

**Product Specification****SPECIFICATION****For****APPROVAL**(☐ Preliminary Entry Level Specification(☐ Final Specification

Title	10.4" VGA TFT LCD
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BUYER NAME	
MODEL NAME	

SUPPLIER	LG Semicon. Co. Ltd.
MODEL NAME	LP104V2

SIGNATURE	DATE
<u> / </u>	<u> </u>
<u> / </u>	<u> </u>
<u> / </u>	<u> </u>

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

APPROVED BY	DATE
<u> /G.Manager </u>	<u> </u>
REVIEWED BY	
<u> /S.Engineer </u>	<u> </u>
PREPARED BY	
<u> / Engineer </u>	<u> </u>

Product Engineering Dept.
LCD Division LG Semicon. Co. Ltd.

Product Specification

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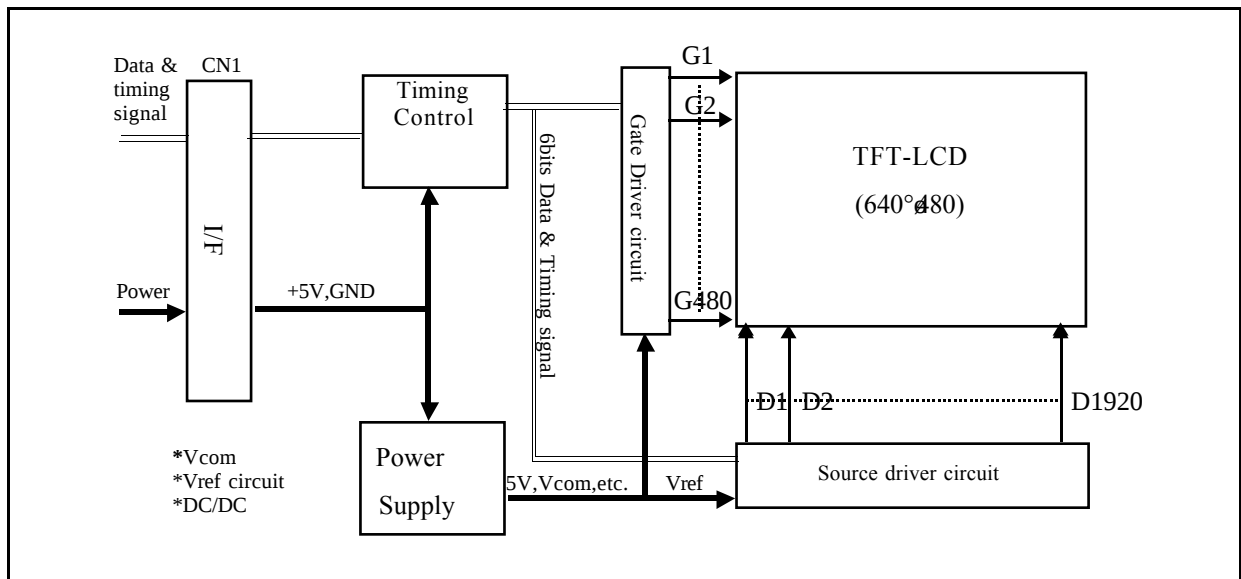
Record of Revision

DATE AND VERSION	DESCRIPTION

1. General Description

The LG Semicon Co., Ltd. model LP104V2 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 640 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 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 characteristics provide an excellent fat panel display for office automation products such as Notebook PC.



General Display Characteristics

The following are general feature of the model LP104V2 LCD;

Active display area	10.4 inches(26.42cm) diagonal
Outsize dimensions	246.5(H) °ø179.4(V) °ø8.0(W) mm(typ)
Pixel pitch	0.33 mm °ø0.33 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	410g (Typ.)

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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°... FlatLink Tx 1
Operating Temperature	T_{OP}	0	+50	°...	
Storage Temperature	T_{ST}	-20	+60	°...	

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°...

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

3. Electrical Specifications

The LP104V2 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	condition	Values			Units
			Min.	Typ.	Max.	
MODULE:						
Power Supply Input Voltage	V _{DD}	Vdd=3.3V	3.0	3.3	3.6	Vdc
Power Supply Input Current	I _{DD}		-	-	-	mA
Ripple/Noise	-		-	-	-	
Logic Input Level, High	V _{IH}		-	-	V _{DD}	V
Logic Input Level, Low	V _{IL}		Vss	-		V
BACK LIGHT						
Lamp current	It	-	10000			mA
Lamp voltage	V _t					V _{RMS}
Lamp frequency	F _t					KHz
Kick-Off Voltage	V _k					V _{RMS}
Lamp life time	L _t					Hrs
Power Consumption	PBL					Watts

Notes: 1. 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.

