

Product Specification

# SPECIFICATION FOR APPROVAL

( ● ) Preliminary Specification  
(   ) Final Specification

|       |                     |
|-------|---------------------|
| Title | 23.0" WUXGA TFT LCD |
|-------|---------------------|

|       |  |
|-------|--|
| BUYER |  |
| MODEL |  |

|          |                          |
|----------|--------------------------|
| SUPPLIER | LG.Philips LCD Co., Ltd. |
| *MODEL   | LM230W02                 |
| SUFFIX   | A2K1                     |

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

| APPROVED BY | SIGNATURE | DATE |
|-------------|-----------|------|
| /           |           |      |
| /           |           |      |
| /           |           |      |

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

| APPROVED BY          | SIGNATURE | DATE |
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**MNT Products Engineering Dept.**  
**LG. Philips LCD Co., Ltd**

## Product Specification

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## RECORD OF REVISIONS

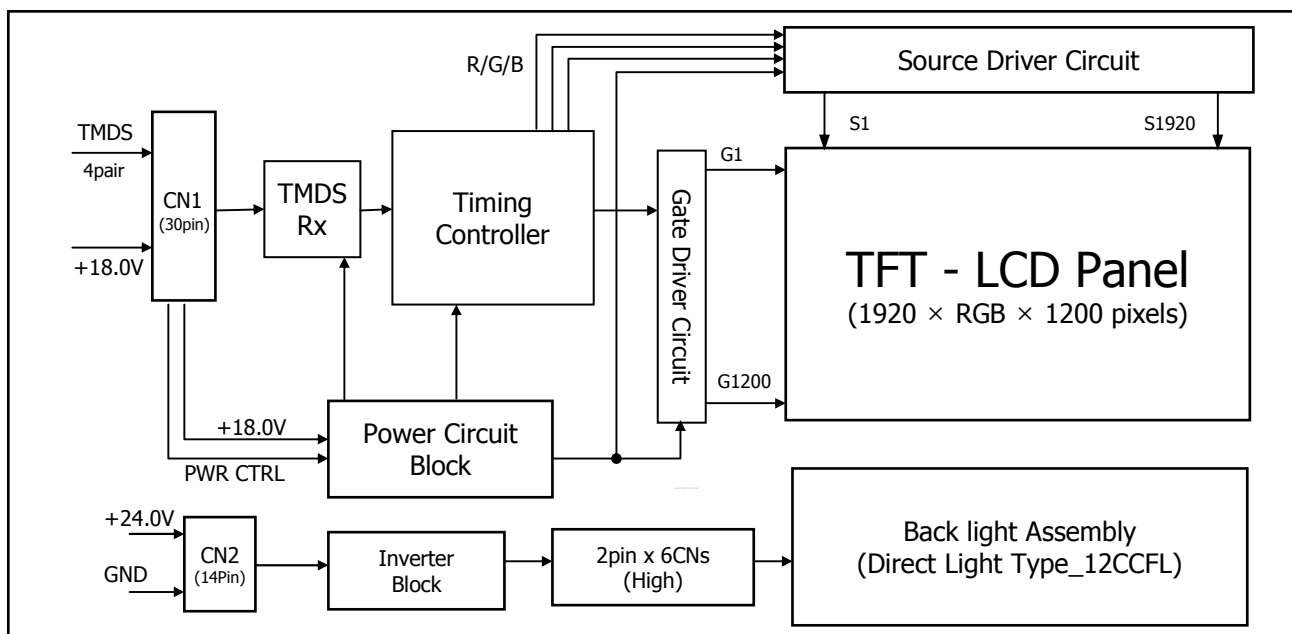
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## Product Specification

### 1. General Description

The LM230W02 LCD is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Lamp(CCFL) back light system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally black mode. This TFT-LCD has a 23.0 inch diagonally measured active display area with WUXGA resolution(1200 vertical by 1920 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 luminance of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,777,216 colors.

The LM230W02 has been designed to apply the TMDST<sup>TM</sup>(Transition Minimized Differential Signaling) interface.



### General Features

|                        |   |
|------------------------|---|
| Active Screen Size     | 23.0 inches(58.4cm) diagonal  |
| Outline Dimension      | 523.4(H) x 335.6(V) x 36.9(D) mm(Typ.)  |
| Pixel Pitch            | 0.258 mm x 0.258 mm   |
| Pixel Format           | 1920 horiz. By 1200 vert. Pixels RGB stripes arrangement                          |
| Color Depth            | 8-bit, 16,777,216 colors  |
| Luminance, White       | 300 cd/m <sup>2</sup> (5 points Avg.)   |
| Viewing Angle(CR>10)   | View Angle Free (R/L 176(Typ.), U/D 176(Typ.))                                    |
| Power Consumption      | Total 59.5 Watt (Typ.) (8.0 Watt @V <sub>LCD</sub> , 51.5 Watt @300cd/[LAMP=5mA]) |
| Weight                 | 2,790g(typ.)  |
| Display Operating Mode | Transmissive mode, normally black   |
| Surface Treatment      | Hard coating(3H), Anti-glare treatment of the front polarizer                     |

## Product Specification

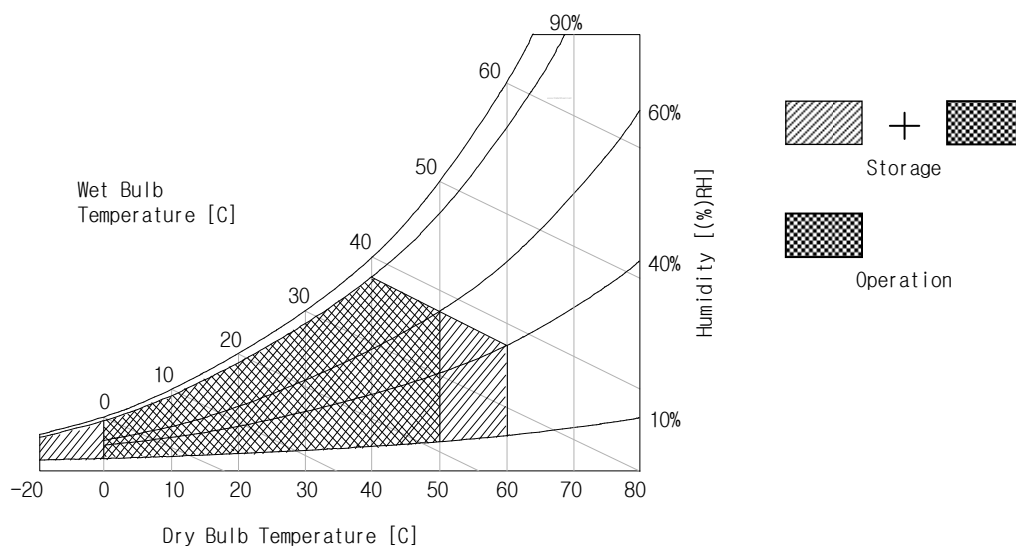
### 2. Absolute Maximum Ratings

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

**Table 1. ABSOLUTE MAXIMUM RATINGS**

| Parameter                  | Symbol           | Values |     | Units           | Notes       |
|----------------------------|------------------|--------|-----|-----------------|-------------|
|                            |                  | Min    | Max |                 |             |
| Power Input Voltage        | V <sub>LCD</sub> | -0.3   | 21  | V <sub>dc</sub> | at 25 ± 2°C |
| Operating Temperature      | T <sub>OP</sub>  | 0      | 50  | °C              | 1           |
| Storage Temperature        | T <sub>ST</sub>  | -20    | 60  | °C              |             |
| Operating Ambient Humidity | H <sub>OP</sub>  | 10     | 90  | %RH             |             |
| Storage Humidity           | H <sub>ST</sub>  | 10     | 90  | %RH             |             |

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.



