DATA DISPLAY AG

LP104V2-W
10.4“ VGA TFT LCD

PRELIMINARY SPECIFICATION

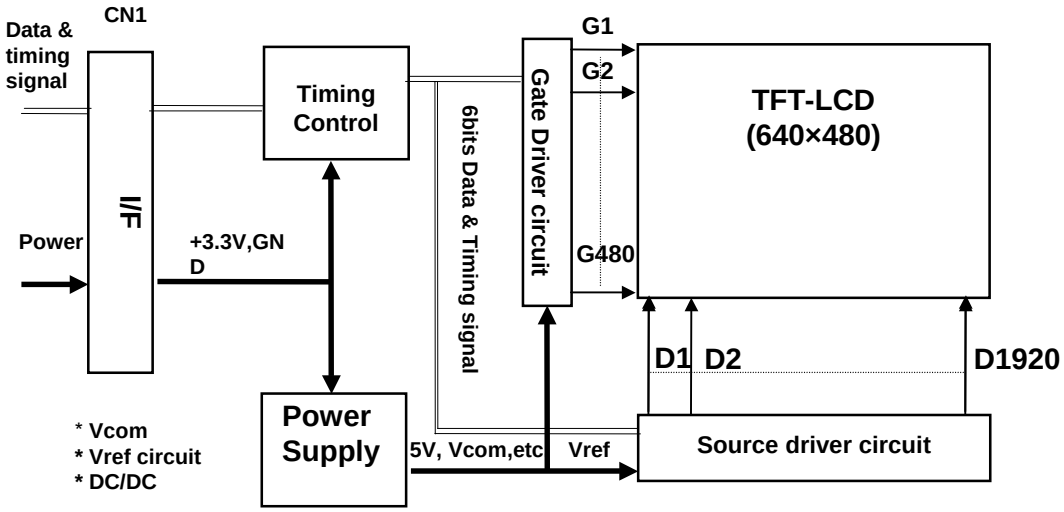
The information given in this document is carefully checked and believed to be reliable. Data Display reserves the right to make changes in product or specification at any time and without further notice. Data Display products are not intended for use in systems in which failures of product could result in personal injury. All mentioned trademarks are registered trademarks of their owner.

LG.Philips LCD: Rev. 1.0, Nov. 98

1. GENERAL DESCRIPTION

The LG.Philips LCD Inc. model LP104V2-W LCD is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Tube (CCFT) back light system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally white mode. This TFT-LCD has a 10.4 inch diagonally measured active display area with VGA resolution (480 vertical by 680 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 6-bit gray scale signal for each dot, thus, presenting a palette of more than 262,144 colors.

The LP104V2-W LCD is intended to support applications where thin thickness, low power are critical factors and graphic displays are important. In combination with the vertical arrangement of the sub-pixels, the LP104V2-W characteristics provide an excellent flat panel display for industrial automation products such as operation panels or POS-Terminals.



General Display Characteristics

The following are general features of model LP104V2-W LCD:

Active display area	10.4 inches (26.42 cm) diagonal
Outsize dimensions	246.5 (H) × 179.4 (V) × 8.0 (W) mm (typ)
Pixel pitch	0.33 mm × 0.33 mm
Pixel format	640 horiz. By 480 vert. pixels RGB stripe arrangement
Color depth	6-bit, 262,144 colors
Display operating mode	transmissive mode, normally white
Surface treatments	hard coating (3H), anti-glare treatment of the front polarizer
Weight	415 g (Typ.)

2. 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	RMKS
		Min.	Max.		
Power Input Voltage	V_{DD}	3.0	3.6	Vdc	at 25°
Operating Temperature	T_{OP}	0	+ 50	°	FlatLink Tx
Storage Temperature	T_{ST}	-20	+ 60	°	1

Note 1: The Relative Humidity must not exceed 95% non-condensing at temperatures of 40° or less. At temperatures greater than 40°, the wet bulb temperature must not exceed 39°.

Note 2: Under no condition should the unit be exposed to corrosive chemicals.

3. ELECTRICAL SPECIFICATIONS

The LP104V2-W requires two power inputs. One is employed to power the LCD electronics and to drive the voltages to drive the TFT array and liquid crystal. The second input which powers the backlight CCFT, is typically generated by an inverter. The inverter is an external unit to the LCD.

