



# Product Specification

G238HAN01.2

AU OPTRONICS CORPORATION

( ) Preliminary Specification

( V ) Final Specification

|            |                     |
|------------|---------------------|
| Module     | 23.8" Color TFT-LCD |
| Model Name | G238HAN01.2         |

|  |                          |      |       |       |             |  |       |       |  |             |      |                  |            |             |      |                  |                   |
|--|--------------------------|------|-------|-------|-------------|--|-------|-------|--|-------------|------|------------------|------------|-------------|------|------------------|-------------------|
| <table><tr><td>Customer</td><td>Date</td></tr><tr><td>_____</td><td>_____</td></tr><tr><td>Approved by</td><td></td></tr><tr><td>_____</td><td>_____</td></tr></table> | Customer                 | Date | _____ | _____ | Approved by |  | _____ | _____ | <table><tr><td>Approved by</td><td>Date</td></tr><tr><td><u>Jason Pan</u></td><td>2018.02.02</td></tr><tr><td>Prepared by</td><td>Date</td></tr><tr><td><u>Mark Shih</u></td><td><u>2018.02.02</u></td></tr></table> | Approved by | Date | <u>Jason Pan</u> | 2018.02.02 | Prepared by | Date | <u>Mark Shih</u> | <u>2018.02.02</u> |
| Customer   | Date                     |      |       |       |             |  |       |       |  |             |      |                  |            |             |      |                  |                   |
| _____  | _____                    |      |       |       |             |  |       |       |  |             |      |                  |            |             |      |                  |                   |
| Approved by  |                          |      |       |       |             |  |       |       |  |             |      |                  |            |             |      |                  |                   |
| _____  | _____                    |      |       |       |             |  |       |       |  |             |      |                  |            |             |      |                  |                   |
| Approved by  | Date                     |      |       |       |             |  |       |       |  |             |      |                  |            |             |      |                  |                   |
| <u>Jason Pan</u>   | 2018.02.02               |      |       |       |             |  |       |       |  |             |      |                  |            |             |      |                  |                   |
| Prepared by  | Date                     |      |       |       |             |  |       |       |  |             |      |                  |            |             |      |                  |                   |
| <u>Mark Shih</u>   | <u>2018.02.02</u>        |      |       |       |             |  |       |       |  |             |      |                  |            |             |      |                  |                   |
| Note: This Specification is subject to change without notice.  | AU Optronics corporation |      |       |       |             |  |       |       |  |             |      |                  |            |             |      |                  |                   |

## 2 General Description

This specification applies to the 23.8 inch wide Color a-Si TFT-LCD Module G238HAN01.1. The display supports the Full HD - 1920(H) x 1080(V) screen format and 16.7M colors. The input interface is dual channel LVDS and this module doesn't contain an driver board for backlight.

### 2.1 Display Characteristics

The following items are characteristics summary on the table under 25°C condition:

| ITEMS   | Unit                 | SPECIFICATIONS   |
|---|----------------------|--|
| Screen Diagonal                                   | [mm]                 | 604.70 (23.81")  |
| Active Area                                       | [mm]                 | 527.04(H) x 296.46(V)  |
| Pixels H x V                                      | -                    | 1920(x3) x 1080  |
| Pixel Pitch                                       | [um]                 | 274.5 (per one triad) ×274.5   |
| Pixel Arrangement                                 | -                    | R.G.B. Vertical Stripe   |
| Display Mode                                      | -                    | AHVA, normally Black   |
| White Luminance ( Center )                        | [cd/m <sup>2</sup> ] | 400 (Typ.)   |
| Contrast Ratio                                    | -                    | 1000 (Typ.)  |
| Response Time                                     | [msec]               | 14 (G to G)  |
| Power Consumption<br>(LCD Module + Backligh unit) | [Watt]               | 17.5 (Typ.)<br>LCD module : PDD (Typ.)=3.2 @ White pattern,Fv=60Hz<br>Backlight unit : P <sub>BLU</sub> (Typ.) =14.28 @Is=70mA |
| Weight  | [Grams]              | 2300 (typ.)  |
| Outline Dimension                                 | [mm]                 | 543.0(H) x 317.4(V) x 11.2(D) (Typ.)   |
| Electrical Interface                              | -                    | Dual channel LVDS  |
| Support Color                                     | -                    | 16.7M colors (RGB 8-bit )  |
| Surface Treatment                                 | -                    | Anti-Glare, 3H   |
| Temperature Range                                 |                      |  |
| Operating   | [°C]                 | 0 to +50   |
| Storage (Shipping)                                | [°C]                 | -20 to +60   |
| RoHS Compliance                                   | -                    | RoHS Compliance  |
| TCO Compliance                                    | -                    | TCO 6.0 Compliance   |

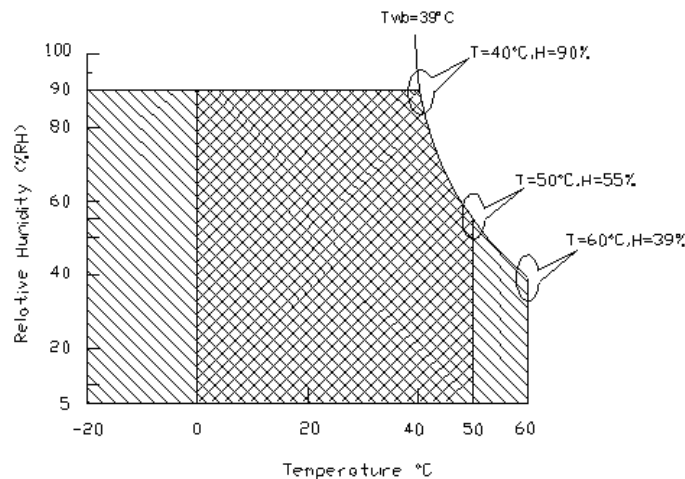
## 2.2 Absolute Maximum Rating of Environment

Permanent damage may occur if exceeding the following maximum rating.

| Symbol | Description                           | Min. | Max. | Unit  | Remark                                  |
|--------|---------------------------------------|------|------|-------|---|
| TOP    | Operating Temperature                 | 0    | +50  | [°C]  | <b>Note 2-1</b>                         |
| TGS    | Glass surface temperature (operation) | 0    | +65  | [°C]  | <b>Note 2-1</b><br>Function judged only |
| HOP    | Operation Humidity                    | 5    | 90   | [%RH] | <b>Note 2-1</b>                         |
| TST    | Storage Temperature                   | -20  | +60  | [°C]  |   |
| HST    | Storage Humidity                      | 5    | 90   | [%RH] |   |

**Note 2-1:** Temperature and relative humidity range are shown as the below figure.

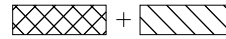
1. 90% RH Max (  $T_a \leq 39^\circ\text{C}$  )
2. Max wet-bulb temperature at  $39^\circ\text{C}$  or less. (  $T_a \leq 39^\circ\text{C}$  )
3. No condensation



Operating Range



Storage Range



## 2.3 Optical Characteristics

The optical characteristics are measured on the following test condition.

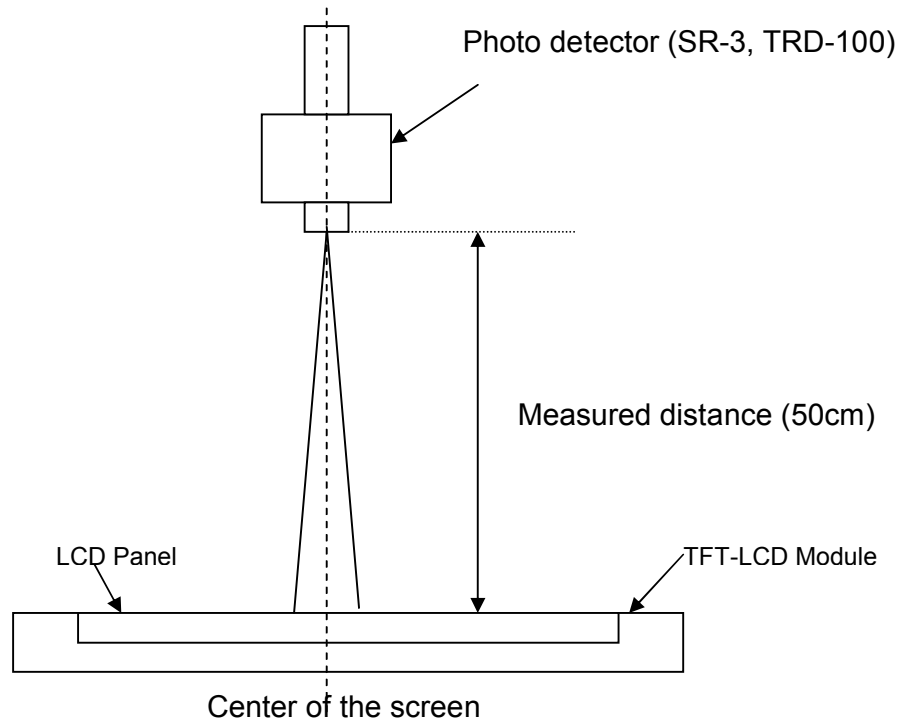
### Test Condition:

