

Product Specification

**SPECIFICATION
FOR
APPROVAL**

- () Preliminary Specification
- (◆) Final Specification

| | |
|-------|-------------------|
| Title | 27.0" QHD TFT LCD |
|-------|-------------------|

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

| | |
|----------|----------------------|
| SUPPLIER | LG Display Co., Ltd. |
| *MODEL | LM270WQ1 |
| SUFFIX | SLB2 |

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

| SIGNATURE | DATE |
|-----------|-------|
| / | _____ |
| / | _____ |
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IT/Mobile Development Division 1
LG Display Co., Ltd

Product Specification
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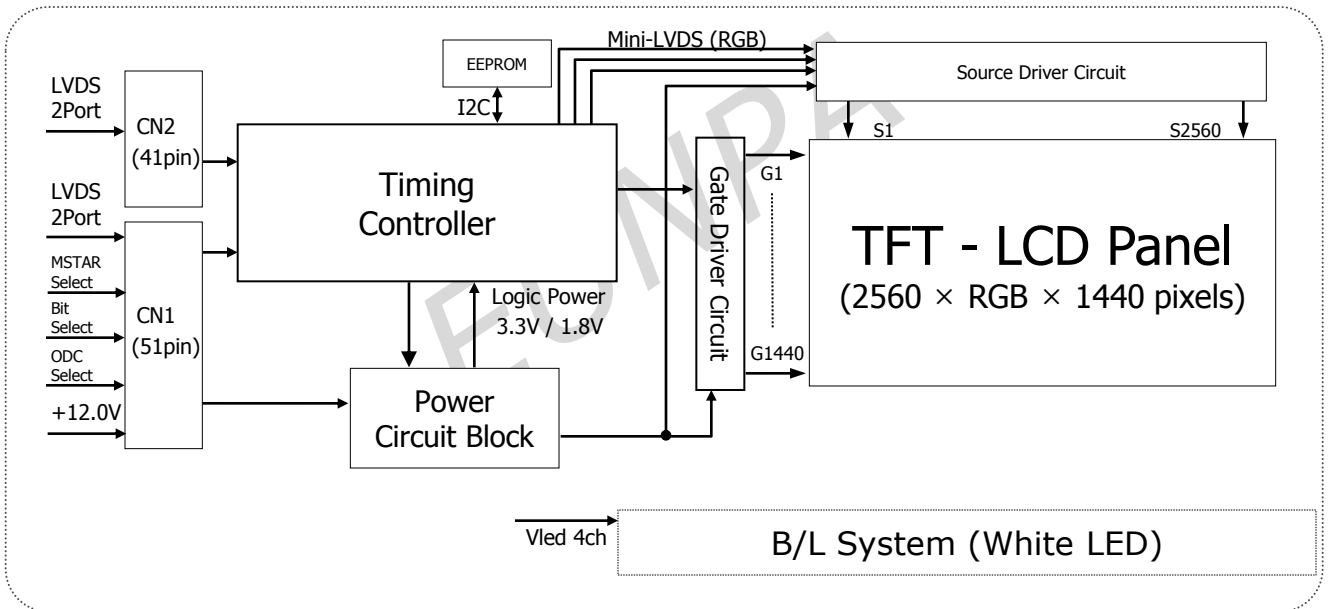
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1. General Description

LM270WQ1 is a Color Active Matrix Liquid Crystal Display with Light Emitting Diode (White LED) backlight system without LED driver. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally black mode. It has a 27inch diagonally measured active display area with QHD resolution (2560 vertical by 1440 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 16.7M colors. It has been designed to apply the 8-bit 4port LVDS interface.

It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important.



General Features

| | |
|------------------------|--|
| Active Screen Size | 27.0 inches(68.47cm) diagonal |
| Outline Dimension | 630.0(H) x 368.2(V) x 14.9(D) mm(Typ.) |
| Pixel Pitch | 0.2331 mm x 0.2331 mm |
| Pixel Format | 2560 horiz. By 1440 vert. Pixels RGB stripes arrangement |
| Color Depth | 16.7M colors, 8Bit |
| Luminance, White | 350 cd/m ² (Center 1Point, Typ.) |
| Viewing Angle(CR>10) | View Angle Free (R/L 178(Typ.), U/D 178(Typ.)) |
| Power Consumption | Total 35.3 Watt (Typ.) (9.6 Watt @VLCD, 25.7 Watt w/o driver) |
| Weight | 3,470g (Typ.) |
| Display Operating Mode | Transmissive mode, normally black |
| Surface Treatment | Hard coating(3H), Anti-glare treatment of the front polarizer |

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2. Absolute Maximum Ratings

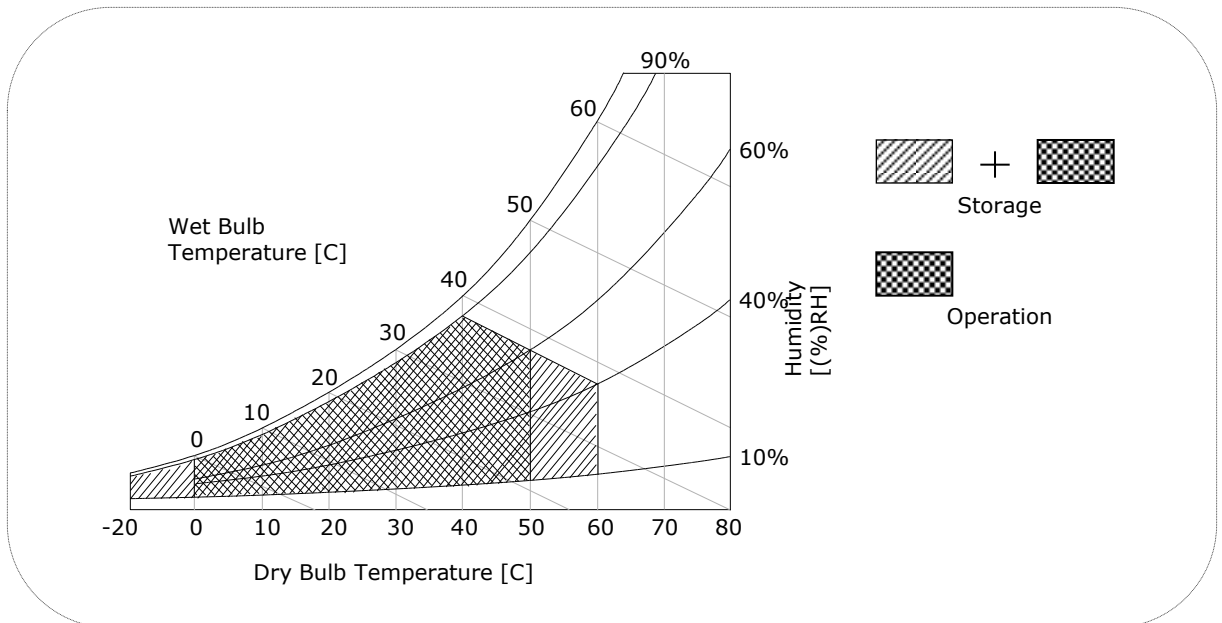
The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 1. ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Values | | Units | Notes |
|----------------------------|------------------|--------|-----|-----------------|-------------|
| | | Min | Max | | |
| Power Input Voltage | V _{LCD} | -0.3 | 14 | V _{dc} | at 25 ± 2°C |
| Operating Temperature | T _{OP} | 0 | 50 | °C | 1, 2 |
| Storage Temperature | T _{ST} | -20 | 60 | °C | |
| Operating Ambient Humidity | H _{OP} | 10 | 90 | %RH | |
| Storage Humidity | H _{ST} | 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.
 2. Maximum Storage Humidity is up to 40°C, 70% RH only for 4 corner light leakage Mura.
 3. Storage condition is guaranteed under packing condition

FIG. 1 Temperature and relative humidity



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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 LED/Backlight, is typically generated by a LED Driver. The LED Driver 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 | V_{LCD} | 11.6 | 12.0 | 12.4 | Vdc | |
| Permissive Power Input Ripple | V_{dRF} | - | | 400 | mVp-p | |
| Power Supply Input Current | $I_{LCD-MOSAIC}$ | - | 800 | 1040 | mA | 1 |
| | $I_{LCD-WHITE}$ | - | 1150 | 1495 | mA | 2 |
| Power Consumption | $P_{LCD-MOSAIC}$ | - | 9.6 | 12.48 | Watt | 1 |
| | $P_{LCD-WHITE}$ | | 13.8 | 17.94 | Watt | 2 |
| Rush Current | I_{RUSH} | - | - | 3.0 | A | 3 |

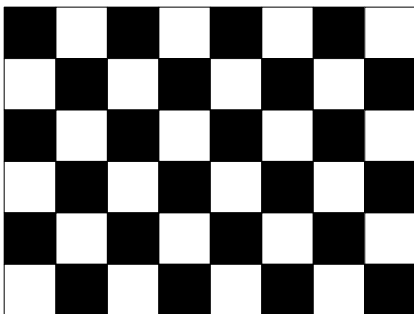
Note :

1. The specified current and power consumption are under the $V_{LCD}=12.0V, 25 \pm 2^{\circ}C, f_V=60Hz$ condition whereas mosaic pattern(8 x 6) is displayed and f_V 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.).