Table 2: ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Units	Notes
		Min.	Typ.	Max.		
MODULE:						
Power Supply Input Voltage	V_{DD}	3.0	3.3	3.6	Vdc	
Power Supply Input Current	I_{DD}	-	170	227	MA	1
Power Consumption	P_{DD}	-	0.56	0.75	Watts	
Ripple/Noise		-	-			
Logic Input Level, High	V_{IH}	2.0	-	V_{DD}	V	2
Logic Input Level, Low	V_{IL}	Vss	-	0.8	V	2
BACK LIGHT	It					
Lamp current	V_t	2.0	5.5	6.0	mA	
Lamp voltage	Ft	490	505	630	V_{RMS}	
Lamp frequency	Vk	40	60	80	KHz	3
Kick-Off Voltage		-	-	845	V_{RMS}	25 ± 2°
		-	-	1015	V_{RMS}	0 ± 2°
Lamp life time	Lt	20.000		-	Hrs	
Power Consumption	P_{BL}	1.8	2.8	2.9	Watts	4

Note 1: The current draw and power consumption specified is for 3.3 Vdc at 25°, fv at 60 Hz and black signal displayed.

Note 2: Logic levels are specified for V_{DD} of 3.3 Vdc at 25 °. The values specified apply to all logic inputs; Hsync, Vsync, clock, data signals, etc.

Note 3: Lamp frequency may produce interference with horizontal sync. frequency, and may cause beat on the display. Therefore lamp frequency shall be detached as much as from the horizontal sync. and from the harmonics of horizontal synchronous to avoid interference.

Note 4: DC/AC inverter for backlight is not built in this module. Back light power consumption shown above does not concern the efficiency of the inverter.

4. OPTICAL SPECIFICATIONS

Optical characteristics are determined after the unit has been 'ON' and stable for approximately 30 minutes in a dark environment at 25°. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0°. Appendix A presents additional information concerning the specified characteristics.

Table 3: OPTICAL CHARACTERISTICS

Parameter	Symbol	Values			Units	RMKS
		Min.	Typ.	Max.		
Contrast Ratio	CR	100	150	-		1
Surface Brightness	Bsf	180	200	-	cd/m^2	2
Brightness Variation	B_V	-	-	1.45		3
Response Time	Tr				msec	4
Rise Time	Tr_R	-	30			
Delay Time	Tr_D	-	50			
CIE Color Coordinates						
Red	x_R	0.513	0.543	0.573		
	y_R	0.304	0.334	0.364		
Green	x_G	0.287	0.317	0.347		± 0.03
	y_G	0.470	0.500	0.530		
Blue	x_B	0.126	0.156	0.186		
	y_B	0.121	0.151	0.181		
White	x_W	0.292	0.322	0.352		
	y_W	0.309	0.339	0.369		
Viewing Angle					degree, °	5
x axis, right (F=0°)	x	70				
x axis, left (F=180°)	x	70				
y axis, up (F=90°)	y	45				
y axis, down (F=270°)	y	50				
Flicker						6

Note 1: Contrast Ratio (CR) is defined mathematically as:
(Surface Brightness with all white pixels) ÷ (Surface Brightness with all black pixels)

Note 2: Surface brightness is measured on the LCD surface 50 cm from the surface with all pixels displaying white. For more information see Appendix A - 1.

Note 3: The variation in surface brightness, SB_V is determined by measuring B_{ON} at each test position 0 through 9, and then dividing the maximum B_{ON} of 9 points luminance by minimum B_{ON} of 9 points luminance. For more information see Appendix A - 1.
SB_V = Maximum (B_{ON0}, B_{ON1}, ...B_{ON9}) ÷ Minimum (B_{ON0}, B_{ON1}, ...B_{ON9})

Note 4: Response time is the time required for the display to transition from white to black (Rise Time, Tr_R) and from black to white (Delay Time, Tr_D). For additional information see Appendix A - 2.

Note 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 Appendix A - 3.

Note 6: When the lcd is refreshed at 60Hz rate with the backlight on, there are no noticeable flicker at green dot level 31 when the screen is viewed with naked eye.

Table 4: Luminance of Grey Level

Gray Level	Luminance (%)(min)	Luminance (%)(max)
L0	0.0	1.0
L7	0.0	3.0
L15	0.0	6.0
L23	1.5	15.0
L31	5.0	38.0
L39	20.0	70.0
L47	50.0	90.0
L55	80.0	98
L63	100	100

5. ENVIRONMENT

5.1 Altitude

operating 0 - 10,000 feet (3048 m)
storage/shipment 0 - 40,000 feet (12192 m)

5.2 Corrosive gas

Use at indoor & outdoor in a big city.

