

( ) Preliminary Specification  
 (V) Final Specification

|            |                     |
|------------|---------------------|
| Module     | 23.8" Color TFT-LCD |
| Model Name | G238HAN04.0         |

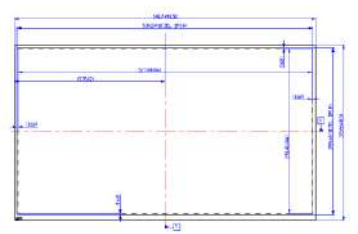
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|-------------|-------|
| Customer    | Date  |
| _____       | _____ |
| Approved by |       |
| _____       | _____ |

|                              |                     |
|------------------------------|---------------------|
| Approved by                  | Date                |
| <u>Elsie MK Kuo</u>          | <u>Aug 28, 2024</u> |
| Prepared by                  | Date                |
| <u>Tim JT Li</u>             | <u>Aug 28, 2024</u> |
| AUO Display Plus corporation |                     |

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## Record of Revision

| Version | Date       | Page | Old description                                                                     | New Description                                                                                        | Remark |
|---------|------------|------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------|
| 0.0     | 2022/11/7  | all  |                                                                                     | Preliminary Spec                                                                                       |        |
| 0.1     | 2022/12/28 | all  |                                                                                     | new format                                                                                             |        |
| 0.2     | 2023/2/16  | all  |                                                                                     | new format (AUO Display Plus LOGO)                                                                     |        |
| 1.0     | 2024/3/29  | all  |                                                                                     | Final Spec.                                                                                            |        |
| 1.1     | 2024/6/20  | 5    | Outline Dimension<br>540.24(H) x 315.66(V)                                          | Outline Dimension<br>540.44(H) x 315.86(V)                                                             |        |
|         |            | 29   |  | Label Revising<br> |        |
|         |            | 30   |  |                    |        |
| 1.2     | 2024/8/28  | 29   |  | Label Revising<br> |        |

## I Handling Precautions

- 1) Since polarizer is easily damaged, do not touch or press the surface of polarizer with hand.
- 2) Be sure to turn off power supply when inserting or disconnecting from input connector.
- 3) Wipe off water drop immediately. Long contact with water may cause discoloration or spots.
- 4) When the panel surface is soiled, wipe it with absorbent cotton or other soft cloth.
- 5) Since the panel is made of glass, it may break or crack if dropped or bumped on hard surface.
- 6) Since CMOS LSI is used in this module, take care of static electricity and insure human earth when handling.
- 7) Do not open or modify the Module Assembly.
- 8) Do not press the reflector sheet at the back of the module to any directions.
- 9) In case a TFT-LCD Module has to be put back into the packing container slot after once it was taken out from the container, do not press the center of the LED lightbar edge. Otherwise the TFT-LCD Module may be damaged.
- 10) Insert or pull out the interface connector, be sure not to rotate nor tilt it of the TFT-LCD Module.
- 11) Do not twist nor bend the TFT -LCD Module even momentary. It should be taken into consideration that no bending/twisting forces are applied to the TFT-LCD Module from outside. Otherwise the TFT-LCD Module may be damaged.
- 12) Please avoid touching COF position while you are doing mechanical design.
- 13) When storing modules as spares for a long time, the following precaution is necessary: Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
- 14) Do not apply the same pattern for a long time, it will enhance relevant defect.
- 15) When this reverse-type model(PCBA on bottom side) is used as forward-type model(PCBA on top side) , AUO can not guarantee any defects of LCM .

## 2 General Description

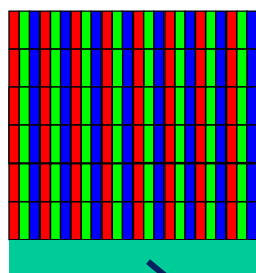
This specification applies to the 23.8 inch wide Color a-Si TFT-LCD Module G238HAN04.0. The display supports the FHD - 1920(H) x 1080 (V) screen format and 16.7M colors (RGB 6 bits+Hi FRC ). The input interface is 2 port LVDS and this module doesn't contain an driver board for backlight.

### 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) x274.5                                                                                   |
| Pixel Arrangement                                    | -            | R.G.B. Vertical Stripe. Source board at bottom <b>Note 2-1</b>                                                 |
| Display Mode                                         | -            | AHVA Mode (Advanced Hyper-Viewing Angle) , Normally Black                                                      |
| White Luminance ( Center )                           | [cd/m²]      | 350 (Typ.)                                                                                                     |
| Contrast Ratio                                       | -            | 1000 (Typ.)                                                                                                    |
| Response Time                                        | [msec]       | 14 (Typ., GTG)                                                                                                 |
| Power Consumption<br>(LCD Module + Backligh unit)    | [Watt]       | TTL=14.32<br>LCD module: PDD (Typ)=1.5 @White pattern Fv=60 Hz<br>Backlight unit: PBLU (Typ)= 12.82 @ IS=65 mA |
| Weight                                               | [Grams]      | 2180 (Typ.)                                                                                                    |
| Outline Dimension                                    | [mm]         | 540.44(H) x 315.86(V) x 12.2(D) (Typ.)                                                                         |
| Electrical Interface                                 | -            | Dual channel LVDS , 8-bit RGB data input                                                                       |
| Support Color                                        | -            | 16.7M colors (RGB 6 bits + Hi FRC)                                                                             |
| Surface Treatment                                    | -            | Anti-Glare, 3H                                                                                                 |
| Temperature Range<br>Operating<br>Storage (Shipping) | [°C]<br>[°C] | 0 to +50<br>-20 to +60                                                                                         |
| RoHS Compliance                                      | -            | RoHS Compliance                                                                                                |
| TCO Compliance                                       | -            | TCO 8.0 Compliance                                                                                             |
| Low Blue Light Compliance                            | -            | The ratio of light in the range from 415nm~455nm compared to 400nm~500nm shall be less than 50%                |

