

**LM270WFA**  
**Liquid Crystal Display**

## Product Specification

# SPECIFICATION FOR APPROVAL

(●) Preliminary Specification  
( ) Final Specification

|       |                   |
|-------|-------------------|
| TITLE | 27.0" FHD TFT LCD |
|-------|-------------------|

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

|          |                      |
|----------|----------------------|
| SUPPLIER | LG Display Co., Ltd. |
| MODEL    | LM270WFA             |
| SUFFIX   | SSA1                 |

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

| APPROVED BY | SIGNATURE | DATE |
|-------------|-----------|------|
| /           |           |      |
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Please return 1 copy for your confirmation  
with your signature and comments.

| APPROVED BY                | SIGNATURE | DATE |
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**LM270WFA**  
**Liquid Crystal Display**
**Product Specification**
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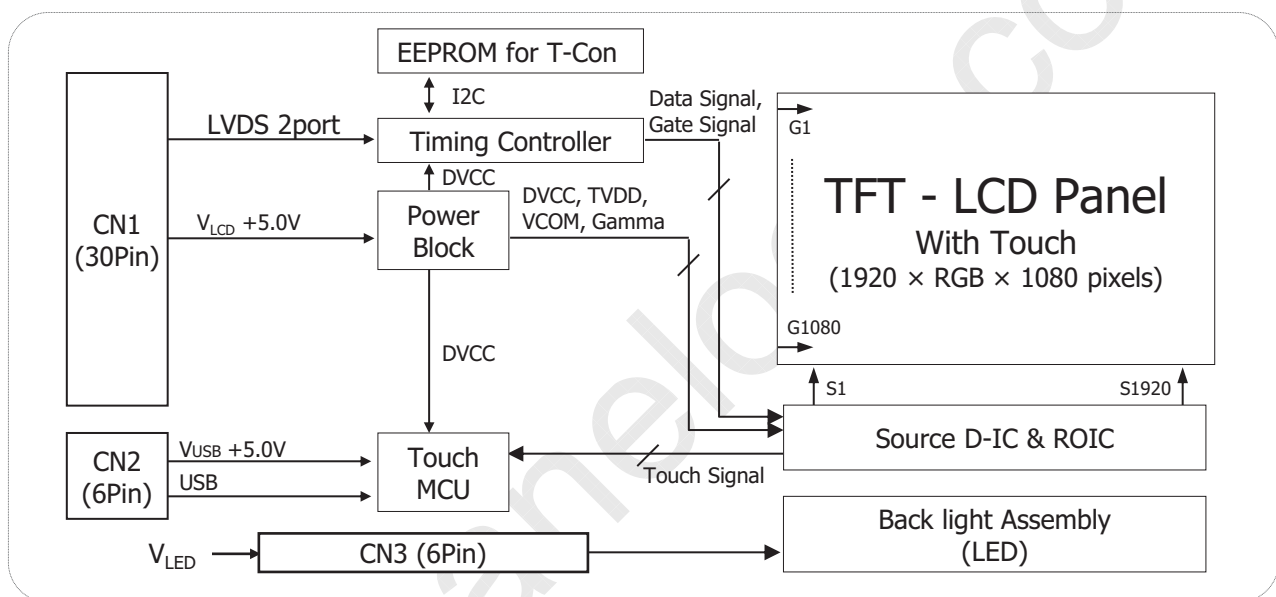
## Record of Revisions

[illegible]

## Product Specification

### 1. General Description

LM270WFA is a color active matrix liquid crystal display with Advanced In-cell Touch 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. It has a 27 inch 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 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16.78 Million colors with A-FRC (Advanced Frame Rate Control). It has been designed to apply 8-bit 2port LVDS interface. It is intended to support displays where thin thickness, wide viewing angle and touch function are important.



**FIG.1 Block Diagram**

### General Features

|                        |                                                                                      |
|------------------------|--------------------------------------------------------------------------------------|
| Active Screen Size     | 27 inches (68.59cm)(Aspect ratio 16:9)                                               |
| Outline Dimension      | 607.1(H) x 354.1(V) x 12.1(D) mm(Typ.)                                               |
| Pixel Pitch            | 0.3114(H) x 0.3114(V) mm                                                             |
| Pixel Format           | 1920(H) x 1080(V) Pixels. RGB stripes arrangement.                                   |
| Color Depth            | 16.78 Million colors, 8 Bit (6 Bit + A-FRC)                                          |
| Luminance, White       | 300 cd/m <sup>2</sup> (Center 1Point, Typ.)                                          |
| Viewing Angle(CR>10)   | R/L 178° (Typ.), U/D 178° (Typ.)                                                     |
| Power Consumption      | Total 2.66 Watt (Typ.) (18.06 Watt@ Mosaic_V <sub>LCD</sub> , 15.4 Watt@ Is = 85 mA) |
| Weight                 | 3140 g (Typ.)                                                                        |
| Display Operating Mode | Transmissive mode, Normally black                                                    |
| Panel type             | Reverse type                                                                         |
| Surface Treatment      | Glare treatment of the front polarizer (3H)                                          |

## Product Specification

### 2. Absolute Maximum Ratings

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

**Table 2-1. Absolute Maximum Ratings**

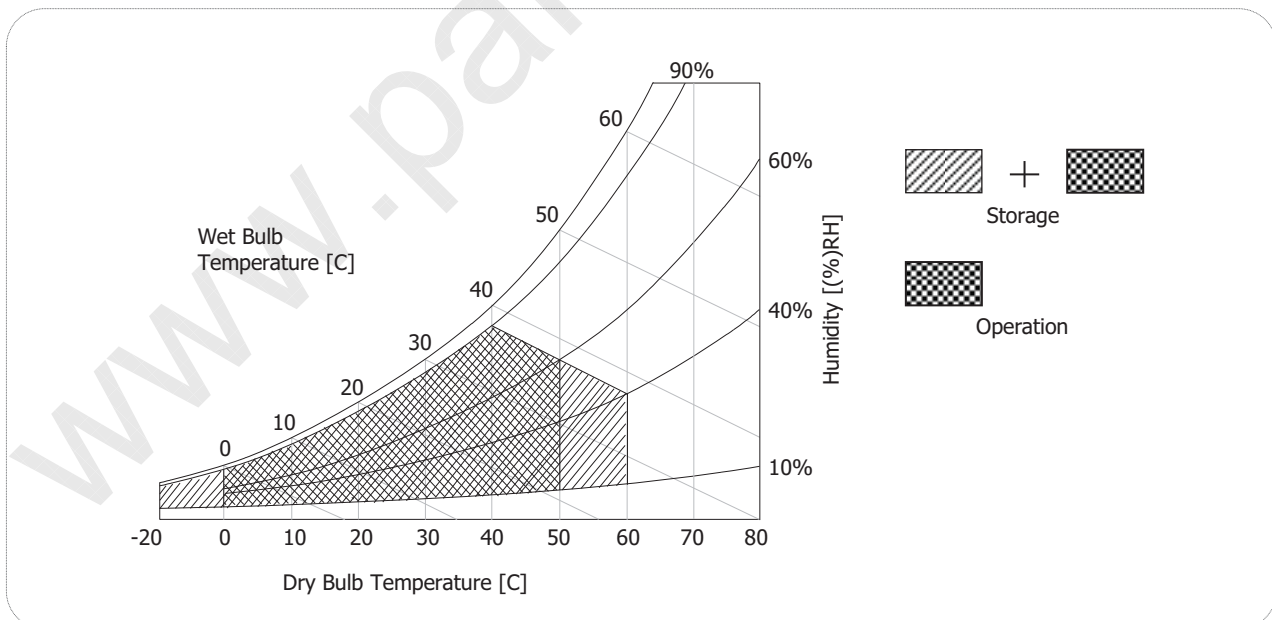
| Parameter                          | Symbol        | Values |      | Units    | Notes   |
|------------------------------------|---------------|--------|------|----------|---------|
|                                    |               | Min    | Max  |          |         |
| Power Supply Input Voltage         | $V_{LCD}$     | -0.3   | +6.0 | $V_{DC}$ | At 25°C |
| Operating Temperature              | $T_{OP}$      | 0      | 50   | °C       | 1,2,3   |
| Storage Temperature                | $T_{ST}$      | -20    | 60   | °C       |         |
| Operating Ambient Humidity         | $H_{OP}$      | 10     | 90   | %RH      |         |
| Storage Humidity                   | $H_{ST}$      | 10     | 90   | %RH      |         |
| LCM Surface Temperature(Operation) | $T_{surface}$ | 0      | 65   | °C       | 1,4     |

Notes:

- 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.
- 4) LCM surface temperature should be measured under the condition of  $V_{LCD} = Typ$ ,  $f_v = 60Hz$ ,  $T_a = 25°C$ , no humidity and typical LED string current.

\*  $f_v$  = Frame frequency

\*  $T_a$  = Ambient temperature



**FIG.2 Temperature And Relative Humidity**



## LM270WFA Liquid Crystal Display

### Product Specification

## 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 other input power for the LED/Backlight, is typically generated by a LED Driver. The LED Driver is an external unit to the LCDs.

