

Product Specification

SPECIFICATION FOR APPROVAL

- (◆) Preliminary Specification
 () Final Specification

| | |
|-------|-------------------|
| Title | 15.0" XGA TFT LCD |
|-------|-------------------|

| | |
|-------|---------|
| Buyer | General |
| Model | |

| | |
|----------|--------------------------|
| Supplier | LG.Philips LCD Co., Ltd. |
| *Model | LM150X06 |
| Suffix | C3 |

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

| Signature | Date |
|-----------|-------|
| / | _____ |
| / | _____ |
| / | _____ |

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

| Approved by | Date |
|------------------------|-------|
| Giant Kim / G.Manager | _____ |
| Reviewed by | |
| Gilbert Kwon / Manager | _____ |
| Prepared by | |
| Khan Seo / Engineer | _____ |

Platform Design 2 Team
LG. Philips LCD Co., Ltd

Product Specification

| NO. | ITEM | Page |
|-----|------------------------------|------|
| - | COVER | 1 |
| - | CONTENTS | 2 |
| - | RECORD OF REVISIONS | 3 |
| 1 | GENERAL DESCRIPTION | 4 |
| 2 | ABSOLUTE MAXIMUM RATINGS | 5 |
| 3 | ELECTRICAL SPECIFICATIONS | 6 |
| 3-1 | ELECTRICAL CHARACTREISTICS | 6 |
| 3-2 | INTERFACE CONNECTIONS | 8 |
| 3-3 | SIGNAL TIMING SPECIFICATIONS | 11 |
| 3-4 | SIGNAL TIMING WAVEFORMS | 13 |
| 3-5 | COLOR INPUT DATA REFERENECE | 14 |
| 3-6 | POWER SEQUENCE | 15 |
| 3-7 | POWER DIP CONDITION | 16 |
| 4 | OPTICAL SPECIFICATIONS | 17 |
| 5 | MECHANICAL CHARACTERISTICS | 21 |
| 6 | RELIABILITY | 24 |
| 7 | INTERNATIONAL STANDARDS | 25 |
| 7-1 | SAFETY | 25 |
| 7-2 | EMC | 25 |
| 8 | PACKING | 26 |
| 8-1 | DESIGNATION OF LOT MARK | 26 |
| 8-2 | PACKING FORM | 26 |
| 9 | PRECAUTIONS | 27 |

Product Specification

RECORDS OF REVISIONS

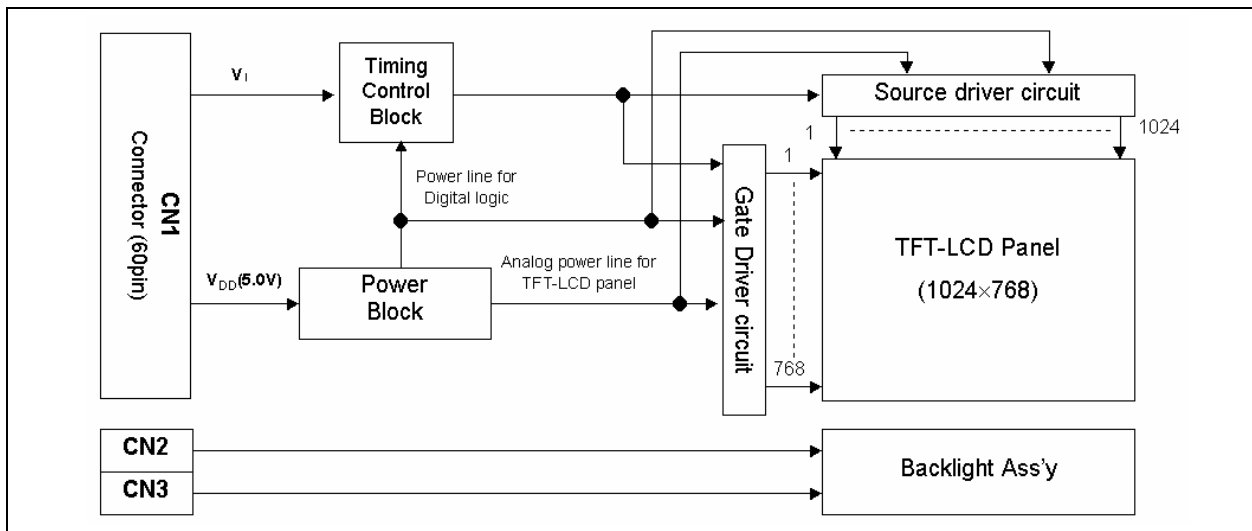
| Revision No. | Date | Page | DESCRIPTION |
|---------------------|----------------------|-------------|--------------------|
| 1.0 | Jan. 28, 2003 | - | First Draft |

Product Specification

1. General Description

The LM150X06-C3 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 a 15.0 inches 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 palette of more than 262,144 colors.

The LM150X06-C3 has been designed to apply the 2-port TTL (2-pixel 1-clock) interface method. The LM150X06-C3 LCD is intended to support applications where high brightness, wide viewing angle, high color saturation, and high color depth are very important. In combination with the vertical arrangement of the sub-pixels, the LM150X06-C3 characteristics provide an excellent flat panel display for office automation products such as monitors.



[Figure 1] Block diagram

General Features

| | |
|------------------------|---|
| Active screen size | 15.0 inches(304.128 x 228.096) diagonal |
| Outline Dimension | 331.3(H) × 257.9(V) × 11.0(D) mm (Typ.) |
| Pixel Pitch | 0.297 mm x 0.297mm |
| Pixel format | 1024 Horiz. by 768 Vert. Pixels RGB stripes arrangement |
| Color depth | 6-bit, 262,144 colors |
| Luminance, white | 250 cd/m ² (Typ.) |
| Power Consumption | 10.18 Watt(Typ.) (2.5W logic(Typ.) + 7.68W CCFL(Typ.)) |
| Weight | 1000 g (Typ.) 1050 g (Max.) |
| Display operating mode | Transmissive mode, normally white |
| Surface treatments | Hard coating(3H) Anti-glare treatment of the front polarizer |

