

**Product Specification**

# SPECIFICATION FOR APPROVAL

( . ) Preliminary Specification

( ) Final Specification

|              |                          |
|--------------|--------------------------|
| <b>Title</b> | <b>15.0" XGA TFT LCD</b> |
|--------------|--------------------------|

|       |       |
|-------|-------|
| Buyer | Sambo |
| Model |       |

|          |                          |
|----------|--------------------------|
| Supplier | LG.Philips LCD CO., Ltd. |
| *Model   | LM150X06                 |
| Suffix   | A3M1                     |

\*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  |      |
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**Platform Design 2 Team**  
**LG. Philips LCD Co., Ltd**

## Product Specification

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Records of Revisions

| Revision No. | Date          | Page | Description |
|--------------|---------------|------|-------------|
| 1.3          | Jul. 05, 2002 | -    | First Draft |

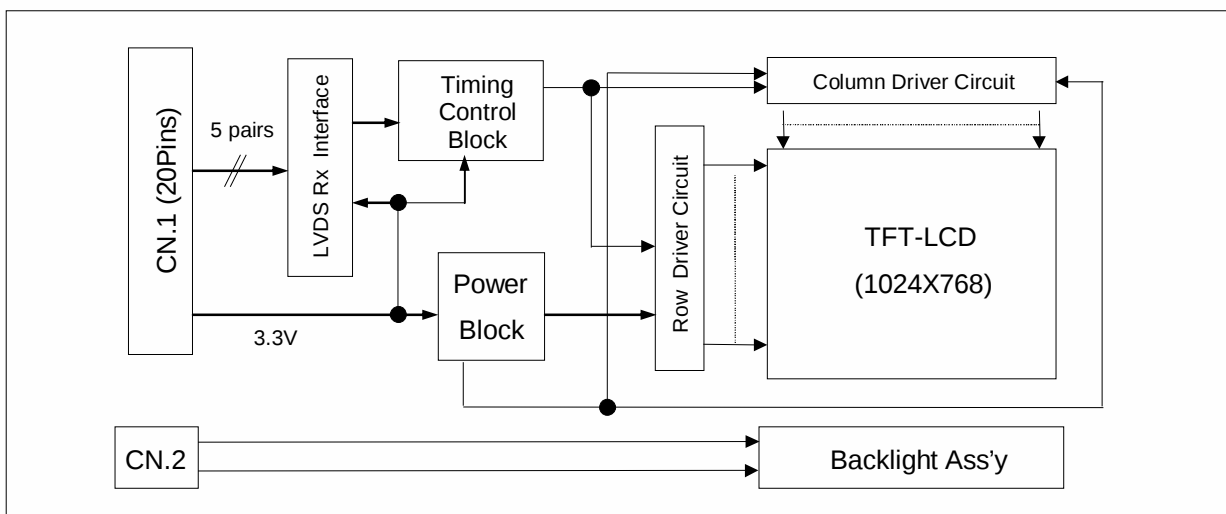
## Product Specification

### 1. General Description

The LM150X06-A3 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 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16M colors.

The LM150X06-A3 has been designed to apply the LVDS(8-bit,1-port) interface method.

The LM150X06-A3 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-A3 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            | 16M colors ( 6-bit with FRC )                                   |
| Luminance, white       | 250 cd/m <sup>2</sup> (Typ.)                                    |
| Power Consumption      | 9.1254 Watt(Typ.)                                               |
| Weight                 | 1000 g (Typ.), 1050 g (Max.)                                    |
| Display operating mode | Transmissive mode, normally white                               |
| Surface treatments     | Hard coating(3H)<br>Anti-glare treatment of the front polarizer |

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### 2. Absolute Maximum Ratings

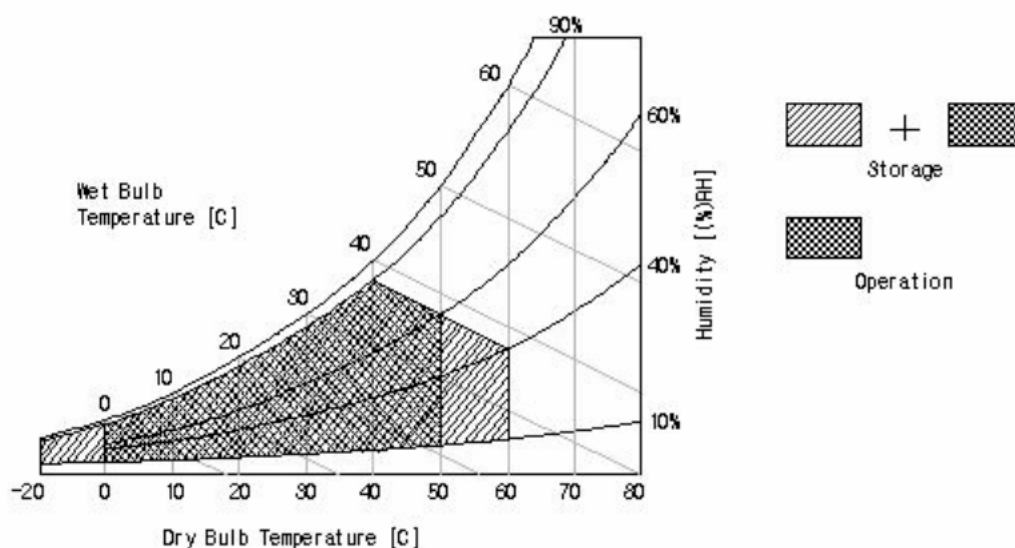
The following are maximum values which, if exceeded, may cause operation or damage to the unit.

**Table 1. Absolute maximum ratings**

| Parameter                  | Symbol   | Values |      | Units | Notes        |
|----------------------------|----------|--------|------|-------|--------------|
|                            |          | Min.   | Max. |       |              |
| Power Input Voltage        | $V_{CC}$ | -0.3   | 3.6  | Vdc   | At 25 ± 2 °C |
| Operating Temperature      | $T_{OP}$ | 0      | 50   | °C    |              |
| Storage Temperature        | $T_{ST}$ | -20    | 60   | °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-A3 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    | $V_{CC}$   | 3.15   | 3.3    | 3.45   | V         |       |
| Permissive power input ripple | $V_{RF}$   | -      | -      | 0.1    | $V_{PP}$  |       |
| Power Supply Input Current    | $I_{CC}$   | -      | 0.438  | 0.638  | A         | 1     |
| Power Consumption             | $P_{CC}$   | -      | 1.4454 | 2.2968 | Watts     |       |
| Rush Current                  | $I_{RUSH}$ |        | 1.0    | 2.0    | A         | 2     |
| LAMP :                        |            |        |        |        |           |       |
| Operating Voltage             | $V_{BL}$   | 460    | 480    | 590    | $V_{RMS}$ | 3     |
| Operating Current             | $I_{BL}$   | 3.0    | 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.** The design of the inverter must have specifications for the lamp in LCD Assembly.

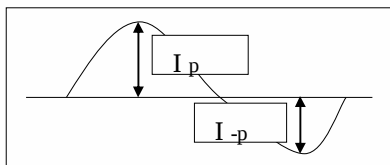
The performance of the Lamp in LCM, for example life time or brightness, is extremely influenced by the characteristics of the DC-AC Inverter. So all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter. When 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.** 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  $V_{CC}=3.3V$ , 25°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 20ms.
3. Operating voltage is measured under 25°C. The variance of the voltage is  $\pm 10\%$ .
4. The voltage above  $V_{BS}$  should be applied to the lamps for more than 1 second for start-up. Otherwise,the lamps may not be turned on.

