HY-LINE®
COMPUTER COMPONENTS

TFT-Display Datenblatt

Modell LB170E01-SL01

Kurzdaten

Hersteller	LG Display
Diagonale	17” / 43,2 cm
Format	5:4
Auflösung	1280 x 1024
Backlight	LED / 400 cd/m²
Interface	LVDS
Touchscreen	nein
Temperatur	-10…+70 °C (Betrieb)

HY-LINE Computer Components Vertriebs GmbH
Inselkammerstr. 10, 82008 Unterhaching bei München
Tel.: +49 89 614 503 40 || Fax: +49 89 614 503 50
computer@hy-line.de || www.hy-line.de/computer

SPECIFICATION
FOR
APPROVAL

( ) **Preliminary Specification**
(◆) **Final Specification**

Title	17" SXGA TFT LCD

Customer	
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LB170E01
Suffix	SL01

*When you obtain standard approval,
please use the above model name without suffix

APPROVED BY		SIGNATURE
/		
/		
/		

Please return 1 copy for your confirmation with your signature and comments.

APPROVED BY	SIGNATURE
Y. T. Woo / G.Manager	2014. 1. 10
REVIEWED BY	
K. H. Choi / Manager [C]	
B. C. Lee / Manager [M]	
M. S. Kang / Manager [P]	
PREPARED BY	
B. Y. Ha / Engineer	2014. 01. 10

Products Engineering Dept.
LG Display Co., Ltd

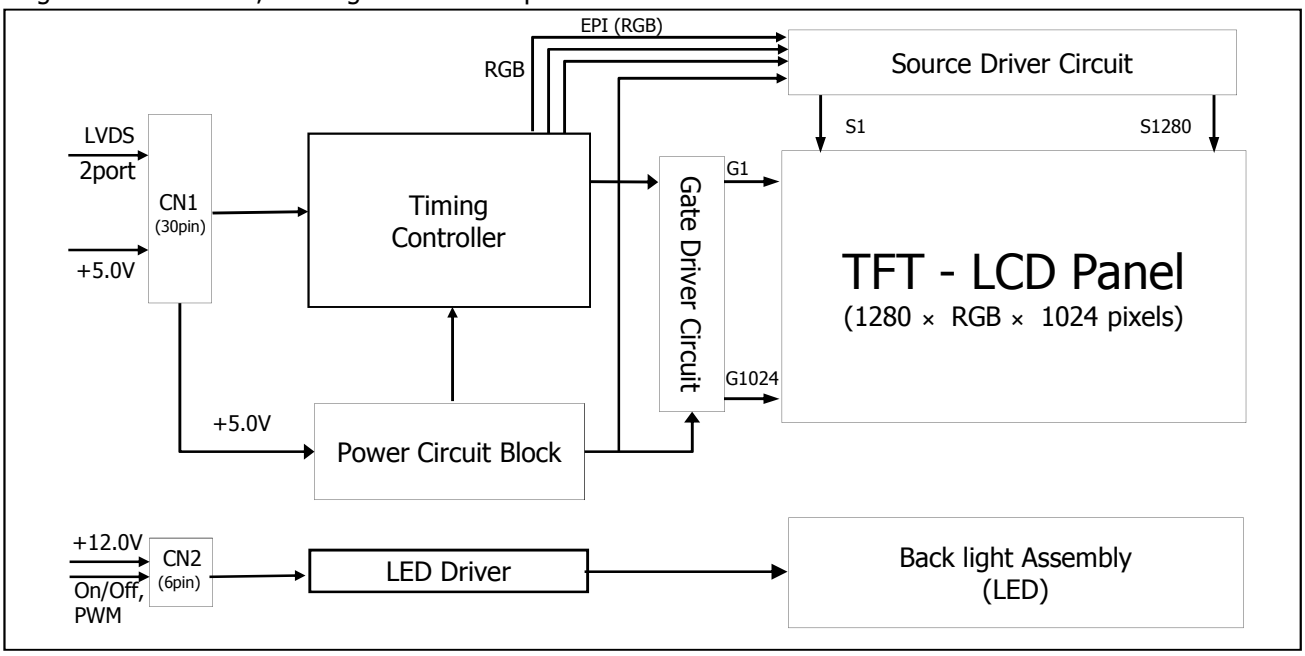
Contents

RECORD OF REVISIONS

Revision No	Revision Date	Page	Description
0.0	Mar. 13. 2013	-	First Draft, Preliminary Specifications
0.1	May. 01. 2013	4	Change General Features
		6	Change Electrical Characteristics
		9	Change Mating Connector
		24	Change Weight
0.2	Jun. 10. 2013	4	Change General Features
		5	Change ABSOLUTE MAXIMUM RATINGS
		6	Change LCD Module ELECTRICAL CHARACTERISTICS
		13	Change Timing Table
		18	Change OPTICAL CHARACTERISTICS
		27	Change Reliability
0.3	Jun. 18. 2013	10	Change Flat Link (THINE:THC63LVD823) Transmitter
0.4	Jul. 12. 2013	13	Change Timing Table
0.5	Oct.10.2013	4	Define weight(Max.)
		6	Define LED PWM Dimming frequency
		8	Change User connector
		18	Change Optical characteristics
		24	Added the LCM weight
		25, 26	Add the screw on the back of LCM, Changed User connector
0.6	Nov.25	9,26	Changed Backlight connector (CN2)
		18	Changed color coordinate Wx,Wy
		26	Change LED connector and Position, Cover shield hole size FFC fixing tape shape
1.0	Dec.16.2013	4,6	Changed Power consumption
		28	Change Safety, Environment
		-	Final Draft

1. General Description

LB170E01 is a Color Active Matrix Liquid Crystal Display with an integral Light Emitting Diode (White LED) backlight system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally black mode. It has a 17.0 inch diagonally measured active display area with SXGA resolution (1024 vertical by 1280 horizontal pixel array) Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,7M colors
It has been designed to apply the 8Bit 2 port LVDS interface.
It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important.



[Figure 1] Block diagram

General Features

Active Screen Size	17.0 inch (432.75mm) diagonal
Outline Dimension	368.0(H) x 306.0(V) x 14.3(D) mm(Typ.)
Pixel Pitch	0.264 mm x 0.264mm
Pixel Format	1280 horiz. by 1024 vert. Pixels. RGB stripe arrangement
Color Depth	16,7M colors
Luminance, White	400 cd/m^2 (Center 1 Point, Typ.)
Viewing Angle(CR>10)	View Angle Free (R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	Total 15.35 Watt (Typ.) (2.75 Watt @V_{LCD}, 12.6 Watt @V_{BL})
Weight	1260 g (typ.),1310g(max.)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Hard coating(3H), Anti-Glare treatment of the front polarizer

2. Absolute Maximum Ratings

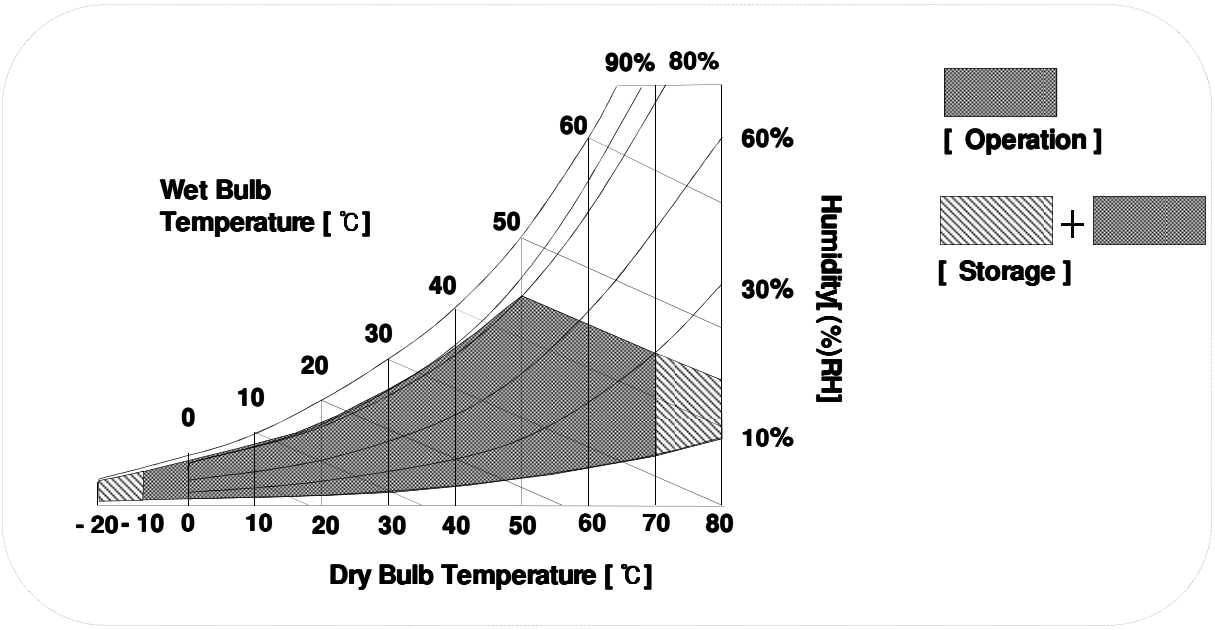
The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	VLCD	-0.3	6.0	Vdc	at 25 ± 2℃
Operating Temperature	TOP	-10	70	℃	1, 2, 3
Storage Temperature	TST	-20	80	℃	
Operating Ambient Humidity	HOP	10	90	%RH	
Storage Humidity	HST	10	90	%RH	