2. 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.

3. At the condition of $Bs_f = 70 \text{ cd/l}$

4. Used connector : BHR-03VS-1

Matching connector : SMO2(8.0)B-BHS-1-TB(JST)

5. BHR - 03VS - Pin configurations

No	Symbol
1	HV
2	NC
3	GND



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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					1
Surface Brightness	B _{sf}		200	-	cd/m ²	2
Brightness Variation	B _V	-	-	1.45		3
Response Time	Tr				msec	4
Rise Time	Tr _R	-	30			
Decay Time	Tr _D	-	50			
CIE Color Coordinates						
Red	x _R	-	0.58	-		
	y _R	-	0.33	-		
Green	x _G	-	0.31	-		°0.03
	y _G	-	0.52	-		
Blue	x _B	-	0.15	-		
	y _B	-	0.14	-		
White	x _W	-	0.32	-		
	y _W	-	0.33	-		
Viewing Angle					degree, °Δ	5
x axis, right (•≒0°)	• $\frac{\pi}{2}$		45			
x axis, left (•≒180°)	• $\frac{3\pi}{2}$		45			
y axis, up (•≒90°)	• $\frac{\pi}{2}$		10			
y axis, down (•≒270°)	• $\frac{3\pi}{2}$		30			
Flicker						6

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

$$\frac{(\text{Surface Brightness with all white pixels})}{(\text{Surface Brightness with all black pixels})}$$

2. Surface brightness is the average of 5 measurement across the LCD surface 50cm from the surface with all pixels displaying white. For more information see Appendix A - 1.

3. The variation in surface brightness, SB_V is determined by measuring B_{CN} at each test position 0 through 9, and then dividing the maximum B_{CN} of 9 points luminance by minimum B_{CN} of 9 points luminance. For more information see Appendix A - 1.

$$SB_V = \frac{\text{Maximum } (B_{CN0}, B_{CN1}, \dots, B_{CN9})}{\text{Minimum } (B_{CN0}, B_{CN1}, \dots, B_{CN9})}$$

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 (Decay Time, Tr_D). For additional information see Appendix A - 2.

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

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.

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Table 4 Luminance of Grey Level

Gray Level	Luminance (%)(min)	Luminance (%)(max)
L0	0.0	1.4
L7	0.0	2.0
L15	0.0	10.0
L23	3.0	29.0
L31	10.0	53.0
L39	27.0	80.0
L47	51.0	93.0
L55	78.0	100
L63	100	100

5. Environment

- 5.1 Altitude : operating 0 - 10,000 feet (3048m)
storage/shipment 0 - 40,000 feet (12192m)
- 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° ..240h
2	Low temperature storage test	Ta = -20° ..240h
3	High temperature & high humidity operation test	Ta = 40° ..95%RH 240h (no condensation)
4	High temperature operation test	Ta = 50° ..240h
5	Low temperature operation test	Ta = 0° ...240h
6	Vibration test (non-operating)	Sine wave, 10~500~10Hz, 1.5G, 0.37oct/min, 3 axis, 1 hour/axis
7	Shock test (non-operating)	- half sine wave, 100G, 6ms, one shock of each six faces (i.e. run 100G 6ms for all six faces.) - square wave, 50G, 18ms. (for box packaging)

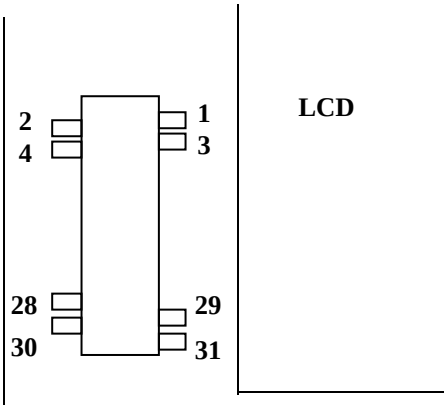
{Result Evaluation Criteria}

There should be no change which might affect the practical display function when the display quality test is conducted under normal operating condition.

