

SPECIFICATION FOR APPROVAL

- () Preliminary Specification
 () Final Specification

Title	10.4" SVGA TFT LCD
-------	--------------------

Customer	
MODEL	

SUPPLIER	LG Display Co., Ltd.
MODEL	LB104S01
Suffix	TL02

SIGNATURE	DATE
/	_____
/	_____
/	_____

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

SIGNATURE	DATE
S. D. JUNG / G.Manager	_____
REVIEWED BY	
J. Y. KIM / Manager	_____
PREPARED BY	
H. Y. LIM / Engineer	_____

**Products Engineering Dept.
LG Display Co., Ltd**

Product Specification

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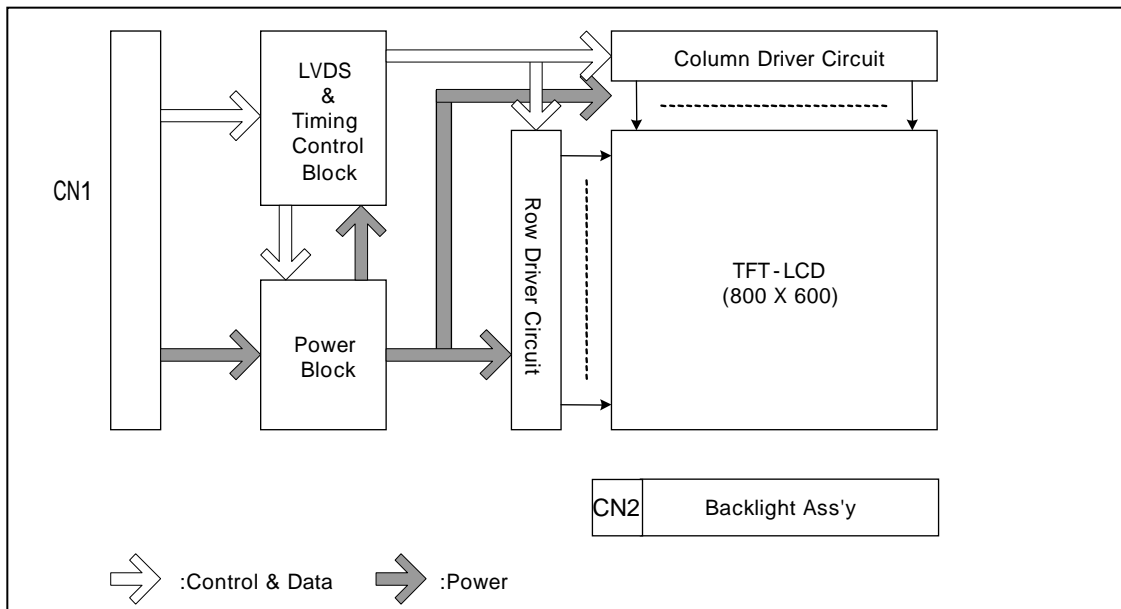
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1. General Description

The LB104S01 is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Lamp (CCFL) backlight 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 10.4 inches diagonally measured active display area with SVGA resolution (600 vertical by 800 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 LB104S01 has been designed to apply the interface method that enables low power, high speed, low EMI.

The LB104S01 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 LB104S01 characteristics provide an excellent flat display for office automation products such as Mini-Notebook PC or Web-pad, etc.



General Features

Active Screen Size	10.4 inches (264.16mm) diagonal
Outline Dimension	224.5(H) x 172.0(V) x 5.7(D) mm(Typ.)
Pixel Pitch	0.264(H) mm x 0.264(V)mm
Pixel Format	800(H) By 600 (V) Pixels RGB stripes arrangement
Color Depth	6-bit, 262,144 colors
Luminance, White	250 cd/m ² (Typ.)
Power Consumption	Total 3.68 Watt(Typ.)
Weight	290g(Typ.)
Display Operating Mode	Transmissive mode, normally white
Surface Treatment	Anti-glare& hard coating(3H)