Product Specification

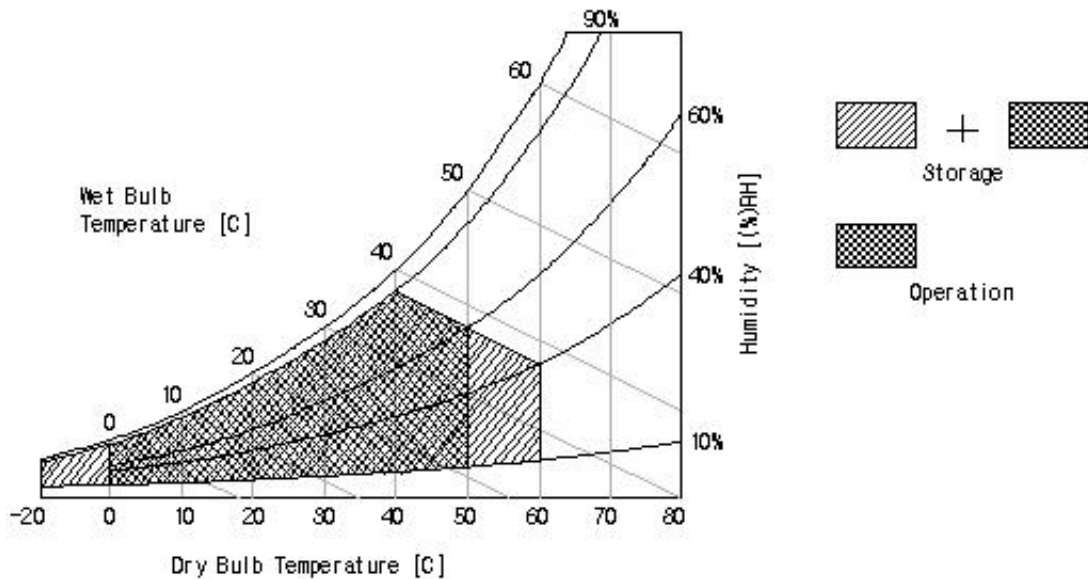
2. Absolute Maximum Ratings

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

Table 1. Absolute maximum ratings

| Parameter | symbol | Values | | Units | Notes |
|----------------------------|----------|--------|------|------------------|-----------------------------|
| | | Min. | Max. | | |
| Power Input Voltage | V_{DD} | -0.3 | 5.5 | Vdc | At $25 \pm 5^\circ\text{C}$ |
| Signal Input Voltage | V_I | -0.3 | 3.6 | V | |
| Operating Temperature | T_{OP} | 0 | 50 | $^\circ\text{C}$ | 1 |
| Storage Temperature | T_{ST} | -20 | 60 | $^\circ\text{C}$ | 1 |
| Operating Ambient Humidity | H_{OP} | 10 | 90 | %RH | 1 |
| Storage Humidity | H_{ST} | 10 | 90 | %RH | 1 |

Note : 1. Temperature and relative humidity range are shown in the [Figure 2]
Wet bulb temperature should be 39°C Max., and no condensation of water.



[Figure 2] Temperature and relative humidity

Product Specification
3. Electrical Specifications
3-1. Electrical Characteristics

The LM150X06-C3 requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. Another 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 | | | Units | Notes |
|-------------------------------|------------|--------|-------|-------|-----------|-------|
| | | Min. | Typ. | Max. | | |
| MODULE : | | | | | | |
| Signal Input Voltage | V_I | 3.0 | 3.3 | 3.6 | V | |
| Power Supply Input Voltage | V_{DD} | 4.5 | 5.0 | 5.5 | V | |
| Permissive power input ripple | V_{RF} | - | - | 0.1 | V_{PP} | |
| Power Supply Input Current | I_{DD} | - | 0.498 | 0.573 | A | 1 |
| Power Consumption | P_C | - | 2.5 | 3.1 | Watts | |
| Rush Current | I_{RUSH} | | 1.0 | 2.0 | A | 2 |
| LAMP : | | | | | | |
| Operating Voltage | V_{BL} | 460 | 480 | 620 | V_{RMS} | 3 |
| Operating Current | I_{BL} | 2.5 | 8.0 | 9.0 | mA | |
| Established Starting Voltage | V_{BS} | | | | | 4 |
| at 25 °C | | - | - | 850 | V_{RMS} | |
| at 0 °C | | - | - | 1100 | V_{RMS} | |
| Operating Frequency | f_{BL} | 45 | 60 | 80 | kHz | 5 |
| Discharge Stabilization Time | T_S | | | 3 | Minutes | 6 |
| Power Consumption | P_{BL} | - | 7.68 | 8.44 | Watts | 7 |
| Life Time | | 40,000 | - | - | Hrs | 8 |

Note : 1. The design of the inverter must have specifications for the lamp in LCD Assembly.

The performance of the Lamp in LCM, for example life time or brightness, is extremely influenced by the characteristics of the DC-AC Inverter. So all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter.

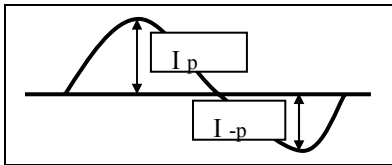
When you design or order the inverter, please make sure unwanted lighting caused by the mismatch of the lamp and the inverter(no lighting, flicker, etc) never occurs. When you confirm it, the LCD Assembly should be operated in the same condition as installed in your instrument.

Note : 2. Do not attach a conducting tape to lamp connecting wire.. If the lamp wire attach to conducting tape, TFT-LCD Module have a low luminance and the inverter has abnormal action because leakage current occurs between lamp wire and conducting tape.

1. The specified current and power consumption are under the $V_{DD}=5.0V$, $25^{\circ}C$, f_v (frame frequency) =60Hz condition whereas mosaic(black & white) pattern shown in the [Figure 3] is displayed.
2. The duration of rush current is about 25ms.
3. Operating voltage is measured under $25^{\circ}C$. The variance of the voltage is $\pm 10\%$.
4. The voltage above V_{BS} should be applied to the lamps for more than 1second for start-up and starting voltage in inverter must be over max. value of lamp V_{BS} . Otherwise, the lamps may not be turned on.

Product Specification

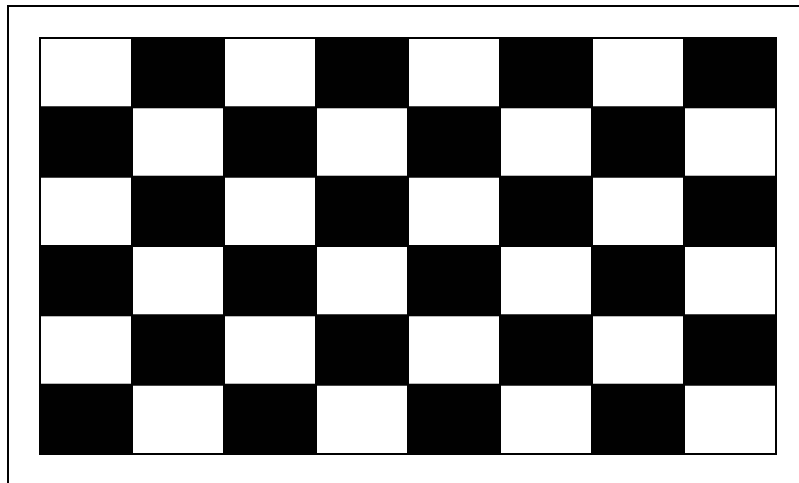
5. The output of the inverter must have symmetrical(negative and positive) voltage waveform and symmetrical current waveform.(Unsymmetrical ratio is less than 10%) Please do not use the inverter which has unsymmetrical voltage and unsymmetrical current and spike wave.
Lamp frequency may produce interference with horizontal synchronous frequency and as a result this may cause beat on the display.Therefore lamp frequency shall be as away as possible from the horizontal synchronous frequency and from its harmonics in order to prevent interference.
6. Let's 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 used lamp current is the lamp typical current.
7. The lamp power consumption shown above does not include loss of external inverter under 25 °C.
The used lamp current is the lamp typical current.
8. The life time is determined as the time at which brightness of lamp is 50% compared to that of initial value at the typical lamp current on condition of continuous operating at 25 ± 2 °C.
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.
It shall help increase the lamp lifetime and reduce its leakage current.
 - a. The unbalance rate of the inverter waveform should be 10% below;
 - b. The distortion rate of the waveform should be within $\sqrt{2} \pm 10\%$;
 - c. The ideal sine wave form shall be symmetric in positive and negative polarities.