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6. Interface Pin Configuration

* Used connector : DF9B-31P-1V(HIROSE), Matching side : DF9B-31S-1V(HIROSE)

Table 5 INTERFACE PIN CONFIGURATION

Pin	Symbol	Description	Notes
1	GND	Ground	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.
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	ENAB	Data timing signal	
28	VDD	Power supply +5V	
29	VDD	Power supply +5V	
30	NC	No connection	
31	NC	No connection	

The backlight interface connector is a model BHSR-02VS-1, manufactured by JST. The mating connector part number is SM02B-BHSS-1 or equivalent. The pin configuration for the connector is shown in the table below.

Table 6 BACKLIGHT CONNECTOR PIN CONFIGURATION

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

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

Product Specification
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 its proper operation.

Table 7 Timing Table

ITEM		SYMBOL	MODE	MIN.	TYP.	MAX.	UNIT	NOTES
DCLK	Freq.	Fclk	ALL		25.18	32.00	Mhz	
	High time	Tch	ALL	7			ns	
	Low time	Tcl	ALL	7			ns	
DATA	Setup time	Tds	ALL	7			ns	
	Hold time	Tdh	ALL	7			ns	
Horizontal sync.	Cycle	Th	ALL	30.0	31.78		β _i	1
			ALL	770	800	900	clock	
	Pulse width	Thp	ALL	2	96	200	clock	
Vertical sync.	Cycle	Tv	480	515	525	560	Lines	2
			400	445	449	480		
			350	447	449	510		
	Pulse width	Tvp	ALL	2		34		
Horizontal display period		Thd	ALL	640	640	640	clock	
Horizontal clock phase diff.		The	ALL	10			ns	
Hsync-Vsync phase difference		Tvh	ALL	0		Th-Thp	ns	

Notes 1. Horizontal display position

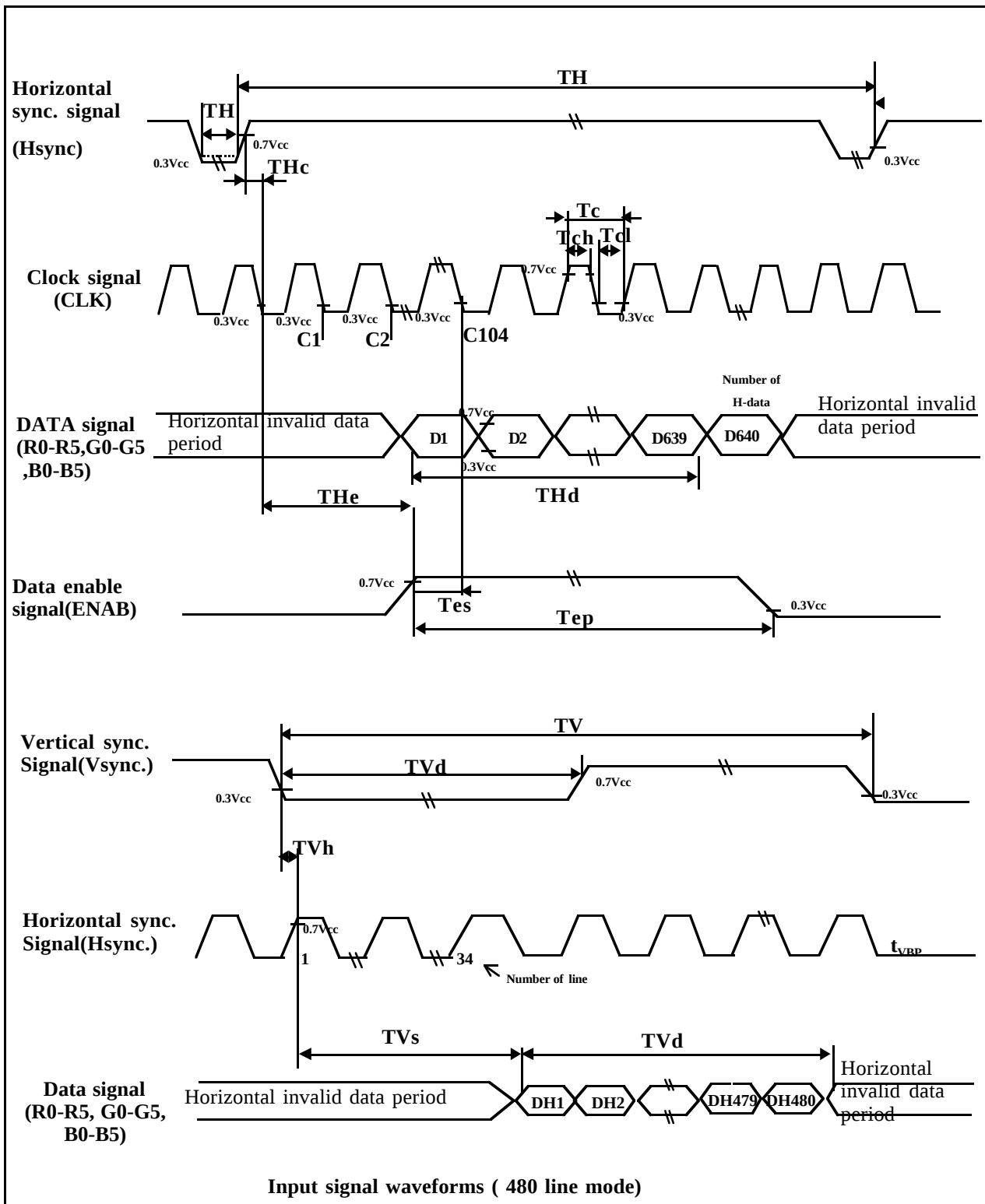
Horizontal display position is determined by DTMG signal and input data corresponding to the rising edge of DTMG signal is displayed at the left end of the display area.