5.3 Environment test condition

No.	Test Item	Conditions
1	High temperature storage test	Ta = 60° 240 h
2	Low temperature storage test	Ta = -20° 240 h
3	High temperature & high humidity operation test	Ta = 40° 95 % RH 240 h (no condensation)
4	High temperature operation test	Ta = 50° 240 h
5	Low temperature operation test	Ta = 0° 240 h
6	Vibration test (non-operating)	- Sine wave, 10 to 500Hz, 1.5 G, 0.5 oct/min, 3axis, - Random Truck: 6-12-18-42-80-200Hz 0.5Grms, 30min. 3axis - Random Air : 6-18-200-500Hz 2.1Grms, 30min. 3axis
7	Shock test (non-operating)	- half sine wave, 180 G, 2 ms, one shock of each six faces (i.e. run 180 G 2 ms forall six faces)

Result Evaluation Criteria
There should be no change which might affect the practical display function when the display quality test isconducted under normal operating condition.

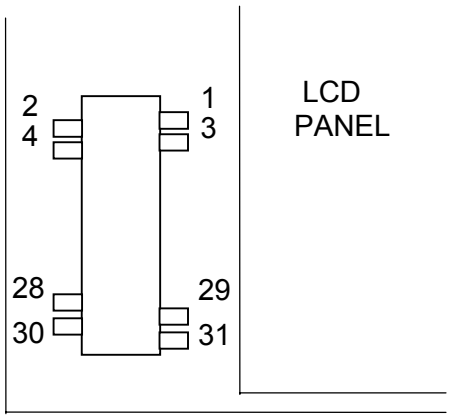
6. INTERFACE PIN CONFIGURATION

Used connector : DF9B-31P-1V(HIROSE), Matching side: DF9B-31S-1V(HIROSE)
The backlight interface connector is a model BHR-03VS-1, manufactured by JST. The mating connector part number is SM02(0.8)B-BHS-1-TB or equivalent. The pin configuration for the connector is shown in the table below.

Table 5: INTERFACE PIN CONFIGURATION

Pin	Symbol	Description
1	GND	Ground
2	CLK	Data clock
3	Hsync	Horizontal sync.
4	Vsync	Vertical sync.
5	GND	Red data (LSB)
6	R0	Red data
7	R1	Red data
8	R2	Red data
9	R3	Red data
10	R4	Red data
11	R5	Red data (MSB)
12	GND	Ground
13	G0	Green data (LSB)
14	G1	Green data
15	G2	Green data
16	G3	Green data
17	G4	Green data
18	G5	Green data (MSB)
19	GND	Ground
20	B0	Blue data (LSB)
21	B1	Blue data
22	B2	Blue data
23	B3	Blue data
24	B4	Blue data
25	B5	Blue data(MSB)
26	GND	Ground
27	DTMG	Data timing signal
28	VDD	Power supply +3.3V
29	VDD	Power supply +3.3V
30	NC	No connection
31	NC	No connection

I/F PIN ARRANGEMENT
(Transparent view) 3



TOP VIEW

* NC (30, 31pin) should be electrically opened during operation.
* The metal top case is connected to GND.
* All GND(ground) pins should be connected together and to Vss which also be connected to the LCD's metal frame.
* All Vdd(power input) pins should be connected together.

The backlight interface cinnector is model BHR-03VS-1, manufactured by JST. The mating connector part number is SM02(0.8)B-BHS-1-TB or equivalent. The pin configuration is shown in the table below.

Table 6: BACKLIGHT CONNECTOR PIN CONFIGURATION

Pin	Symbol	Description	Notes
1	HV	Lamp power input	1
2	NC	NC	
3	LV	Ground	2

Note 1: The input power terminal is colored pink. Ground pin color is black.
Note 2: The backlight ground should be common with Vss.