FIG.2 Pattern for Electrical characteristics

power consumption measurement

White : 255Gray
Black : 0Gray



Mosaic Pattern(8 x 6)

power input ripple

Maximum current pattern



White Pattern

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Table 2-2. LED BAR ELECTRICAL CHARACTERISTICS

| Parameter | Symbol | Values | | | Unit | Notes |
|--------------------|--------|--------|------|------|------|-------|
| | | Min. | Typ. | Max. | | |
| LED String Current | Is | 10 | 120 | 125 | mA | 1,2,5 |
| LED String Voltage | Vs | 50.2 | 53.6 | 57.0 | V | 1,5 |
| Power Consumption | PBar | - | 25.7 | 27.3 | Watt | 1,2,4 |
| LED Life Time | LED_LT | 30,000 | - | - | Hrs | 3 |

Notes) The LED Bar consists of 68 LED packages, 4 strings (parallel) x 17 packages (serial)

LED driver design guide

- : The design of the LED driver must have specifications for the LED in LCD Assembly. The performance of the LED in LCM, for example life time or brightness, is extremely influenced by the characteristics of the LED driver. So all the parameters of an LED driver should be carefully designed and output current should be Constant current control. Please control feedback current of each string individually to compensate the current variation among the strings of LEDs. When you design or order the LED driver, please make sure unwanted lighting caused by the mismatch of the LED and the LED driver (no lighting, flicker, etc) never occurs. When you confirm it, the LCD module should be operated in the same condition as installed in your instrument.

1. Specified values are for a single LED bar.
2. The specified current is defined as the input current for a single LED string with 100% duty cycle.
3. The LED life time is defined as the time when brightness of LED packages become 50% or less than the initial value under the conditions at $T_a = 25 \pm 2^\circ\text{C}$ and LED string current is typical value.
4. The power consumption shown above does not include loss of external driver.
 The typical power consumption is calculated as $P_{\text{Bar}} = V_s(\text{Typ.}) \times I_s(\text{Typ.}) \times \text{No. of strings}$.
 The maximum power consumption is calculated as $P_{\text{Bar}} = V_s(\text{Max.}) \times I_s(\text{Typ.}) \times \text{No. of strings}$.
5. LED operating conditions are must not exceed Max. ratings.

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3-2. Interface Connections

This LCD module employs two kinds of interface connection, 51-pin and 41-pin connectors are used for the module electronics and 14-pin connectors are used for the integral backlight system.

3-2-1. LCD Module (CN1, CN2)

- LCD Connector(CN1): IS050-C51B-C39-A(manufactured by UJU) or FI-RE51S-HF(manufactured by JAE) or compatible. Refer to below and next Page table.

- Mating Connector : FI-RE51HL(JAE) or compatible

Table 3-1. MODULE CONNECTOR(CN1) PIN CONFIGURATION

| No | Symbol | Description | No | Symbol | Description |
|----|-------------|---------------------------------------|----|------------|--------------------------------------|
| 1 | GND | Ground | 27 | Bit Select | 'H' = 10bit , 'L' or NC = 8bit |
| 2 | NC | No Connection | 28 | R2AN | SECOND LVDS Receiver Signal (A-) |
| 3 | NC | No Connection | 29 | R2AP | SECOND LVDS Receiver Signal (A+) |
| 4 | NC | No Connection | 30 | R2BN | SECOND LVDS Receiver Signal (B-) |
| 5 | NC | No Connection | 31 | R2BP | SECOND LVDS Receiver Signal (B+) |
| 6 | ODC Select | 'H' or NC = Enable , 'L' = Disable | 32 | R2CN | SECOND LVDS Receiver Signal (C-) |
| 7 | LVDS Format | 'H'= MSTAR Concept , 'L'=normal | 33 | R2CP | SECOND LVDS Receiver Signal (C+) |
| 8 | NC | No Connection | 34 | GND | Ground |
| 9 | PWM_OUT | Reference signal for inverter control | 35 | R2CLKN | SECOND LVDS Receiver Clock Signal(-) |
| 10 | NC | No Connection | 36 | R2CLKP | SECOND LVDS Receiver Clock Signal(+) |
| 11 | GND | Ground | 37 | GND | Ground |
| 12 | R1AN | FIRST LVDS Receiver Signal (A-) | 38 | R2DN | SECOND LVDS Receiver Signal (D-) |
| 13 | R1AP | FIRST LVDS Receiver Signal (A+) | 39 | R2DP | SECOND LVDS Receiver Signal (D+) |
| 14 | R1BN | FIRST LVDS Receiver Signal (B-) | 40 | R2EN | SECOND LVDS Receiver Signal (E-) |
| 15 | R1BP | FIRST LVDS Receiver Signal (B+) | 41 | R2EP | SECOND LVDS Receiver Signal (E+) |
| 16 | R1CN | FIRST LVDS Receiver Signal (C-) | 42 | Reserved | No connection or GND |
| 17 | R1CP | FIRST LVDS Receiver Signal (C+) | 43 | Reserved | No connection or GND |
| 18 | GND | Ground | 44 | GND | Ground |
| 19 | R1CLKN | FIRST LVDS Receiver Clock Signal(-) | 45 | GND | Ground |
| 20 | R1CLKP | FIRST LVDS Receiver Clock Signal(+) | 46 | GND | Ground |
| 21 | GND | Ground | 47 | NC | No connection |
| 22 | R1DN | FIRST LVDS Receiver Signal (D-) | 48 | VLCD | Power Supply +12.0V |
| 23 | R1DP | FIRST LVDS Receiver Signal (D+) | 49 | VLCD | Power Supply +12.0V |
| 24 | R1EN | FIRST LVDS Receiver Signal (E-) | 50 | VLCD | Power Supply +12.0V |
| 25 | R1EP | FIRST LVDS Receiver Signal (E+) | 51 | VLCD | Power Supply +12.0V |
| 26 | Reserved | No connection or GND | - | - | - |

- Notes :
- All GND(ground) pins should be connected together to the LCD module's metal frame.
 - All VLCD (power input) pins should be connected together.
 - All Input levels of LVDS signals are based on the EIA 644 Standard.
 - Specific pins(pin No. #2~#6) are used for internal data process of the LCD module.
If not used, these pins are no connection.
 - LVDS pin (pin No. #24,25,40,41) are used for 10Bit(D) of the LCD module.
If used for 8Bit(R), these pins are no connection.
 - Specific pin No. #44 is used for "No signal detection" of system signal interface.
It should be GND for NSB(No Signal Black) during the system interface signal is not.
If this pin is "H", LCD Module displays AGP(Auto Generation Pattern).

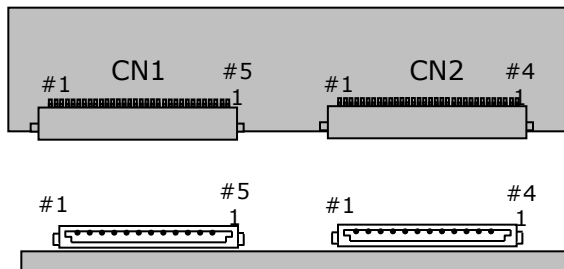
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- LCD Connector(CN2): IS050-C41B-C39-A(manufactured by UJU) or FI-RE41S-HF(manufactured by JAE) or compatible. Refer to below table.
- Mating Connector : FI-RE41HL or compatible.

Table 3-2. MODULE CONNECTOR(CN2) PIN CONFIGURATION

| No | Symbol | Description | No | Symbol | Description |
|----|--------|-------------------------------------|----|--------|-------------------------------------|
| 1 | NC | No connection(Reserved) | 22 | R3EN | THIRD LVDS Receiver Signal (E-) |
| 2 | NC | No connection | 23 | R3EP | THIRD LVDS Receiver Signal (E+) |
| 3 | NC | No connection | 24 | GND | Ground |
| 4 | NC | No connection | 25 | GND | Ground |
| 5 | NC | No connection | 26 | R4AN | FORTH LVDS Receiver Signal (A-) |
| 6 | NC | No connection | 27 | R4AP | FORTH LVDS Receiver Signal (A+) |
| 7 | NC | No connection | 28 | R4BN | FORTH LVDS Receiver Signal (B-) |
| 8 | NC | No connection | 29 | R4BP | FORTH LVDS Receiver Signal (B+) |
| 9 | GND | Ground | 30 | R4CN | FORTH LVDS Receiver Signal (C-) |
| 10 | R3AN | THIRD LVDS Receiver Signal (A-) | 31 | R4CP | FORTH LVDS Receiver Signal (C+) |
| 11 | R3AP | THIRD LVDS Receiver Signal (A+) | 32 | GND | Ground |
| 12 | R3BN | THIRD LVDS Receiver Signal (B-) | 33 | R4CLKN | FORTH LVDS Receiver Clock Signal(-) |
| 13 | R3BP | THIRD LVDS Receiver Signal (B+) | 34 | R4CLKP | FORTH LVDS Receiver Clock Signal(+) |
| 14 | R3CN | THIRD LVDS Receiver Signal (C-) | 35 | GND | Ground |
| 15 | R3CP | THIRD LVDS Receiver Signal (C+) | 36 | R4DN | FORTH LVDS Receiver Signal (D-) |
| 16 | GND | Ground | 37 | R4DP | FORTH LVDS Receiver Signal (D+) |
| 17 | R3CLKN | THIRD LVDS Receiver Clock Signal(-) | 38 | R4EN | FORTH LVDS Receiver Signal (E-) |
| 18 | R3CLKP | THIRD LVDS Receiver Clock Signal(+) | 39 | R4EP | FORTH LVDS Receiver Signal (E+) |
| 19 | GND | Ground | 40 | GND | Ground |
| 20 | R3DN | THIRD LVDS Receiver Signal (D-) | 41 | GND | Ground |
| 21 | R3DP | THIRD LVDS Receiver Signal (D+) | - | | |

- Notes : 1. All GND(ground) pins should be connected together to the LCD module's metal frame.
 2. LVDS pin (pin No. #22,23,38,39) are used for 10Bit(D) of the LCD module.
 If used for 8Bit(R), these pins are no connection.



