Display Specification

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SPECIFICATION

For

APPROVAL

( ) Preliminary Specification

( ) Final Specification

Title	12.1" XGA TFT LCD

BUYER NAME	
MODEL NAME	

SUPPLIER	LG Electronics Inc
MODEL NAME	LP121XQ

SIGNATURE	DATE
/	
/	
/	

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

APPROVED BY	DATE
/G.Manager	
REVIEWED BY	
/S.Engineer	
PREPARED BY	
H.M.KANG /S.Engineer	

Product Engineering Dept.
LCD Division LG Electronics Inc.

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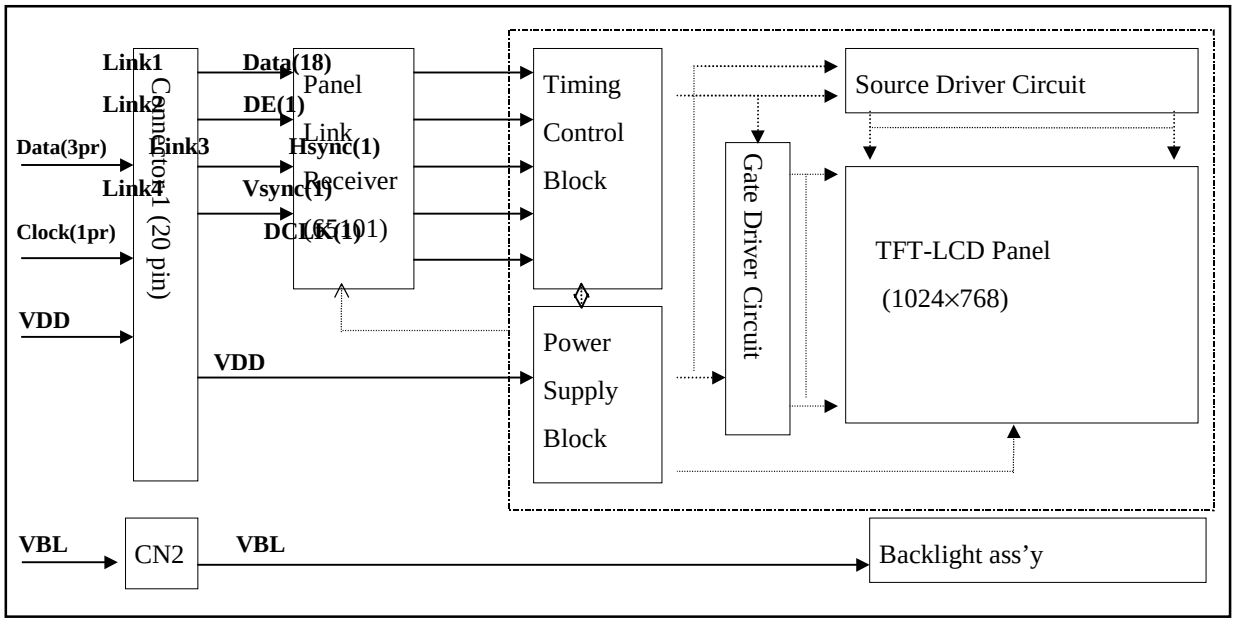
Record of Revision

DATE AND VERSION	DESCRIPTION
Dec.031996	1. Table 2 Input Current 700 --> 650mA 800 --> 850mA 2. Weight 420 ± 20 gram --> 430 ± 20 gram

1. General Description

The LG Electronics model LP121XQ 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 12.1 inch diagonally measured active display area with XGA resolution(768 vertical by 1024 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 pallete of more than 262,000 colors.

The LP121XQ LCD is intended to support applications where low power consumption, weight and thickness are critical factors and graphic displays are important. In combination with the Panel-Link interface, the LP121XQ characteristics provide an excellent flat panel display for office automation products such as portable computers.