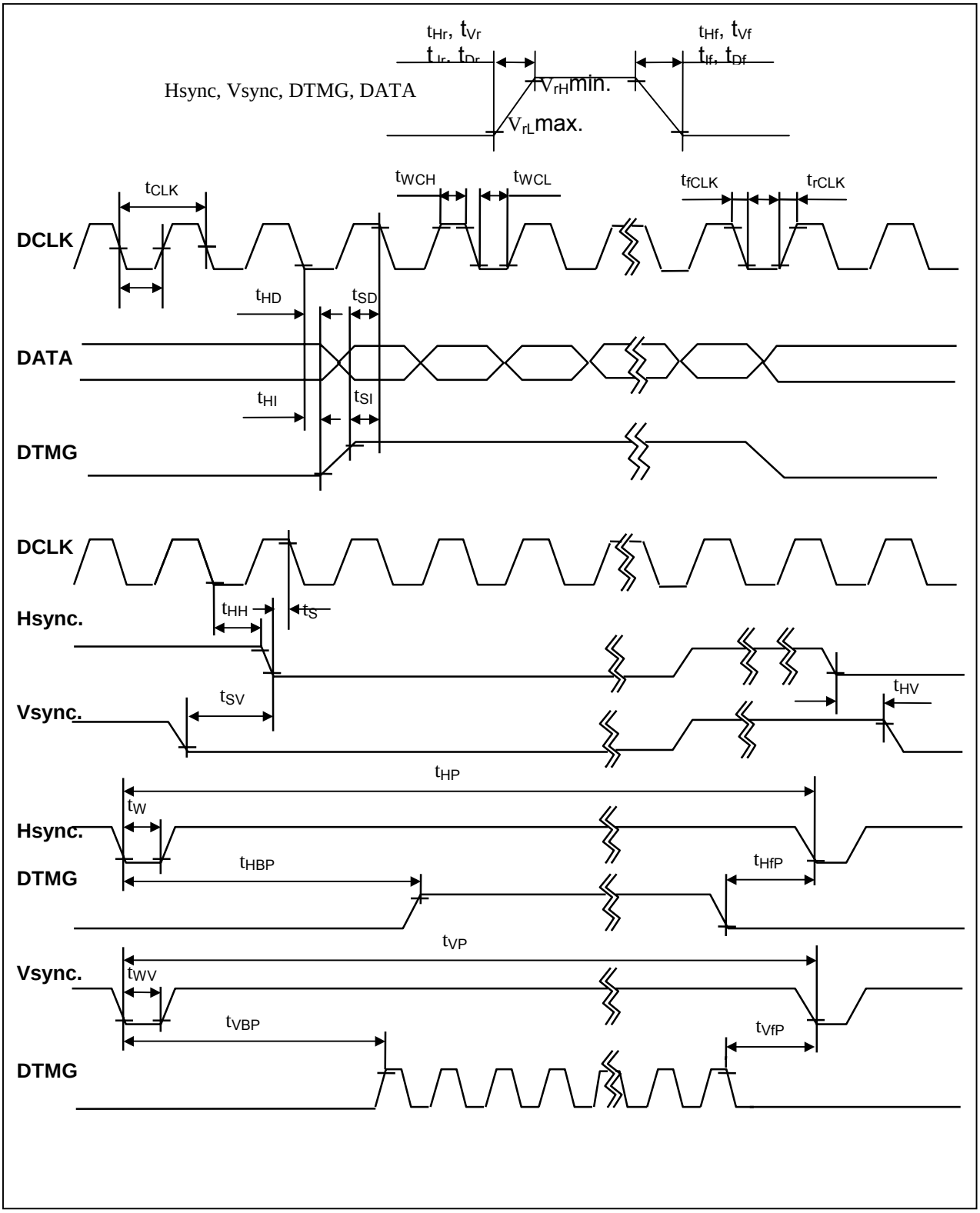
7. SIGNAL TIMING SPECIFICATION

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

Table 7: Timing Table

ITEM		Symbol	MIN.	TYP.	MAX.	UNIT	NOTE
DCLK	Frequency	f_{CLK}	21	25	32	MHz	
	Width-Low	t_{WCL}	7	-	-	ns	
	Width-High	t_{WCH}	7	-	-		
	Rise Time	t_{rCLK}	-	-	20		
	Fall Time	t_{fCLK}	-	-	20		
	Duty	D	0,45	0.5	0.55	-	$D=t_{CLKL}/t_{CLK}$
Hsync	Set up Time	t_{SH}	0	-	-	ns	
	Hold Time	t_{HH}	15	-	-		
	Period	t_{HP}	770	800	900	t_{CLK}	
	Width-Active	t_{WH}	9	-	128		
	Rise/Fall Time	t_{Hr}, t_{Hf}	-	-	30	ns	
Vsync	Set up Time	t_{SV}	0	-	-	t_{CLK}	for HSYNC
	Hold Time	t_{HV}	15	-	-		
	Period	t_{VP}	515	525	560	t_{HP}	
	Width-Active	t_{WV}	1	-	15		
	Rise/Fall Time	t_{Vr}, t_{Vf}	-	-	50	ns	
DTMG	Set up Time	t_{SI}	0	-	-	ns	for DLCK
	Hold Time	t_{HI}	15	-	-		
	Rise/Fall Time	t_{Ir}, t_{If}	-	-	30	ns	
	Horizontal Back Porch	t_{HBP}	10	-	-	t_{CLK}	
	Horizontal Front Porch	t_{HFP}	10	-	-		
DTMG	Vertikal Back Porch	t_{VBP}	34	-	-	t_{HP}	
	Vertikal Front Porch	t_{VFP}	1	-	-		
DATA	Set up Time	t_{SD}	0	-	-	ns	for DCLK
	Hold Time	t_{HD}	15	-	-		
	Rise/Fall Time	t_{Dr}, t_{Df}	-	-	20	ns	