Rear view of LCM

- [CN1]
 - Part/No. : IS050-C51B-C39-A(UJU)
 - Mating connector : FI-RE51HL
 (Manufactured by JAE)
- [CN2]
 - Part/No. : IS050-C41B-C39-A(UJU)
 - Mating connector : FI-RE41HL
 (Manufactured by JAE)

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3-2-2. BACKLIGHT CONNECTOR PIN CONFIGURATION(CN3)

The LED interface connector is a model SM06B-SHJH(HF), wire-locking type manufactured by JST. The mating connector is a SHJP-06V-S(HF) or SHJP-06-A-K(HF) and Equivalent. The pin configuration for the connector is shown in the table below.

Table 3-3. LED CONNECTOR PIN CONFIGURATION

| Pin | Symbol | Description |
|-----|--------|---------------------------|
| 1 | FB1 | Channel1 Current Feedback |
| 2 | FB2 | Channel2 Current Feedback |
| 3 | VLED | LED Power Supply |
| 4 | VLED | LED Power Supply |
| 5 | FB3 | Channel3 Current Feedback |
| 6 | FB4 | Channel4 Current Feedback |

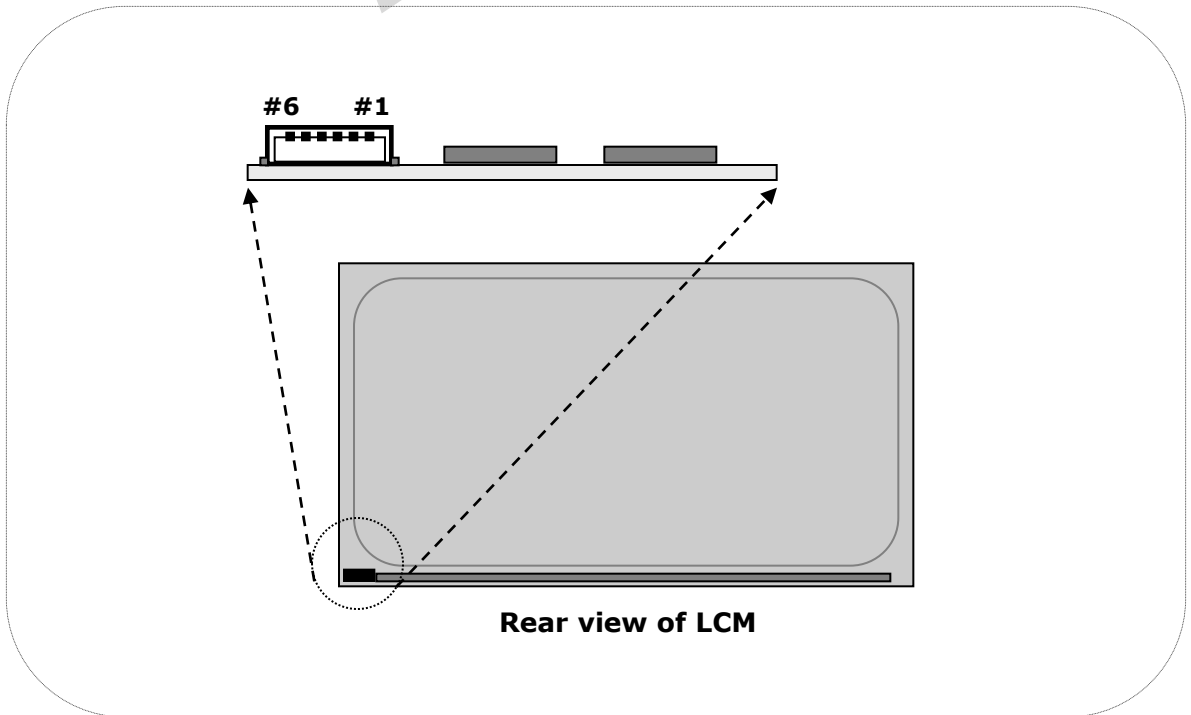
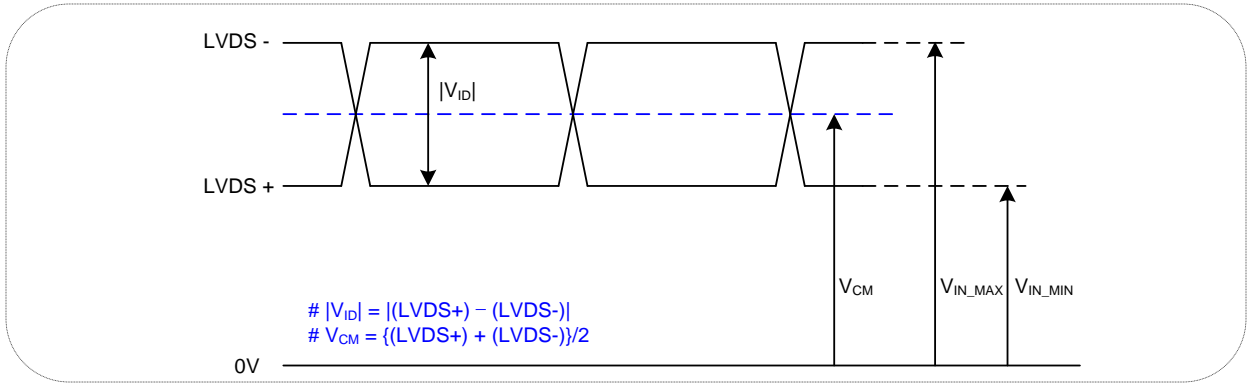


Figure 3. Backlight connector view

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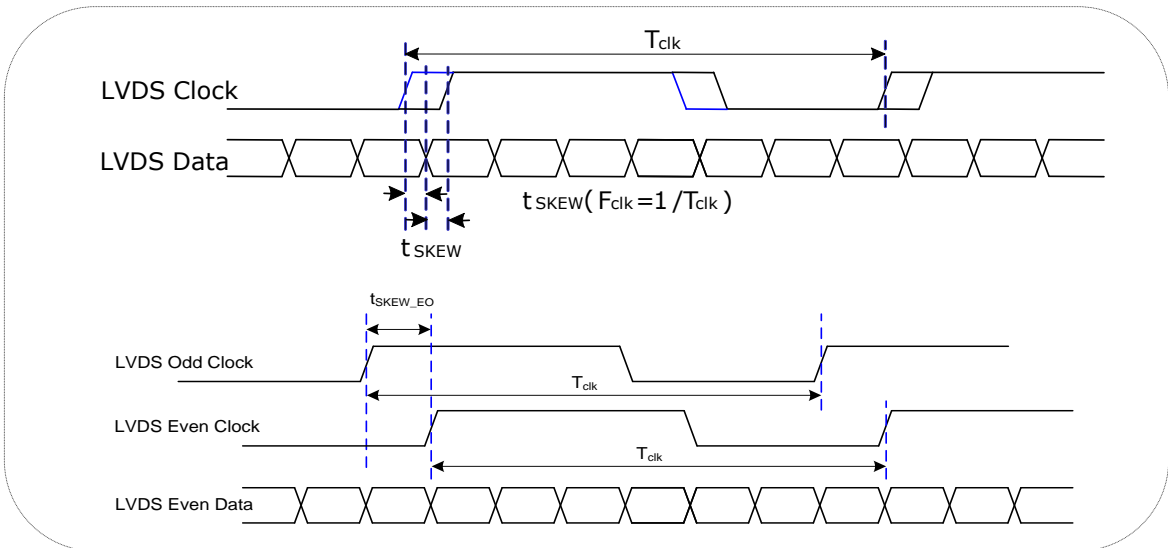
3-3. LVDS characteristics

3-3-1. DC Specification



| Description | Symbol | Min | Max | Unit | Notes |
|-------------------------------|-----------------|-----|-----|------|-------|
| LVDS Differential Voltage | $ V_{ID} $ | 200 | 600 | mV | - |
| LVDS Common mode Voltage | V_{CM} | 1.0 | 1.5 | V | - |
| LVDS Input Voltage Range | V_{IN} | 0.7 | 1.8 | V | - |
| Change in common mode Voltage | ΔV_{CM} | - | 250 | mV | - |