Parameter							
DTMG	Setup time						
	Pulse width						
Hsync-Vsync signal phase difference							



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8. Signal Timing Wave form





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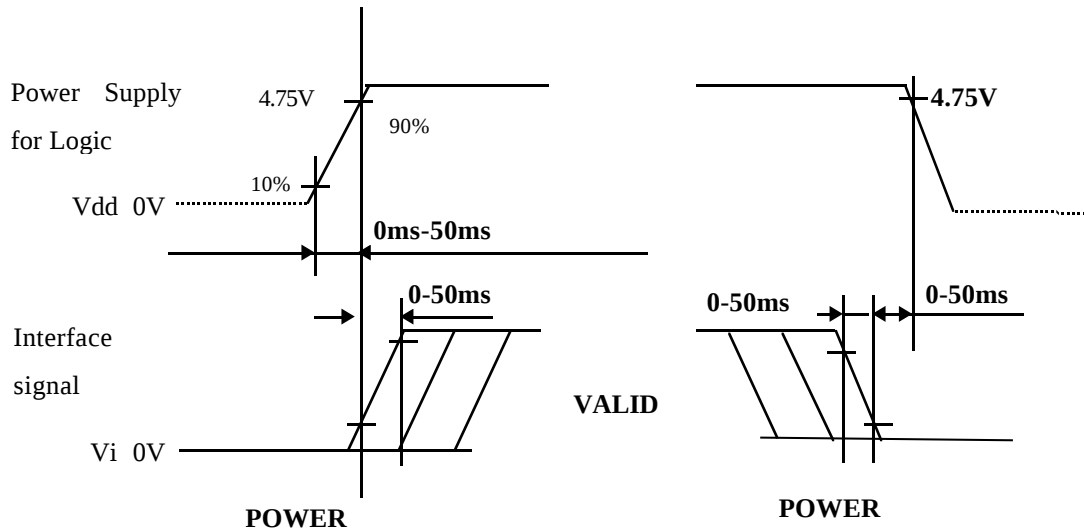
9. Color Input Data Reference

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



* Set 0V $\circ$ Vi(t) $\circ$ Vdd(t)

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

- 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_{DD} to 0V.

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11. Mechanical Characteristics