* **Asymmetry rate** = $| I_p - I_{-p} | / I_{rms} * 100\%$

* **Distortion rate** = $I_p \text{ (or } I_{-p}) / I_{rms}$

10. Inverter output voltage must be more than lamp starting voltage.
11. The inverter which is combined with this LCM, is highly recommended to connect coupling(ballast) condenser at the high voltage output side. When you use the inverter which has not coupling(ballast) condenser, it may cause abnormal lamp lighting because of biased mercury as time goes.



[Figure 3] Mosaic pattern for power consumption measurement

Product Specification

3-2. Interface Connections

This LCM has three interface connections, a 60 pin connector is used for the module electronics and, two three pin connectors are used for the integral back light system.

The interface pin configuration for the connector is shown in the table below.

LCD Connector : FX8-60S-SV(Hirose Electric Co.,Ltd.)

Mating Connector : FX8-60P-SV or FX8-60P-SV-1(Hirose Electric Co.,Ltd.)

Table 3. Module connector pin's configuration

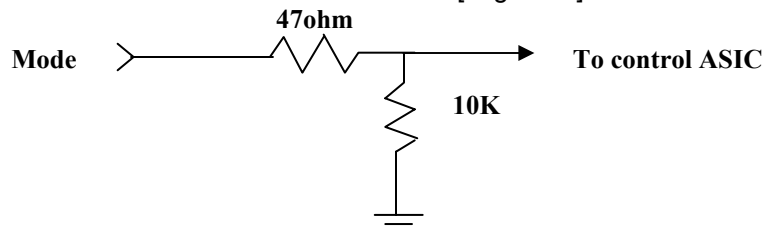
| Pin | Symbol | Description | Notes |
|-----|--------|-----------------------------|-----------------------------------|
| 1 | GND | GND | |
| 2 | RB0 | RED even data signal(LSB) | Even data means second pixel data |
| 3 | RB1 | RED even data signal | |
| 4 | RB2 | RED even data signal | |
| 5 | RB3 | RED even data signal | |
| 6 | RB4 | RED even data signal | |
| 7 | RB5 | RED even data signal(MSB) | |
| 8 | GND | GND | |
| 9 | GB0 | GREEN even data signal(LSB) | |
| 10 | GB1 | GREEN even data signal | |
| 11 | GB2 | GREEN even data signal | |
| 12 | GB3 | GREEN even data signal | |
| 13 | GB4 | GREEN even data signal | |
| 14 | GB5 | GREEN even data signal(MSB) | |
| 15 | GND | GND | |
| 16 | BB0 | BLUE even data signal(LSB) | |
| 17 | BB1 | BLUE even data signal | |
| 18 | BB2 | BLUE even data signal | |
| 19 | BB3 | BLUE even data signal | |
| 20 | BB4 | BLUE even data signal | |
| 21 | BB5 | BLUE even data signal(MSB) | |
| 22 | GND | GND | |
| 23 | RA0 | RED odd data signal(LSB) | Odd data means first pixel data |
| 24 | RA1 | RED odd data signal | |
| 25 | RA2 | RED odd data signal | |
| 26 | RA3 | RED odd data signal | |
| 27 | RA4 | RED odd data signal | |
| 28 | RA5 | RED odd data signal(MSB) | |
| 29 | GND | GND | |
| 30 | GA0 | GREEN odd data signal(LSB) | |

Product Specification

| Pin | Symbol | Description | Notes |
|-----|--------|---|-------|
| 31 | GA1 | GREEN odd data signal | |
| 32 | GA2 | GREEN odd data signal | |
| 33 | GA3 | GREEN odd data signal | |
| 34 | GA4 | GREEN odd data signal | |
| 35 | GA5 | GREEN odd data signal(MSB) | |
| 36 | GND | GND | |
| 37 | BA0 | BLUE odd data signal(LSB) | |
| 38 | BA1 | BLUE odd data signal | |
| 39 | BA2 | BLUE odd data signal | |
| 40 | BA3 | BLUE odd data signal | |
| 41 | BA4 | BLUE odd data signal | |
| 42 | BA5 | BLUE odd data signal(MSB) | |
| 43 | GND | GND | |
| 44 | GND | GND | |
| 45 | GND | GND | |
| 46 | Vsync. | Vertical synchronous signal | |
| 47 | Hsync. | Horizontal synchronous signal | |
| 48 | ENAB. | Data enable signal(signal to settle the display position) | |
| 49 | GND | GND | |
| 50 | GND | GND | |
| 51 | CKB | Clock B signal for sampling even data signal | |
| 52 | CKA | Clock A signal for sampling odd data signal | |
| 53 | GND | GND | |
| 54 | GND | GND | |
| 55 | GND | GND | |
| 56 | MODE | Timing signal select | 1 |
| 57 | Vcc | +5V power supply | |
| 58 | Vcc | +5V power supply | |
| 59 | Vcc | +5V power supply | |
| 60 | Vcc | +5V power supply | |

Notes : 1. Mode is set "Low" in LCD module, if this pin is "OPEN" or "Low" then data latch is at falling edge trigger, "High" then rising edge trigger.

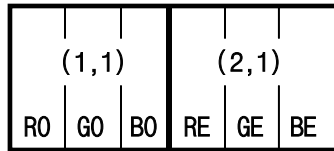
Mode signal circuit in LCD module is shown in the [Figure 4].



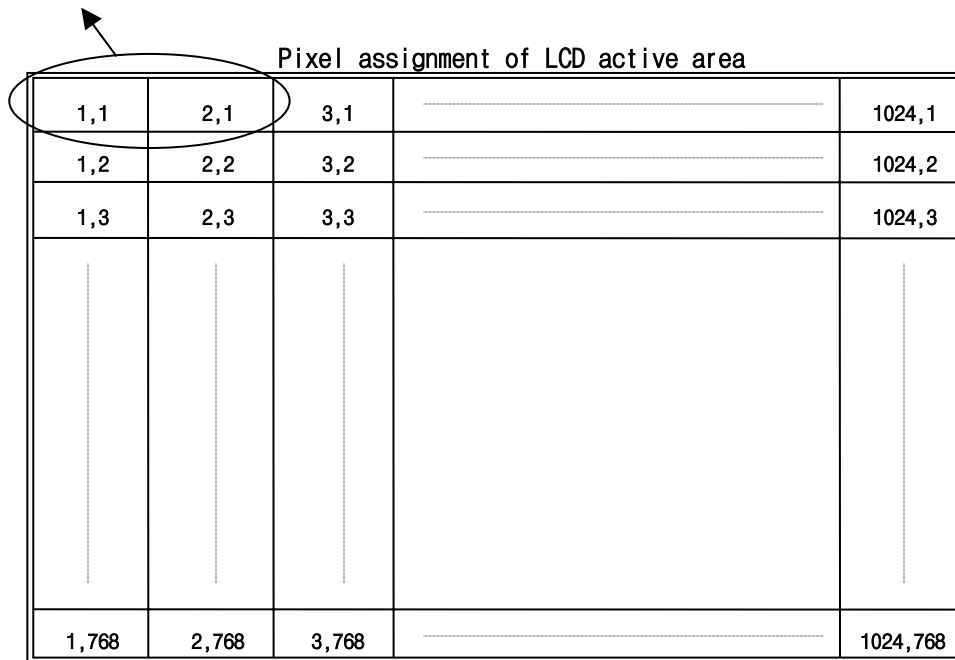
[Figure 4] Mode signal circuit in LCD module

Product Specification

Note 2. Correspondence between input data and screen image.
Display data of 2-pixel are latched by 1-cycle of DCLK.



