SAMSUNG

LT104S1-101 Specifications

TFT LCD Panel Display

August 1995, Rev. 2.0

CONTENTS

GENERAL DESCRIPTION

DESCRIPTION

LT104S1-101 is the color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) using amorphous silicon TFT's as switching devices. It is composed of a TFT LCD panel, a driver circuit and a backlight system. The 10.4- inch- diagonal contains 800 x 600 pixels and can display 262,144 colors. Optimum viewing direction is 6 o'clock.

FEATURES

- Thin and light weight
- High contrast ratio, wide viewing angle, wide color gamut
- High-speed response
- SVGA (800x600 pixels) resolution
- Low power consumption
- Single CCFL
- Sync or DE (Data enable) function.

APPLICATIONS

- A4 size notebook computer
- Display terminals for AV application products
- Monitors for process controller and NC machine

General Specifications

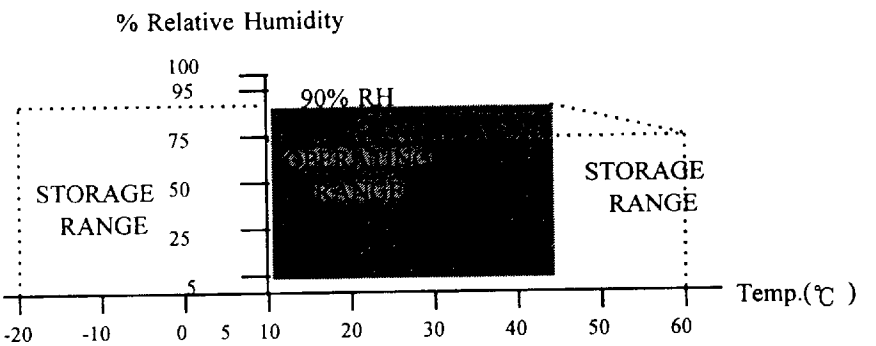
ITEM	SPECIFICATION	UNIT	NOTE
Display area	211.2(H) x 158.4(V) (10.4" diagonal)	mm	
Number of dots	800 x 600	pixel	
Pixel pitch	0.264(H) x 0.264(W)	mm	
Pixel arrangement	RGB vertical stripe		
Display colors	262,144	colors	
Viewing Angle	6 O'clock		
Display Mode	Normally white		
Module Size	264 (W) x 180 (H) x 9.5 (D)	mm	
Weight	500(Typ)	g	

1. ABSOLUTE MAXIMUM RATINGS

1.1 ENVIRONMENTAL ABSOLUTE RATINGS

ITEM	OPERATING		STORAGE		UNIT	NOTE
	MIN.	MAX.	MIN.	MAX.		
Ambient Temp.	10	45	-25	60	℃	(1)
Humidity	-	-	-	90	%RH	(1)
Vibration	-	0.5G	-	1.5G	(1G= 9.8 m/s^2)	
Shock	-	3G	-	100G		
Corrosive Gas	Not acceptable		Not acceptable		-	

Note (1) Operating and storage range for temperature and humidity are summarized in the figure below.



1.2 ELECTRICAL ABSOLUTE RATINGS

(1) TFT LCD MODULE

Vss = 0 V

ITEM	SYMBOL	MIN.	MAX.	UNIT	NOTE
Power Supply Voltage	V_{DD}	0	6	V	T_a = 25 ℃
Logic Input Voltage	V_{IN}	Vss	V_{DD}	V	
Electro-static Durability	V_{TER}	-	± 200	V	1),2)
	V_{CHA}	-	± 5	kV	1),3)

Note 1) 200 pF, 0 Ω, 25 ℃, 50%RH.
2) Interface connector pins are subjected.
3) The surface of chassis and LCD panel are subjected.

(2) BACK-LIGHT UNIT

ITEM	SYMBOL	MIN.	MAX.	UNIT.	NOTE
Lamp Current	I_L	-	5.0	mArms	
Lamp Voltage	V_L	-	2,000	Vrms	

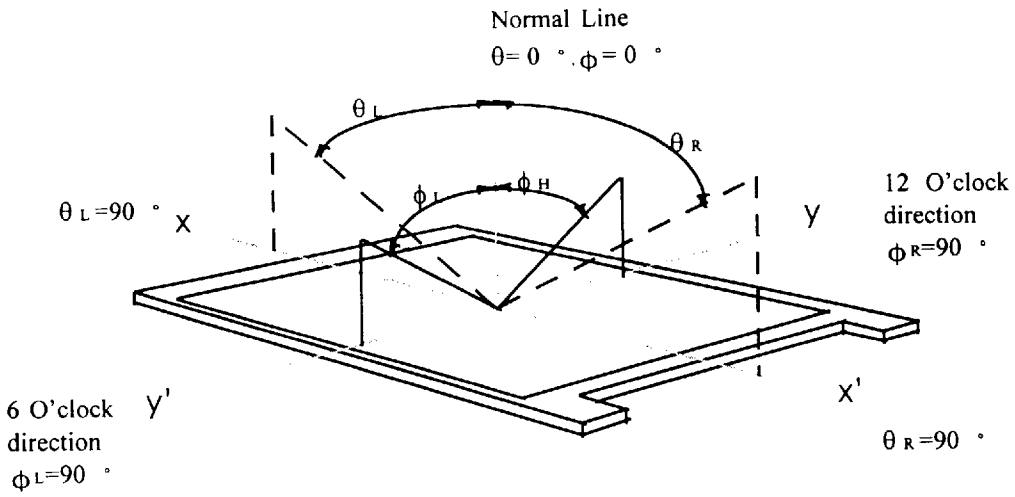
2. OPTICAL CHARACTERISTICS

The following items are measured when the conditions of this unit and measuring systems are stable. The optical characteristics shall be measured in the dark room or eqivalent state with the method shown in Note (6).
Measuring equipment : TOPCON BM-7, Prichard 1980B, or equivalent.