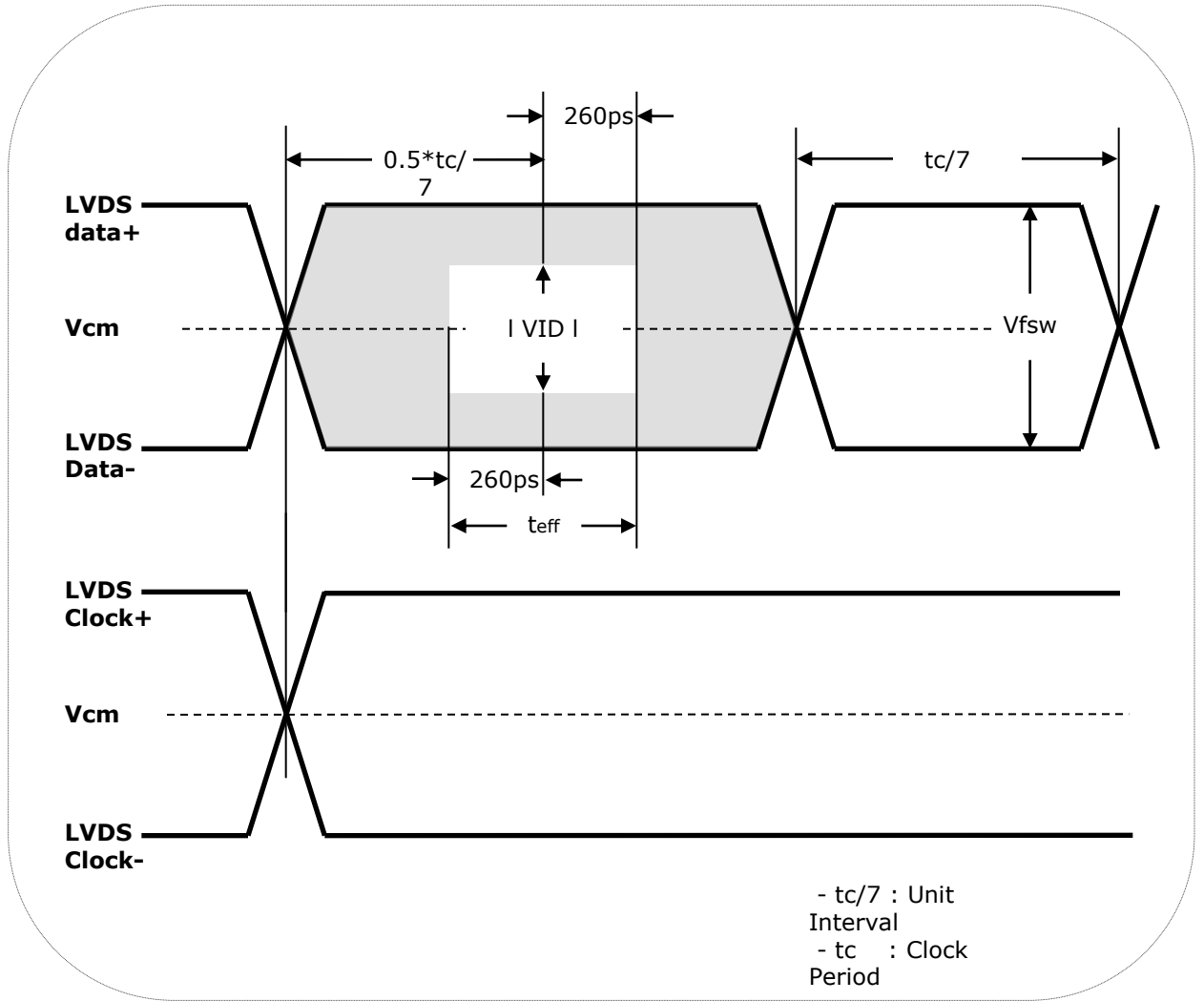
3-3-2. AC Specification



| Description | Symbol | Min | Max | Unit | Notes |
|---------------------------------|----------------|---------------------------|---------------------------|-----------|-------|
| LVDS Clock to Data Skew Margin | t_{SKEW} | $-(0.25 \cdot t_{CLK})/7$ | $+(0.25 \cdot t_{CLK})/7$ | ps | - |
| LVDS Clock to Clock Skew Margin | t_{SKEW_EO} | $-1/7$ | $+1/7$ | T_{clk} | - |
| Effective time of LVDS | t_{eff} | 520 | | ps | - |

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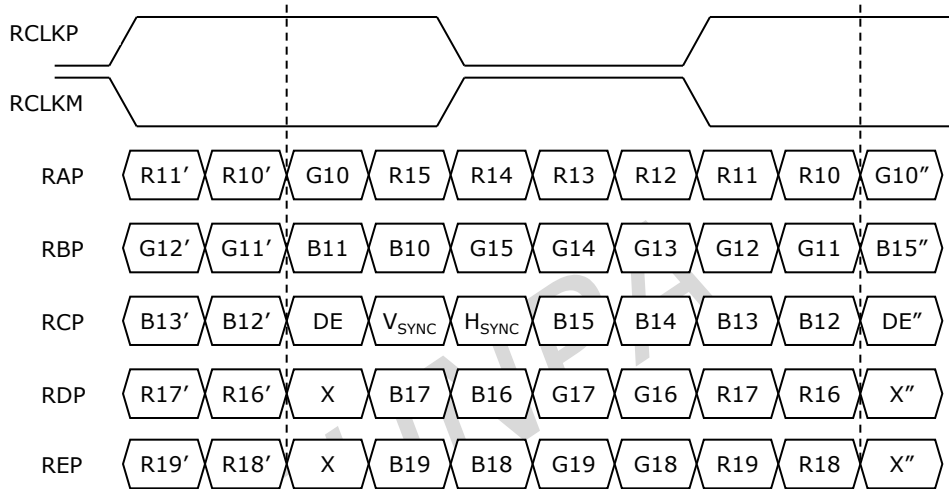
- LVDS Effective Period



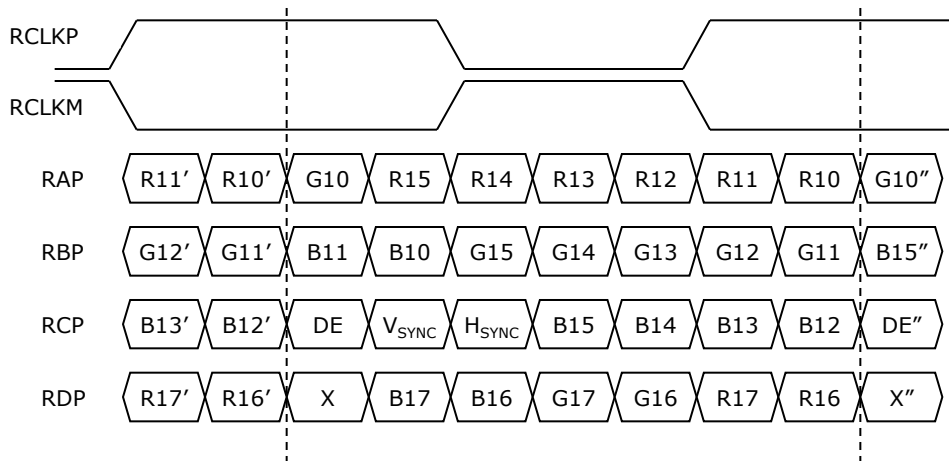
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3-3-3. LVDS Data format (Bit Select)

■ Bit Select "H" : 10Bit Data-Mapping (VESA format)



■ Bit Select "L" : 8Bit Data-Mapping (VESA format)



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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 for it's proper operation.

Table 4. TIMING TABLE (VESA COORDINATED VIDEO TIMING)