8. SIGNAL TIMING WAVE FORM



9. COLOR INPUT DATA REFERENCE

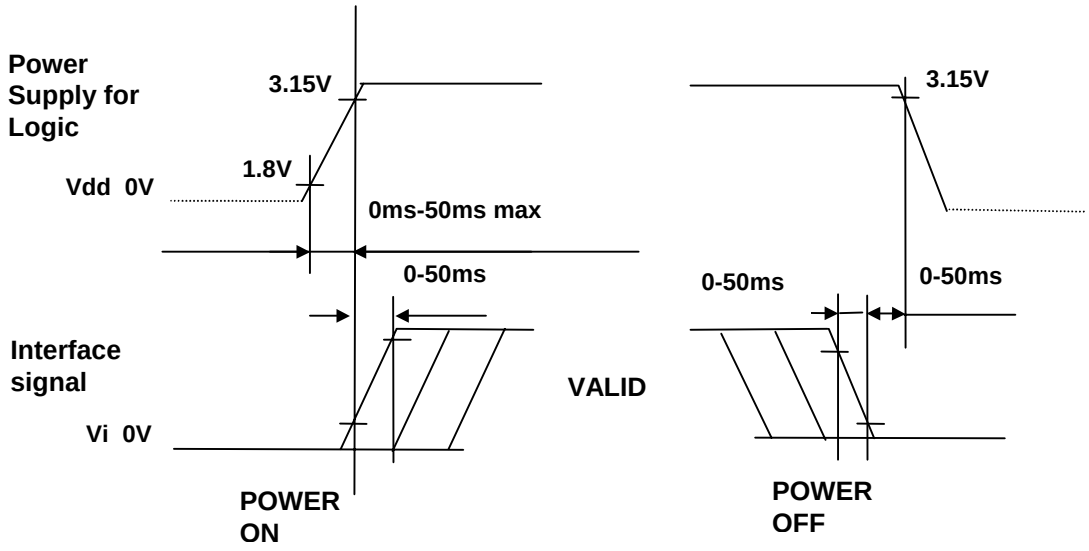
The brightness of each primary color (red, green and blue) is based on the 6-bit gray scale data input for the color; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 8: COLOR DATA REFERENCE

Color		Input Color Data																	
		Red						Green						Blue					
		MSB					LSB	MSB					LSB	MSB					LSB
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Green (63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Blue (63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	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
Red	Red (00) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (01)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Red (02)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Red (61)	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Red (62)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (63) Bright	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Green	Green (00) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (01)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Green (02)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Green (61)	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0
	Green (62)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	Green (63) Bright	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
Blue	Blue (00) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue (01)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Blue (02)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Blue (61)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1
	Blue (62)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	Blue (63) Bright	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

10. POWER ON/OFF SEQUENCE

Note 1: Please avoid floating state of interface signal at invalid period.
Note 2: When the interface signal is invalid, be sure to pull down the power supply for LCD V_{DD} to 0V.



* Set 0V ≤ Vi(t) ≤ Vdd(t)
Here, Vi(t), Vdd(t) indicate the transitive state of Vi, Vdd when power supply is turned ON or OFF

Note 1: Please avoid floatingstate of interface signal at invalid period
Note 2: When the interface signal is invalid, be sure to pull down the power supply for LCD V_{DD} to 0V

11. MECHANICAL CHARACTERISTICS

The chart below provides general mechanical characteristics for the model LP104V2-W LCD. In addition, the figure below is a detailed mechanical drawing of the LCD. Note that dimensions are given for reference purposes only.