ITEM		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	NOTE
Contrast Ratio		CR	$\phi = 0$, $\theta = 0$, Normal viewing angle	80	100	-		(1), (2)
Response Time at 25℃	Rise	T_R		-	20	-	msec	(1), (3)
	Fall	T_F		-	30	-		
White Luminance				-	**70**	-	cd/m^2	
White Variation				-	-	1.25		(4)
Cross Modulation				-	-	5	%	(5)
Color Chromaticity (CIE)	Red	R_X		0.57	0.60	0.63		(1)
		R_Y		0.31	0.34	0.37		
	Green	G_X		0.28	0.31	0.34		
		G_Y		0.53	0.56	0.59		
	Blue	B_X		0.12	0.15	0.18		
		B_Y		0.10	0.13	0.16		
	White	W_X		0.30	0.33	0.36		
		W_Y		0.30	0.33	0.36		
Viewing Angle	Hor.	θ_L	CR ≥ 10	45	-	-	degree	
		θ_R		45	-	-		
	Ver.	ϕ_H		10	-	-		
		ϕ_L		30	-	-		

*. Ta = 25℃, Vcc= 5.0V, fv= 60Hz, f_{DCLK}= 40 MHz

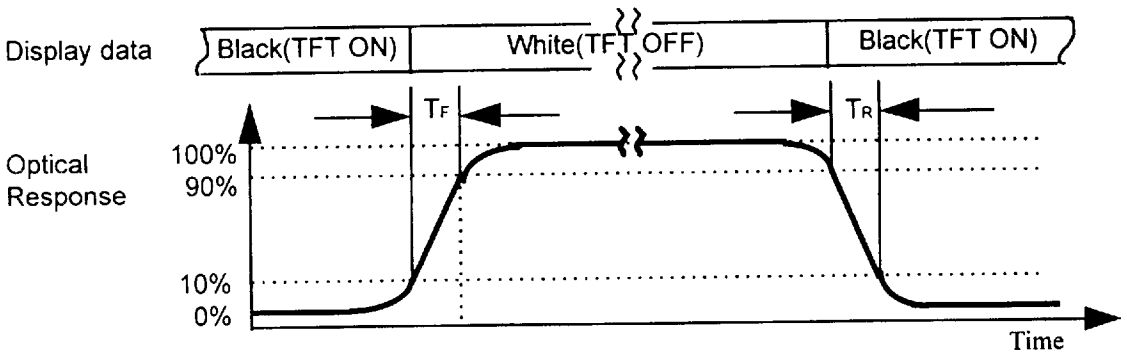
Note 1) Definition of Viewing Angle :



Note 2) Definition of Contrast Ratio(CR) :

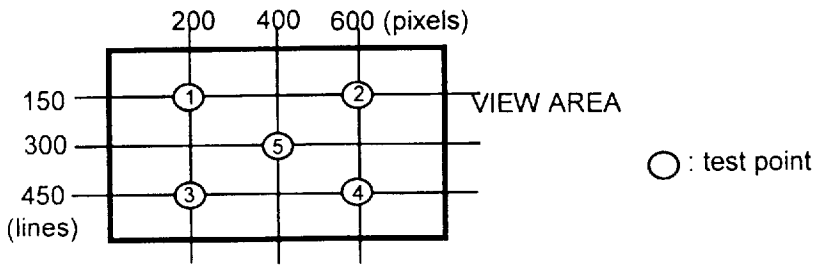
$$CR = \frac{\text{Luminance of all pixel white}}{\text{Luminance of all pixel dark}}$$

Note 3) Definition of Response time :



Note 4) Definition of White Variation : check the white luminance variation at 5 points.

$$\text{White Variation} = \frac{\text{MAX luminance}}{\text{MIN luminance}}$$



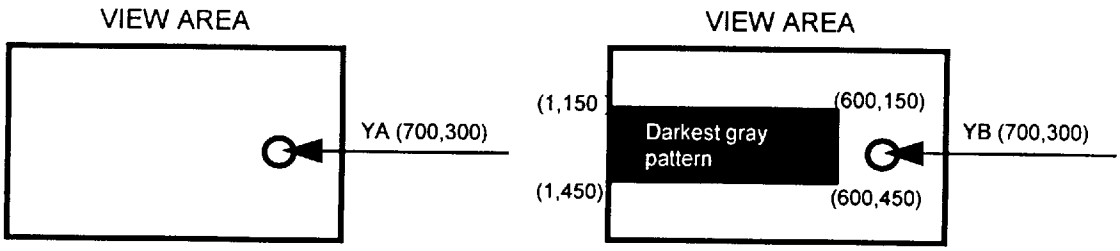
Note 5) Definition of Cross Modulation :