1. Equipment setup: Please refer to **Note 2-2**.
2. Panel Lighting time: 30 minutes
3. VDD=5.0V, Fv=60Hz, Is=70mA, Ta=25°C

| Symbol     | Description                         |              | Min.  | Typ.  | Max.  | Unit                 | Remark                        |
|------------|-------------------------------------|--------------|-------|-------|-------|----------------------|-------------------------------|
| $L_w$      | White Luminance (Center of screen)  |              | 320   | 400   | -     | [cd/m <sup>2</sup> ] | <b>Note 2-2</b><br>By SR-3    |
| $L_{uni}$  | Luminance Uniformity (9 points)     |              | 75    | 80    | -     | [%]                  | <b>Note 2-3</b><br>By SR-3    |
| CR         | Contrast Ratio (Center of screen)   |              | 600   | 1000  | -     | -                    | <b>Note 2-4</b><br>By SR-3    |
| $\theta_R$ | Horizontal Viewing Angle<br>(CR=10) | Right        | 75    | 89    | -     | [degree]             | <b>Note 2-5</b><br>By SR-3    |
| $\theta_L$ |                                     | Left         | 75    | 89    | -     |                      |                               |
| $\Phi_H$   | Vertical Viewing Angle<br>(CR=10)   | Up           | 75    | 89    | -     |                      |                               |
| $\Phi_L$   |                                     | Down         | 75    | 89    | -     |                      |                               |
| $T_{GTG}$  | Response Time                       | Gray to Gray | -     | 14    | -     | [msec]               | <b>Note 2-6</b><br>By TRD-100 |
| $R_x$      | Color Coordinates<br>(CIE 1931)     | Red x        | 0.635 | 0.665 | 0.695 | -                    | By SR-3                       |
| $R_y$      |                                     | Red y        | 0.28  | 0.310 | 0.34  |                      |                               |
| $G_x$      |                                     | Green x      | 0.243 | 0.273 | 0.303 |                      |                               |
| $G_y$      |                                     | Green y      | 0.609 | 0.639 | 0.669 |                      |                               |
| $B_x$      |                                     | Blue x       | 0.122 | 0.152 | 0.182 |                      |                               |
| $B_y$      |                                     | Blue y       | 0.022 | 0.052 | 0.082 |                      |                               |
| $W_x$      |                                     | White x      | 0.283 | 0.313 | 0.343 |                      |                               |
| $W_y$      |                                     | White y      | 0.299 | 0.329 | 0.359 |                      |                               |
| CT         | Crosstalk                           |              | -     | -     | 1.5   | [%]                  | <b>Note 2-7</b><br>By SR-3    |
| $F_{dB}$   | Flicker (Center of screen)          |              | -     | -     | -20   | [dB]                 | <b>Note 2-8</b><br>By SR-3    |

## Note 2-2: Equipment setup :

The LCD module should be stabilized at given temperature for 30 minutes to avoid abrupt temperature change during measuring (at surface 35°C). In order to stabilize the luminance, the measurement should be executed after lighting Backlight for 30 minutes in a stable, windless and dark room.

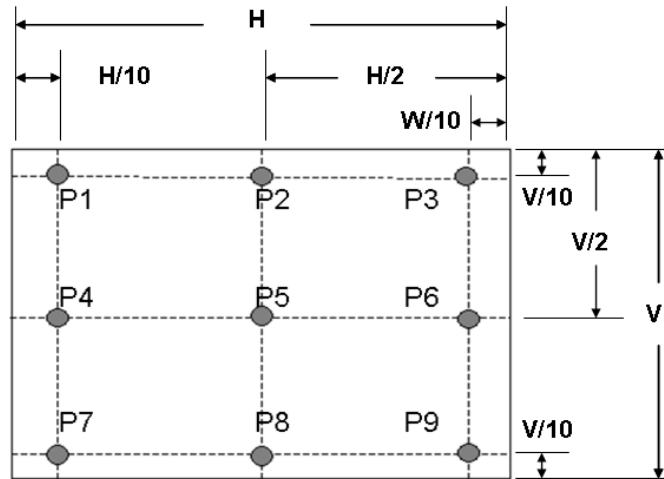


## Note 2-3: Luminance Uniformity Measurement

### Definition:

$$\text{Luminance Uniformity} = \frac{\text{Minimum Luminance of 9 Points (P1 ~ P9)}}{\text{Maximum Luminance of 9 Points (P1 ~ P9)}}$$

*a. Test pattern: White Pattern*



## Note 2-4: Contrast Ratio Measurement

### Definition:

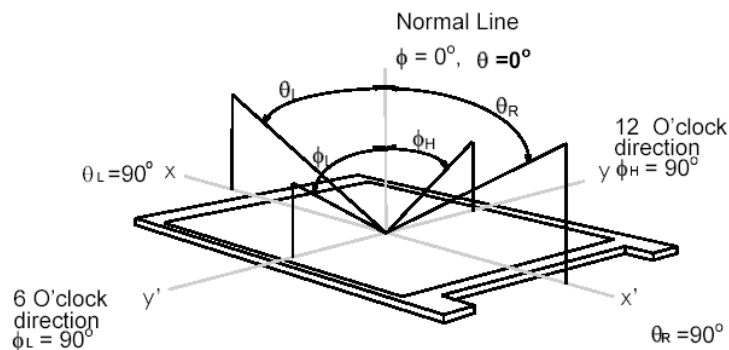
$$\text{Contrast Ratio} = \frac{\text{Luminance of White pattern}}{\text{Luminance of Black pattern}}$$

- Measured position: Center of screen (P5) & perpendicular to the screen ( $\theta = \Phi = 0^\circ$ )

## Note 2-5: Viewing angle measurement

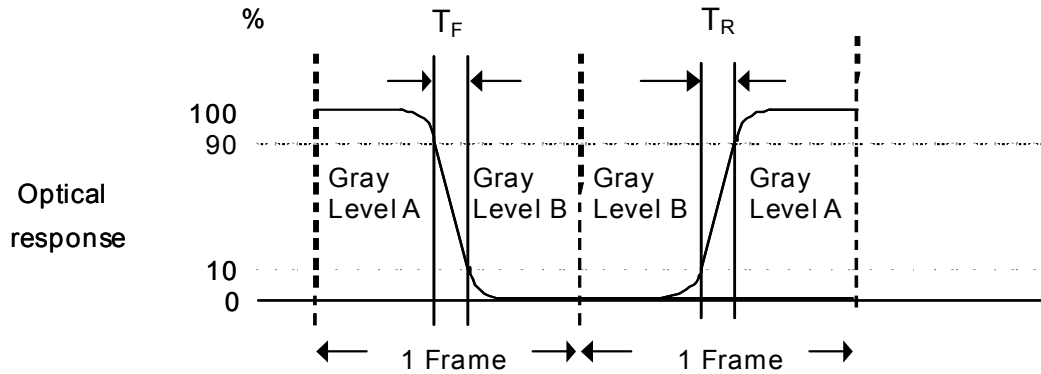
**Definition:** The angle at which the contrast ratio is greater than 10 & 5 .

- Horizontal view angle: Divide to left & right ( $\theta_L$  &  $\theta_R$ )  
Vertical view angle: Divide to up & down ( $\Phi_H$  &  $\Phi_L$ )



## Note 2-6: Response time measurement

The output signals of photo detector are measured when the input signals are changed from “Gray level A” to “Gray level B” (falling time,  $T_F$ ), and from “Gray level B” to “Gray level A” (rising time,  $T_R$ ), respectively. The response time is interval between the 10% and 90% of optical response.



The gray to gray response time is defined as the following table.

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

■  $T_{GTG\_typ}$  is the total average time at rising time and falling time of gray to gray.

## Note 2-7: Crosstalk measurement

### Definition:

$$CT = \text{Max. } (CT_H, CT_V);$$

Where

a. Maximum Horizontal Crosstalk :

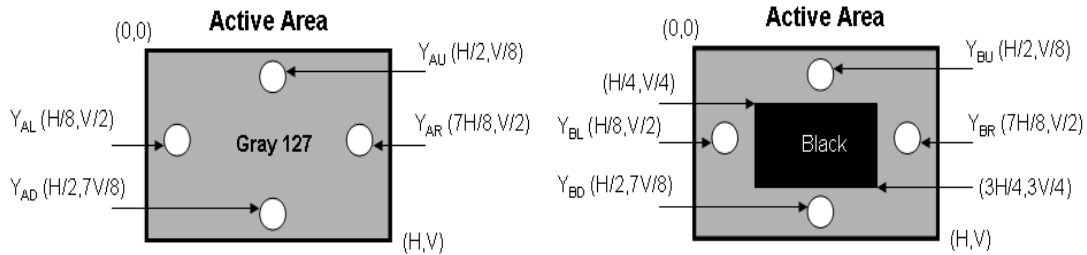
$$CT_H = \text{Max. } (|Y_{BL} - Y_{AL}| / Y_{AL} \times 100 \%, |Y_{BR} - Y_{AR}| / Y_{AR} \times 100 \%);$$

Maximum Vertical Crosstalk:

$$CT_V = \text{Max. } (|Y_{BU} - Y_{AU}| / Y_{AU} \times 100 \%, |Y_{BD} - Y_{AD}| / Y_{AD} \times 100 \%);$$

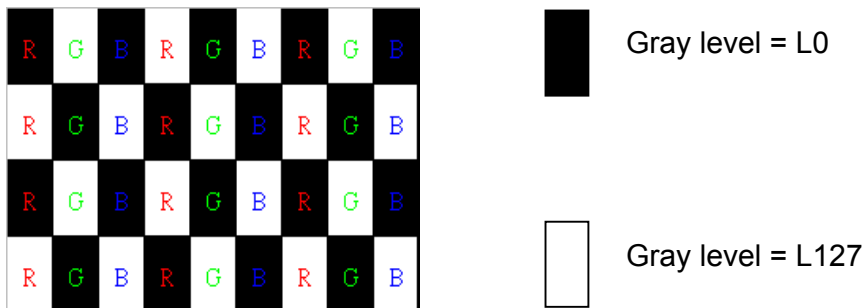
b.  $Y_{AU}$ ,  $Y_{AD}$ ,  $Y_{AL}$ ,  $Y_{AR}$  = Luminance of measured location without Black pattern

$Y_{BU}$ ,  $Y_{BD}$ ,  $Y_{BL}$ ,  $Y_{BR}$  = Luminance of measured location with Black pattern



## Note 2-8: Flicker measurement

a. Test pattern: It is listed as following.