General Display Characteristics

The following are general feature of the model LP121XQ LCD;

Active display area	12.1 inches(245.75 mm × 184.34 mm)
Outsize dimensions	275.0(W) × 197.0(H) × 6.0(D) mm
Pixel pitch	0.24 mm × 0.24 mm
Pixel format	768 horiz. By 1024 vert. pixels
	RGB vertical stripe arrangement
Color depth	6-bit, 262,140 colors
Display operating mode	transmissive mode, normally white
Surface treatments	hard coating(2H) and anti-glare treatment

2. Maximum Ratings

The followings 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 Supply Voltage	V_{DD}	-0.3	+4.0	Vdc	at 25•
Logic Input Voltage	Vi	-0.3	V_{DD}+0.3	Vdc	at 25•
Operating Temperature	T_{OP}	5	+50	•	1
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•.

3. Electrical Specifications

The LP121XQ requires two power inputs. One is employed to power the LCD electronics and to derive 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 Voltage	V_{DD}	3.15	3.3	3.45	Vdc	
Power Supply Current	I_{DD}	-	650	850	mA	1
Ripple/Noise	-	-	-	100	mV	
Logic Input Level, High	V_{IH}	$0.7V_{DD}$	-	V_{DD}	Vdc	2
Logic Input Level, Low	V_{IL}	V_{SS}	-	$0.3V_{DD}$	Vdc	2
						2
BACKLIGHT						
Backlight Input voltage	V_{BL}	635	705	730	V_{RMS}	
Backlight Current	I_{BL}	2.0	3.0	4.0	mA	
Lamp Kick-Off Voltage		935	-	-	V_{RMS}	25•
		1280		-	V_{RMS}	5•
Operating Frequency	F_{BL}		50		KHz	3

Notes: 1. The current draw and power consumption specified is for 3.3 Vdc at 25• and fv at 60Hz and dot frequency at 65MHZ.
2. Logic levels are specified for VDD of 3.3Vdc at 25•. The values specified apply to all logic inputs; Hsync, Vsync, Clock, data enable, data signals,etc.
3. The backlight current consumption shown above does not include loss of external 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 2 OPTICAL CHARACTERISTICS

Parameter	Symbol	Values			Units	Notes
		Min.	Typ.	Max.		
Contrast Ratio	CR	80	100	-		1
Surface Brightness, white	SB_{WH}	60	70		cd/m^2	2
Brightness Variation	SB_V		1.20	1.45	%	3
Response Time	Tr				msec	4
Rise Time	Tr_R		-	50		
Decay Time	Tr_D		-	50		
CIE Color Coordinates						
Red	x_R	0.56	0.59	0.62		
	y_R	0.32	0.35	0.38		
Green	x_G	0.30	0.33	0.36		
	y_G	0.53	0.56	0.59		
Blue	x_B	0.13	0.16	0.19		
	y_B	0.10	0.13	0.16		
White	x_W	0.30	0.33	0.36		
	y_W	0.30	0.33	0.36		
Viewing Angle					degree, °	5
x axis, right (•=0°)	•	40				
x axis, left(•=180°)	•	40				
y axis, up(•=90°)	•	10				
y axis, down (•=270°)	•	30				

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 9 measurement across the LCD surface 50cm from the surface with all pixels displaying white.

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} by the minimum B_{ON}.

$$\frac{\text{Maximum } (B_{ON0}, B_{ON1}, ...B_{ON9})}{\text{Minimum } (B_{ON0}, B_{ON1}, ...B_{ON9})}$$

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).

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.

5. Interface Connections

This LCD employs two interface connections, a 20 pin connector is used for the module electronics and a three pin connector is used for the integral backlight system.

The electronics interface connector is a model DF15B-20DS-0.65V, manufactured by Hirose. The mating connector part number is DF15B-20DP-0.65V or equivalent. The pin configuration for the connector is shown in the table below.

Table 3 MODULE CONNECTOR PIN CONFIGURATION

Pin	Symbol	Description	Notes
1	GND	Ground	1
2	GND	Ground	1
3	RX0-	Low voltage swing differential input data pairs	
4	RXC-	Low voltage swing differential input clock pairs	
5	RX0+	Low voltage swing differential input data pairs	
6	RXC+	Low voltage swing differential input clock pairs	
7	GND	Ground	1
8	GND	Ground	1
9	RX2-	Low voltage swing differential input data pairs	
10	RX1-	Low voltage swing differential input data pairs	
11	RX2+	Low voltage swing differential input data pairs	
12	RX1+	Low voltage swing differential input data pairs	
13	GND	Ground	1
14	GND	Ground	1
15	VDD	Power supply voltage	
16	VDD	Power supply voltage	
17	VDD	Power supply voltage	
18	GND	GND	1
19	VDD	Power supply voltage	
20	VDD	Power supply voltage	

Notes: 1. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.