$$\text{Cross Modulation Ratio} = \frac{|Y_B - Y_A|}{Y_B} \times 100\ (\%)$$

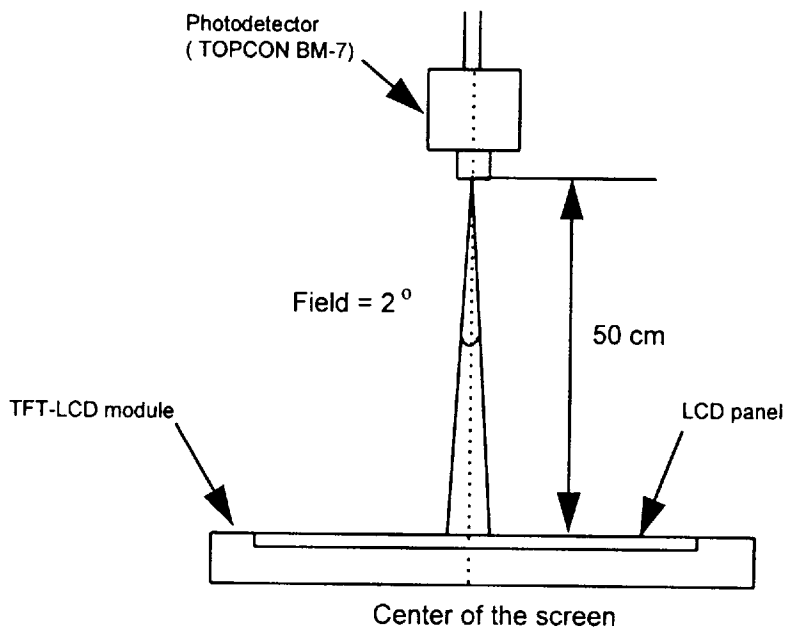
Where:

Y_A = Luminance of measured location without darkest gray pattern (cd/m^2)

Y_B =Luminance of measured location with darkest gray pattern (cd/m^2)



Note 6) The measurement shall be executed 30 minutes after lighting at rating.
The lamp current should be 3.2mA.



Optical characteristics measurement setup

3. ELECTRICAL CHARACTERISTICS

3.1 TFT LCD MODULE

Ta=25 ℃

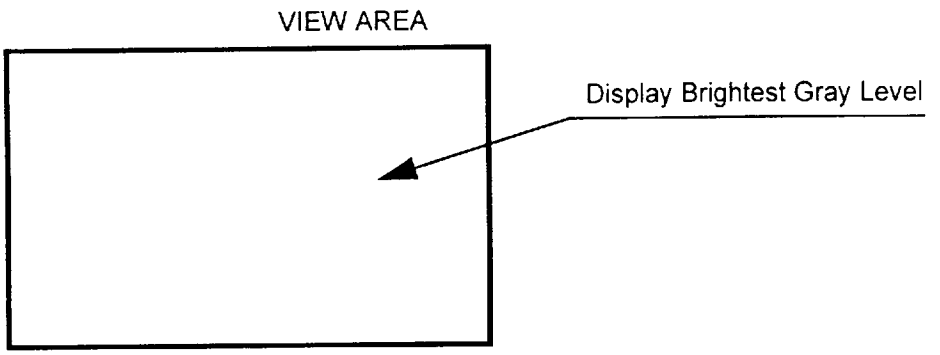
ITEM		SYMBOL	MIN	TYP	MAX	UNIT	NOTE
Power Supply Voltage		V_{DD}	4.75	5 .0	5.25	V	
Input Voltage for Logic Signals	High	V_{IH}	2.7	-	V_{DD}	V	(1)
	Low	V_{IL}	Vss	-	0.6	V	(1)
Power Supply Current		I_{DD}	100	115	180	mA	(2),(3),(4)
Vsync Frequency		f_V	-	60	-	Hz	
Hsync Frequency		f_H	-	37.879	-	kHz	
Main Frequency		f_{DCLK}	-	40	TBD	MHz	

Note (1) Display data pins and timing signal pins are subjected.

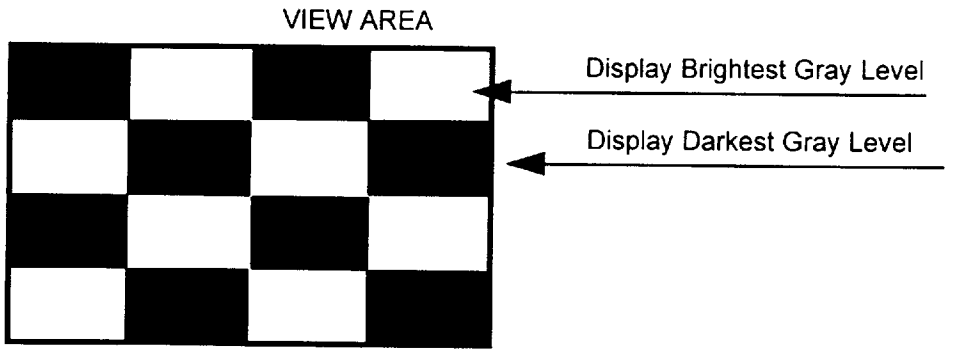
(2) f_V=60Hz, f_{CLK} =40MHZ, V_{DD} = 5.0 V, DC Current.

(3) Power dissipation check pattern.

