# SPECIFICATION
# FOR
# APPROVAL

( ) **Preliminary Specification**
( ◆ ) **Final Specification**

| Title | 15.5” Full HD TFT LCD |
|---|---|

| Customer | Sony |
|---|---|
| MODEL | |

| SUPPLIER | LG Display Co., Ltd. |
|---|---|
| *MODEL | LP156WF1 |
| Suffix | TLC1 |

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

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

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

| APPROVED BY | SIGNATURE |
|---|---|
| K. J. Kwon / S.Manager | |
| **REVIEWED BY** | |
| S. R. Kim / Manager | |
| **PREPARED BY** | |
| C. J. Park / Engineer | |

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

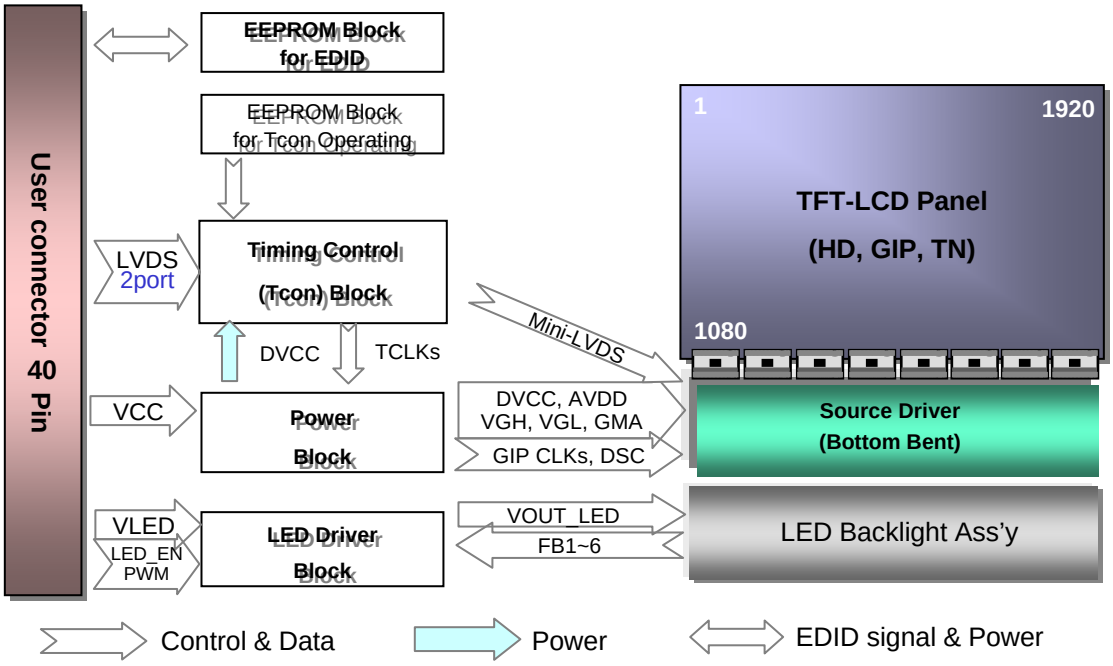
# Contents

## RECORD OF REVISIONS

| Revision No | Revision Date | Page | Description | EDID ver |
|---|---|---|---|---|
| 0.0 | Sep. 19. 2009 | - | First Draft (Preliminary Specification) | 0.0 |
| 0.1 | Oct. 1. 2009 | 6 | Correct LED Power Inrush Current 1.5→1500 | |
| | | 11-12 | Add Tentative Timing Table for 50Hz and 40Hz Refresh Rate | |
| 0.2 | Nov 2. 2009 | - | Active area size 15.6inch → 15.5inch | |
| 1.0 | Dec. 10, 2009 | - | Final Draft | 1.0 |

## 1. General Description

The LP156WF1 is a Color Active Matrix Liquid Crystal Display with an integral LED 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 15.5 inches diagonally measured active display area with FHD resolution (1920 horizontal by 1080 vertical pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 6-bit gray scale signal for each dot, thus, presenting a palette of more than 262,144 colors. The LP156WF1 has been designed to apply the interface method that enables low power, high speed, low EMI. The LP156WF1 is intended to support applications where thin thickness, low power are critical factors and graphic displays are important. In combination with the vertical arrangement of the sub-pixels, the LP156WF1 characteristics provide an excellent flat display for office automation products such as Notebook PC.




## General Features

| | |
|---|---|
| Active Screen Size | 15.5 inches diagonal |
| Outline Dimension | 359.3(H, typ.) × 209.5(V, typ.) × 5.7(D,max) [mm]] |
| Pixel Pitch | 0.17925 mm x 0.17925 mm |
| Pixel Format | 1920 horiz. By 1080 vert. Pixels RGB strip arrangement |
| Color Depth | 6-bit, 262,144 colors |
| Luminance, White | 220 cd/m$^2$(Typ.5 point) |
| Power Consumption | Total 6.94 Watt(Typ.) @ LCM circuit 1.74 Watt (Typ.), B/L input 5.2 Watt (Typ.) |
| Weight | 470g ( Max.) / 450g ( Typ.) |
| Display Operating Mode | Transmissive mode, normally white |
| Surface Treatment | Hard Coating(3H), Glare treatment of the front polarizer |
| RoHS Compliance | Yes |
| BFR / PVC / As Free | Yes for all |

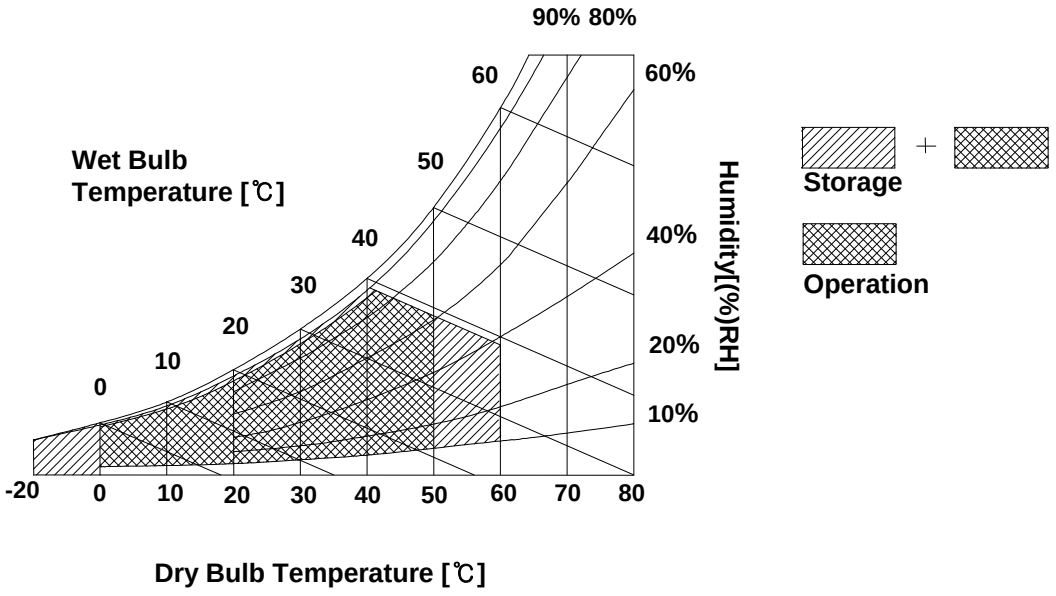
## 2. Absolute Maximum Ratings

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

**Table 1. ABSOLUTE MAXIMUM RATINGS**

| Parameter | Symbol | Values | | Units | Notes |
|---|---|---|---|---|---|
| | | Min | Max | | |
| Power Input Voltage | VCC | -0.3 | 4.0 | Vdc | at 25 ± 5°C |
| Operating Temperature | TOP | 0 | 50 | °C | 1 |
| Storage Temperature | HST | -20 | 60 | °C | 1 |
| Operating Ambient Humidity | HOP | 10 | 90 | %RH | 1 |
| Storage Humidity | HST | 10 | 90 | %RH | 1 |

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



## 3. Electrical Specifications

## 3-1. Electrical Characteristics

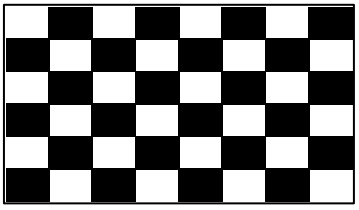
The LP156WF1 requires two power inputs. The first logic is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second backlight is the input about LED BL with LED Driver.