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### 3. Electrical Specifications

#### 3-1. Electrical Characteristics

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

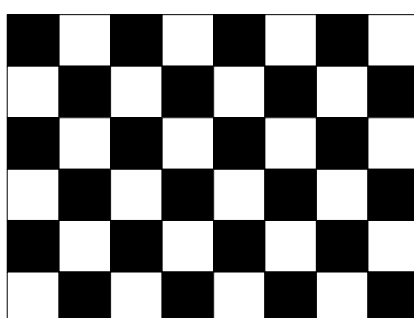
**Table 2-1. ELECTRICAL CHARACTERISTICS**

| Parameter                     | Symbol | Values |       |       | Unit  | Notes |
|-------------------------------|--------|--------|-------|-------|-------|-------|
|                               |        | Min    | Typ   | Max   |       |       |
| MODULE :                      |        |        |       |       |       |       |
| Power Supply Input Voltage    | VLCD   | 17.0   | 18.0  | 19.0  | Vdc   |       |
| Permissive Power Input Ripple | VdRF   |        |       | 400   | mVp-p |       |
| Power Supply Input Current    | ILCD   | -      | 0.445 | 0.510 | A     | 1     |
|                               |        | -      | 0.605 | 0.695 | A     | 2     |
| Power Consumption             | PLCD   | -      | 8.0   | 9.2   | Watt  | 1     |
| Rush current                  | IRUSH  | -      | -     | 3.0   | A     | 3     |

Note :

1. The specified current and power consumption are under the V<sub>LCD</sub>=18.0V, 25 ± 2°C, f<sub>V</sub>=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f<sub>V</sub> is the frame frequency.
2. The current is specified at the maximum current pattern.
3. The duration of rush current is about 2ms and rising time of power Input is 1ms(min.).

White : 255Gray  
 Black : 0Gray



Mosaic Pattern(8 x 6)

Maximum current pattern



White Pattern

# Product Specification

**Table 2-2. INVERTER ELECTRICAL CHARACTERISTICS**

| Parameter          | Symbol           | Condition              | Values |      |      | Unit | Notes |
|--------------------|------------------|------------------------|--------|------|------|------|-------|
|                    |                  |                        | Min.   | Typ. | Max. |      |       |
| <b>Inverter :</b>  |                  |                        |        |      |      |      |       |
| Input Voltage      | V <sub>DDB</sub> |                        | 22.0   | 24.0 | 26.0 | V    | 1     |
| Input Current      | I <sub>DDB</sub> | V <sub>BR</sub> = 3.3V | 1.8    | 2.15 | 2.5  | A    | 2     |
| Input Power        | PB               | V <sub>BR</sub> = 3.3V | 46.3   | 51.5 | 56.7 | Watt | 2     |
| B/L on/off control | VON/OFF          | Lamp ON = High         | 4.0    | -    | 5.0  | V    |       |
|                    |                  | Lamp OFF =Low          | 0.0    | -    | 0.8  | V    |       |
| Brightness Adj     | VBR              |                        | 0      | -    | 3.3  | V    |       |
| <b>LAMP :</b>      |                  |                        |        |      |      |      |       |
| Life time          |                  |                        | 50,000 |      |      | Hrs  | 3     |

Notes :

1. The input voltage ripple is limited below 400mVp-p.
2. The specified current and power consumption are under the typical supply Input voltage, 24V.
3. The life is determined as the time at which luminance of the lamp is 50% compared to that of initial value at the typical lamp current on condition of continuous operating at  $25 \pm 2^{\circ}C$ .
4. Electrical characteristics are determined after the unit has been 'ON' and stable for approximately 30min in a dark environment at  $25^{\circ}C \pm 2^{\circ}C$ .

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### 3-2. Interface Connections

This LCD employs Two interface connections, a 30 pin connector is used for the module electronics and a 14Pin Connector is used for the integral backlight system.

#### 3-2-1. LCD Module

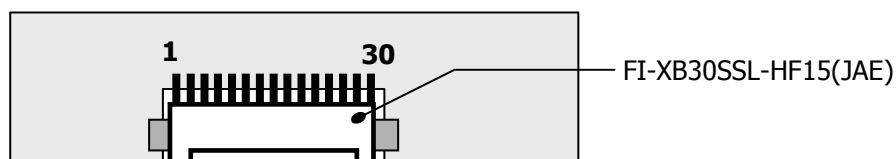
- LCD Connector(CN1):FI-XB30SL-HF10, FI-XB30SSL-HF15 (Manufactured by JAE) or Equivalent
- Mating Connector : FI-X30C2L (Manufactured by JAE) or Equivalent

**Table 3 MODULE CONNECTOR(CN1) PIN CONFIGURATION**

| No | Symbol | Description                        | No | Symbol           | Symbol   |
|----|--------|------------------------------------|----|------------------|--|
| 1  | GND    | Ground                             | 16 | OPEN             | NC   |
| 2  | SHLD2  | Shield for TMDS channel 2          | 17 | OPEN             | NC   |
| 3  | RX2+   | TMDS Differential Output(+) (CH 2) | 18 | OPEN             | NC   |
| 4  | RX2-   | TMDS Differential Output(-) (CH 2) | 19 | GND              | Ground   |
| 5  | SHLD1  | Shield for TMDS channel 1          | 20 | GND              | Ground   |
| 6  | RX1+   | TMDS Differential Output(+) (CH 1) | 21 | GND              | Ground   |
| 7  | RX1-   | TMDS Differential Output(-) (CH 1) | 22 | V <sub>LCD</sub> | Supply voltage for LCD                             |
| 8  | SHLD0  | Shield for TMDS channel 0          | 23 | V <sub>LCD</sub> | Supply voltage for LCD                             |
| 9  | RX0+   | TMDS Differential Output(+) (CH 0) | 24 | V <sub>LCD</sub> | Supply voltage for LCD                             |
| 10 | RX0-   | TMDS Differential Output(-) (CH 0) | 25 | PWR_ON           | Power ON control signal input<br>3.3V(H:90%,L:10%) |
| 11 | SHLDC  | Shield for TMDS channel C          | 26 | HS_OUT           | Hsync Output                                       |
| 12 | RXC+   | TMDS Differential Output(+) (CH C) | 27 | VS_OUT           | Vsync Output                                       |
| 13 | RXC-   | TMDS Differential Output(-) (CH C) | 28 | GND              | Ground   |
| 14 | GND    | Ground                             | 29 | OPEN             | DDC -Clk(HDCP) for future use                      |
| 15 | OPEN   | NC                                 | 30 | OPEN             | DDC -Data(HDCP) for future use                     |

- Notes: 1. All GND(ground) pins should be connected together and should also be connected to the LCD's metal frame.
2. All V<sub>LCD</sub>(power input) pins should be connected together.
3. Input Level of TMDS signal is based on the Digital Visual Interface (DVI 1.0) Standard.