**Table 3-1. Electrical Characteristics**

| Parameter                     | Symbol                | Values |      |      | Unit  | Notes |
|-------------------------------|-----------------------|--------|------|------|-------|-------|
|                               |                       | Min    | Typ  | Max  |       |       |
| Module:                       |                       |        |      |      |       |       |
| Power Supply Input voltage    | V <sub>LCD</sub>      | 4.5    | 5.0  | 5.5  | Vdc   | 4     |
|                               | V <sub>USB</sub>      | 4.5    | 5.0  | 5.5  | Vdc   |       |
| Permissive Power Input Ripple | V <sub>RIPPLE</sub>   | -      |      | 400  | mVp-p | 1     |
| Power Supply Input Current    | I <sub>LCD</sub> Typ. | -      | 531  | 664  | mA    | 2     |
|                               | I <sub>LCD</sub> Max. | -      | 645  | 807  | mA    |       |
| Power Consumption             | P <sub>LCD</sub> Typ. | -      | 2.66 | 3.32 | Watt  |       |
|                               | P <sub>LCD</sub> Max. |        | 3.23 | 4.03 | Watt  |       |
| Rush Current                  | I <sub>RUSH</sub>     | -      | -    | 3    | A     | 3     |

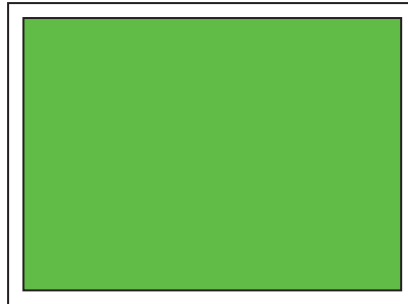
Notes:

- 1) Permissive power ripple should be measured under the condition of V<sub>LCD</sub> = Typ, 25±2℃, f<sub>v</sub> = Max.  
Refer to page 7 for the pattern and more information.
- 2) The specified current and power consumption can be measured under the V<sub>LCD</sub> = Typ, 25±2℃, f<sub>v</sub> = 60Hz and the pattern should be changed according to the typical or maximum power condition.  
The max. current can be measured only with the maximum power pattern. See the page 7 for details.
- 3) Maximum condition of inrush current:  
The duration of rush current is about 5ms and rising time of power input is 500us ±20%.(Min).
- 4) V<sub>LCD</sub> level must be measured between two points on PCB of LCM V<sub>LCD</sub>(test point) ~ LCM Ground.  
(Test condition: Maximum power pattern, 25℃, f<sub>v</sub> = 60Hz)

\* f<sub>v</sub> = Frame frequency

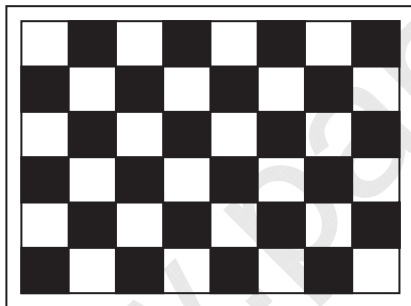
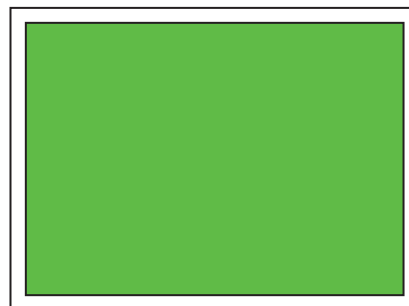
**Product Specification**

- **Permissive Power Input Ripple**( $V_{LCD} = \text{Typ}$ ,  $25^{\circ}\text{C}$ ,  $f_V(\text{frame frequency}) = \text{Max condition}$ )

**Full Green Pattern**

For the exact ripple measurement, the condition of Max 20MHz is recommended in the bandwidth configuration of oscilloscope.

- **Power Consumption**( $V_{LCD} = \text{Typ}$ ,  $25^{\circ}\text{C}$ ,  $f_V(\text{frame frequency}) = 60\text{Hz condition}$ )

**Typical Power Pattern****Maximum Power Pattern****FIG.3-1 Mosaic Pattern & Full Green Pattern For Power Consumption Measurement**

**Product Specification**
**Table 3-2. LED Bar Electrical Characteristics**

| Parameter          | Symbol | Values |       |       | Unit | Notes |
|--------------------|--------|--------|-------|-------|------|-------|
|                    |        | Min    | Typ   | Max   |      |       |
| LED String Current | Is     | -      | 85    | 90    | mA   | 1,2   |
| LED String Voltage | Vs     | 42.08  | 45.28 | 48.48 | V    | 1,3   |
| Power Consumption  | PBar   | -      | 15.40 | 16.48 | Watt | 2,5   |
| LED Life Time      | LED_LT | 30,000 | -     | -     | Hrs  | 4     |

Note: The LED consists of 64LED packages, 4 strings(parallel) x 16 packages(serial) x 1 bar

**Notes:**

- 1) The specified values are for single LED bar.
- 2) The specified current is defined as the input current for single LED string with 100% duty cycle.
- 3) The specified voltage is the input LED string voltage at typical current 100% duty cycle.
- 4) The LED life time is defined as the when brightness of LED itself reach to the 50% of initial value under the conditions at  $T_a = 25 \pm 2^\circ\text{C}$  and typical LED string current.
- 5) The power consumption shown above does not include the loss of external LED 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  $P_{\text{Bar}} = V_s(\text{Max.}) \times I_s(\text{Typ.}) \times \text{No. of strings}$ .

## Product Specification

### 3-2. Interface Connections

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

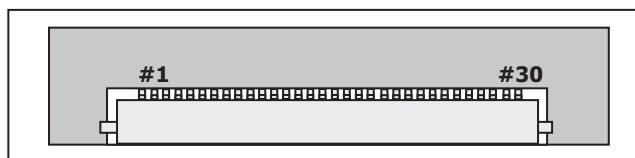
- LCD Connector(Receptacle): IS100-L300-C23(Manufactured by UJU)
- Mating Connector(Plug): FI-X30C2L(Manufactured by JAE) or equivalent

**Table 3-3. Module Connector(CN1) Pin Configuration**

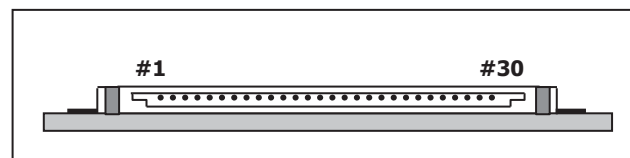
| No | Symbol | Description                             | No | Symbol           | Symbol                                            |
|----|--------|-----------------------------------------|----|------------------|---------------------------------------------------|
| 1  | RX00-  | Minus signal of odd channel 0(LVDS)     | 16 | RXE1+            | Plus signal of even channel 1(LVDS)               |
| 2  | RX00+  | Plus signal of odd channel 0(LVDS)      | 17 | GND              | Ground                                            |
| 3  | RX01-  | Minus signal of odd channel 1(LVDS)     | 18 | RXE2-            | Minus signal of even channel 2(LVDS)              |
| 4  | RX01+  | Plus signal of odd channel 1(LVDS)      | 19 | RXE2+            | Plus signal of even channel 2(LVDS)               |
| 5  | RX02-  | Minus signal of odd channel 2(LVDS)     | 20 | RXEC-            | Minus signal of even clock channel(LVDS)          |
| 6  | RX02+  | Plus signal of odd channel 2(LVDS)      | 21 | RXEC+            | Plus signal of even clock channel(LVDS)           |
| 7  | GND    | Ground                                  | 22 | RXE3-            | Minus signal of even channel 3(LVDS)              |
| 8  | RXOC-  | Minus signal of odd clock channel(LVDS) | 23 | RXE3+            | Plus signal of even channel 3(LVDS)               |
| 9  | RXOC+  | Plus signal of odd clock channel(LVDS)  | 24 | GND              | Ground                                            |
| 10 | RX03-  | Minus signal of odd channel 3(LVDS)     | 25 | NC               | No Connection(I2C serial interface for LCM)       |
| 11 | RX03+  | Plus signal of odd channel 3(LVDS)      | 26 | NC               | No Connection(I2C serial interface for LCM)       |
| 12 | RXE0-  | Minus signal of even channel 0(LVDS)    | 27 | ITLC             | Interlace image sticking reduction mode selection |
| 13 | RXE0+  | Plus signal of even channel 0(LVDS)     | 28 | V <sub>LCD</sub> | Power Supply +5.0V                                |
| 14 | GND    | Ground                                  | 29 | V <sub>LCD</sub> | Power Supply +5.0V                                |
| 15 | RXE1-  | Minus signal of even channel 1(LVDS)    | 30 | V <sub>LCD</sub> | Power Supply +5.0V                                |

**Notes:**

- 1) All GND(ground) pins should be connected together to the LCD module's metal frame.
- 2) All V<sub>LCD</sub>(power input) pins should be connected together.
- 3) All input level of LVDS signals are based on the EIA 644 standard.
- 4) ITLC is used for image sticking reduction in interlace mode.  
 (L: Normal mode, H: Interlace image sticking reduction mode)  
 This pin should be connected to GND in normal mode.  
 (Low level Input Voltage : GND ~ 0.4V, High level Input Voltage : 1.6 ~ 3.6V)



IS100-L300-C23



Rear view of LCM

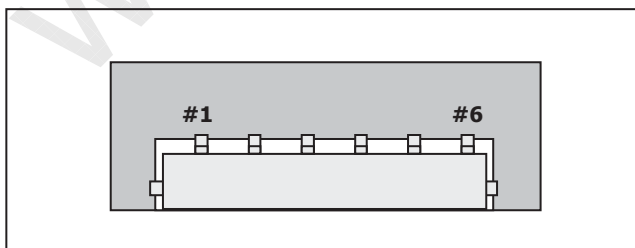
**Product Specification**

- LCD Connector(Receptacle): DF14A-6P-1.25H(HIROSE)
- Mating Connector(Plug): DF14-6S-1.25C (Manufactured by HIROSE) or equivalent

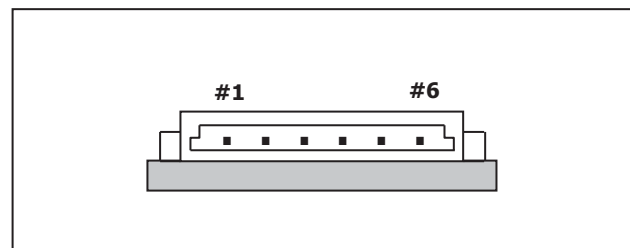
**Table 3-3-1. Module Connector(CN2) Pin Configuration**

| No | Symbol | Description                   |
|----|--------|-------------------------------|
| 1  | VUSB   | Power for USB interface (+5V) |
| 2  | USB -  | USB Data ( - ) for Touch      |
| 3  | USB +  | USB Data ( + ) for Touch      |
| 4  | GND    | Ground                        |
| 5  | GND    | Ground                        |
| 6  | GND    | Ground                        |

LGD Highly recommendation:  
Please recommend that you must shield the USB cable.