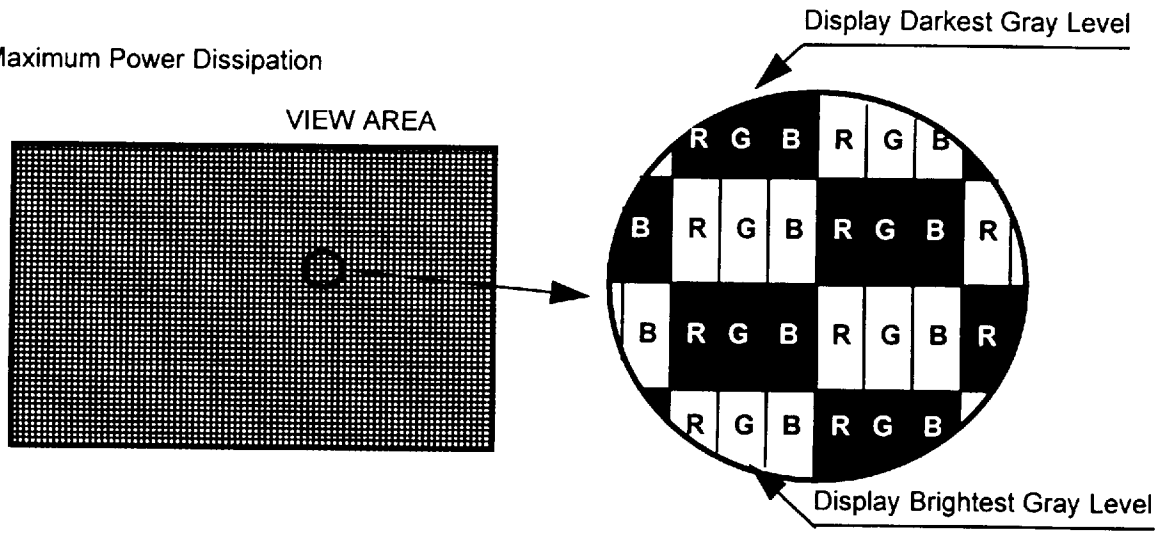
A) Minimum Power Dissipation



B) Typical Power Dissipation



C) Maximum Power Dissipation



3.2 BACK-LIGHT UNIT

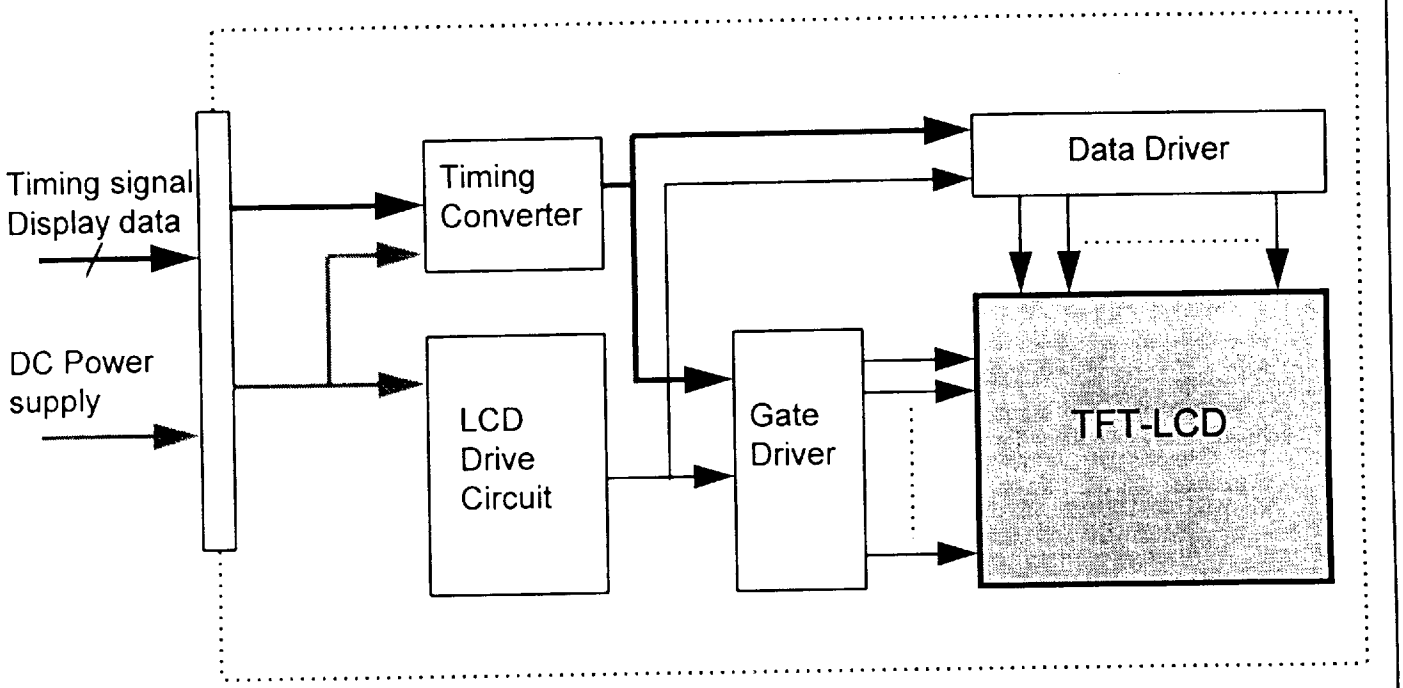
Ta=25 ℃

ITEM	SYMBOL	MIN	TYP	MAX	UNIT	NOTE
Lamp Current	I_L	2.0	3.2	5.0	mArms	(1)
Lamp Voltage	V_L	-	500	-	Vrms	
Frequency	f_L	-	50	-	kHz	
Power Consumption	P_L	-	1.6	-	W	(2)
Operating Life Time	Hr	10,000	-	-	Hour	(3)
Startup Voltage	V_S	-	-	950	Vrms	(4)
Lamp Startup Time		2	5	10	msec	