**Note 2-1:** The following shows the figure of pixel arrangement



Source Board

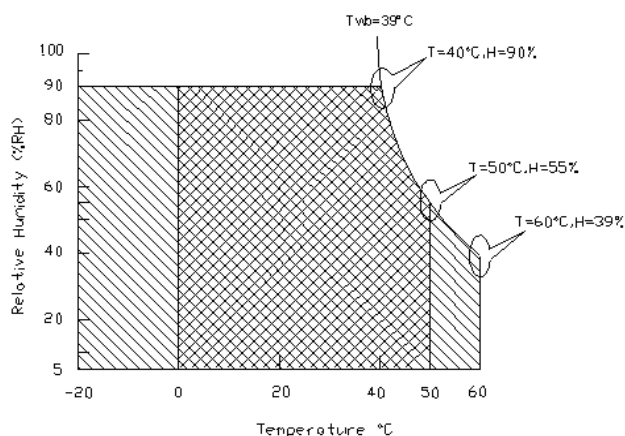
## 2.2 Absolute Maximum Rating of Environment

Permanent damage may occur if exceeding the following maximum rating.

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

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

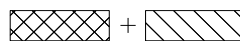
- 90% RH Max (  $T_a \leq 39^{\circ}\text{C}$  )
- Max wet-bulb temperature at  $39^{\circ}\text{C}$  or less. (  $T_a \leq 39^{\circ}\text{C}$  )
- No condensation



Operating Range



Storage Range



## 2.3 Optical Characteristics

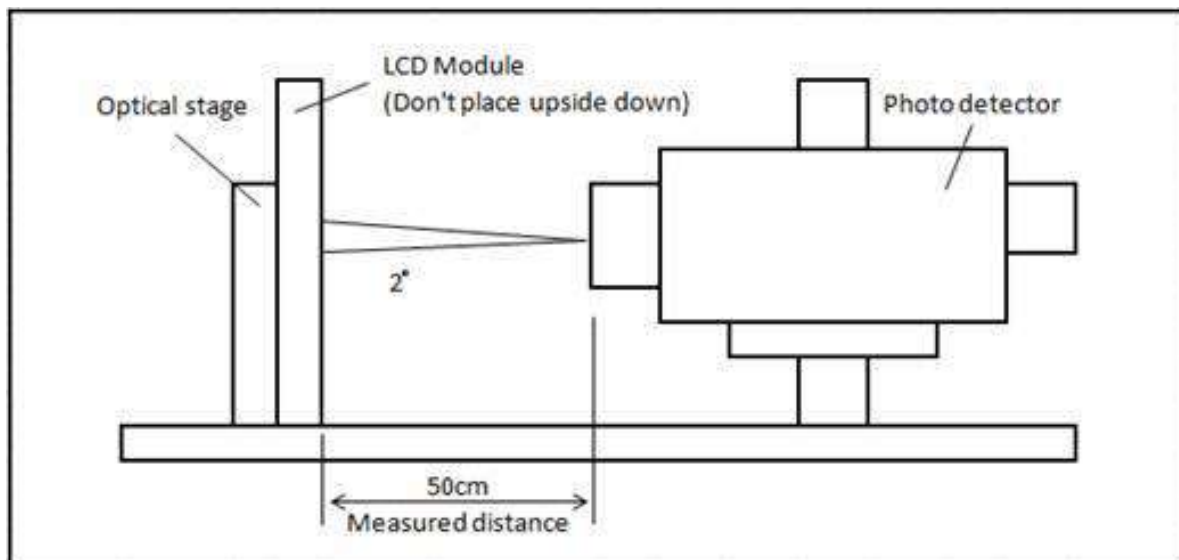
The optical characteristics are measured on the following test condition.

### Test Condition:

1. Equipment setup: Please refer to **Note 2-3**.
2. Panel Lighting time: 30 minutes
3. VDD=5.0V, Fv=60Hz, Is= 65mA, Ta=25°C