R: Red, G: Green, B:Blue

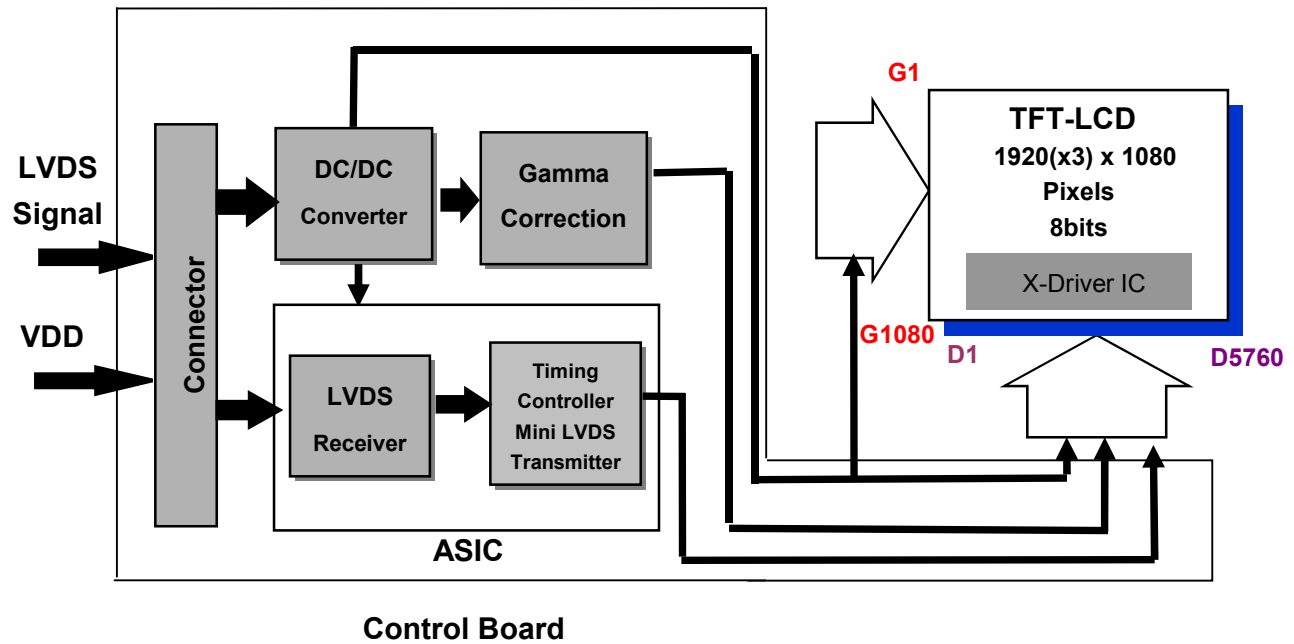
b. Measured position: Center of screen (P5) & perpendicular to the screen ( $\theta=\Phi=0^\circ$ )



## 3 TFT-LCD Module

### 3.1 Block Diagram

The following shows the block diagram of the 23.8 inch Color TFT-LCD Module.



## 3.2 Interface Connection

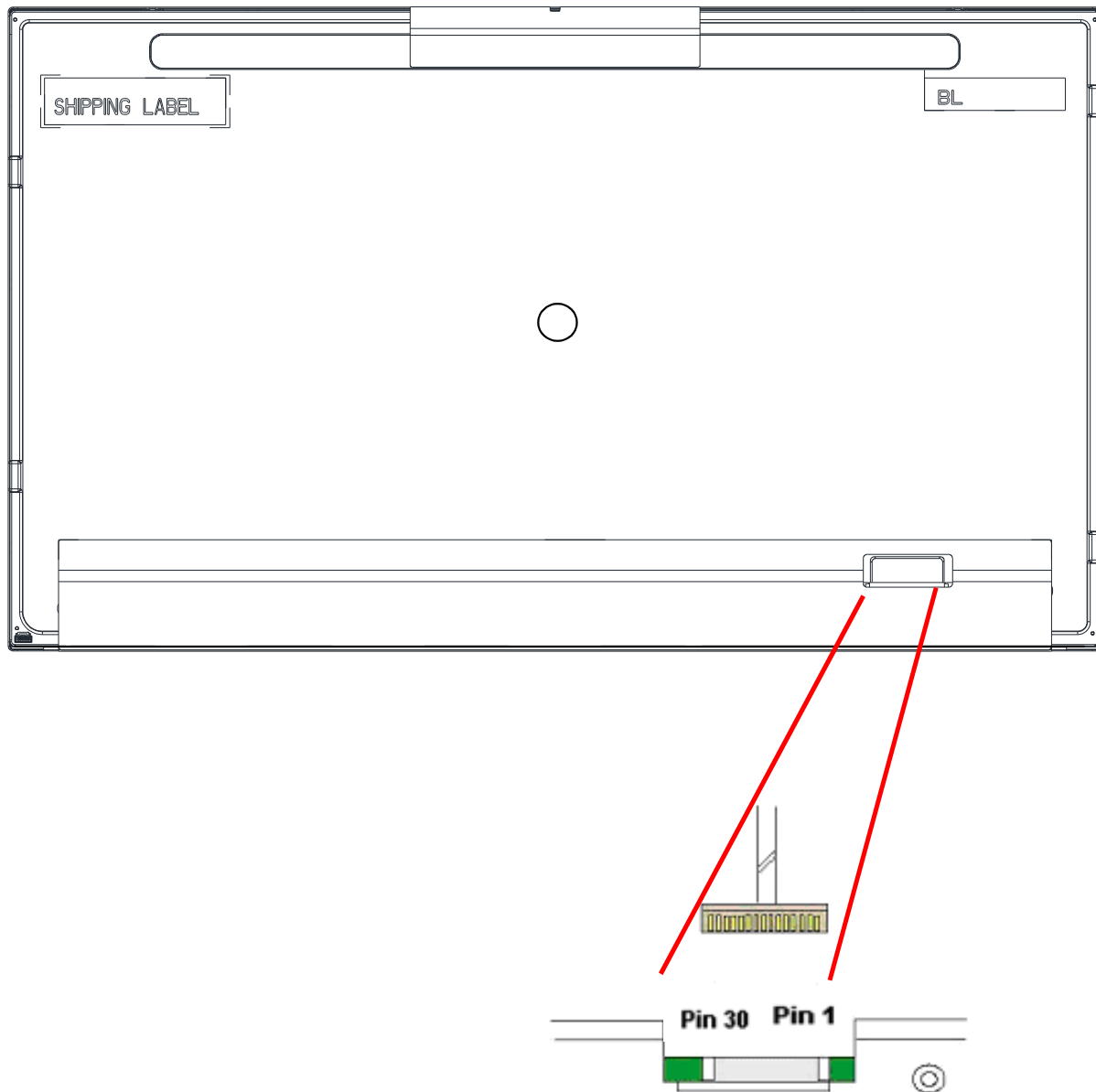
### 3.2.1 Connector Type

|                   |              |                        |                |
|-------------------|--------------|------------------------|----------------|
| TFT-LCD Connector | Manufacturer | P-TWO                  | STM            |
|                   | Part Number  | 187034-3009            | MSBKT2407P30HB |
| Mating Connector  | Manufacturer | JAE or Equivalent      |                |
|                   | Part Number  | FI-X30HL (Locked Type) |                |

### 3.2.2 Connector Pin Assignment

| PIN # | Symbol  | Description   | Remark |
|-------|---------|---|--------|
| 1     | RxO0-   | Negative LVDS differential data input (Odd data)    |        |
| 2     | RxO0+   | Positive LVDS differential data input (Odd data)    |        |
| 3     | RxO1-   | Negative LVDS differential data input (Odd data)    |        |
| 4     | RxO1+   | Positive LVDS differential data input (Odd data)    |        |
| 5     | RxO2-   | Negative LVDS differential data input (Odd data)    |        |
| 6     | RxO2+   | Positive LVDS differential data input (Odd data)    |        |
| 7     | GND     | Ground  |        |
| 8     | RxOCLK- | Negative LVDS differential clock input (Odd clock)  |        |
| 9     | RxOCLK+ | Positive LVDS differential clock input (Odd clock)  |        |
| 10    | RxO3-   | Negative LVDS differential data input (Odd data)    |        |
| 11    | RxO3+   | Positive LVDS differential data input (Odd data)    |        |
| 12    | RxE0-   | Negative LVDS differential data input (Even data)   |        |
| 13    | RxE0+   | Positive LVDS differential data input (Even data)   |        |
| 14    | GND     | Ground  |        |
| 15    | RxE1-   | Negative LVDS differential data input (Even data)   |        |
| 16    | RxE1+   | Positive LVDS differential data input (Even data)   |        |
| 17    | GND     | Ground  |        |
| 18    | RxE2-   | Negative LVDS differential data input (Even data)   |        |
| 19    | RxE2+   | Positive LVDS differential data input (Even data)   |        |
| 20    | RxECLK- | Negative LVDS differential clock input (Even clock) |        |
| 21    | RxECLK+ | Positive LVDS differential clock input (Even clock) |        |
| 22    | RxE3-   | Negative LVDS differential data input (Even data)   |        |
| 23    | RxE3+   | Positive LVDS differential data input (Even data)   |        |
| 24    | GND     | Must Connect to GND                                 |        |
| 25    | NC      | No connection (for AUO test only. Do not connect)   |        |
| 26    | NC      | No connection (for AUO test only. Do not connect)   |        |

|    |     |   |  |
|----|-----|---|--|
| 27 | NC  | No connection (for AUO test only. Do not connect) |  |
| 28 | VDD | Power Supply Input Voltage                        |  |
| 29 | VDD | Power Supply Input Voltage                        |  |
| 30 | VDD | Power Supply Input Voltage                        |  |



## 3.3 Electrical Characteristics

### 3.3.1 Absolute Maximum Rating

Permanent damage may occur if exceeding the following maximum rating.