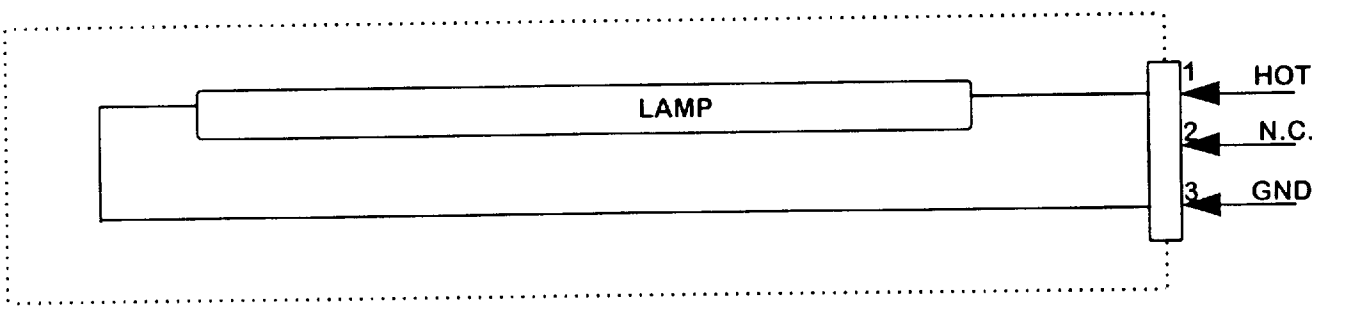
Note 1) Higher I_L cause the short life time of CCFL
2)Calucated value for reference (I_L x V_L)
3) Brightness become 50% of the original brightness at the standard condition.
4) 1400 Vrms at Ta = 0 ℃

4. BLOCK DIAGRAM

4.1 TFT LCD MODULE



4.2 BACK-LIGHT UNIT



5. INPUT TERMINAL PIN ASSIGNMENT

5.1 TFT LCD MODULE (interface signals & power)

Connector : Hirose DF9-41P-1V

Pin NO.	Symbol	Function	Polarity	Remark
1	GND	Power Ground	-	-
2	DCLK	Data Clock	-	(1)
3	GND	Power Ground	-	-
4	HSYNC	Horizontal Sync Signal	Negative	-
5	VSYNC	Vertical Sync Signal	Negative	-
6	GND	Power Ground	-	-
7	GND	Power Ground	-	-
8	GND	Power Ground	-	-
9	R0	Red Data (LSB)	Positive	(2)
10	R1	Red Data	"	
11	R2	Red Data	"	
12	GND	Power Ground	-	-
13	R3	Red Data	"	(2)
14	R4	Red Data	"	
15	R5	Red Data [MSB]	"	
16	GND	Power Ground	-	-
17	GND	Power Ground	-	-
18	GND	Power Ground	-	-
19	G0	Green Data [LSB]	Positive	(2)
20	G1	Green Data	"	
21	G2	Green Data	"	
22	GND	Power Ground	-	-
23	G3	Green Data	"	(2)
22	G4	Green Data	"	
25	G5	Green Data [MSB]	"	
26	GND	Power Ground	-	-
27	GND	Power Ground	-	-
28	GND	Power Ground	-	-
29	B0	Blue Data	"	(2)
30	B1	Blue Data	"	
31	B2	Blue Data	"	
32	GND	Power Ground	-	-
33	B3	Blue Data	"	(2)
34	B4	Blue Data	"	
35	B5	Blue Data [MSB]	"	
36	GND	Power Ground	-	-
37	DE [DTMG]	Data Enable [Display Timing]	Positive	-
38	N.C.	No Connection	-	Open
39	VDD	Power Supply [+5.0V]	-	-
40	VDD	Power Supply [+5.0V]	-	-
41	N.C.	No Connection	-	Open

Remark 1. Display Data is sampled at the negative edge of Data Clock.
2. Data level 0 means no color (Black).

5.2 Input Signals, Basic Display Colors and Gray Scale of Each Color

Color & Gray scale	Data Signal																	
	R0	R1	R2	R3	R4	R5	G0	G1	G2	G3	G4	G5	B0	B1	B2	B3	B4	B5
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
Light blue	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
Purple	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
Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	1	0	^ : 0	0	0	0	0	0	^ : 0	0	0	0	0	0	^ : 0	0	0
	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
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	1	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	^ : 0	0	0	0	1	0	^ : 0	0	0	0	0	0	^ : 0	0	0
	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0
Green	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0
Black	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	^ : 0	0	0	0	0	0	^ : 0	0	0	1	0	0	^ : 0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