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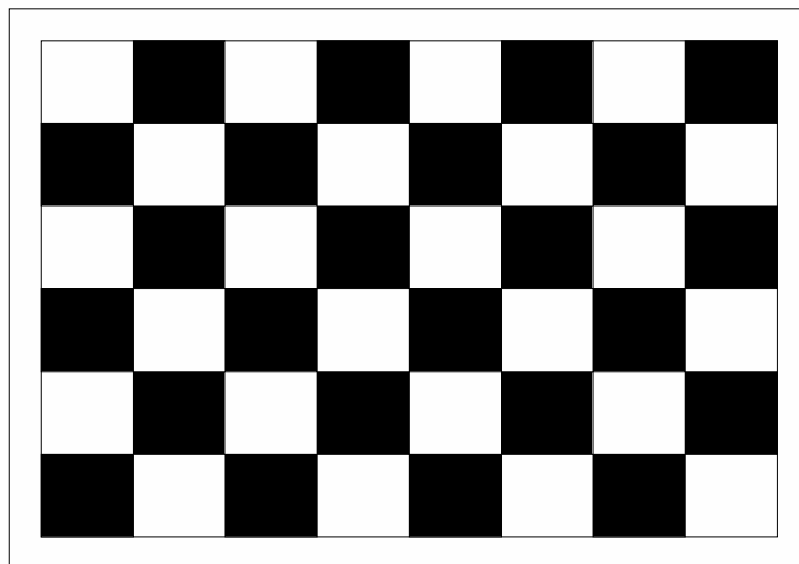
5. The output of the inverter must have symmetrical(negative and positive) voltage waveform and symmetrical current waveform.(Unsymmetrical ratio is less than 10%) Please do not use the inverter which has unsymmetrical voltage and unsymmetrical current and spike wave.  
Lamp frequency may produce interference 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%.  
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  $25 \pm 2^\circ$ .
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.



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

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

10. Inverter open voltage must be more than lamp starting voltage.



[ Figure 3 ] Mosaic pattern for power consumption measurement

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### 3-2. Interface Connections

This LCM has three interface connections, a 20-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 LVDS Connector : DF14H-20P-1.25H(Hirose) or IN-20-OA 125(UJU)

Mating Connector : DF14-20S-1.25C(Hirose)

**Table 3. Module connector pin's configuration**

| Pin | Symbol | Description        | Notes                                                                                                                                                                                                          |
|-----|--------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Vcc    | Power Supply +3.3V | <b>Interface chips</b><br>LCD : Single 8-bit Input LVDS(NS) One Chip<br>System : THC63LVDM83R(Thine)<br>or compatible transmitters<br><br>*The signal pin's assignment of transmitter is shown in the Table 4. |
| 2   | Vcc    | Power Supply +3.3V |                                                                                                                                                                                                                |
| 3   | GND    | GND                |                                                                                                                                                                                                                |
| 4   | GND    | GND                |                                                                                                                                                                                                                |
| 5   | Rx0-   | LVDS signal(-)     |                                                                                                                                                                                                                |
| 6   | Rx0+   | LVDS signal(+)     |                                                                                                                                                                                                                |
| 7   | GND    | GND                |                                                                                                                                                                                                                |
| 8   | Rx1-   | LVDS signal(-)     |                                                                                                                                                                                                                |
| 9   | Rx1+   | LVDS signal(+)     |                                                                                                                                                                                                                |
| 10  | GND    | GND                |                                                                                                                                                                                                                |
| 11  | Rx2-   | LVDS signal(-)     |                                                                                                                                                                                                                |
| 12  | Rx2+   | LVDS signal(+)     |                                                                                                                                                                                                                |
| 13  | GND    | GND                |                                                                                                                                                                                                                |
| 14  | RxC-   | LVDS signal(-)     |                                                                                                                                                                                                                |
| 15  | RxC+   | LVDS signal(+)     |                                                                                                                                                                                                                |
| 16  | GND    | GND                |                                                                                                                                                                                                                |
| 17  | Rx3-   | LVDS signal(-)     |                                                                                                                                                                                                                |
| 18  | Rx3+   | LVDS signal(+)     |                                                                                                                                                                                                                |
| 19  | GND    | GND                |                                                                                                                                                                                                                |
| 20  | NC     | No Connection      |                                                                                                                                                                                                                |

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

2. All Vcc(power input) pins should be connected together.

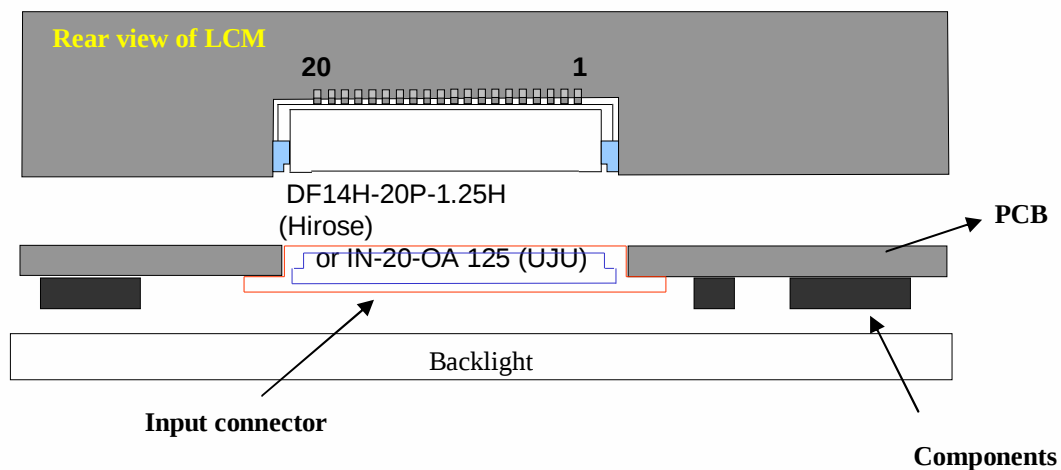
**Product Specification**
**Table 4. Required signal assignment for FlatLink's transmitter**