| Symbol           | Description                         |              | Min.  | Typ.  | Max.  | Unit     | Remark                                                            |
|------------------|-------------------------------------|--------------|-------|-------|-------|----------|-------------------------------------------------------------------|
| L <sub>w</sub>   | White Luminance (Center of screen)  |              | 280   | 350   |       | [cd/m2]  | <b>Note 2-3</b><br>By SR-3<br><b>Max=Peak</b><br><b>Note 2-12</b> |
| L <sub>uni</sub> | Luminance Uniformity (9 points)     |              | 75    | 80    | -     | [%]      | <b>Note 2-4</b><br>By SR-3                                        |
| CR               | Contrast Ratio (Center of screen)   |              | 700   | 1000  | -     | -        | <b>Note 2-5</b><br>By SR-3                                        |
| θ <sub>R</sub>   | Horizontal Viewing Angle<br>(CR=10) | Right        | 85    | 89    | -     | [degree] | <b>Note 2-6</b><br>By SR-3                                        |
| θ <sub>L</sub>   |                                     | Left         | 85    | 89    | -     |          |                                                                   |
| Φ <sub>H</sub>   | Vertical Viewing Angle<br>(CR=10)   | Up           | 85    | 89    | -     |          |                                                                   |
| Φ <sub>L</sub>   |                                     | Down         | 85    | 89    | -     |          |                                                                   |
| T <sub>GTG</sub> | Response Time                       | Gray To Gray | -     | 14    | -     | [msec]   | <b>Note 2-7</b><br>By TRD-100                                     |
| R <sub>x</sub>   | Color Coordinates<br>(CIE 1931)     | Red x        | 0.630 | 0.660 | 0.690 | -        | By SR-3                                                           |
| R <sub>y</sub>   |                                     | Red y        | 0.299 | 0.329 | 0.359 |          |                                                                   |
| G <sub>x</sub>   |                                     | Green x      | 0.256 | 0.286 | 0.316 |          |                                                                   |
| G <sub>y</sub>   |                                     | Green y      | 0.591 | 0.621 | 0.651 |          |                                                                   |
| B <sub>x</sub>   |                                     | Blue x       | 0.114 | 0.144 | 0.174 |          |                                                                   |
| B <sub>y</sub>   |                                     | Blue y       | 0.024 | 0.054 | 0.084 |          |                                                                   |
| W <sub>x</sub>   |                                     | White x      | 0.283 | 0.313 | 0.343 |          |                                                                   |
| W <sub>y</sub>   |                                     | White y      | 0.299 | 0.329 | 0.359 |          |                                                                   |
| Ru'              | Color Coordinates<br>(CIE 1976)     | Red u'       |       | 0.469 |       | -        | -                                                                 |
| Rv'              |                                     | Red v'       |       | 0.526 |       |          |                                                                   |
| Gu'              |                                     | Green u'     |       | 0.116 |       |          |                                                                   |
| Gv'              |                                     | Green v'     |       | 0.566 |       |          |                                                                   |
| Bu'              |                                     | Blue u'      |       | 0.171 |       |          |                                                                   |
| Bv'              |                                     | Blue v'      |       | 0.145 |       |          |                                                                   |
| Wu'              |                                     | White u'     |       | 0.198 |       |          |                                                                   |
| Wv'              |                                     | White v'     |       | 0.468 |       |          |                                                                   |
| sRGB             |                                     |              |       | 99%   |       |          | By SR-3                                                           |

**Note 2-3:** Equipment setup :

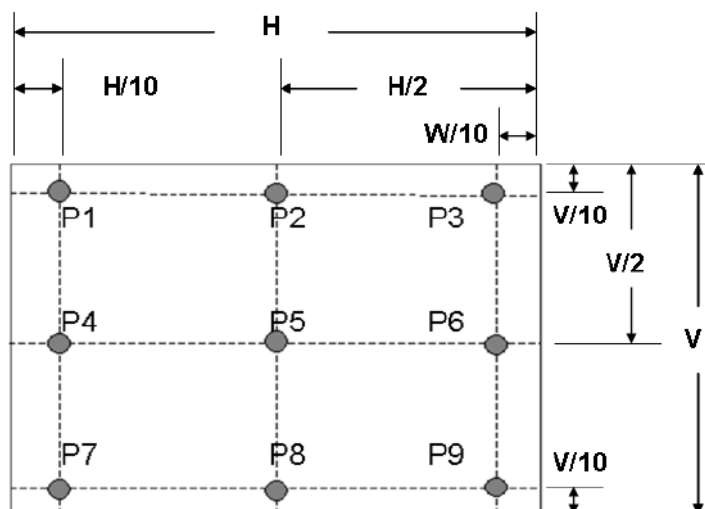


**Note 2-4:** Luminance Uniformity Measurement

**Definition:**

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

*Test pattern: White Pattern*



**Note 2-5:** Contrast Ratio Measurement

**Definition:**

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

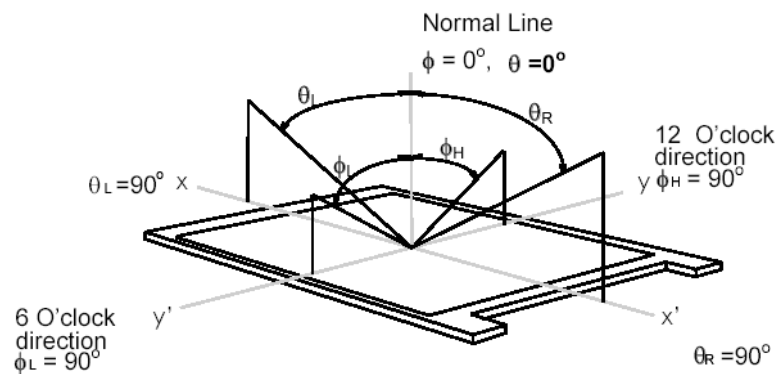
Measured position: Center of screen (P5) & perpendicular to the screen ( $\theta=\Phi=0^\circ$ )

**Note 2-6:** Viewing angle measurement

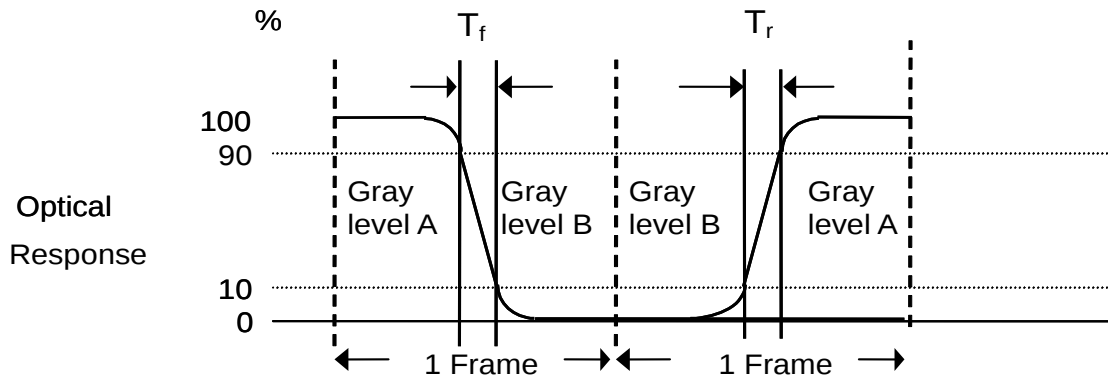
**Definition:** The angle at which the contrast ratio is equal to 10.