Interface Connections (cont'd)

The backlight interface connector is a model BHR-03VS-1, manufactured by JST. The mating connector part number is SM02(8.0)B-BHS-1-TB or equivalent. The pin configuration for the connector is shown in the table below.

Table 4 BACKLIGHT CONNECTOR PIN CONFIGURATION

Pin	Symbol	Description	Notes
1	HV	Lamp power input	1
2	NC	No connect	
3	LV	Ground	2

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

6. Signal Timing Specification

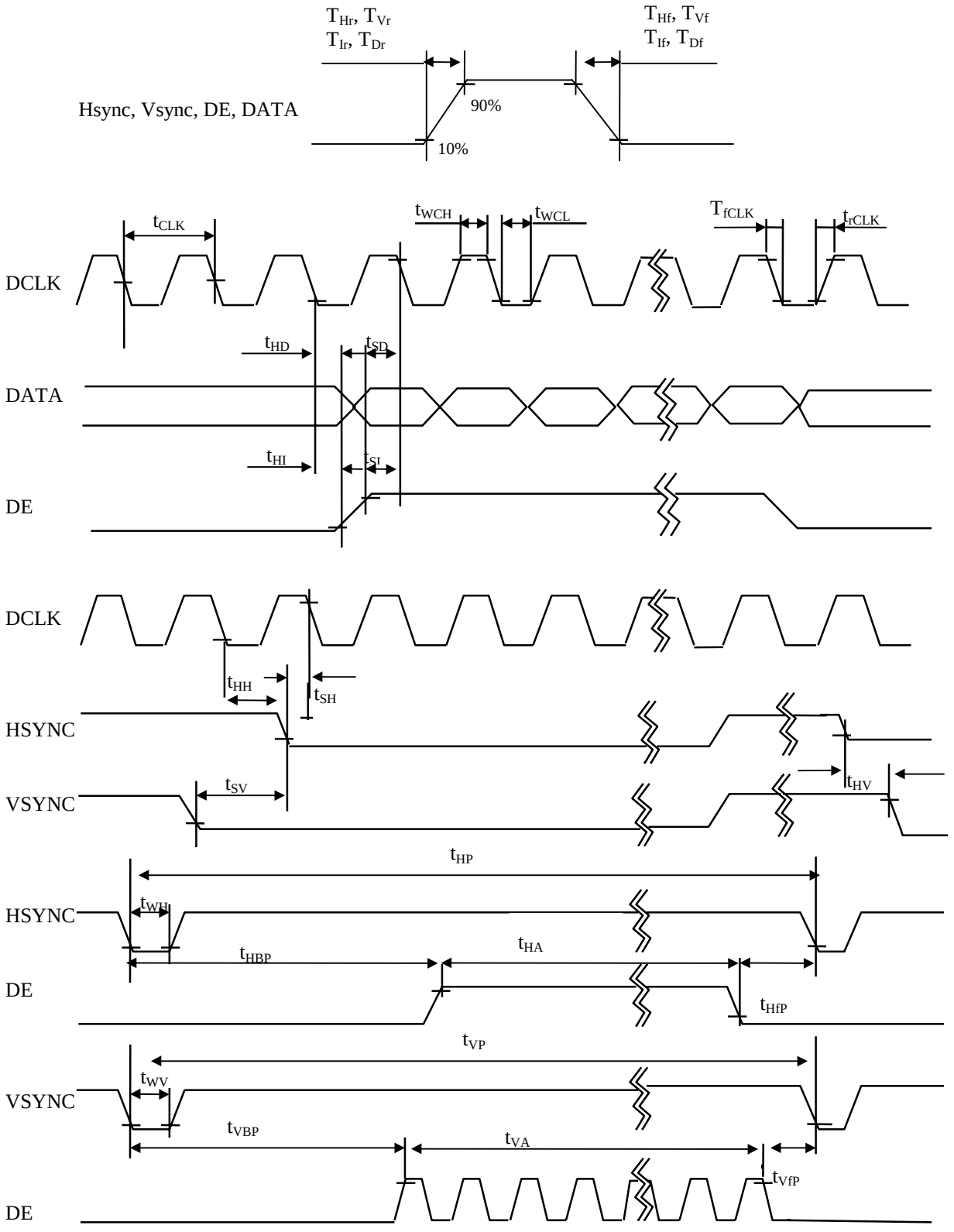
This Specifications shall be defined as digital output signal of VGA controller.