Odd data refers to first pixel data.
Even data refers to second pixel data.



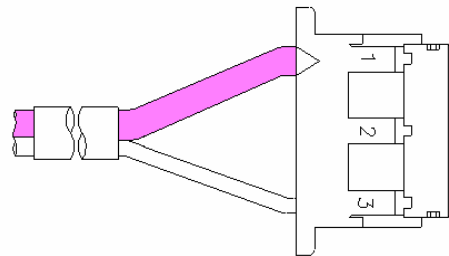
Product Specification

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's configuration

| Pin | Symbol | Description | Notes |
|-----|--------|--|-------|
| 1 | HV | Power supply for lamp (High voltage side) | 1 |
| 2 | NC | No Connect | |
| 3 | LV | Power supply for lamp (Low voltage side) | |

Notes : 1. The high voltage side terminal is colored pink.



[Figure 7] Backlight connector view

Product Specification
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 for its proper operation.

Table 5. Timing table

| | Item | Symbol | Min. | Typ. | Max. | Unit | Notes | | |
|---------------------|------------------------|-------------|----------|------|-------------------|-----------|------------------------------|----------|--|
| Dclk | Period | t_{CLK} | 25 | 30.8 | 40 | ns | | | |
| | Frequency | f_{CLK} | 25 | 32.5 | 40 | MHz | Note 2 | | |
| Hsync. | Period | t_{HP} | 604 | 672 | 680 | t_{CLK} | | | |
| | Width | t_{WH} | 12 | 68 | 120 | | | | |
| Vsync. | Period | t_{VP} | 780 | 806 | 830 | t_{HP} | | | |
| | Frequency | f_V | 50 | 60 | 75 | Hz | Note 2 | | |
| DE (Data Enable) | Width | t_{WV} | 1 | 6 | 24 | t_{HP} | | | |
| | Horizontal Valid | t_{HV} | 512 | 512 | 512 | t_{CLK} | Note 1 | | |
| | Horizontal Back Porch | t_{HBP} | 24 | 80 | - | | | | |
| | Horizontal Front Porch | t_{HFP} | 12 | 12 | - | | | | |
| | Horizontal Blank | - | 48 | 160 | $t_{HP} - t_{HV}$ | | $t_{WH} + t_{HBP} + t_{HFP}$ | | |
| | Vertical Valid | t_{VW} | 768 | 768 | 768 | t_{HP} | | | |
| | Vertical Back Porch | t_{VBP} | 2 | 29 | - | | | | |
| | Vertical Front Porch | t_{VFP} | 1 | 3 | - | | | | |
| | Vertical Blank | - | 4 | 38 | $t_{VP} - t_{VW}$ | | $t_{WV} + t_{VBP} + t_{VFP}$ | | |
| | Data | Set up time | t_{SI} | 3 | - | - | ns | For Dclk | |
| Hold time | | t_{HI} | 3 | - | - | | | | |
| Data | Set up time | t_{SD} | 3 | - | - | | | | |
| | Hold time | t_{HD} | 3 | - | - | | | | |

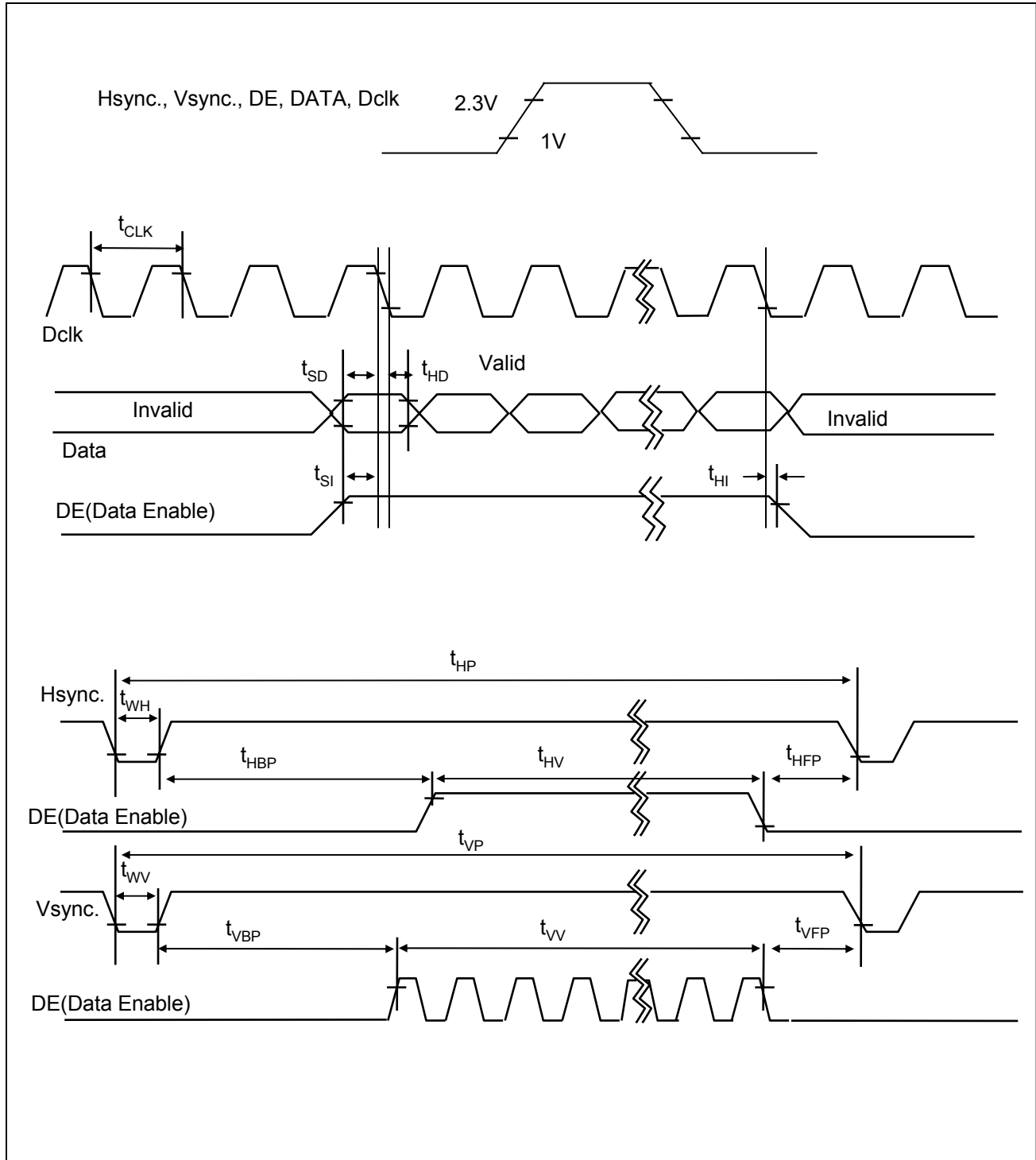
Note 1: No variation of Hsync.(or DE) input is required for normal operation.