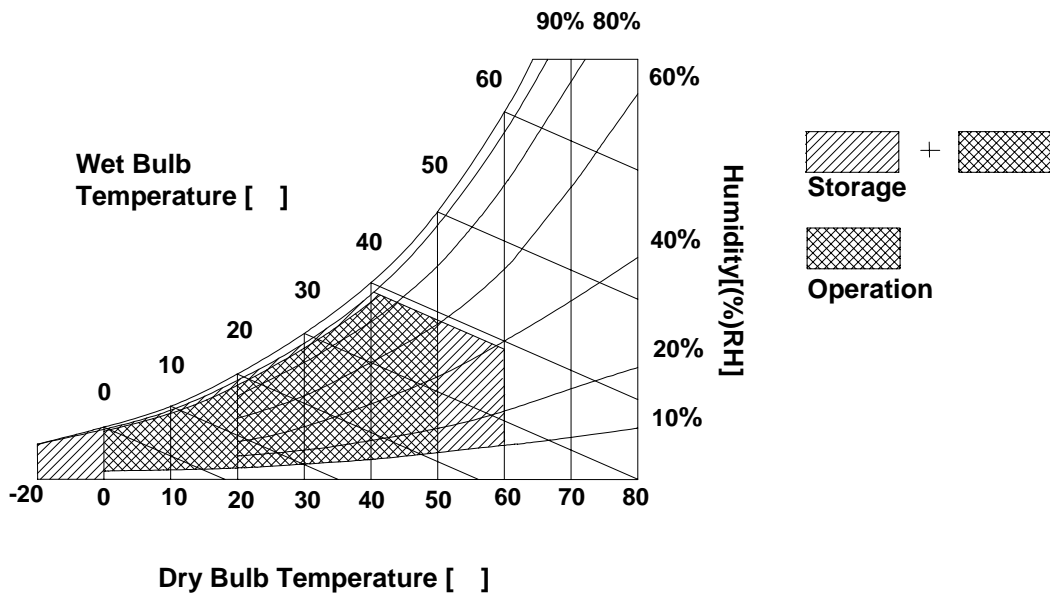
2. Absolute Maximum Ratings

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	VCC	-0.3	4.0	Vdc	at 25 ± 5°C
Operating Temperature	TOP	0	50	°C	1
Storage Temperature	HST	-20	60	°C	1
Operating Ambient Humidity	HOP	10	90	%RH	1
Storage Humidity	HST	10	90	%RH	1

Note : 1. Temperature and relative humidity range are shown in the figure below.
 Wet bulb temperature should be 39°C Max, and no condensation of water.



3. Electrical Specifications

3-1. Electrical Characteristics

The LB104S01 requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input which powers the CCFL, is typically generated by an inverter. The inverter is an external unit to the LCD.

Table 2. ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	VCC	3.0	3.3	3.6	V _{DC}	
Power Supply Input Current	I _{CC}	-	205	230	mA	1
Power Consumption	P _c	-	0.68	0.76	Watt	1
Differential Impedance	Z _m	90	100	110	Ohm	2
LAMP :						
Operating Voltage	V _{BL}	488 (6.5 mA _{RMS})	500 (6.0 mA _{RMS})	640 (2.0 mA _{RMS})	V _{RMS}	Tolerance: ± 10%
Operating Current	I _{BL}	2.0	6.0	6.5	mA _{RMS}	3
Power Consumption	P _{BL}	-	3.0	3.3	W	@ 6mA _{RMS}
Operating Frequency	f _{BL}	45	60	80	kHz	
Discharge Stabilization Time	T _s	-	-	3	Min	4
Life Time		20,000	30,000	-	Hrs	5
Established Starting Voltage at 25 at 0	V _s			845 1015	V _{RMS} V _{RMS}	6

Note)

- The specified current and power consumption are under the Vcc = 3.3V , 25 , fv = 60Hz condition whereas full black pattern is displayed and fv is the frame frequency.
- This impedance value is needed to proper display and measured from LVDS Tx to the mating connector.
- The typical operating current is 6mA_{RMS} for the typical surface luminance (L_{WH}) in optical characteristics.
- Define the brightness of the lamp after being lighted for 5 minutes as 100%, T_s is the time required for the brightness of the center of the lamp to be not less than 95%.
- The life time is determined as the time at which brightness of lamp is 50% compare to that of initial value at the typical lamp current.
- The "Max" of "Established Starting Voltage" means the minimum voltage for inverter to turn on the CCFL normally in the LCD module. It should be careful that "Established Starting Voltage" is changed by an increase of stray capacitance in your set, inverter method, value of ballast capacitor in your inverter and so on. Especially, the value of "Established Starting Voltage" is higher in low temperature condition than in normal temperature condition, because impedance of CCFL is increased. The voltage above V_s should be applied to the lamps for more than 1 second for start-up.
- Lamp frequency may produce interference with horizontal synchronous frequency and as a result this may cause beat on the display. Therefore lamp frequency shall be as away possible from the horizontal synchronous frequency and from its harmonics in order to prevent interference.
- The lamp power consumption shown above does not include loss of external inverter.
The applied lamp current is a typical one.

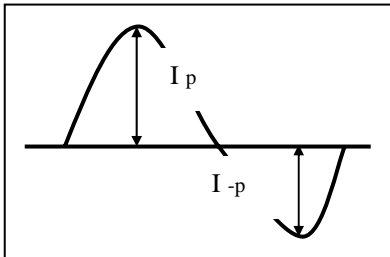
Product Specification

Note)

9. Requirements for a system inverter design, which is intended to have a better display performance, a better power efficiency and a more reliable lamp, are following.

It shall help increase the lamp lifetime and reduce leakage current.

- a. The asymmetry rate of the inverter waveform should be less than 10%.
 - b. The distortion rate of the waveform should be within $2 \pm 10\%$.
- * Inverter output waveform had better be more similar to ideal sine wave.



* Asymmetry rate:

$$\frac{|I_p - I_{-p}|}{I_{RMS}} * 100\%$$

* Distortion rate

$$I_p \text{ (or } I_{-p}) / I_{RMS}$$

Do not attach a conducting tape to lamp connecting wire.

If the lamp wire attach to a conducting tape, TFT-LCD Module has a low luminance and the inverter has abnormal action. Because leakage current is occurred between lamp wire and conducting tape.