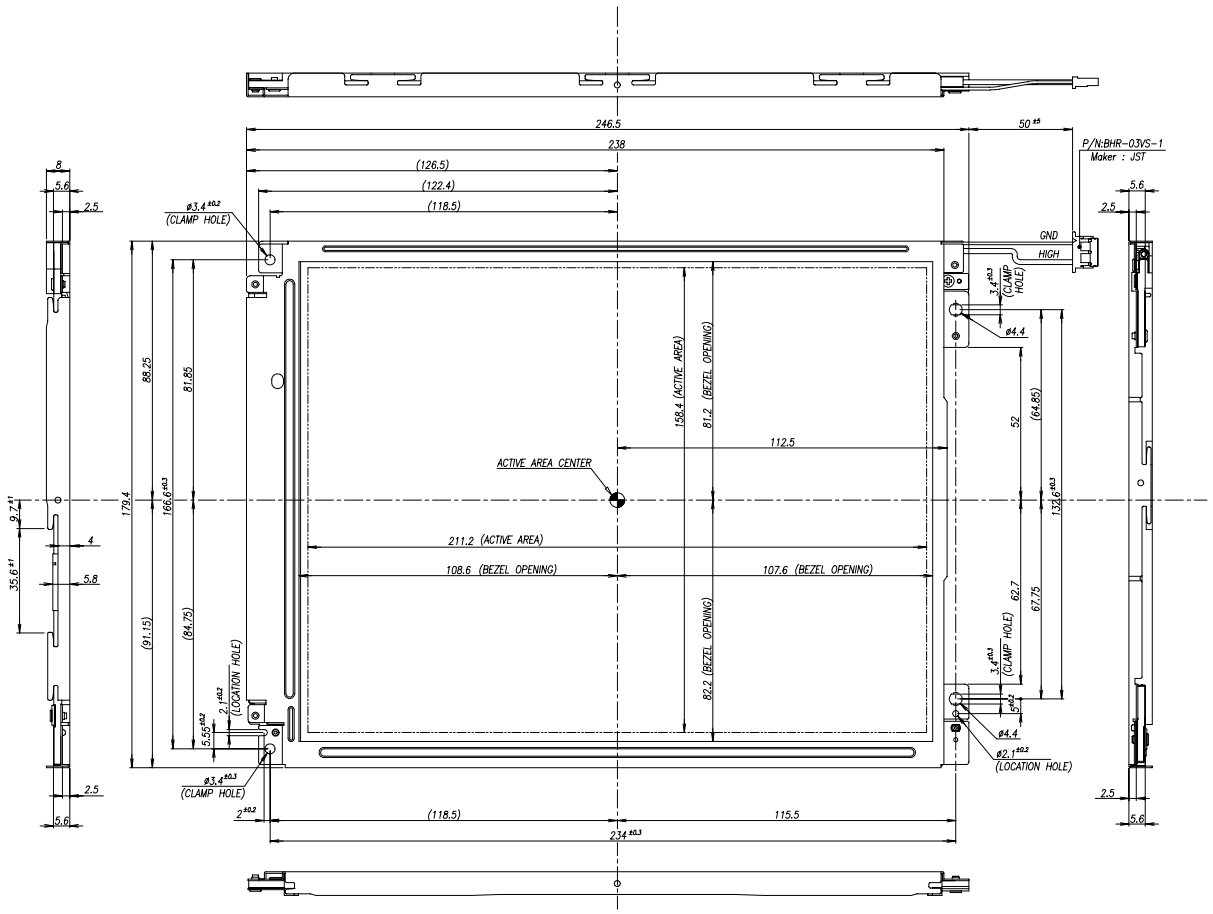
Outside dimensions:

Width	246.5 mm (Typ.)
Height	179.4 mm (Typ.)
Thickness	8.0 mm (Typ.)

Active Display area:

Width	211.2 mm
Height	158.4 mm

Weight (approximate): 415 (±10) g



LCM FRONT SIDE

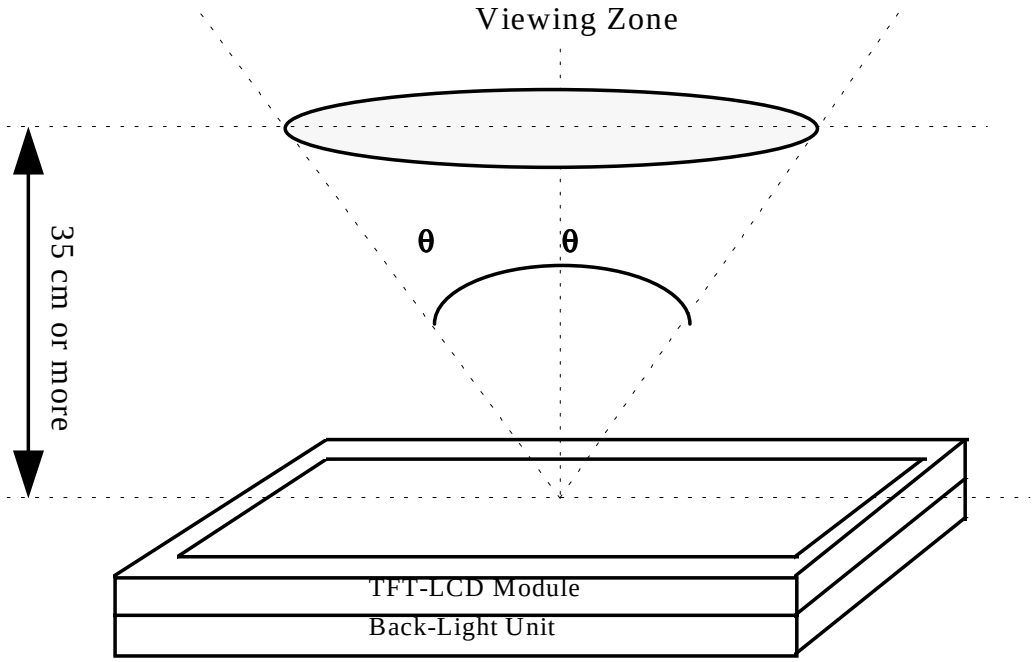
12. COSMETICS

This cosmetic inspection is related to the acceptance quality levels of any defects in the LCD module which we produce. For more information about the following, please contact LG Semicon Co., Ltd. any time.