Parameter		Symbol	Value			Units	Notes
			Min.	Typ.	Max.		
DCLK	Frequency	fclk(=1/Tclk)	-	50	65	MHZ	1
	Width-Low	Twcl	6	-	-	ns	
	Width-High	Twch	6	-	-	ns	
	Rise/Fall Time	Trclk, Tfclk	-	-	10	ns	
Hsync	Setup Time	Tsh	6	-	-	ns	2
	Hold Time	Thh	6	-	-	ns	
	Period	Thp	-	1070	1344	Tclk	
	Width-Active	Twh	10	25	-	Tclk	
	Rise/Fall Time	Thr,Thf	-	-	10	ns	
Vsync	Setup Time	Tsv	tbd			Tclk	3
	Hold Time	Thv	tbd			Tclk	
	Period	Tvp	-	780	806	Thp	
	Width-Active	Twv	2	-	6	Thp	
	Rise/Fall Time	Tvt,Tvf	-	-	10	ns	
DE	Setup Time	Tsi	6	-	-	ns	4
	Hold Time	Thi	6	-	-	ns	
	Rise/Fall Time	Tvr,Tvf	-	-	10	ns	
	Horizontal active	Tha	1024	1024	1024	Tclk	
	Horizontal back porch	Thbp	10	32	-	Tclk	
	Horizontal front porch	Thfp	1	24	-	Tclk	
	Vertical active	Tva	769	769	769	Thp	
	Vertical back porch	Tvbp	4	5	-	Thp	
	Vertical front porch	Tvfp	2	3	-	Thp	
Data	Setup Time	Tsd	7	-	-	ns	
	Hold Time	Thd	2	-	-	ns	
	Rise/Fall Time	Tdr,Tdf	-	2	3	ns	

Notes: 1. Dot Clock (Jitter <= 2ns)
2. Horizontal sync control signal.
3. Vertical sync control signal.
4. Data Enable. This signal qualifies the active data area.

7. Signal Timimg Wave forms

This waveforms shall be defined as digital output signal of VGA controller



8. Color Input Data Reference

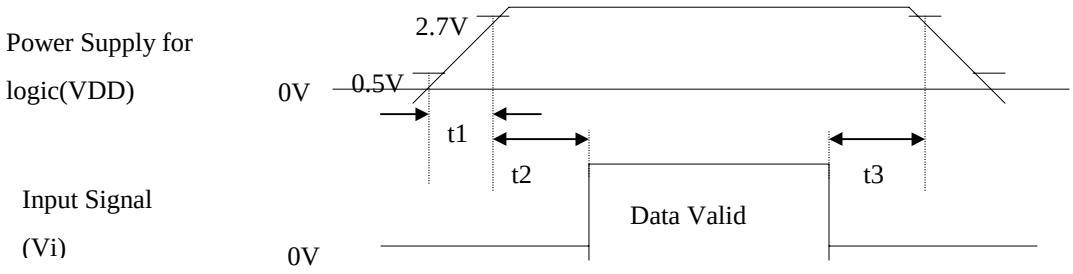
The brightness of each primary color(red, green and blue) is based on the 6-bit gray scale data input for the color; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 5 COLOR DATA REFERENCE

Color		Input Color Data																	
		Red						Green						Blue					
		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(00)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Green(00)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Blue(00)	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(63) Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(62)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Red(61)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Red(02)	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Red(01)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red(00)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Green	Green(63) Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green(62)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Green(61)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Green(02)	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0
	Green(01)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	Green(00)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
Blue	Blue(63) Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue(62)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Blue(61)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	Blue(02)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1
	Blue(01)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	Blue(00)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

Note : Gray scale L(0) is darkest and L(63) is brightest.