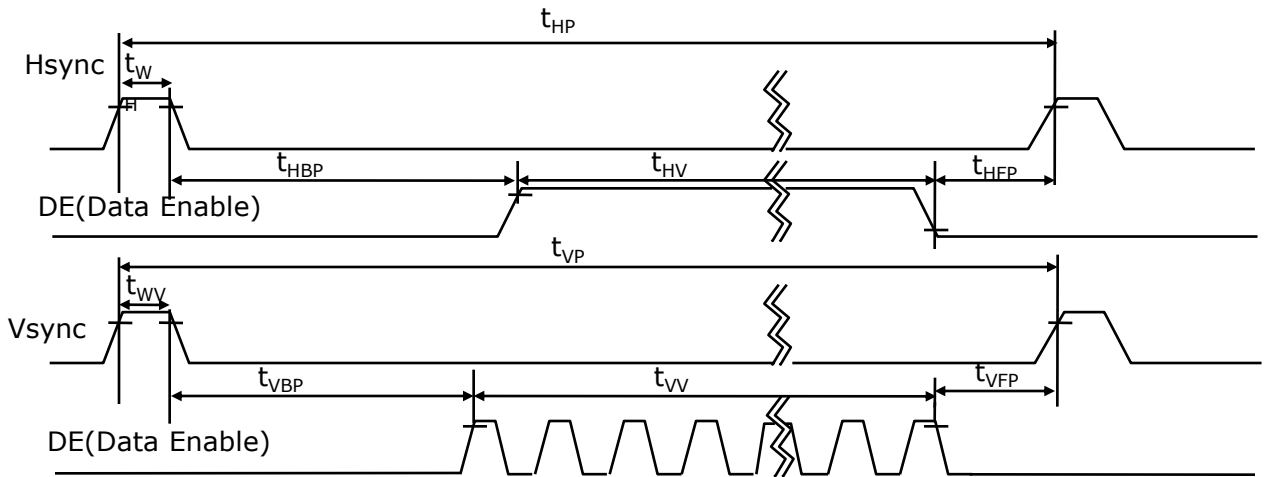
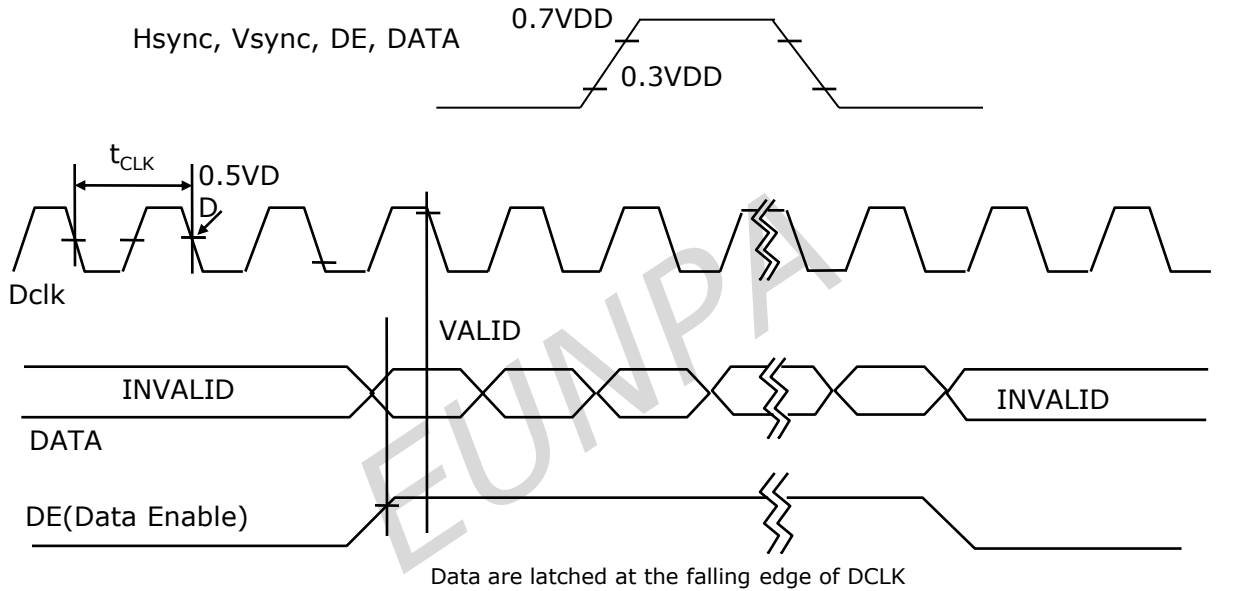
| Parameter | | Symbol | Min. | Typ. | Max. | Unit | Notes |
|-----------|------------------------|--------|-------|-------|-------|------|-----------------------------------|
| DCLK | Period | tCLK | 16.46 | 16.56 | 16.67 | ns | Pixel frequency : Typ.241.5MHz |
| | Frequency | fCLK | 60 | 60.38 | 60.75 | MHz | |
| Hsync | Period | tHP | 678 | 680 | 682 | tCLK | |
| | Width-Active | tWH | 8 | 8 | 8 | | |
| Vsync | Period | tVP | 1479 | 1481 | 1483 | tHP | |
| | Frequency | fV | 59.38 | 59.95 | 60.12 | Hz | |
| | Width-Active | tWV | 5 | 5 | 5 | tHP | |
| Data | Horizontal Valid | tHV | 640 | 640 | 640 | tCLK | |
| | Horizontal Back Porch | tHBP | 18 | 20 | 22 | | |
| | Horizontal Front Porch | tHFP | 10 | 12 | 14 | | |
| | Horizontal Blank | - | 36 | 40 | 44 | | tWH+ tHBP+ tHFP |
| Enable | Vertical Valid | tVV | 1440 | 1440 | 1440 | tHP | |
| | Vertical Back Porch | tVBP | 32 | 33 | 34 | | |
| | Vertical Front Porch | tVFP | 2 | 3 | 4 | | |
| | Vertical Blank | - | 39 | 41 | 43 | | tWV+ tVBP+ tVFP |

Note:

1. DE Only mode operation. The input of Hsync & Vsync signal does not have an effect on LCD normal operation.
2. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
3. Horizontal period should be even.

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3-5. Signal Timing Waveforms



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3-6. Color Data Reference

The Brightness of each primary color(red,green,blue) is based on the 10-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 5. 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 Color | 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 (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) | 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 (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) | 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 (254) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 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 |

Product Specification

3-7. Power Sequence & Dip condition for LCD Module

3-7-1. Power Sequence

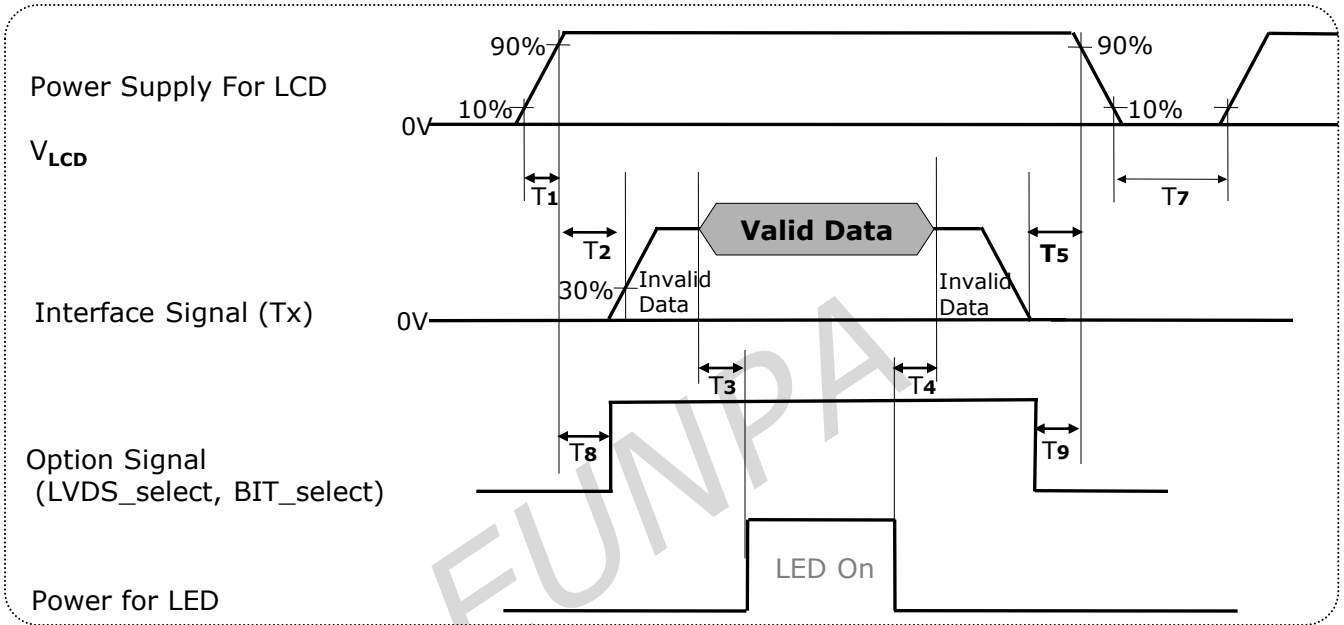


Table 6. Power sequence

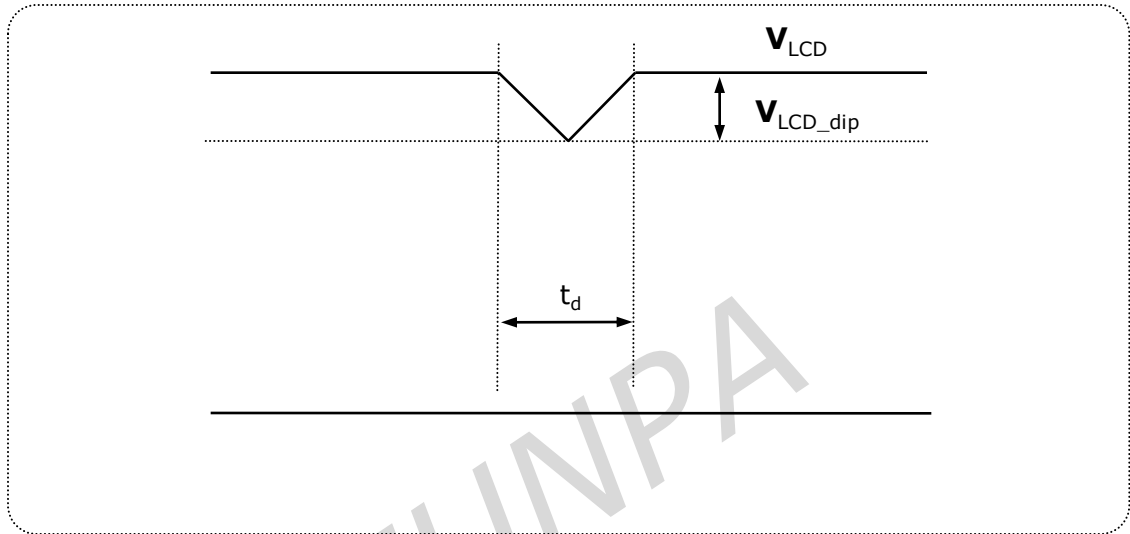
| Parameter | Values | | | Units |
|-----------|-------------|-----|-----|-------|
| | Min | Typ | Max | |
| T1 | 0.5 | - | 10 | ms |
| T2 | 0.5 | - | 50 | ms |
| T3 | 500 | - | - | ms |
| T4 | 200 | - | - | ms |
| T5 | 0.01 | - | 50 | ms |
| T7 | 1 | - | - | s |
| T8 | 0 < T8 < T2 | | | ms |
| T9 | 0 < T9 < T5 | | | ms |

Notes :

1. Please V_{LCD} power on only after connecting interface cable to LCD.
2. Please avoid floating state of interface signal at invalid period.
3. When the interface signal is invalid, be sure to pull down the power supply for LCD V_{LCD} to 0V.
4. LED power must be turn on after power supply for LCD an interface signal are valid.

