , V_{DD} = 3.3V, fv= 60Hz, f_{DCLK}=32.5MHz, I_L = 6.0 mArms

ITEM		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	NOTE
Contrast Ratio (Center of screen)		CR	ϕ = 0, θ = 0 Normal Viewing Angle	200	300	-		(1), (2), (4)
Response Time at Ta	Rising	T_R		-	10	-	msec	(1), (3)
	Falling	T_F		-	35	-		
Luminance of White (Center of screen)		Y_L		-	200	-	cd/m^2	(1), (4)
Color Chromaticity (CIE)	Red	R_X		-	0.615	-		(1), (4)
		R_Y		-	0.342	-		
	Green	G_X		-	0.314	-		
		G_Y		-	0.545	-		
	Blue	B_X		-	0.147	-		
		B_Y		-	0.118	-		
	White	W_X		-	0.315	-		
		W_Y		-	0.324	-		
Viewing Angle	Hor.	θ_L	CR ≥ 5	-	70	-	Degrees	
		θ_R		-	70	-		
	Ver.	ϕ_H		-	55	-		
		ϕ_L		-	60	-		

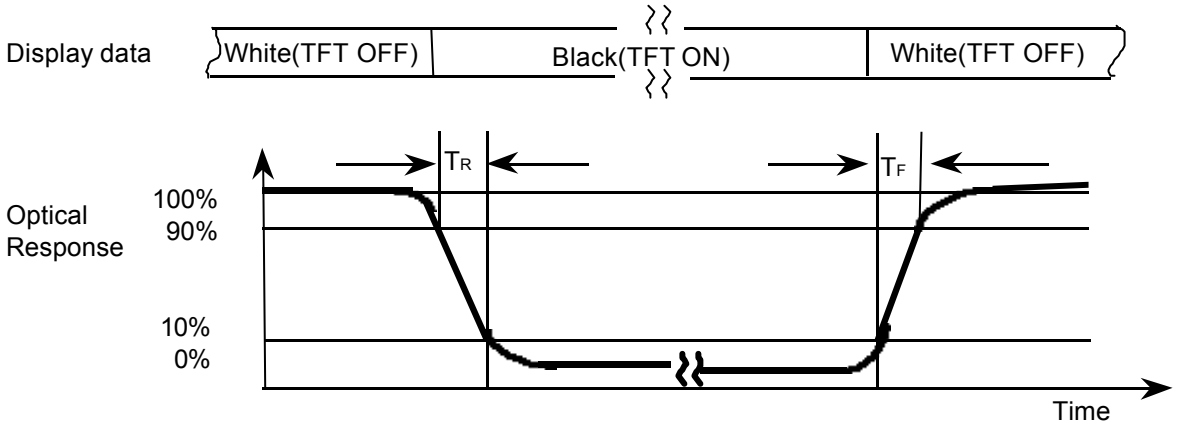
Note 1) Definition of Viewing Angle : Viewing angle range ($5 \leq CR$)



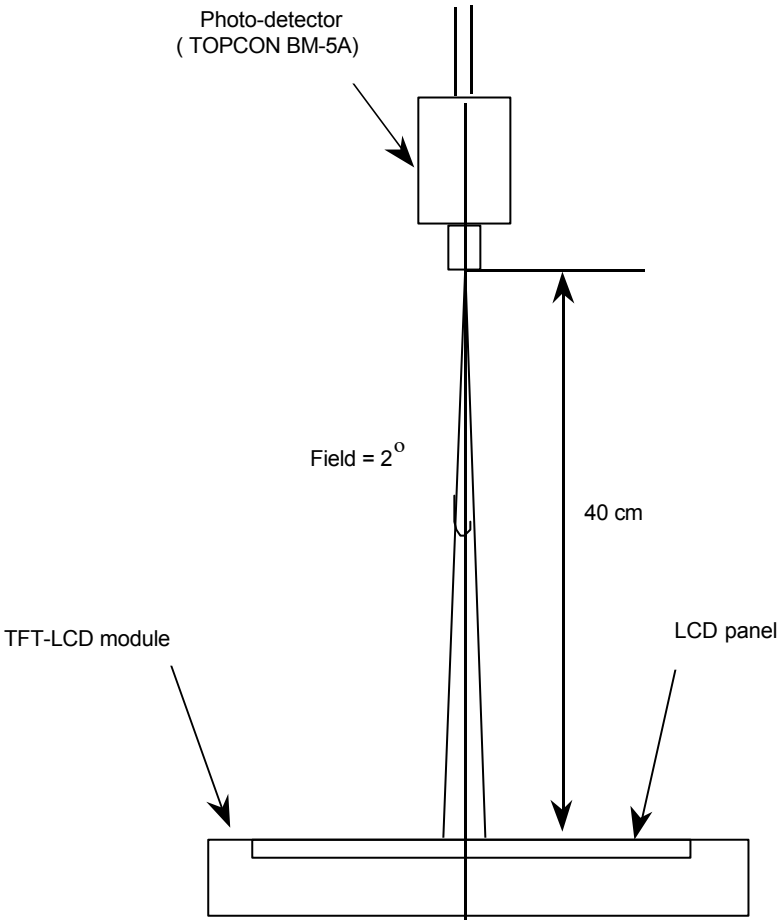
Note 2) Definition of Contrast Ratio (CR) : Ratio of gray max (Gmax) ,gray min (Gmin) at the center point of panel.

$$CR = \frac{\text{Luminance with all pixels white (Gmax)}}{\text{Luminance with all pixels black (Gmin)}}$$

Note 3) Definition of Response time : Sum of T_R ,T_F



Note 4) 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.
lamp current : 6.0mA
Environment condition : Ta = 25 ± 2 °C