**Table 2. ELECTRICAL CHARACTERISTICS**

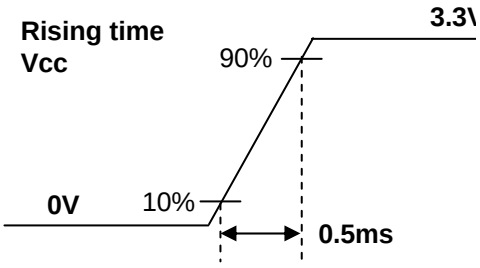
| Parameter | | Symbol | Values | | | Unit | Notes |
|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | | |
| LOGIC : | | | | | | | |
| Power Supply Input Voltage | | $V_{CC}$ | 3.0 | 3.3 | 3.6 | V | 1 |
| Power Supply Input Current | Mosaic | $I_{CC}$ | - | 530 | 610 | mA | 2 |
| Power Consumption | | $P_{CC}$ | - | 1.74 | 2.0 | W | 2 |
| Power Supply Inrush Current | | $I_{CC\_P}$ | - | - | 1500 | mA | 3 |
| LVDS Impedance | | $Z_{LVDS}$ | 90 | 100 | 110 | Ω | 4 |
| BACKLIGHT : ( with LED Driver) | | | | | | | |
| LED Power Input Voltage | | $V_{LED}$ | 7.0 | 12.0 | 21.0 | V | 5 |
| LED Power Input Current | | $I_{LED}$ | - | 433 | 500 | mA | 6 |
| LED Power Consumption | | $P_{LED}$ | - | 5.2 | 6.0 | W | 6 |
| LED Power Inrush Current | | $I_{LED\_P}$ | - | - | 1500 | mA | 7 |
| PWM Duty Ratio | | | 5 | - | 100 | % | 8 |
| PWM Jitter | | - | 0 | - | 0.2 | % | 9 |
| PWM Impedance | | $Z_{PWM}$ | 20 | 40 | 60 | kΩ | |
| PWM Frequency | | $F_{PWM}$ | 200 | - | 1000 | Hz | 10 |
| PWM High Level Voltage | | $V_{PWM\_H}$ | 3.0 | - | 5.3 | V | |
| PWM Low Level Voltage | | $V_{PWM\_L}$ | 0 | - | 0.3 | V | |
| LED_EN Impedance | | $Z_{PWM}$ | 20 | 40 | 60 | kΩ | |
| LED_EN High Voltage | | $V_{LED\_EN\_H}$ | 3.0 | - | 5.3 | V | |
| LED_EN Low Voltage | | $V_{LED\_EN\_L}$ | 0 | - | 0.3 | V | |
| Life Time | | | 12,000 | - | - | Hrs | 11 |

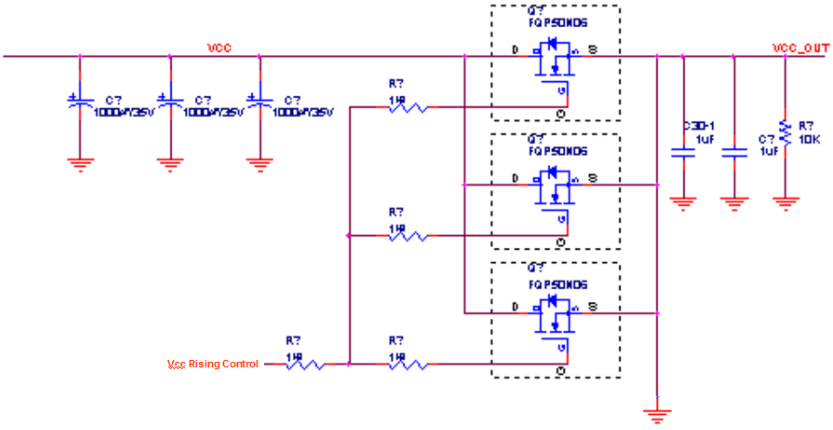
Note)

1. The measuring position is the connector of LCM and the test conditions are under 25℃, fv = 60Hz, Black pattern.
2. The specified Icc current and power consumption are under the Vcc = 3.3V , 25℃, fv = 60Hz condition and Mosaic pattern.

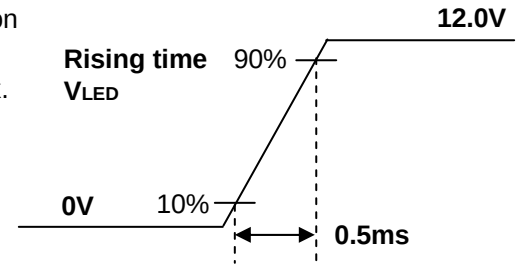


3. This Spec. is the max load condition for the cable impedance designing.
4. The below figures are the measuring Vcc condition and the Vcc control block LGD used. The Vcc condition is same as the minimum of T1 at Power on sequence.




5. This impedance value is needed for proper display and measured form LVDS Tx to the mating connector.
6. The measuring position is the connector of LCM and the test conditions are under 25℃.
7. The current and power consumption with LED Driver are under the Vled = 12.0V , 25℃, Dimming of Max luminance and White pattern with the normal frame frequency operated(60Hz).
8. The below figures are the measuring Vled condition and the Vled control block LGD used. VLED control block is same with Vcc control block.

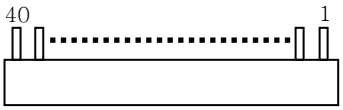



9. The operation of LED Driver below minimum dimming ratio may cause flickering or reliability issue.
10. If Jitter of PWM is bigger than maximum, it may induce flickering.
11. This Spec. is not effective at 100% dimming ratio as an exception because it has DC level equivalent to 0Hz. In spite of acceptable range as defined, the PWM Frequency should be fixed and stable for more consistent brightness control at any specific level desired.
12. The life time is determined as the time at which brightness of LCD is 50% compare to that of minimum value specified in table 7. under general user condition.

## 3-2. Interface Connections

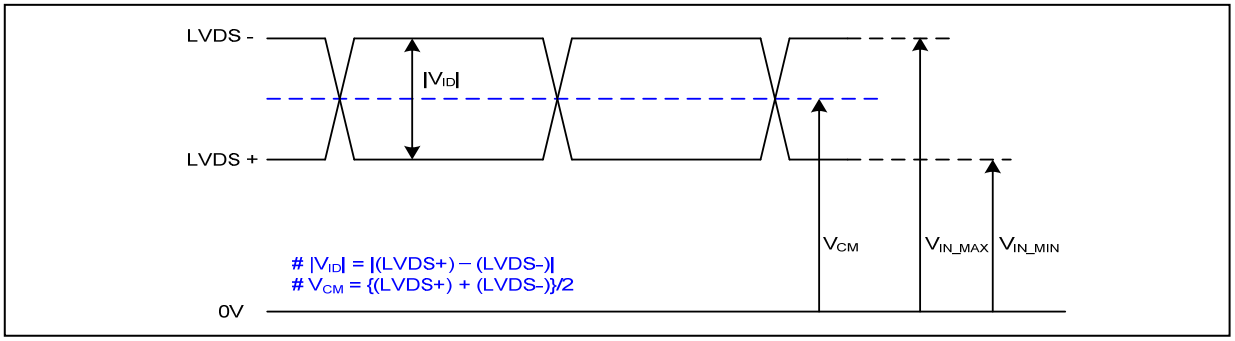
This LCD employs two interface connections, a 40 pin connector used for the module electronics interface and the other connector used for the integral backlight system.

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

| Pin | Symbol | Description | Notes |
|---|---|---|---|
| 1 | Test Loop | Test loop to 34pin | **[Interface Chip]**<br>1. LCD :<br>SiW, ST2_BS(LCD Controller)<br>Including LVDS Receiver.<br>2. System : SiW LVDSRx or equivalent<br>* Pin to Pin compatible with LVDS<br><br>**[Connector]**<br>20455-040E-0x, I-PEX or its compatibles<br><br>**[Mating Connector]**<br>20345-#40E-## series or equivalent<br><br>**[Connector pin arrangement]**<br><br>  <br><br>[LCD Module Rear View] |
| 2 | VCC | LCD Logic and driver power (3.3V Typ.) | |
| 3 | VCC | LCD Logic and driver power (3.3V Typ.) | |
| 4 | V EEDID | DDC Power (3.3V) | |
| 5 | Bist | LCD Panel Self Test Enable | |
| 6 | Clk EEDID | DDC Clock | |
| 7 | DATA EEDID | DDC Data | |
| 8 | ORX0- | Negative LVDS differential data input | |
| 9 | ORX0+ | Positive LVDS differential data input | |
| 10 | GND | High Speed Ground | |
| 11 | ORX1- | Negative LVDS differential data input | |
| 12 | ORX1+ | Positive LVDS differential data input | |
| 13 | GND | High Speed Ground | |
| 14 | ORX2- | Negative LVDS differential data input | |
| 15 | ORX2+ | Positive LVDS differential data input | |
| 16 | GND | High Speed Ground | |
| 17 | ORXC- | Negative LVDS differential clock input | |
| 18 | ORXC+ | Positive LVDS differential clock input | |
| 19 | GND | High Speed Ground | |
| 20 | ERX0- | Negative LVDS differential data input | |
| 21 | ERX0+ | Positive LVDS differential data input | |
| 19 | GND | High Speed Ground | |
| 23 | ERX1- | Negative LVDS differential data input | |
| 24 | ERX1+ | Positive LVDS differential data input | |
| 19 | GND | High Speed Ground | |
| 26 | ERX2- | Negative LVDS differential data input | |
| 27 | ERX2+ | Positive LVDS differential data input | |
| 19 | GND | High Speed Ground | |
| 29 | ERXC- | Negative LVDS differential clock input | |
| 30 | ERXC+ | Positive LVDS differential clock input | |
| 31 | GND | LED Backlight Ground | |
| 32 | GND | LED Backlight Ground | |
| 33 | GND | LED Backlight Ground | |
| 34 | Test Loop | Test loop to 1pin | |
| 35 | PWM | System PWM Signal input for dimming | |
| 36 | LED_EN | LED Backlight On/Off | |
| 37 | NC | No Connection | |
| 38 | VLED | LED Backlight Power (7V-21V) | |
| 39 | VLED | LED Backlight Power (7V-21V) | |
| 40 | VLED | LED Backlight Power (7V-21V) | |