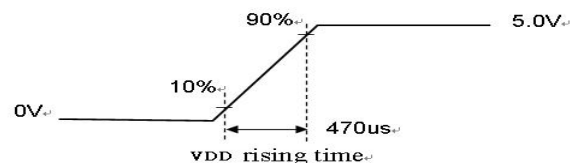
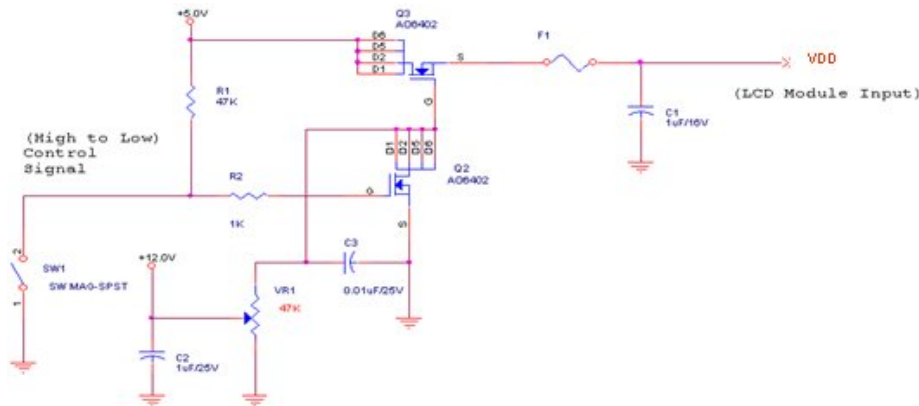
| Symbol | Description                | Min     | Max | Unit   | Remark  |
|--------|----------------------------|---------|-----|--------|---------|
| VDD    | Power Supply Input Voltage | GND-0.3 | 6.0 | [Volt] | Ta=25°C |

### 3.3.2 Recommended Operating Condition

| Symbol | Description                      | Min | Typ  | Max  | Unit   | Remark                            |
|--------|----------------------------------|-----|------|------|--------|-----------------------------------|
| VDD    | Power supply Input voltage       | 4.5 | 5.0  | 5.5  | [Volt] |                                   |
| IDD    | Power supply Input Current (RMS) | -   | 0.64 | 0.76 | [A]    | VDD= 5.0V, White Pattern, Fv=60Hz |
|        |                                  | -   | 0.74 | 0.88 | [A]    | VDD= 5.0V, White Pattern, Fv=75Hz |
| PDD    | VDD Power Consumption            | -   | 3.2  | 3.8  | [Watt] | VDD= 5.0V, White Pattern, Fv=60Hz |
|        |                                  | -   | 3.7  | 4.4  | [Watt] | VDD= 5.0V, White Pattern, Fv=75Hz |
| IRush  | Inrush Current                   | -   | -    | 3.0  | [A]    | <b>Note 3-1</b>                   |
| VDDrp  | Allowable VDD Ripple Voltage     | -   | -    | 500  | [mV]   | VDD= 5.0V, Black Pattern, Fv=75Hz |

**Note 3-1:** Inrush Current measurement:

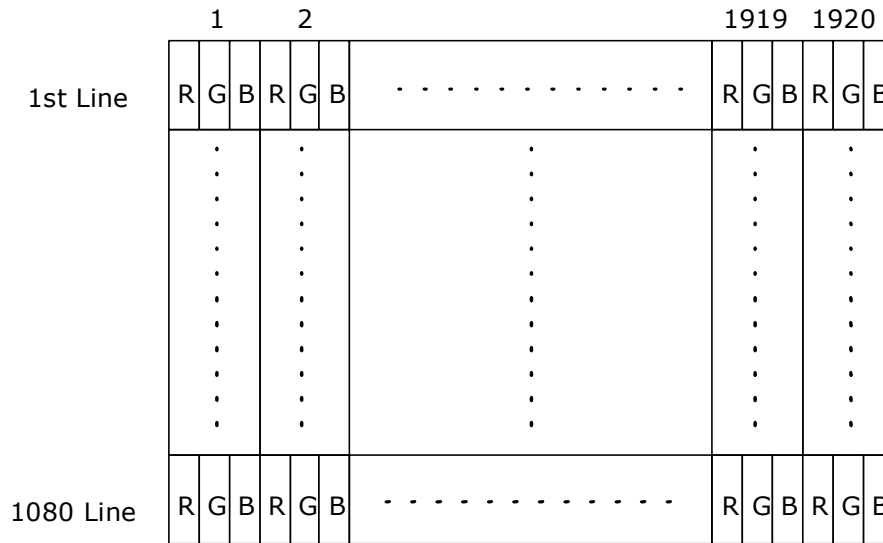
Test circuit:



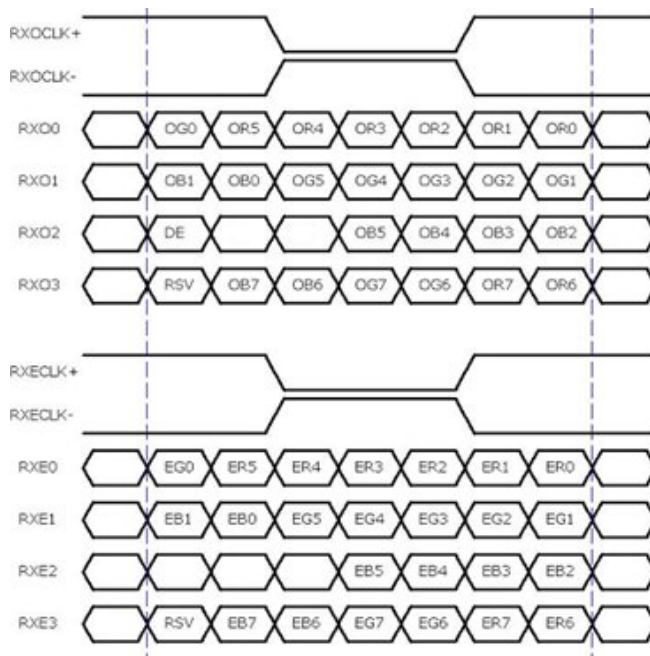
The duration of VDD rising time: 470us.

## 3.4 Signal Characteristics

### 3.4.1 LCD Pixel Format



### 3.4.2 LVDS Data Format



| 8 Bit Color Bit Order |    |    |    |
|-----------------------|----|----|----|
| MSB                   | R7 | G7 | B7 |
|                       | R6 | G6 | B6 |
|                       | R5 | G5 | B5 |
|                       | R4 | G4 | B4 |
|                       | R3 | G3 | B3 |
|                       | R2 | G2 | B2 |
|                       | R1 | G1 | B1 |
| LSB                   | R0 | G0 | B0 |

#### Note 3-2:

- O = "Odd Pixel Data" E = "Even Pixel Data"
- Refer to 3.4.1 LCD pixel format, the 1st data is 1 (Odd Pixel Data), the 2<sup>nd</sup> data is 2 (Even Pixel Data) and the last data is 1920 (Even Pixel Data).

## 3.4.3 Color versus Input Data

The following table is for color versus input data (8bit). The higher the gray level, the brighter the color.

| Color    | Gray Level | Color Input Data                              |    |    |    |    |    |    |    |   |    |    |    |    |    |    |    |  |    |    |    |    |    |    |       | Remark |
|----------|------------|---|----|----|----|----|----|----|----|---|----|----|----|----|----|----|----|--|----|----|----|----|----|----|-------|--------|
|          |            | RED data<br>( <b>MSB</b> :R7, <b>LSB</b> :R0) |    |    |    |    |    |    |    | GREEN data<br>( <b>MSB</b> :G7, <b>LSB</b> :G0) |    |    |    |    |    |    |    | BLUE data<br>( <b>MSB</b> :B7, <b>LSB</b> :B0) |    |    |    |    |    |    |       |        |
|          |            | R7  | R6 | R5 | R4 | R3 | R2 | R1 | R0 | G7  | G6 | G5 | G4 | G3 | G2 | G1 | G0 | B7   | B6 | B5 | B4 | B3 | B2 | B1 | B0    |        |
| Black    | -          | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 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  |       |        |
| Gray 127 | -          | 0   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 1  | 1  | 1  | 1  |       |        |
| Red      | L0         | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | Black |        |
|          | :          | :   | :  | :  | :  | :  | :  | :  | :  | :   | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  |       |        |
|          | L255       | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |       |        |
| Green    | L0         | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | Black |        |
|          | :          | :   | :  | :  | :  | :  | :  | :  | :  | :   | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  |       |        |
|          | L255       | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  |       |        |
| Blue     | L0         | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | Black |        |
|          | :          | :   | :  | :  | :  | :  | :  | :  | :  | :   | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  | :  |       |        |
|          | L255       | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 1  | 1  | 1  | 1  | 1  |       |        |

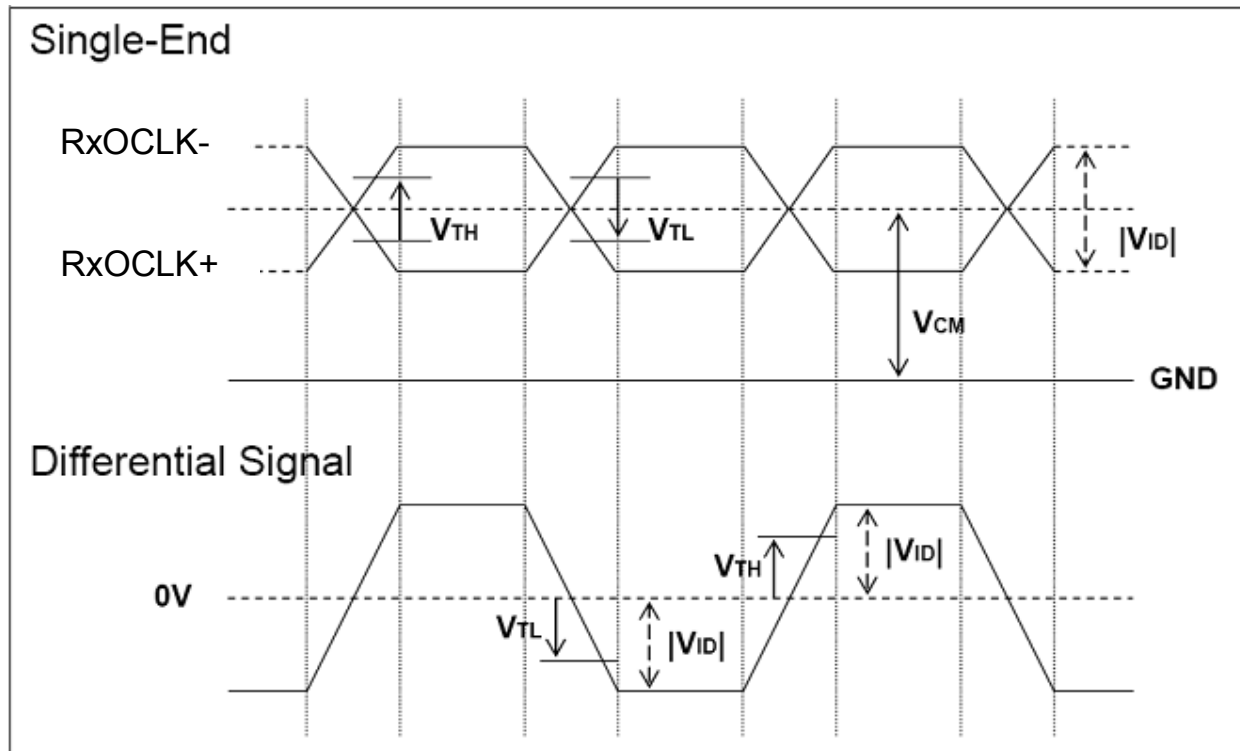
## 3.4.4 LVDS Specification

### a. DC Characteristics:

| Symbol     | Description                            | Min  | Typ  | Max  | Units | Condition               |
|------------|--|------|------|------|-------|-------------------------|
| $V_{TH}$   | LVDS Differential Input High Threshold | -    | -    | +100 | [mV]  | $V_{CM} = 1.2V$         |
| $V_{TL}$   | LVDS Differential Input Low Threshold  | -100 | -    | -    | [mV]  | $V_{CM} = 1.2V$         |
| $ V_{ID} $ | LVDS Differential Input Voltage        | 100  | -    | 600  | [mV]  |                         |
| $V_{CM}$   | LVDS Common Mode Voltage               | +1.0 | +1.2 | +1.5 | [V]   | $V_{TH}-V_{TL} = 200mV$ |