12.1 Cosmetic Inspection Conditions

Inspective viewing angle

This inspection should be executed according to the following figure:



Viewing angle should be in the range of:

q < 45° when non-operating inspection
q < 20° when operating inspection (horizontal direction)
q < 10° when operating inspection (vertical direction)

12.2 Environment Conditions

Ambient temperature: 25 ± 5°C
Ambient Humidity: 65 ± 5 % RH
Ambient Lumination: Using single 20 watts fluorescent lamp (about 500 lux)
Distance by eyes of inspector from the module: 35 cm or more

13. SAFETY

13.1 Sharp edge

There will be no sharp edges or corners on the display assembly that could cause injury.

13.2 Materials

Toxicity: There is no carcinogenic materials used anywhere in the display module.
Flammability: All components including electrical components of the module should meet the flammability grade Min.UL94-V1. The printed circuit board is made from material rated UL94-V1 or better. The actual UL flammability rating is printed on the printed circuit board.

13.3 Capacitors

If any polarized capacitors are used in the display assembly, provisions will be made to keep them from being inserted backwards.

13.4 Hazardous Voltages

Any points exceeding 42.2 volts meets the requirement of the limited current circuit. The current through a 2 Kohm resistance is less than 0.7 x f (Khz) mA.

14. PACKAGING

The packaging of the LCD meets 75 cm drop test.

15. SMOKE FREE DESIGN

No smoke or strange smell shall not be observed by the operator as a result of any single failure. Display technology will demonstrate it to the representative by open/short test in design verification test for approval if there is any default symptoms.

16. PERFORMANCE

All electromagnetic compatibility apply when the display module is attached to the host system.

17. PRECAUTIONS

Please pay attention to the followings when you use this TFT/LCD module with Back-light unit.

17.1 Mounting Precautions

- You must mount a module using holes arranged in four corners.
- 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 forace is not transmitted directly to the module.
- Please attach the surface with a transparent protective plate in order to protect the polarizer LC cell. Transparent protective plate should have sufficient strength in order to resist external force.
- You should adopt radiation structure to satisfy the temperature specification.
- Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polalizer at high temperature and the latter causes circuit break by electro-chemical reaction.
- Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil ead. Please do not rub with dustclothes with chemical treatment. Do not touch the surface of polarizer for bare hand or greasy cloth (some cosmetics are detrimental to the polarizer).
- When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaked with petrolium benzene. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluen and alcohol because they cause chemical damage to the polarizer.
- Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
- Do not open the case because inside circuits do not have sufficent strength.

17.2 Operating Precautions

- The spike noise causes the mis-operation of circuits. It should be lower than following voltage: VDD = ± 200 mV, V1 = ± 200 mV (over and under shoot voltage).
- Response time depends on the temperature (in lower temperature, it becomes longer).
- Brightness depends on the temperature (in lower temperature, it becomes lower). In lower temperature, response time (required time that brightness is stable after turned on) becomes longer.
- 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.
- When fixed patterns are displayed for a long time, remnant image is likely to occur.
- A module has high frequency circuit. If you need to shield the electromagnetic noise, please do in yours.

- When a Back-light unit is operating, it sounds. If you need to shield the noise, please do in yours.

17.3 Electrostatic Discharge Control

If 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. Please do not touch touch I/F pin directly.

17.4 Precaution for strong light exposure

Strong light exposure causes degradation of polarizer and color filter.

17.5 Storage

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

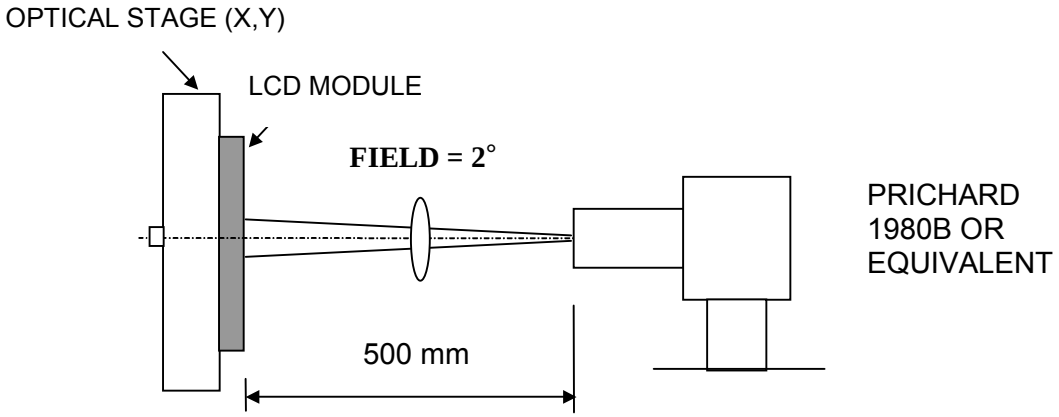
- Do not leave the module in high temperature, especially in high humidity for a long time.
- Store the module not to expose to the sunlight directly.
- Avoid condensation of water. It may cause misoperation.