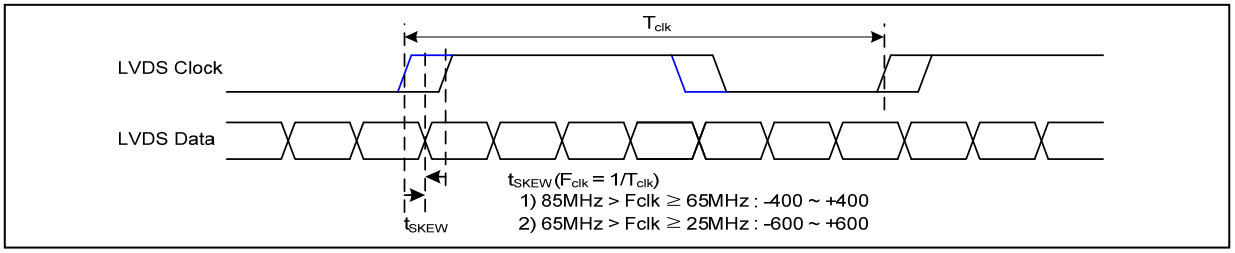
## 3-3. LVDS Signal Timing Specifications

### 3-3-1. DC Specification

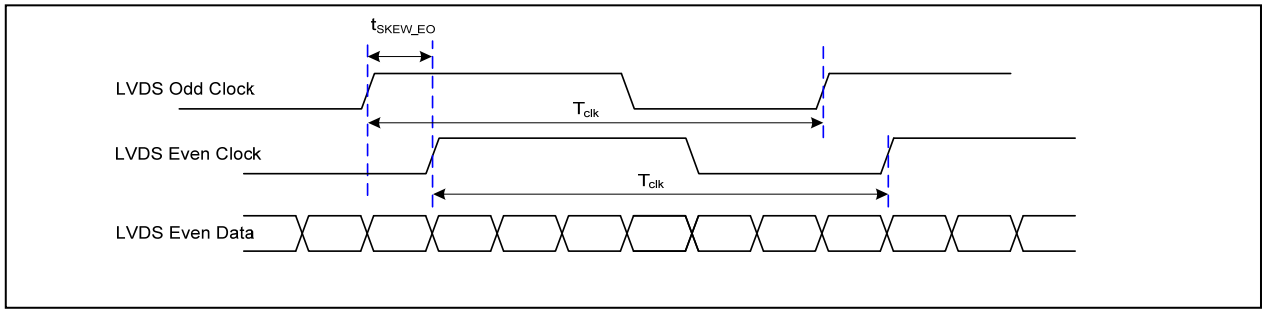



| Description | Symbol | Min | Max | Unit | Notes |
|---|---|---|---|---|---|
| LVDS Differential Voltage | $\|V_{ID}\|$ | 100 | 600 | mV | - |
| LVDS Common mode Voltage | $V_{CM}$ | 0.6 | 1.8 | V | - |
| LVDS Input Voltage Range | $V_{IN}$ | 0.3 | 2.1 | V | - |

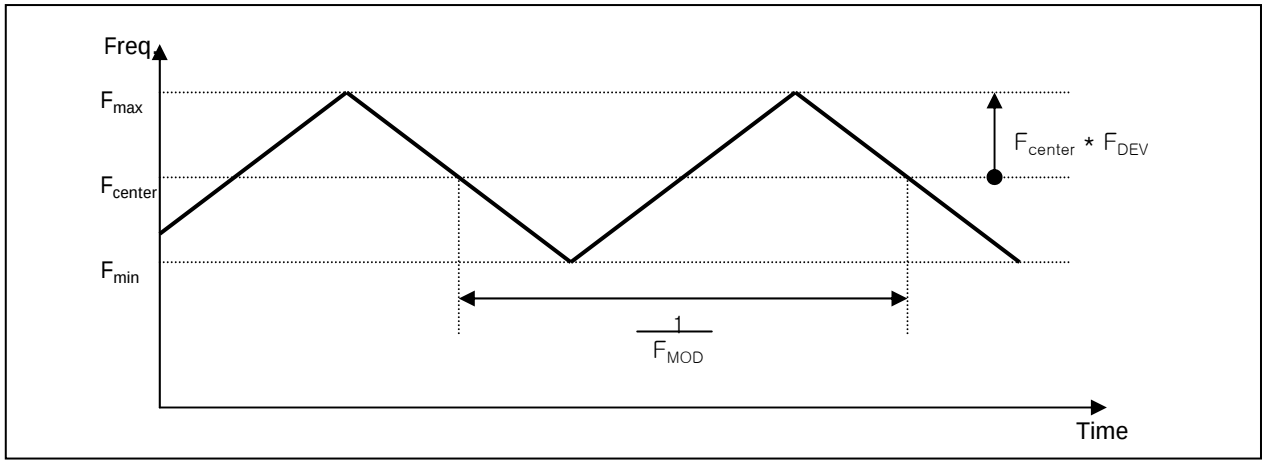
### 3-3-2. AC Specification




| Description | Symbol | Min | Max | Unit | Notes |
|---|---|---|---|---|---|
| LVDS Clock to Data Skew Margin | $t_{SKEW}$ | - 400 | + 400 | ps | 85MHz > Fclk ≥ 65MHz |
| | $t_{SKEW}$ | - 600 | + 600 | ps | 65MHz > Fclk ≥ 25MHz |
| LVDS Clock to Clock Skew Margin (Even to Odd) | $t_{SKEW\_EO}$ | - 1/7 | + 1/7 | $T_{clk}$ | - |
| Maximum deviation of input clock frequency during SSC | $F_{DEV}$ | - | ± 3 | % | - |
| Maximum modulation frequency of input clock during SSC | $F_{MOD}$ | - | 200 | KHz | - |



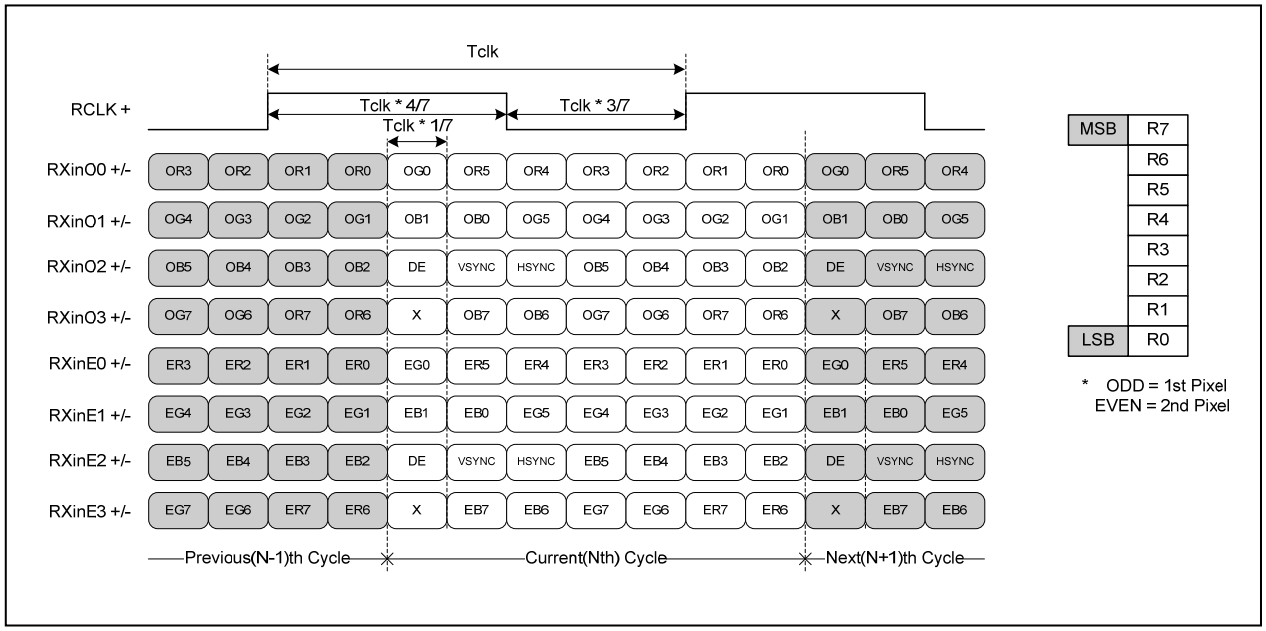

< Clock skew margin between channel >




< Spread Spectrum >

## 3-3-3. Data Format

1) LVDS 2 Port




< LVDS Data Format >

## 3-4. Signal Timing Specifications

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

**Table 6. TIMING TABLE**

| ITEM | Symbol | | Min | Typ | Max | Unit | Note |
|---|---|---|---|---|---|---|---|
| DCLK | Frequency | $f_{CLK}$ | 66.4 | 69.25 | 72.6 | MHz | LVDS 2 port ( 60Hz ) |
| Hsync | Period | $t_{HP}$ | 1010 | 1040 | 1078 | tCLK | |
| | Width | $t_{WH}$ | 16 | 16 | 16 | | |
| | Width-Active | $t_{WHA}$ | 960 | 960 | 960 | | |
| Vsync | Period | $t_{VP}$ | 1096 | 1111 | 1122 | tHP | |
| | Width | $t_{WV}$ | 5 | 5 | 5 | | |
| | Width-Active | $t_{WVA}$ | 1080 | 1080 | 1080 | | |
| Data Enable | Horizontal back porch | $t_{HBP}$ | 24 | 40 | 50 | tCLK | |
| | Horizontal front porch | $t_{HFP}$ | 10 | 24 | 52 | | |
| | Vertical back porch | $t_{VBP}$ | 10 | 23 | 28 | tHP | |
| | Vertical front porch | $t_{VFP}$ | 1 | 3 | 9 | | |