Optical characteristics measurement setup

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	
Input Voltage	High	V_{IH}	2.64	-	V_{DD}	V	(1)
	Low	V_{IL}	GND	-	0.6	V	
Current of Power Supply	White	I_{DD}	-	210	-	mA	(2)(4)*a
	Mosaic		-	260	-	mA	(2)(4)*b
	V.stripe		-	370	400	mA	(2)(4)*c
Vsync Frequency		fV	-	60	75	Hz	
Hsync Frequency		fH	-	48.3	60	kHz	
Main Frequency		fDCLK	-	32.5	40	MHz	(3)
Rush Current		Irush	-	-	2.5	A	(5)

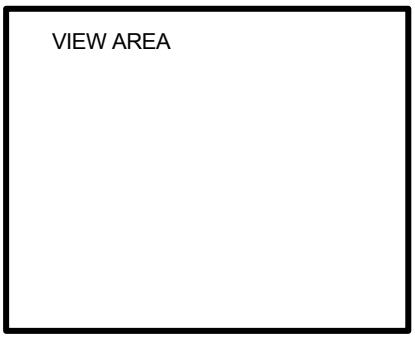
Note (1) MCLK , Vsync , Hsync , DE , RA0 ~ RA5 , GA0 ~ GA5 , BA0 ~ BA5 , RB0 ~ RB5 , GB0 ~ GB5 , BB0 ~ BB5

(2) f_V=60Hz, f_{DCLK} =32.5MHZ, V_{DD} = 3.3V, DC Current.

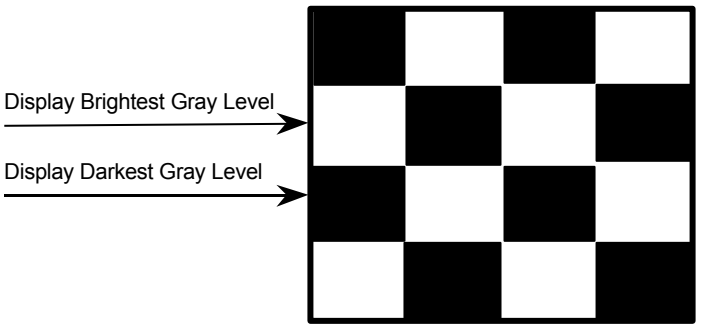
(3) 2 Pixels/clock

(4) Power dissipation check pattern

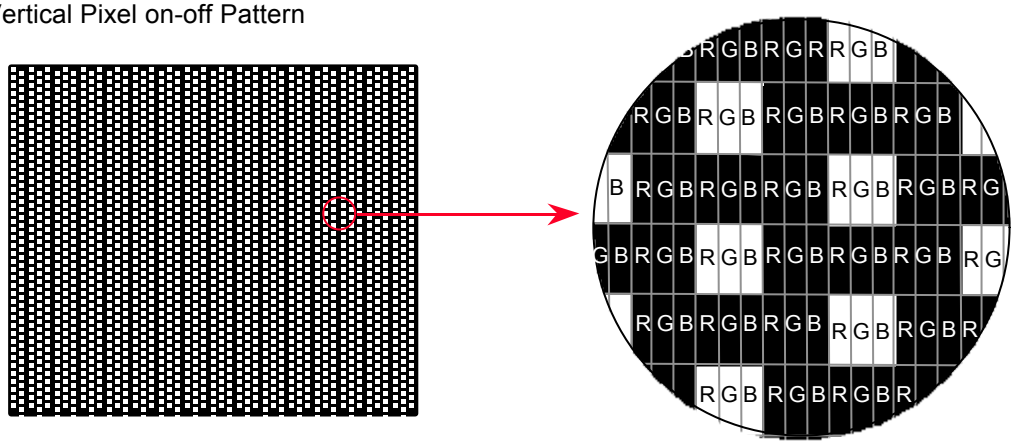
*a) White Pattern



*b) Mosaic Pattern

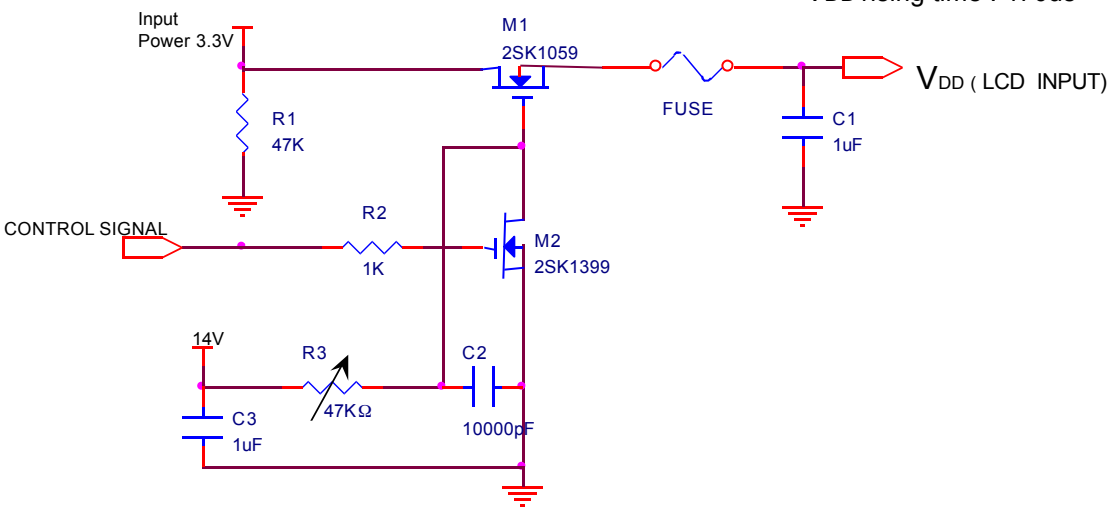


c) Vertical Pixel on-off Pattern



(5) Measurement Conditions

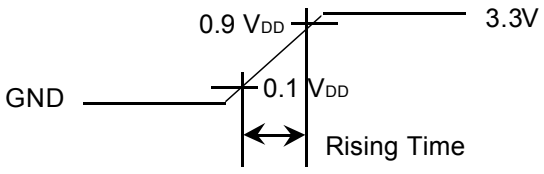
VDD rising time : 470us



Note : Control Signal : High(+3.3V) -->Low(Ground)

All Signal lines to panel except for power 3.3V : 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 CCFTs(Cold Cathode Fluorescent Tube).