| Pin # | Pin Name | Require Signals | IN/OUT | Pin # | Pin Name | Require Signals | IN/OUT |
|-------|----------|-----------------|--------|-------|----------|-----------------|--------|
| 1     | VCC      | Vcc             |        | 56    | TXIN4    | R4              | I      |
| 2     | TXIN5    | R7(MSB)         | I      | 55    | TXIN3    | R3              | I      |
| 3     | TXIN6    | R5              | I      | 54    | TXIN2    | R2              | I      |
| 4     | TXIN7    | G0(LSB)         | I      | 53    | GND      | GND             |        |
| 5     | GND      | GND             |        | 52    | TXIN1    | R1              | I      |
| 6     | TXIN8    | G1              | I      | 51    | TXIN0    | R0(LSB)         | I      |
| 7     | TXIN9    | G2              | I      | 50    | TXIN27   | R6              | I      |
| 8     | TXIN10   | G6              | I      | 49    | LVDSGND  | LVDSGND         |        |
| 9     | VCC      | Vcc             |        | 48    | TXOUT0-  | TX0-            | O      |
| 10    | TXIN11   | G7(MSB)         | I      | 47    | TXOUT0+  | TX0+            | O      |
| 11    | TXIN12   | G3              | I      | 46    | TXOUT1-  | TX1-            | O      |
| 12    | TXIN13   | G4              | I      | 45    | TXOUT1+  | TX1+            | O      |
| 13    | GND      | GND             |        | 44    | LVDSVCC  | LVDSVCC         |        |
| 14    | TXIN14   | G5              | I      | 43    | LVDSGND  | LVDSGND         |        |
| 15    | TXIN15   | B0(LSB)         | I      | 42    | TXOUT2-  | TX2-            | O      |
| 16    | TXIN16   | B6              | I      | 41    | TXOUT2+  | TX2+            | O      |
| 17    | R_FB     | R_FB            | I      | 40    | TXCOUT-  | TXC-            | O      |
| 18    | TXIN17   | B7(MSB)         | I      | 39    | TXCOUT+  | TXC+            | O      |
| 19    | TXIN18   | B1              | I      | 38    | TXOUT3-  | TX3-            | O      |
| 20    | TXIN19   | B2              | I      | 37    | TXOUT3+  | TX3+            | O      |
| 21    | GND      | GND             |        | 36    | LVDSGND  | LVDSGND         |        |
| 22    | TXIN20   | B3              | I      | 35    | PLLGND   | PLLGND          |        |
| 23    | TXIN21   | B4              | I      | 34    | PLLVCC   | PLLVCC          |        |
| 24    | TXIN22   | B5              | I      | 33    | PLLGND   | PLLGND          |        |
| 25    | TXIN23   | RES             | I      | 32    | PD       | PD              | I      |
| 26    | VCC      | Vcc             |        | 31    | TXCIN    | DCLK            | I      |
| 27    | TXIN24   | Hsync.          | I      | 30    | TXIN26   | DATA ENABLE     | I      |
| 28    | TXIN25   | Vsync.          | I      | 29    | GND      | GND             |        |

Notes 1. Refer to LVDS transmitter data sheet for detail descriptions.

2. 7 means MSB and 0 means LSB at R,G,B pixel data

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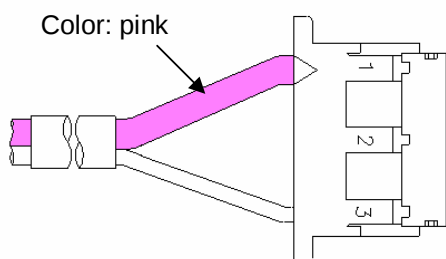
[ Figure 4 ] Connector diagram

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 5.

**Table 5. Backlight connector pin's configuration**

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

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



[ Figure 5 ] Backlight connector view

## Product Specification

### 3-3. Signal Timing Specifications

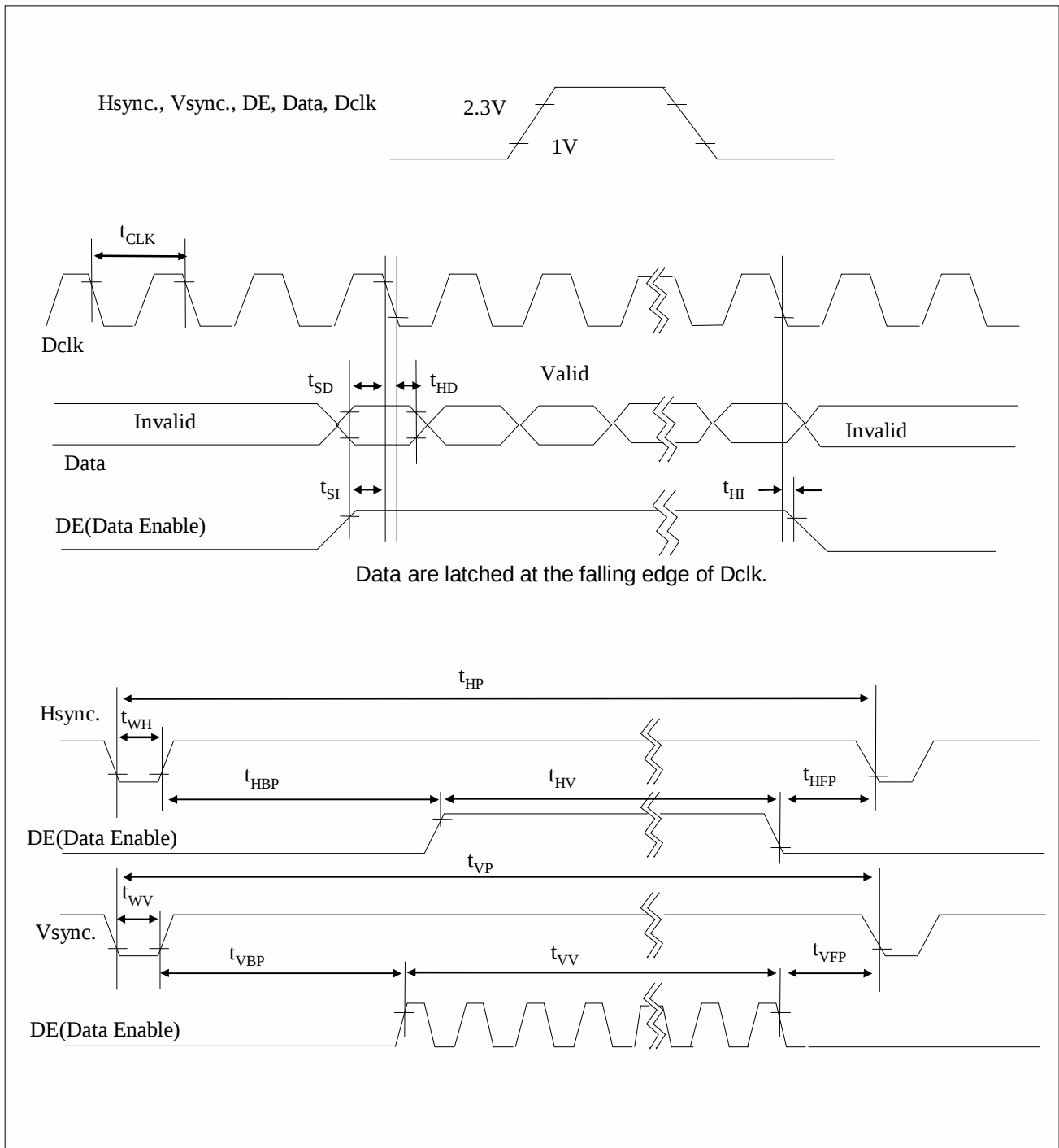
This is the signal timing required at the input of the LVDS Transmitter. All of the interface signal timing should be satisfied with the following specifications for it's proper operation.