Note : 1. Temperature and relative humidity range are shown in the figure below.
Wet bulb temperature should be 39 ℃ Max, and no condensation of water.
2. Maximum Storage Humidity is up to 40℃, 70% RH only for 4 corner light leakage Mura.
3. Storage condition is guaranteed under packing condition

FIG.2 Temperature and relative humidity



3. Electrical Specifications

3-1. Electrical Characteristics

It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input power for the LED/Backlight, is typically generated by a LED Driver. The LED Driver is an internal unit to the LCDs.

Table 2-1. LCD Module ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	V_{LCD}	4.5	5.0	5.5	Vdc	
Power Supply Input Current	I_{LCD}	-	550	715	mA	1
		-	800	1040	mA	2
Power Consumption	$P_{C\ TYP}$	-	2.75	3.58	Watt	1
	$P_{C\ MAX}$	-	4.0	5.2	Watt	2
Differential Impedance	Zm	90	100	110	Ohm	
Rush current	I_{RUSH}	-	-	3.0	A	3
BACKLIGHT(With LED Driver):						
LED Power Supply Voltage	V_{BL}	11.5	12	12.5	V	
LED Power Supply Current	I_{BL}	-	1050	1155	mA	
LED Power Consumption	P_{BL}	-	12.6	13.86	Watt	
PWM Duty Ratio		10		100	%	
PWM Dimming Frequency	F_{PWM}	9	10	11	KHz	
PWM Duty High Voltage	V_H	3.0	3.3	3.6	Vdc	
PWM Duty Low Voltage	V_L	0.0		0.3	Vdc	
Backlight Enable Voltage	V_{ON}	-	3.3	-	Vdc	
Backlight Disable Voltage	V_{OFF}	-	0	-	Vdc	
Life Time	LED_LT	50,000	-	-	Hrs	7

Note : Product Specification

1. The specified current and power consumption are under the V_{LCD}=5.0V, 25 ℃,f_V=60Hz condition whereas Typical Power Pattern[Mosaic] shown in the [Figure 3] is displayed.

2. The current is specified at the maximum current pattern.

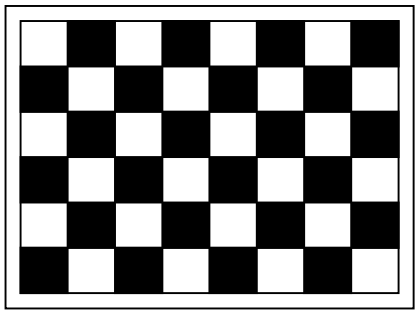
3. Maximum Condition of Inrush current :
   The duration of rush current is about 5ms and rising time of power Input is 500us ± 20%.(min.).

4. The current and power consumption with LED Driver are under the V_{BL} = 12.0V, 25℃, Dimming of Max luminance and White pattern with the normal frame frequency operated(60Hz).

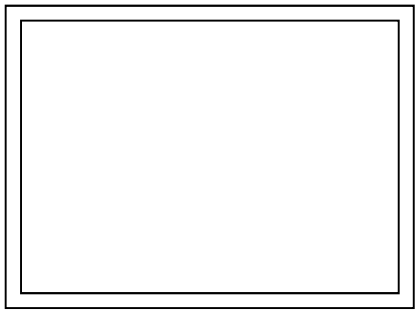
5. The operation of LED Driver below minimum dimming ratio may cause flickering or reliability issue.

6. This Spec. is not effective at 100% dimming ratio as an exception because it has DC level equivalent to 0Hz. In spite of acceptable range as defined, the PWM Frequency should be fixed and stable for more consistent brightness control at any specific level desired.

7. The life is determined as the time at which luminance of the LED is 50% compared to that of initial value at the typical LED current on condition of continuous operating at 25 ± 2℃



Typical power Pattern



Maximum power Pattern

FIG.3 Mosaic pattern & White Pattern for power consumption measurement

3-2. Interface Connections

3-2-1. LCD Module

- LCD Connector(CN1). : GT103-30S-H23 (LSM)
- Mating Connector : FI-X30C2L (Manufactured by JAE) or Equivalent

Table 3. MODULE CONNECTOR(CN1) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Symbol
1	FR0M	Minus signal of odd channel 0 (LVDS)	16	SR1P	Plus signal of even channel 1 (LVDS)
2	FR0P	Plus signal of odd channel 0 (LVDS)	17	GND	Ground
3	FR1M	Minus signal of odd channel 1 (LVDS)	18	SR2M	Minus signal of even channel 2 (LVDS)
4	FR1P	Plus signal of odd channel 1 (LVDS)	19	SR2P	Plus signal of even channel 2 (LVDS)
5	FR2M	Minus signal of odd channel 2 (LVDS)	20	SCLKINM	Minus signal of even clock channel (LVDS)
6	FR2P	Plus signal of odd channel 2 (LVDS)	21	SCLKINP	Plus signal of even clock channel (LVDS)
7	GND	Ground	22	SR3M	Minus signal of even channel 3 (LVDS)
8	FCLKINM	Minus signal of odd clock channel (LVDS)	23	SR3P	Plus signal of even channel 3 (LVDS)
9	FCLKINP	Plus signal of odd clock channel (LVDS)	24	GND	Ground
10	FR3M	Minus signal of odd channel 3 (LVDS)	25	NC	No Connection.(I2C Serial interface for LCM)
11	FR3P	Plus signal of odd channel 3 (LVDS)	26	NC	No Connection.(I2C Serial interface for LCM)
12	SR0M	Minus signal of even channel 0 (LVDS)	27	NC	No Connection.
13	SR0P	Plus signal of even channel 0 (LVDS)	28	V_{LCD}	Power Supply +5.0V
14	GND	Ground	29	V_{LCD}	Power Supply +5.0V
15	SR1M	Minus signal of even channel 1 (LVDS)	30	V_{LCD}	Power Supply +5.0V

Note: 1. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.
2. All V_{LCD} (power input) pins should be connected together.
3. Input Level of LVDS signal is based on the IEA 664 Standard.

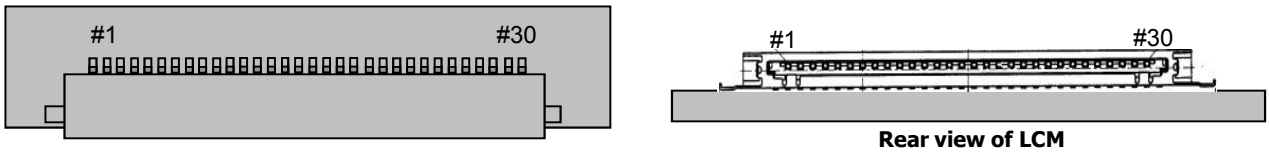


FIG.4 Connector diagram

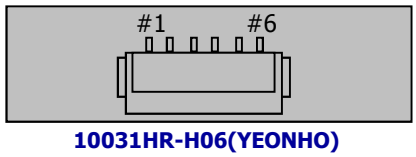
3-2-2. BACKLIGHT

- BACKLIGHT Connector(CN2). : **10031HR-H06 (YENHO)**

Table 4. BACKLIGHT CONNECTOR(CN2) PIN CONFIGURATION

No	Symbol	Description
1	V_{BL}	Backlight Power Supply(12.0 Typ.)
2	V_{BL}	Backlight Power Supply(12.0 Typ.)
3	V_{BL}	Backlight Power Supply(12.0 Typ.)
4	GND	Ground
5	On/Off	Backlight On/Off, High(3.3V Typ.): On, Low(Ground): Off
6	PWM	PWM Dimming Signal

Note: 1. All GND(ground) pins should be connected together and the LCD's metal frame.
2. All V_{BL} (power input) pins should be connected together.