## * Tentative Timing Table for 50Hz Refresh Rate (Note 1)

| ITEM | Symbol | | Min | Typ | Max | Unit | Note |
|---|---|---|---|---|---|---|---|
| DCLK | Frequency | $f_{CLK}$ | 66.4 | 69.25 | 72.6 | MHz | LVDS 2 port ( 50Hz ) |
| Hsync | Period | $t_{HP}$ | 1152 | 1186 | 1226 | tCLK | |
| | Width | $t_{WH}$ | 16 | 16 | 16 | | |
| | Width-Active | $t_{WHA}$ | 960 | 960 | 960 | | |
| Vsync | Period | $t_{VP}$ | 1153 | 1168 | 1184 | tHP | |
| | Width | $t_{WV}$ | 5 | 5 | 5 | | |
| | Width-Active | $t_{WVA}$ | 1080 | 1080 | 1080 | | |
| Data Enable | Horizontal back porch | $t_{HBP}$ | 152 | 186 | 226 | tCLK | |
| | Horizontal front porch | $t_{HFP}$ | 24 | 24 | 24 | | |
| | Vertical back porch | $t_{VBP}$ | 65 | 80 | 96 | tHP | |
| | Vertical front porch | $t_{VFP}$ | 3 | 3 | 3 | | |

Note 1. Slow refresh rate, under 60Hz could not be guaranteed about flickering and some noise on screen.

## * Tentative Timing Table for 40Hz Refresh Rate (Note 1)

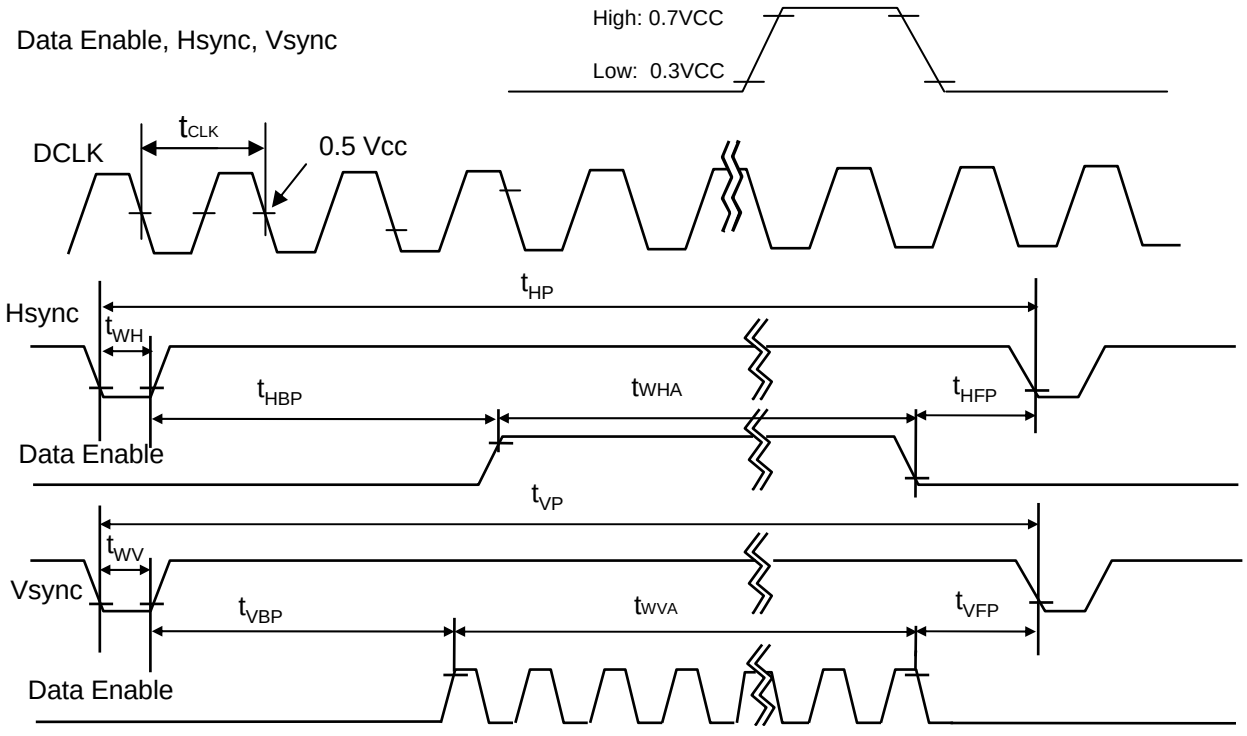
| ITEM | Symbol | | Min | Typ | Max | Unit | Note |
|---|---|---|---|---|---|---|---|
| DCLK | Frequency | $f_{CLK}$ | 66.4 | 69.25 | 72.6 | MHz | LVDS 2 port ( 40Hz ) |
| Hsync | Period | $t_{HP}$ | 1320 | 1361 | 1406 | tCLK | |
| | Width | $t_{WH}$ | 16 | 16 | 16 | | |
| | Width-Active | $t_{WHA}$ | 960 | 960 | 960 | | |
| Vsync | Period | $t_{VP}$ | 1257 | 1272 | 1291 | tHP | |
| | Width | $t_{WV}$ | 5 | 5 | 5 | | |
| | Width-Active | $t_{WVA}$ | 1080 | 1080 | 1080 | | |
| Data Enable | Horizontal back porch | $t_{HBP}$ | 320 | 361 | 406 | tCLK | |
| | Horizontal front porch | $t_{HFP}$ | 24 | 24 | 24 | | |
| | Vertical back porch | $t_{VBP}$ | 169 | 184 | 203 | tHP | |
| | Vertical front porch | $t_{VFP}$ | 3 | 3 | 3 | | |

Note 1. Slow refresh rate, under 60Hz could not be guaranteed about flickering and some noise on screen.

## 3-5. Signal Timing Waveforms

Condition : VCC =3.3V

Data Enable, Hsync, Vsync



## 3-6. Color Input Data Reference

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

**Table 7. COLOR DATA REFERENCE**

| Color | | Input Color Data | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RED | | | | | | GREEN | | | | | | BLUE | | | | | |
| | | MSB | | | | | LSB | MSB | | | | | LSB | MSB | | | | | LSB |
| | | R 5 | R 4 | R 3 | R 2 | R 1 | R 0 | G 5 | G 4 | G 3 | G 2 | G 1 | G 0 | B 5 | B 4 | B 3 | B 2 | B 1 | B 0 |
| Basic Color | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Blue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Cyan | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Magenta | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Yellow | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | White | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| RED | RED (00) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | RED (01) | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | … | | | … | | | | | | … | | | | | | … | | | |
| | RED (62) | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | RED (63) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GREEN | GREEN (00) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GREEN (01) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | ... | | | ... | | | | | | ... | | | | | | ... | | | |
| | GREEN (62) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GREEN (63) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| BLUE | BLUE (00) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | BLUE (01) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | … | | | … | | | | | | … | | | | | | … | | | |
| | BLUE (62) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| | BLUE (63) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |