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

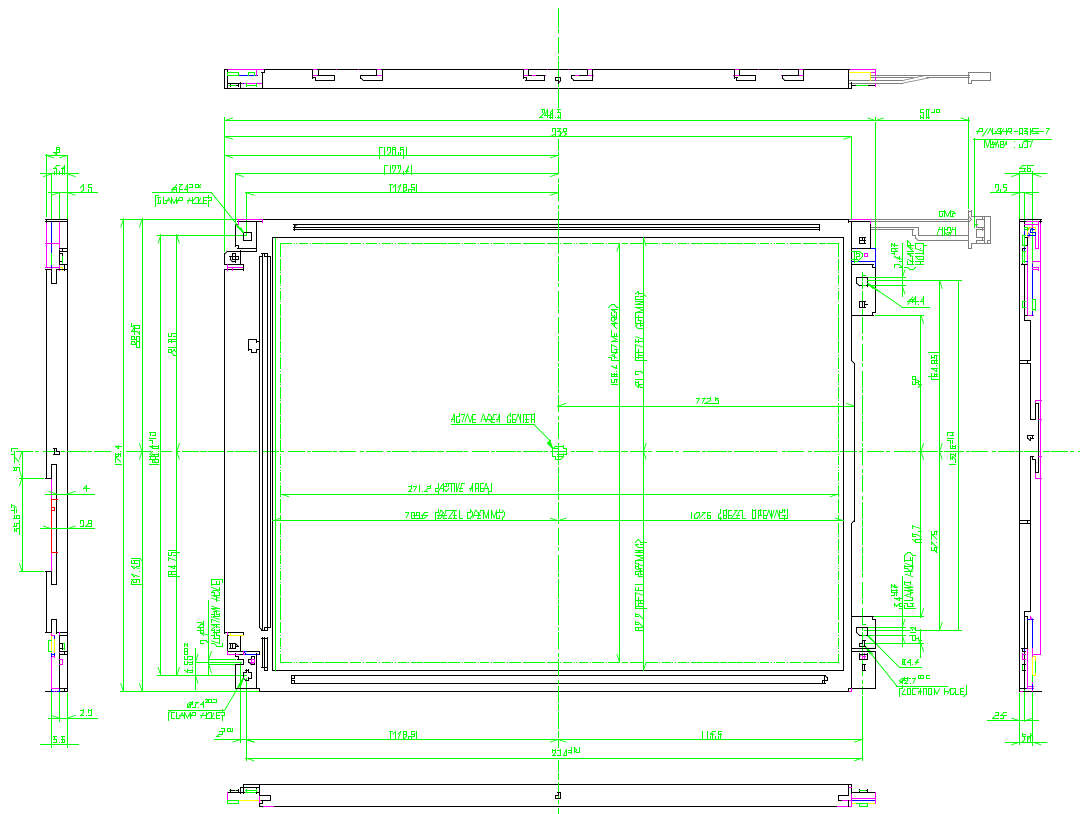
Outside dimensions :

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

Active Display area :

Width	211.2mm
Height	158.4mm

Weight (approximate): 350(Typ.) g



< LCM FRONT SIDE >

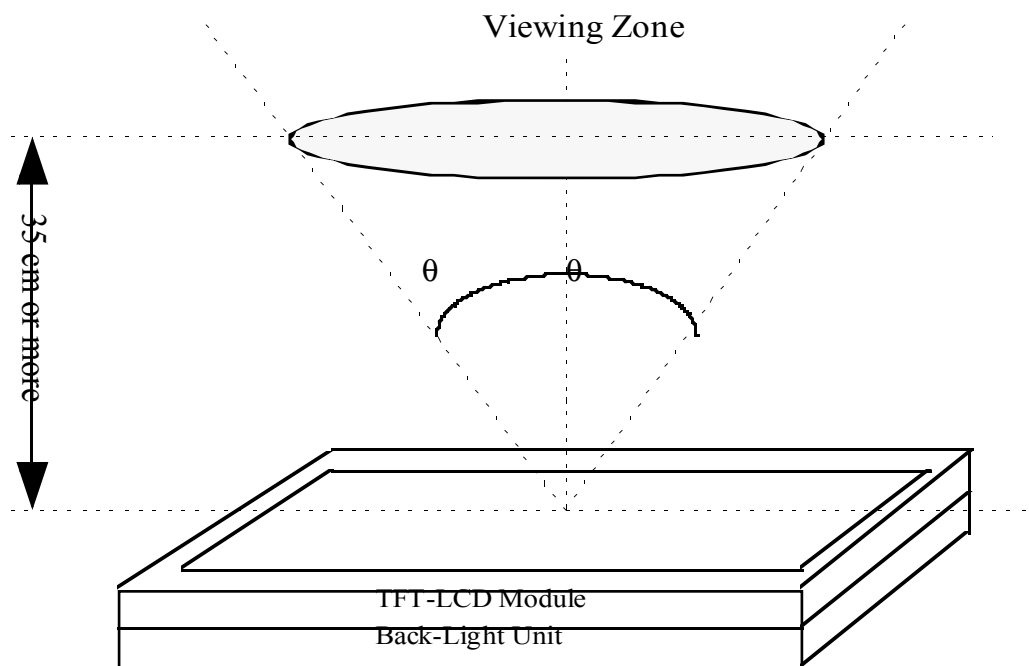
12. COSMETICS

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, contact LG Semicon Co., Ltd. any time.