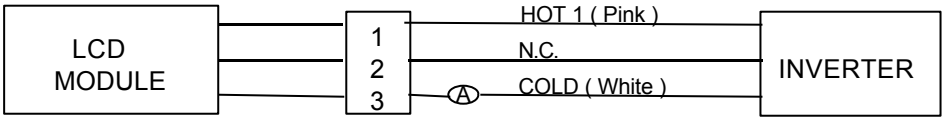
The characters of two lamps are shown in the following tables. Ta= 25 ± 2 ˚C

ITEM	SYMBOL	MIN	TYP	MAX	UNIT	NOTE
Lamp Current	I_L	2.5	6.0	6.5	mA_{rms}	(1)
Lamp Voltage	V_L	-	690	-	V_{rms}	
Lamp Frequency	f_L	40	-	60	kHz	(2)
Operating Life Time	Hr	50,000	-	-	Hour	(3)
Startup Voltage	Vs	-	-	870 (25°C) 1450 (0°C)	Vrms	(4)

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.



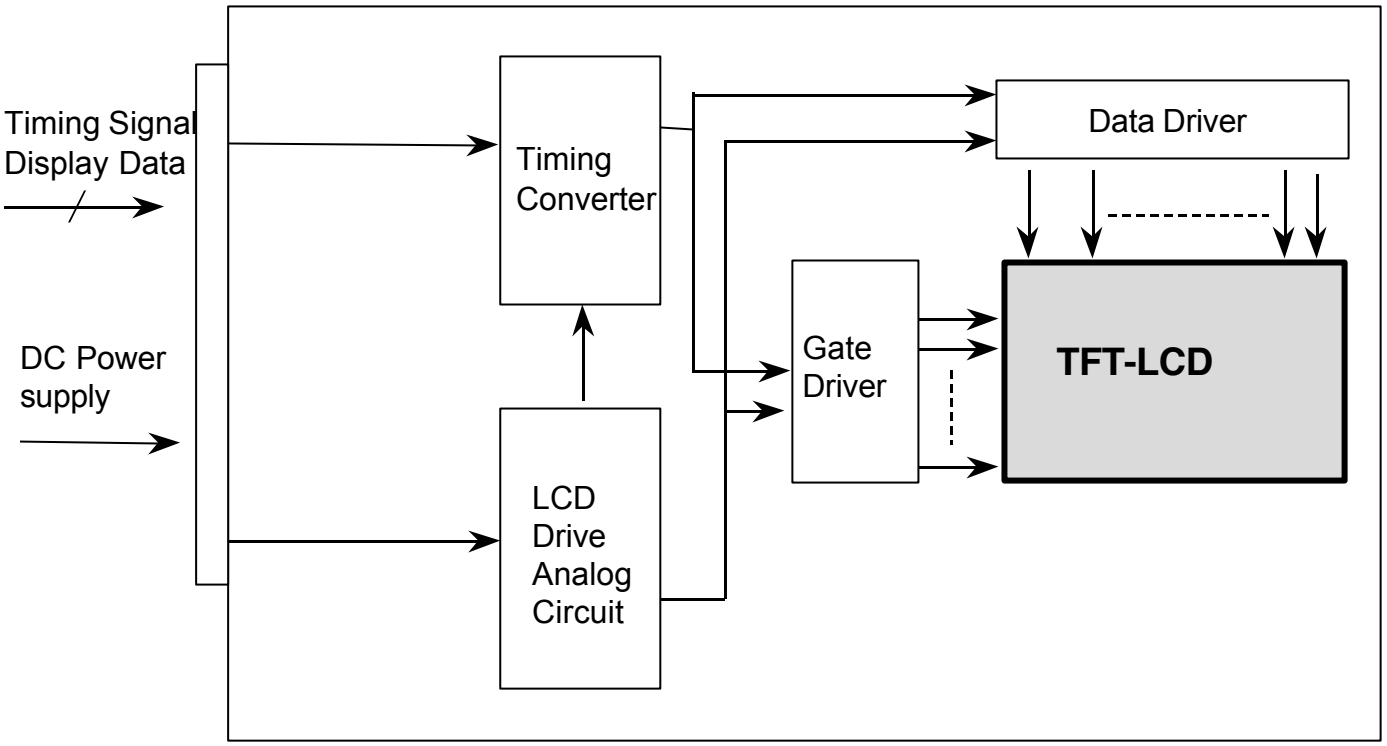
(2) Lamp frequency may produce interference with horizontal synchronous frequency and this may cause line flow on the display. Therefore lamp frequency shall be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.

(3) Life time (Hr) of a lamp is defined as the time in which it continues to operate under the condition of Ta = 25 ± 2 ˚C and I_L = 6 mArms until the brightness becomes 50% or lower than it's original value.