### LVDS Signal Waveform:

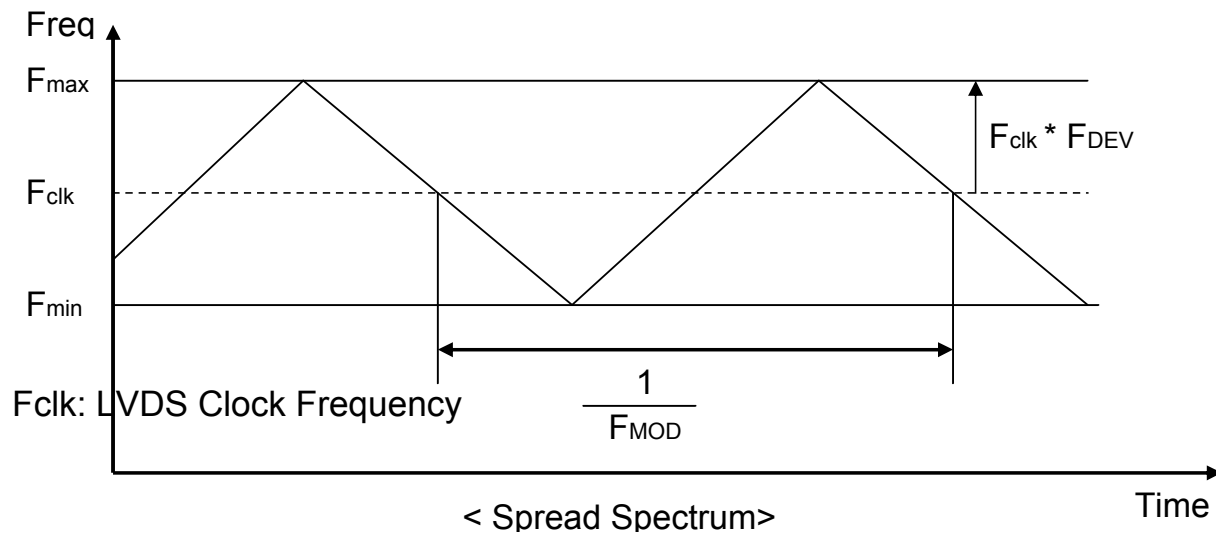
Use RxOCLK- & RxOCLK+ as example.



### b. AC Characteristics:

| Symbol | Description | Min | Max | Unit | Remark |
|--------|-------------|-----|-----|------|--------|
|--------|-------------|-----|-----|------|--------|

|           |  |   |         |     |  |
|-----------|--|---|---------|-----|--|
| $F_{DEV}$ | Maximum deviation of input clock frequency during Spread Spectrum  | - | $\pm 3$ | %   |  |
| $F_{MOD}$ | Maximum modulation frequency of input clock during Spread Spectrum | - | 200     | KHz |  |





## 3.4.5 Input Timing Specification

It only support DE mode, and the input timing are shown as the following table.

| Symbol    | Description        |           | Min. | Typ. | Max. | Unit | Remark          |
|-----------|--------------------|-----------|------|------|------|------|-----------------|
| Tv        | Vertical Section   | Period    | 1092 | 1130 | 1793 | Th   |                 |
| Tdisp (v) |                    | Active    | 1080 | 1080 | 1080 | Th   |                 |
| Tblk (v)  |                    | Blanking  | 12   | 50   | 713  | Th   |                 |
| Fv        |                    | Frequency | 49   | 60   | 76   | Hz   |                 |
| Th        | Horizontal Section | Period    | 1004 | 1050 | 1100 | Tclk |                 |
| Tdisp (h) |                    | Active    | 960  | 960  | 960  | Tclk |                 |
| Tblk (h)  |                    | Blanking  | 44   | 90   | 140  | Tclk |                 |
| Fh        |                    | Frequency | 54   | 68   | 90   | KHz  | <b>Note 3-3</b> |
| Tclk      | LVDS Clock         | Period    | 11.1 | 14.0 | 18.2 | ns   | 1/Fclk          |
| Fclk      |                    | Frequency | 53.7 | 71.2 | 90.0 | MHz  | <b>Note 3-4</b> |

**Note 3-3:** The equation is listed as following. Please don't exceed the above recommended value.

$$Fh (\text{Min.}) = Fclk (\text{Min.}) / Th (\text{Min.});$$

$$Fh (\text{Typ.}) = Fclk (\text{Typ.}) / Th (\text{Typ.});$$

$$Fh (\text{Max.}) = Fclk (\text{Max.}) / Th (\text{Min.});$$

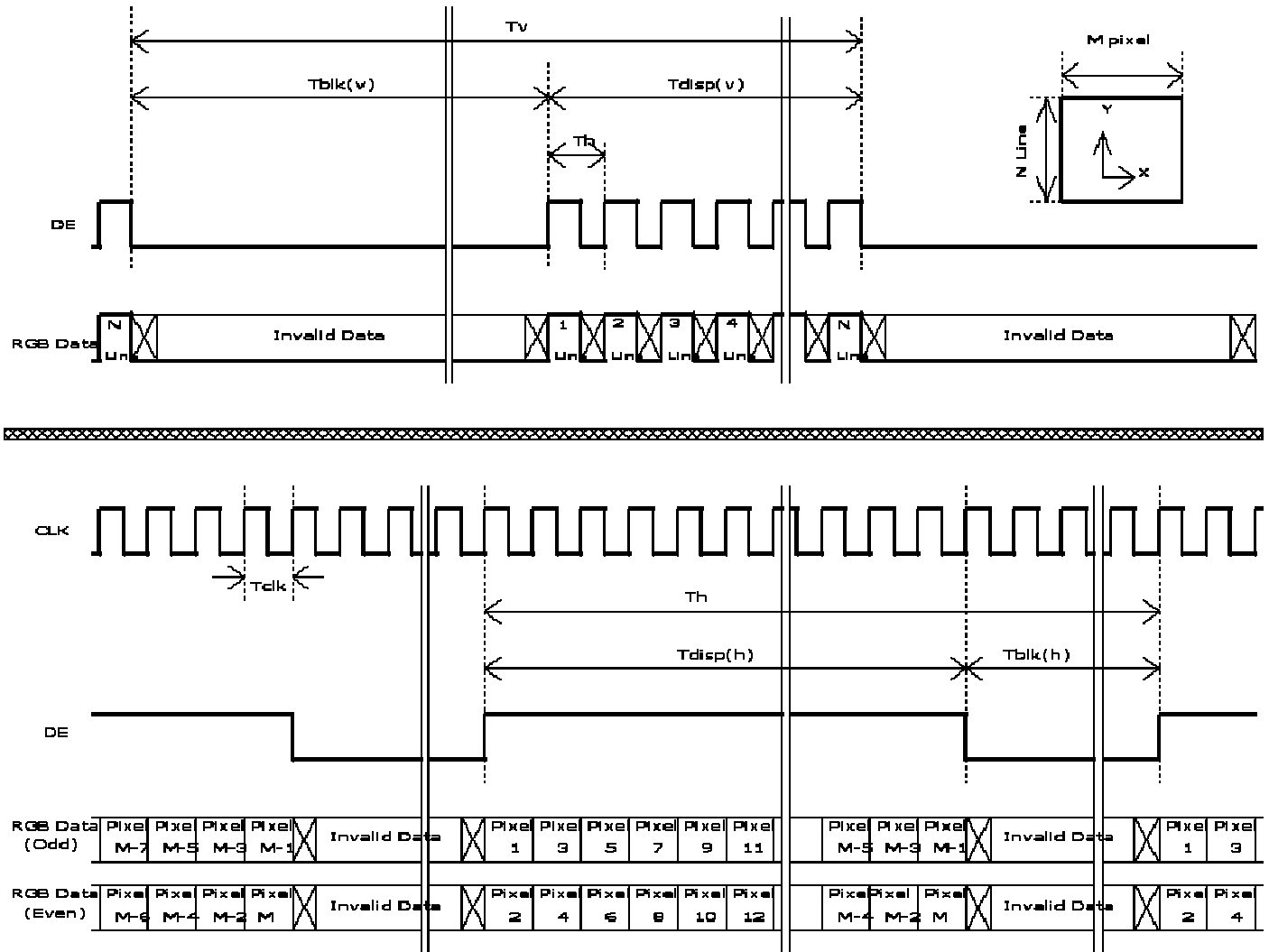
**Note 3-4:** The equation is listed as following. Please don't exceed the above recommended value.

$$Fclk (\text{Min.}) = Fv (\text{Min.}) \times Th (\text{Min.}) \times Tv (\text{Min.});$$

$$Fclk (\text{Typ.}) = Fv (\text{Typ.}) \times Th (\text{Typ.}) \times Tv (\text{Typ.});$$