12.1 Cosmetic Inspection Conditions

12.1.1 Inspective viewing angle

- This inspection should be executed according to the following figure.



- Viewing angle should be in the range of :

- $\theta < 45^{\circ}$ when non-operating inspection
- $\theta < 20^{\circ}$ when operating inspection (Horizontal direction)
- $\theta < 10^{\circ}$ when operating inspection (Vertical direction)

12.1.2 Environment Conditions

- Ambient temperature : $25 \pm 5^{\circ}\text{C}$
- Ambient Humidity : $65 \pm 5\% \text{ RH}$
- Ambient Lumination : Using single 20 watts fluorescent lamp (about 500 lux)
- Distance by eyes of inspector from the module : 35 cm or more

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13. Reliability

TEST ITEM		TEST CONDITIONS
STORAGE	High temperature	Ta = 60°... 240 Hrs
	Low temperature	Ta = -20°... 240 Hrs
OPERATION	High TEMP.&humidity	Ta = 40°... 95% RH 240 Hrs
	High temperature	Ta = 50°... 240 Hrs
	Low temperature	Ta = 0°... 240 Hrs
VIBRATION TEST (No operation)	Frequency	10~57Hz / WIDTH : 0.075mm 58~500Hz / Gravity 9.8m/s²
	Sweep time	11 minutes
	Test period	3 Hrs (1Hr for each direction of X, Y, Z)
SHOCK TEST (No operation)	Max. Gravity	490m/s²
	Pulse width	11 minutes, sine wave
	Direction	°X, °Y, °Z (once for each direction)

* The module should be inspected after 2 hours storage in normal conditions

(25°...50°... 65 °...50% RH)

* Definitions of failure for judgement.

- 1) Function of the module should be maintained.
- 2) Appearance and display quality should not have distinguished degradation.
- 3) Luminance should be larger than 50% of initial value.



14. Safety

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

14.2 materials

14.2.1 Toxicity : There is no carcinogenic materials used anywhere in the display module.

14.2.2 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.

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

14.2.4 Hazardous Voltages : Any points exceeding 42.2volts meets the requirement of the limited current circuit.

The current through a 2 Kohm resistance is less than $0.7 \times f(\text{Khz})\text{mA}$.

15. Packaging

: The packaging of the LCD meets 75 cm drop test.

16. 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.

17. Performance

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



18. PRECAUTIONS

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

18.1 MOUNTING PRECAUTIONS

- (1) You must mount a module using holes arranged in four corners.
- (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 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.
- (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 dustclothes 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 soaked 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.

18.2 OPERATING PRECAUTIONS

- (1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :
 $V_{DD} = \pm 200\text{mV}$, $V_1 = \pm 200\text{mV}$ (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) A module has high frequency circuit. If you need to shield the electromagnetic noise, please do in yours.
- (7) When a Back-light unit is operating, it sounds. If you need to shield the noise, please do in yours.

18.3 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 I/F pin directly.

18.4 PRECAUTION FOR STRONG LIGHT EXPOSURE

Strong light exposure causes degradation of polarizer and color filter.