10031HR-H06(YEONHO)

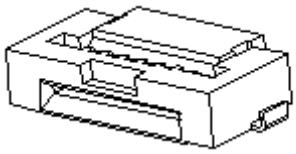


FIG.5 Connector diagram

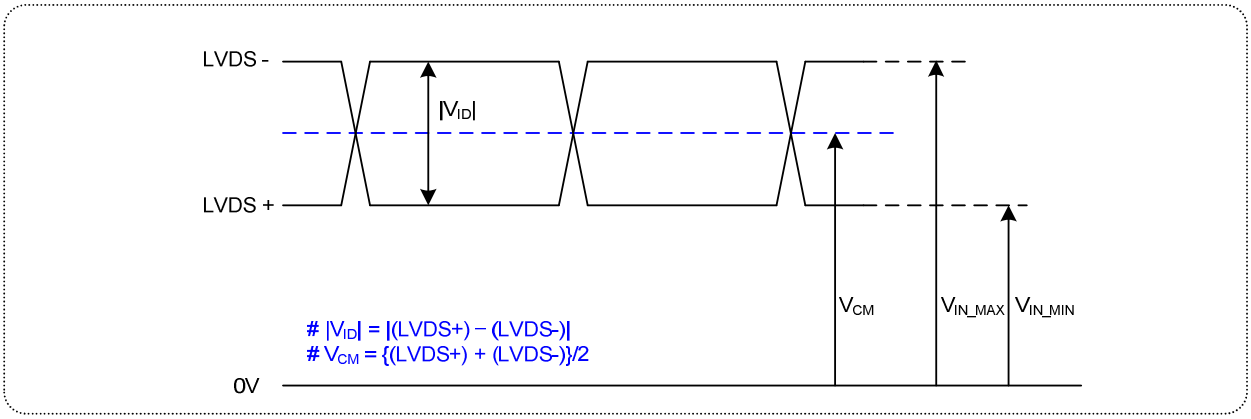
Table 4. REQUIRED SIGNAL ASSIGNMENT FOR Flat Link (THINE:THC63LVD823) Transmitter

Pin#	Pin Name	Descrption	Pin#	Pin Name	Descrption
1	B24	The 2nd Pixel Data Input	51	R10	The 1st Pixel Data Input
2	B25	The 2nd Pixel Data Input	52	R11	The 1st Pixel Data Input
3	VCC	Power Supply for TTL input	53	R12	The 1st Pixel Data Input
4	GND	Ground for TTL input	54	R13	The 1st Pixel Data Input
5	B26	The 2nd Pixel Data Input	55	VCC	Power Supply for TTL input
6	B27	The 2nd Pixel Data Input	56	GND	Ground for TTL input
7	HSYNC	Hsync Input	57	R14	The 1st Pixel Data Input
8	VSYNC	Vsync Input	58	R15	The 1st Pixel Data Input
9	DE	Data Enable Input	59	R16	The 1st Pixel Data Input
10	CLKIN	Clock Input	60	R17	The 1st Pixel Data Input
11	R/F	Input Clock Triggering Edge Select	61	G10	The 1st Pixel Data Input
12	RS	LVDS swig range select	62	G11	The 1st Pixel Data Input
13	TEST1	Test pin	63	G12	The 1st Pixel Data Input
14	TEST2	Test pin	64	G13	The 1st Pixel Data Input
15	MODE1	Pixel Data Mode	65	G14	The 1st Pixel Data Input
16	MODE0	Pixel Data Mode	66	G15	The 1st Pixel Data Input
17	OE	Output enable	67	G16	The 1st Pixel Data Input
18	6/8	6bit/8bit color select	68	G17	The 1st Pixel Data Input
19	/PDWN	Power down	69	B10	The 1st Pixel Data Input
20	TEST3	Test pin	70	B11	The 1st Pixel Data Input
21	TEST4	Test pin	71	VCC	Power Supply for TTL input
22	TEST5	Test pin	72	GND	Ground for TTL input
23	PLL GND	Ground for PLL circuitry	73	B12	The 1st Pixel Data Input
24	PLL VCC	Power Supply for PLL circuitry	74	B13	The 1st Pixel Data Input
25	PLL GND	Ground for PLL circuitry	75	B14	The 1st Pixel Data Input
26	LVDS GND	Ground for LVDS output	76	B15	The 1st Pixel Data Input
27	TD2+	The 2nd Link. The 2nd pixel output data	77	B16	The 1st Pixel Data Input
28	TD2-	The 2nd Link. The 2nd pixel output data	78	B17	The 1st Pixel Data Input
29	TCLK2+	LVDS Clock Out for 2nd Link	79	B20	The 2nd Pixel Data Input
30	TCLK2-	LVDS Clock Out for 2nd Link	80	B21	The 2nd Pixel Data Input
31	TC2	The 2nd Link. The 2nd pixel output data	81	B22	The 2nd Pixel Data Input
32	TC2+	The 2nd Link. The 2nd pixel output data	82	B23	The 2nd Pixel Data Input
33	LVDS VCC	Power Supply for LVDS Output	83	B24	The 2nd Pixel Data Input
34	TB2+	The 2nd Link. The 2nd pixel output data	84	B25	The 2nd Pixel Data Input
35	TB2-	The 2nd Link. The 2nd pixel output data	85	B26	The 2nd Pixel Data Input
36	TA2+	The 2nd Link. The 2nd pixel output data	86	B27	The 2nd Pixel Data Input
37	TA2-	The 2nd Link. The 2nd pixel output data	87	VCC	Power Supply for TTL input
38	LVDS GND	Ground for LVDS output	88	GND	Ground for TTL input
39	TD1+	The 1st Link. The 1st Pixel output data	89	G20	The 2nd Pixel Data Input
40	TD1-	The 1st Link. The 1st Pixel output data	90	G21	The 2nd Pixel Data Input
41	TCLK1+	LVDS Clock Out for 1st Link	91	G22	The 2nd Pixel Data Input
42	TCLK1-	LVDS Clock Out for 1st Link	92	G23	The 2nd Pixel Data Input
43	TC1+	The 1st Link. The 1st Pixel output data	93	G24	The 2nd Pixel Data Input
44	TC1-	The 1st Link. The 1st Pixel output data	94	G25	The 2nd Pixel Data Input
45	LVDS VCC	Power Supply for LVDS Output	95	G26	The 2nd Pixel Data Input
46	TB1+	The 1st Link. The 1st Pixel output data	96	G27	The 2nd Pixel Data Input
47	TB1-	The 1st Link. The 1st Pixel output data	97	B20	The 2nd Pixel Data Input
48	TA1+	The 1st Link. The 1st Pixel output data	98	B21	The 2nd Pixel Data Input
49	TA1-	The 1st Link. The 1st Pixel output data	99	B22	The 2nd Pixel Data Input
50	LVDS GND	Ground for LVDS output	100	B23	The 2nd Pixel Data Input

Note : Refer to LVDS Transmitter Data Sheet for detail descriptions.

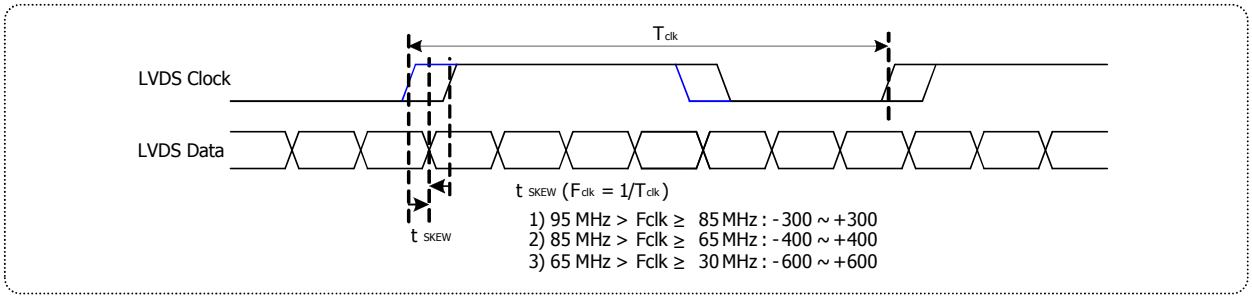
LVDS Input characteristics

1. DC Specification

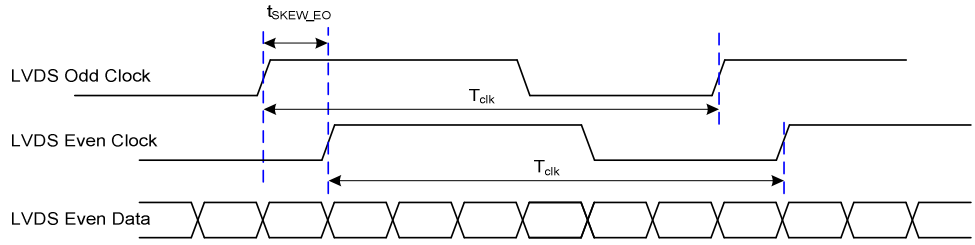


Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$\|V_{ID}\|$	200	600	mV	-
LVDS Common mode Voltage	V_{CM}	1.0	1.5	V	-
LVDS Input Voltage Range	V_{IN}	0.7	1.8	V	-
Change in common mode Voltage	ΔV_{CM}	-	250	mV	-