#### Rear view of LCM





## Product Specification

### 3-2-2. Backlight Interface

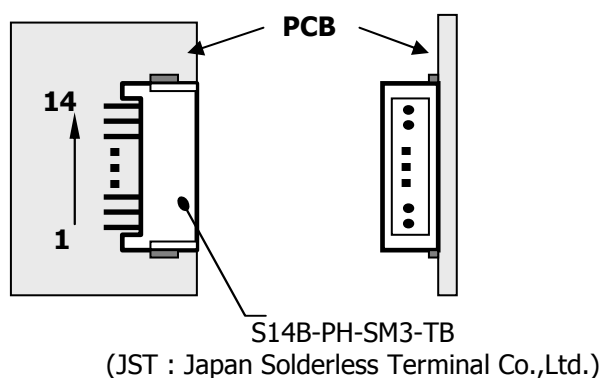
- Inverter Connector : S14B-PH-SM3 Side entry type (Manufactured by JST) or Equivalent
- Mating Connector : PHR-14(Manufactured by JST) or Equivalent

**Table 4. INVERTER CONNECTOR PIN CONFIGURATION**

| Pin No | Symbol          | Description                   | Remarks                     |
|--------|-----------------|-------------------------------|-----------------------------|
| 1      | V <sub>BL</sub> | Power Supply +24.0V           |                             |
| 2      | V <sub>BL</sub> | Power Supply +24.0V           |                             |
| 3      | V <sub>BL</sub> | Power Supply +24.0V           |                             |
| 4      | V <sub>BL</sub> | Power Supply +24.0V           |                             |
| 5      | V <sub>BL</sub> | Power Supply +24.0V           |                             |
| 6      | GND             | Power Ground                  | Note 1                      |
| 7      | GND             | Power Ground                  |                             |
| 8      | GND             | Power Ground                  |                             |
| 9      | GND             | Power Ground                  |                             |
| 10     | GND             | Power Ground                  |                             |
| 11     | OPEN            | NC                            |                             |
| 12     | V <sub>ON</sub> | Backlight On/off Signal       | (On :4.0V~5V/Off :0.0~0.8V) |
| 13     | V <sub>BR</sub> | Brightness Adjustable Voltage | (Max :3.3V / Min :0.0V)     |
| 14     | OPEN            | NC                            |                             |

Notes : 1. GND is connected to the LCD's metal frame.

#### Rear view of LCM



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### 3-3. Signal Timing Specifications

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

**Table 5. TIMING TABLE 1**

| ITEM        |                        | SYMBOL | Min  | Typ  | Max  | Unit | Note            |
|-------------|------------------------|--------|------|------|------|------|-----------------|
| DCLK        | Period                 | tCLK   | 6.49 | 6.41 | 6.33 | ns   |                 |
|             | Frequency              | fCLK   | 154  | 156  | 158  | MHz  |                 |
| Hsync       | Period                 | tHP    | 1984 | 2144 | -    | tCLK |                 |
|             | Width-Active           | tWH    | 32   | 32   | 32   |      |                 |
| Vsync       | Period                 | tVP    | 1206 | 1212 | -    | tHP  |                 |
|             | Frequency              | fV     | 56   | 60   | 64   | Hz   |                 |
|             | Width-Active           | tWV    | 2    | 3    | -    | tHP  |                 |
| Data Enable | Horizontal Valid       | tHV    | 1920 | 1920 | 1920 | tCLK |                 |
|             | Horizontal Back Porch  | tHBP   | 16   | 128  | -    |      |                 |
|             | Horizontal Front Porch | tHFP   | 16   | 64   | -    |      |                 |
|             | Horizontal Blank       | -      | 64   | 224  | -    |      | tWH+ tHBP+ tHFP |
|             | Vertical Valid         | tV     | 1200 | 1200 | 1200 | tHP  |                 |
|             | Vertical Back Porch    | tVBP   | 3    | 6    | -    |      |                 |
|             | Vertical Front Porch   | tVFP   | 1    | 3    | -    |      |                 |
|             | Vertical Blank         | -      | 6    | 12   | -    |      | tWV+ tVBP+ tVFP |

Note: Hsync period and Hsync width-active should be even number times of tCLK. If the value is odd number times of tCLK, display control signal can be asynchronous. In order to operate this LCM a Hsync, Vsyn, and DE(data enable) signals should be used.

1. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
2. Vsync and Hsync should be keep the above specification.
3. Hsync Period, Hsync Width, and Horizontal Back Porch should be any times of of character number(8).
4. The polarity of Hsync, Vsync is not restricted.

**Product Specification**
**Table 6. TIMING TABLE 2 (VESA COORDINATED VIDEO TIMING)**

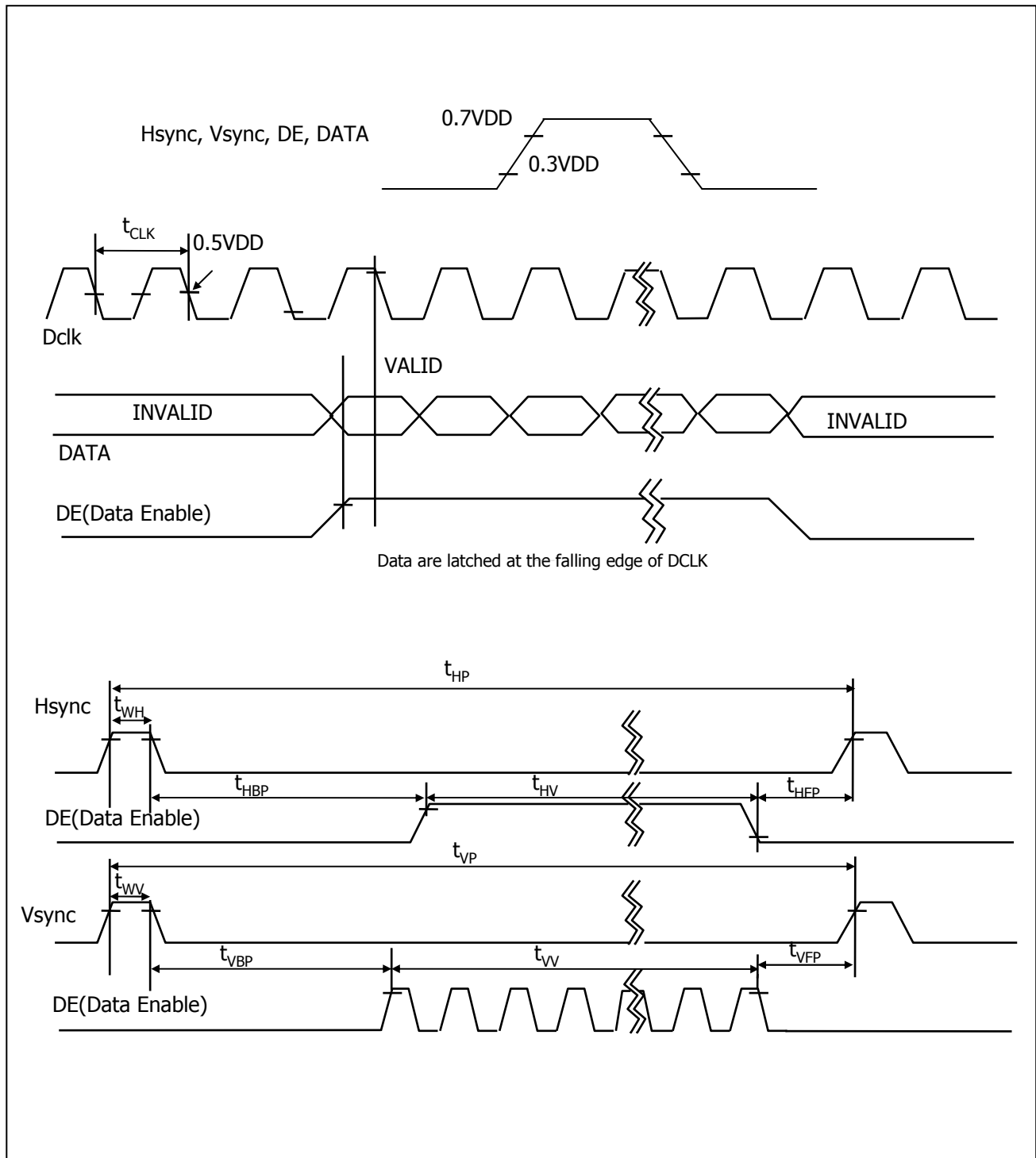
| ITEM        |                        | SYMBOL | Min  | Typ   | Max  | Unit | Note            |
|-------------|------------------------|--------|------|-------|------|------|-----------------|
| DCLK        | Period                 | tCLK   | 6.49 | 6.49  | 6.49 | ns   |                 |
|             | Frequency              | fCLK   | 154  | 154   | 154  | MHz  |                 |
| Hsync       | Period                 | tHP    | 2080 | 2080  | 2080 | tCLK |                 |
|             | Width-Active           | tWH    | 32   | 32    | 32   |      |                 |
| Vsync       | Period                 | tVP    | 1235 | 1235  | 1235 | tHP  |                 |
|             | Frequency              | fV     | -    | 59.95 | -    | Hz   |                 |
|             | Width-Active           | tWV    | -    | 6     | -    | tHP  |                 |
| Data Enable | Horizontal Valid       | tHV    | 1920 | 1920  | 1920 | tCLK |                 |
|             | Horizontal Back Porch  | tHBP   | -    | 80    | -    |      |                 |
|             | Horizontal Front Porch | tHFP   | -    | 48    | -    |      |                 |
|             | Horizontal Blank       | -      | -    | 160   | -    |      | tWH+ tHBP+ tHFP |
|             | Vertical Valid         | tVW    | 1200 | 1200  | 1200 | tHP  |                 |
|             | Vertical Back Porch    | tVBP   | -    | 26    | -    |      |                 |
|             | Vertical Front Porch   | tVFP   | -    | 3     | -    |      |                 |
|             | Vertical Blank         | -      | -    | 35    | -    |      | tWV+ tVBP+ tVFP |