DF14A-6P-1.25H



Rear view of LCM



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### Required signal assignment for flat link(TI:SN75LVDS83) transmitter

| No | Pin Name | Required Signal            | No | Pin Name    | Required Signal                          |
|----|----------|----------------------------|----|-------------|------------------------------------------|
| 1  | VCC      | Power supply for TTL Input | 29 | GND         | Ground pin for TTL                       |
| 2  | D5       | TTL Input(R7)              | 30 | D26         | TTL Input(DE)                            |
| 3  | D6       | TTL Input(R5)              | 31 | Tx CLKIN    | TTL Level clock Input                    |
| 4  | D7       | TTL Input(G0)              | 32 | PWR DWN     | Power down Input                         |
| 5  | GND      | Ground pin for TTL         | 33 | PLL GND     | Ground pin for PLL                       |
| 6  | D8       | TTL Input(G1)              | 34 | PLL VCC     | Power supply for PLL                     |
| 7  | D9       | TTL Input(G2)              | 35 | PLL GND     | Ground pin for PLL                       |
| 8  | D10      | TTL Input(G6)              | 36 | LVDS GND    | Ground pin for LVDS                      |
| 9  | VCC      | Power supply for TTL Input | 37 | Tx OUT3 +   | Positive LVDS differential data output 3 |
| 10 | D11      | TTL Input(G7)              | 38 | Tx OUT3 -   | Negative LVDS differential data output 3 |
| 11 | D12      | TTL Input(G3)              | 39 | Tx CLKOUT + | Positive LVDS differential clock output  |
| 12 | D13      | TTL Input(G4)              | 40 | Tx CLKOUT - | Negative LVDS differential clock output  |
| 13 | GND      | Ground pin for TTL         | 41 | Tx OUT2 +   | Positive LVDS differential data output 2 |
| 14 | D14      | TTL Input(G5)              | 42 | Tx OUT2 -   | Negative LVDS differential data output 2 |
| 15 | D15      | TTL Input(B0)              | 43 | LVDS GND    | Ground pin for LVDS                      |
| 16 | D16      | TTL Input(B6)              | 44 | LVDS VCC    | Power supply for LVDS                    |
| 17 | VCC      | Power supply for TTL Input | 45 | Tx OUT1 +   | Positive LVDS differential data output 1 |
| 18 | D17      | TTL Input(B7)              | 46 | Tx OUT1 -   | Negative LVDS differential data output 1 |
| 19 | D18      | TTL Input(B1)              | 47 | Tx OUT0 +   | Positive LVDS differential data output 0 |
| 20 | D19      | TTL Input(B2)              | 48 | Tx OUT0 -   | Negative LVDS differential data output 0 |
| 21 | GND      | Ground pin for TTL Input   | 49 | LVDS GND    | Ground pin for LVDS                      |
| 22 | D20      | TTL Input(B3)              | 50 | D27         | TTL Input(R6)                            |
| 23 | D21      | TTL Input(B4)              | 51 | D0          | TTL Input(R0)                            |
| 24 | D22      | TTL Input(B5)              | 52 | D1          | TTL Input(R1)                            |
| 25 | D23      | TTL Input(RSVD)            | 53 | GND         | Ground pin for TTL                       |
| 26 | VCC      | Power supply for TTL Input | 54 | D2          | TTL Input(R2)                            |
| 27 | D24      | TTL Input(HSYNC)           | 55 | D3          | TTL Input(R3)                            |
| 28 | D25      | TTL Input(VSYNC)           | 56 | D4          | TTL Input(R4)                            |

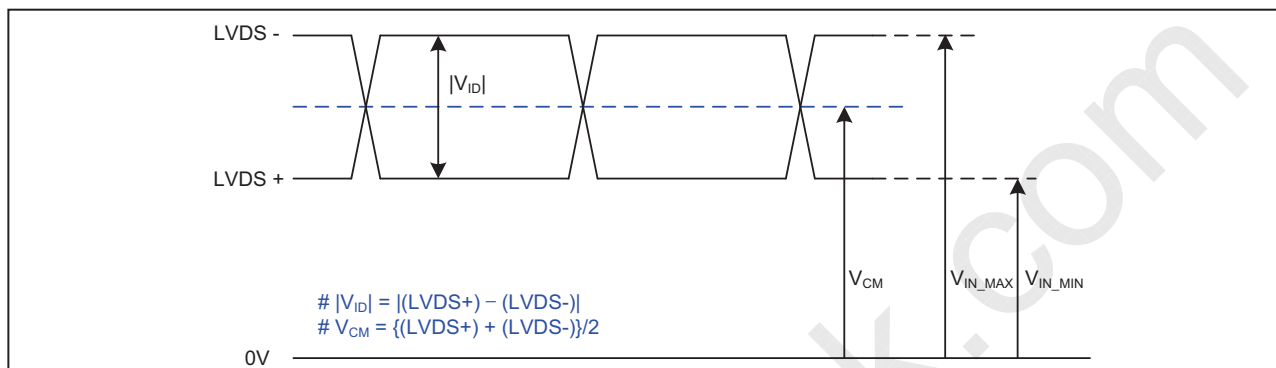
#### Notes:

- 1) Refer to LVDS transmitter data sheet for detail description.
- 2) 7 means MSB and 0 means LSB at R,G,B pixel data.

## Product Specification

## 3-2-2. LVDS Signal Specifications

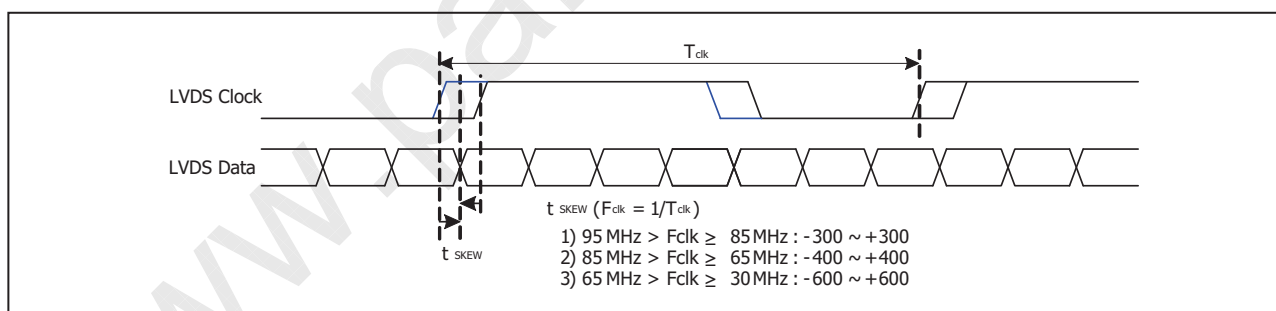
## 1. DC Specification



| Parameter                     | Symbol          | Min | Max | Unit | Notes |
|-------------------------------|-----------------|-----|-----|------|-------|
| LVDS Differential voltage     | $ V_{ID} $      | 150 | 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 | $\Delta V_{CM}$ | -   | 250 | mV   |       |

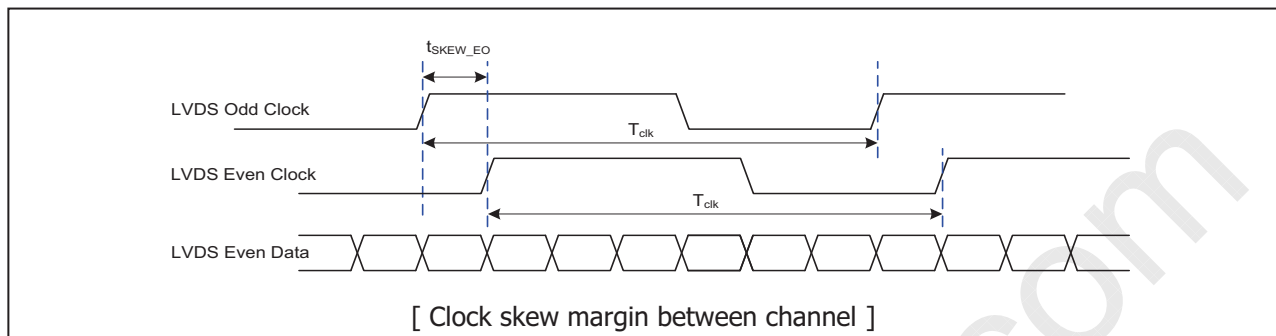
Notes: Does not have any Noise & Peaking in LVDS Signal.