2. AC Specification



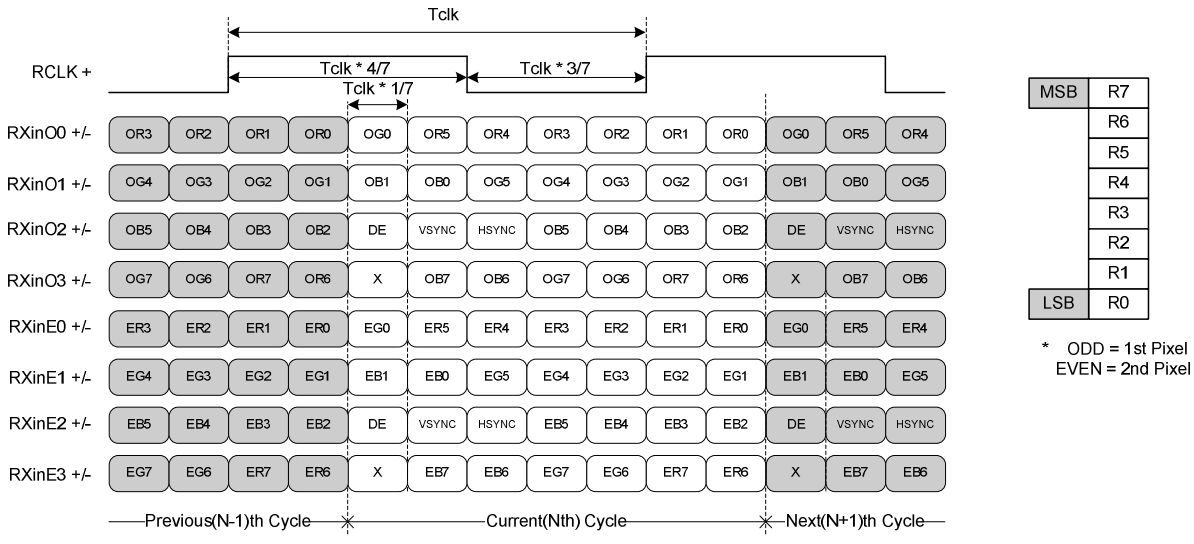
Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	- 300	+ 300	ps	95MHz > Fclk ≥ 85MHz
	t_{SKEW}	- 400	+ 400	ps	85MHz > Fclk ≥ 65MHz
	t_{SKEW}	- 600	+ 600	ps	65MHz > Fclk ≥ 30MHz
LVDS Clock to Clock Skew Margin (Even to Odd)	t_{SKEW_EO}	- 1/7	+ 1/7	T_{clk}	-



< Clock skew margin between channel >

3. Data Format

1) LVDS 2 Port



< LVDS Data Format >

3-3. Signal Timing Specifications

This is signal timing required at the input of the TMDS transmitter. All of the interface signal timing should be satisfied with the following specifications for it's proper operation.

Table 6. TIMING TABLE

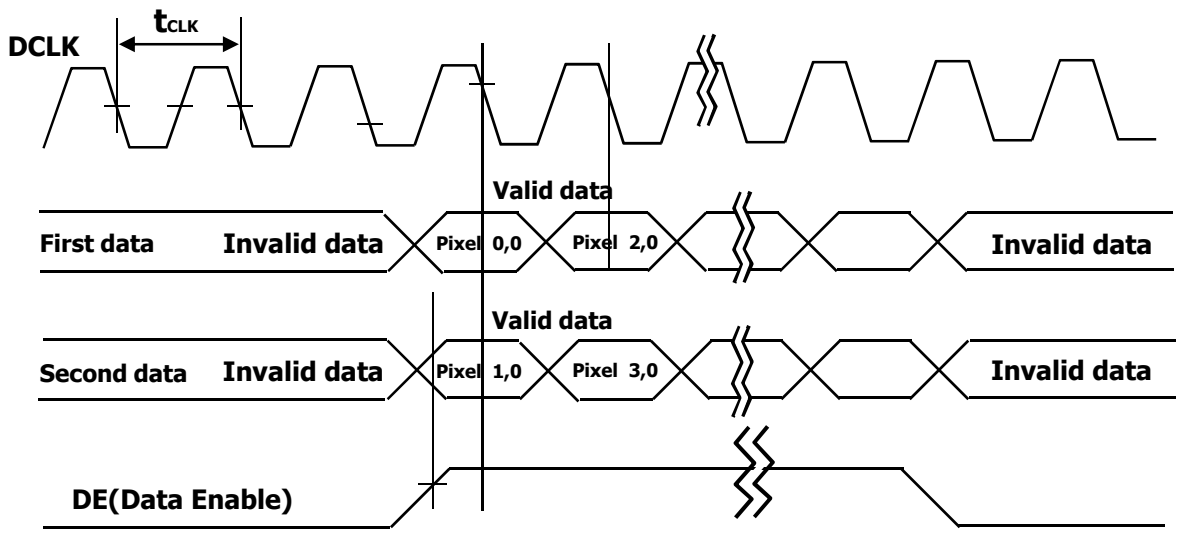
ITEM	Symbol		Min	Typ	Max	Unit	Note
DCLK	Period	t_{CLK}	14.7	18.5	23.6	ns	
	Frequency	-	42.3	54.0	68.4	MHz	
Horizontal	total	t_{HP}	688	844	960	t_{CLK}	
	Frequency	f_H	49.4	64.0	81.3	KHz	
	Blanking		48	204	300	t_{CLK}	
	valid	t_{WH}	640	640	640	t_{CLK}	
Vertical	total	t_{VP}	1040	1066	1320	t_{HP}	
	Frequency	f_V	47	60	76	Hz	
	Blanking		16	42	296	t_{HP}	
	valid	t_{WV}	1024	1024	1024	t_{HP}	

Note:

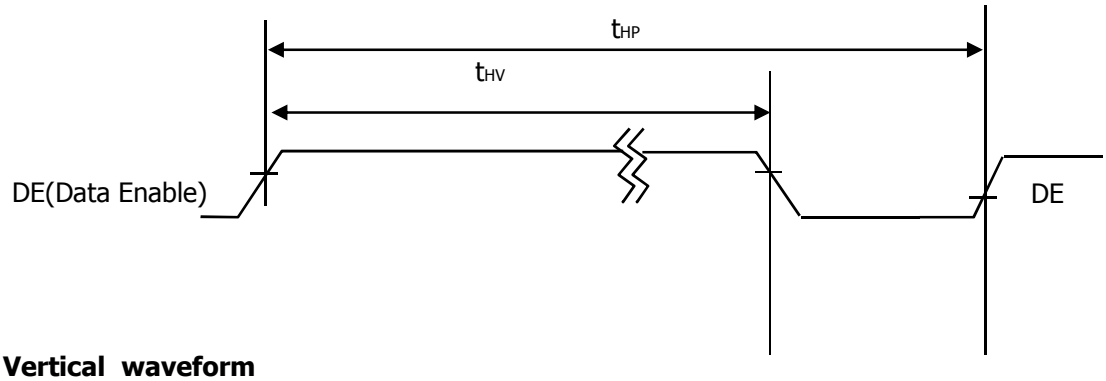
1. DE Only mode operation. The input of Hsync & Vsync signal does not have an effect on LCD normal operation.
2. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
3. Horizontal period should be even.