Note: Hsync period and Hsync width-active should be even number times of tCLK. If the value is odd number times of tCLK, display control signal can be asynchronous. In order to operate this LCM a Hsync, Vsyn, and DE(data enable) signals should be used.

1. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
2. Vsync and Hsync should be keep the above specification.
3. Hsync Period, Hsync Width, and Horizontal Back Porch should be any times of of character number(8).
4. The polarity of Hsync, Vsync is not restricted.

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### 3-4. Signal Timing Waveforms



## Product Specification

### 3-5. Color Data Reference

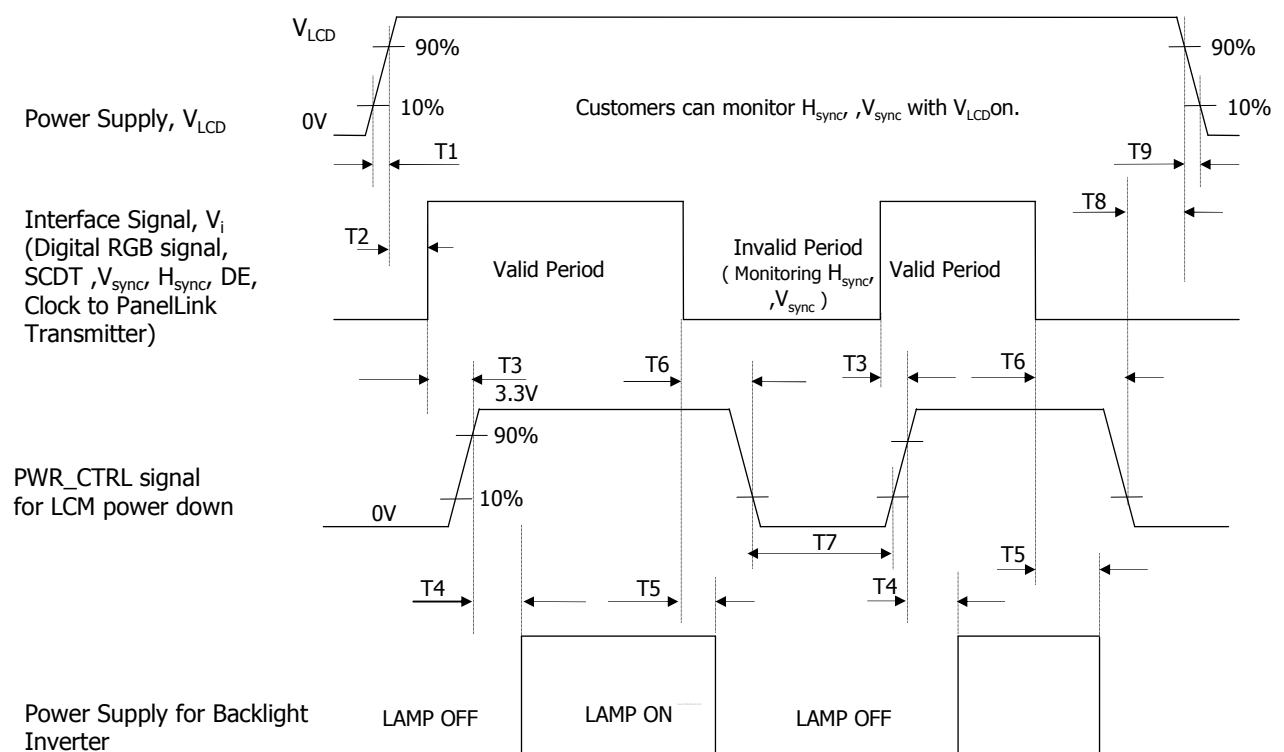
The Brightness of each primary color(red,green,blue) is based on the 8-bit gray scale data input for the color; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

**Table 7. COLOR DATA REFERENCE**

| Color       |                  | Input Color Data |    |    |    |     |    |    |    |       |    |    |    |     |    |    |    |
|-------------|------------------|------------------|----|----|----|-----|----|----|----|-------|----|----|----|-----|----|----|----|
|             |                  | RED              |    |    |    |     |    |    |    | GREEN |    |    |    |     |    |    |    |
|             |                  | 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 Color | Black            | 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  |
|             | Green (255)      | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1   | 1  | 1  | 1  |
|             | Blue (255)       | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  |
|             | Cyan             | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 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  |
|             | Yellow           | 1                | 1  | 1  | 1  | 1   | 1  | 1  | 1  | 1     | 1  | 1  | 1  | 1   | 1  | 1  | 1  |
|             | White            | 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  |
|             | RED (001)        | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 1  | 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  |
|             | RED (255)        | 1                | 1  | 1  | 1  | 1   | 1  | 1  | 1  | 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  |
|             | GREEN (001)      | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 1  | 0  |
|             | ...              | ...              |    |    |    |     |    |    |    | ...   |    |    |    |     |    |    |    |
|             | GREEN (254)      | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1   | 1  | 1  | 0  |
|             | GREEN (255)      | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1   | 1  | 1  | 1  |
| BLUE        | BLUE (000) Dark  | 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  | 1  |
|             | ...              | ...              |    |    |    |     |    |    |    | ...   |    |    |    |     |    |    |    |
|             | BLUE (254)       | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 1  | 1  |
|             | BLUE (255)       | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 1  | 1  |