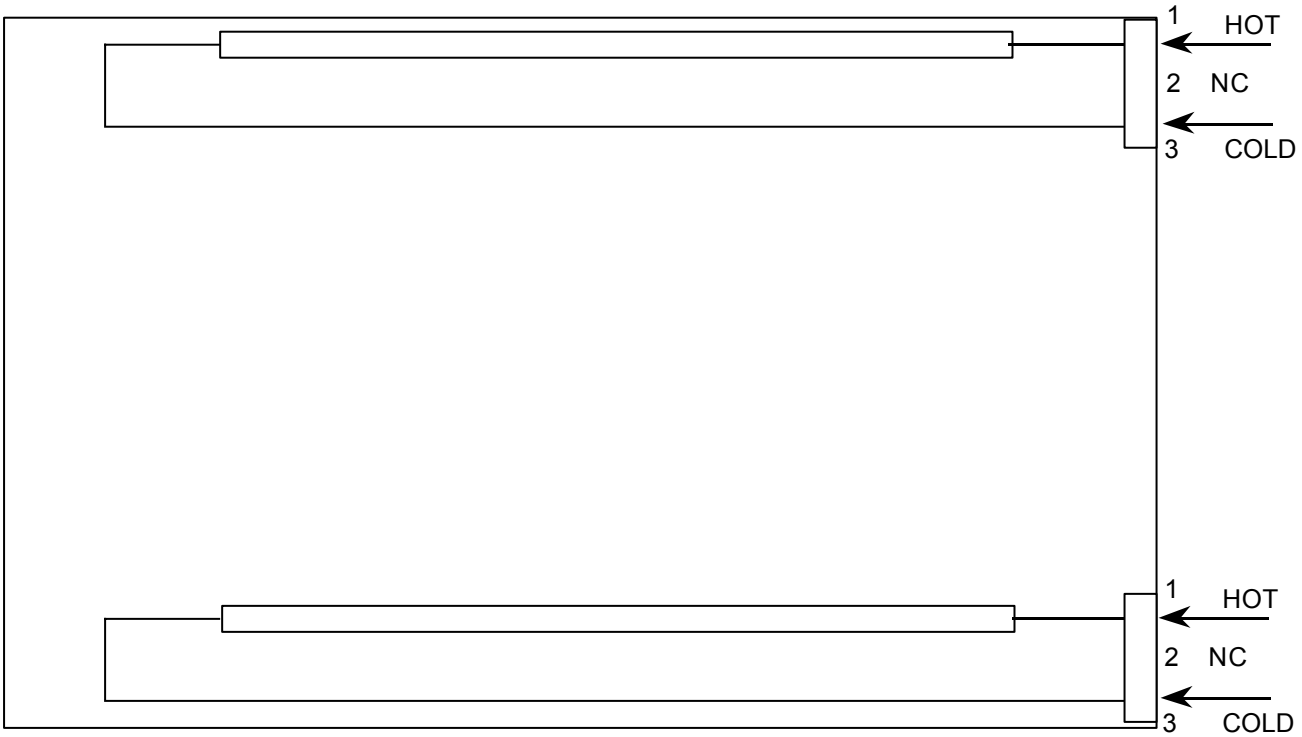
(4) The voltage above this value should be applied to the lamps for more than 1 second to startup. Otherwise the lamps may not to be turned on.

4. BLOCK DIAGRAM

4.1 TFT LCD MODULE



4.2 BACK-LIGHT UNIT



5. INPUT TERMINAL PIN ASSIGNMENT

5.1. TFT LCD MODULE (Interface Signal & Power)
Connector : Hirose DF14A-30P-1.25H
Matching Socket : Hirose DF14-30S-1.25C

Pin NO.	Symbol	Function	Polarity	Remark
1	VDD	Power Supply [+3.3V]	-	-
2	VDD	Power Supply [+3.3V]	-	-
3	GND	Ground	-	-
4	MCLK	Data Clock	-	(1)
5	GND	Ground	-	-
6	VSYNC	Vertical Sync Signal	Negative	-
7	HSYNC	Horizontal Sync Signal	Negative	-
8	DE	Data Enable	Positive	-
9	GND	Ground	-	-
10	RA0(ODD)	Red Data [LSB] - ODD	Positive	-
11	RA1	Red Data	Positive	-
12	RA2	Red Data	Positive	-
13	RA3	Red Data	Positive	-
14	RA4	Red Data	Positive	-
15	RA5	Red Data [MSB] -ODD	Positive	-
16	GND	Ground	-	-
17	GA0(ODD)	Green Data [LSB] - ODD	Positive	-
18	GA1	Green Data	Positive	-
19	GA2	Green Data	Positive	-
20	GA3	Green Data	Positive	-
21	GA4	Green Data	Positive	-
22	GA5	Green Data [MSB] -ODD	Positive	-
23	GND	Ground	-	-
24	BA0(ODD)	Blue Data [LSB] -ODD	Positive	-
25	BA1	Blue Data	Positive	-
26	BA2	Blue Data	Positive	-
27	BA3	Blue Data	Positive	-
28	BA4	Blue Data	Positive	-
29	BA5	Blue Data [MSB] -ODD	Positive	-
30	GND	Ground	-	-

Connector : Hirose DF14A-25P-1.25H

Matching Socket : Hirose DF14-25S-1.25C

Pin NO.	Symbol	Function	Polarity	Remark
1	GND	Ground	-	-
2	RB0(EVEN)	Red Data [LSB] -EVEN	Positive	-
3	RB1	Red Data	Positive	-
4	RB2	Red Data	Positive	-
5	NC(GND)	No Connection	-	-
6	RB3	Red Data	Positive	-
7	RB4	Red Data	Positive	-
8	RB5	Red Data [MSB] -EVEN	Positive	-
9	GND	Ground	-	-
10	GB0(EVEN)	Green Data [LSB] -EVEN	Positive	-
11	GB1	Green Data	Positive	-
12	GB2	Green Data	Positive	-
13	NC(GND)	No Connection	-	-
14	GB3	Green Data	Positive	-
15	GB4	Green Data	Positive	-
16	GB5	Green Data [MSB] -EVEN	Positive	-
17	GND	Ground	-	-
18	BB0(EVEN)	Blue Data [LSB] -EVEN	Positive	-
19	BB1	Blue Data	Positive	-
20	BB2	Blue Data	Positive	-
21	NC	No Connection	-	-
22	BB3	Blue Data	Positive	-
23	BB4	Blue Data	Positive	-
24	BB5	Blue Data [MSB] -EVEN	Positive	-
25	GND	Ground	-	-

Note (1) Display data is sampled at the falling edge of data clock.