Note 2: There may be a little flicker around Dclk Min. 25MHz and Vsync. Min. 50Hz.

But there is no timing distortion at Dclk Min. 25MHz and Vsync. Min. 50Hz.

Product Specification

3-4. Signal Timing Waveforms



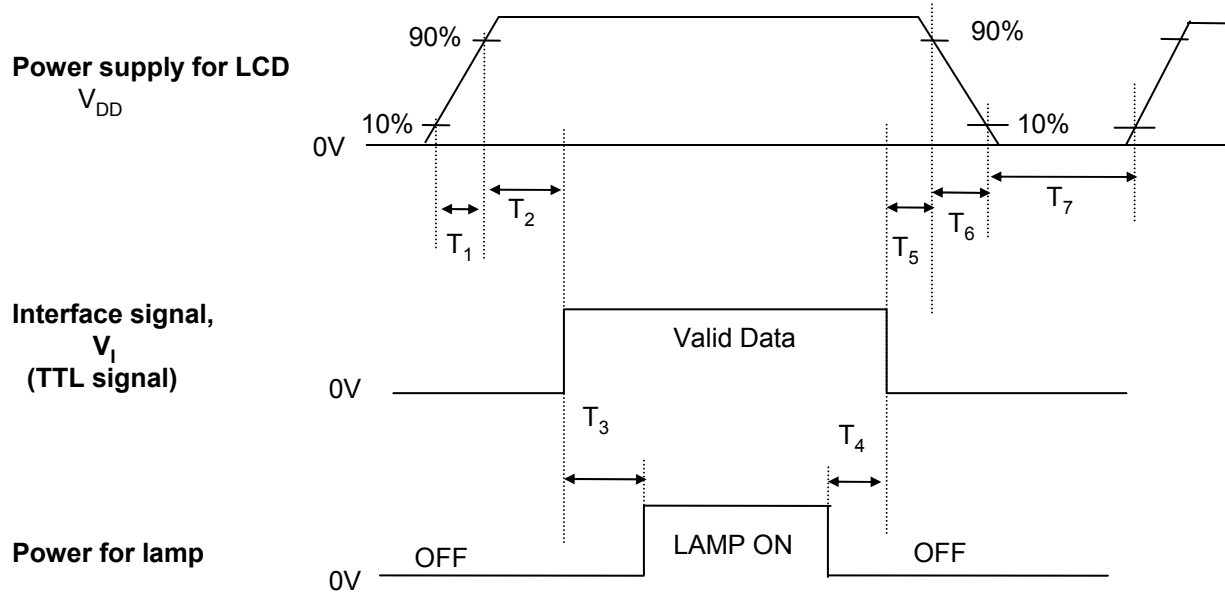
[Figure 8] Signal timing waveforms

Product Specification
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 6. Color data reference

| Color | | Input Color Data | | | | | | | | | | | | | | | | | |
|--------------|-----------------|------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| | | Red | | | | | | Green | | | | | | Blue | | | | | |
| | | MSB | | | LSB | | | MSB | | | LSB | | | MSB | | LSB | | | |
| | | RO5 RE5 | RO4 RE4 | RO3 RE3 | RO2 RE2 | RO1 RE1 | RO0 RE0 | GO5 GE5 | GO4 GE4 | GO3 GE3 | GO2 GE2 | GO1 GE1 | GO0 GE0 | BO5 BE5 | BO4 BE4 | BO3 BE3 | BO2 BE2 | BO1 BE1 | BO0 BE0 |
| 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 | 0 | 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 |

Product Specification
3-6. Power Sequence


[Figure 9] Power sequence

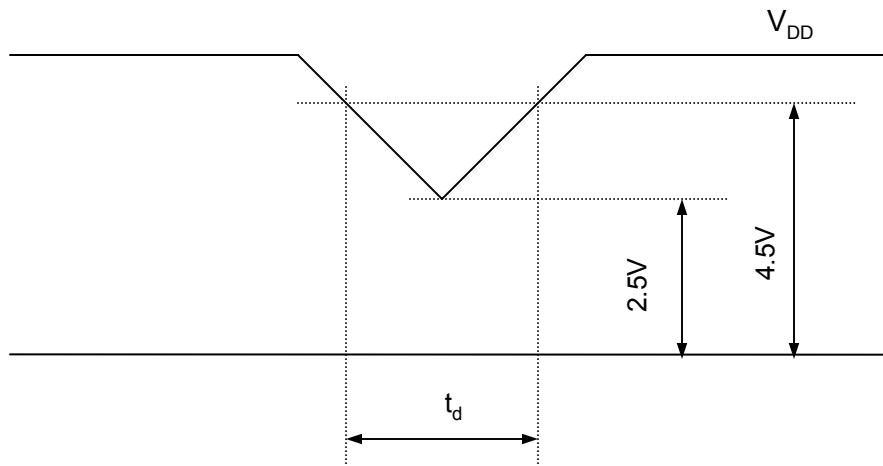
Table 7. Power sequence time delay

| Parameter | Values | | | 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 | 500 | - | - | ms |

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

Product Specification

3-7. V_{DD} Power Dip Condition



[Figure 10] Power dip condition

1) Dip condition

$$2.5V \leq V_{DD} < 4.5V, t_d \leq 20ms$$

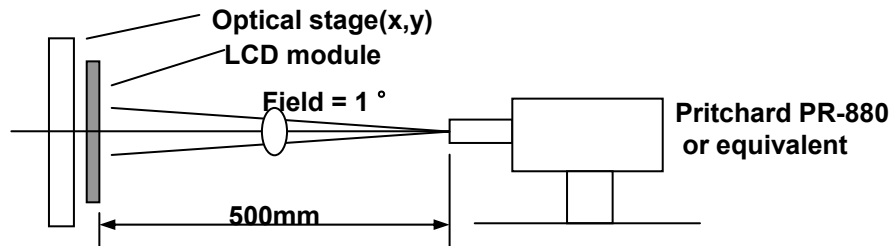
2) $V_{DD} < 2.5V$

V_{DD} -dip conditions should also follow the power on/off conditions for supply voltage.

Product Specification
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 °.

[Figure 11] presents additional information concerning the measurement equipment and method.