3-4. Signal Timing Waveforms

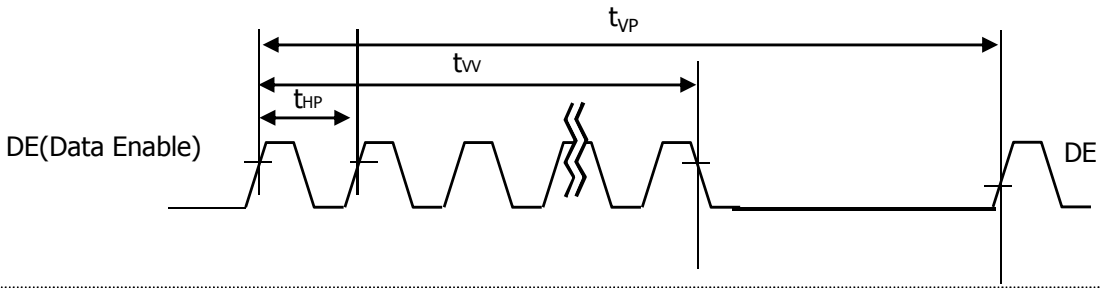
1. DCLK , DE, DATA waveforms



2. Horizontal waveform



3. Vertical waveform



3-5. Color Input Data Reference

The Brightness of each primary color(red,green,blue) is based on the 8-bit gray scale data input for the color; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 7. COLOR DATA REFERENCE

Color		Input Color Data																							
		RED								GREEN								BLUE							
		MSB							LSB	MSB							LSB	MSB							LSB
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
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
	Red (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	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
	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
RED	RED (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (001)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	...					...								...								...			
	RED (254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	...					...								...								...			
	GREEN (254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	GREEN (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
BLUE	BLUE (000) Dark	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 (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	...					...								...								...			
	BLUE (254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	BLUE (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

3-6. Power Sequence

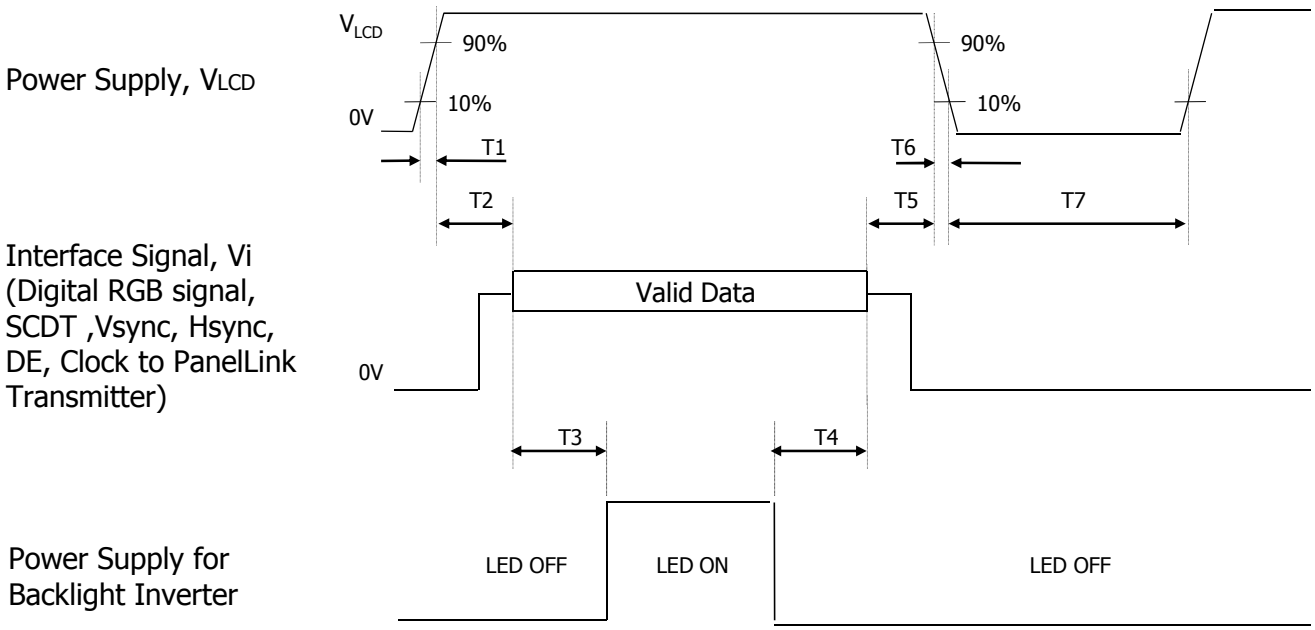


FIG.5 Power sequence

Table 8. POWER SEQUENCE

Parameter	Values			Units
	Min	Typ	Max	
T1	0.5	-	10	ms
T2	0.01	-	50	ms
T3	500	-	-	ms
T4	200	-	-	ms
T5	0.01	-	50	ms
T7	1000		-	ms

Notes : 1. Please avoid floating state of interface signal at invalid period.
2. When the interface signal is invalid, be sure to pull down the power supply for LCD V_{LCD} to 0V.
3. LED power must be turn on after power supply for LCD and interface signal are valid.

3-7. V_{LCD} Power Dip Condition

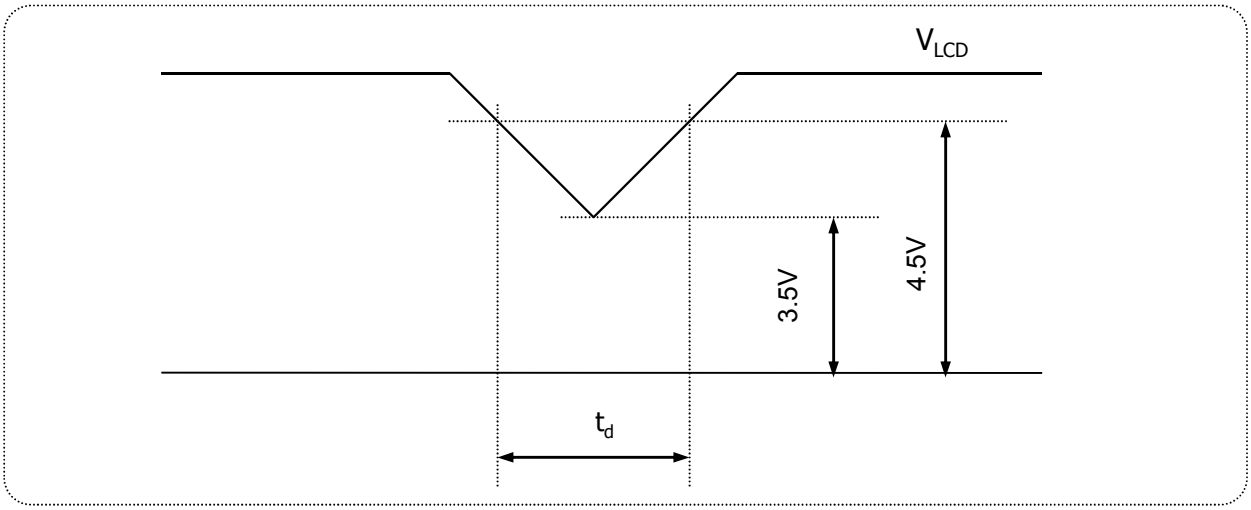


FIG.6 Power dip condition

1) Dip condition

$3.5V \leq V_{LCD} < 4.5V$, $t_d \leq 20ms$

2) $V_{LCD} < 3.5V$

V_{LCD}-dip conditions should also follow the Power On/Off conditions for supply voltage.

4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 15 minutes in a dark environment at 25± 2℃. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0 ° and aperture 1 degree.
FIG. 1 presents additional information concerning the measurement equipment and method.

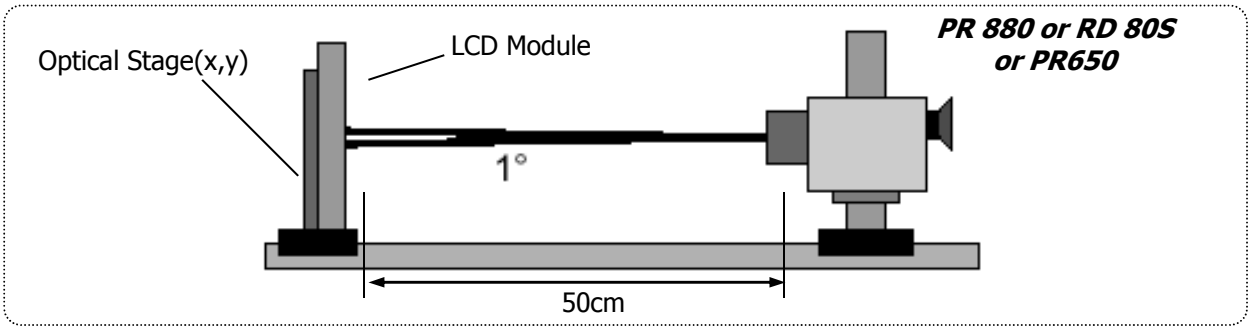


FIG.7 Optical Characteristic Measurement Equipment and Method

Table 9. OPTICAL CHARACTERISTICS (Ta=25 ℃, V_{LCD}=5V, f_V=60Hz Dclk=45.5MHz)