5.2 BACK-LIGHT UNIT

PIN No.	INPUT [ch1] , [ch2]	Color	Function
1	HOT 1	Pink	High Voltage
2	N.C	-	No Connection
3	COLD	White	Ground
Connector Part No.	JST SM02(8.0)B-BHS-1		

5.3 Input Signal,Basic Display Colors and Gray Scale of Each Colors

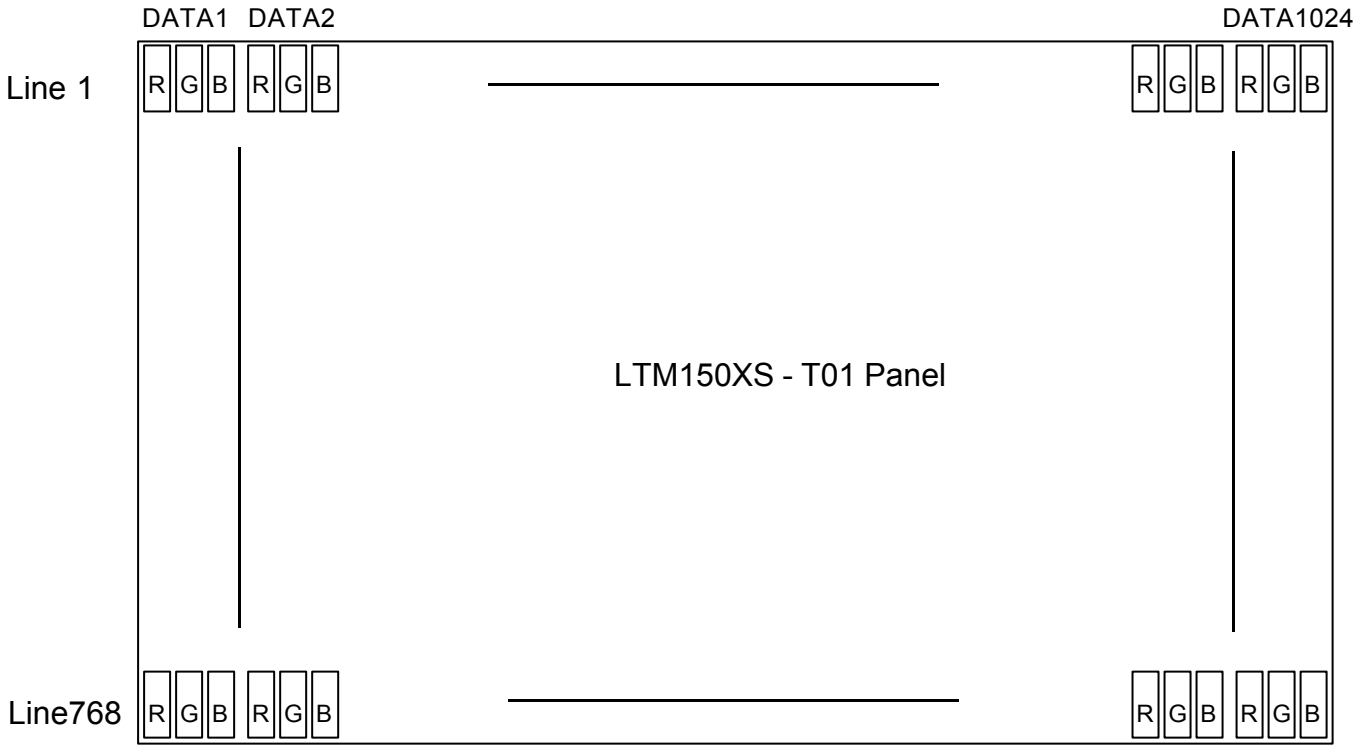
COLOR	DISPLAY	DATA SIGNAL																		GRAY SCALE LEVEL
		RED						GREEN						BLUE						
		R0	R1	R2	R3	R4	R5	G0	G1	G2	G3	G4	G5	B0	B1	B2	B3	B4	B5	
BASIC COLOR	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	-
	GREEN	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	-
	CYAN	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	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
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓ 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	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
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓ 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	B63