## 3-7. Power Sequence

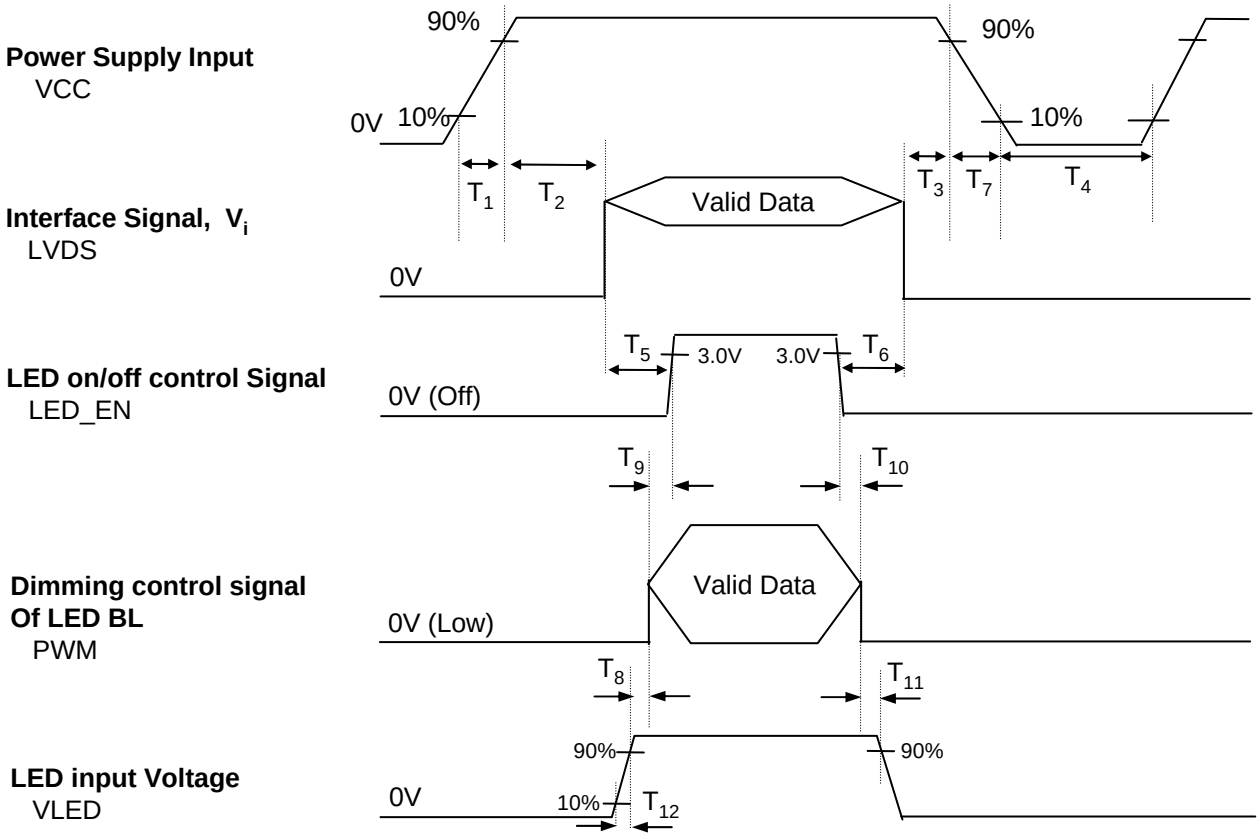



**Table 6. POWER SEQUENCE TABLE**

| Logic Parameter | Value | | | Units |
|---|---|---|---|---|
| | Min. | Typ. | Max. | |
| $T_1$ | 0.5 | - | 10 | ms |
| $T_2$ | 0 | - | 50 | ms |
| $T_3$ | 0 | - | 50 | ms |
| $T_4$ | 400 | - | - | ms |
| $T_5$ | 200 | - | - | ms |
| $T_6$ | 200 | - | - | ms |
| $T_7$ | 3 | - | 10 | ms |

| LED Parameter | Value | | | Units |
|---|---|---|---|---|
| | Min. | Typ. | Max. | |
| $T_8$ | 10 | - | - | ms |
| $T_9$ | 0 | - | - | ms |
| $T_{10}$ | 0 | - | - | ms |
| $T_{11}$ | 10 | - | - | ms |
| $T_{12}$ | 0.5 | - | - | ms |
| | | | | |
| | | | | |

Note)
1. Do not insert the mating cable when system turn on.
2. Valid Data have to meet "3-3. LVDS Signal Timing Specifications"
3. LVDS, LED_EN and PWM need to be on pull-down condition on invalid status.
4. LGD recommend the rising sequence of VLED after the Vcc and valid status of LVDS turn on.

## 4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' and stable for approximately 30 minutes in a dark environment at 25°C. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and Θ equal to 0°.
FIG. 1 presents additional information concerning the measurement equipment and method.

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

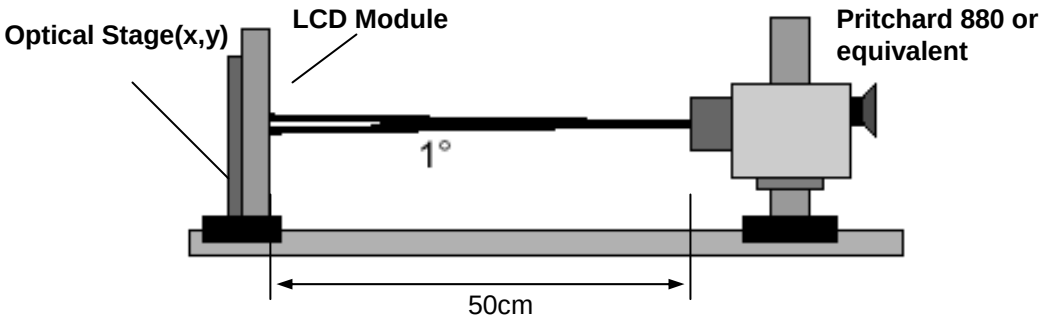



**Table 9. OPTICAL CHARACTERISTICS**

Ta=25°C, VCC=3.3V, fv=60Hz, $f_{CLK}$= 69.25MHz, $I_{LED}$= 20mA(typ)

| Parameter | Symbol | Values | | | Units | Notes |
|---|---|---|---|---|---|---|
| | | Min | Typ | Max | | |
| Contrast Ratio | CR | 400 | - | - | | 1 |
| Surface Luminance, white | $L_{WH}$ | 185 | 220 | - | $cd/m^2$ | 2 |
| Luminance Variation | $\delta_{WHITE}$ | - | 1.4 | 1.6 | | 3 |
| Response Time | $Tr_R + Tr_D$ | - | 8 | - | ms | 4 |
| Color Coordinates | | | | | | |
| RED | RX | 0.587 | 0.617 | 0.647 | | |
| | RY | 0.319 | 0.349 | 0.379 | | |
| GREEN | GX | 0.283 | 0.313 | 0.343 | | |
| | GY | 0.565 | 0.595 | 0.625 | | |
| BLUE | BX | 0.121 | 0.151 | 0.181 | | |
| | BY | 0.026 | 0.056 | 0.086 | | |
| WHITE | WX | 0.283 | 0.313 | 0.343 | | |
| | WY | 0.299 | 0.329 | 0.359 | | |
| Viewing Angle | | | | | | 5 |
| x axis, right(Φ=0°) | Θr | 60 | - | - | degree | |
| x axis, left (Φ=180°) | Θl | 60 | - | - | degree | |
| y axis, up (Φ=90°) | Θu | 50 | - | - | degree | |
| y axis, down (Φ=270°) | Θd | 50 | - | - | degree | |
| Gray Scale | | | | | | 6 |

Note)

1. Contrast Ratio(CR) is defined mathematically as

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

2. Surface luminance is the average of 5 point across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 1.

$$L_{WH} = \text{Average}(L_1, L_2, \ldots L_5)$$

3. The variation in surface luminance , The panel total variation ($\delta_{WHITE}$) is determined by measuring $L_N$ at each test position 1 through 13 and then defined as followed numerical formula.
For more information see FIG 2.

$$\delta_{WHITE} = \frac{\text{Maximum}(L_1, L_2, \ldots L_{13})}{\text{Minimum}(L_1, L_2, \ldots L_{13})}$$

4. Response time is the time required for the display to transition from white to black (rise time, $Tr_R$) and from black to white(Decay Time, $Tr_D$). For additional information see FIG 3.

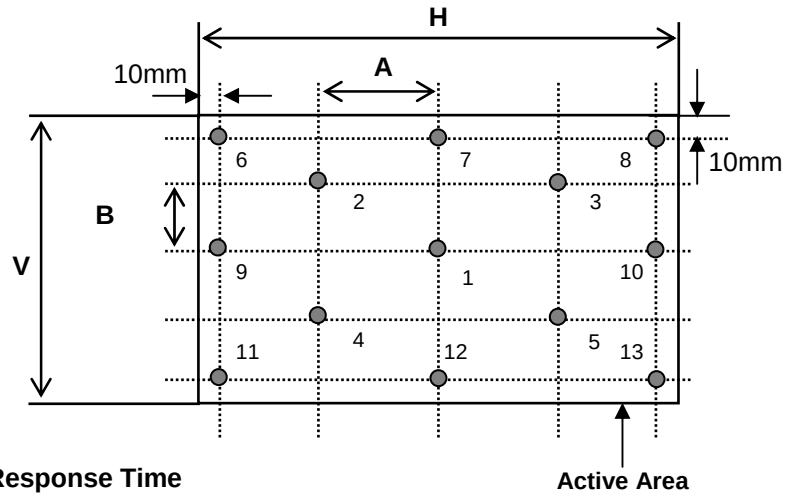
5. Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see FIG 4.

6. Gray scale specification * $f_V$ = 60Hz

| Gray Level | Luminance [%] (Typ) |
|---|---|
| L0 | 0 |
| L7 | 1.00 |
| L15 | 4.25 |
| L23 | 10.90 |
| L31 | 21.01 |
| L39 | 34.82 |
| L47 | 52.49 |
| L55 | 74.17 |
| L63 | 100 |

**FIG. 2 Luminance**

<Measuring point for Average Luminance & measuring point for Luminance variation>