Horizontal view angle: Divide to left & right ( $\theta_L$  &  $\theta_R$ )

Vertical view angle: Divide to up & down ( $\Phi_H$  &  $\Phi_L$ )



**Note 2-7:** 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 |      | Target gray level |     |      |      |      |
|--------------------------|------|-------------------|-----|------|------|------|
|                          |      | L0                | L63 | L127 | L191 | L255 |
| Start gray level         | L0   |                   |     |      |      |      |
|                          | L63  |                   |     |      |      |      |
|                          | L127 |                   |     |      |      |      |
|                          | L191 |                   |     |      |      |      |
|                          | L255 |                   |     |      |      |      |

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

## 2.4 Mechanical Characteristics

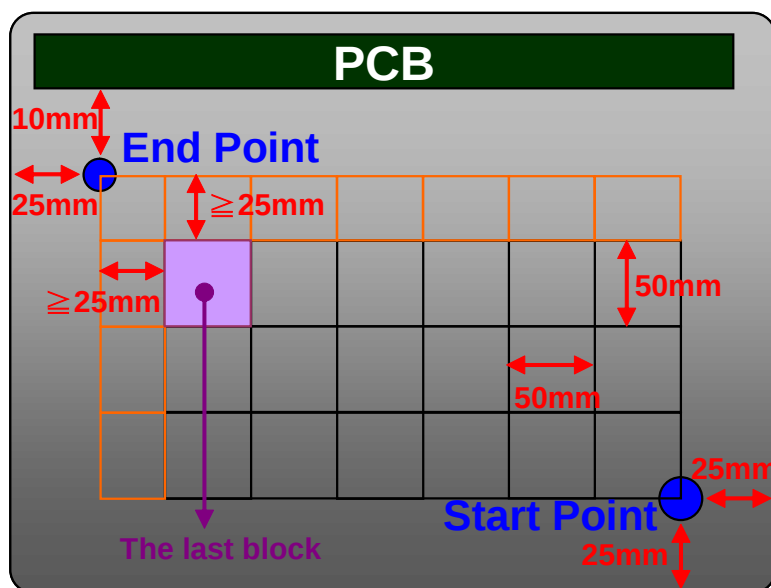
| Symbol          | Description          | Min. | Max. | Unit  | Remark           |
|-----------------|----------------------|------|------|-------|------------------|
| P <sub>bc</sub> | Backside Compression | 2.5  | -    | [Kgf] | <b>Note 2-10</b> |

**Note 2-10:** Test Method:

The point is at a distance from right-downside 25mm x 25mm defined as the Start Point of Measure Points, and the point is at a distance 25mm from left-side & around 10mm from PCB defined as the End Point.

Align 50mm x 50mm block from Start Point on the Bezel Back, and the corners of each block are Measure Points.

If the distance from the last block to each side of the End Point  $\geq 25\text{mm}$ , add other blocks to make sure that most area of Bezel Back can be measured.