## 2. AC Specification



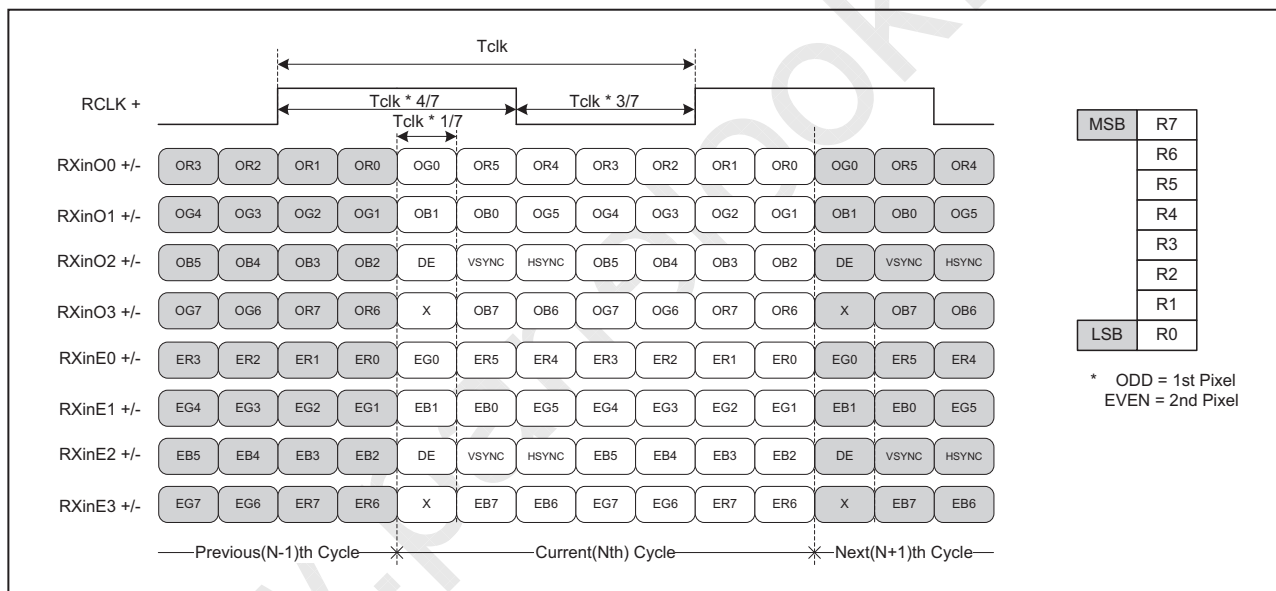
| Parameter                                    | Symbol         | Min   | Max   | Unit      | Notes                |
|----------------------------------------------|----------------|-------|-------|-----------|----------------------|
| LVDS Clock to data skew margin               | $t_{SKEW}$     | - 300 | + 300 | ps        | 95MHz > Fclk ≥ 85MHz |
|                                              | $t_{SKEW}$     | - 400 | + 400 | ps        | 85MHz > Fclk ≥ 65MHz |
|                                              | $t_{SKEW}$     | - 600 | + 600 | ps        | 65MHz > Fclk ≥ 30MHz |
| LVDS Clock to clock skew margin(Even to odd) | $t_{SKEW\_EO}$ | - 1/7 | + 1/7 | $T_{clk}$ | -                    |

## Product Specification



## 3. Data Format

## 1) LVDS 2 Port



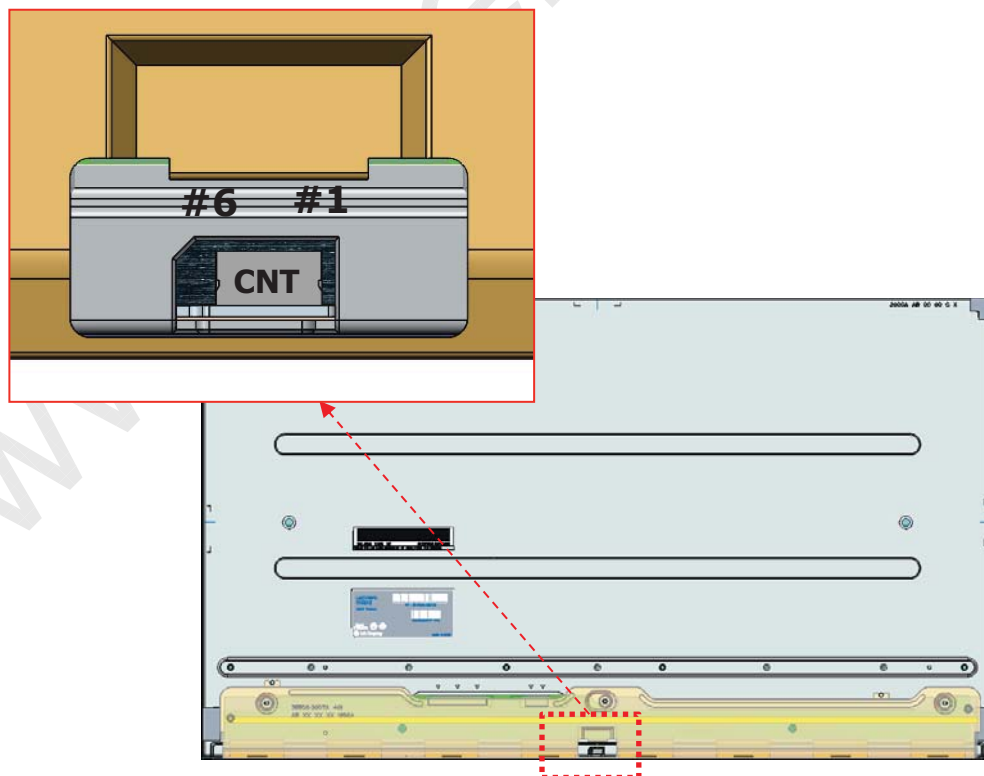
### 3-2-3. Backlight Connector Pin Configuration

The LED interface connector is a BM06B-SHJS(HF) manufactured by JST.  
 The mating connector is a SHJP-06V-S(HF) or equivalent.  
 The pin configuration for the connector is shown in the table below.

**Table 3-4. LED Connector(CN3) Pin Configuration**

| Pin | Symbol           | Pin-description                    | Notes |
|-----|------------------|------------------------------------|-------|
| 1   | FB1              | Channel 1 current feedback         | CNT A |
| 2   | FB2              | Channel 2 current feedback         |       |
| 3   | V <sub>LED</sub> | LED power supply<br>(Common Anode) |       |
| 4   | V <sub>LED</sub> |                                    |       |
| 5   | FB3              | Channel 3 current feedback         |       |
| 6   | FB4              | Channel 4 current feedback         |       |

**[ Rear View of LCM ]**



**FIG.3-2 Backlight Connector View**

## Product Specification

### 3-3. Signal Timing Specifications

This is the signal timing requirement from the signal transmitter. All of the interface signal timing should be satisfied with the following specifications for its proper operation.

**Table 3-5. Timing Table**

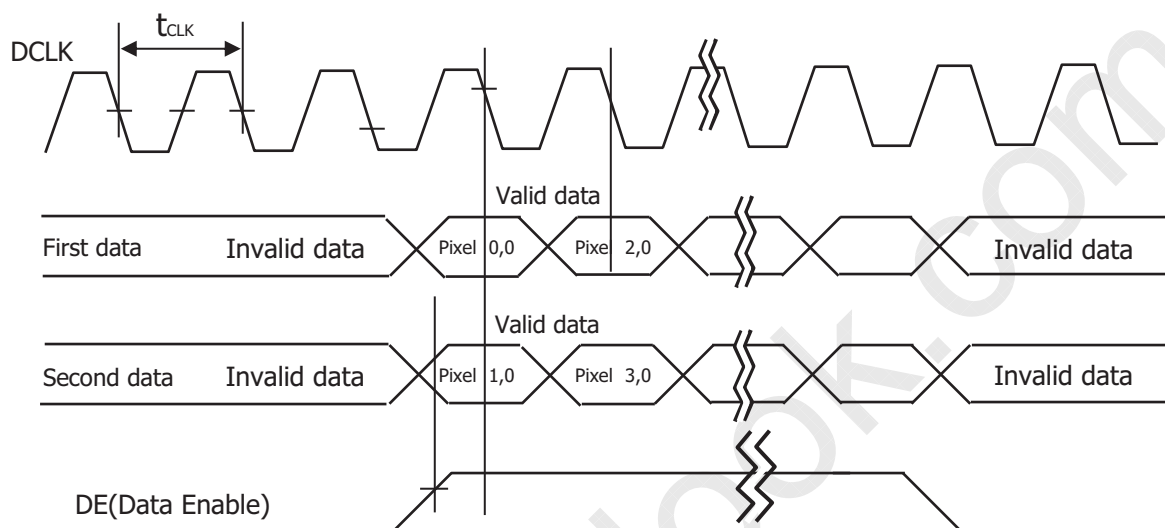
| Item  | Symbol                 | Symbol | Min  | Typ   | Max  | Unit | Notes                             |
|-------|------------------------|--------|------|-------|------|------|-----------------------------------|
| DCLK  | Period                 | tCLK   | 11.1 | 13.89 | 16.7 | ns   | Pixel frequency<br>(Typ. 144 MHz) |
|       | Frequency              | fCLK   | 60   | 72    | 90   | MHz  |                                   |
| Hsync | Period                 | tHP    | 1024 | 1088  | 1120 | tCLK | 1,3,4                             |
|       | Horizontal Valid       | tHV    | 960  | 960   | 960  | tCLK |                                   |
|       | Horizontal Blank       | tHB    | 64   | 128   | 160  | tCLK |                                   |
|       | Frequency              | fH     | 64   | 66    | 83   | kHz  |                                   |
|       | Width                  | tWH    | 16   | 32    | 48   | tCLK |                                   |
|       | Horizontal Back Porch  | tHBP   | 32   | 48    | 64   | tCLK |                                   |
|       | Horizontal Front Porch | tHFP   | 16   | 48    | 48   | tCLK |                                   |
| Vsync | Period                 | tVP    | 1090 | 1100  | 1160 | tHP  | 2,4                               |
|       | Vertical Valid         | tVV    | 1080 | 1080  | 1080 | tHP  |                                   |
|       | Vertical Blank         | tVB    | 10   | 20    | 80   | tHP  |                                   |
|       | Frequency              | fV     | 50   | 60    | 75   | Hz   |                                   |
|       | Width                  | tWV    | 2    | 4     | 16   | tHP  |                                   |
|       | Vertical Back Porch    | tVBP   | 5    | 8     | 32   | tHP  |                                   |
|       | Vertical Front Porch   | tVFP   | 3    | 8     | 32   | tHP  |                                   |

**Notes:**

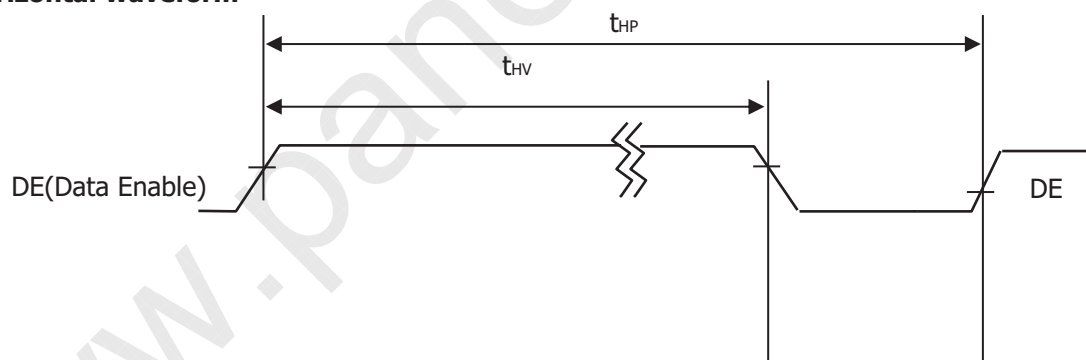
- 1) The value of Hsync Period, Hsync Width and Hsync valid should be even number times of tCLK. If the value is odd number times of tCLK, it can make asynchronous signal timing and cause abnormal display.
- 2) The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
- 3) The value of Hsync Period, Hsync Width, and Horizontal Back Porch should be divided by 4 without a remainder.
- 4) The polarity of Hsync, Vsync is not restricted.