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

5.4 PIXEL FORMAT

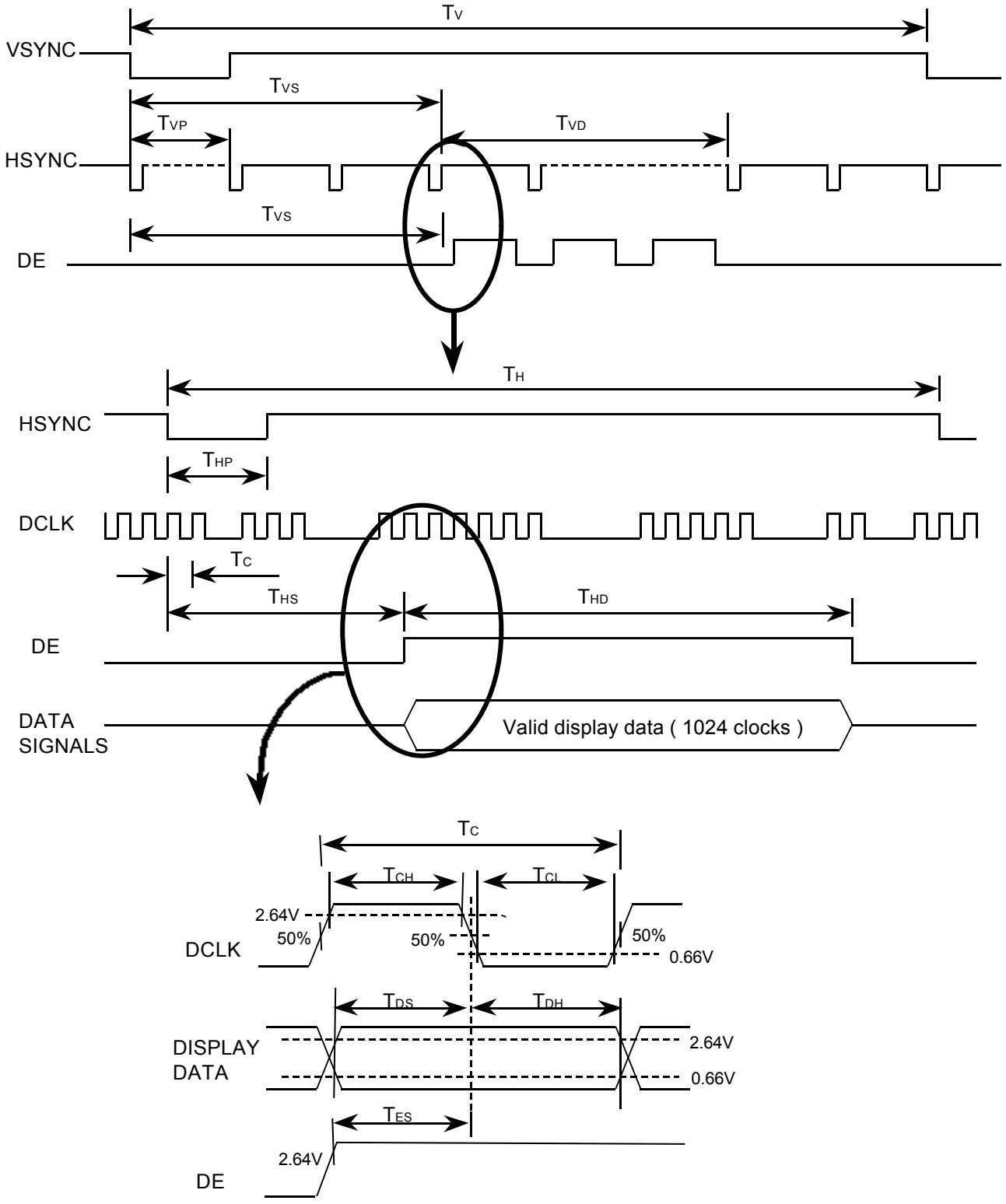


6. INTERFACE TIMING

6.1 Timing Parameters (SYNC & DE Mode)

Signal	Item	Symbol	MIN	TYP	MAX	Unit	Note
Clock	Frequency	1 / TC	-	32.5	40	MHz	
	High Time	TCH	4	-	-	nsec	
	Low Time	TCL	4	-	-	nsec	
Data	Setup Time	TDS	4	-	-	nsec	
	Hold Time	TDH	4	-	-	nsec	
Data Enable	Setup Time	TES	4	-	-	nsec	(1)
Horizontal Sync	Cycle	TH	-	20.68	-	usec	
			545	672	-	clocks	
	Pulse Width	THP	4	68	148	clocks	
Vertical Sync	Cycle	TV	772	16.7 | 806	-	msec | lines	
	Pulse Width	TVP	1	-	35	lines	
Horizontal Signal	Display Start	THS	-	148	-	clocks	
	Display Period	THD	512	512	512	clocks	
Vertical Signal	Display Start	TVS	-	35	-	lines	
	Display Period	TVD	768	768	768	lines	