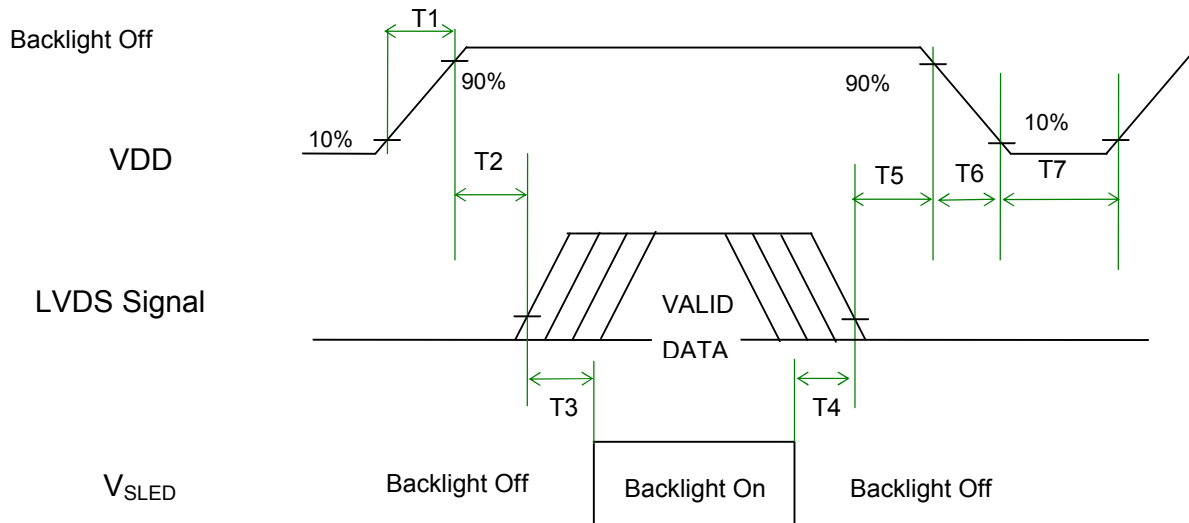
$$Fclk (\text{Max.}) = Fv (\text{Max.}) \times Th (\text{Typ.}) \times Tv (\text{Typ.});$$

## 3.4.6 Input Timing Diagram



## 3.5 Power ON/OFF Sequence

VDD power, LVDS signal and backlight on/off sequence are as following. LVDS signals from any system shall be Hi-Z state when VDD is off.



Power Sequence Timing

| Symbol | Value |      |      | Unit | Remark                             |
|--------|-------|------|------|------|------------------------------------|
|        | Min.  | Typ. | Max. |      |                                    |
| T1     | 0.5   | -    | 10   | [ms] |                                    |
| T2     | 0     | -    | 50   | [ms] |                                    |
| T3     | 500   | -    | -    | [ms] |                                    |
| T4     | 100   | -    | -    | [ms] |                                    |
| T5     | 0     |      | 50   | [ms] | <b>Note 3-5</b><br><b>Note 3-6</b> |
| T6     | 0     | -    | 150  | [ms] | <b>Note 3-6</b>                    |
| T7     | 1000  | -    | -    | [ms] |                                    |

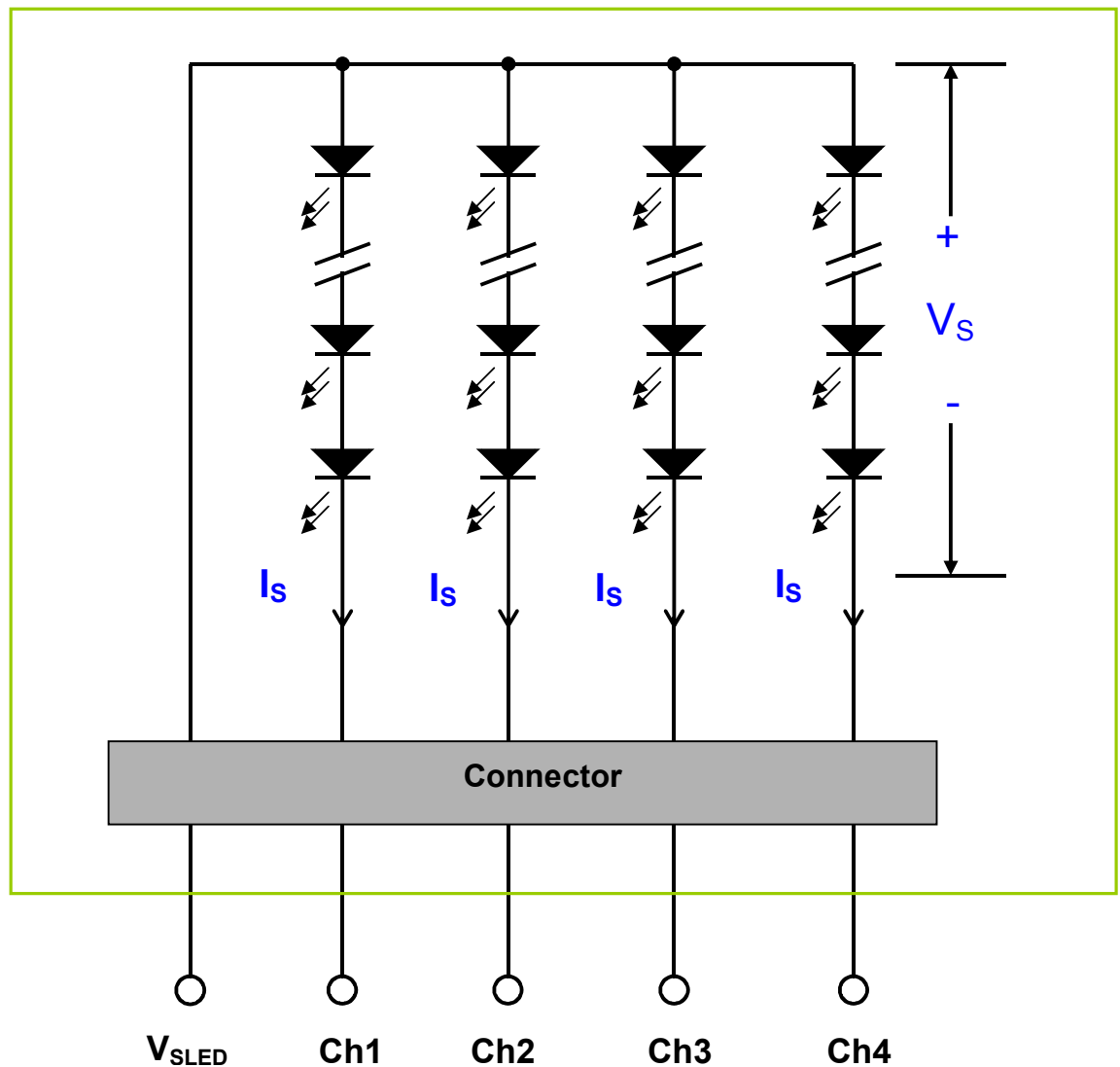
**Note 3-5** : Recommend setting T5 = 0ms to avoid electronic noise when VDD is off.

**Note 3-6** : During T5 and T6 period , please keep the level of input LVDS signals with Hi-Z state.

## 4 Backlight Unit

### 4.1 Block Diagram

The following shows the block diagram of the 23.8 inch Backlight Unit. And it includes 68 pcs LED in the LED light bar. (4 strings and 17 pcs LED of one string).



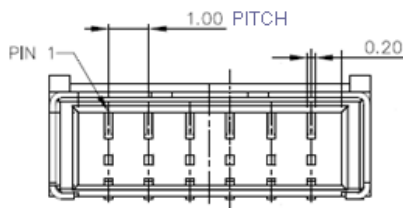
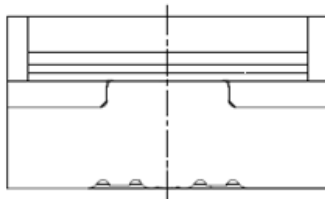
## 4.2 Interface Connection

### 4.2.1 Connector Type

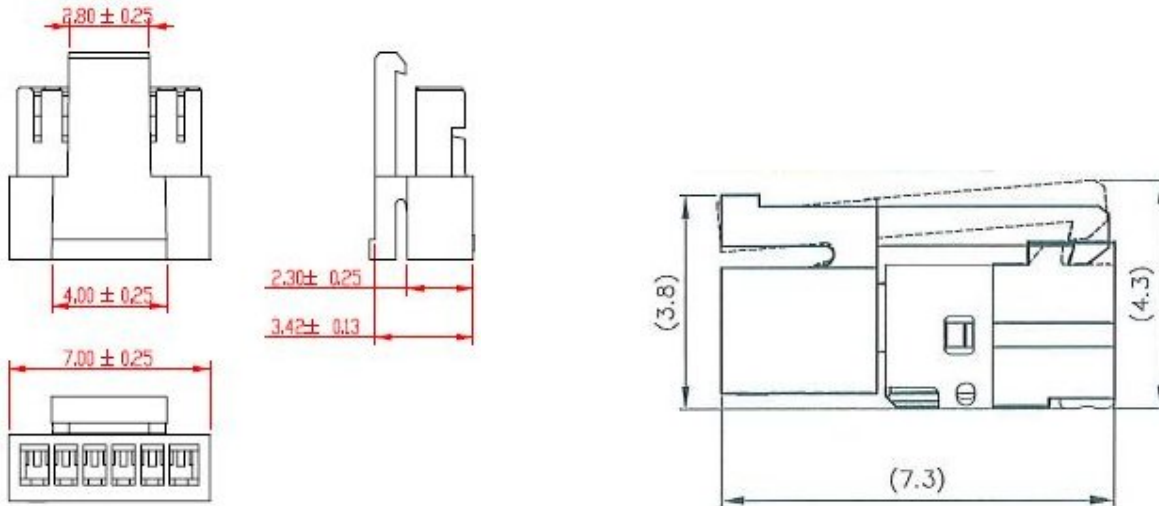
|                     |              |  |
|---------------------|--------------|--|
| Backlight Connector | Manufacturer | ENTERY   |
|                     | Part Number  | 3707K-S06N-21R (BLACK)<br>(Locking Type, Wire Harness)             |
| Mating Connector    | Manufacturer | ENTERY or Equivalent   |
|                     | Part Number  | H112K-P06N-00B (Non-Locking type)<br>H112K-P06N-03B (Locking type) |

### Backlight Connector dimension:

$H \times V \times D = 7.9 \times 3.05 \times 4.25$ , Pitch=1.0(unit=mm)