### 3-4. Signal Timing Waveforms

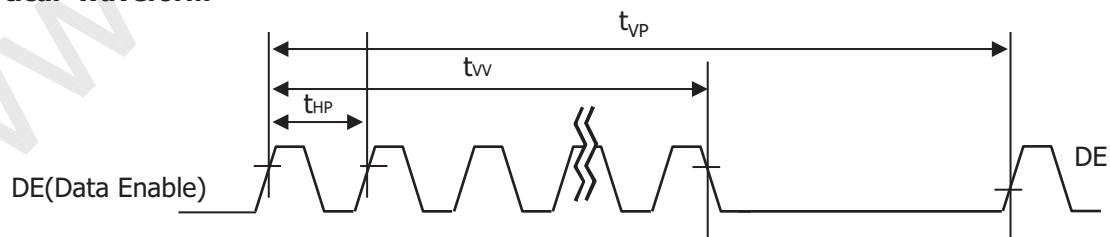
#### 1. DCLK, DE, DATA waveforms



#### 2. Horizontal waveform



#### 3. Vertical waveform





**LM270WFA**  
**Liquid Crystal Display**

## 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.

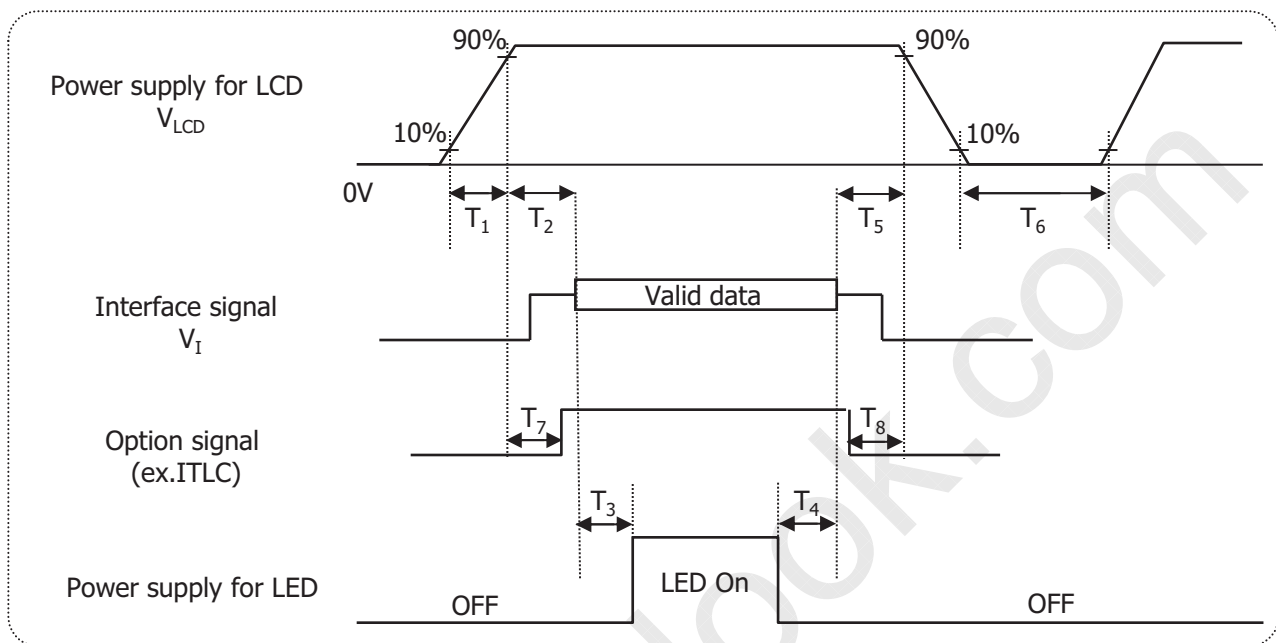
The table below provides a reference for color versus data input.

**Table 3-6. 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 (0)     | 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 (1)     | 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 (0)   | 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 (1)   | 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 (0)    | 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 (1)    | 0                | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0   | 0  | 1  | 0  |
|             | ...         |                  |    |    |    |     |    |    |    |       |    |    |    |     |    |    |    |      |    |    |    |     |    |    |    |
|             | 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

### 3-6. Power Sequence



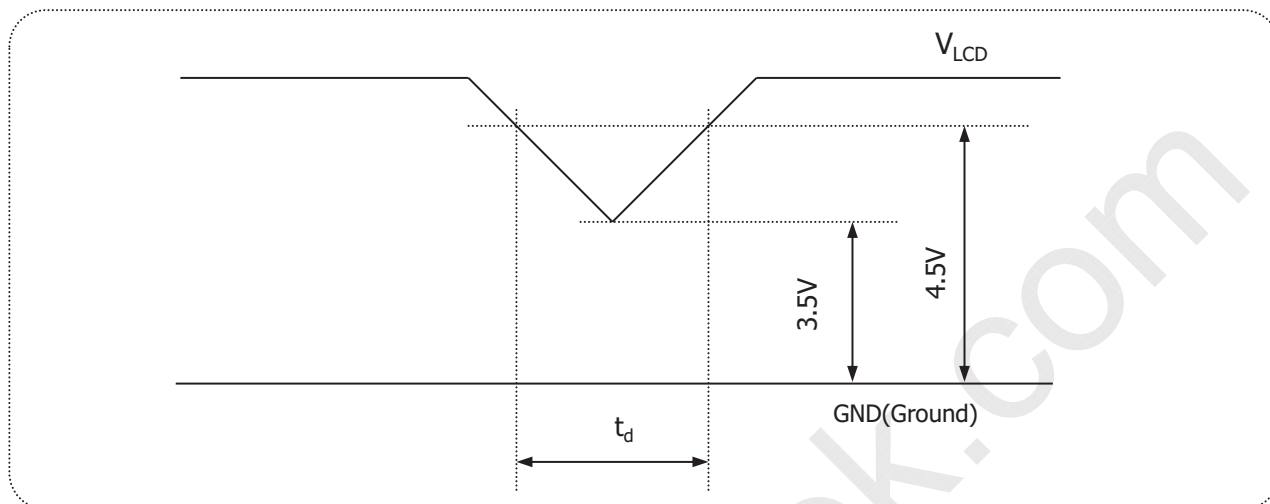
**Table 3-7. Power Sequence**

| Parameter      | Values |      |      | Units |
|----------------|--------|------|------|-------|
|                | Min.   | Typ. | Max. |       |
| T <sub>1</sub> | 0.5    | -    | 10   | ms    |
| T <sub>2</sub> | 0.01   | -    | 50   | ms    |
| T <sub>3</sub> | 500    | -    | -    | ms    |
| T <sub>4</sub> | 200    | -    | -    | ms    |
| T <sub>5</sub> | 0.01   | -    | 50   | ms    |
| T <sub>6</sub> | 1000   | -    | -    | ms    |
| T <sub>7</sub> | 0.5    | -    | T2   | ms    |
| T <sub>8</sub> | 0      | -    | -    | ms    |

**Notes:**

- Power sequence should be kept all the time including below cases for normal operation.
  - AC/DC Power On/Off
  - Mode change (resolution, frequency, timing, sleep mode, color depth change, etc.)
 The violation of power sequence can cause a significant trouble in display and reliability.
- Please avoid floating state of interface signal during signal invalid period.
- When the interface signal is invalid, be sure to pull down the  $V_{LCD}$  (0V)
- Please turn off the power supply for LED when the level of  $V_{LCD}$  changes to prevent noise issue.
- When measuring valid data starting point, it can be measured that LVDS signal starts swing.

### 3-7. Power Dip Condition



**FIG.3-3 Power Dip Condition**

For proper operation, stable power supply of  $V_{LCD}$  is necessary and power dip is allowed only in below condition. Except this condition, power on/off should follow power sequence specification exactly.