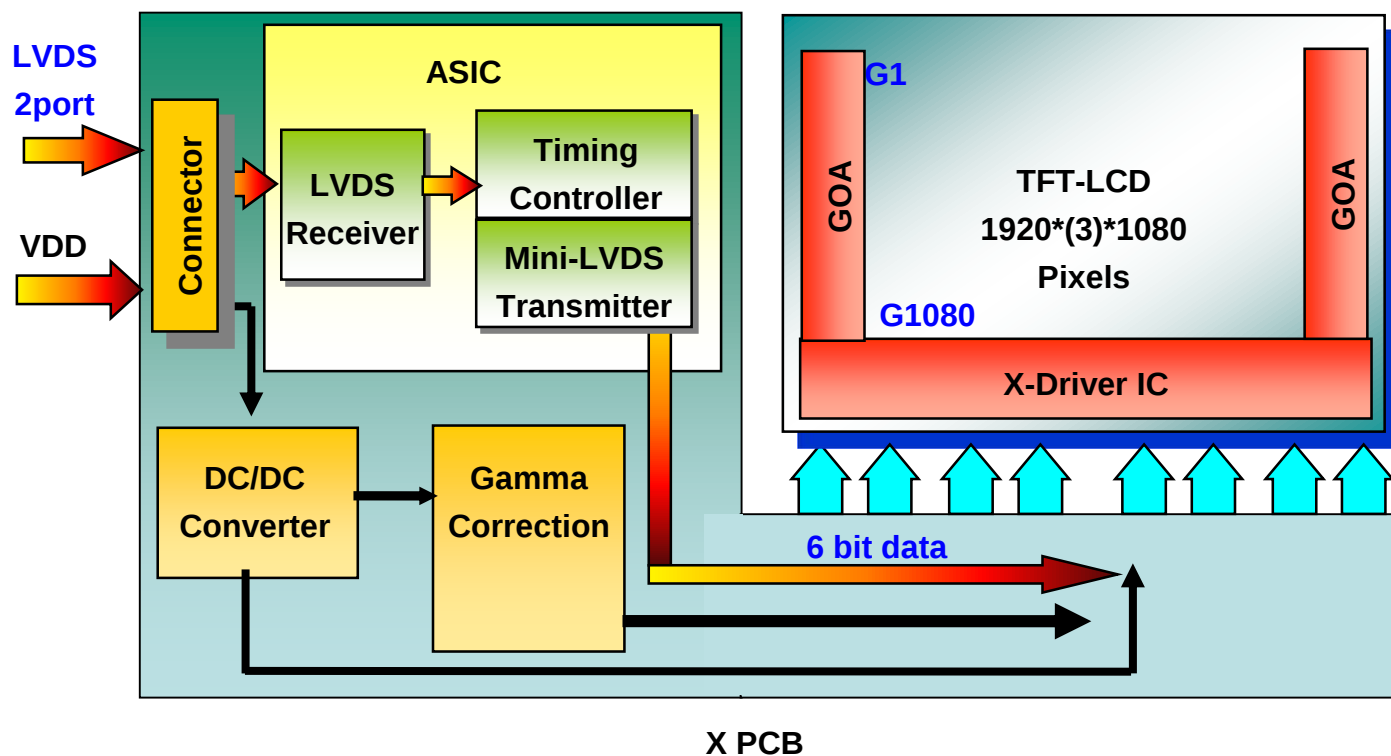


**Note 2-12 :** Evaluation test and mass production inspection shall be applied with LED current I<sub>s</sub> @ HDR off condition if there is not specified condition.

### 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

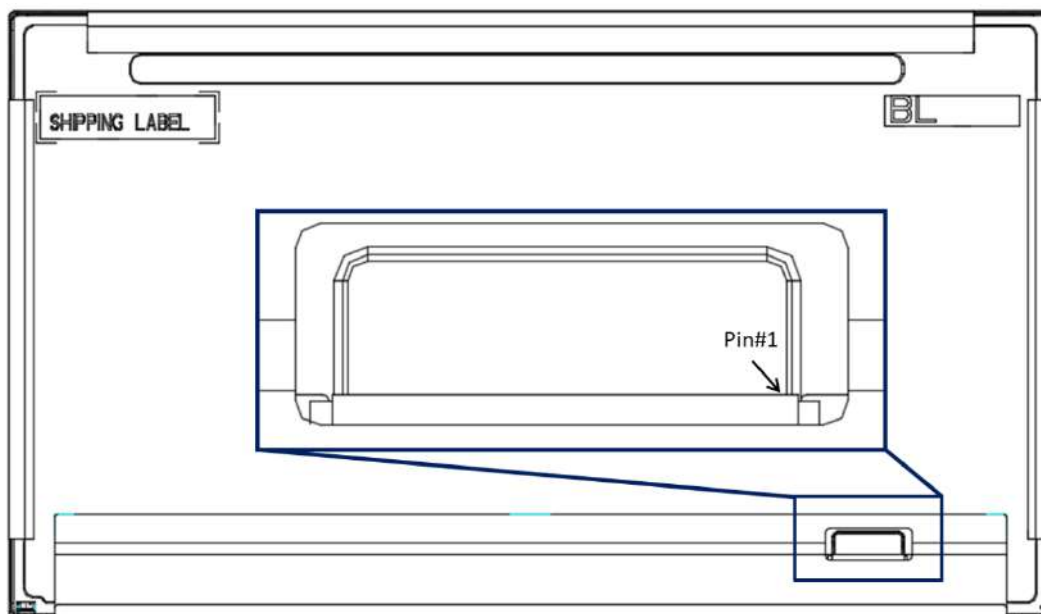
|                   |              |                        |                |
|-------------------|--------------|------------------------|----------------|
| TFT-LCD Connector | Manufacturer | P-TWO                  | STM            |
|                   | Part Number  | I87034-3009            | MSBKT2407P30HB |
| Mating Connector  | Manufacturer | JAE or Compatible      |                |
|                   | Part Number  | FI-X30HL (Locked Type) |                |

### 3.2.2 Connector Pin Assignment

LVDS CNT

| 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     | Power 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     | Power Ground                                        |        |
| 15    | RxE1-   | Negative LVDS differential data input (Even data)   |        |
| 16    | RxE1+   | Positive LVDS differential data input (Even data)   |        |
| 17    | GND     | Power 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    | NC      | No connection (for AUO test only. Do not connect)   |        |
| 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 +5V                                           |        |
| 29    | VDD     | Power +5V                                           |        |

|    |     |           |  |
|----|-----|-----------|--|
| 30 | VDD | Power +5V |  |
|----|-----|-----------|--|