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### 3-6. Power Sequence

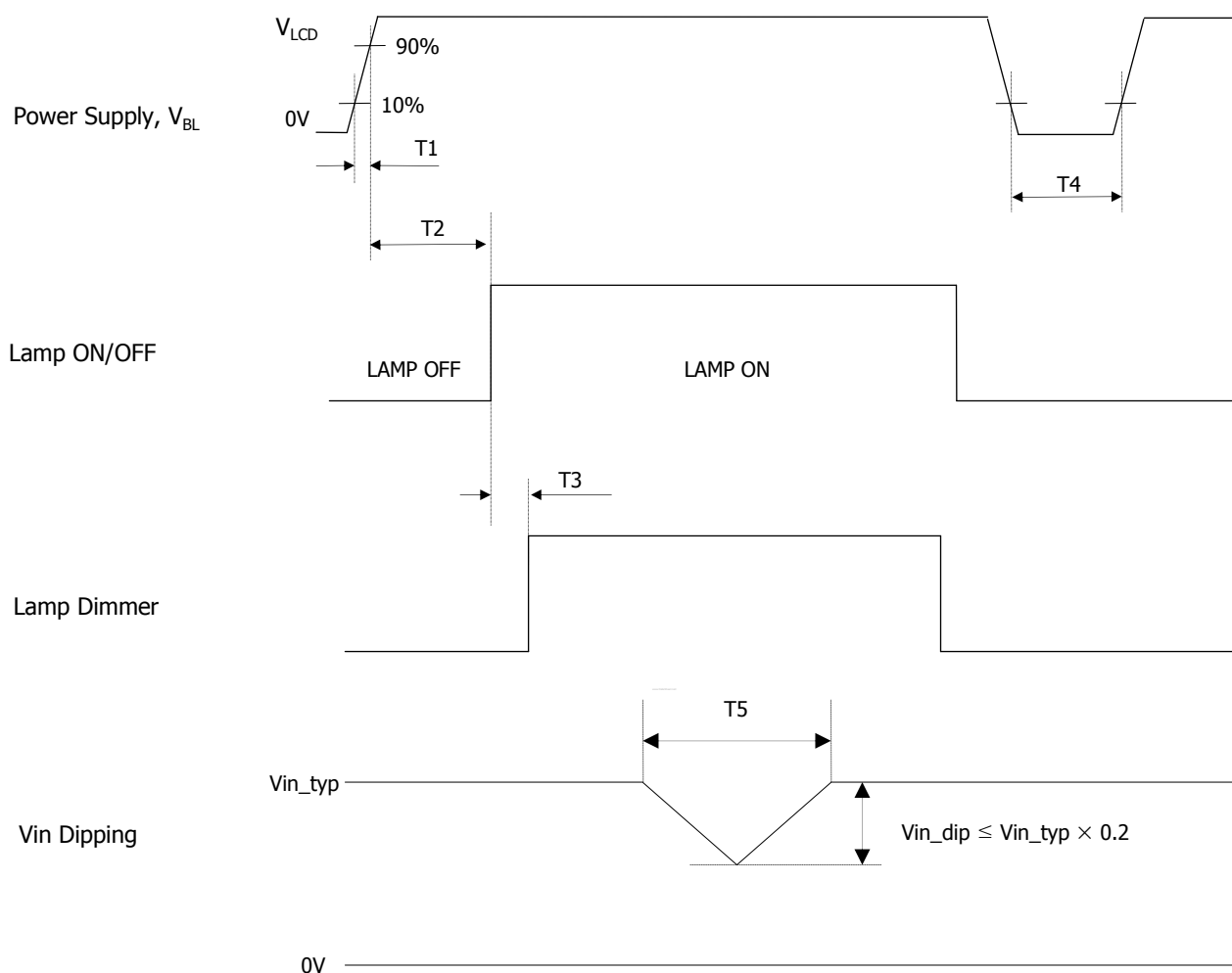

**Table 8. POWER SEQUENCE**

| Parameter | Values |     |     | Units |
|-----------|--------|-----|-----|-------|
|           | Min    | Typ | Max |       |
| T1        | -      | -   | 30  | ms    |
| T2        | -      | -   | -   | ms    |
| T3        | -      | -   | 300 | ms    |
| T4        | 100    | -   | -   | ms    |
| T5        | -      | -   | 80  | ms    |
| T6        | -      | -   | 80  | ms    |
| T7        | 400    | -   | -   | ms    |
| T8        | 50     | -   | -   |       |
| T9        | -      | -   | 10  |       |

- 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  $V_{LCD}$  to 0V.
  3. Lamp power must be turn on after power supply for LCD and interface signal are valid.

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### 3-7. Power Sequence for Inverter



**Table 9. POWER SEQUENCE**

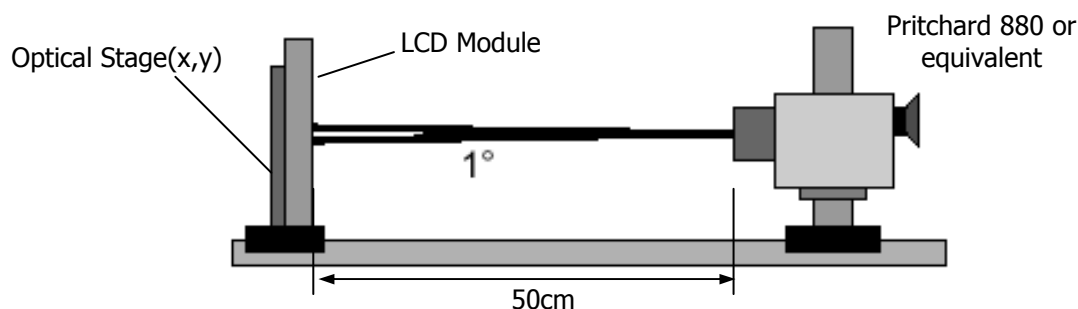
| Parameter | Values |     |     | Units |
|-----------|--------|-----|-----|-------|
|           | Min    | Typ | Max |       |
| T1        | 1      | -   | 30  | ms    |
| T2        | 200    | -   | -   | ms    |
| T3        | -      | -   | 50  | ms    |
| T4        | 500    | -   | -   | ms    |
| T5        | -      | -   | 10  | ms    |

## Product Specification

### 4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at  $25 \pm 2^\circ\text{C}$ . The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of  $\Phi$  and  $\theta$  equal to  $0^\circ$  and aperture 1 degree.

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



**FIG. 1 Optical Characteristic Measurement Equipment and Method**

**Table 10. OPTICAL CHARACTERISTICS** ( $T_a = 25^\circ\text{C}$ ,  $V_{\text{LCD}} = 18.0\text{V}$ ,  $f_v = 60\text{Hz}$ ,  $\text{Dclk} = 156\text{MHz}$ ,  $V_{\text{BR}} = 3.3\text{V}$ )