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	600	1000	-		1
Surface Luminance, white		L_{WH}	320	400	-	cd/m^2	2
Luminance Variation		δ_{WHITE}	-	-	1.33	%	3
Response Time	Rise Time	Tr_R	-	13	20	ms	
	Decay Time	Tr_D		9	14		
Color Coordinates [CIE1931] ***(By PR650)***	RED	Rx	Typ -0.03	0.639	Typ +0.03		
		Ry		0.346			
	GREEN	Gx		0.319			
		Gy		0.636			
	BLUE	Bx		0.152			
		By		0.060			
	WHITE	Wx		0.310			
		Wy		0.338			
Color Shift (Avg. Δu'v' < 0.02))	Horizontal	θ_{CST_H}	-	178	-	Degree	4
	Vertical	θ_{CST_V}	-	178	-		
Viewing Angle (CR>10)							
General	Horizontal	θ_H	170	178	-	Degree	5
	Vertical	θ_V	170	178	-		
GSR @ 60dgree (Gamma shift rate)	Horizontal	δ_{Gamma_H}	-	-	20	%	6
	Vertical	δ_{Gamma_V}	-	-	20		
Gray Scale		-		2.2			7

Notes 1. Contrast Ratio(CR) is defined mathematically as : ***(By PR880)***

$$\text{Contrast Ratio} = \frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$$

It is measured at center point(Location P1)

2. Surface luminance(L_{WH})is luminance value at Center 1 point(P1) across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG.8 (By PR880)

3. The variation in surface luminance , δ WHITE is defined as : ***(By PR880)***

$$\delta_{WHITE} = \frac{\text{Maximum}(L_{P1}, L_{P2}, \ldots . L_{P9})}{\text{Minimum}\,(L_{P1}, L_{P2}, \ldots . L_{P9})}$$

Where L1 to L9 are the luminance with all pixels displaying white at 9 locations.
For more information see FIG.8

4. Color shift is the angle at which the average color difference for all Macbeth is lower than 0.02. For more information see FIG.9 ***(By EZ Contrast)***
   - Color difference (Δu'v')

$$u' = \frac{4x}{-2x+12y+3} \qquad v' = \frac{9y}{-2x+12y+3} \qquad \Delta u'v' = \sqrt{(u'_1 - u'_2)^2 + (v'_1 - v'_2)^2}$$

$$Avg(\Delta u'v') = \frac{\sum_{i=1}^{24} (\Delta u'v')i}{24}$$

u'1, v'1 : u'v' value at viewing angle direction
u'2, v'2 : u'v' value at front (θ=0)
i : Macbeth chart number (Define 23 page)

   - Pattern size : 25% Box size
   - Viewing angle direction of color shift : Horizontal, Vertical

5. Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see FIG.10 ***(By PR880)***

6. GSR is the rate of gamma shift at up, down, left and right 60 degree viewing angle compare with center gamma. For more information see FIG.11 and FIG.12 ***(By EZ Contrast)***
   - GSR (δ_{Gamma}) is defined as :

.

$$GSR = \left(1 - \frac{\text{View angle Gamma Value (Up, Down, Reft, Light 60 Degree)}}{\text{Center Gamma Value (0 Degree)}}\right) \times 100$$

7. Gamma Value is approximately 2.2. For more information see Table 11.

Measuring point for surface luminance & measuring point for luminance variation.

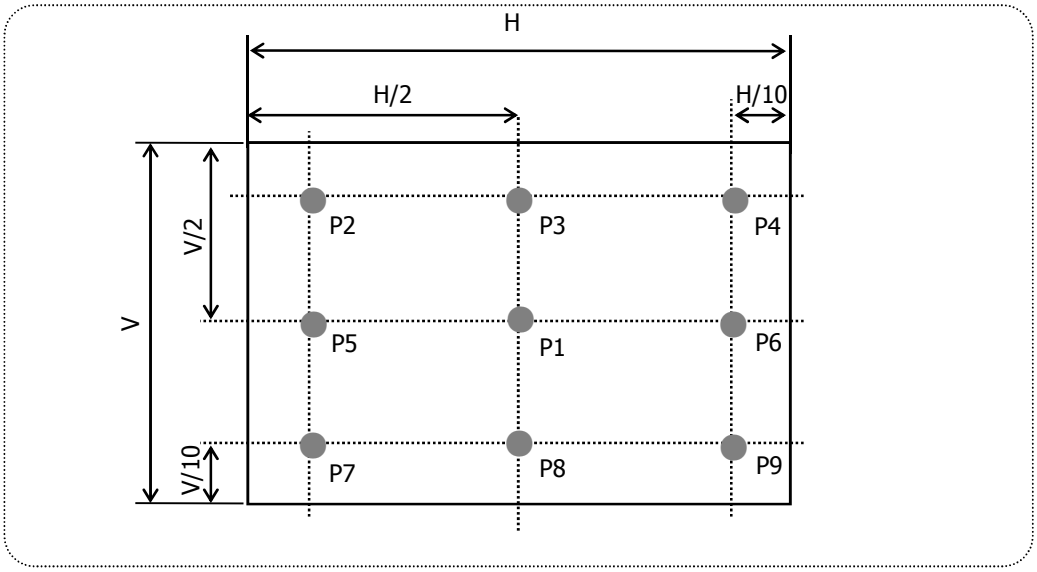
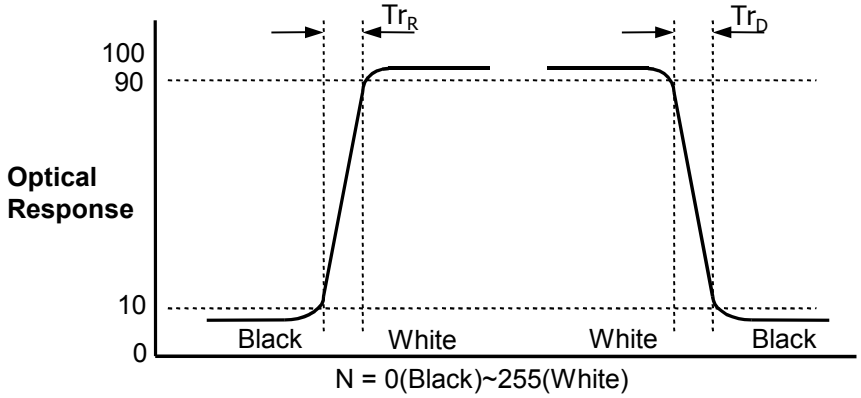


FIG.8 Measure Point for Luminance

Response time is defined as the following figure and shall be measured by switching the input signal for "Black" and "White".



Color shift is defined as the following test pattern and color.

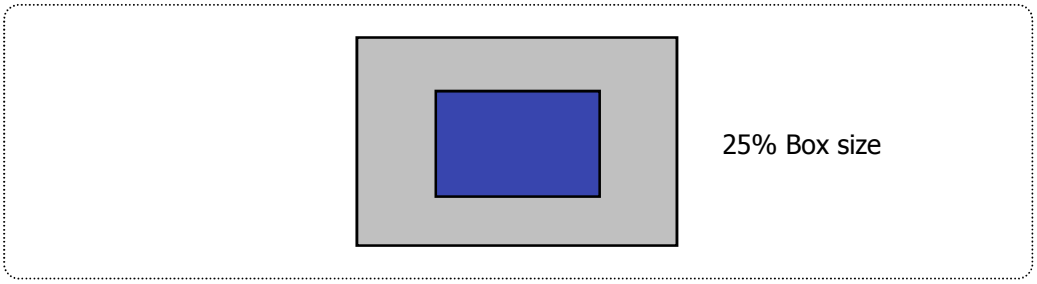


FIG.9 Color Shift Test Pattern

Average RGB values in Bruce RGB for Macbeth Chart

	Dark skin (i=1)	Light skin	Blue sky	Foliage	Blue flower	Bluish green
R	98	206	85	77	129	114
G	56	142	112	102	118	199
B	45	123	161	46	185	178
	Orange	Purplish blue	Moderate red	Purple	Yellow green	Orange yellow
R	219	56	211	76	160	230
G	104	69	67	39	193	162
B	24	174	87	86	58	29
	Blue	Green	Red	Yellow	Magenta	Cyan
R	26	72	197	241	207	35
G	32	148	27	212	62	126
B	145	65	37	36	151	172
	White	Neutral 8	Neutral 6.5	Neutral 5	Neutral 3.5	Black
R	240	206	155	110	63	22
G	240	206	155	110	63	22
B	240	206	155	110	63	22

Dimension of viewing angle range.