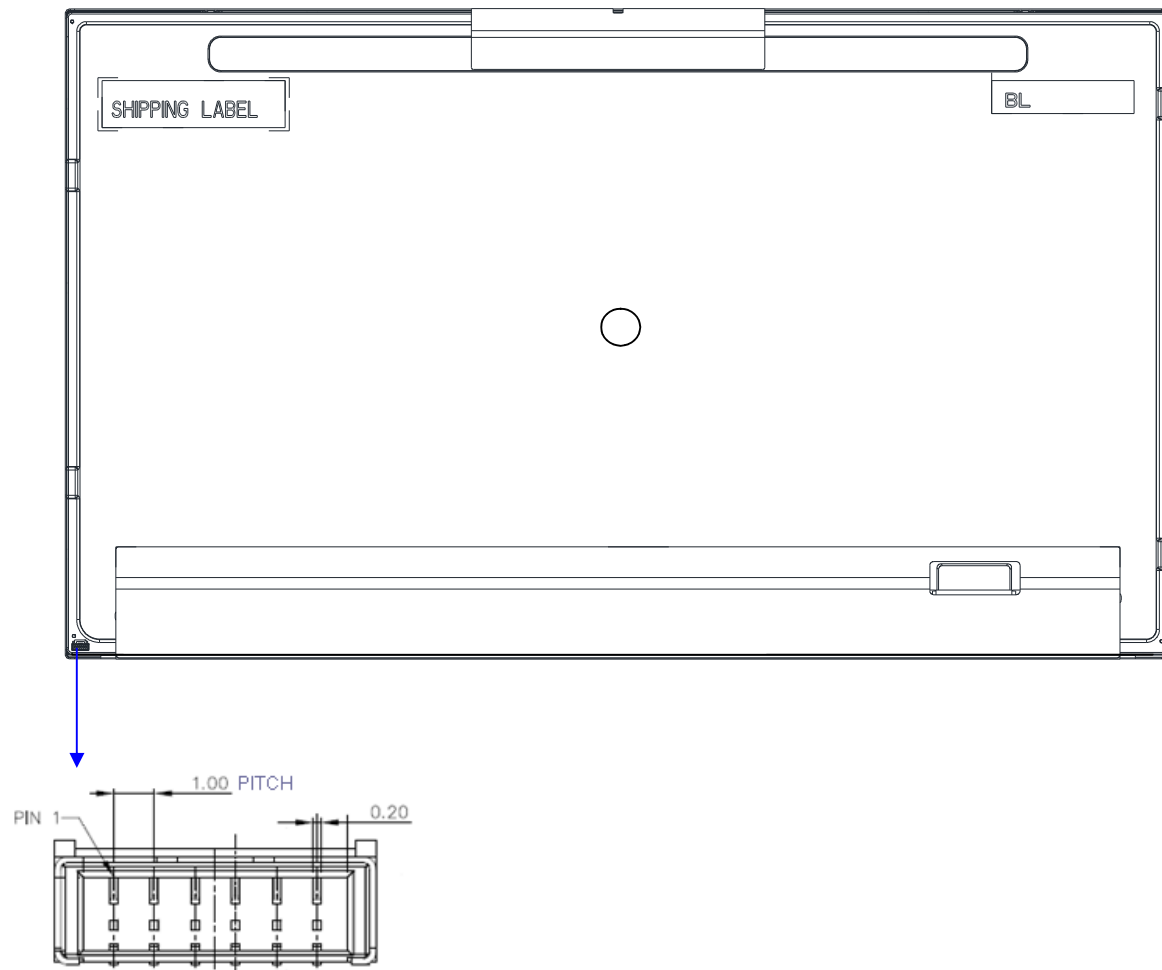


## Mating Connector dimension:



## 4.2.2 Connector Pin Assignment

| Pin# | Symbol            | Description                               | Remark |
|------|-------------------|---|--------|
| 1    | Ch1               | LED Current Feedback Terminal (Channel 1) |        |
| 2    | Ch2               | LED Current Feedback Terminal (Channel 2) |        |
| 3    | V <sub>SLED</sub> | LED Power Supply Voltage Input Terminal   |        |
| 4    | V <sub>SLED</sub> | LED Power Supply Voltage Input Terminal   |        |
| 5    | Ch3               | LED Current Feedback Terminal (Channel 3) |        |
| 6    | Ch4               | LED Current Feedback Terminal (Channel 4) |        |



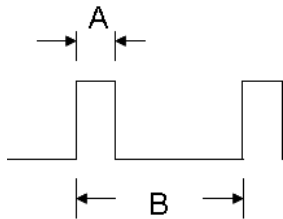
## 4.3 Electrical Characteristics

### 4.3.1 Absolute Maximum Rating

Permanent damage may occur if exceeding the following maximum rating.

(Ta=25°C)

| Symbol | Description        | Min | Max | Unit | Remark                               |
|--------|--------------------|-----|-----|------|--------------------------------------|
| Is     | Single LED Current | 0   | 90  | [mA] | 100% duty ratio                      |
|        |                    |     | 150 | [mA] | Duty ratio ≤ 10%<br>Pulse time=10 ms |



Duty ratio= (A / B) X 100% ; (A: Pulse time, B: Period)

### 4.3.2 Recommended Operating Condition

(Ta=25°C)

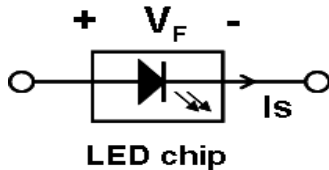
| Symbol            | Description                               | Min.          | Typ.  | Max.  | Unit   | Remark  |
|-------------------|---|---------------|-------|-------|--------|---|
| Is                | LED String Current                        | -             | 70    | -     | [mA]   | 100% duty ratio of LED chip                   |
| Vs                | LED String Voltage                        | 45.9          | 51.0  | 57.8  | [Volt] | Is=70mA @ 100% duty ratio; Note 4-1, Note 4-5 |
| ΔVs               | Maximum Vs Voltage Deviation of light bar | 2.7           | 3.0   | 3.4   | [Volt] | Is=70mA @ 100% duty ratio; Note 4-2           |
| P <sub>BLU</sub>  | LED Light Bar Power Consumption           | -             | 14.28 | 16.18 | [Watt] | <b>Note 4-3</b>                               |
| LT <sub>LED</sub> | LED Life Time                             | 30,000        | -     | -     | [Hour] | <b>Note 4-4</b>                               |
| OVP               | Over Voltage Protection in system board   | 110% Vs (max) | -     | -     | [Volt] | <b>Note 4-5</b>                               |



**Note 4-1:**  $V_s (\text{Typ.}) = V_F (\text{Typ.}) \times \text{LED No. (one string)}$ ;

a.  $V_F$ : LED chip forward voltage,  $V_F (\text{Min.})=2.7$ ,  $V_F (\text{Typ.})=3.0\text{V}$ ,  $V_F (\text{Max.})=3.4\text{V}$

b. The same equation to calculate  $V_s (\text{Min.})$  &  $V_s (\text{Max.})$  for respective  $V_F (\text{Min.})$  &  $V_F (\text{Max.})$ ;



**Note 4-2:**  $\Delta V_s (\text{Max.}) = \Delta V_F \times \text{LED No. (one string)}$ ;

a.  $\Delta V_F$ : LED chip forward voltage deviation; (0.2 V , each Bin of LED  $V_F$ )

**Note 4-3:**  $P_{\text{BLU}} (\text{Typ.}) = V_s (\text{Typ.}) \times I_s (\text{Typ.}) \times 4$  ; ( 4 is total String No. of LED Light bar)

$P_{\text{BLU}} (\text{Max.}) = V_s (\text{Max.}) \times I_s (\text{Typ.}) \times 4$  ;

**Note 4-4:** Definition of life time:

a. Brightness of LED becomes to 50% of its original value

b. Test condition:  $I_s = 70\text{mA}$  and  $25^\circ\text{C}$  (Room Temperature)

**Note 4-5:** The LED life-time is estimated data. And is defined when a single LED operated in room temperature, the estimated time to 50% degradation of initial luminous.

Recommendation for LED driver power design:

Due to there are electrical property deviation in LED & monitor set system component after long time operation. AUO strongly recommend the design value of LED driver board OVP (over voltage protection) should be 10% higher than max. value of LED string voltage ( $V_s$ ) at least.

**Note 4-6:** AUO strongly recommend “Analog Dimming” method for backlight brightness control for Wavy Noise Free. Otherwise, recommend that Dimming Control Signal (PWM Signal) should be synchronized with Frame Frequency.

## 5 Reliability Test

AUO reliability test items are listed as following table. (*Bare Panel only*)

| Items                             | Condition   | Remark        |
|-----------------------------------|---|---------------|
| Temperature Humidity Bias (THB)   | Ta= 50°C , 80%RH, 300hours  |               |
| High Temperature Operation (HTO)  | Ta= 50°C , 300hours   |               |
| Low Temperature Operation (LTO)   | Ta= 0°C , 300hours  |               |
| High Temperature Storage (HTS)    | Ta= 60°C , 300hours   |               |
| Low Temperature Storage (LTS)     | Ta= -20°C , 300hours  |               |
| Vibration Test<br>(Non-operation) | Acceleration: 1.5 Grms<br>Wave: Random<br>Frequency: 10 - 200 Hz<br>Sweep: 30 Minutes each Axis (X, Y, Z)     |               |
| Shock Test<br>(Non-operation)     | Acceleration: 50 G<br>Wave: Half-sine<br>Active Time: 20 ms<br>Direction: ±X, ±Y, ±Z (one time for each Axis) |               |
| Thermal Shock Test (TST)          | -20°C/30min, 60°C/30min, 100 cycles   | <b>Note 1</b> |
| On/Off Test                       | On/10sec, Off/10sec, 30,000 cycles  |               |
| ESD (Electro Static Discharge)    | Contact Discharge: ± 8KV, 150pF(330Ω ) 1sec,<br>8 points, 25 times/ point.                                    | <b>Note 2</b> |
|                                   | Air Discharge: ± 15KV, 150pF(330Ω ) 1sec<br>8 points, 25 times/ point.  |               |
| Altitude Test                     | Operation:18,000 ft<br>Non-Operation:40,000 ft  |               |

Note 1: A cycle of rapid temperature change consists of varying the temperature from -20°C to 60°C , and back again.