Product Specification**18.5 STORAGE**

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

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

18.6 HANDLING PRECAUTIONS FOR PROTECTION FILM

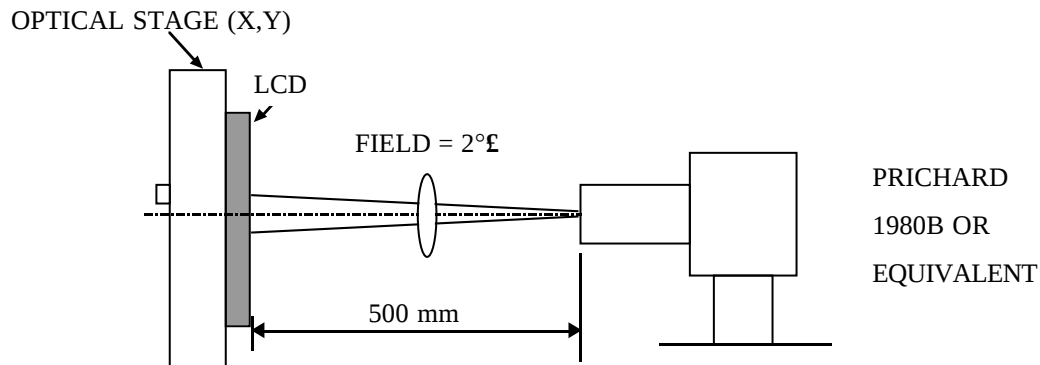
- (1) Be sure to turn off the power when connecting or disconnecting circuit.
- (2) Note that polarizer are easily damaged, pay attention not to scratch or press these surface with any hard object.
- (3) When lcd surface become dirty, please wipe them off with soft material like absorbent cotton.
- (4) 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.
- (5) 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.



Product Specification

A-1 Measurement setup & method

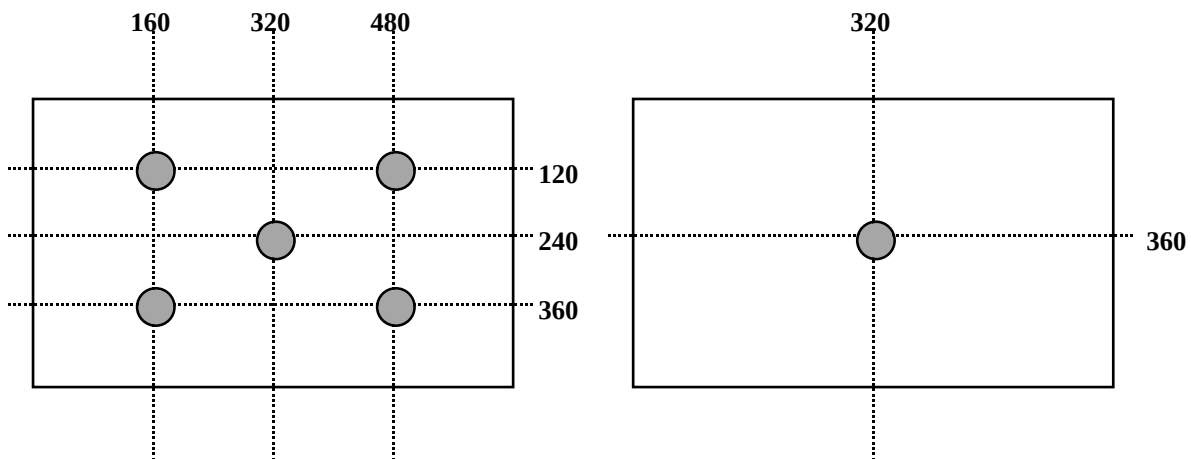
Optical measurement shall be executed in a dark room or equivalent state with the following method.
Measurement shall be executed 30 minutes after back light turn on.



A-2 Brightness

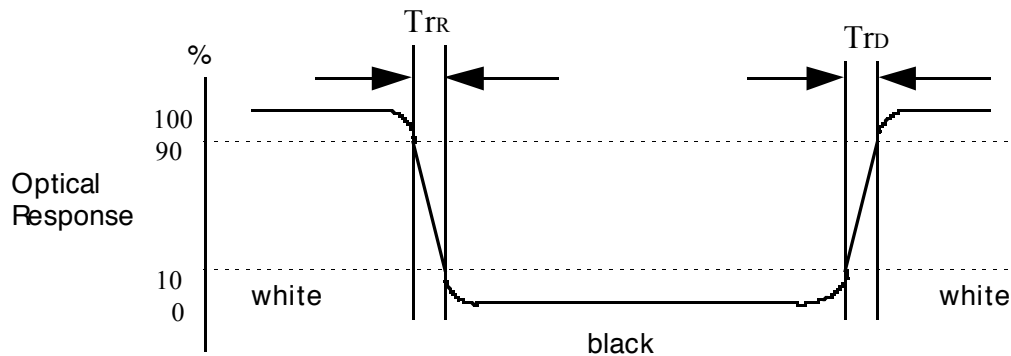
<measuring point for brightness vibration>

<measuring point for surface brightness >



A-3 RESPONSE TIME

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



A-4 Viewing angle

<Definition of viewing angle range>