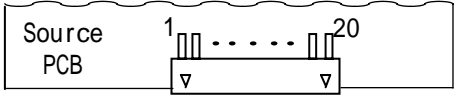
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3-2. Interface Connections

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

The electronics interface connector is a model GT100-20P-LS-SMT manufactured by LS Cable.

Table 3. MODULE CONNECTOR PIN CONFIGURATION (CN1)

Pin	Symbol	Description	Notes
1	VCC	Power Supply, 3.3V Typ.	1, Interface chips 1.1 LCD : SW, SW0602_U(LCD Controller) including LVDS Receiver 1.2 System : THC63LVDM63A or Equivalent * Pin to Pin compatible with TI LVDS 2. Connector 2.1 LCD : GT100-20P-LS-SMT, LS Cable or Equivalent 2.2 Mating Discrete Wire type:DF19G-20S-1C(HIROSE) FPC type :DF19G-20S-1F(HIROSE) 2.3 Connector pin arrangement 
2	VCC	Power Supply, 3.3V Typ.	
3	GND	Ground	
4	GND	Ground	
5	A1M	Negative LVDS differential data input	
6	A1P	Positive LVDS differential data input	
7	GND	Ground	
8	A2M	Negative LVDS differential data input	
9	A2P	Positive LVDS differential data input	
10	GND	Ground	
11	A3M	Negative LVDS differential data input	
12	A3P	Positive LVDS differential data input	
13	GND	Ground	
14	CLKM	Negative LVDS differential clock input	
15	CLKP	Positive LVDS differential clock input	
16	GND	Ground	
17	GND	Ground	
18	GND	Ground	
19	GND	Ground	
20	GND	Ground	

The backlight interface connector is a model BHSR-02VS-1, manufactured by JST or Compatible.

The mating connector part number is SM02B-BHSS-1 or equivalent.

Table 5. BACKLIGHT CONNECTOR PIN CONFIGURATION (CN2)

Pin	Symbol	Description	Notes
1	HV	Power supply for lamp (High voltage side)	1
2	LV	Power supply for lamp (Low voltage side)	1

Notes : 1. The high voltage side terminal is colored pink and the low voltage side terminal is black.

3-3. Signal Timing Specifications

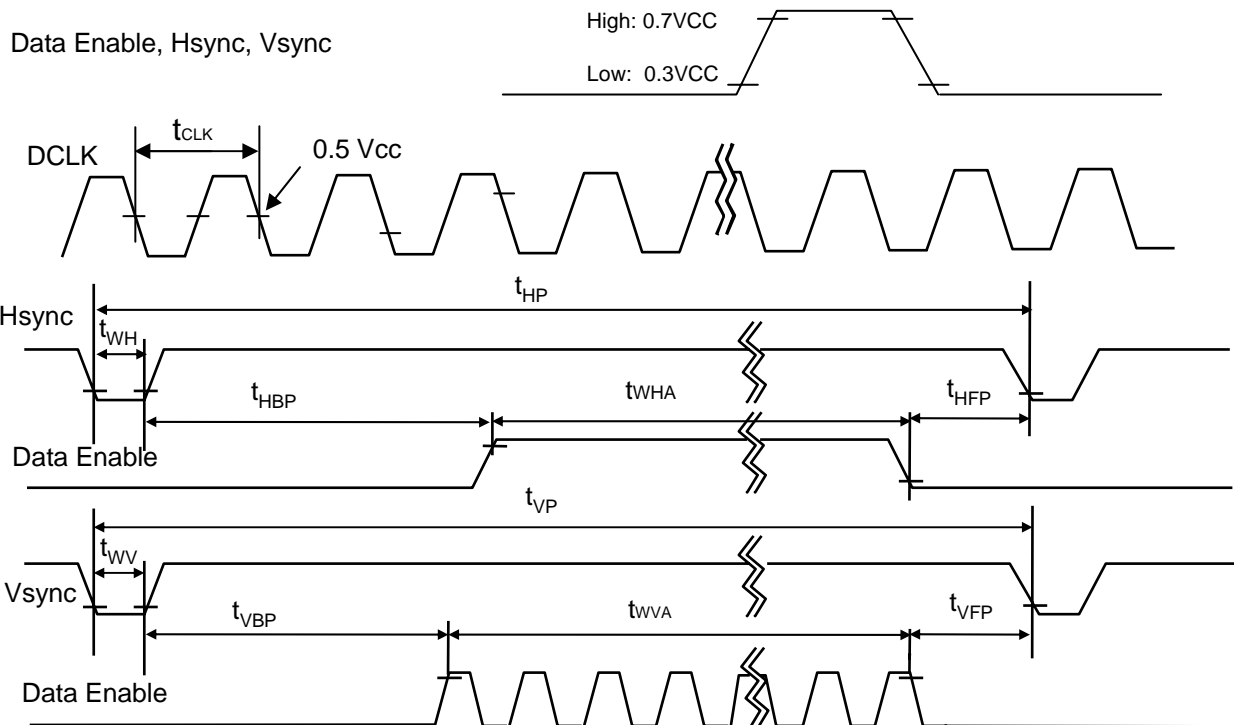
This is the signal timing required at the input of the User connector. All of the interface signal timing should be satisfied with the following specifications and specifications of LVDS Tx/Rx for its proper operation.