Power is not applied during the test. After finish temperature cycling, the unit is placed in normal room ambient for at least 4 hours before power on.

Note 2: According to EN61000-4-2, ESD class B: Some performance degradation allowed. No data lost Self-recoverable.

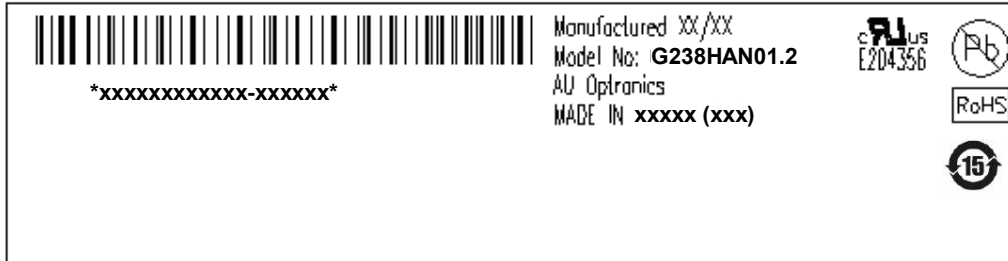
No hardware failures.

Note3:

- Water condensation is not allowed for each test items.
- Each test is done by new TFT-LCD module. Don't use the same TFT-LCD module repeatedly for reliability test.
- The reliability test is performed only to examine the TFT-LCD module capability.
- To inspect TFT-LCD module after reliability test, please store it at room temperature and room humidity for 24 hours at least in advance.
- No function failure occurs.

## 6 Shipping Label

The label is on the panel as shown below:



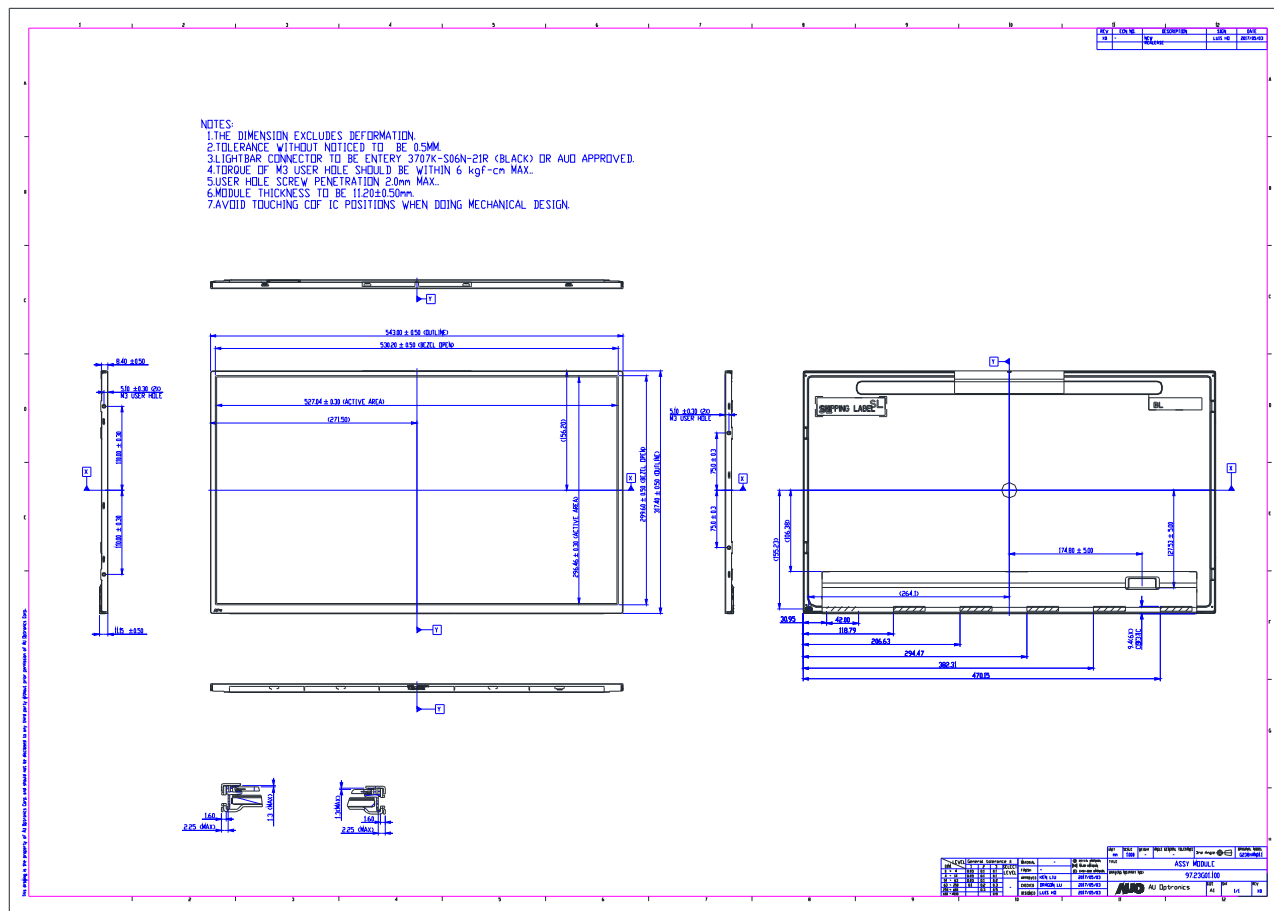
**Note 6-1:** For Pb Free products, AUO will add  for identification.

**Note 6-2:** For RoHS compatible products, AUO will add  for identification.

**Note 6-3:** For China RoHS compatible products, AUO will add  for identification.

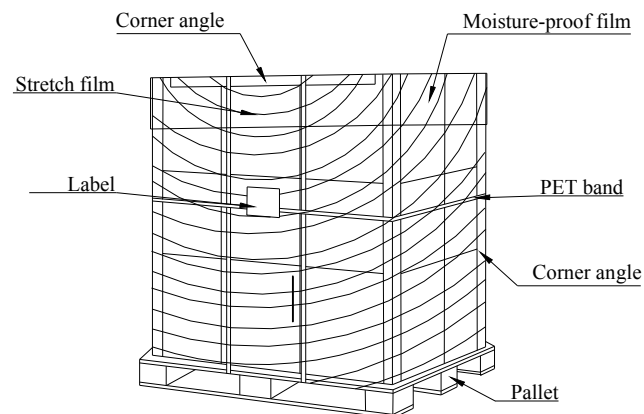
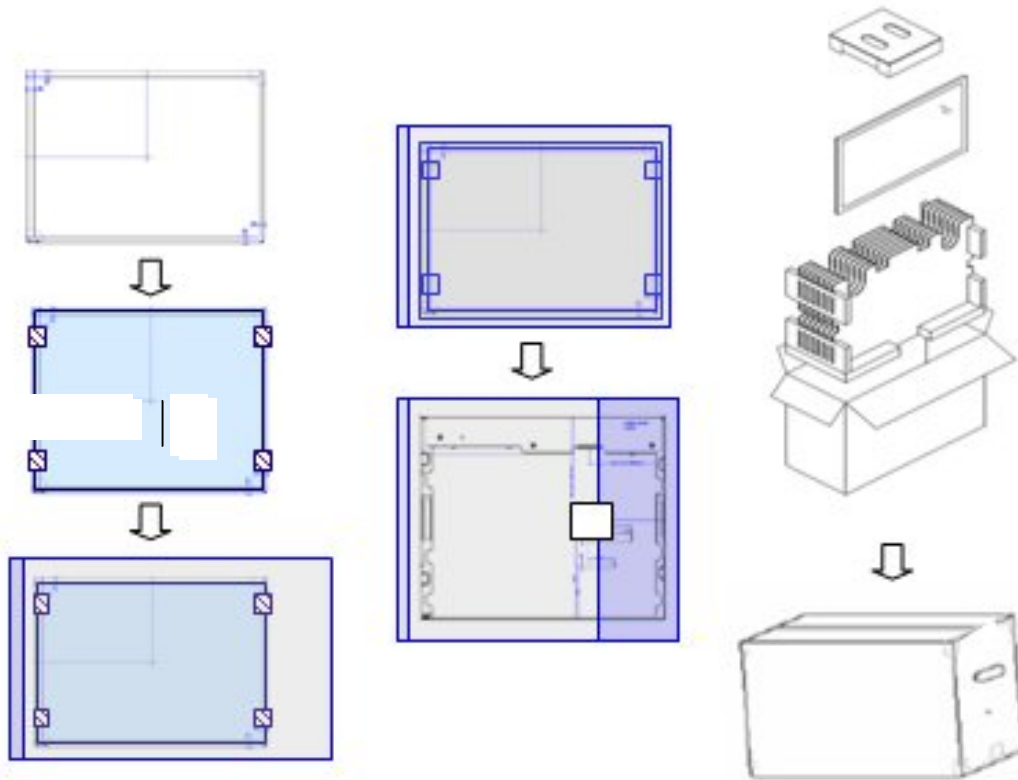
**Note 6-4:** The Green Mark will be presented only when the green documents have been ready by AUO Internal Green Team.

### 7 Mechanical Characteristics



## 8 Packing Specification

### 8.1 Packing Flow



## 8.2 Pallet and shipment information

| Item                 | Specification   |                                      |            | Remark                  |
|----------------------|-----------------|--------------------------------------|------------|-------------------------|
|                      | Q'ty            | Dimension                            | Weight(kg) |                         |
| Panel                | 1               | 543.0(H) x 317.4(V) x 11.2(D) (Typ.) | 2.300      |                         |
| Cushion              | 1               | -                                    | 1.7        |                         |
| Box                  | 1               | 610mmx 270mmx 430 mm                 | 1.3        | without Panel & cushion |
| Packing Box          | 7 pcs/Box       | 610mmx 270mmx 430 mm                 | 19         | with panel & cushion    |
| Pallet               | 1               | 1150 mm * 840mm * 132 mm             | 12         |                         |
| Pallet after Packing | 12 boxes/pallet | 1150(L)mm x 840(W)mm x 1440(H)mm     | 240        |                         |