0 : Low level voltage
1 : High level voltage

Note. MSB is R5,G5 & B5 and LSB is R0, G0 and B0

5.3 BACK LIGHT UNIT

Connector : JST BHR-03VS-1

Pin NO.	Symbol	Function
1	HOT	High Voltage
2	N.C.	No Connection
3	GND	Ground

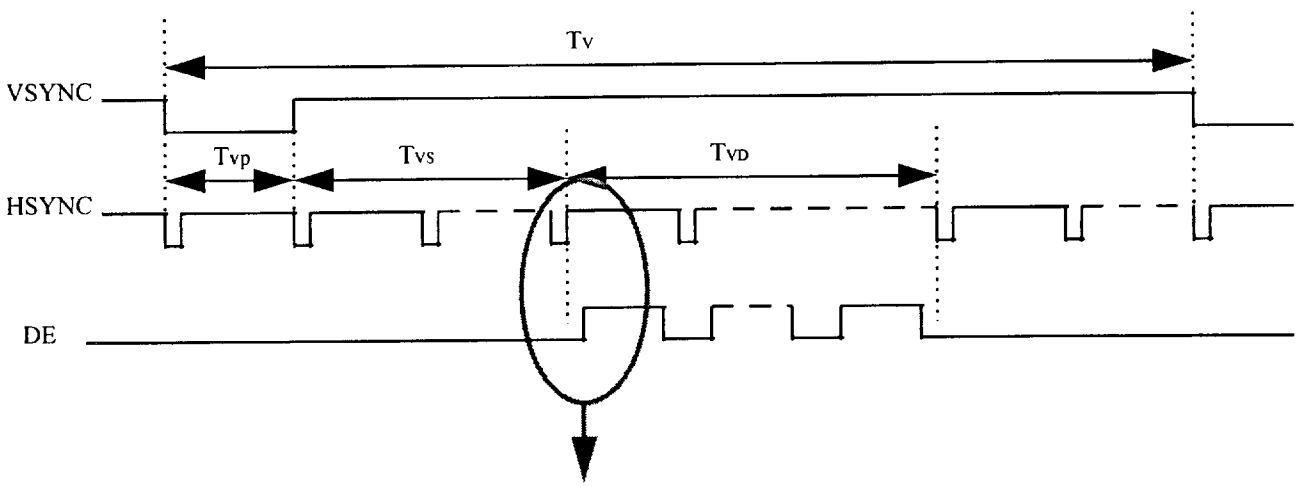
6. INTERFACE TIMING

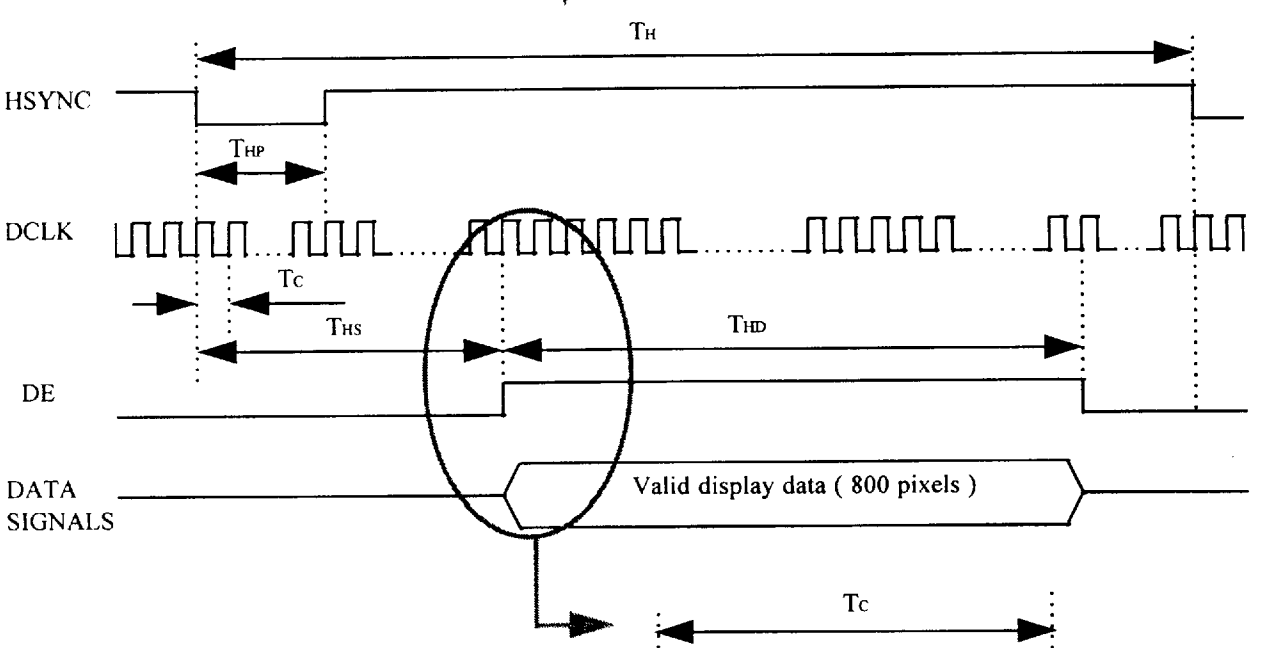
6.1 Timing Parameters (SYNC only and SYNC&DE mode)

Signal	Item	Symbol	MIN.	TYP.	MAX.	Unit	Note
Clock	Frequency	1 / Tc	38.0	40.0	42 .0	MHz	
	High Time	Tch	4	-	-	nsec	
	Low Time	Tcl	10	-	-	nsec	
Data	Setup Time	Tds	5	-	-	nsec	
	Hold Time	Tdh	10	-	-	nsec	
Data Enable	Setup Time	Tes	5	-	-	nsec	(1)
Horizontal Sync	Cycle	Th	24.0	26.4	31.5	usec	
			1024	1056	1056	clocks	
	Pulse Width	Thp	-	128	-	clocks	
Vertical Sync	Cycle	Tv	620	628	664	lines	
	Pulse Width	Tvp	-	4	-	lines	
Horizontal Signal	Display Start	Ths	-	216	-	clocks	
	Display period	Thd	-	800	-	clocks	
Vertical Signal	Display Start	Tvs	-	23	-	lines	
	Display Period	Tvd	-	600	-	lines	
Hsync - Vsync Phase Difference	Front	Tvhd	-320	-	1000	nsec	