Table 6. TIMING TABLE

ITEM	Symbol	Min	Typ	Max	Unit	Note
DCLK	Frequency	fCLK	37.0	38.5	40.0	MHz
Hsync	Period	tHP	990	1024	1100	tCLK
	Width	tWH	12	64	120	
	Horizontal Valid	tHV	800	800	800	
Vsync	Period	tVP	606	625	730	tHP
	Width	tWV	1	6	24	
	Vertical Valid	tVV	600	600	600	
	Horizontal back porch	tHBP	30	88	120	tCLK
	Horizontal front porch	tHFP	30	72	80	
	Vertical back porch	tVBP	2	15	22	tHP
	Vertical front porch	tVFP	3	4	5	

3-4. Signal Timing Waveforms

Condition : VCC = 3.3V



3-5. 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 7. COLOR DATA REFERENCE

Color		Input Color Data																	
		RED						GREEN						BLUE					
		MSB				LSB		MSB				LSB		MSB		LSB			
		R 5	R 4	R 3	R 2	R 1	R 0	G 5	G 4	G 3	G 2	G 1	G 0	B 5	B 4	B 3	B 2	B 1	B 0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	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)	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 (62)	1	1	1	1	1	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	GREEN (00)	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 (62)	0	0	0	0	0	0	1	1	1	1	1	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	BLUE (00)	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 (62)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	BLUE (63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

3-6. Power Sequence

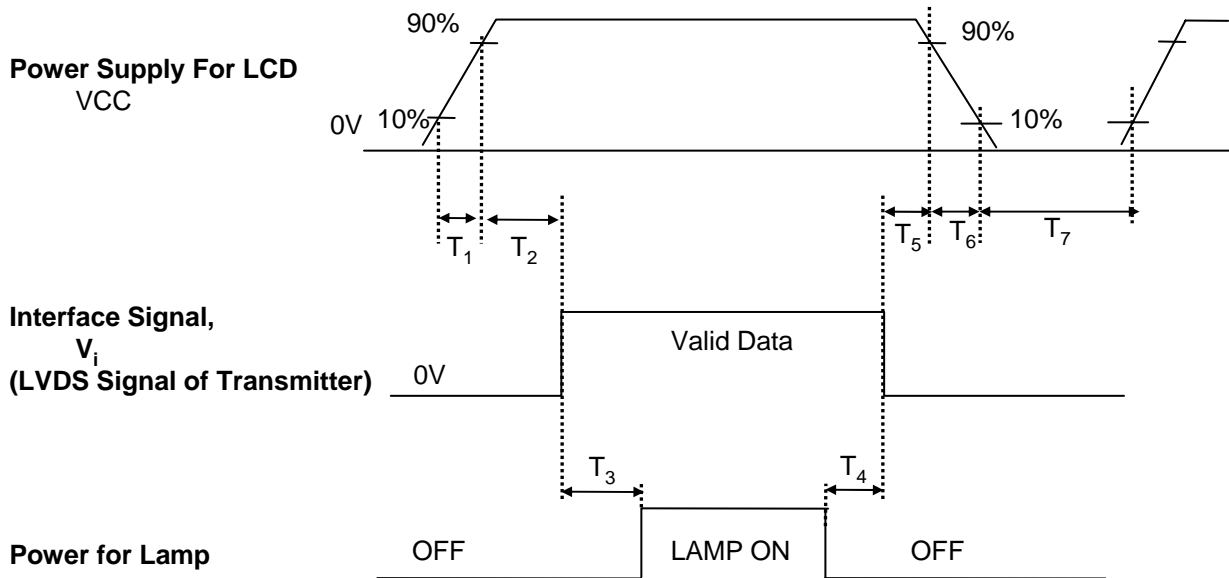


Table 8. POWER SEQUENCE TABLE

Parameter	Value			Units
	Min.	Typ.	Max.	
T ₁	-	-	10	(ms)
T ₂	0	-	50	(ms)
T ₃	200	-	-	(ms)
T ₄	200	-	-	(ms)
T ₅	0	-	50	(ms)
T ₆	-	-	10	(ms)
T ₇	400	-	-	(ms)

Note)

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 VCC to 0V.
3. Lamp power must be turn on after power supply for LCD and interface signal are valid.

4. Optical Specification

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

FIG. 1 presents additional information concerning the measurement equipment and method.