6.2 Timing diagrams of interface signal (SYNC & DE mode)

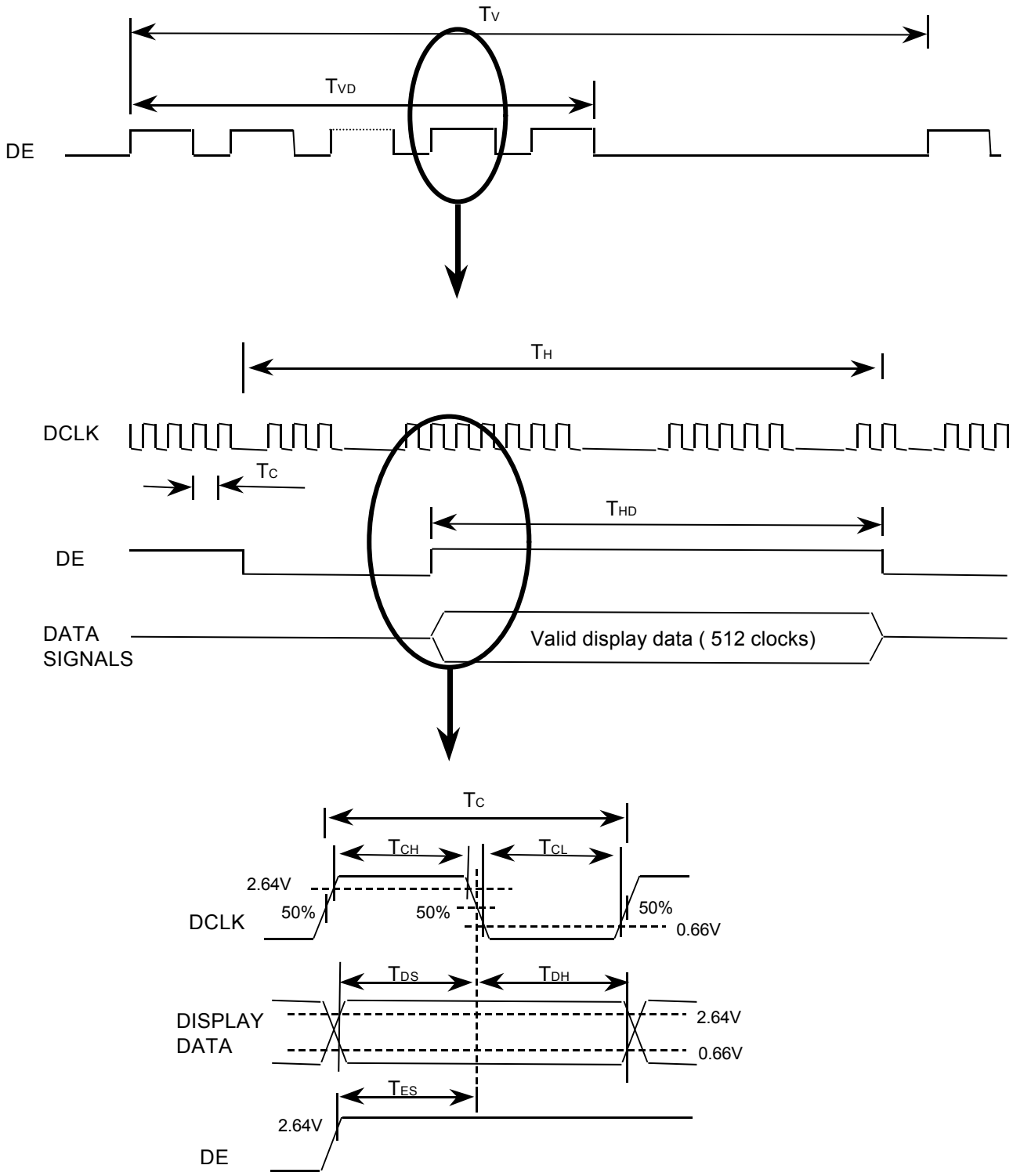


6.3 Timing Parameters (DE mode)

Signal	Item	Symbol	MIN	TYP	MAX	Unit	Note
Clock	Frequency	1 / TC	-	32.5	40	MHz	
	High Time	TCH	4	-	-	nsec	
	Low Time	TCL	4	-	-	nsec	
Data	Setup Time	TDS	4	-	-	nsec	
	Hold Time	TDH	4	-	-	nsec	
Data Enable	Setup Time	TES	4	-	-	nsec	(1)
Frame Frequency	Cycle	TV	772	16.7 | 806	-	msec | lines	
Vertical Active Display Term	Display Period	TVD	768	768	768	lines	
One Line Scanning Time	Cycle	TH	545	672	900	clocks	
Horizontal Active Display Term	Display Period	THD	512	512	512	clocks	

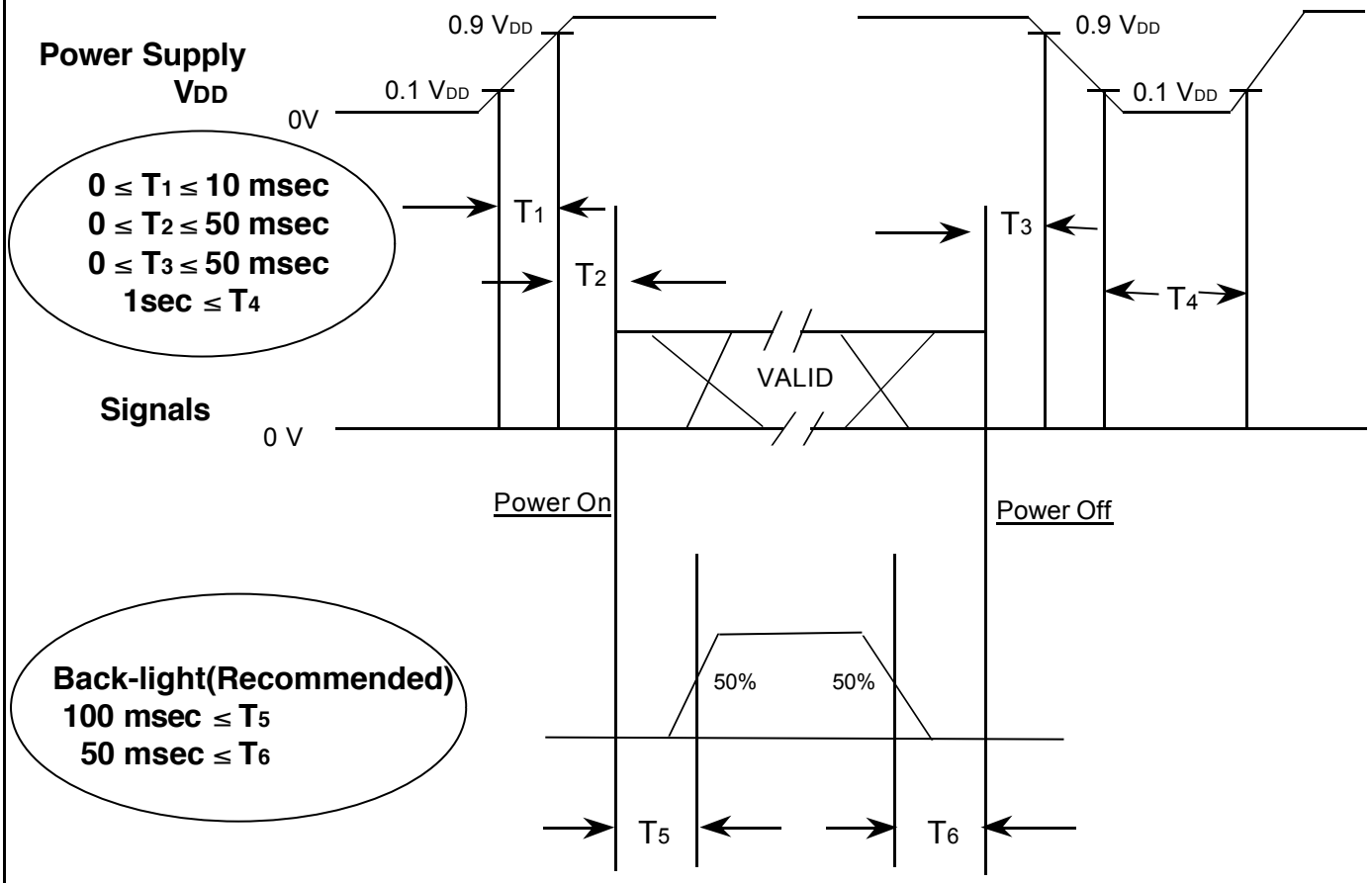
Note (1) When LTM150XS-T01 model is operated by DE only mode, Hsync and Vsync input signals should be fixed to "Low" for stable operation. Otherwise, the module could operate abnormally.