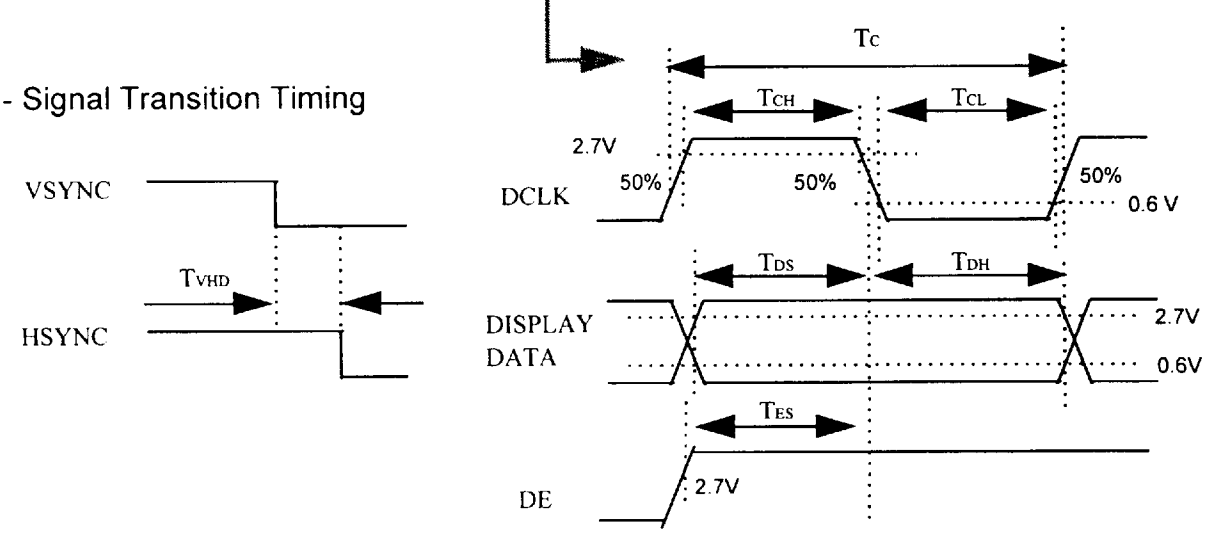
Note 1. The duration of DE [DTMG] signal must be longer than 1 clock period at every horizontal sync. period