FIG. 1 Optical Characteristic Measurement Equipment and Method

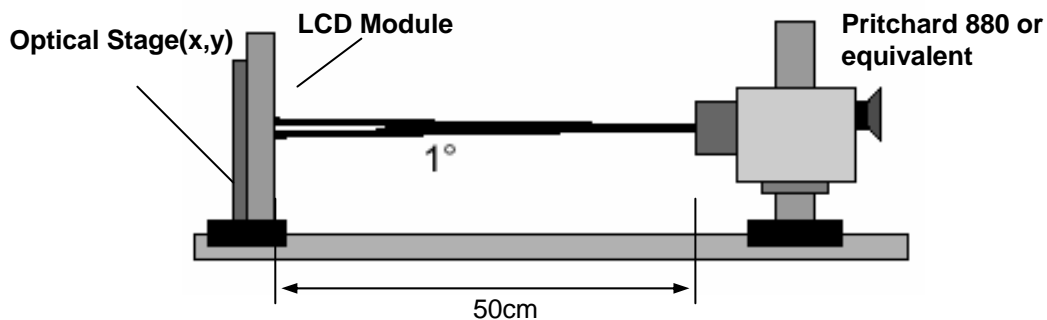


Table 9. OPTICAL CHARACTERISTICS

$T_a=25^\circ\text{C}$, $V_{CC}=3.3\text{V}$, $f_v=60\text{Hz}$, $f_{CLK}=38.5\text{MHz}$, $I_{BL}=6.0\text{mA}$

Parameter	Symbol	Values			Units	Notes
		Min	Typ	MAx		
Contrast Ratio	CR	300	400	-		1
Surface Luminance, white	L_{WH}	200	250	-	cd/m ²	2
Luminance Variation	δ_{WHITE}	-	-	1.4		3
Response Time						4
Rise Time	T_{rR}	-	6	10	ms	
Delay Time	T_{rD}	-	19	30	ms	
Color Coordinates						
RED	RX	0.543	0.573	0.603		
RY	RY	0.297	0.327	0.357		
GREEN	GX	0.279	0.309	0.339		
GY	GY	0.513	0.543	0.573		
BLUE	BX	0.118	0.148	0.178		
BY	BY	0.096	0.126	0.156		
WHITE	WX	0.275	0.305	0.335		
WY	WY	0.290	0.320	0.350		
Viewing Angle						5
x axis, right ($\Phi=0^\circ$)	Θ_r	65	-	-	degree	
x axis, left ($\Phi=180^\circ$)	Θ_l	65	-	-	degree	
y axis, up ($\Phi=90^\circ$)	Θ_u	45	-	-	degree	
y axis, down ($\Phi=270^\circ$)	Θ_d	55	-	-	degree	

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Note)

1. Contrast Ratio(CR) is defined mathematically as

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

2. Surface luminance is the center point across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 1.

$$L_{WH} = L_1$$

3. The variation in surface luminance , The panel total variation (δ_{WHITE}) is determined by measuring L_N at each test position 1 through 5 and then defined as followed numerical formula.
For more information see FIG 2.

$$\delta_{WHITE} = \frac{\text{Maximum}(L_1, L_2, \dots L_5)}{\text{Minimum}(L_1, L_2, \dots L_5)}$$

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 FIG 3.
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 4.