[Figure 11] Optical characteristic measurement equipment and method

Table 8. Optical characteristics

($T_a=25\text{ }^\circ\text{C}$, $V_{DD}=5.0\text{V}$, $f_v=60\text{Hz}$
 $D_{clk}=32.5\text{MHz}$, $I_{BL}=8\text{mA}$)

| 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} | - | 1.25 | 1.40 | | 3 |
| Response Time | T_r | | 25 | 30 | ms | 4 |
| Rise Time | T_{rR} | - | 7.5 | 10 | | |
| Decay Time | T_{rD} | - | 17.5 | 20 | | |
| CIE Color Coordinates | | | | | | |
| Red | XR | 0.596 | 0.626 | 0.656 | | |
| | YR | 0.317 | 0.347 | 0.377 | | |
| Green | XG | 0.278 | 0.308 | 0.338 | | |
| | YG | 0.558 | 0.588 | 0.618 | | |
| Blue | XB | 0.116 | 0.146 | 0.176 | | |
| | YB | 0.089 | 0.119 | 0.149 | | |
| White | XW | 0.283 | 0.313 | 0.343 | | |
| | YW | 0.299 | 0.329 | 0.359 | | |
| Viewing Angle | | | | | degree | 5 |
| by $CR \geq 5$ | | | | | | |
| x axis, right ($\Phi=0^\circ$) | θ_r | 70 | 80 | - | | |
| x axis, left ($\Phi=180^\circ$) | θ_l | 70 | 80 | - | | |
| y axis, up ($\Phi=90^\circ$) | θ_u | 50 | 60 | - | | |
| y axis, down ($\Phi=270^\circ$) | θ_d | 50 | 60 | - | | |
| by $CR \geq 10$ | | | | | | |
| x axis, right ($\phi=0^\circ$) | θ_r | 55 | 60 | - | | |
| x axis, left ($\phi=180^\circ$) | θ_l | 55 | 60 | - | | |
| y axis, up ($\phi=90^\circ$) | θ_u | 40 | 45 | - | | |
| y axis, down ($\phi=270^\circ$) | θ_d | 40 | 55 | - | | |
| Gray Scale | | - | 2.2 | - | | 6 |
| Flicker | | - | - | -18 | dB | 7 |

Product Specification

Notes : 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 [Figure 12].

When $I_{BL}=8\text{mA}$, $L_{WH}=200\text{cd/m}^2(\text{Min.})$ $250\text{cd/m}^2(\text{Typ.})$

3. The variation in surface luminance, δ WHITE is determined by measuring L_{ON} at each test position 1 through 9, and then dividing the maximum L_{ON} of 9 points luminance by minimum L_{ON} of 9 points luminance. For more information see [Figure 12].

$$\delta \text{ WHITE} = \text{Maximum}(L_{ON1}, L_{ON2}, \dots, L_{ON9}) \div \text{Minimum}(L_{ON1}, L_{ON2}, \dots, L_{ON9})$$

4. Response time is the time required for the display to transition from to black(Rise Time, Tr_R) and from black to white(Decay Time, Tr_D). For additional information see [Figure 13].

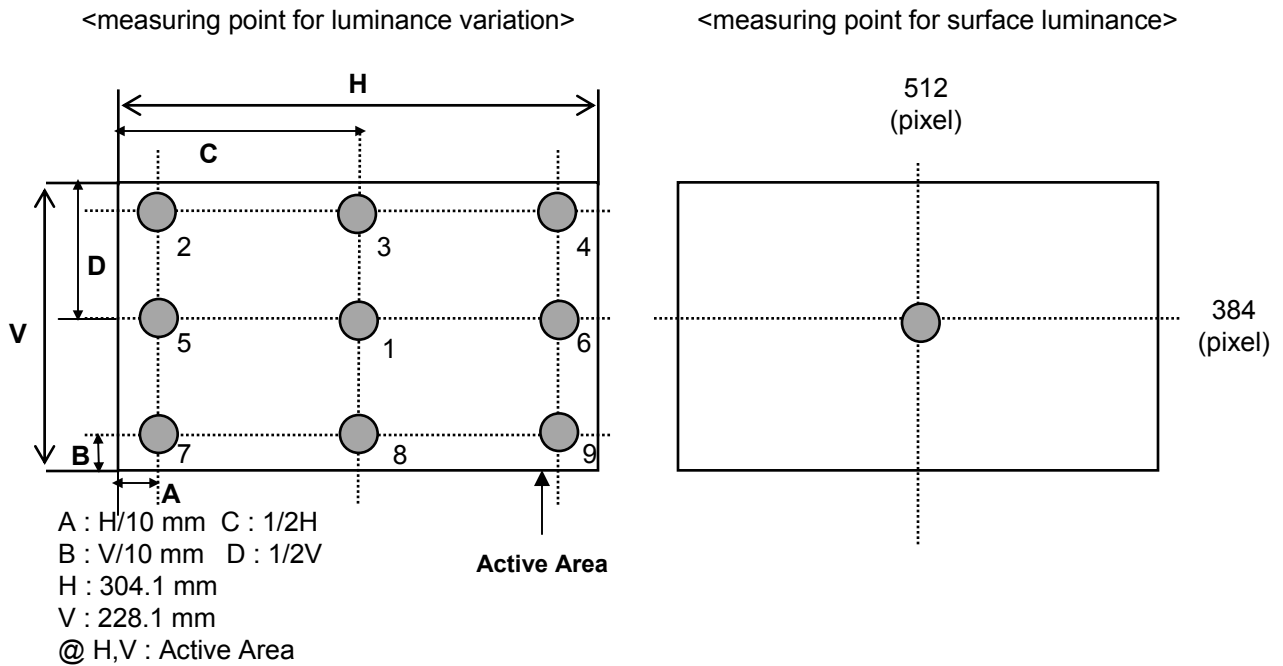
5. Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see [Figure 14].

6. Gray scale specification

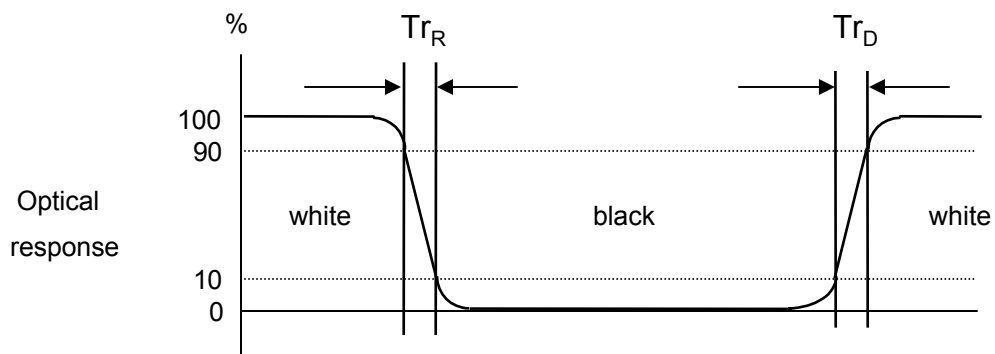
Table 9. Gray scale

| Gray level | Luminance(%) (Typ.) |
|------------|------------------------|
| L0 | 0.22 |
| L7 | 0.81 |
| L15 | 4.29 |
| L23 | 11.4 |
| L31 | 22.1 |
| L39 | 36.4 |
| L47 | 55.4 |
| L55 | 78.0 |
| L63 | 100 |