Product Specification

3-7-2. V_{LCD} Power Dip Condition



Notes :

Dip condition

$$V_{LCD_dip} \leq V_{LCD_typ} \times 0.2, \quad t_d \leq 10ms$$

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 Φ and θ equal to 0° and aperture 1 degree.

FIG. 4 presents additional information concerning the measurement equipment and method.

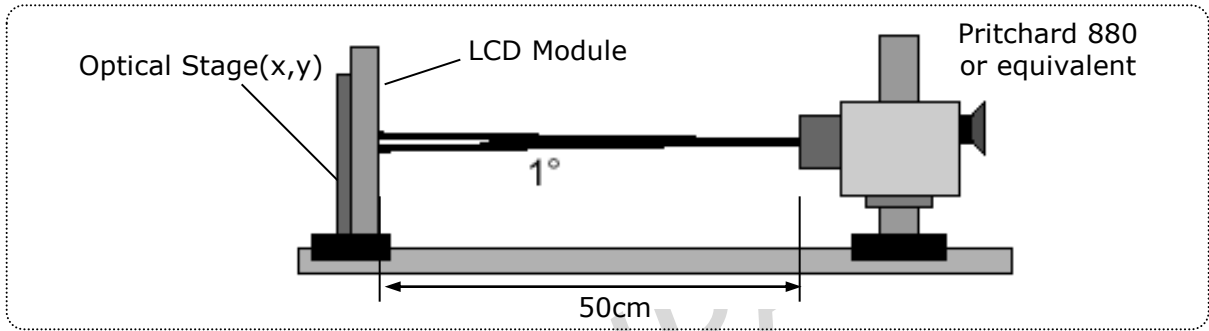


FIG. 4 Optical Characteristic Measurement Equipment and Method

Table 7. OPTICAL CHARACTERISTICS ($T_a=25^\circ\text{C}$, $V_{\text{LCD}}=12.0\text{V}$, $f_v=60\text{Hz}$ Dclk=241.5MHz)

| Parameter | Symbol | Values | | | Units | Notes | |
|--------------------------------|-------------------------|------------------------------|-------|-------|-------------------|--------|---|
| | | Min | Typ | Max | | | |
| Contrast Ratio | CR | 700 | 1000 | - | | 1 | |
| Surface Luminance, white | L_{WH} | 280 | 350 | - | cd/m ² | 2 | |
| Luminance Variation | δ_{WHITE} | 75 | | | % | 3 | |
| Response Time | Gray to Gray | T_{GTG} | - | 12 | 24 | ms | 5 |
| | | $T_{\text{GTG}}(\text{ODC})$ | - | 6 | 12 | | |
| Color Coordinates [CIE1931] | RED | Rx | | 0.653 | | | |
| | | Ry | | 0.336 | | | |
| | GREEN | Gx | | 0.295 | | | |
| | | Gy | Typ | 0.640 | Typ | | |
| | BLUE | Bx | -0.03 | 0.146 | +0.03 | | |
| | | By | | 0.042 | | | |
| | | Wy | | 0.329 | | | |
| Color Shift | Horizontal | θ_{CST_H} | - | 178 | - | Degree | 6 |
| | Vertical | θ_{CST_V} | - | 178 | - | | |
| Viewing Angle (CR>10) | | | | | | | |
| General | Horizontal | θ_H | 170 | 178 | - | Degree | 7 |
| | Vertical | θ_V | 170 | 178 | - | | |
| Effective | Horizontal | θ_{GMA_H} | | 178 | - | Degree | 8 |
| | Vertical | θ_{GMA_V} | | 178 | - | | |
| Gray Scale | | | | 2.2 | | | 9 |

Product Specification

Notes 1. Contrast Ratio(CR) is defined mathematically as : (By PR880)

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

It is measured at center point(Location P1)

2. Surface luminance(L_{WH}) is luminance value at 1 point across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 5.

3. The variation in surface luminance , δ WHITE is defined as : (By PR880)

$$\delta_{WHITE} = \frac{\text{Minimum}(L_{P1}, L_{P2}, \dots, L_{P9})}{\text{Maximum}(L_{P1}, L_{P2}, \dots, L_{P9})} \times 100$$

Where L1 to L9 are the luminance with all pixels displaying white at 9 locations. For more information see FIG 5.

4. Response time is the time required for the display to transition from black to white (Rise Time, Tr_R) and from white to black (Decay Time, Tr_D). For additional information see FIG 6.

5. Gray to gray response time is the time required for the display to transition from gray to gray. For additional information see Table 8. (By PR880)

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

For more information see FIG 7. (By EZ Contrast)

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

$$u' = \frac{4x}{-2x + 12y + 3} \quad v' = \frac{9y}{-2x + 12y + 3}$$

$$\Delta u'v' = \sqrt{(u'_1 - u'_2)^2 + (v'_1 - v'_2)^2} \quad \begin{array}{l} u'_1, v'_1 : u'v' \text{ value at viewing angle direction} \\ u'_2, v'_2 : u'v' \text{ value at front } (\theta=0) \end{array}$$

- Pattern size : 25% Box size

- Viewing angle direction of color shift : Horizontal, Vertical

7. 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 8. (By PR880)

8. Effective viewing angle is the angle at which the gamma shift of gray scale is lower than 0.3. For more information see FIG 9 and FIG 10.

9. Gray scale specification

Gamma Value is approximately 2.2. For more information see Table 9.

Product Specification

Measuring point for surface luminance & measuring point for luminance variation.