**Table 6. Timing table**

| Parameter           |                        | Symbol    | Min.   | Typ.   | Max.   | Unit      | Notes          |
|---------------------|------------------------|-----------|--------|--------|--------|-----------|----------------|
| Dclk                | Period                 | $t_{CLK}$ | 12.698 | 15.384 | 20.000 | ns        |                |
|                     | Frequency              | $f_{CLK}$ | 60     | 65     | 78.75  | MHz       |                |
| Hsync.              | Period                 | $t_{HP}$  | 1096   | 1344   | 1360   | $t_{CLK}$ |                |
|                     | Width                  | $t_{WH}$  | 8      | -      | -      |           | Note 1, Note 2 |
| Vsync.              | Period                 | $t_{VP}$  | 800    | 806    | 862    | $t_{HP}$  |                |
|                     | Width                  | $t_{WV}$  | 2      | -      | -      | $t_{HP}$  |                |
|                     | Frequency              | $f_v$     | -      | 60     | 75     | Hz        |                |
| DE<br>(Data Enable) | Horizontal Valid       | $t_{HV}$  | 1024   | 1024   | 1024   | $t_{CLK}$ | Note 2         |
|                     | Horizontal Back Porch  | $t_{HBP}$ | 8      | 160    | -      |           |                |
|                     | Horizontal Front Porch | $t_{HFP}$ | 8      | 24     | -      |           |                |
|                     | -                      | -         | -      | -      | -      |           |                |
|                     | Vertical Valid         | $t_{VV}$  | 768    | 768    | 768    | $t_{HP}$  |                |
|                     | Vertical Back Porch    | $t_{VBP}$ | 3      | 29     | -      |           |                |
|                     | Vertical Front Porch   | $t_{VFP}$ | 2      | 3      | -      |           |                |
|                     | -                      | -         | -      | -      | -      |           |                |
|                     | -                      | $t_{SI}$  | -      | -      | -      | ns        | For Dclk       |
|                     | -                      | $t_{HI}$  | -      | -      | -      |           |                |
| Data                | -                      | $t_{SD}$  | -      | -      | -      |           |                |
|                     | -                      | $t_{HD}$  | -      | -      | -      |           |                |

Note 1:  $t_{HFP} + t_{WH} + t_{HBP} < t_{HV}$

Note 2: No variation of Hsync.(or DE) input is required for normal operation.

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**3-4. Signal Timing Waveforms**

**[ Figure 6 ] Signal timing waveforms**



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## 3-5. Color Input Data Reference

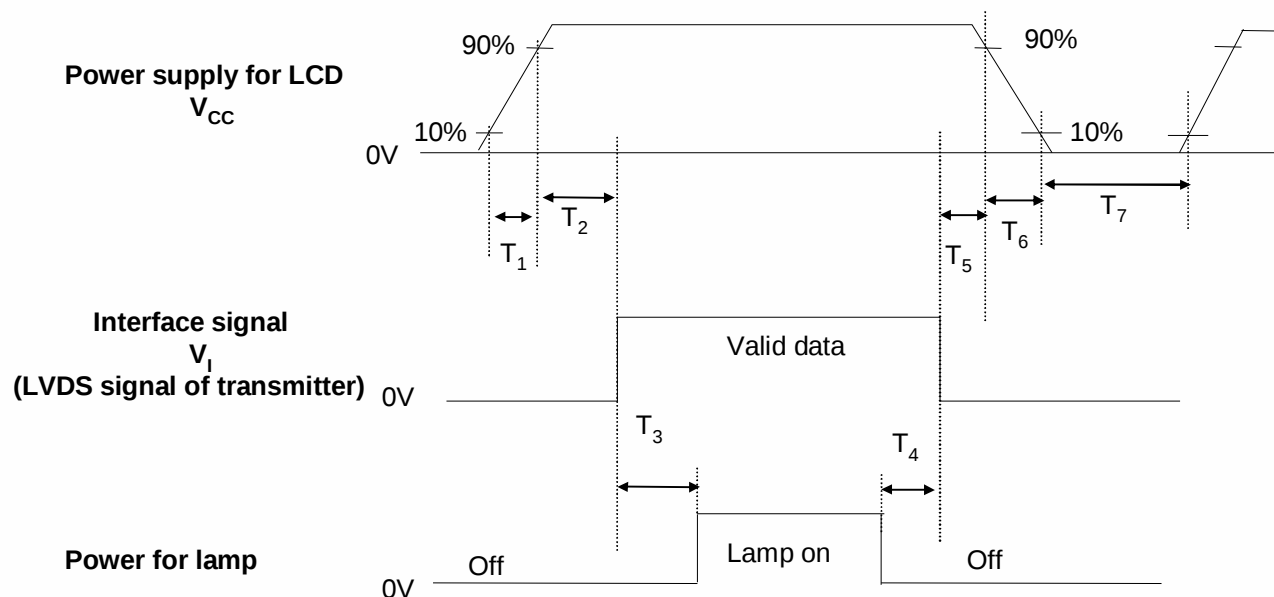
The brightness of each primary color(red,green and blue) is based on the 8-bit gray scale data input for the color ; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 7. Color data reference

| Color        |                  | Input color data |    |    |    |     |    |    |    |       |    |    |    |     |    |    |    |      |    |    |    |     |    |    |    |
|--------------|------------------|------------------|----|----|----|-----|----|----|----|-------|----|----|----|-----|----|----|----|------|----|----|----|-----|----|----|----|
|              |                  | Red              |    |    |    |     |    |    |    | Green |    |    |    |     |    |    |    | Blue |    |    |    |     |    |    |    |
|              |                  | MSB              |    |    |    | LSB |    |    |    | MSB   |    |    |    | LSB |    |    |    | MSB  |    |    |    | LSB |    |    |    |
|              |                  | R7               | R6 | R5 | R4 | R3  | R2 | R1 | R0 | G7    | G6 | G5 | G4 | G3  | G2 | G1 | G0 | B7   | B6 | 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  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Red(255)         | 1                | 1  | 1  | 1  | 1   | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Green(255)       | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1   | 1  | 1  | 1  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Blue(255)        | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 1    | 1  | 1  | 1  | 1   | 1  | 1  | 1  |
|              | Cyan             | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1   | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 1   | 1  | 1  | 1  |
|              | Magenta          | 1                | 1  | 1  | 1  | 1   | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 1    | 1  | 1  | 1  | 1   | 1  | 1  | 1  |
|              | Yellow           | 1                | 1  | 1  | 1  | 1   | 1  | 1  | 1  | 1     | 1  | 1  | 1  | 1   | 1  | 1  | 1  | 0    | 0  | 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  | 1  | 1  | 1   | 1  | 1  | 1  |
| Red          | Red(000) dark    | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Red(001)         | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 1  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Red(002)         | 0                | 0  | 0  | 0  | 0   | 0  | 1  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | :                | :                | :  | :  | :  | :   | :  | :  | :  | :     | :  | :  | :  | :   | :  | :  | :  | :    | :  | :  | :  | :   | :  | :  | :  |
|              | Red(253)         | 1                | 1  | 1  | 1  | 1   | 1  | 0  | 1  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Red(254)         | 1                | 1  | 1  | 1  | 1   | 1  | 1  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Red(255) bright  | 1                | 1  | 1  | 1  | 1   | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
| Green        | Green(000)dark   | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Green(001)       | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 1  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Green(002)       | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 1  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | :                | :                | :  | :  | :  | :   | :  | :  | :  | :     | :  | :  | :  | :   | :  | :  | :  | :    | :  | :  | :  | :   | :  | :  | :  |
|              | Green(253)       | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1   | 1  | 0  | 1  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Green(254)       | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1   | 1  | 1  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Green(255)bright | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1   | 1  | 1  | 1  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
| Blue         | Blue(000) dark   | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|              | Blue(001)        | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 0  | 1  |
|              | Blue(002)        | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 1  | 0  | 0  |
|              | :                | :                | :  | :  | :  | :   | :  | :  | :  | :     | :  | :  | :  | :   | :  | :  | :  | :    | :  | :  | :  | :   | :  | :  | :  |
|              | Blue(253)        | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 1  | 1    | 1  | 1  | 1  | 1   | 0  | 1  | 0  |
|              | Blue(254)        | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 1  | 1    | 1  | 1  | 1  | 1   | 1  | 0  | 0  |
|              | Blue(255) bright | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 1  | 1    | 1  | 1  | 1  | 1   | 1  | 1  | 1  |