6.4 Timing diagrams of interface signal (DE mode)



6.5 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.

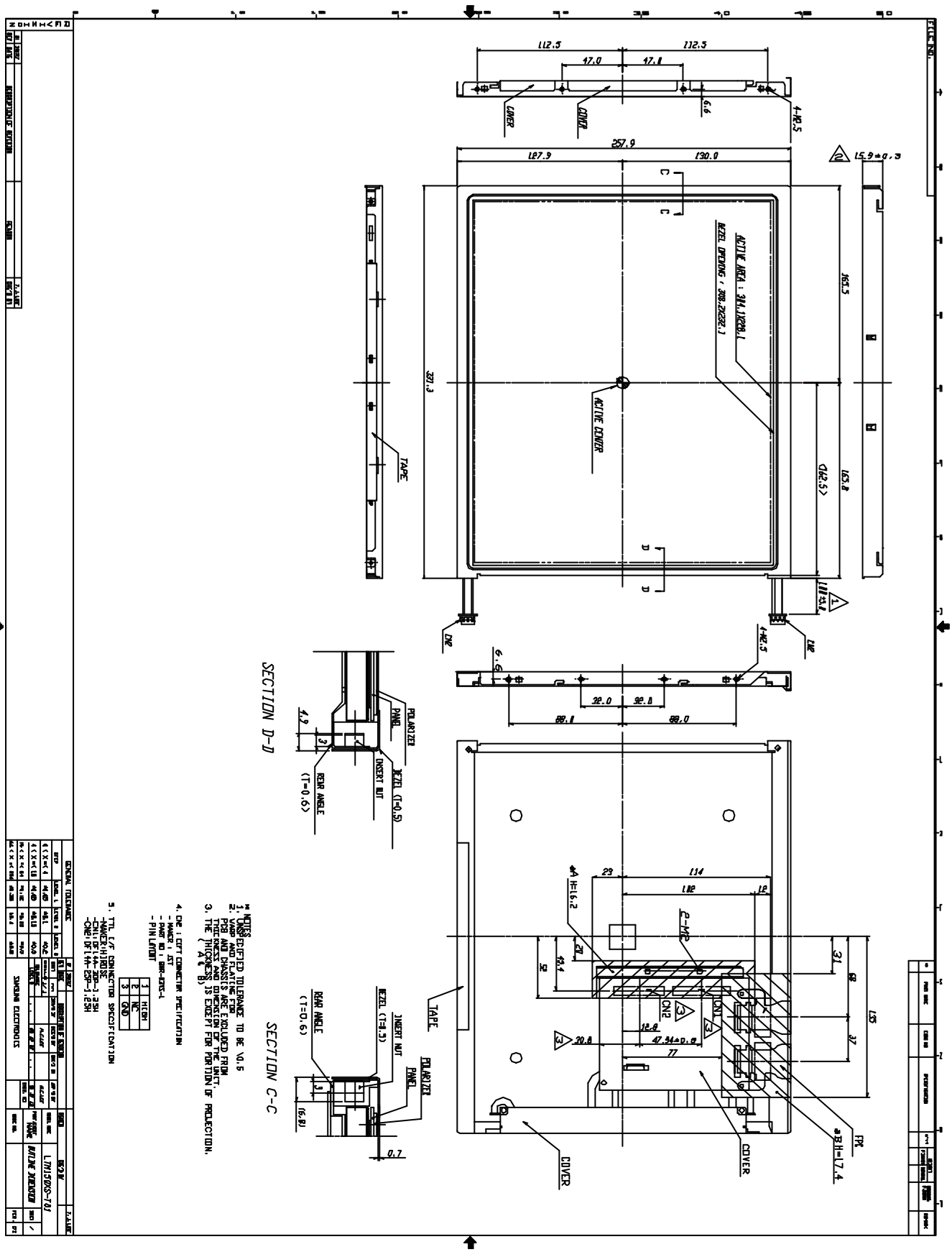
(2) Apply the lamp voltage within the LCD operation range. When the back-light turns on before the LCD operation or the LCD turns off before the back-light turns off, the display may momentarily become white.

(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.

7. OUTLINE DIMENSION



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 back side.

(m) 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 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.

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 6.6 " 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, 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.