**H,V : ACTIVE AREA**
**A : H/4 mm**
**B : V/4 mm**
**POINTS: 13 POINTS**

**FIG. 3 Response Time**

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

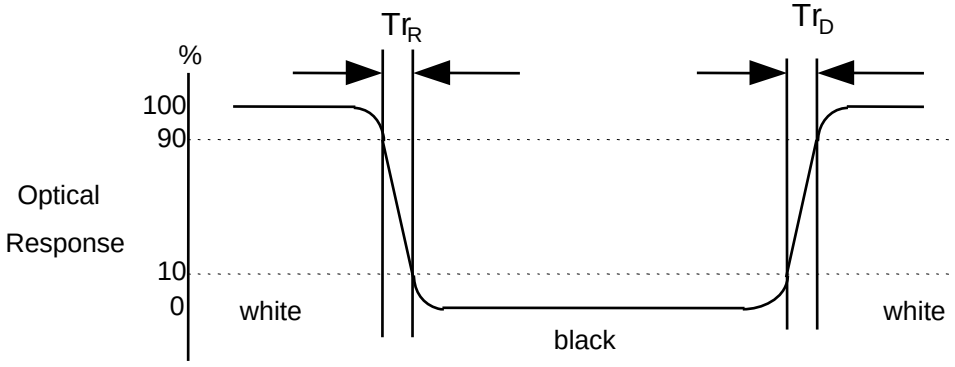
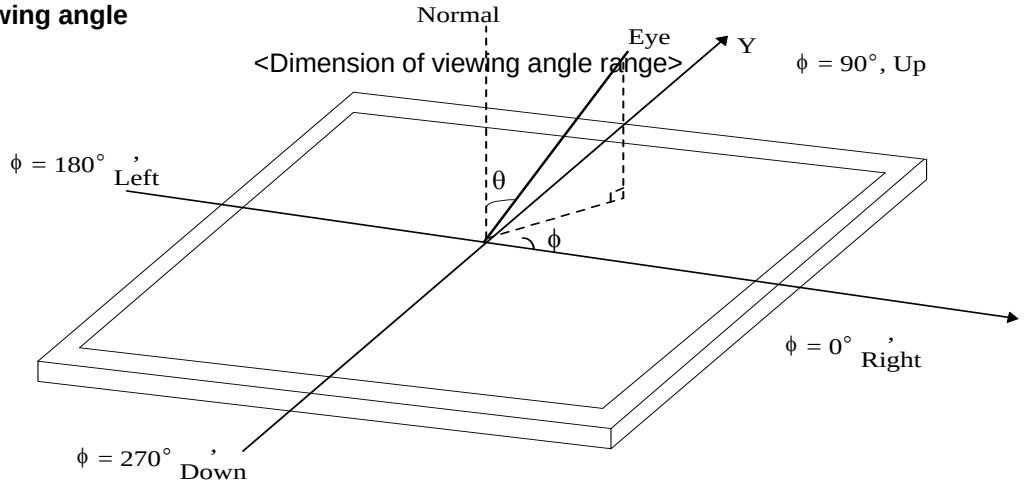



**FIG. 4 Viewing angle**

<Dimension of viewing angle range>



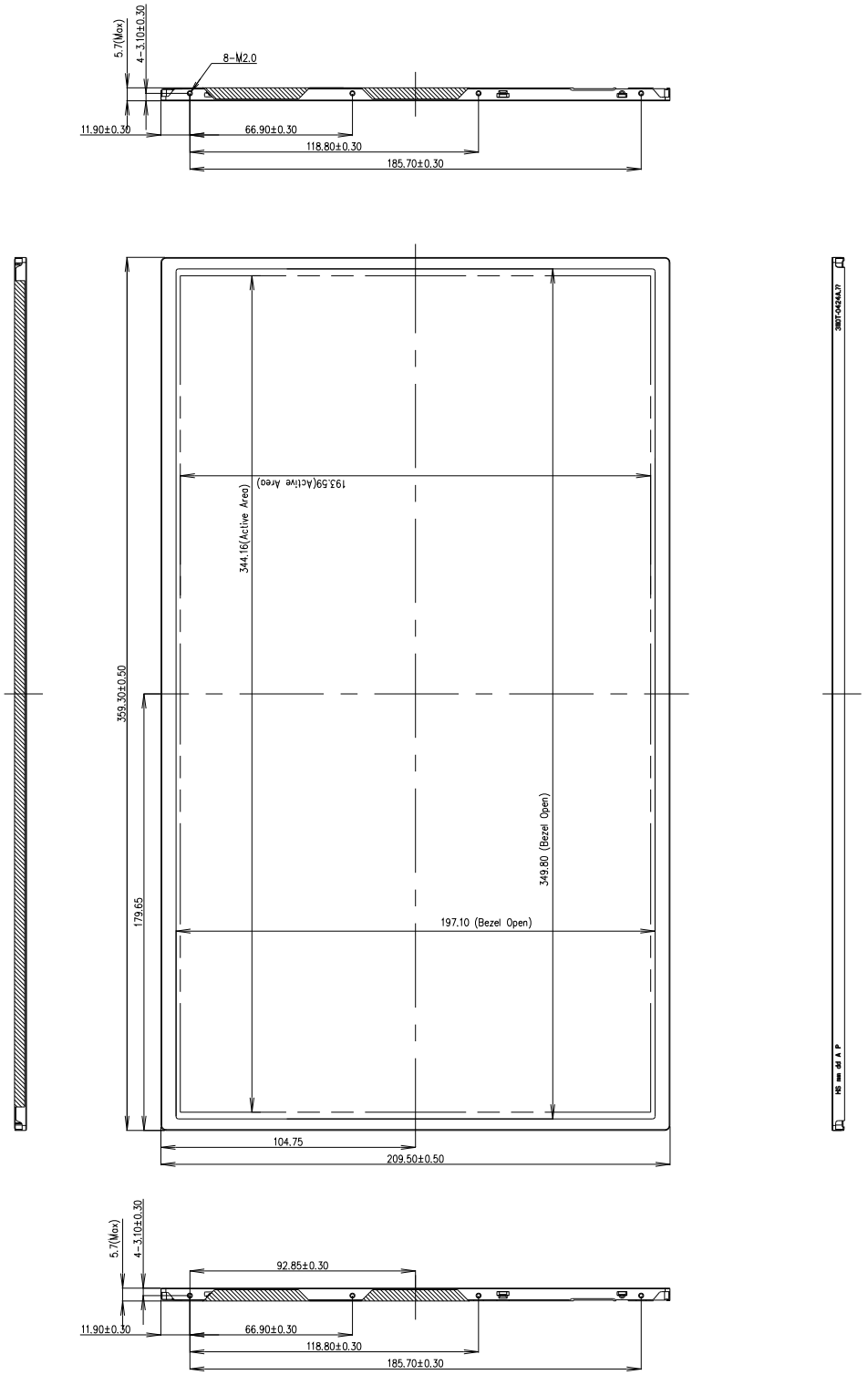
## 5. Mechanical Characteristics

The contents provide general mechanical characteristics for the model LP156WF1. In addition the figures in the next page are detailed mechanical drawing of the LCD.

| | | |
|---|---|---|
| Outline Dimension | Horizontal | 359.3 ± 0.5mm |
| | Vertical | 209.5 ± 0.5mm |
| | Thickness | 5.7mm (max) |
| Bezel Area | Horizontal | 349.8 ± 0.5mm |
| | Vertical | 197.1 ± 0.5mm |
| Active Display Area | Horizontal | 344.16 ± 0.3 mm |
| | Vertical | 193.59 ± 0.3 mm |
| Weight | 470g ( Max.) / 450g ( Typ.) | |
| Surface Treatment | Hard Coating(3H), Glare treatment of the front polarizer | |