9. Power Sequence



*** V_{DD}-turn-on conditions**

0 < t1 • tbd
0 < t2 • tbd
0 < t3 • tbd

*** Set 0 Volt < Vi(t) < V_{DD}(t)**
Here Vi(t), V_{DD}(t) indicate the transitive state of Vi, V_{DD} 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.

10. Mechanical Characteristics

The chart below provides general mechanical characteristics for the model LP121XQ LCD. The surface of the LCD has an anti-glare coating to minimize reflection and a 2H hard coating to reduce scratching.

Parameters	Specifications	Unit	Notes
Unit Outsize dimension	275(W)×197(V)×6(D)	mm	1
Bezel opening Area	249.8(H)×188.4(V)	mm	1
Display part Effevctive Display Area Screen size Pixel pitch Number of pixels Pixel configuration Display mode	 245.75(H)×184.34(V) 12.1 0.240 1024(H)×768(V) RGB vertical stripes Normally white	 mm inch mm	
Weight	430 (Typ) 450 (Max)	gram	
Surface treatment	Anti-glare and Hard coating(2H)		

Notes : **1. The detailed specifications are referred to mechanical drawings of LP121XQ.**

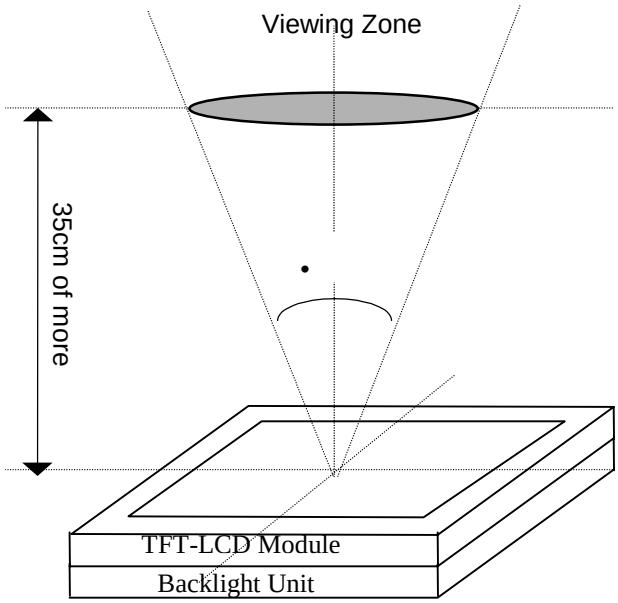
11.Cosmetic

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 Electronics any time.

11.1 Cosmetic Inspection Conditions

11.1.1 Inspective viewing angle

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



- Viewing angle should be in the range of :
  - < 40 ^{o} when non-operating inspection
  - < 5^{o} when operating inspection

11.1.2 Environment Conditions

- Ambient temperature : 25 ± 5 ^{o}C
- Ambient Humidity : 65 ±5 % RH
- Ambient Lumination : Using single 20 watts fluorescent lamp (about 500 lux)

11.1.3 Sampling method[TBD]

- Lot size : Quality of shipment per model
- Sampling type : Normal inspection, single sampling
- Inspection level :
- Sampling table : Table in MIL-STD-

11.1.4 Acceptance Quality Level ['AQL'] [TBD]

- Major Defects : AQL %
- Minor Defects : AQL %

11.2 Cosmetic Specifications

	Item	Description	Classification	
Display Inspection	System function	No display Malfunction	Major Major	
	Display defects	Vertical line defect Horizontal line defect Sub-pixel defect Flicker Deterioration of display Quantity Newton ring	Major Major Minor Minor Minor Minor	
	Contrast ratio	Out of spec.	Major	
	Viewing angle	Out of spec.	Minor	
	Uniformity	Out of spec.	Minor	
	Backlight	No operation	Major	
	Image persistance	Out of spec.	Minor	1
Appearance Inspection	Dimension	Outline Mounting hole position	Major Major	
	Scratch & Dent on the polarizer		Minor	
	Bezel status	Irregular plating & coating	Minor	
	Black / White spot or line	Active area, below 10 dots	Minor	2
	Damaged part	Deep damage of B/L lead wire	Major	
	Others	Polarizer bubble Scratch on C/F or Cr layer	Minor Minor	

Notes : 1.Image persistance should be tested after displaying same pattern for 30 minutes

and should disappear within 20 seconds.