## Product Specification

### 3-6. Power Sequence

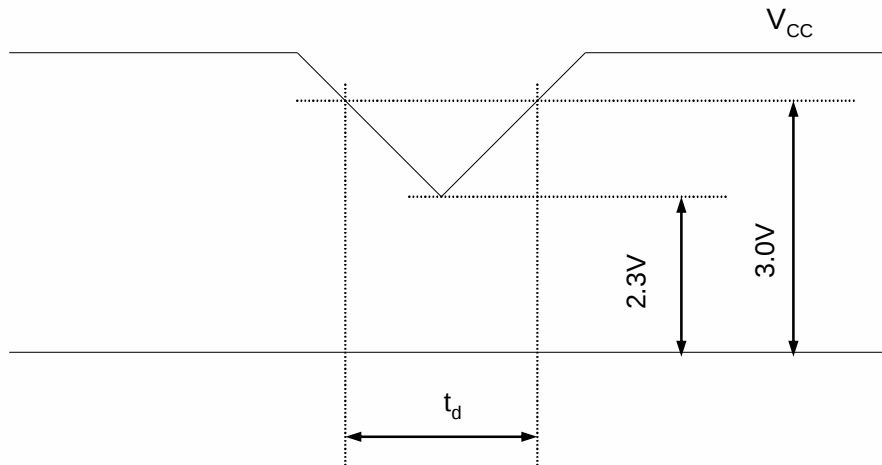


[ Figure 7 ] Power sequence

Table 8. Power sequence time delay

| Parameter | Values |      |      | Units |
|-----------|--------|------|------|-------|
|           | Min.   | Typ. | Max. |       |
| $T_1$     | -      | -    | 10   | ms    |
| $T_2$     | 0.01   | -    | 50   | ms    |
| $T_3$     | 200    | -    | -    | ms    |
| $T_4$     | 200    | -    | -    | ms    |
| $T_5$     | 0.01   | -    | 50   | ms    |
| $T_6$     | 0.01   | -    | 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  $V_{CC}$  to 0V.
  3. Lamp power must be turn on after power supply for LCD and interface signal are valid.

**Product Specification**
**3-7.  $V_{CC}$  Power Dip Condition**

**[ Figure 8 ] Power dip condition**

1) Dip condition

$$2.3V = V_{CC} < 3.0V, \quad t_d = 20ms$$

2)  $V_{CC} < 2.3V$

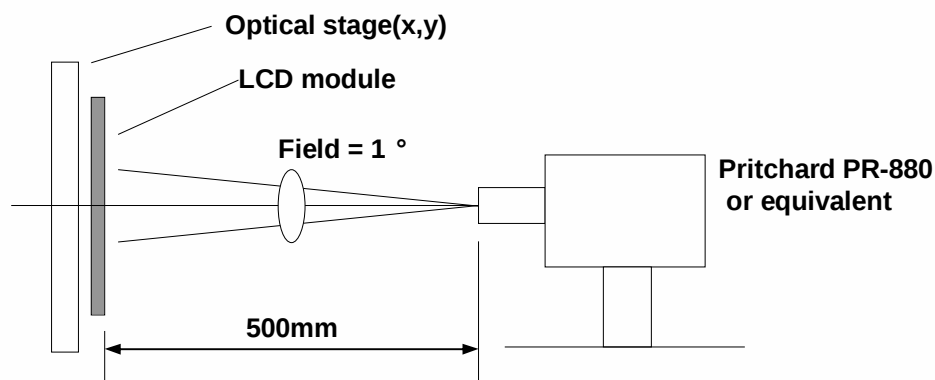
$V_{CC}$ -dip conditions should also follow the Power On/Off conditions for supply voltage.

## 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  $\theta$  and  $\theta$  equal to 0 °.

[ Figure 9 ] presents additional information concerning the measurement equipment and method.



[Figure 9] Optical characteristic measurement equipment and method

(Ta=25 °C, V<sub>CC</sub>=3.3V, f<sub>V</sub>=60Hz  
Dclk=65MHz, I<sub>BL</sub>=8mA)

Table 9. Optical characteristics

| Parameter                           | Symbol          | Values |       |       | Units             | Notes     |
|-------------------------------------|-----------------|--------|-------|-------|-------------------|-----------|
|                                     |                 | Min.   | Typ.  | Max.  |                   |           |
| Contrast ratio                      | CR              | 250    | 350   | -     |                   | 1         |
| Surface luminance, white            | L <sub>WH</sub> | 200    | 250   | -     | cd/m <sup>2</sup> | 2         |
| Luminance variation                 | $\theta$ WHITE  | -      | -     | 1.3   |                   | 3         |
| Response time                       | Tr              |        | 30    | 45    | ms                | 4         |
| Rise time                           | Tr <sub>R</sub> | -      | 10    | 15    |                   |           |
| Decay time                          | Tr <sub>D</sub> | -      | 20    | 30    |                   |           |
| CIE color coordinates               |                 |        |       |       |                   |           |
| Red                                 | XR              | 0.601  | 0.631 | 0.661 |                   |           |
|                                     | YR              | 0.317  | 0.347 | 0.377 |                   |           |
| Green                               | XG              | 0.279  | 0.309 | 0.339 |                   |           |
|                                     | YG              | 0.553  | 0.583 | 0.613 |                   |           |
| Blue                                | XB              | 0.119  | 0.149 | 0.179 |                   |           |
|                                     | YB              | 0.083  | 0.113 | 0.143 |                   |           |
| White                               | XW              | 0.283  | 0.313 | 0.343 |                   |           |
|                                     | YW              | 0.299  | 0.329 | 0.359 |                   |           |
| Viewing angle                       |                 |        |       |       |                   |           |
| X axis, right ( $\theta=0^\circ$ )  | $\theta_r$      | 55     | 60    | -     | degree            | 5         |
| X axis, left ( $\theta=180^\circ$ ) | $\theta_l$      | 55     | 60    | -     |                   |           |
| Y axis, up ( $\theta=90^\circ$ )    | $\theta_u$      | 40     | 45    | -     |                   |           |
| Y axis, down ( $\theta=270^\circ$ ) | $\theta_d$      | 40     | 45    | -     |                   |           |
| Gray scale                          |                 | -      | 2.2   | -     |                   | 6         |
| Flicker                             |                 |        |       | -18   | dB                | Figure 13 |
| Crosstalk                           |                 |        |       | 2.2   | %                 | Figure 14 |