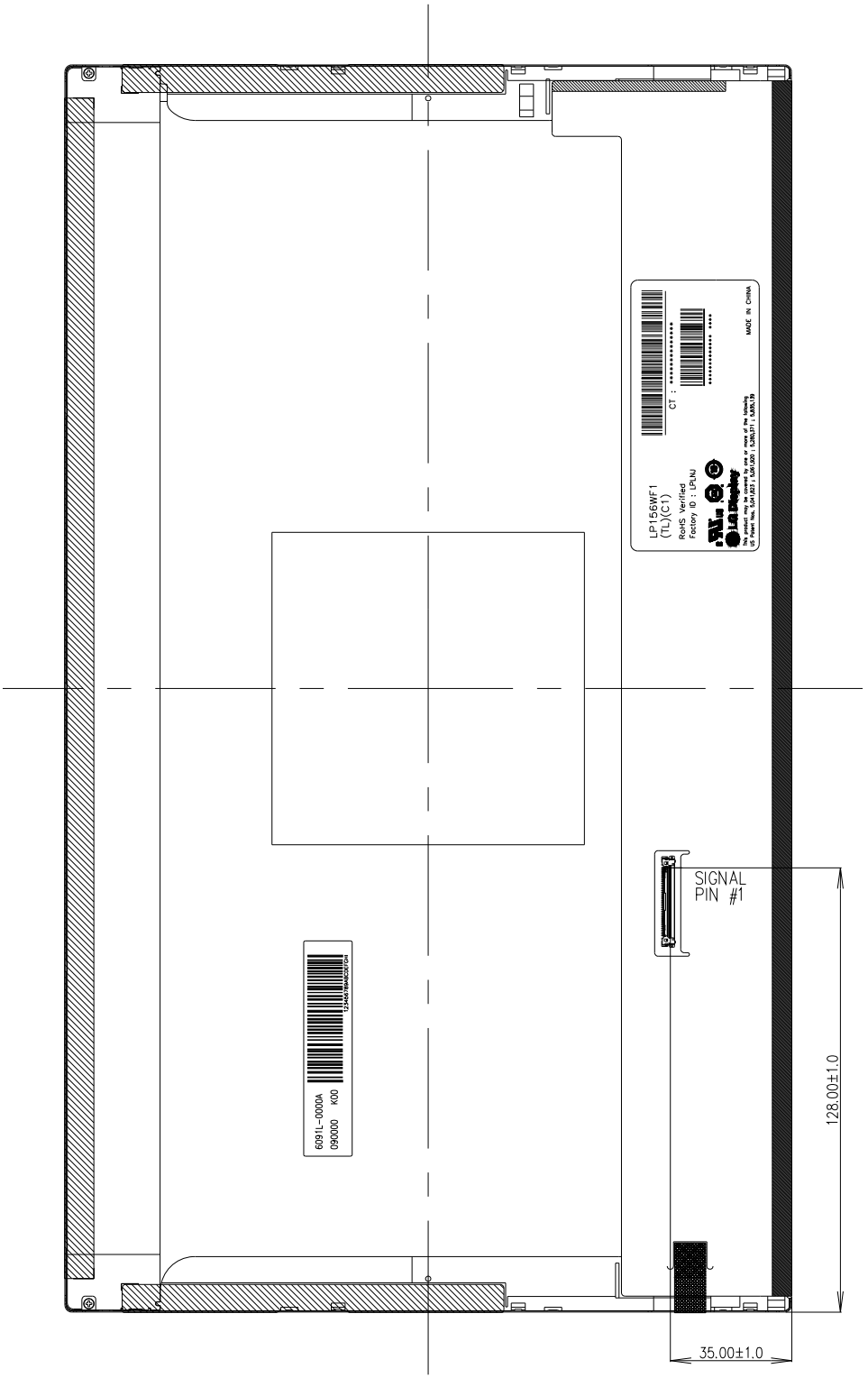
<FRONT VIEW>

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

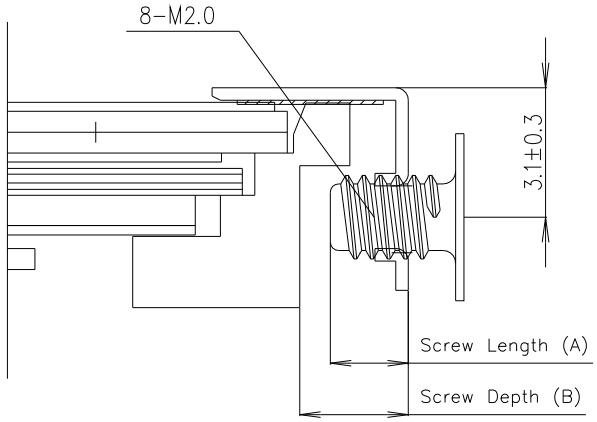


<REAR VIEW>

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



[ DETAIL DESCRIPTION OF SIDE MOUNTING SCREW ]




*Mounting Screw Length (A)
= 2.0(Min) / 2.5(Max)
*Mounting Screw Hole Depth (B)
= 2.5(Min)
*Mounting Hole Location : 3.10(typ.)
*Torque : 2.0 kgf.cm(Max)
(Measurement gauge : torque meter)

Notes : 1. Screw plated through the method of non-electrolytic nickel plating is preferred to reduce possibility that results in vertical and/or horizontal line defect due to the conductive particles from screw surface.

## 6. Reliability

Environment test condition

| No. | Test Item | Conditions |
|---|---|---|
| 1 | High temperature storage test | Ta= 60°C, 240h |
| 2 | Low temperature storage test | Ta= -20°C, 240h |
| 3 | High temperature operation test | Ta= 50°C, 50%RH, 240h |
| 4 | Low temperature operation test | Ta= 0°C, 240h |
| 5 | Vibration test (non-operating) | Sine wave, 10 ~ 500 ~ 10Hz, 1.5G, 0.37oct/min<br>3 axis, 1hour/axis |
| 6 | Shock test (non-operating) | Half sine wave, 180G, 2ms<br>one shock of each six faces(I.e. run 180G 2ms<br>for all six faces) |
| 7 | Altitude operating<br>storage / shipment | 0 ~ 10,000 feet (3,048m) 24Hr<br>0 ~ 40,000 feet (12,192m) 24Hr |

{ Result Evaluation Criteria }

There should be no change which might affect the practical display function when the display quality test is conducted under normal operating condition.

## 7. International Standards

### 7-1. Safety

a) UL 60950-1, Second Edition, Underwriters Laboratories Inc.
Information Technology Equipment - Safety - Part 1 : General Requirements.

b) CAN/CSA C22.2 No.60950-1-07, Second Edition, Canadian Standards Association.
Information Technology Equipment - Safety - Part 1 : General Requirements.

c) EN 60950-1:2006 + A11:2009, European Committee for Electrotechnical Standardization (CENELEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.

d) IEC 60950-1:2005, Second Edition, The International Electrotechnical Commission (IEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.

### 7-2. EMC

a) ANSI C63.4 “American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.” American National Standards Institute (ANSI), 2003.

b) CISPR 22 “Information technology equipment – Radio disturbance characteristics – Limit and methods of measurement." International Special Committee on Radio Interference (CISPR), 2005.

c) CISPR 13 “Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and method of measurement." International Special Committee on Radio Interference (CISPR), 2006.

### 7-3. Environment

a) RoHS, Directive 2002/95/EC of the European Parliament and of the council of 27 January 2003

# 8. Packing

## 8-1. Designation of Lot Mark

a) Lot Mark

| A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

A,B,C : SIZE(INCH)
E : MONTH
D : YEAR
F ~ M : SERIAL NO.

Note

1. YEAR

| Year | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Mark | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |

2. MONTH

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mark | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C |

b) Location of Lot Mark

Serial No. is printed on the label. The label is attached to the backside of the LCD module.
This is subject to change without prior notice.

## 8-2. Packing Form

a) Package quantity in one box : 20 pcs

b) Box Size : 482 x 390 x 275

## 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 the resist external force.
(4) You should adopt radiation structure to satisfy the temperature specification.
(5) Acetic acid type and chlorine type materials for the cover case are not 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=± 200mV(Over and under shoot voltage)

(2) Response time depends on the temperature.(In lower temperature, it becomes longer.)
(3) Brightness depends on the temperature. (In lower temperature, it becomes lower.)
And in lower temperature, response time(required time that brightness is stable after turned on) becomes longer.
(4) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
(5) When fixed patterns are displayed for a long time, remnant image is likely to occur.
(6) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference.

## 9-3. ELECTROSTATIC DISCHARGE CONTROL

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

## 9-4. PRECAUTIONS FOR STRONG LIGHT EXPOSURE

Strong light exposure causes degradation of polarizer and color filter.

## 9-5. STORAGE

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

(1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
(2) The polarizer surface should not come in contact with any other object.
It is recommended that they be stored in the container in which they were shipped.

## 9-6. HANDLING PRECAUTIONS FOR PROTECTION FILM

(1) When the protection film is peeled off, static electricity is generated between the film and polarizer. This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
(2) The protection film is attached to the polarizer with a small amount of glue. If some stress is applied to rub the protection film against the polarizer during the time you peel off the film, the glue is apt to remain on the polarizer.
Please carefully peel off the protection film without rubbing it against the polarizer.
(3) When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the polarizer after the protection film is peeled off.
(4) You can remove the glue easily. When the glue remains on the polarizer surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.

# APPENDIX A. Enhanced Extended Display Identification Data (EEDID™) 1/3

| | Byte (Dec) | Byte (Hex) | Field Name and Comments | Value (Hex) | Value (Bin) |
|---|---|---|---|---|---|
| *Header* | 0 | **00** | Header | **00** | 00000000 |
| | 1 | **01** | Header | **FF** | 11111111 |
| | 2 | **02** | Header | **FF** | 11111111 |
| | 3 | **03** | Header | **FF** | 11111111 |
| | 4 | **04** | Header | **FF** | 11111111 |
| | 5 | **05** | Header | **FF** | 11111111 |
| | 6 | **06** | Header | **FF** | 11111111 |
| | 7 | **07** | Header | **00** | 00000000 |
| *EDID Vendor / Product Version* | 8 | **08** | EISA manufacture code ( 3 Character ID ) LGD | **30** | 00110000 |
| | 9 | **09** | EISA manufacture code (Compressed ASCII ) | **E4** | 11100100 |
| | 10 | **0A** | Panel Supplier Reserved - Product Code 01E9h | **E9** | 11101001 |
| | 11 | **0B** | ( Hex. LSB first ) | **01** | 00000001 |
| | 12 | **0C** | LCD Module Serial No - Preferred but Optional ("0" If not used) | **00** | 00000000 |
| | 13 | **0D** | LCD Module Serial No - Preferred but Optional ("0" If not used) | **00** | 00000000 |
| | 14 | **0E** | LCD Module Serial No - Preferred but Optional ("0" If not used) | **00** | 00000000 |
| | 15 | **0F** | LCD Module Serial No - Preferred but Optional ("0" If not used) | **00** | 00000000 |
| | 16 | **10** | Week of Manufacture 00 weeks | **00** | 00000000 |
| | 17 | **11** | Year of Manufacture 2009 years | **13** | 00010011 |
| | 18 | **12** | EDID structure version # = 1 | **01** | 00000001 |
| | 19 | **13** | EDID revision # = 3 | **03** | 00000011 |
| *Display Parameters* | 20 | **14** | Video input Definition = Digital signal | **80** | 10000000 |
| | 21 | **15** | Max H image size (Rounded cm) = 35 cm | **23** | 00100011 |
| | 22 | **16** | Max V image size (Rounded cm) = 19 cm | **13** | 00010011 |
| | 23 | **17** | Display gamma = (gamma*100)-100 = Example:(2.2*100)-100=120 = 2.2 Gamma | **78** | 01111000 |
| | 24 | **18** | Feature Support (no_DPMS, no_Active Off/Very Low Power, RGB color display, Timing BLK 1,no_ GTF) | **0A** | 00001010 |
| *Panel Color Coordinates* | 25 | **19** | Red/Green Low Bits (RxRy/GxGy) | **08** | 00001000 |
| | 26 | **1A** | Blue/White Low Bits (BxBy/WxWy) | **D5** | 11010101 |
| | 27 | **1B** | Red X Rx = 0.621 | **9F** | 10011111 |
| | 28 | **1C** | Red Y Ry = 0.352 | **5A** | 01011010 |
| | 29 | **1D** | Green X Gx = 0.314 | **50** | 01010000 |
| | 30 | **1E** | Green Y Gy = 0.586 | **96** | 10010110 |
| | 31 | **1F** | Blue X Bx = 0.147 | **25** | 00100101 |
| | 32 | **20** | Blue Y By = 0.118 | **1E** | 00011110 |
| | 33 | **21** | White X Wx = 0.313 | **50** | 01010000 |
| | 34 | **22** | White Y Wy = 0.329 | **54** | 01010100 |
| *Established Timings* | 35 | **23** | Established timing 1 (00h if not used) | **00** | 00000000 |
| | 36 | **24** | Established timing 2 (00h if not used) | **00** | 00000000 |
| | 37 | **25** | Manufacturer's timings (00h if not used) | **00** | 00000000 |
| *Standard Timing ID* | 38 | **26** | Standard timing ID1 (01h if not used) | **01** | 00000001 |
| | 39 | **27** | Standard timing ID1 (01h if not used) | **01** | 00000001 |
| | 40 | **28** | Standard timing ID2 (01h if not used) | **01** | 00000001 |
| | 41 | **29** | Standard timing ID2 (01h if not used) | **01** | 00000001 |
| | 42 | **2A** | Standard timing ID3 (01h if not used) | **01** | 00000001 |
| | 43 | **2B** | Standard timing ID3 (01h if not used) | **01** | 00000001 |
| | 44 | **2C** | Standard timing ID4 (01h if not used) | **01** | 00000001 |
| | 45 | **2D** | Standard timing ID4 (01h if not used) | **01** | 00000001 |
| | 46 | **2E** | Standard timing ID5 (01h if not used) | **01** | 00000001 |
| | 47 | **2F** | Standard timing ID5 (01h if not used) | **01** | 00000001 |
| | 48 | **30** | Standard timing ID6 (01h if not used) | **01** | 00000001 |
| | 49 | **31** | Standard timing ID6 (01h if not used) | **01** | 00000001 |
| | 50 | **32** | Standard timing ID7 (01h if not used) | **01** | 00000001 |
| | 51 | **33** | Standard timing ID7 (01h if not used) | **01** | 00000001 |
| | 52 | **34** | Standard timing ID8 (01h if not used) | **01** | 00000001 |
| | 53 | **35** | Standard timing ID8 (01h if not used) | **01** | 00000001 |