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





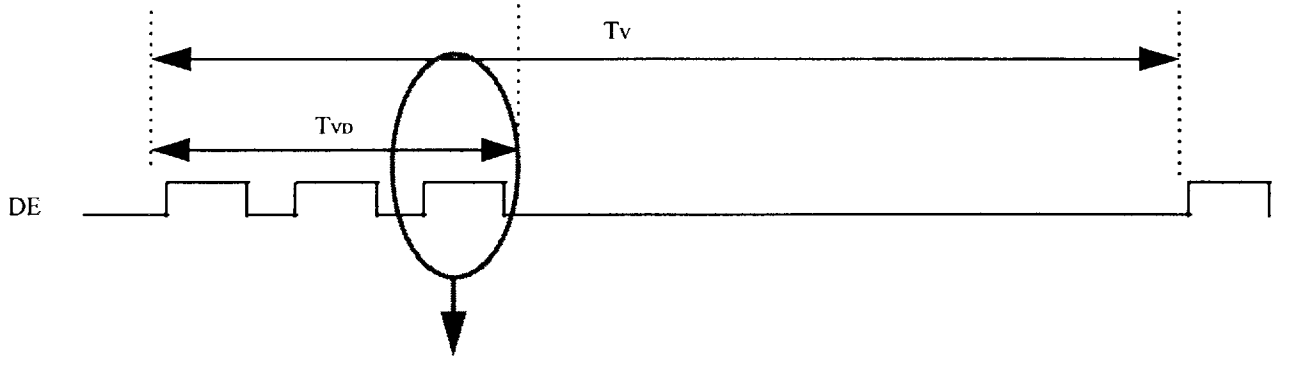
- Signal Transition Timing

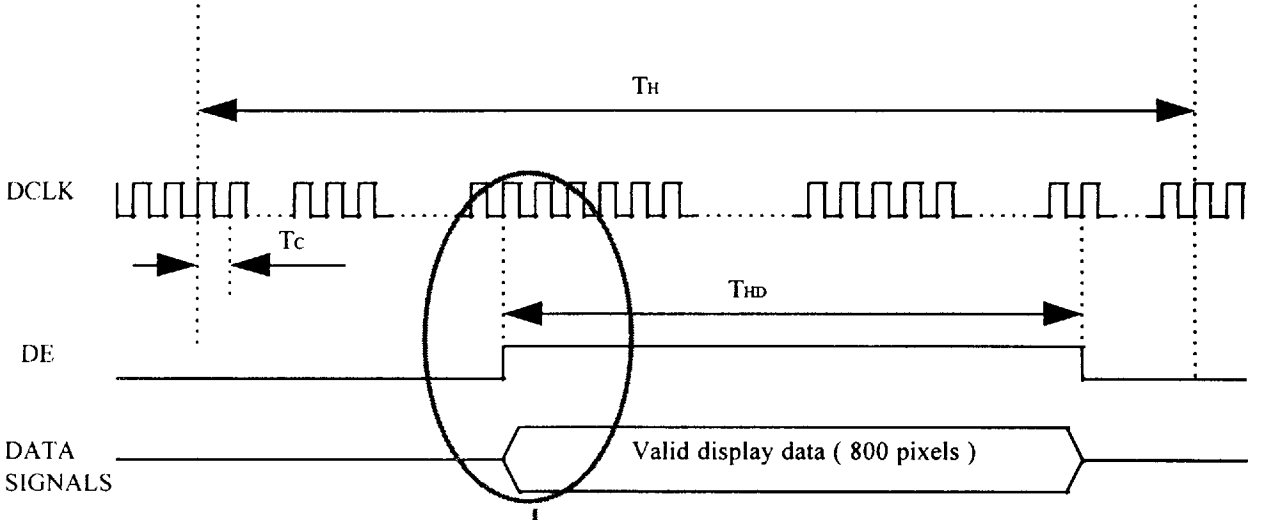


6.3 Timing Parameters (DE only mode)

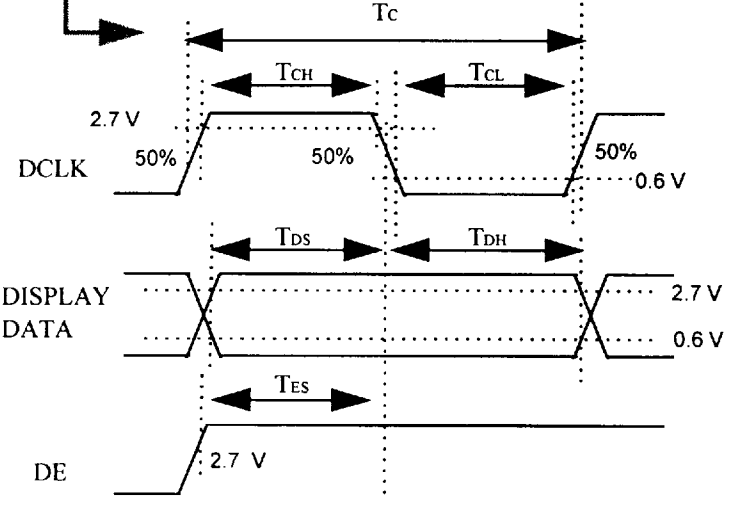
Signal	Item	Symbol	MIN	TYP	MAX	Unit	Note
Clock	Frequency	1 / Tc	38.0	40.0	42.0	MHz	
	High Time	T_{CH}	4	-	-	nsec	
	Low Time	T_{CL}	10	-	-	nsec	
Data	Setup Time	T_{DS}	5	-	-	nsec	
	Hold Time	T_{DH}	10	-	-	nsec	
Data Enable	Setup Time	T_{ES}	5	-	-	nsec	
Frame Frequency	Cycle	T_V	620	628	664	lines	
Vertical Active Display Term	Display Period	T_{VD}	600	600	600	lines	
One Line Scanning Time	Cycle	T_H	1024	1056	1056	clocks	
Horizontal Active Display Term	Display Period	T_{HD}	800	800	800	clocks	

6.4 Timing diagrams of interface signal (DE only mode)



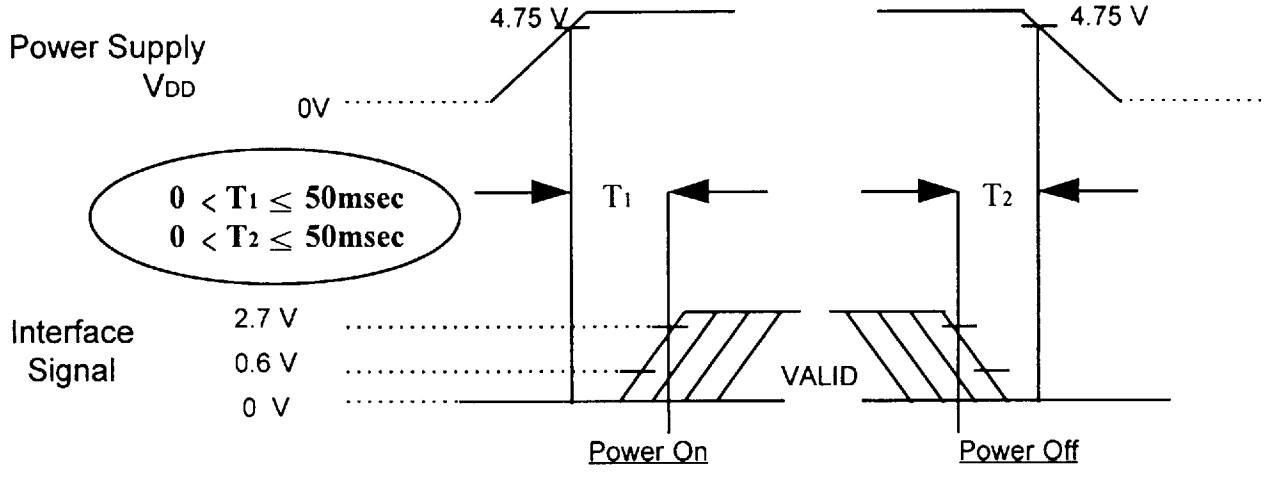


- Signal Transition Timing



6.5 Power ON/OFF Sequence

: To prevent a latch-up or DC operation of the LCD module, the power on/off sequence shall be as shown below.



Power ON/OFF Sequence

NOTE. Do not keep the interface signal high-impedance when power is on.

7. RELIABILITY TEST

No.	Test Item	Condition
1	High temperature storage test	Ta = 60 ℃, 250hr
2	Low temperature storage test	Ta = - 25 ℃, 250hr
3	High temperature & high humidity operation test	Ta = 40 ℃, 90%, 250hr (Without condensation)
4	High temperature operation test	Ta = 50℃, Dynamic, 250hr
5	Low temperature operation test	Ta = 0 ℃, Dynamic, 250hr
6	Vibration test (non-operatiing)	10 ~ 50 Hz (1.5mm stroke) 5-~ 500 Hz (1.5G) Test period : 6 hours (2 hours for each direction)
7	Shock test (non-operating)	Max. gravity : 100G Pulse width : 6ms, sine wave Direction : ± X , ±Y, ±Z Three times for each direction
8	Thermal shock	-20℃ (0.5 hr) 60℃ (0.5hr) 50 cycle
9	Electrostatic Discharge Test	200 pF, 0 ohm ±200V(terminals) ±5000V(chassis and panel)

[Result Evaluation Criteria]
Under the dispaly quality test conditions with normal operation state, these shall be no change which may affect practical display function.