7. Flicker is measured at cyan dot pattern of foreground RGB(0,0,0) and background RGB(0,31,31).

Product Specification
[Figure 12] Luminance measuring point

[Figure 13] Response time

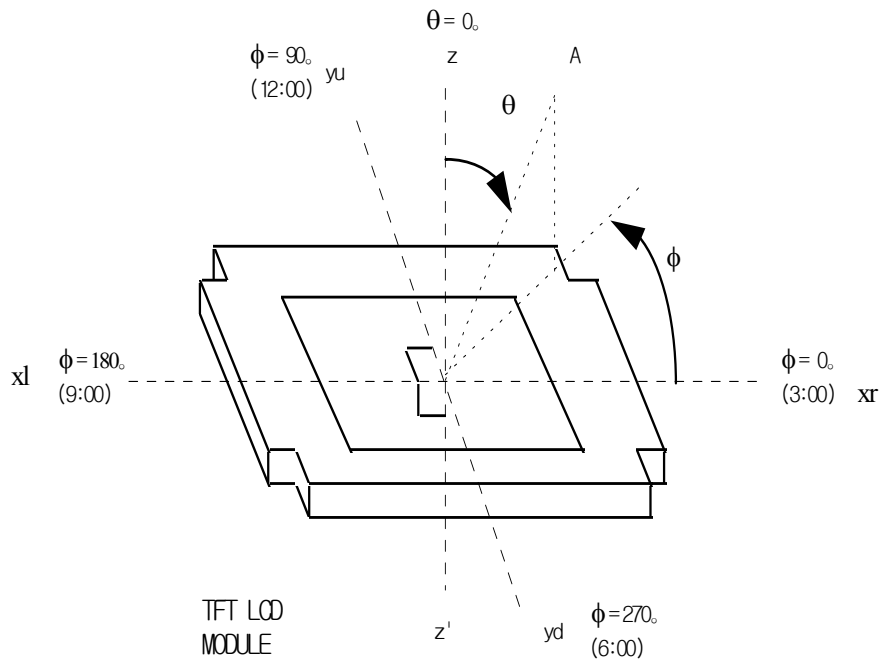
The response time is defined as the following figure and shall be measured by switching the input signal for “black” and “white”.



Product Specification

[Figure 14] Viewing angle

<Dimension of viewing angle range>



Product Specification

5. Mechanical Characteristics

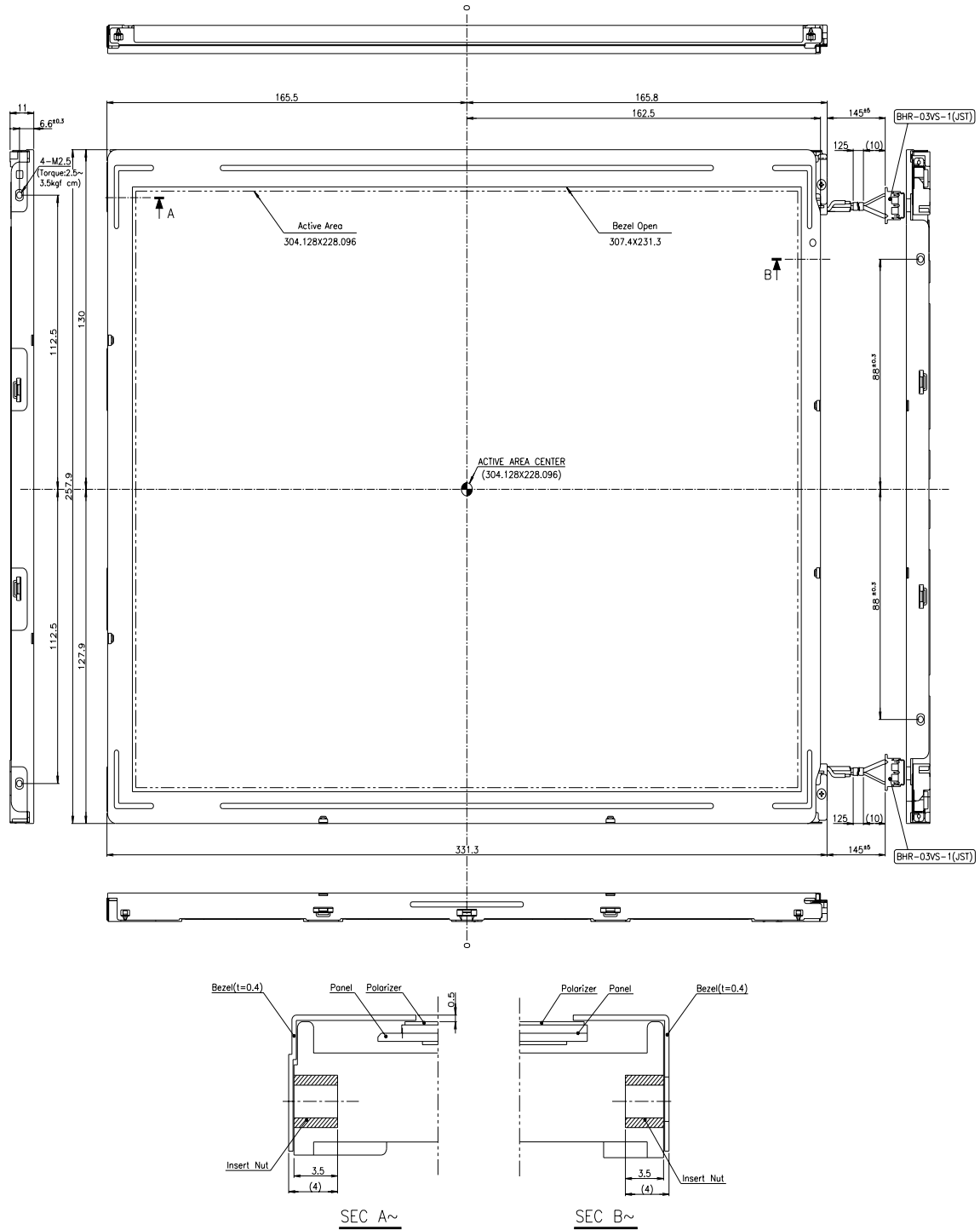
The contents provide general mechanical characteristics for the model LM150X06-C3. In addition, the figures in the next page are detailed mechanical drawing of the LCD.