| Parameter                   |              | Symbol                   | Values       |       |              | Units           | Notes |
|-----------------------------|--------------|--------------------------|--------------|-------|--------------|-----------------|-------|
|                             |              |                          | Min          | Typ   | Max          |                 |       |
| Contrast Ratio              |              | CR                       | 300          | 400   |              |                 | 1     |
| Surface Luminance, white    |              | $L_{\text{WH}}$          | 250          | 300   |              | $\text{cd/m}^2$ | 2     |
| Luminance Variation         |              | $\delta_{\text{WHITE}}$  |              |       | 35           | %               | 3     |
| Response Time               | Rise Time    | $T_{\text{R}}$           | -            | 8.5   | 15           | ms              | 4     |
|                             | Decay Time   | $T_{\text{D}}$           | -            | 7.5   | 15           | ms              | 4     |
|                             | Gray to Gray | $T_{\text{GTG\_AVR}}$    | -            | 12    |              | ms              | 5     |
|                             |              | $T_{\text{GTG\_MAX}}$    | -            | 18    |              | ms              | 5     |
| Color Coordinates [CIE1931] | RED          | $R_x$                    | Typ<br>-0.03 | 0.640 | Typ<br>+0.03 |                 |       |
|                             |              | $R_y$                    |              | 0.332 |              |                 |       |
|                             | GREEN        | $G_x$                    |              | 0.288 |              |                 |       |
|                             |              | $G_y$                    |              | 0.601 |              |                 |       |
|                             | BLUE         | $B_x$                    |              | 0.146 |              |                 |       |
|                             |              | $B_y$                    |              | 0.065 |              |                 |       |
|                             | WHITE        | $W_x$                    |              | 0.313 |              |                 |       |
| Color Shift                 |              | $W_y$                    |              | 0.329 |              |                 |       |
|                             | Horizontal   | $\theta_{\text{CST\_H}}$ | -            | 176   | -            | Degree          | 6     |
|                             | Vertical     | $\theta_{\text{CST\_V}}$ | -            | 176   | -            |                 |       |
| Viewing Angle (CR>10)       |              |                          |              |       |              |                 |       |
| General                     | Horizontal   | $\theta_{\text{H}}$      | 170          | 176   | -            | Degree          | 7     |
|                             | Vertical     | $\theta_{\text{V}}$      | 170          | 176   | -            |                 |       |
| Effective                   | Horizontal   | $\theta_{\text{GMA\_H}}$ |              | 176   | -            | Degree          | 8     |
|                             | Vertical     | $\theta_{\text{GMA\_V}}$ |              | 176   | -            |                 |       |
| Gray Scale                  |              |                          |              | 2.2   |              |                 | 9     |



**Product Specification**

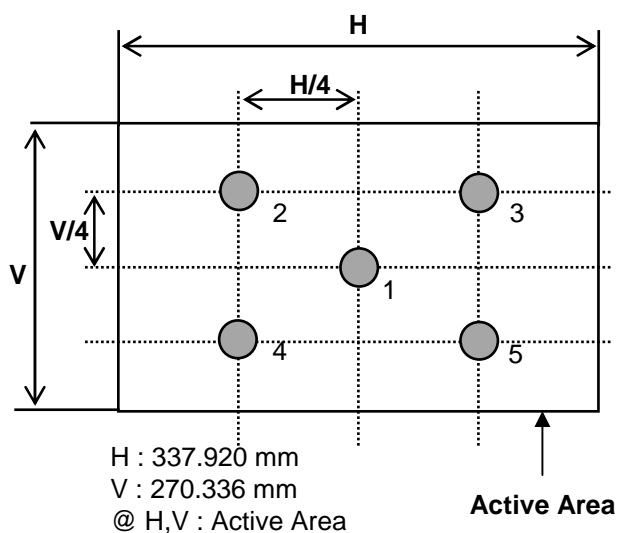
Notes 1. Contrast Ratio(CR) is defined mathematically as :

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

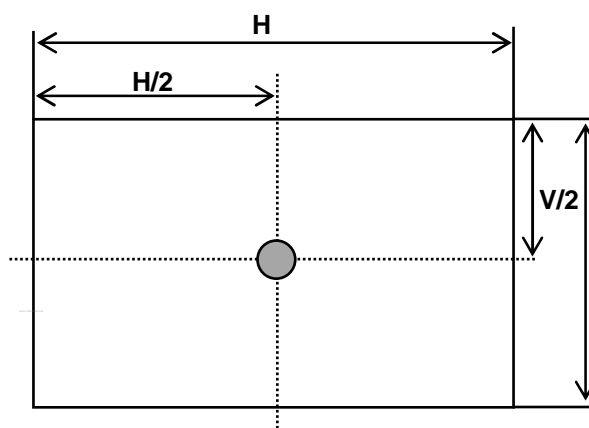
2. Surface luminance is the center point across the LCD surface 50cm from the surface with all pixels displaying white.

3. The variation in surface luminance ,  $\delta$  WHITE is defined as :

<Measuring point for luminance variation>

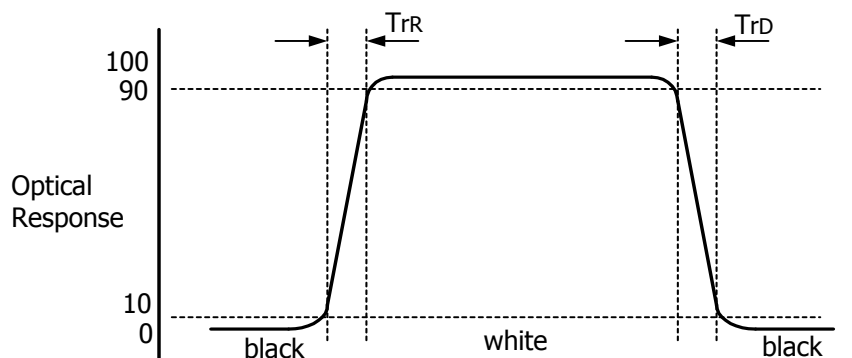


<Measuring point for surface luminance>



# Product Specification

4. The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white".  
 Response time is the time required for the display to transition from black to white (Rise Time,  $T_{rR}$ ) and from white to black (Decay Time,  $T_{rD}$ ).



**FIG. 3 Response Time**

5. The Gray to Gray response time is defined as the following figure and shall be measured by switching the input signal for "Gray To Gray".
- Gray step : 5 Step
  - $T_{GTG\_AVR}$  is the total average time at rising time and falling time for "Gray To Gray".
  - $T_{GTG\_MAX}$  is the max time at rising time or falling time for "Gray To Gray".

| Gray to Gray |      | Rising Time |      |      |     |    |
|--------------|------|-------------|------|------|-----|----|
|              |      | G255        | G191 | G127 | G63 | G0 |
| Falling Time | G255 |             |      |      |     |    |
|              | G191 |             |      |      |     |    |
|              | G127 |             |      |      |     |    |
|              | G63  |             |      |      |     |    |
|              | G0   |             |      |      |     |    |

## Product Specification

6. Color shift is the angle at which the color difference is lower than 0.04.

- Color difference ( $\Delta u'v'$ )

$$u' = \frac{4x}{-2x + 12y + 3}$$

$$v' = \frac{9y}{-2x + 12y + 3}$$

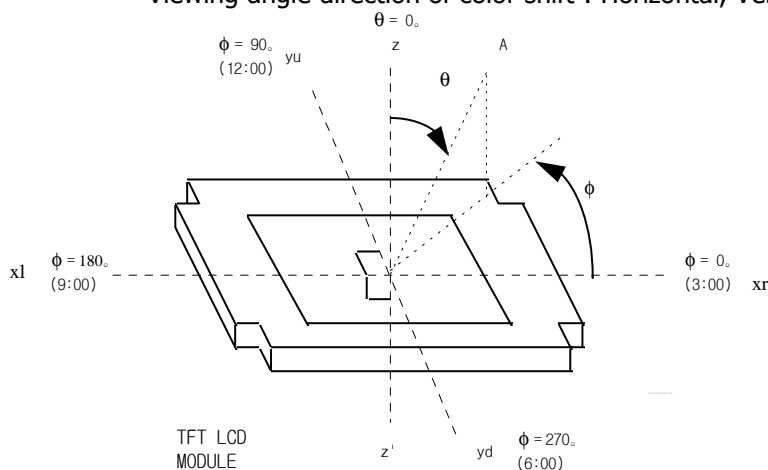
$$\Delta u'v' = \sqrt{(u'_1 - u'_2)^2 + (v'_1 - v'_2)^2}$$