2. Inspected in the bright/dark pattern respectively.
3. Quality acceptance level of defects on LCM module is defined as follows.

Item	Acceptance Level	
Black spot White spot Line	TBD	When operating
Scratches Dent	TBD	On the polarizer

[L : Length in mm , D : Diameter in mm , N & Nt : Number]

12. Reliability

No.	Test ITEM	Conditions
1	High temperature operation test	Ta = 40• 80%RH 168 Hrs (no condensation)
2	Low temperature operation test	Ta = 0• 168 Hrs
3	Vibration test (non-operating)	5 ~ 500 Hz 0.5G 0.5 oct/min 1 hour for each direction of X,Y,Z
4	Shock test (non-operating)	50G 2 msec one for each direction of X,Y,Z

{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.

In High temperature and low temperature operation test, lamp current should be 3 mA.

13. International Standards

13.1 Safety

UL1950 "Safety of Information Technology Equipment Including Electrical Business Equipment. Second Edition" Underwriters Laboratories,Inc. 1993

CAS C22.2 "Safety of Information Technology Equipment Including Electrical Business Equipment. Second Edition" Canadian Standards Association, 1993

EN 60 950 "Safety of Information Technology Equipment Including Electrical Business Equipment." European Committee for Electrotechnical Standardization (CENELEC),1993,(IEC 950, Second Edition, including Amendments 1 and 2)

13.2 EMC

ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40GHz." American National Standards Institute(ANSI),1992.

C.I.S P.R "Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment."International Special Committee on Radio Interference

EN 55 022 "Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment."European Committee for Electrotechnical Standardization (CENELEC),1988

14. Designation of Lot Mark

14.1.Lot Mark

A	B	C	D	E	F	G	H	I	J	K	L
			1)	2)							

A,B : SBU CODE
C,D,E : MODEL CODE
F : YEAR
G : MONTH
H,I,J,K,L : SERIAL NO.

NOTE 1) YEAR

YEAR	89	90	91	92	93	94	95	96	97	98	99
Mark	9	0	1	2	3	4	5	6	7	8	9

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	O	N	D

14.2. Location of Lot Mark

Serial NO. is printed on the label. The label is attached to the backside of the backlight unit. This is subject to change without prior notice.

15. Packing Form

a) Package quantity in one box : 10pcs
b) Box size : TBD

Packing form is shown on the next page.

16. Handling Precautions

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

16.1.MOUNTING PREACAUTION

1)You must mount Module using mounting holes arranged in 4 corners.
Be sure to turn off the power when connecting or disconnecting the circuit.

2) Note that the polarizers are easily damaged. Pay attention not to scratch or press this surface with any hard object.

3) When the LCD surface become dirty, please wipe it off with a soft material. (ie.cotton ball)

4) Protect the module from the ESD as it may damage the electronic circuit (C-MOS). Make certain that treatment person's body are grounded thru wrist bend.

5) Do not disassemble the module and be careful not to incur a mechanical shock that might occur during installation. It may cause permanent damage.

6) Do not leave the module in high temperatures, Particularly in areas of high humidity for a long time.

7) The module not be expose to the direct sunlight.

8) Avoid contact with water as it may a short circuit within the module.

16.2 OPERATING PRECAUTION

1) The spike noise causes the mis-operation of circuits.
Be lower the spike noise as follows :

VDD=±200mV, V1=±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 turn on)becomes longer.

4) Be careful for condensation at suddern temperature change. Condensation make damage to polarizer or electrical contact part. And after fading condensation, smear or spot will occur.

5) When fixed pattern are displayed at long times, remnant image is likely to occur.

6) Module has high frequency circuit. If you need to shield the electromagnetic noise. Please do in yours.

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

16.3 ELECTROSTATIC DISCHARGE CONTROL

Since module is composed with electronic circuit, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through list band etc.. And don't touch I/F pin directly.