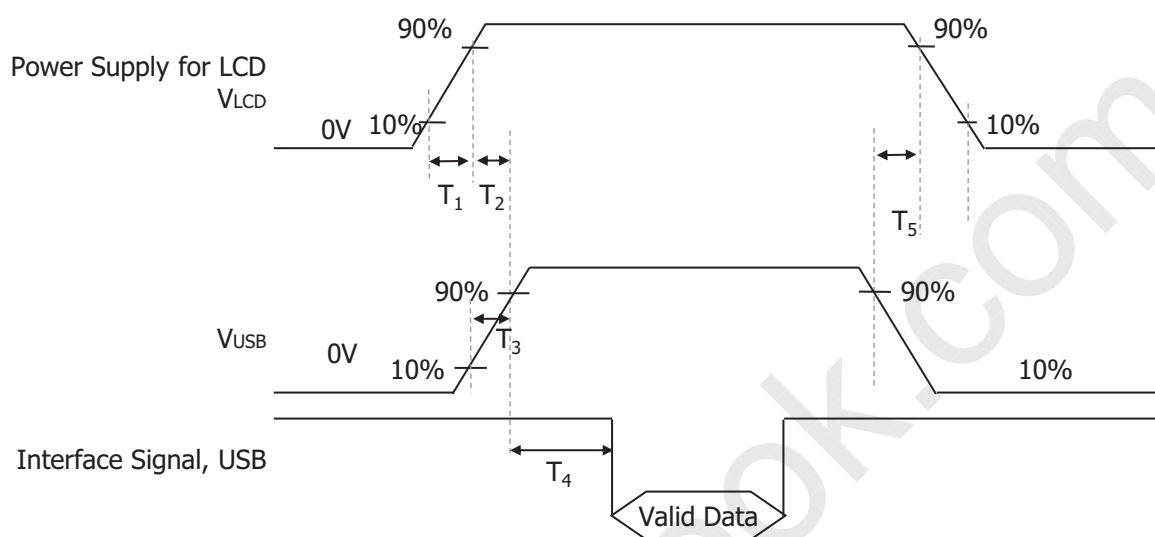
- 1) Dip Condition  
 $3.5V \leq V_{LCD} < 4.5V$  ,  $t_d \leq 20ms$

## Product Specification

**3-8. General Specifications For Touch****Table 3-8. General Specifications For Touch**

| Item                     |                      | Spec                    | Notes         |
|--------------------------|----------------------|-------------------------|---------------|
| System                   |                      | Self Capacitive type    |               |
| Multi Touch Points       |                      | 10 points               |               |
| Active touch area        |                      | Same as LCD A/A         |               |
| Sensor                   | Type                 | Advanced In-Cell Touch  |               |
|                          | Sensor Channel Pitch | 7.47mm (X) x 7.47mm (Y) |               |
| Touch IC Information     | IC                   | SW42101M                | Silicon Works |
|                          | Firmware             | FF.50                   |               |
|                          | PID                  | 9101                    |               |
| Number of Sensor Channel |                      | 80ea (X) x 45ea (Y)     |               |
| Interface                |                      | HID-USB                 | USB 2.0       |

### 3-9. Power Sequence For Touch



**Table 3-9. Power Sequence For Touch**

| Parameter      | Values |      |      | Units |
|----------------|--------|------|------|-------|
|                | Min.   | Typ. | Max. |       |
| T <sub>1</sub> | 0.5    | -    | 10   | ms    |
| T <sub>2</sub> | 0      | -    | -    | ms    |
| T <sub>3</sub> | 0.5    | -    | 10   | ms    |
| T <sub>4</sub> | 50     | -    | -    | ms    |
| T <sub>5</sub> | 0      | -    | -    | ms    |

Notes:

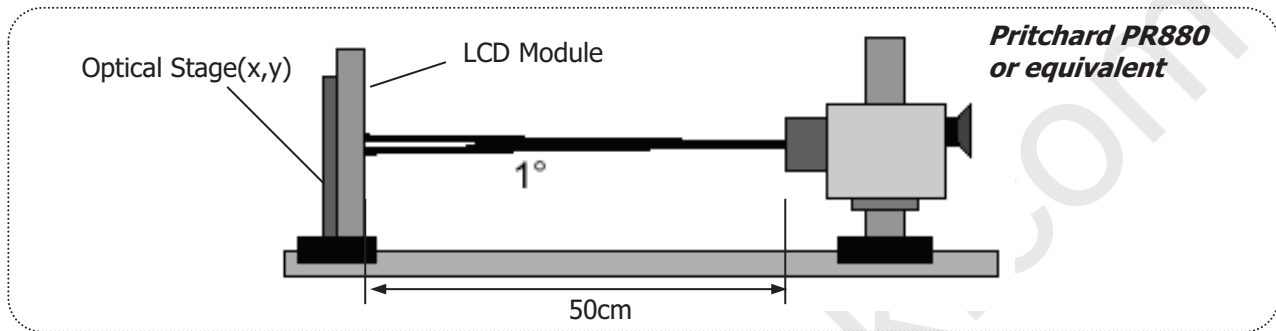
1) T<sub>4</sub>: USB communication ready.

## 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.4-1 presents additional information concerning the measurement equipment and method.



**FIG.4-1 Optical Characteristic Measurement Equipment And Method**

**Table 4-1. Optical Characteristics**

( $T_a = 25^\circ\text{C}$ ,  $V_{\text{LCD}} = \text{Typ}$ ,  $f_v = 60\text{ Hz}$ ,  $\text{DCLK} = \text{Typ}$ ,  $I_s = \text{Typ}$ )

| Parameter                                            |              | Symbol               | Values       |       |              | Units  | Notes |
|------------------------------------------------------|--------------|----------------------|--------------|-------|--------------|--------|-------|
|                                                      |              |                      | Min.         | Typ.  | Max.         |        |       |
| Contrast Ratio                                       |              | CR                   | 700          | 1000  | -            |        | 1     |
| Surface Luminance, white                             |              | L <sub>WH</sub>      | 240          | 300   | -            | cd/m²  | 2     |
| Luminance Variation                                  |              | δ <sub>WHITE</sub>   | 75           | -     | -            | %      | 3     |
| Response Time                                        | Gray to Gray | T <sub>GTG_AVR</sub> | -            | 14    | 28           | ms     | 4     |
| Color Gamut (CIE 1931)                               |              | sRGB                 | -            | 99    | -            | %      |       |
| Color Coordinates<br>[CIE 1931]<br><i>(By PR650)</i> | Red          | Rx                   | Typ<br>-0.03 | 0.661 | Typ<br>+0.03 |        |       |
|                                                      |              | Ry                   |              | 0.332 |              |        |       |
|                                                      | Green        | Gx                   |              | 0.302 |              |        |       |
|                                                      |              | Gy                   |              | 0.622 |              |        |       |
|                                                      | Blue         | Bx                   |              | 0.147 |              |        |       |
|                                                      |              | By                   |              | 0.055 |              |        |       |
|                                                      | White        | Wx                   |              | 0.313 |              |        |       |
|                                                      |              | Wy                   |              | 0.329 |              |        |       |
| Color Temperature                                    |              | -                    | -            | 6500  | -            | K      |       |
| Viewing Angle<br>(CR>10, General)                    | Horizontal   | θ <sub>H</sub>       | 170          | 178   | -            | Degree | 5     |
|                                                      | Vertical     | θ <sub>V</sub>       | 170          | 178   | -            |        |       |
| Gray Scale                                           |              | -                    |              | 2.2   |              |        | 6     |

## Product Specification

Notes:

- 1) **Contrast Ratio(CR)** is defined mathematically as: **(By PR880)**  
 It is measured at center point(1)

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

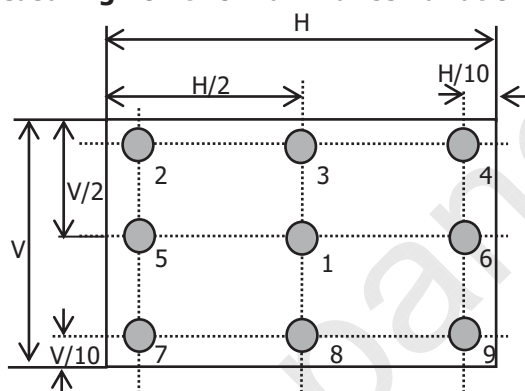
- 2) **Surface Luminance(L<sub>WH</sub>)** is the luminance value at center 1 point(1) across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG.4-1. **(By PR880)**

- 3) The **Variation in Surface Luminance**,  $\delta_{\text{WHITE}}$  is defined as: **(By PR880)**

$$\delta_{\text{WHITE}} = \frac{\text{Minimum}(LP1, LP2, \dots, LP9)}{\text{Maximum}(LP1, LP2, \dots, LP9)} \times 100(\%)$$

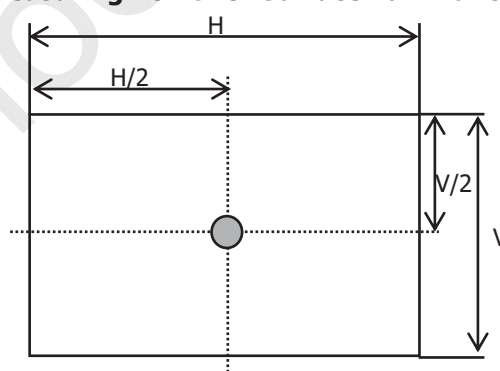
Where L1 to L9 are the luminance with all pixels displaying white at 9 locations.  
 For more information see FIG.4-2.

### <Measuring Point For Luminance Variation>



@ H,V: Active Area

### <Measuring Point For Surface Luminance>



**FIG.4-2 Measure Point for Luminance**

## Product Specification

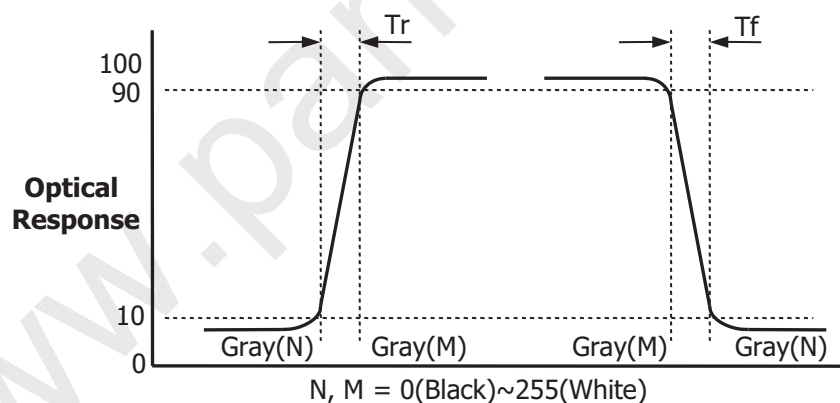
### Notes:

- 4) 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 ". (**By RD80S**)
- Gray step: 5 Step
  - $T_{GTG\_AVR}$  is the total average time at rising time and falling time for "Gray To Gray ".
  - For the GTG measurement, the sampling rate of oscilloscope is 500k/s.