## Product Specification

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

$$\text{Contrast ratio} = \frac{\text{Surface luminance with all white pixels}}{\text{Surface luminance with all black pixels}}$$

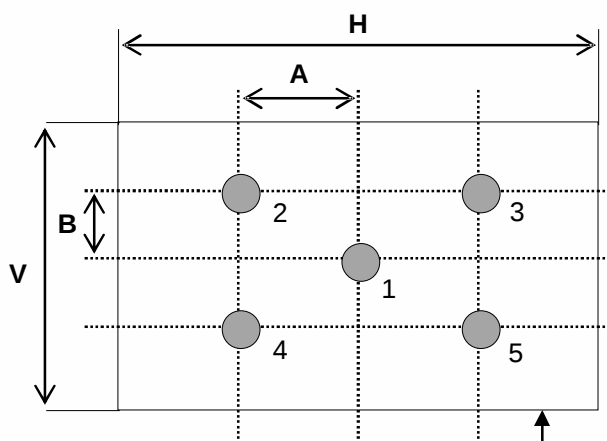
2. Surface luminance is the center point across the LCD surface 50cm from the surface with all pixels displaying white. For more information see [ Figure 10 ].  
When  $I_{BL}=8\text{mA}$ ,  $L_{WH}=200\text{cd/m}^2(\text{Min.})$   $250\text{cd/m}^2(\text{Typ.})$
3. The variation in surface luminance, % WHITE is determined by measuring  $L_{ON}$  at each test position 1 through 5, and then dividing the maximum  $L_{ON}$  of 5 points luminance by minimum  $L_{ON}$  of 5 points luminance. For more information see [ Figure 10 ].  
% WHITE =  $\frac{\text{Maximum}(L_{ON1}, L_{ON2}, \dots, L_{ON5})}{\text{Minimum}(L_{ON1}, L_{ON2}, \dots, L_{ON5})}$
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 11 ].
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 12 ].
6. Gray scale specification

**Table 10. Gray scale**

| Gray level | Luminance(%)<br>(Typ.) |
|------------|------------------------|
| L000       | 0.22                   |
| L031       | 0.81                   |
| L063       | 4.29                   |
| L095       | 11.4                   |
| L127       | 22.1                   |
| L159       | 36.4                   |
| L191       | 55.4                   |
| L223       | 78.0                   |
| L255       | 100                    |

**Product Specification**
**[ Figure 10 ] Luminance measuring point**

&lt;Measuring point for luminance variation&gt;



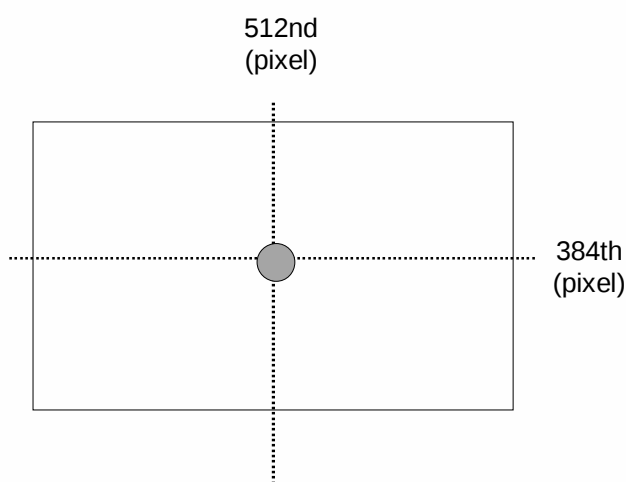
A : H/4 mm, B : V/4 mm

H : 304.128 mm, V : 228.096 mm

@ H,V : Active Area

Active area

&lt;Measuring point for surface luminance&gt;

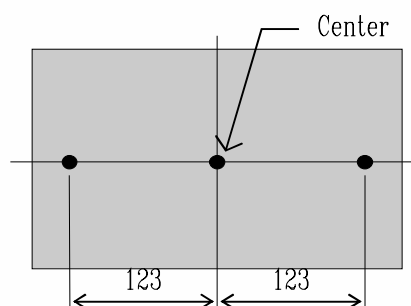

 < Luminance Uniformity - angular – dependent ( $L_R$ ) >

 TCO '99 Certification requirements and test methods for environmental labelling of Display [Flat]  
 report No.2 (Luminance uniformity- angular – dependent)

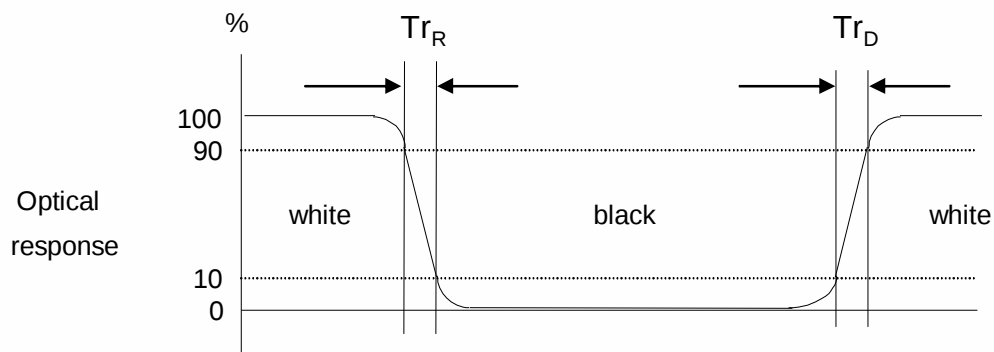
Test pattern : 80% white pattern

Test point : 3-point

Test distance : 50?

 Test method :  $L_R = \frac{(L_{\max. +30\deg.} / L_{\min. +30\deg.}) + (L_{\max. -30\deg.} / L_{\min. -30\deg.})}{2}$ 

**[ Figure 11 ] Response time**

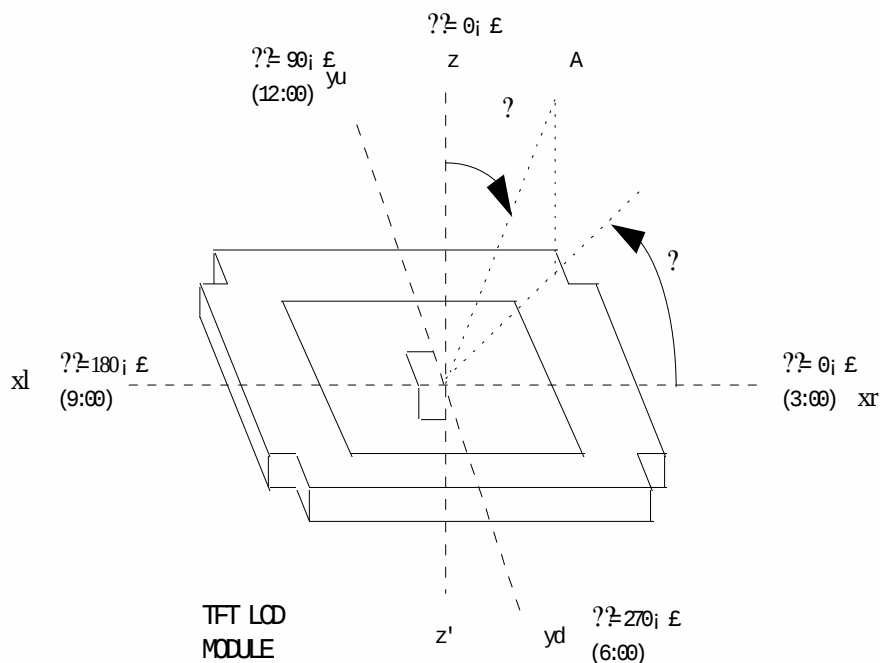
The response time is defined as the following Figure and shall be measured by switching the input signal for "black" and "white".