16.4 PRECAUTION FOR STRONG LIGHT EXPOSURE.

Strong light exposure causes degradation of polarizer and color filter.

16.5 STORAGE

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

1) Store them in a dark place : do not expose then 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.

16.6 HANDLING PRECAUTIONS FOR PROTECTION FILM

1) When the protection film is pealed off, static electricity is generated between the film and the polarizer. This film should be pealed off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition. etc.

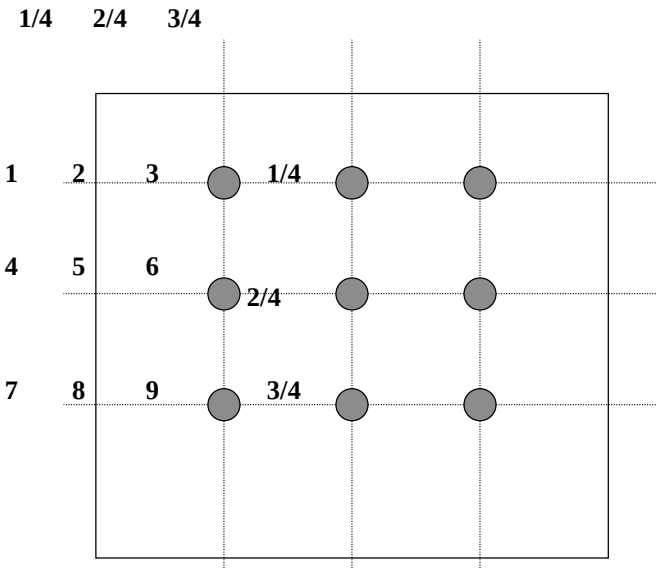
2) The protection film is attached the polarizer with a small amount of glue.If some stress is applied to rub the protection film against the polarizer during the time you peal off the film, the glue is apt to remain more on the polarizer. So please carefully peal off the protection film without rubbing it against the polarizer.
3) When the module with protection film attached is stored for long time, sometimes there remains a very small amount of glue still on the polarizer after the protaction film is pealed off.
Please refrain from storing the module at the high temperature and high humidity for glue is apt to remain in these condition.
4) The glue may be taken for the modules failure, but you can remove the giue easily. When the glue remains on the polarizer surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with Normal-hexane.

16.7 SAFETY
1) If module is broken, be careful to handle not to injure. (TFT/LCD and lamp are made of glass)
Please wash hands sufficiently when you touch the liquid crystal coming out from broken LCDs.
2) As it is possible for PCB or other electronic parts of module to small to smoke and to take fire becauseof the short circuit. Please design the circuit of your instrument not to flow the electric current to TFT/LCD module more than 1A. (by apply the fuse for example)
3) As Back-light unit has high voltage circuit internal, do not open the case and do not insert foreign materials in the case.

Apendix

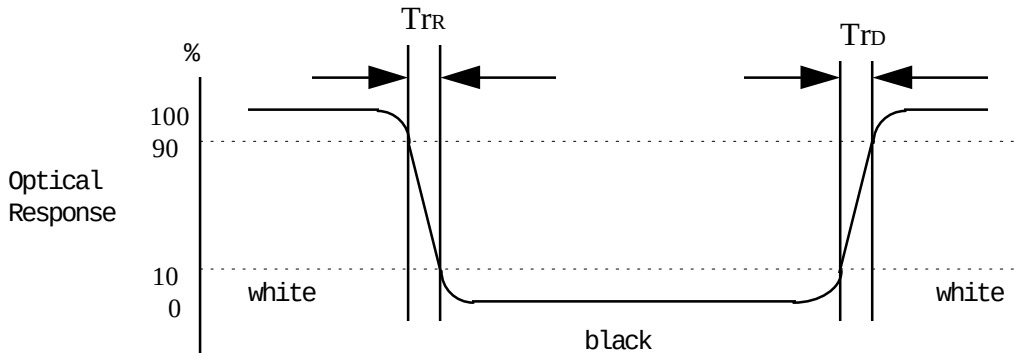
A-1 Brightness

<measuring point> Effective Display Area



A-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".



A-3 Viewing angle

<Definition of viewing angle range>