**Table 4-2. GTG Gray**

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

Response Time is defined as the following figure and shall be measured by switching the input signal for "Gray(N)" and "Gray(M)".

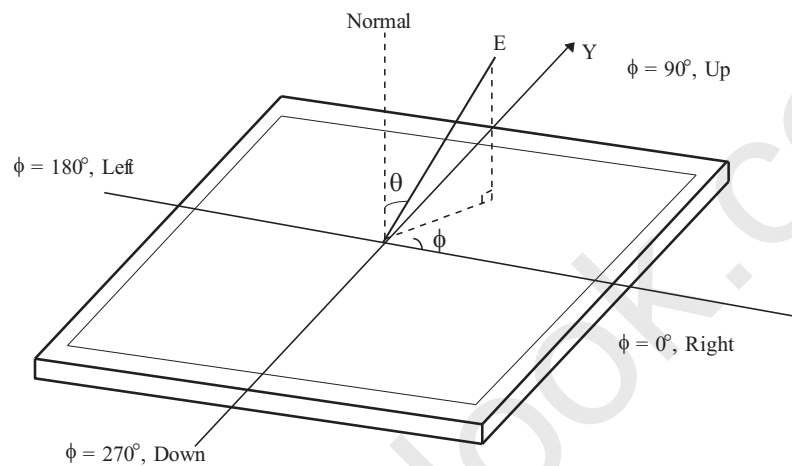


**FIG.4-3 Response Time**

## Product Specification

Notes:

- 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.4-4. **(By PR880)**



**FIG.4-4 Viewing Angle**

- 6) **Gamma Value** is approximately 2.2. For more information see below table.

**Table 4-3. Gray Scale Specification**

| Gray Level | Relative Luminance [%](Typ) |
|------------|-----------------------------|
| 0          | 0.10                        |
| 15         | 0.31                        |
| 31         | 1.08                        |
| 47         | 2.53                        |
| 63         | 4.72                        |
| 79         | 7.7                         |
| 95         | 11.5                        |
| 111        | 16.1                        |
| 127        | 21.7                        |
| 143        | 28.1                        |
| 159        | 35.5                        |
| 175        | 43.7                        |
| 191        | 53.0                        |
| 207        | 63.2                        |
| 223        | 74.5                        |
| 239        | 86.7                        |
| 255        | 100                         |

**LM270WFA**  
**Liquid Crystal Display****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                                  | 607.1 mm  |
|                     | Vertical                                    | 354.1 mm  |
|                     | Depth                                       | 12.1 mm   |
| Bezel Area          | Horizontal                                  | -         |
|                     | Vertical                                    | -         |
| Active Display Area | Horizontal                                  | 597.89 mm |
|                     | Vertical                                    | 336.31 mm |
| Weight              | Typ: 3140 g , Max: 3300 g                   |           |
| Surface Treatment   | Glare treatment of the front polarizer (3H) |           |

Note: Please refer to a mechanical drawing in terms of tolerance at the next page.

- Outline dimensions (horizontal, vertical and outside depth) are measured by using vernier calipers.
- The inside depth dimensions are measured by using height gauge, when LCM is put face down onto a flat surface.

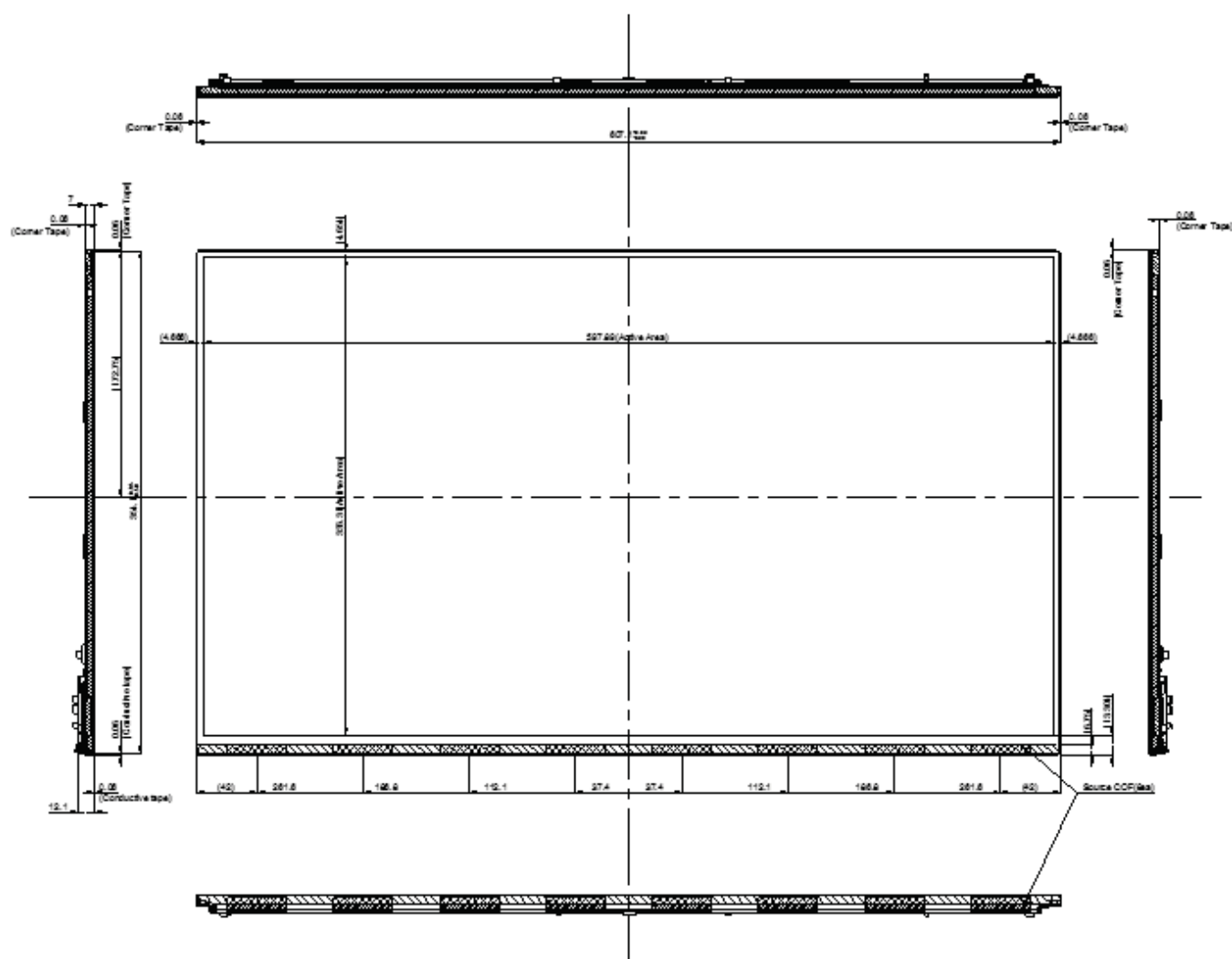


# LM270WFA Liquid Crystal Display

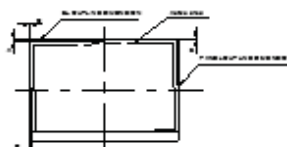
## Product Specification

<Front View>

<Update : 2020.01.09>



- NOTES
1. I/F Connector Specification  
(1) CN1 : 191004509-009 (JUL)  
(2) CN2 : F-RS2419-4F (JAS)
  2. LED connector specification : 527.65(Active Area)
  3. Torque of screw hole : 0.0~0.05g/cm
  4. Tilt and parallel disposition tolerance of display area are following  
(1) Y-direction :  $\pm 0.45\text{mm}$  (45°),  $\pm 0.45\text{mm}$  (45°)  
(2) X-direction :  $\pm 0.45\text{mm}$  (45°),  $\pm 0.45\text{mm}$  (45°)



5. Undetected tolerance to be  $\pm 0.5$
6. The LCD (surface) is sensitive to heat, so please don't press the COF area
7. The COF area is weak and sensitive, so please don't press the COF area
8. Undetected height should follow the 3D modeling data