$u'_1, v'_1$  :  $u'v'$  value at viewing angle direction

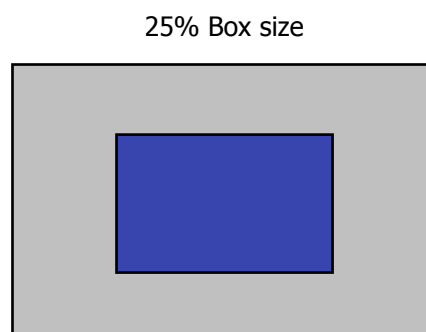
$u'_2, v'_2$  :  $u'v'$  value at front ( $\theta=0$ )

- Pattern size : 25% Box size

- Viewing angle direction of color shift : Horizontal, Vertical



**FIG. 4 Viewing angle direction**



**FIG. 5 Color shift test pattern**

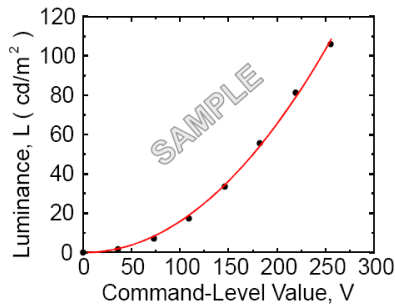
Average RGB values in Bruce RGB for Macbeth Chart

|   | Dark skin | Light skin    | Blue sky     | Foliage   | Blue flower  | Bluish green  |
|---|-----------|---------------|--------------|-----------|--------------|---------------|
| R | 98        | 206           | 85           | 77        | 129          | 114           |
| G | 56        | 142           | 112          | 102       | 118          | 199           |
| B | 45        | 123           | 161          | 46        | 185          | 178           |
|   | Orange    | Purplish blue | Moderate red | Purple    | Yellow green | Orange yellow |
| R | 219       | 56            | 211          | 76        | 160          | 230           |
| G | 104       | 69            | 67           | 39        | 193          | 162           |
| B | 24        | 174           | 87           | 86        | 58           | 29            |
|   | Blue      | Green         | Red          | Yellow    | Magenta      | cyan          |
| R | 26        | 72            | 197          | 241       | 207          | 35            |
| G | 32        | 148           | 27           | 212       | 62           | 126           |
| B | 145       | 65            | 37           | 36        | 151          | 172           |
|   | White     | Neutral 8     | Neutral 6.5  | Neutral 5 | Neutral 3.5  | black         |
| R | 240       | 206           | 155          | 110       | 63           | 22            |
| G | 240       | 206           | 155          | 110       | 63           | 22            |
| B | 240       | 206           | 155          | 110       | 63           | 22            |

Product Specification

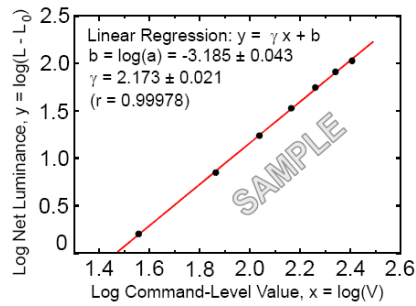
7. Viewing angle(general) is the angle at which the contrast ratio is greater than 10.

8. Effective viewing angle is the angle at which the gamma shift of gray scale is lower than 0.3.



**FIG. 6 Sample Luminance vs. gray scale (using a 256 bit gray scale)**

$$L = aV^r + L_b$$



**FIG. 7 Sample Log-log plot of luminance vs. gray scale**

$$\log(L - L_b) = r \log(V) + \log(a)$$

Here the Parameter  $\alpha$  and  $\gamma$  relate the signal level  $V$  to the luminance  $L$ .

The GAMMA we calculate from the log-log representation (FIG. 7)

9. Gray scale specification

Gamma Value is approximately 2.2. For more information see Table 10.

**Table 11. Gray Scale Specification**

| Gray Level | Relative Luminance [%] (Typ.) |
|------------|-------------------------------|
| 0          | 0.3                           |
| 31         | 1.2                           |
| 63         | 4.7                           |
| 95         | 11.7                          |
| 127        | 21.2                          |
| 159        | 35.2                          |
| 191        | 53.0                          |
| 223        | 75.4                          |
| 255        | 100                           |

10. TCO '03 item regarding display characteristic is satisfied.

## Product Specification

### 5. Mechanical Characteristics

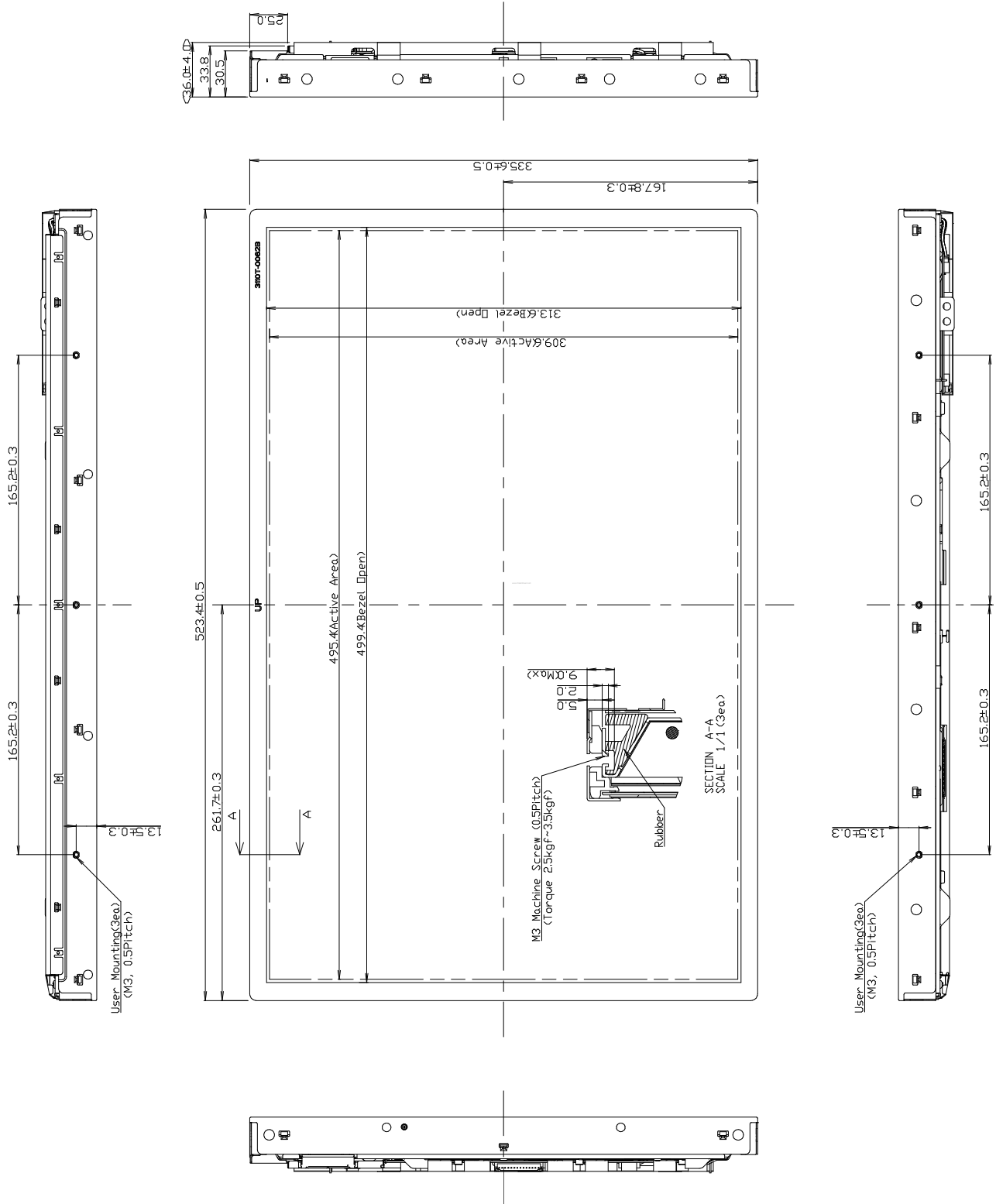
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