FIG. 2 Luminance

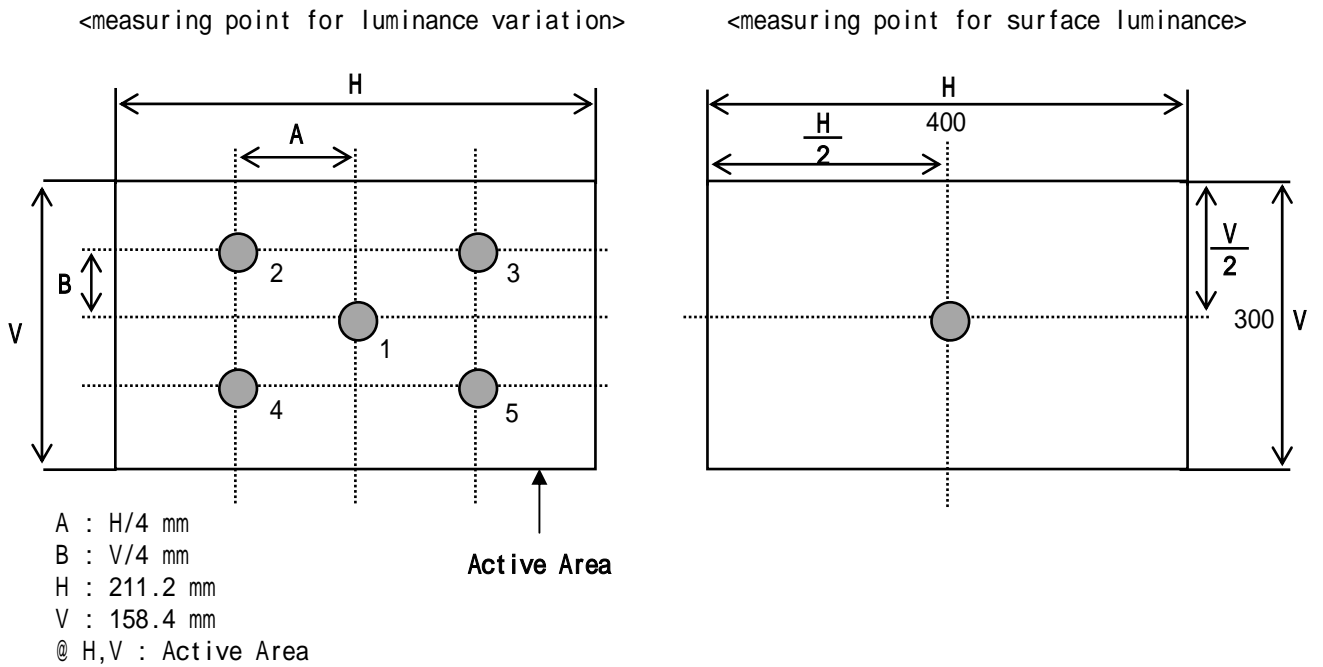


FIG. 3 Response Time

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

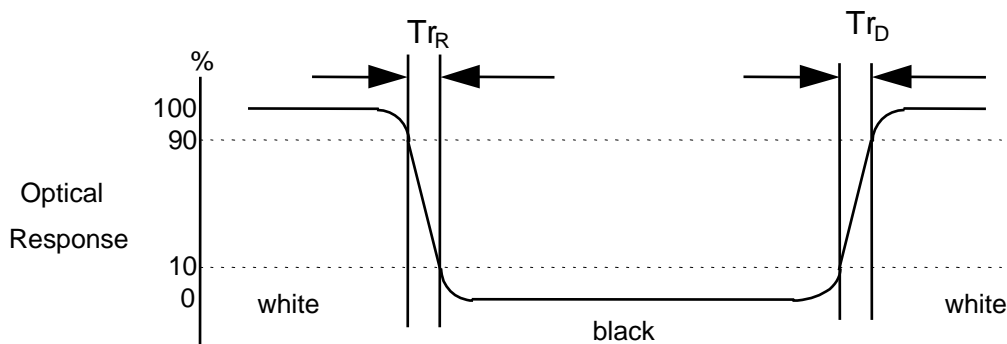
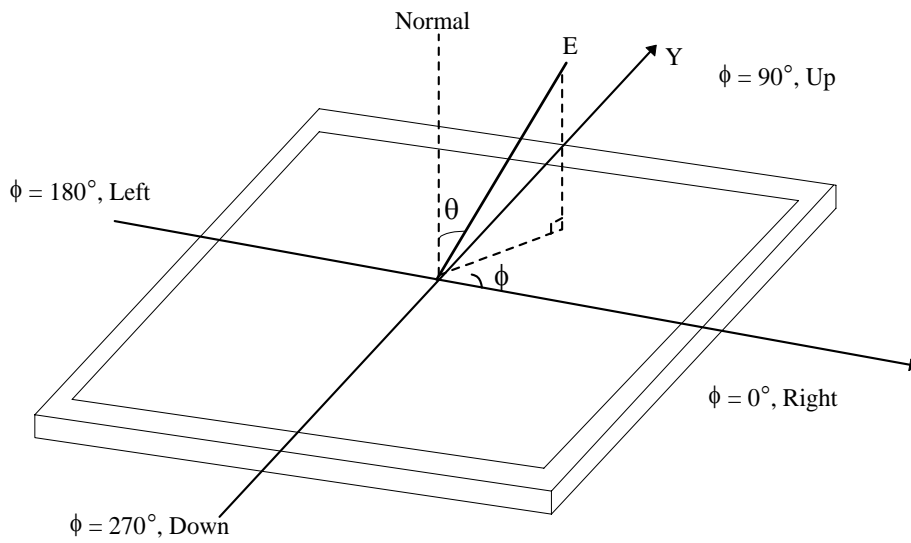