# APPENDIX A. Enhanced Extended Display Identification Data (EEDID™) 2/3

| | Byte (Dec) | Byte (Hex) | Field Name and Comments | Value (Hex) | Value (Bin) |
|---|---|---|---|---|---|
| *Timing Descriptor #1* | 54 | **36** | Pixel Clock/10,000 (LSB) 138.5 MHz @ 59.9Hz | **1A** | 00011010 |
| | 55 | **37** | Pixel Clock/10,000 (MSB) | **36** | 00110110 |
| | 56 | **38** | Horizontal Active (lower 8 bits) 1920 Pixels | **80** | 10000000 |
| | 57 | **39** | Horizontal Blanking(Thp-HA) (lower 8 bits) 160 Pixels | **A0** | 10100000 |
| | 58 | **3A** | Horizontal Active / Horizontal Blanking(Thp-HA) (upper 4:4bits) | **70** | 01110000 |
| | 59 | **3B** | Vertical Avtive 1080 Lines | **38** | 00111000 |
| | 60 | **3C** | Vertical Blanking (Tvp-HA) (DE Blanking typ.for DE only panels) 31 Lines | **1F** | 00011111 |
| | 61 | **3D** | Vertical Active : Vertical Blanking (Tvp-HA) (upper 4:4bits) | **40** | 01000000 |
| | 62 | **3E** | Horizontal Sync. Offset (Thfp) 48 Pixels | **30** | 00110000 |
| | 63 | **3F** | Horizontal Sync Pulse Width (HSPW) 32 Pixels | **20** | 00100000 |
| | 64 | **40** | Vertical Sync Offset(Tvfp) : Sync Width (VSPW) 3 Lines : 5 Lines | **35** | 00110101 |
| | 65 | **41** | Horizontal Vertical Sync Offset/Width (upper 2bits) | **00** | 00000000 |
| | 66 | **42** | Horizontal Image Size (mm) 345 mm | **59** | 01011001 |
| | 67 | **43** | Vertical Image Size (mm) 194 mm | **C2** | 11000010 |
| | 68 | **44** | Horizontal Image Size / Vertical Image Size | **10** | 00010000 |
| | 69 | **45** | Horizontal Border = 0 (Zero for Notebook LCD) | **00** | 00000000 |
| | 70 | **46** | Vertical Border = 0 (Zero for Notebook LCD) | **00** | 00000000 |
| | 71 | **47** | Non-Interlace, Normal display, no stereo, Digital Separate ( Vsync_NEG, Hsync_NEG ), DE only note : LSB is set to '1' if panel is DE-timing only. H/V can be ignored | **19** | 00011001 |
| *Timing Descriptor #2* | 72 | **48** | Flag | **00** | 00000000 |
| | 73 | **49** | Flag | **00** | 00000000 |
| | 74 | **4A** | Flag | **00** | 00000000 |
| | 75 | **4B** | Data Type Tag (Descriptor Defined by manufacturer) | **00** | 00000000 |
| | 76 | **4C** | Flag | **00** | 00000000 |
| | 77 | **4D** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 78 | **4E** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 79 | **4F** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 80 | **50** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 81 | **51** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 82 | **52** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 83 | **53** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 84 | **54** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 85 | **55** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 86 | **56** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 87 | **57** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 88 | **58** | Descriptor Defined by manufacturer | **00** | 00000000 |
| | 89 | **59** | Descriptor Defined by manufacturer | **00** | 00000000 |
| *Timing Descriptor #3* | 90 | **5A** | Flag | **00** | 00000000 |
| | 91 | **5B** | Flag | **00** | 00000000 |
| | 92 | **5C** | Flag | **00** | 00000000 |
| | 93 | **5D** | Data Type Tag ( ASCII String ) | **FE** | 11111110 |
| | 94 | **5E** | Flag | **00** | 00000000 |
| | 95 | **5F** | ASCII String L | **4C** | 01001100 |
| | 96 | **60** | ASCII String G | **47** | 01000111 |
| | 97 | **61** | ASCII String | **20** | 00100000 |
| | 98 | **62** | ASCII String D | **44** | 01000100 |
| | 99 | **63** | ASCII String i | **69** | 01101001 |
| | 100 | **64** | ASCII String s | **73** | 01110011 |
| | 101 | **65** | ASCII String p | **70** | 01110000 |
| | 102 | **66** | ASCII String l | **6C** | 01101100 |
| | 103 | **67** | ASCII String a | **61** | 01100001 |
| | 104 | **68** | ASCII String y | **79** | 01111001 |
| | 105 | **69** | Manufacturer P/N(If<13 char--> 0Ah, then terminate with ASCII code 0Ah,set remaini | **0A** | 00001010 |
| | 106 | **6A** | Manufacturer P/N(If<13 char--> 0Ah, then terminate with ASCII code 0Ah,set remaini | **20** | 00100000 |
| | 107 | **6B** | Manufacturer P/N(If<13 char--> 0Ah, then terminate with ASCII code 0Ah,set remaining char= 20h) | **20** | 00100000 |

## APPENDIX A. Enhanced Extended Display Identification Data (EEDID™) 3/3

| | Byte (Dec) | Byte (Hex) | Field Name and Comments | | Value (Hex) | Value (Bin) |
|---|---|---|---|---|---|---|
| *Timing Descriptor #4* | 108 | **6C** | Flag | | **00** | 00000000 |
| | 109 | **6D** | Flag | | **00** | 00000000 |
| | 110 | **6E** | Flag | | **00** | 00000000 |
| | 111 | **6F** | Data Type Tag ( ASCII String ) | | **FE** | 11111110 |
| | 112 | **70** | Flag | | **00** | 00000000 |
| | 113 | **71** | ASCII String | L | **4C** | 01001100 |
| | 114 | **72** | ASCII String | P | **50** | 01010000 |
| | 115 | **73** | ASCII String | 1 | **31** | 00110001 |
| | 116 | **74** | ASCII String | 5 | **35** | 00110101 |
| | 117 | **75** | ASCII String | 6 | **36** | 00110110 |
| | 118 | **76** | ASCII String | W | **57** | 01010111 |
| | 119 | **77** | ASCII String | F | **46** | 01000110 |
| | 120 | **78** | ASCII String | 1 | **31** | 00110001 |
| | 121 | **79** | ASCII String | - | **2D** | 00101101 |
| | 122 | **7A** | ASCII String | T | **54** | 01010100 |
| | 123 | **7B** | ASCII String | L | **4C** | 01001100 |
| | 124 | **7C** | ASCII String | C | **43** | 01000011 |
| | 125 | **7D** | ASCII String | 1 | **31** | 00110001 |
| *Chec* | 126 | **7E** | Extension flag (# of optional 128 panel ID extension block to follow, Typ = 0) | | **00** | 00000000 |
| | 127 | **7F** | Check Sum (The 1-byte sum of all 128 bytes in this panel ID block shall = 0) | | **B0** | 10110000 |