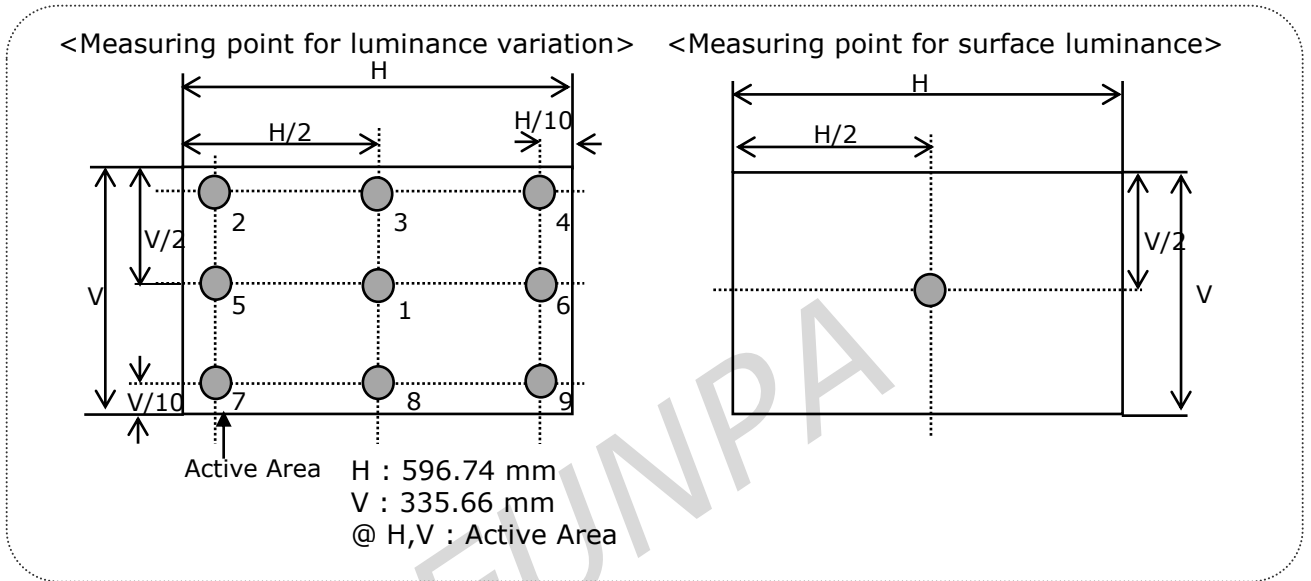


FIG. 5 Measure Point for Luminance

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

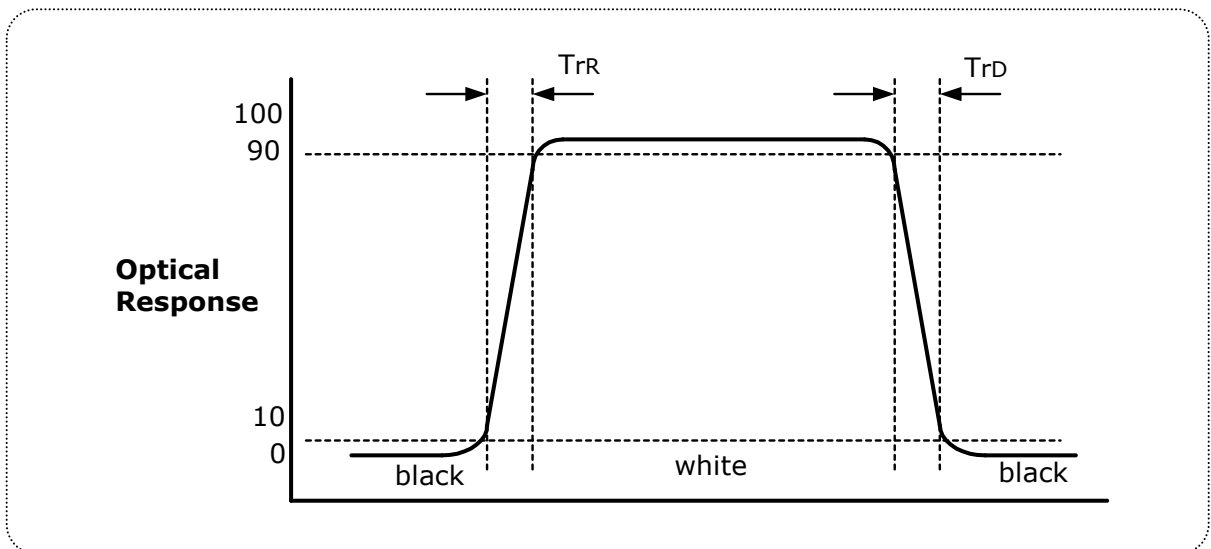


FIG. 6. Response Time

Product Specification

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".

Table 8. Gray to gray response time table

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

Color shift is defined as the following test pattern and color.

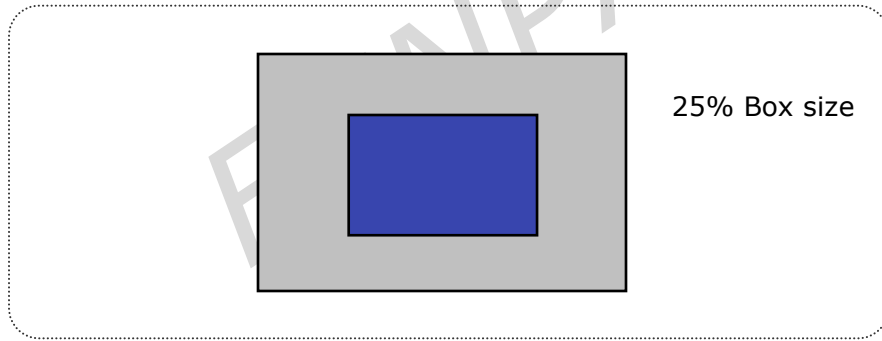


FIG. 7 Test Pattern

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

Dimension of viewing angle range.

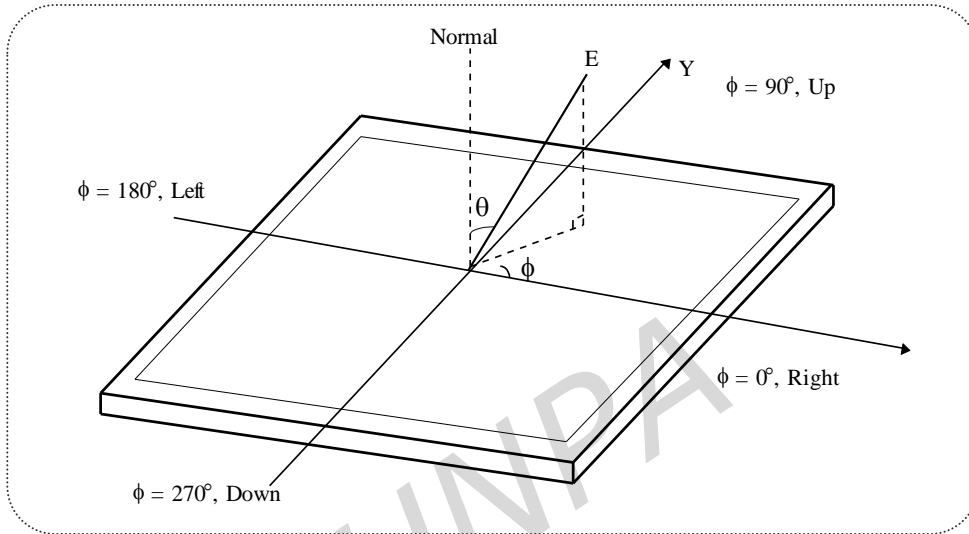


FIG. 8 Viewing angle

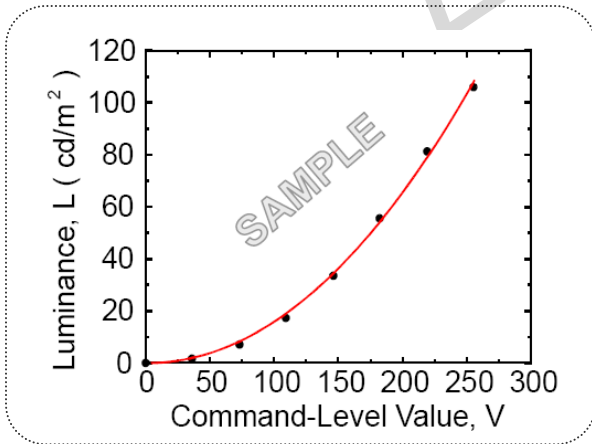


FIG. 9 Sample Luminance vs. gray scale (using a 256 bit gray scale)

$$L = aV^r + L_b$$

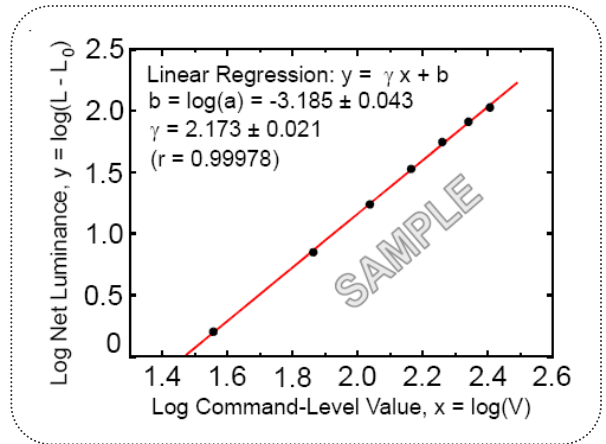


FIG. 10 Sample Log-log plot of luminance vs. gray scale

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

Here the Parameter a and γ relate the signal level V to the luminance L .
The GAMMA we calculate from the log-log representation (FIG. 10)

Product Specification

Table 9. Gray Scale Specification

| Gray Level | Relative Luminance [%] (Typ.) |
|------------|-------------------------------|
| 0 | 0.10 |
| 31 | 1.08 |
| 63 | 4.71 |
| 95 | 11.5 |
| 127 | 21.7 |
| 159 | 35.5 |
| 191 | 53.1 |
| 223 | 74.5 |
| 255 | 100 |