## 3.3 Electrical Characteristics

### 3.3.1 Absolute Maximum Rating

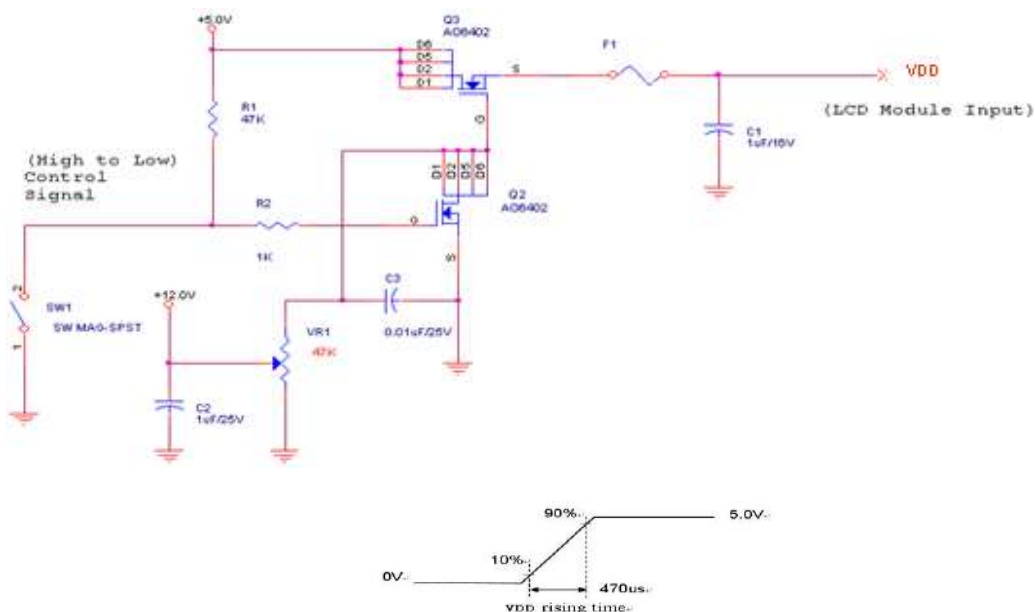
Permanent damage may occur if exceeding the following maximum rating.

| 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 | Item                         |          | Min. | Typ. | Max. | Unit   | Note                                     |
|--------|------------------------------|----------|------|------|------|--------|------------------------------------------|
| VDD    | Power Supply Input Range     |          | 4.5  | 5.0  | 5.5  | [Volt] |                                          |
| IDD    | Current of Power Supply@60Hz | White    | -    | 0.3  | 0.36 | [A]    | Note3-1                                  |
|        |                              | Black    | -    | 0.3  | 0.36 | [A]    |                                          |
|        |                              | H-stripe | -    | 0.8  | 0.96 | [A]    |                                          |
|        | Current of Power Supply@75Hz | White    | -    | 0.3  | 0.36 | [A]    |                                          |
|        |                              | Black    | -    | 0.3  | 0.36 | [A]    |                                          |
|        |                              | H-stripe | -    | 1.0  | 1.2  | [A]    |                                          |
| PDD    | VDD Power Consumption@60Hz   |          | -    | 1.5  | 1.8  | [Watt] | White                                    |
|        | VDD Power Consumption@75Hz   |          | -    | 5.0  | 6.0  | [Watt] | H-stripe                                 |
| IRUSH  | Inrush current               |          | -    | -    | 3    | [A]    | Note3-2                                  |
| VDDrp  | Allowable VDD Ripple Voltage |          |      |      | 500  | [mV]   | VDD=5.0V, White Pattern @Maxi Frame rate |

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



The duration of VDD rising time: 470us.



## 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  | 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  |        |
| 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  | 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  | 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  | 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  | 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  | 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  | 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  | 1  |        |