## Product Specification

**[ Figure 12 ] Viewing angle**

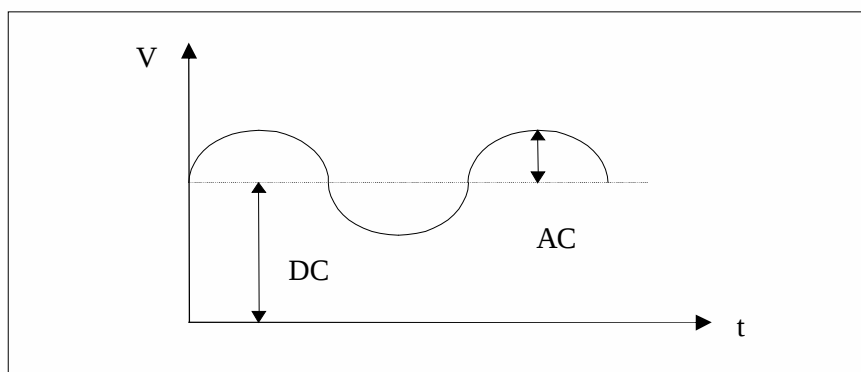
<Dimension of viewing angle range>



**[ Figure 13 ] Flicker**

13.1 The condition of measurement : background RGB gray (0,0,0), foreground RGB gray (0, 127, 127)  
half green & blue dot

### 13.2 The definition of flicker

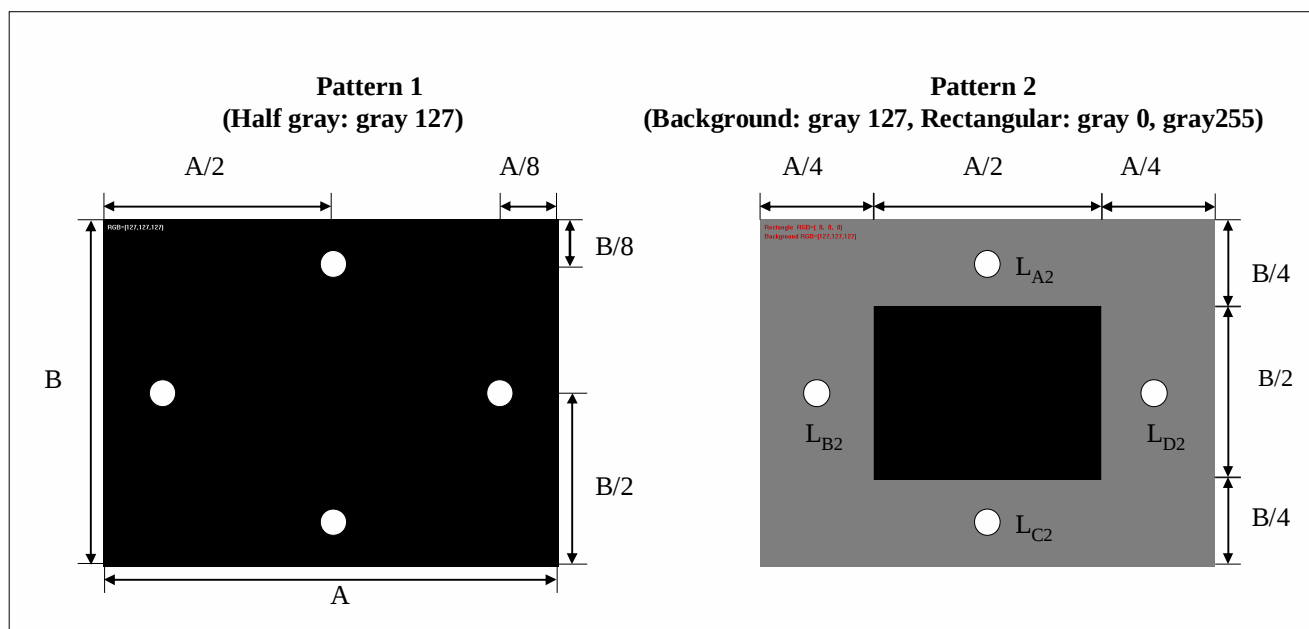


### 13.3 The equation of flicker : $-20\log (AC, 30\text{Hz}/DC)$

## Product Specification

### [ Figure 14 ] Crosstalk

14.1 The equation of crosstalk :  $(\frac{L_{A[or C]2} - L_{A[or C]1}}{L_{A[or C]1}}) \times 100(\%) [??]$ ,  
 $(\frac{L_{B[or D]2} - L_{B[or D]1}}{L_{B[or D]1}}) \times 100(\%) [??]$



## 5. Mechanical Characteristics

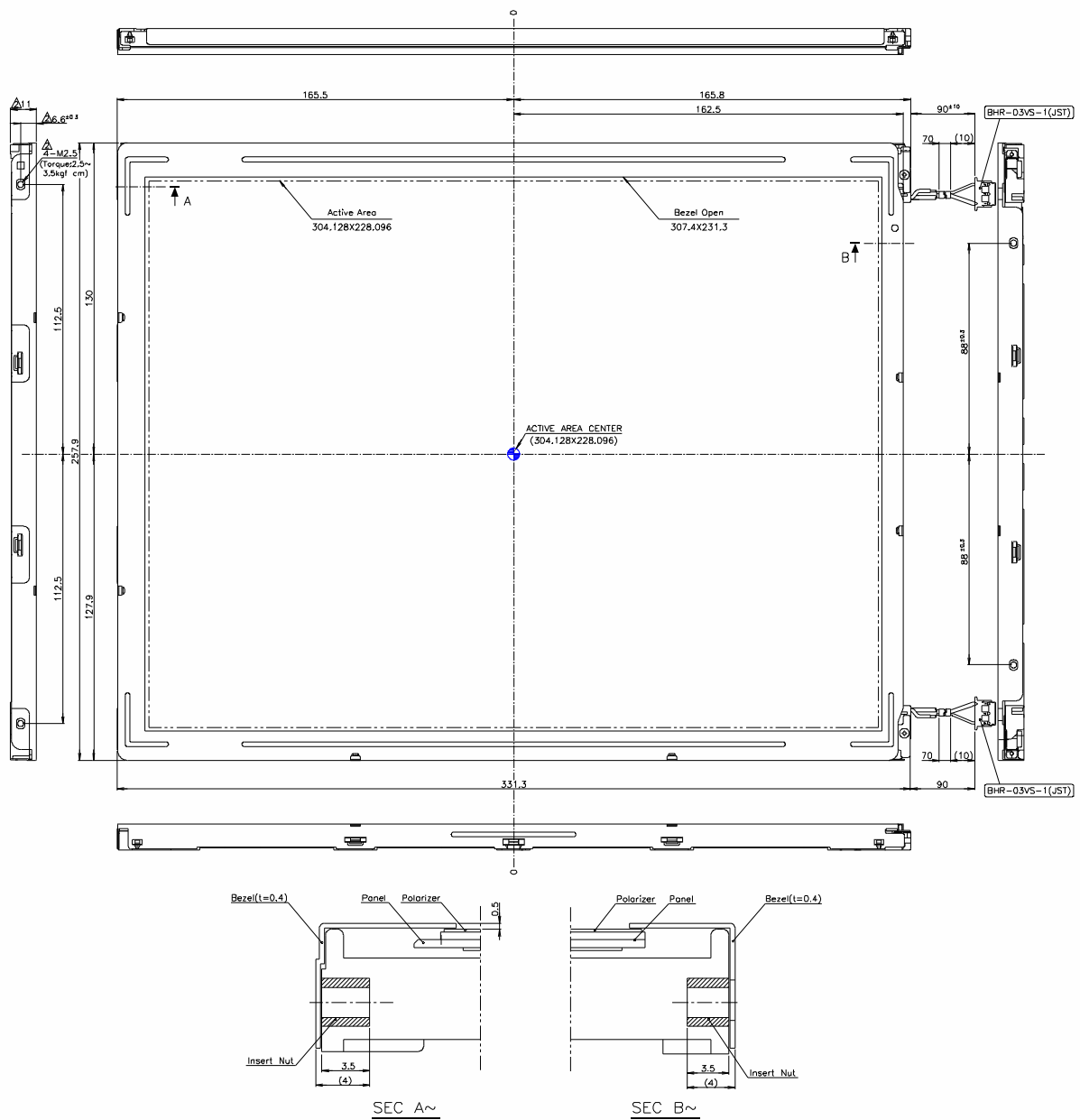
The contents provide general mechanical characteristics for the model LM150X06-A3. In addition, the Figures in the next page are detailed mechanical drawing of the LCD.