Product Specification

5. Mechanical Characteristics

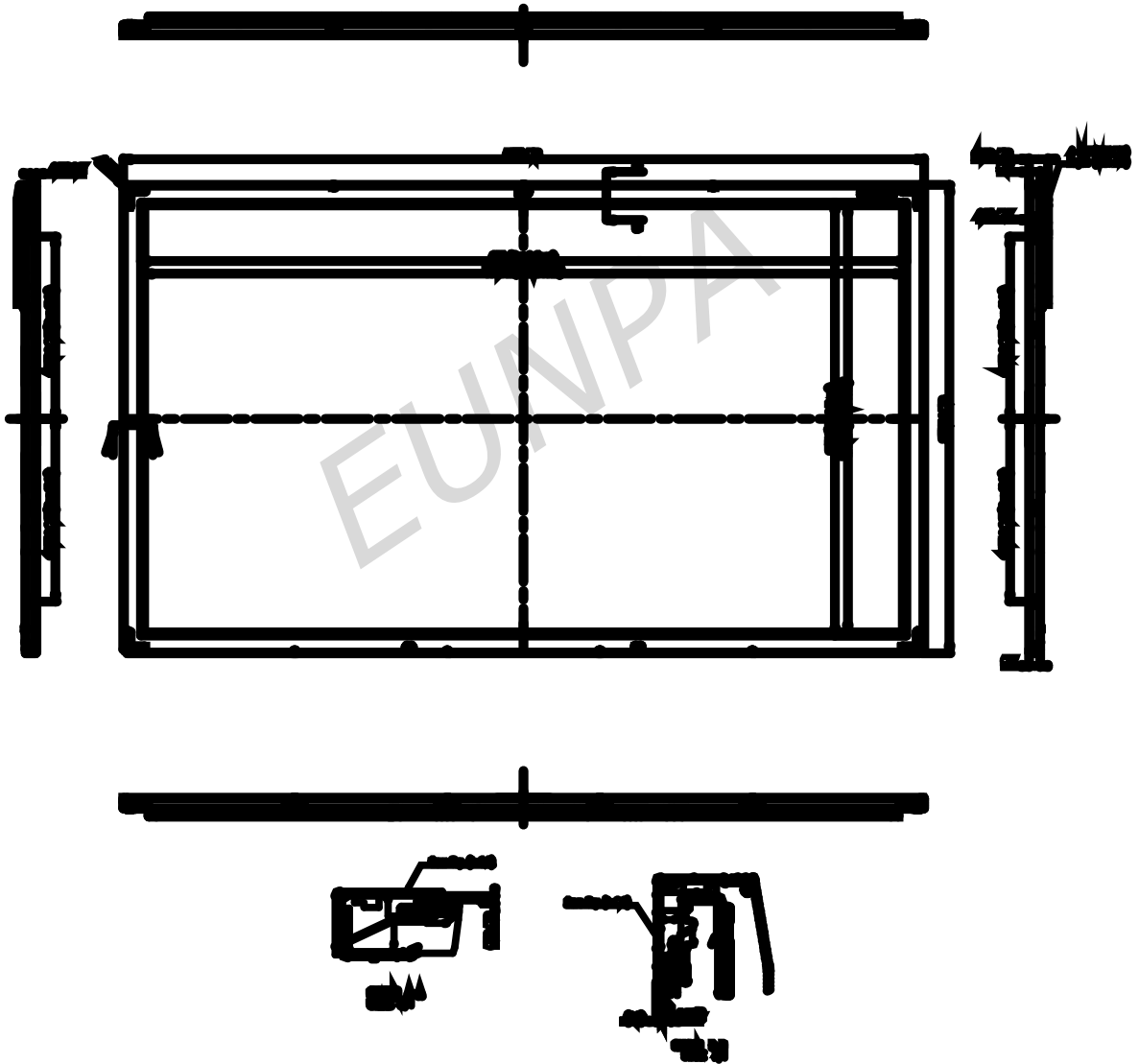
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

| | | |
|---------------------|---|----------|
| Outline Dimension | Horizontal | 630.0mm |
| | Vertical | 368.2mm |
| | Depth | 14.9mm |
| Bezel Area | Horizontal | 602.0mm |
| | Vertical | 340.4mm |
| Active Display Area | Horizontal | 596.74mm |
| | Vertical | 335.66mm |
| Weight | 3,470g (Typ.) / 3,645g (Max.) | |
| Surface Treatment | Hard coating(3H) Anti-glare treatment of the front polarizer | |

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

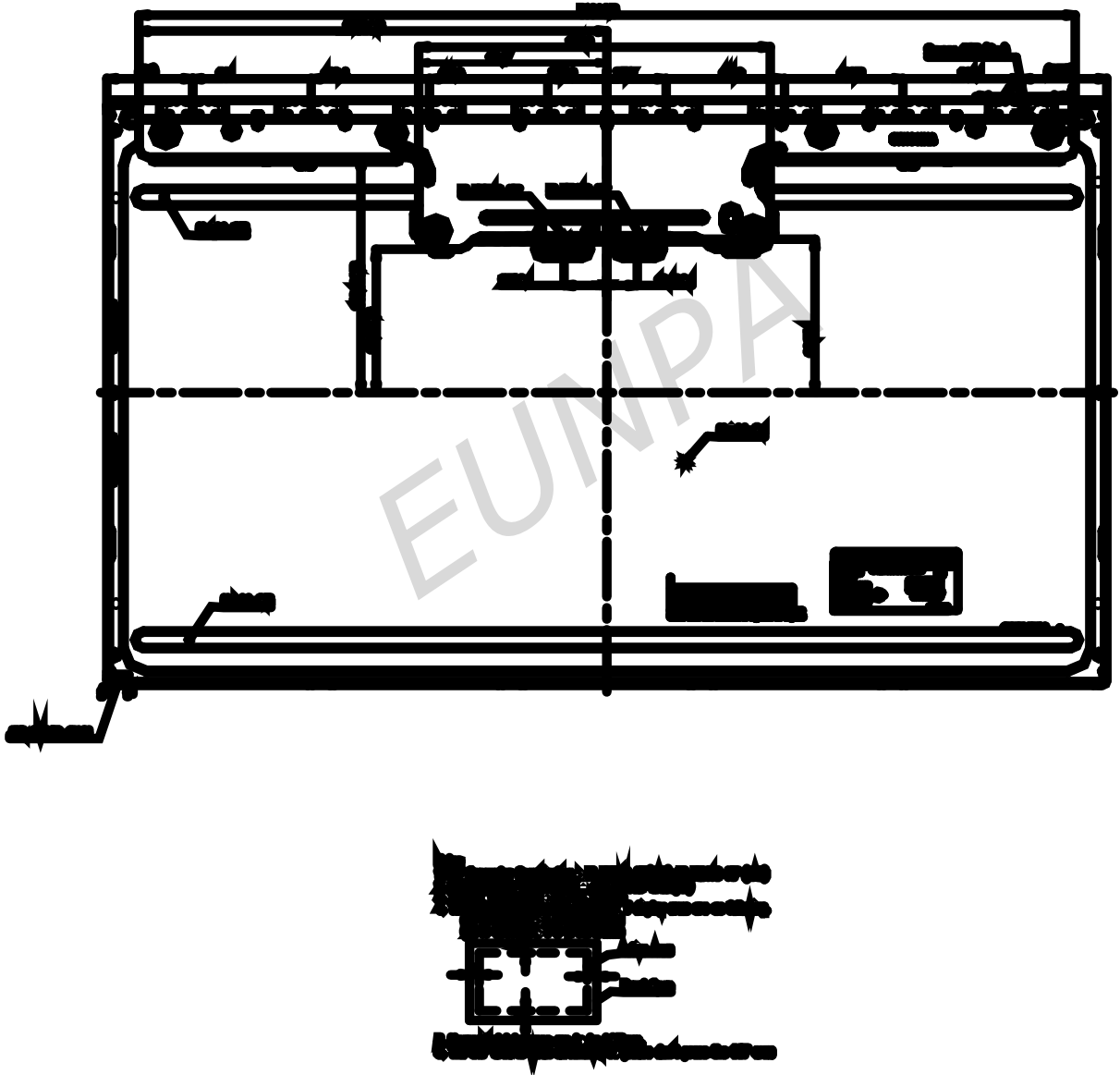
Product Specification

<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 (non-operating) | Wave form : random Vibration level : 1.0G RMS Bandwidth : 10-300Hz Duration : X,Y,Z, 10 min One time each direction |
| 6 | Shock test (non-operating) | Shock level : 100Grms Waveform : half sine wave, 2ms Direction : ±X, ±Y, ±Z One time each direction |
| 7 | Altitude Operating Storage / Shipment | 0 - 16,500 feet(5,000m) 0 - 40,000 feet(12,192m) |

Product Specification

7. International Standards

7-1. Safety

- a) UL 60950-1, Underwriters Laboratories Inc.
Information Technology Equipment - Safety - Part 1 : General Requirements.
- b) CAN/CSA C22.2 No.60950-1-07, Canadian Standards Association.
Information Technology Equipment - Safety - Part 1 : General Requirements.
- c) EN 60950-1, European Committee for Electrotechnical Standardization (CENELEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.
- d) IEC 60950-1, The International Electrotechnical Commission (IEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.
(Including report of IEC60825-1:2001 clause 8 and clause 9)

Notes

1. Laser (LED Backlight) Information

Class 1M LED Product
 IEC60825-1 : 2001
 Embedded LED Power (Class1M)

2. Caution
 : LED inside.
 Class 1M laser (LEDs) radiation when open.
 Do not open while operating.

7-2. EMC

- a) ANSI C63.4-2003 "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40GHz."
American National Standards Institute (ANSI), 2003.
- b) C.I.S.P.R. Pub. 22. Limits and methods of measurement of radio interference characteristics of information technology equipment." International Special Committee on Radio Interference (C.I.S.P.R.), 2005.
- c) EN 55022 "Limits and methods of measurement of radio interference characteristics of information technology equipment." European Committee for Electrotechnical Standardization (CENELEC), 2006.

7-3. Environment

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

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)
E : Month

D : Year
F ~ M : Serial No.

Note:

1. Year

| | | | | | | | | | | |
|------|------|------|------|------|------|------|------|------|------|------|
| Year | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
| Mark | A | B | C | D | E | F | G | H | J | K |

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 : 10ea

b) Box Size : 355mm X 700mm X 430mm

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.
- (10) As The IPS panel is sensitive & slim, please recommend the metal frame of the system supports the panel by the double side-mount.

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 Higher 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.
- (7) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can not be operated its full characteristics perfectly.
- (8) A screw which is fastened up the steels should be a machine screw (if not, it causes metal foreign material and deal LCM a fatal blow)
- (9) Please do not set LCD on its edge.
- (10) When LCMs are used for public display defects such as Yogore, image sticking can not be guarantee.
- (11) Partial darkness may happen during 3~5 minutes when LCM is operated initially in condition that luminance is under 40% at low temperature (under 5°C). This phenomenon which disappears naturally after 3~5 minutes is not a problem about reliability but LCD characteristic
- (12) LCMs cannot support "Interlaced Scan Method"

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.