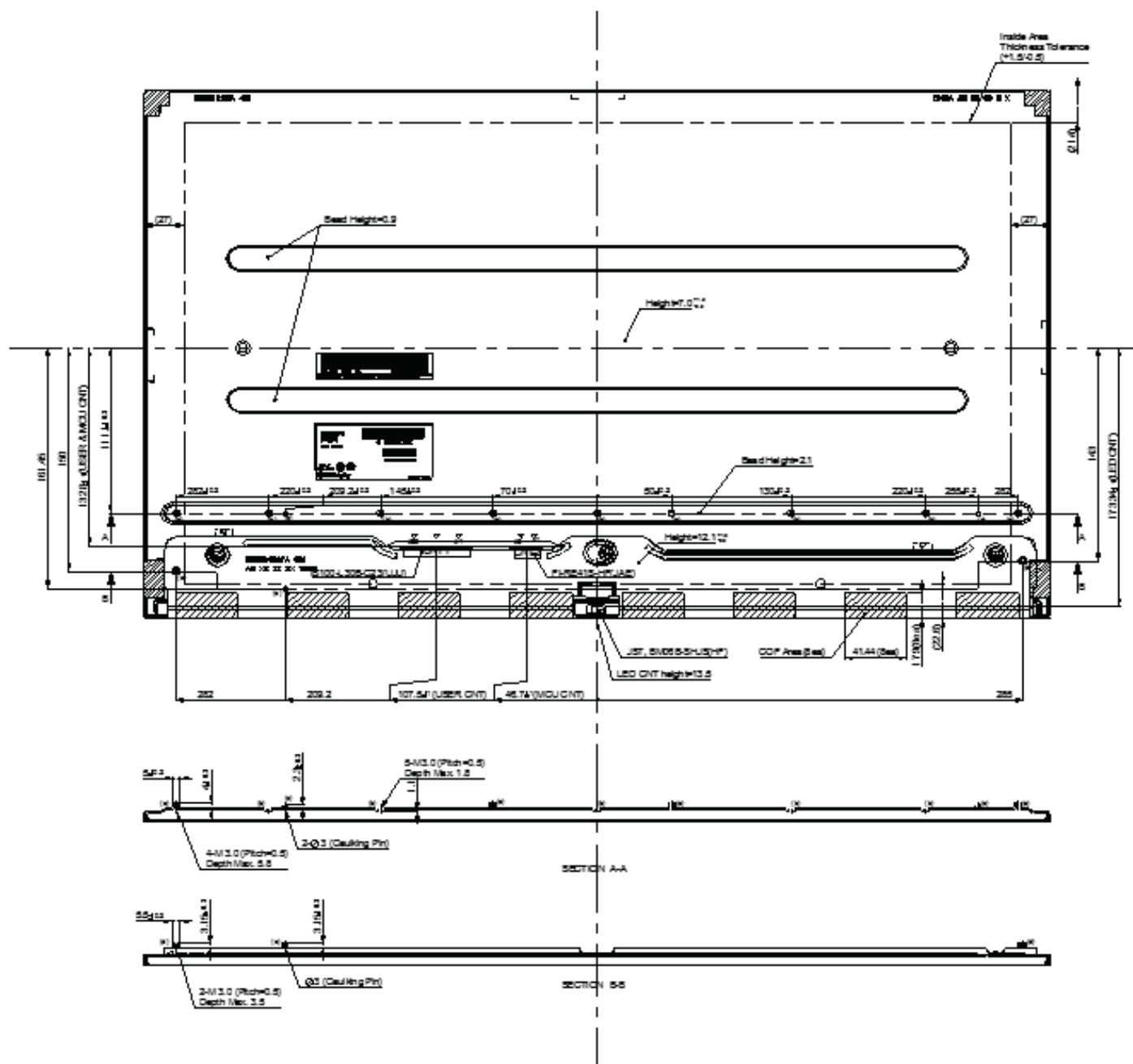


## LM270WFA Liquid Crystal Display

## Product Specification

### <Rear View>

<Update : 2020.01.09>





**LM270WFA**  
**Liquid Crystal Display**

## Product Specification

### 6. Reliability

Environment test condition

| No | Test Item                                                   | Condition                                             | Notes |
|----|-------------------------------------------------------------|-------------------------------------------------------|-------|
| 1  | High temperature storage test                               | $T_a = 60^{\circ}\text{C}$ , 240h                     | 1     |
| 2  | Low temperature storage test                                | $T_a = -20^{\circ}\text{C}$ , 240h                    | 1     |
| 3  | High temperature operation test                             | $T_a = 50^{\circ}\text{C}$ , 50%RH, 240h              | 1     |
| 4  | Low temperature operation test                              | $T_a = 0^{\circ}\text{C}$ , 240h                      | 1     |
| 5  | Humidity condition operation                                | $T_a = 40^{\circ}\text{C}$ , 90%RH                    | 1     |
| 6  | Altitude<br>Operating<br>Storage / Shipment                 | 0 - 10,000 feet (3,048m)<br>0 - 40,000 feet (12,192m) |       |
| 7  | Maximum storage humidity for<br>4 corner light leakage Mura | Max 70%RH, $T_a = 40^{\circ}\text{C}$                 |       |

Note 1) Result Evaluation Criteria:

TFT-LCD panels test should take place after cooling enough at room temperature.

In the standard condition, there should be no particular problems that may affect the display function.

\*  $T_a$  = Ambient Temperature

## 7. International Standards

### 7-1. Safety

- a) IEC 62368-1, The International Electro-technical Commission(IEC).  
Audio/video, Information and Communication Technology Equipment - Safety - Safety Requirements.
- b) EN 62368-1, European Committee for Electro-technical Standardization (CENELEC)  
Audio/video, Information and Communication Technology Equipment - Safety Requirements
- c) UL 62368-1, UL LLC.  
Audio/video, Information and Communication Technology Equipment - Safety Requirements
- d) CAN/CSA C22.2 No.62368-1, Canadian Standards Association (CSA).  
Audio/video, Information and Communication Technology Equipment - Safety Requirements
- e) IEC 60950-1, The International Electro technical Commission (IEC).  
Information Technology Equipment - Safety - Part 1 : General Requirements

### 7-2. Environment

- a) RoHS, Commission Delegated Directive (EU) 2015/863 of 31 March 2015 amending Annex II to Directive 2011/65/EU of the European Parliament and of the Council

**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.

Notes:

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.

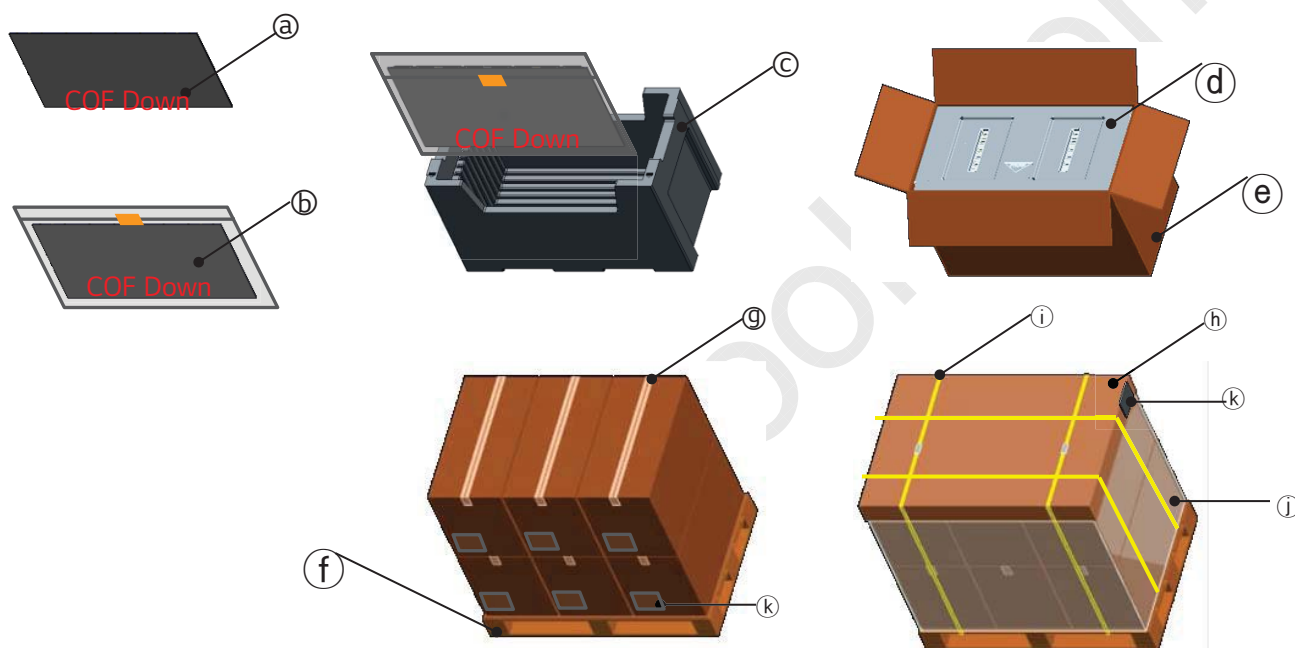
This is subject to change without prior notice.

**Product Specification****8-2. Packing Form**

&lt;Update : 2019.11.28&gt;

- a) Package quantity in one box : 9 ea  
Package quantity in one Pallet : 54 ea  
b) Box Size : 365mm x 710mm x 448mm  
c) Pallet Ass'y Size: 1,140mm x740mm x1,019mm

\* LCM Direction(Insert to Bottom Packing): COF Down



| No. | Description    | Material  |
|-----|----------------|-----------|
| (a) | LCM            | -         |
| (b) | AL-Bag         | AL        |
| (c) | Packing,Bottom | EPS       |
| (d) | Packing,Top    | EPS       |
| (e) | Box            | Paper(SW) |
| (f) | Pallet         | Plywood   |
| (g) | Tape           | OPP       |
| (h) | Angle Cover    | Paper(SW) |
| (i) | BAND           | PP        |
| (j) | Wrap           | -         |
| (k) | Label          | Yupo      |

## 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 rear side.
- 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.
- 10) System frame should not have an interference with panel which can cause LC Leakage/Panel Crack due to the contraction of system frame at low temperature condition or panel damage by any other circumstances.

### 9-2. Operating Precautions

- 1) Response time depends on the temperature.(In lower temperature, it becomes longer.)
- 2) 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.
- 3) 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.
- 4) When fixed patterns are displayed for a long time, remnant image is likely to occur.
- 5) 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.
- 6) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
- 7) 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)
- 8) Please do not set LCD on its edge.
- 9) When LCMs are used for public display, defects such as Yogore & image sticking can not be guaranteed.
- 10) LCMs cannot support "Interlaced Scan Method"
- 11) When this reverse model is used as a forward-type model (PCB on top side) or a Portrait-type mode at storage and operation, LGD can not guarantee any defects of LCM.
- 12) Please conduct image sticking test after 2-hour aging with Rolling Pattern at normal temperature.(25~40℃)

**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 and Hazardous Materials Exposure**

Strong light exposure causes degradation of polarizer and color filter.  
The LCM should be avoided direct contact with hazardous materials such as sulfur, acetic acid, chlorine, etc. These materials may cause chemical reaction such as sulfurization, corrosion, discoloration, etc.

**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℃ and 35℃ 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.