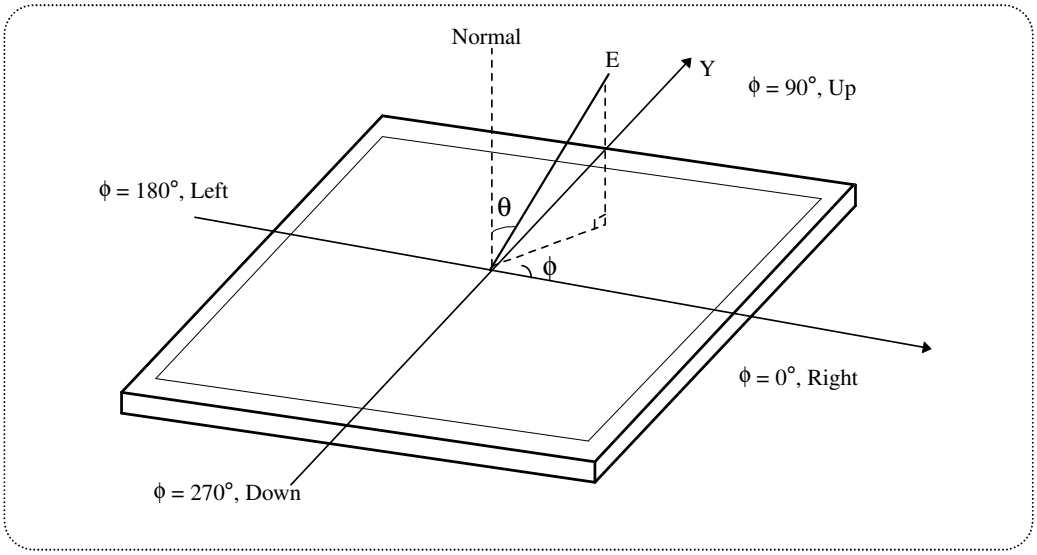


FIG.10 Viewing angle

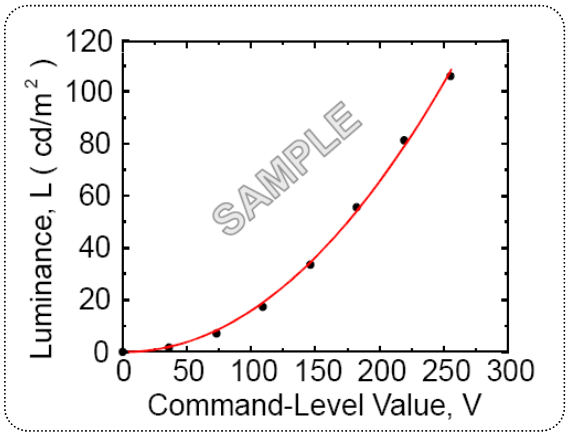


FIG.11 Sample Luminance vs. gray scale (using a 256 bit gray scale)

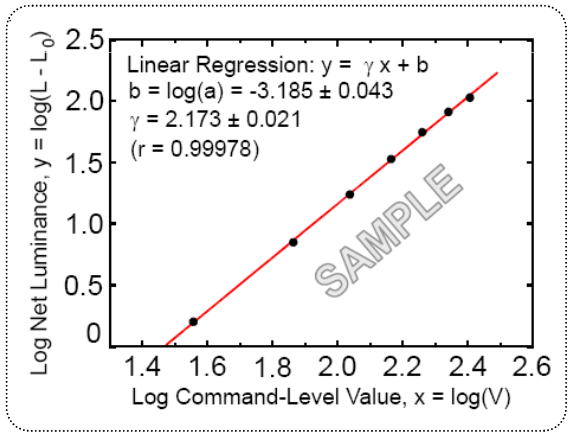


FIG.12 Sample Log-log plot of luminance vs. gray scale

$$L = aV^{r} + L_b$$

$$\log(L - L_b) = r\log(V) + \log(a)$$

Here the Parameter α and γ relate the signal level V to the luminance L.
The GAMMA we calculate from the log-log representation (FIG.11)

Table 11. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	(0.11)
31	(1.08)
63	(4.72)
95	(11.49)
127	(21.66)
159	(35.45)
191	(53.00)
223	(74.48)
255	(100)

5. Mechanical Characteristics

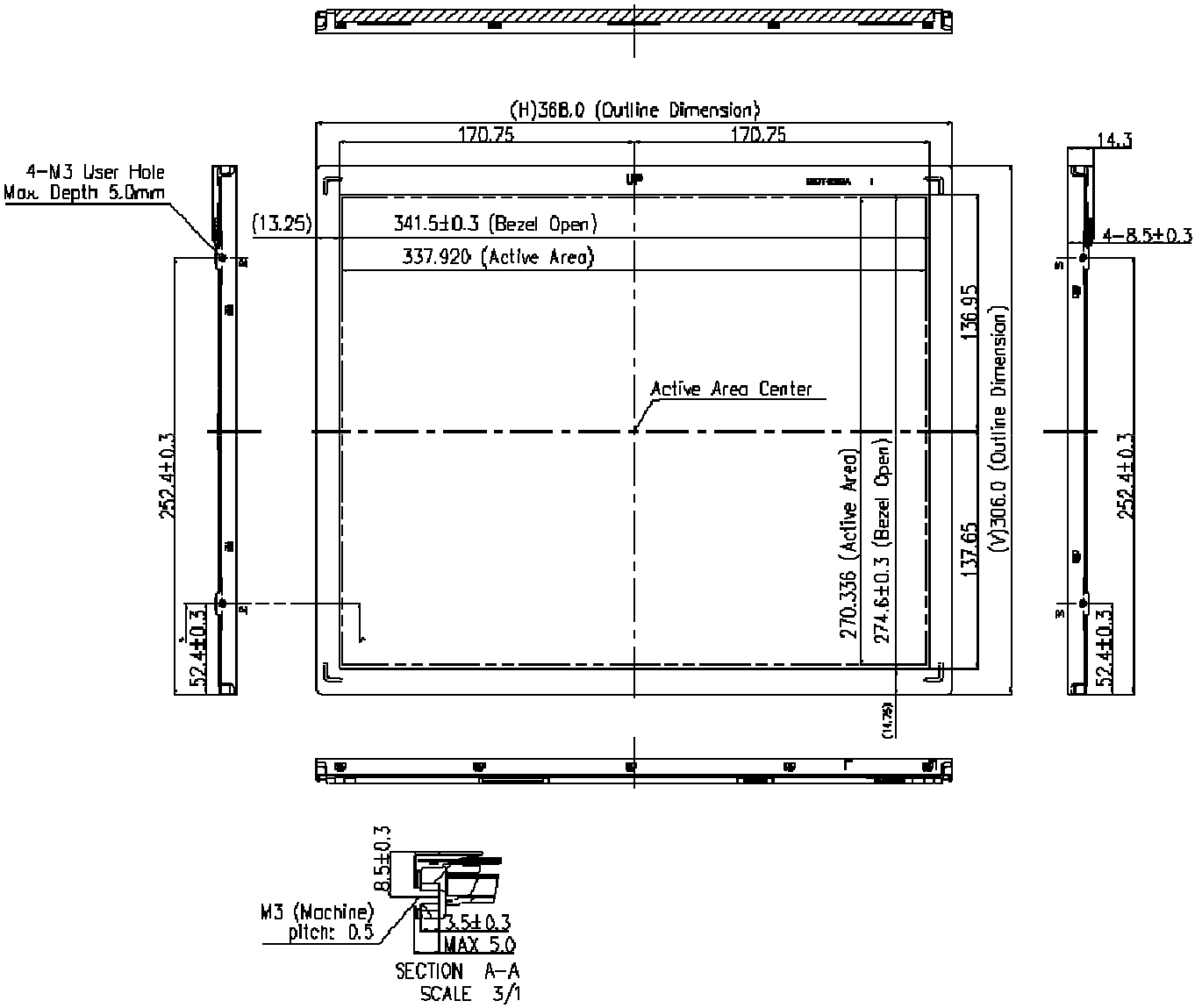
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline Dimension	Horizontal	368.0mm
	Vertical	306.0mm
	Depth	14.3mm
Bezel Area	Horizontal	341.5mm
	Vertical	274.6mm
Active Display Area	Horizontal	337.92mm
	Vertical	270.336mm
Weight(approximate)	1260g (typ.) , 1310g (max.)	
Surface Treatment	Hard coating(3H) Anti-Glare treatment of the front polarizer	