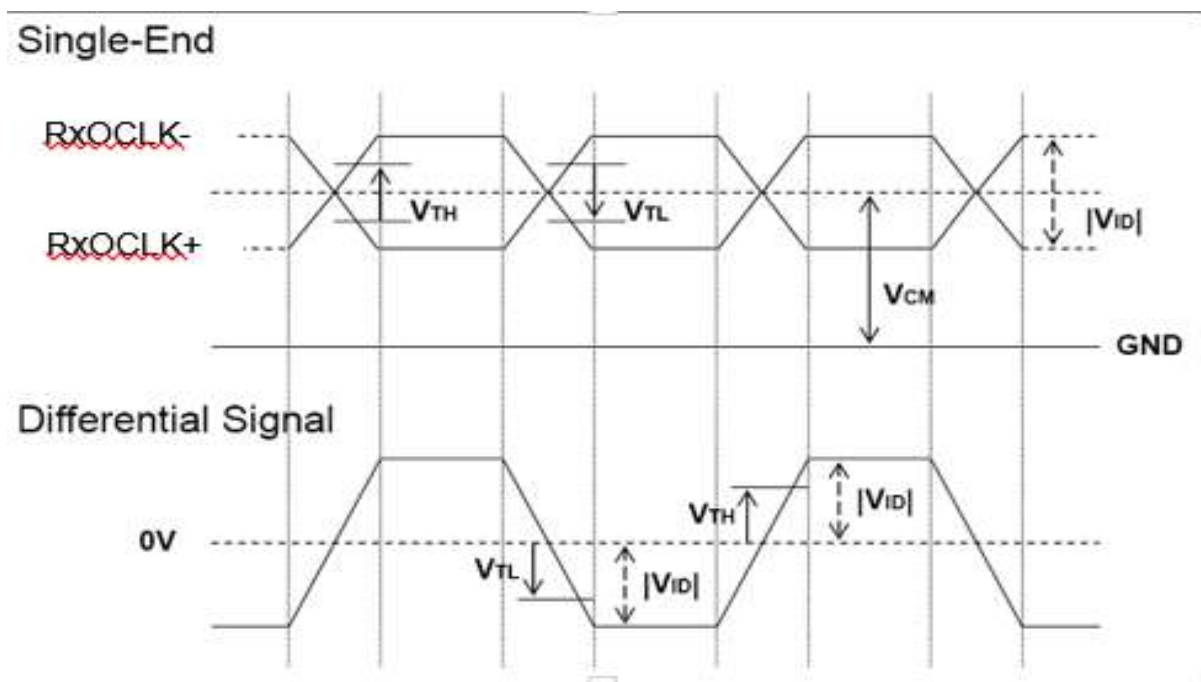
## 3.4.4 LVDS Specification

### 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]   | $V_{TH}-V_{TL} = 200mV$ |

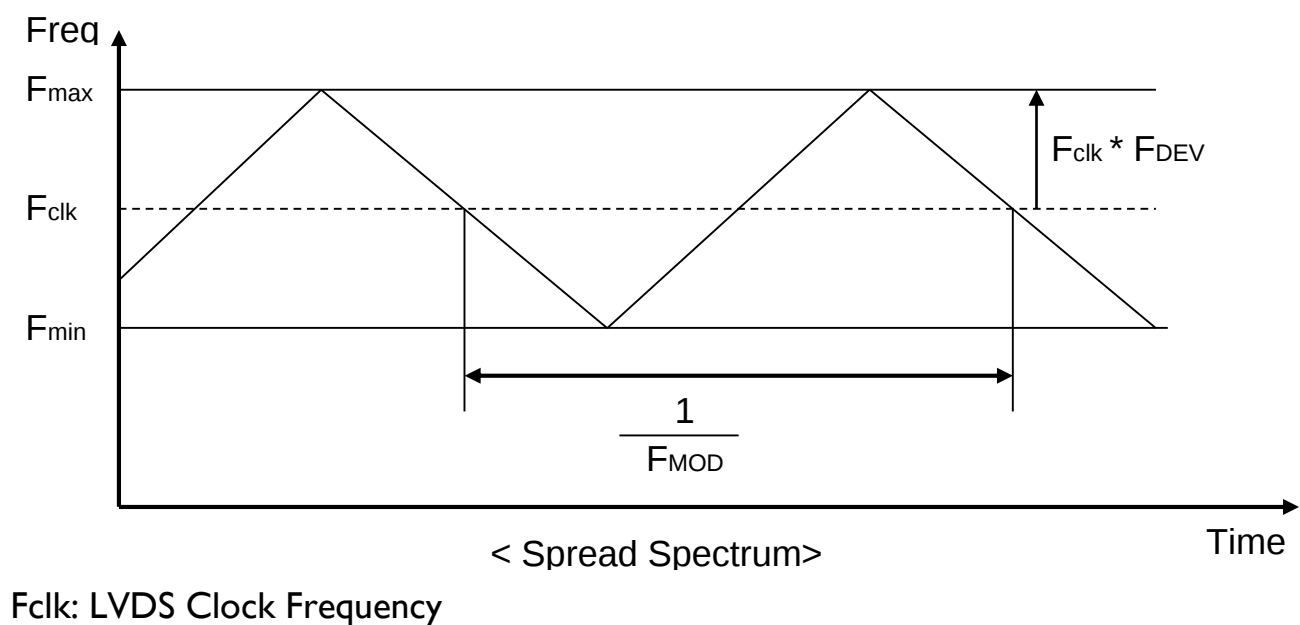
### LVDS Signal Waveform:

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    | 1100 | 1160 | 1837 | Th   |                 |
| Tdisp (v) |                    | Active    | 1080 | 1080 | 1080 | Th   |                 |
| Tblk (v)  |                    | Blanking  | 20   | 80   | 757  | Th   |                 |
| Fv        |                    | Frequency | 48   | 60   | 76   | Hz   |                 |
| Th        | Horizontal Section | Period    | 1034 | 1050 | 1100 | Tclk |                 |
| Tdisp (h) |                    | Active    | 960  | 960  | 960  | Tclk |                 |
| Tblk (h)  |                    | Blanking  | 74   | 90   | 140  | Tclk |                 |
| Fh        |                    | Frequency | 52.9 | 69.6 | 88.1 | KHz  | <b>Note 3-4</b> |
| Tclk      | LVDS Clock         | Period    | 10.6 | 13.7 | 18.4 | ns   | I/Fclk          |
| Fclk      |                    | Frequency | 54.6 | 73.1 | 94.0 | MHz  | <b>Note 3-5</b> |