17.6 Handling precautions for protection film

- Be sure to turn off the power when connecting or disconnecting circuit.
- Note that polarizer are easily damaged, pay attention not to scratch or press these surface with any hard object.
- When lcd surface becomes dirty, please wipe them off with soft material like absorbent cotton.
- Protect the module from the ESD. AS it may damage electronic circuit (C-MOS). Make certain that treatment persons body are grounded through wrist bend.
- Do not disassemble the module and be careful not to have strong mechanical shock such as twist when install to the cabinet. It may cause damage permanently.

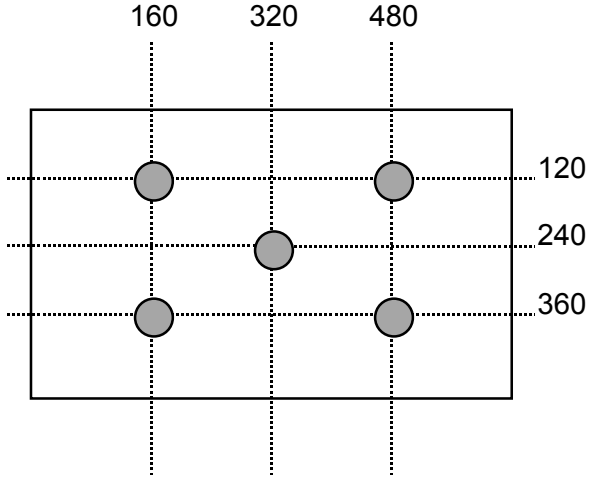
18. MEASUREMENT SETUP & METHOD

Optical measurement shall be executed in a dark room or equivalent state with the following method.
Measurement shall be executed 30 minutes after back light turn on.

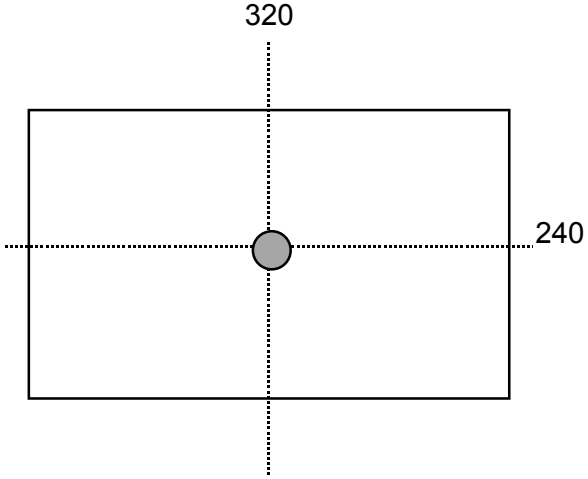


18.1 Brightness

<measuring point for brightness vibration>

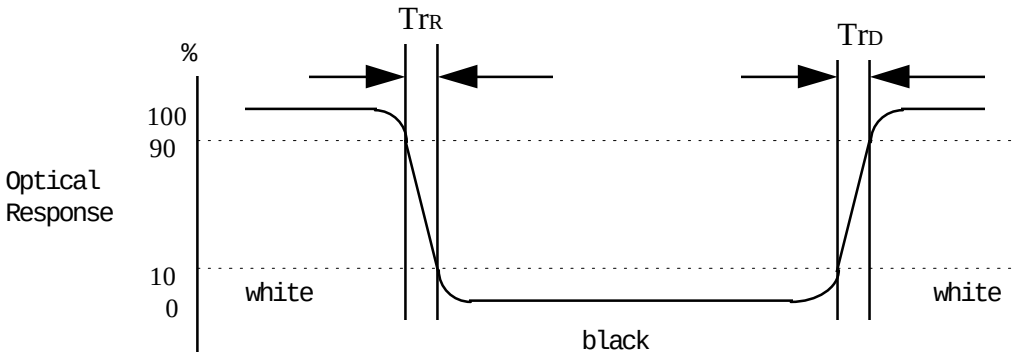


<measuring point for surface brightness>



18.2 RESPONSE TIME

The response time is defined as the following figure and shall be measured by switching the input signal for „black“ and „white“.



18.3 Viewing angle

Definition of viewing angle range