FIG. 4 Viewing angle

<Dimension of viewing angle range>



5. Mechanical Characteristics

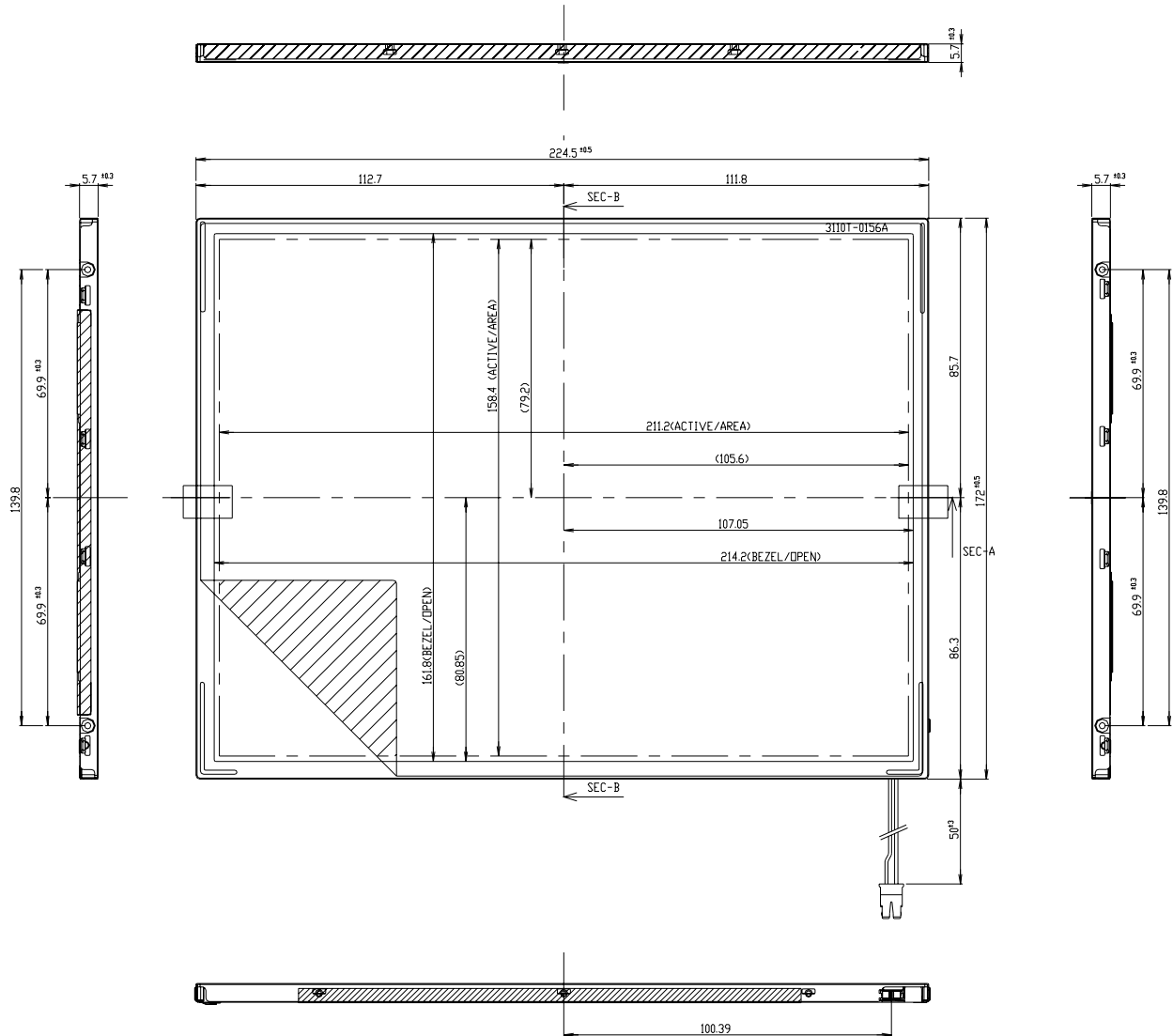
The contents provide general mechanical characteristics for the model LB104S01. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline Dimension	Horizontal	224.5 ± 0.5mm
	Vertical	172.0 ± 0.5mm
	Depth	5.7 ± 0.3mm
Bezel Area	Horizontal	214.2 ± 0.5mm
	Vertical	161.8 ± 0.5mm
Active Display Area	Horizontal	211.2 mm
	Vertical	158.4 mm
Weight	290g (Typ.) 300g (Max.)	

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<FRONT VIEW>

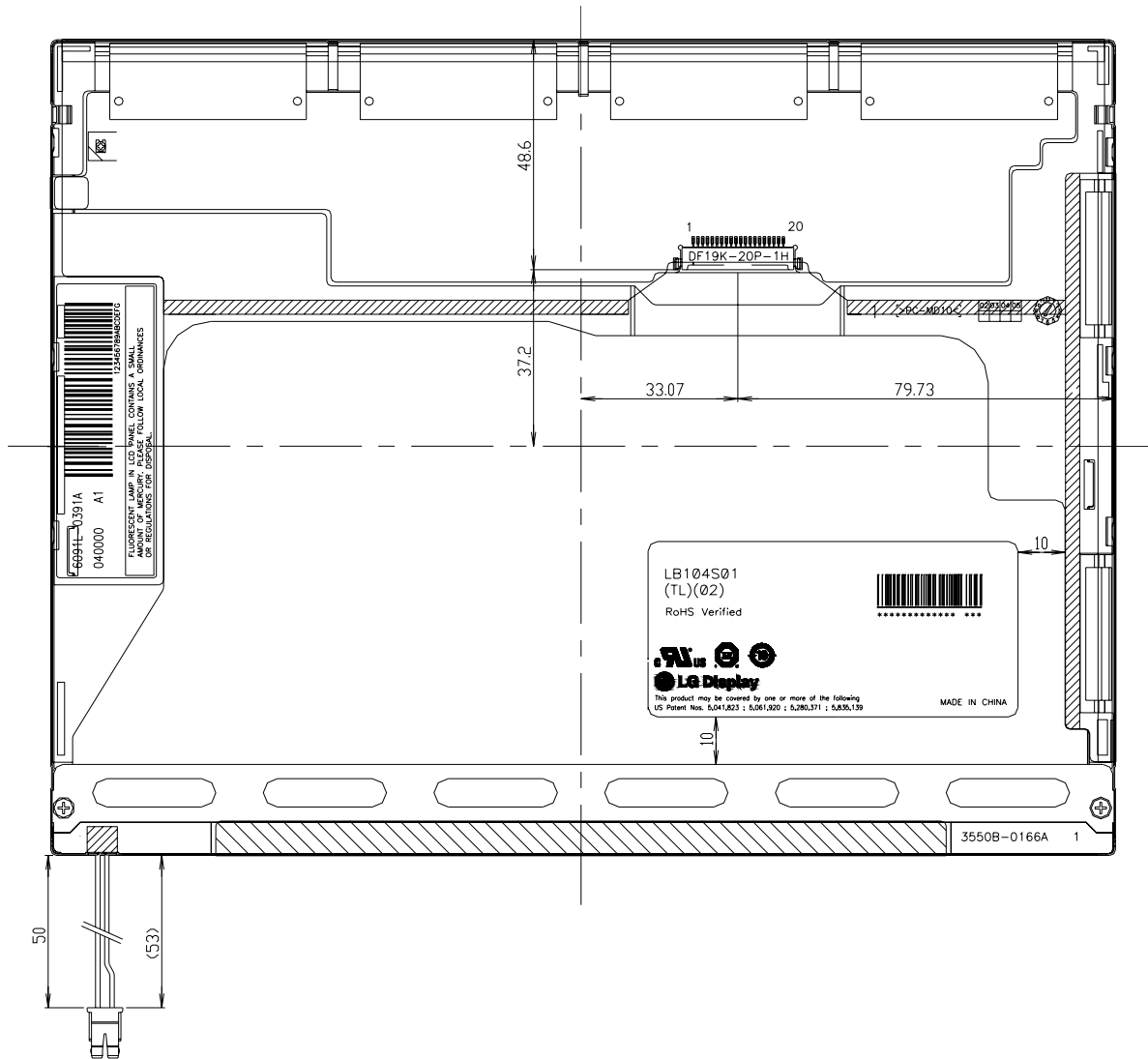
Note) Unit:[mm], General tolerance: ± 0.5mm