|                     |  |          |
|---------------------|--|----------|
| Outline Dimension   | Horizontal   | 523.4mm  |
|                     | Vertical   | 335.6mm  |
|                     | Depth  | 36.9mm   |
| Bezel Area          | Horizontal   | 499.4mm  |
|                     | Vertical   | 313.6mm  |
| Active Display Area | Horizontal   | 495.36mm |
|                     | Vertical   | 309.6mm  |
| Weight              | 2,790g (Typ.) / 2,930g (Max.)  |          |
| Surface Treatment   | Hard coating(3H)<br>Anti-glare(13%) treatment of the front polarizer |          |

Notes : Please refer to a mechanic drawing in terms of tolerance at the next page.

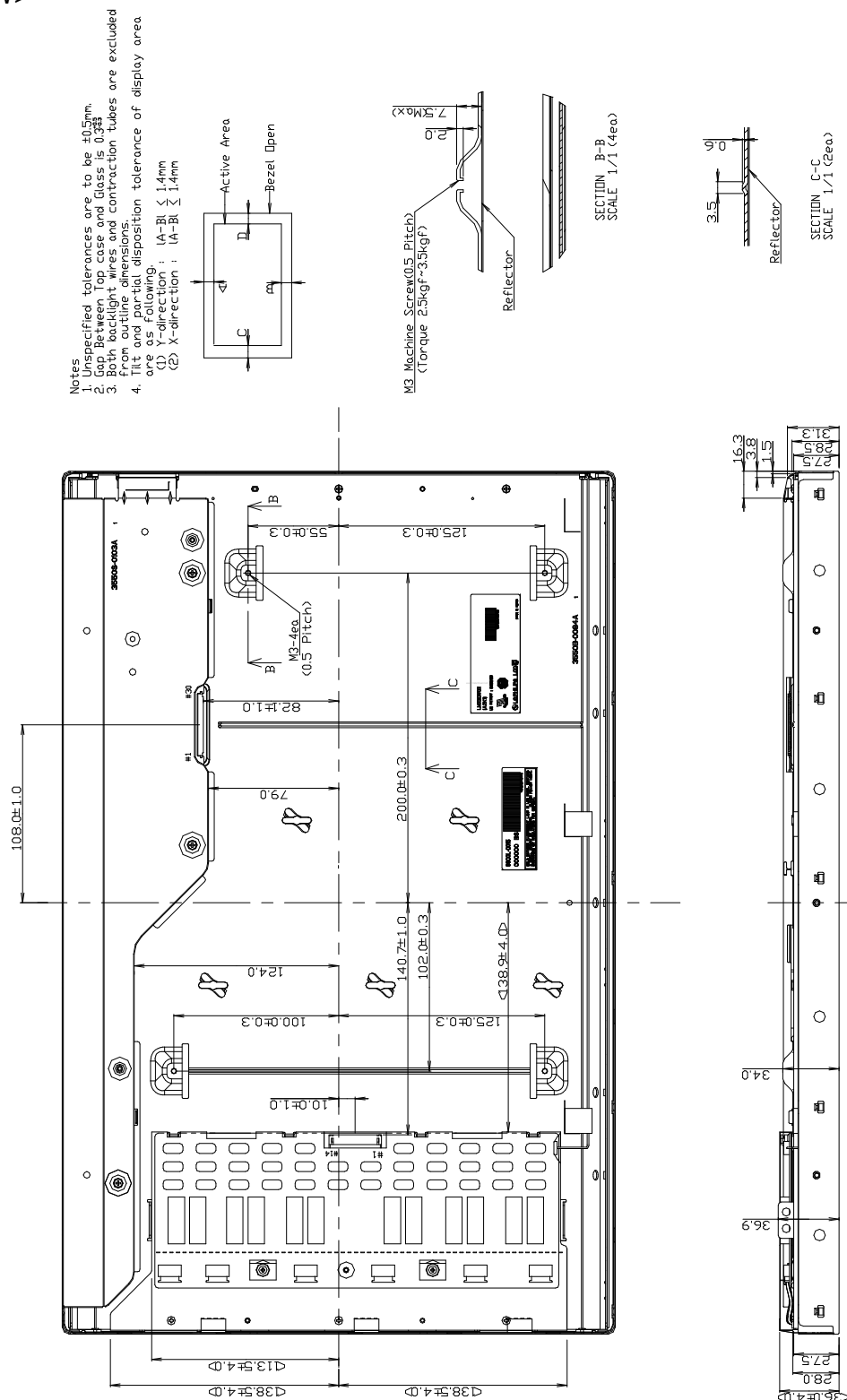
Product Specification

<FRONT VIEW>



## Product Specification

<REAR VIEW>



## Product Specification

### 6. Reliability

Environment test condition

| No | Test Item                                   | Condition   |
|----|---|---|
| 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, 10 min<br>One time each direction |
| 6  | Shock test<br>(non-operating)               | Shock level : 100G<br>Waveform : half sine wave, 2ms<br>Direction : $\pm X$ , $\pm Y$ , $\pm Z$<br>One time each direction      |
| 7  | Altitude<br>operating<br>storage / shipment | 0 - 10,000 feet(3048m)<br>0 - 40,000 feet(12,192m)  |



## Product Specification

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

- a) UL 60950, Third Edition, Underwriters Laboratories, Inc., Dated Dec. 11, 2000.  
Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment.
- b) CAN/CSA C22.2, No. 60950, Third Edition, Canadian Standards Association, Dec. 1, 2000.  
Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment.
- c) EN 60950 : 2000, Third Edition  
IEC 60950 : 1999, Third Edition  
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  
( Including A1: 2000 )

## 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(INCH)

D : YEAR

F : PANEL CODE

H : ASSEMBLY CODE

E : MONTH

G : FACTORY 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. PANEL CODE

|            |            |            |            |            |            |             |
|------------|------------|------------|------------|------------|------------|-------------|
| Panel Code | P1 Factory | P2 Factory | P3 Factory | P4 Factory | P5 Factory | Hydis Panel |
| Mark       | 1          | 2          | 3          | 4          | 5          | H           |

4. FACTORY CODE

|              |          |             |
|--------------|----------|-------------|
| Factory Code | LPL Gumi | LPL Nanjing |
| Mark         | K        | C           |

5. SERIAL NO.

|      |               |                              |
|------|---------------|------------------------------|
| Year | 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 : 4PCS

b) Box Size : 493 X 333 X 675

## Product Specification

**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 minimize the interference.
- (7) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
- (8) A screw which is fastened up the steels should be a machine screw.  
(if not, it causes metallic foreign material and deal LCM a fatal blow)
- (9) Please do not set LCD on its edge.

## 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 surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.