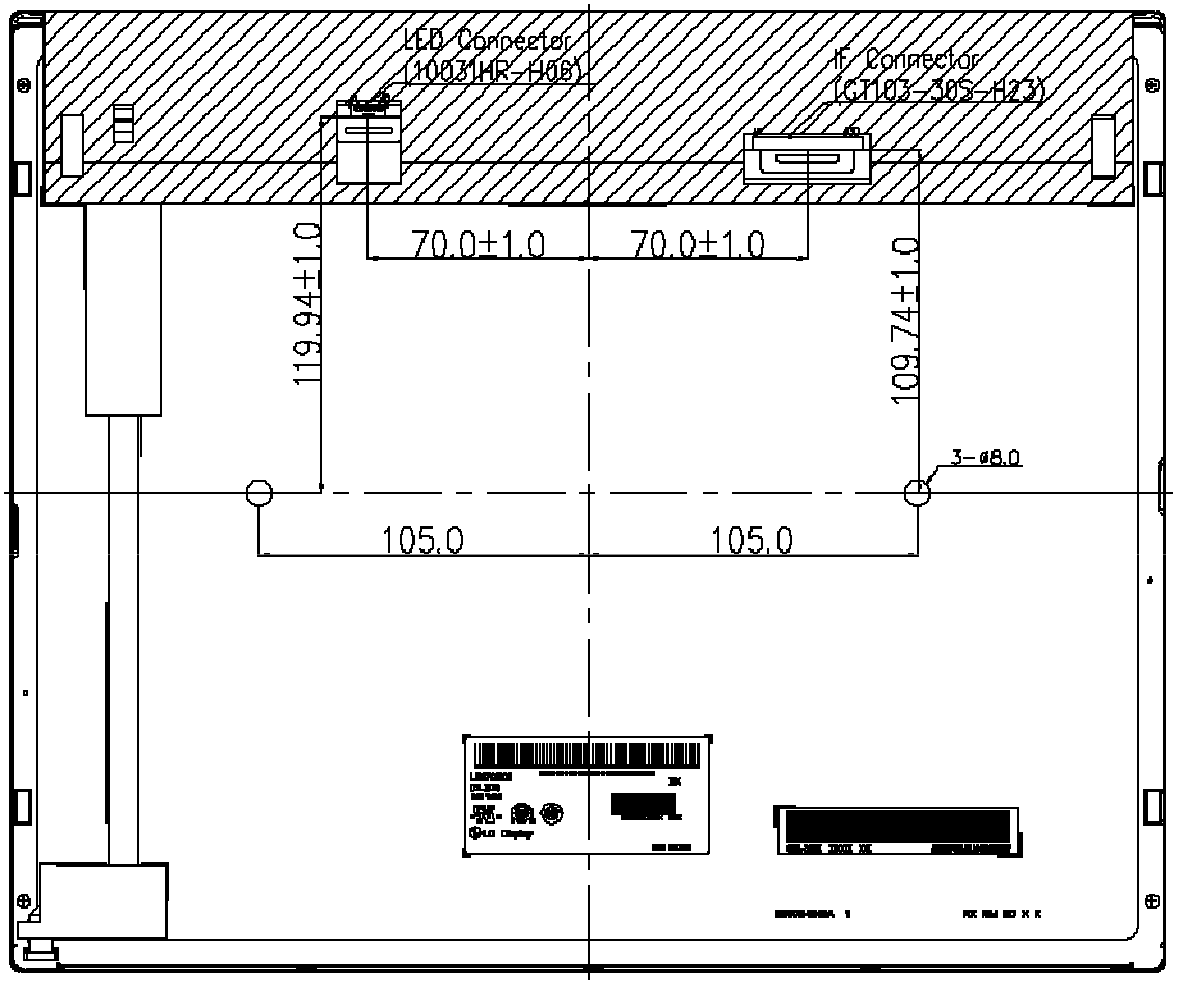
Notes : Please refer to a mechanic drawing in terms of tolerance at the next page.

<FRONT VIEW>

Note) Unit:[mm], General tolerance: ± 0.5mm



<REAR VIEW>



Notes
1. I/F Connector Specification : GT103-30S-H23
2. LED Connector Specification :10031HR-H06
3. Torque of user hole : 4.0 kgf-cm Max.
4. Unspecified tolerances to be ± 0.5mm
5. The COF area is weak & sensitive, So, please don't press the COF area.
6. Outline Dimension is not including Tape and Cover Shield thickness.

6. Reliability

Environment test condition

No	Test Item	Condition
1	High temperature storage test	Ta= 80℃ 240h
2	Low temperature storage test	Ta= -20℃ 240h
3	High temperature operation test	Ta= 70℃ 240h
4	Low temperature operation test	Ta= -10℃ 240h
5	Vibration test (non-operating)	Wave form : random Vibration level : 1.00G RMS Bandwidth : 10-300Hz Duration : X, Y, Z, 10 min One time each direction
6	Shock test (non-operating)	Shock level : 100G Waveform : half sine wave, 2ms Direction : ±X, ±Y, ±Z One time each direction
7	Humidity condition Operation	Ta= 50 ℃ ,80%RH
8	Altitude operating storage / shipment	 0 - 16,000 feet(4,876m) 0 - 40,000 feet(12,192m)

7. International Standards

7-1. Safety

a) UL 60950-1, Underwriters Laboratories Inc.
Information Technology Equipment - Safety - Part 1 : General Requirements.

b) CAN/CSA -C22.2 No.60950-1-07, Canadian Standards Association.
Information Technology Equipment - Safety - Part 1 : General Requirements.

c) EN 60950-1, European Committee for Electrotechnical Standardization (CENELEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.

7-2. EMC

a) ANSI C63.4 "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz." American National Standards Institute (ANSI), 2003.

b) CISPR 22 "Information technology equipment – Radio disturbance characteristics – Limit and methods of measurement." International Special Committee on Radio Interference (CISPR), 2005.

c) CISPR 13 "Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and method of measurement." International Special Committee on Radio Interference (CISPR), 2006.

7-3. Environment

a) RoHS, Directive 2011/65/EU of the European Parliament and of the council of 8 June 2011

8. Packing

8-1. Designation of Lot Mark

a) Lot Mark

A	B	C	D	E	F	G	H	I	J	K	L	M

A,B,C : SIZE(INCH)
D : YEAR
E : MONTH
F ~ M : SERIAL NO.

Note

1. YEAR

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mark	A	B	C	D	E	F	G	H	J	K

2. MONTH

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	A	B	C

b) Location of Lot Mark

Serial No. is printed on the label. The label is attached to the backside of the LCD module.
This is subject to change without prior notice.

8-2. Packing Form

a) Package quantity in one box : 12 pcs

b) Box Size : 365 X 315 X 492mm

9. PRECAUTIONS

Please pay attention to the followings when you use this TFT LCD module.

9-1. MOUNTING PRECAUTIONS

(1) You must mount a module using holes arranged in four corners or four sides.
(2) You should consider the mounting structure so that uneven force (ex. Twisted stress) is not applied to the module. And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
(3) Please attach the surface transparent protective plate to the surface in order to protect the polarizer. Transparent protective plate should have sufficient strength in order to the resist external force.
(4) You should adopt radiation structure to satisfy the temperature specification.
(5) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
(6) Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment.
Do not touch the surface of polarizer for bare hand or greasy cloth.(Some cosmetics are detrimental to the polarizer.)
(7) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
(8) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
(9) Do not open the case because inside circuits do not have sufficient strength.
(10) As The IPS panel is sensitive & slim, please recommend the metal frame of the system supports the panel by the double side-mount.

9-2. OPERATING PRECAUTIONS

(1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :
V=± 200mV(Over and under shoot voltage)
(2) Response time depends on the temperature.(In lower temperature, it becomes longer.)
(3) Brightness depends on the temperature. (In lower temperature, it becomes lower.)
And in lower temperature, response time(required time that brightness is stable after turned on) becomes longer.
(4) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
(5) When fixed patterns are displayed for a long time, remnant image is likely to occur.
(6) 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 minimized the interference.
(7) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
(8) A screw which is fastened up the steels should be a machine screw.
(if not, it causes metallic foreign material and deal LCM a fatal blow)
(9) Please do not set LCD on its edge.
(10) When LCMs are used for public display defects such as Yogure, image sticking can not be guarantee.

9-3. ELECTROSTATIC DISCHARGE CONTROL

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

9-4. PRECAUTIONS FOR STRONG LIGHT EXPOSURE

Strong light exposure causes degradation of polarizer and color filter.

9-5. STORAGE

When storing modules as spares for a long time, the following precautions are necessary.

(1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5℃ and 35℃ at normal humidity.
(2) The polarizer surface should not come in contact with any other object.
It is recommended that they be stored in the container in which they were shipped.

9-6. HANDLING PRECAUTIONS FOR PROTECTION FILM

(1) The protection film is attached to the bezel with a small masking tape.
When the protection film is peeled off, static electricity is generated between the film and polarizer.
This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
(2) When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the bezel after the protection film is peeled off.
(3) You can remove the glue easily. When the glue remains on the bezel surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.