Product Specification

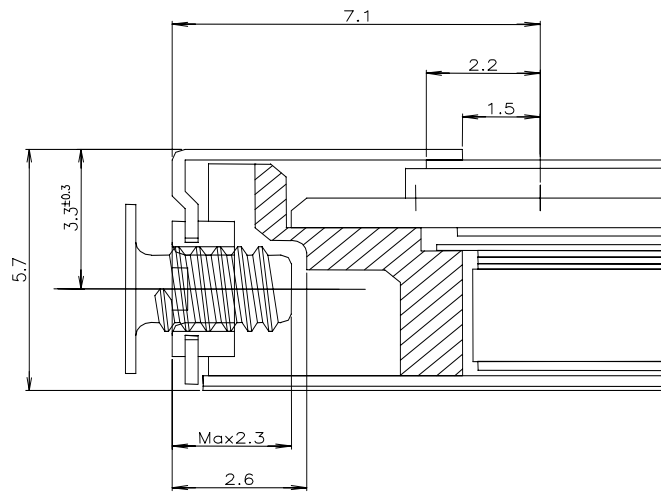
<REAR VIEW>

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



Product Specification

[DETAIL DESCRIPTION OF SIDE MOUNTING SCREW]



- *Mounting screw depth : Max 2.3mm
- *Screw(4ea) Torque : Max 2kgf•cm

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

6. Reliability

Environment test condition

No.	Test Item	Conditions
1	High temperature storage test	Ta= 60°C, 240h
2	Low temperature storage test	Ta= -20°C, 240h
3	High temperature operation test	Ta= 50°C, 50%RH, 240h
4	Low temperature operation test	Ta= 0°C, 240h
5	Vibration test (non-operating)	Random, 10 ~ 300Hz, 0.0035~0.0035G/Hz 1.0Grms, 1 axis, 0.5hour/axis
6	Shock test (non-operating)	Half sine wave, 180G, 2ms one shock of each three faces (I.e. run 180G 6ms for all one faces)
7	Altitude operating storage / shipment	0 ~ 10,000 feet (3,048m) 24Hr 0 ~ 40,000 feet (12,192m) 24Hr

{ 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.

7. International Standards

7-1. Safety

- a) UL 60950-1:2003, First Edition, Underwriters Laboratories, Inc., Standard for Safety of Information Technology Equipment.
- b) CAN/CSA C22.2, No. 60950-1-03 1st Ed. April 1, 2003, Canadian Standards Association, Standard for Safety of Information Technology Equipment.
- c) EN 60950-1:2001, First Edition, European Committee for Electrotechnical Standardization(CENELEC) European Standard for Safety of Information Technology Equipment.

7-2. EMC

- a) ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electrical Equipment in the Range of 9kHz to 40GHz." American National Standards Institute(ANSI), 1992
- b) C.I.S.P.R. "Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment." International Special Committee on Radio Interference.
- c) EN 55022 "Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment." European Committee for Electrotechnical Standardization.(CENELEC), 1998 (Including A1: 2000)

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 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.

9-2. OPERATING PRECAUTIONS

- (1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :
 $V = \pm 200\text{mV}$ (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) 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.

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)
 E : MONTH

D : YEAR
 F ~ M : SERIAL NO.

Note

1. YEAR

Year	2001 2011	2002 2012	2003 2013	2004 2014	2005 2015	2006 2016	2007 2017	2008 2018	2009 2019	2010 2020
Mark	1	2	3	4	5	6	7	8	9	0

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 : 26 pcs
- b) Box Size : 425mm(L) × 246mm(W) × 287mm(H)

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°C and 35°C 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) 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) The protection film is attached to 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 peel off the film, the glue is apt to remain on the polarizer.
Please carefully peel off the protection film without rubbing it against the polarizer.
- (3) 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 polarizer after the protection film is peeled off.
- (4) You can remove the glue 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.