**Table 11. 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,coating treatment of the front polarizer. |              |

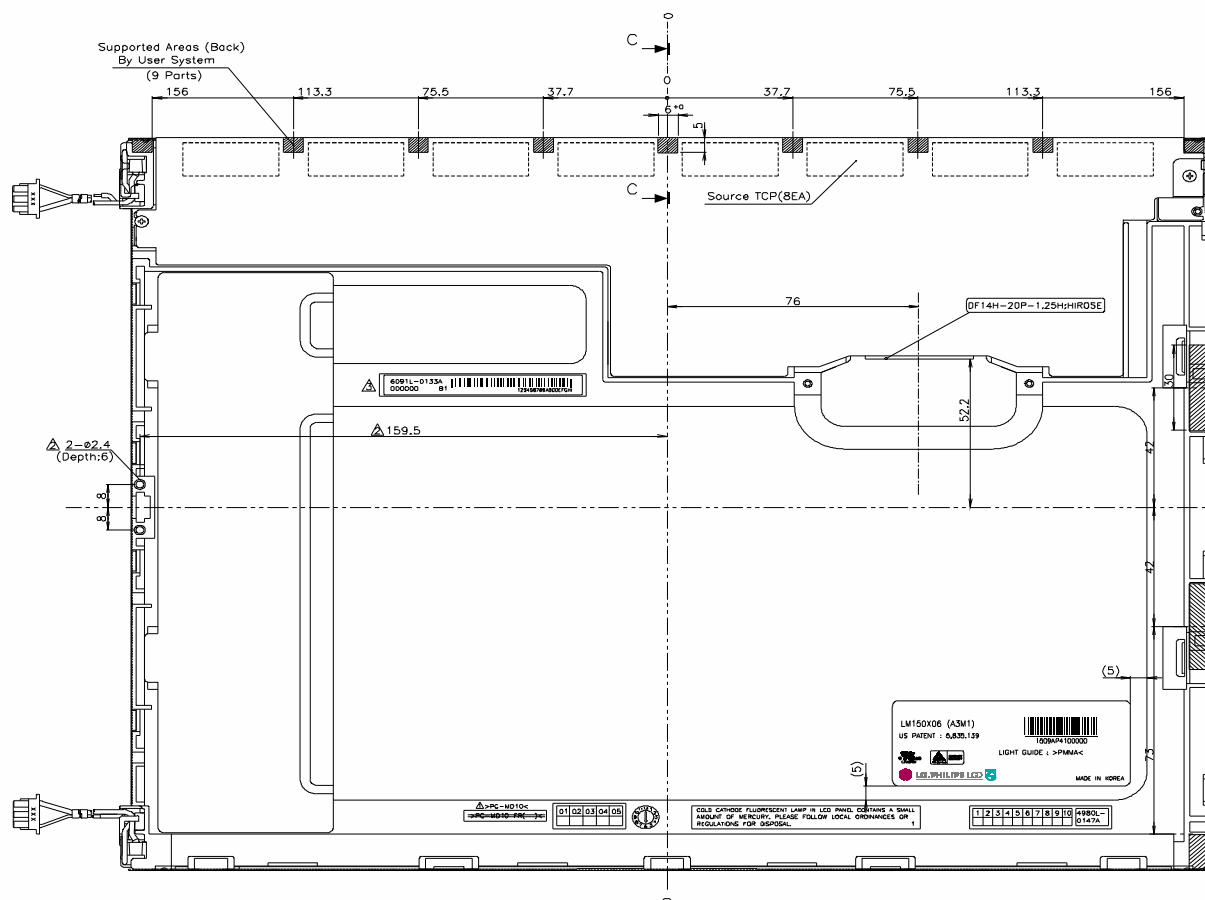
## Product Specification

**[ Figure 15 ] LM150X06-A3M1 Front View**



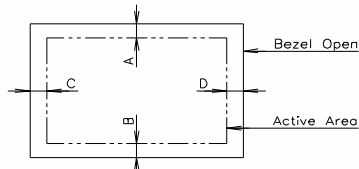
## Product Specification

**[ Figure 16 ] LM150X06-A3M1 Rear View**

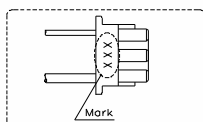


## NOTES

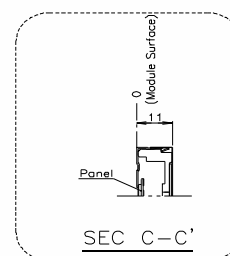
1. Unspecified tolerances to be  $\pm 0.5$
2. Backlight wires and contraction tubes are excluded from outline dimensions.
3. Tilt and partial disposition tolerance of display area as following.
  - (1) Y-Direction :  $|A-B| \leq 0.7$
  - (2) X-Direction :  $|C-D| \leq 0.7$



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



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



## Product Specification

### 6. Reliability

**Table 12. 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<br>(non-operating) | Wave form : random<br>Vibration level : 1.0G RMS<br>Bandwidth : 10-500Hz<br>Duration : X,Y,Z, 20 min.<br>One time each direction |
| 6   | Shock test<br>(non-operating)     | Shock level : 120G<br>Waveform : half sine wave, 2ms<br>Direction : ±X, ±Y, ±Z<br>One time each direction                        |
| 7   | Altitude<br>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 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 described 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 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.

#### 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 minimize 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) The protection film is attached to the bezel with a small masking tape.  
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) 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 Bezel after the protection film is peeled off.
- (3) You can remove the glue easily. When the glue remains on the Bezel or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.