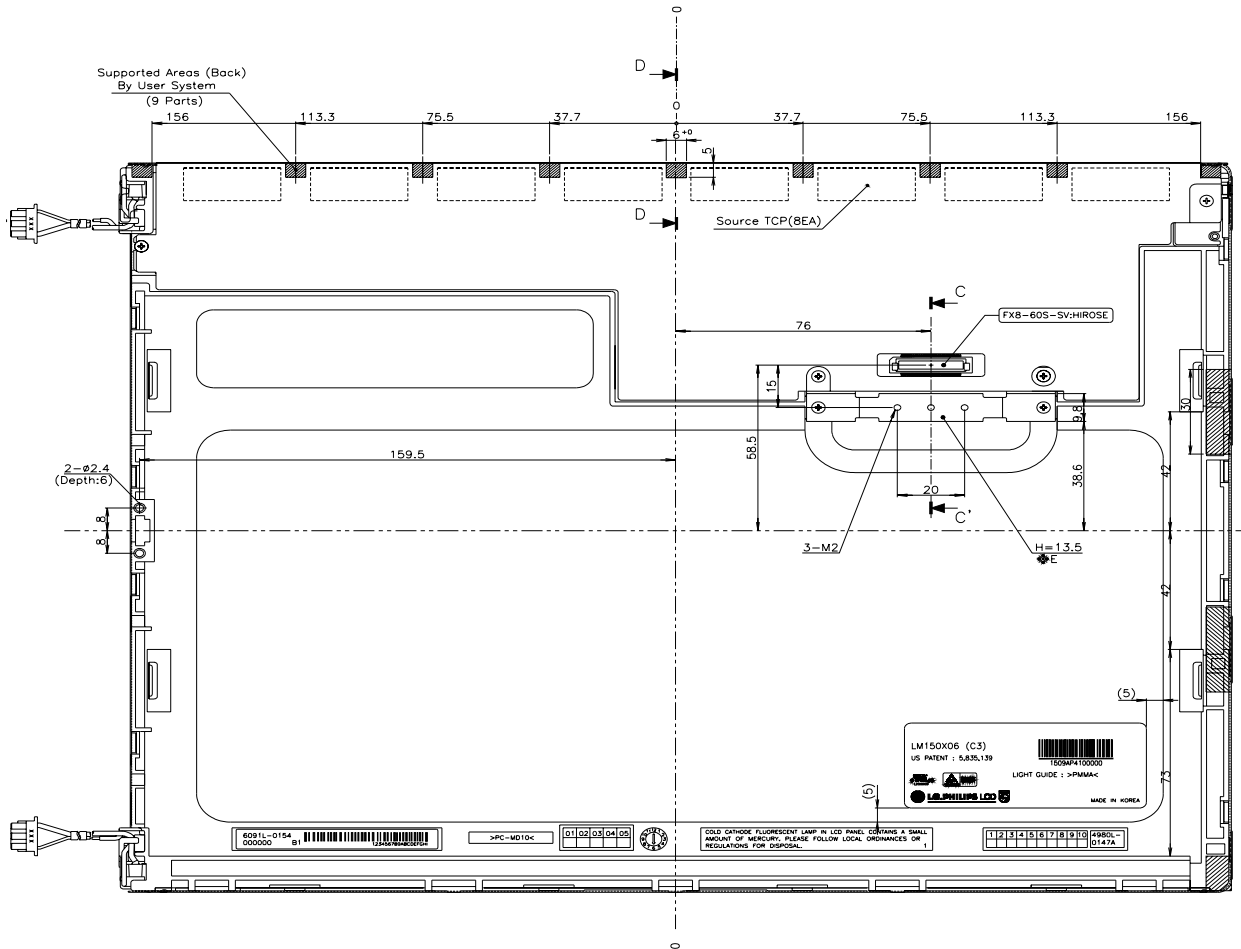
Table 10. Mechanical characteristics

| | | |
|---------------------|--|----------------|
| Outside dimensions | Horizontal | 331.3 ± 0.5 mm |
| | Vertical | 257.9 ± 0.5 mm |
| | Depth | 11.0 ± 0.5 mm |
| Bezel area | Horizontal | 307.4 ± 0.5 mm |
| | Vertical | 231.3 ± 0.5 mm |
| Active display area | Horizontal | 304.128 mm |
| | Vertical | 228.096 mm |
| Weight | 1000 g(Typ.) 1050 g(Max.) | |
| Surface Treatment | Hard coating 3H. Anti-glare, LR coating treatment of the front polarizer. | |

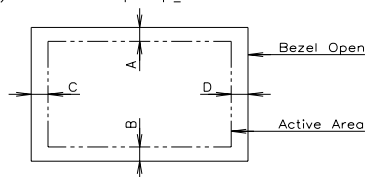
Product Specification

[Figure 15] LM150X06-C3 Front View

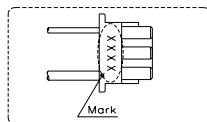


Product Specification
[Figure 16] LM150X06-C3 Rear View

NOTES

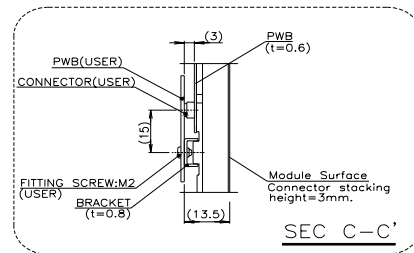
1. Unspecified tolerances to be ± 0.5 .
2. Backlight wires and contraction tubes are excluded from outline dimensions.
3. The thickness is except for portion of projection. (E)
4. Tilt and partial disposition tolerance of display area as following.
 - (1) Y-Direction : $|A-B| \leq 0.7$
 - (2) X-Direction : $|C-D| \leq 0.7$



5. Lamp(CCFL) Lot No. is marked at backlight connector.



6. Do not wind conductive tape around the backlight wires.



Product Specification

6. Reliability

Table 11. 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 | Humidity Condition operation | 10%RH ~ 90%RH |
| 6 | Humidity Condition storage | 10%RH ~ 90%RH |
| 7 | Vibration test (non-operating) | Wave form : random Vibration level : 1.0G RMS Bandwidth : 10-500Hz Duration : X,Y,Z, 20 min. One time each direction |
| 8 | Shock test (non-operating) | Shock level : 120G Waveform : half sine wave, 2ms Direction : ±X, ±Y, ±Z One time each direction |
| 9 | Altitude storage / shipment | 0 - 40,000 feet(12,192m) |

{ 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.

Product Specification**7. International Standards****7-1. Safety**

- a) UL 1950 Third Edition, Underwriters Laboratories, Inc. Jan. 28, 1995.
Standard for Safety of Information Technology Equipment Including Electrical Business Equipment.
- b) CAN/CSA C22.2 No. 950-95 Third Edition, Canadian Standards Association, Jan. 28, 1995.
Standard for Safety of Information Technology Equipment Including Electrical Business Equipment.
- c) EN 60950 : 1992+A1: 1993+A2: 1993+A3: 1995+A4: 1997+A11: 1997
IEC 950 : 1991+A1: 1992+A2: 1993+A3: 1995+A4: 1996
European Committee for Electrotechnical Standardization(CENELEC)
EUROPEAN STANDARD for Safety of Information Technology Equipment Including Electrical
Business 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

Product Specification
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

D : YEAR

E : MONTH

F,G : PANEL CODE

H : ASSEMBLY CODE

I,J,K,L,M : SERIAL NO.

Note:

1. YEAR

| | | | | | | | | | | | |
|------|----|----|----|------|------|------|------|------|------|------|------|
| YEAR | 97 | 98 | 99 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
| Mark | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

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 |

3. Serial No.

| | | |
|------------|---------------|----------------------------|
| Serial No. | 1 ~ 99999 | 100000 ~ |
| Mark | 00001 ~ 99999 | A0001 ~ A9999,....., Z9999 |

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 : 8 pcs

b) Box Size : 344mm X 315mm X 410mm.

Product Specification

9. PRECAUTIONS

Please pay attention to the following 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 a transparent protective plate to the surface in order to protect the polarizer.
Transparent protective plate should have sufficient strength in order to the resist external force.
- (4) You should adopt radiation structure to satisfy the temperature specification.
- (5) Acetic acid type and chlorine type materials for the cover case are not describe 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 determined 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.

Product Specification

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.