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

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

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

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

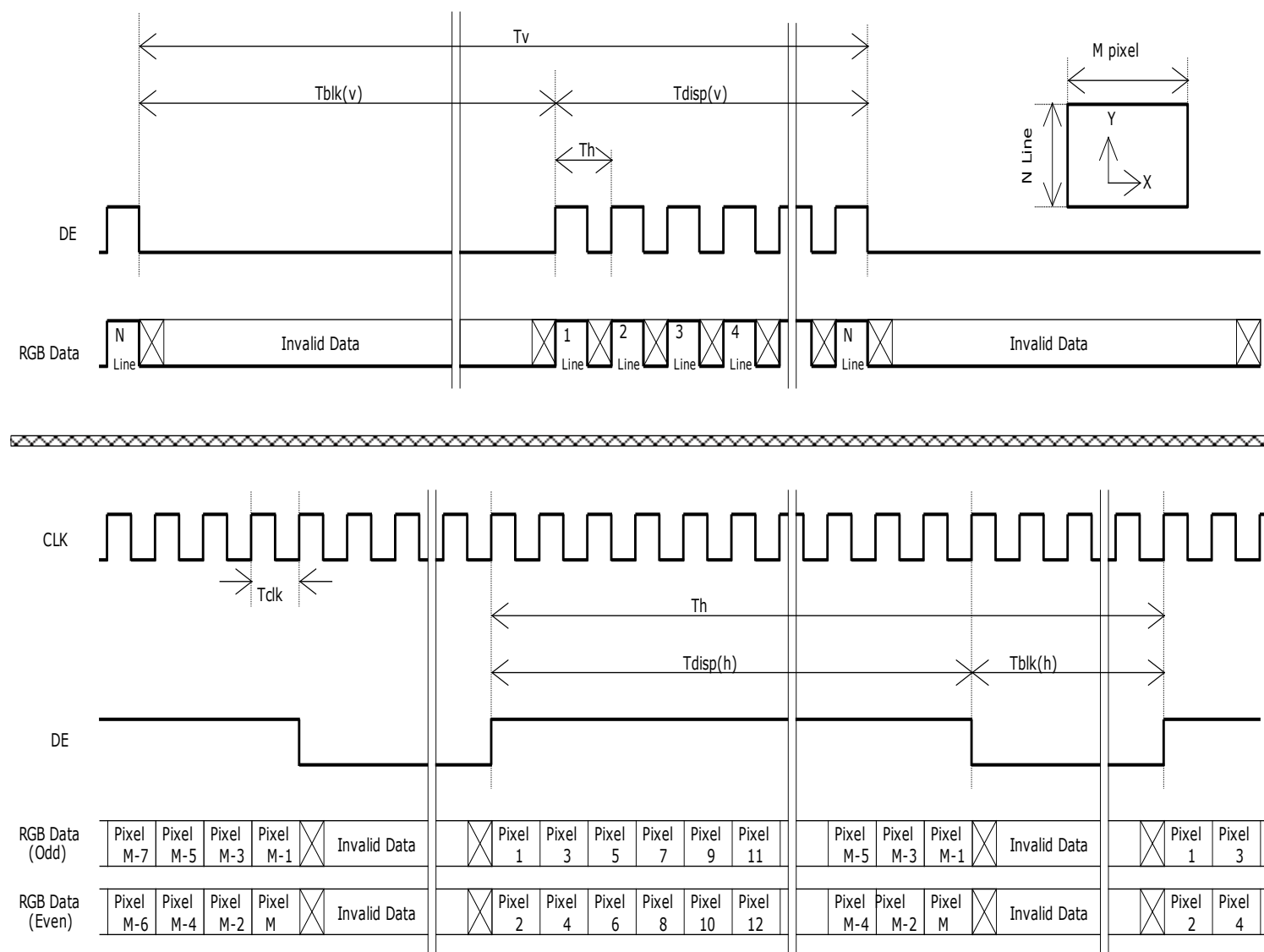
**Note 3-5:** The equation is listed as following. Please don't exceed the above recommended value.

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

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

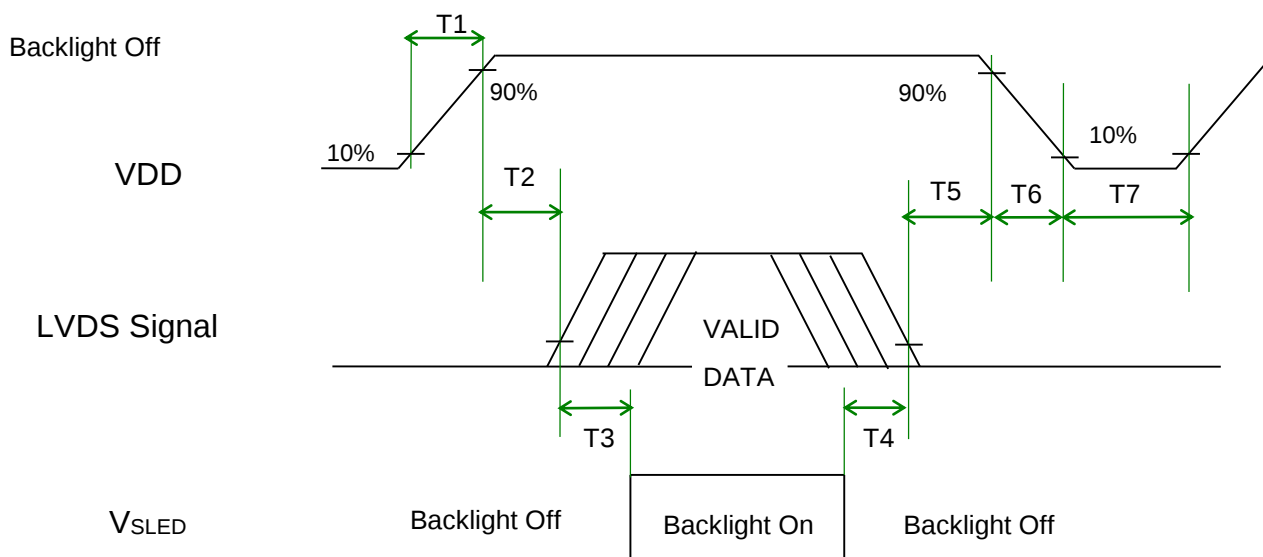
$$Fclk \text{ (Max.)} = Fv \text{ (Max.)} \times Th \text{ (Typ.)} \times Tv \text{ (Typ.)};$$

## 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] | <b>Note 3-8</b>                    |
| T5     | 0     |      | 50   | [ms] | <b>Note 3-6</b><br><b>Note 3-7</b> |
| T6     | 0     |      | 200  |      | <b>Note 3-9</b>                    |
| T7     | 1000  | -    | -    | [ms] |                                    |

**Note 3-6 :** Recommend setting T5 = 0ms to avoid electronic noise when VDD is off.

**Note 3-7 :** During T5 period , please keep the level of input LVDS signals with Hi-Z state.

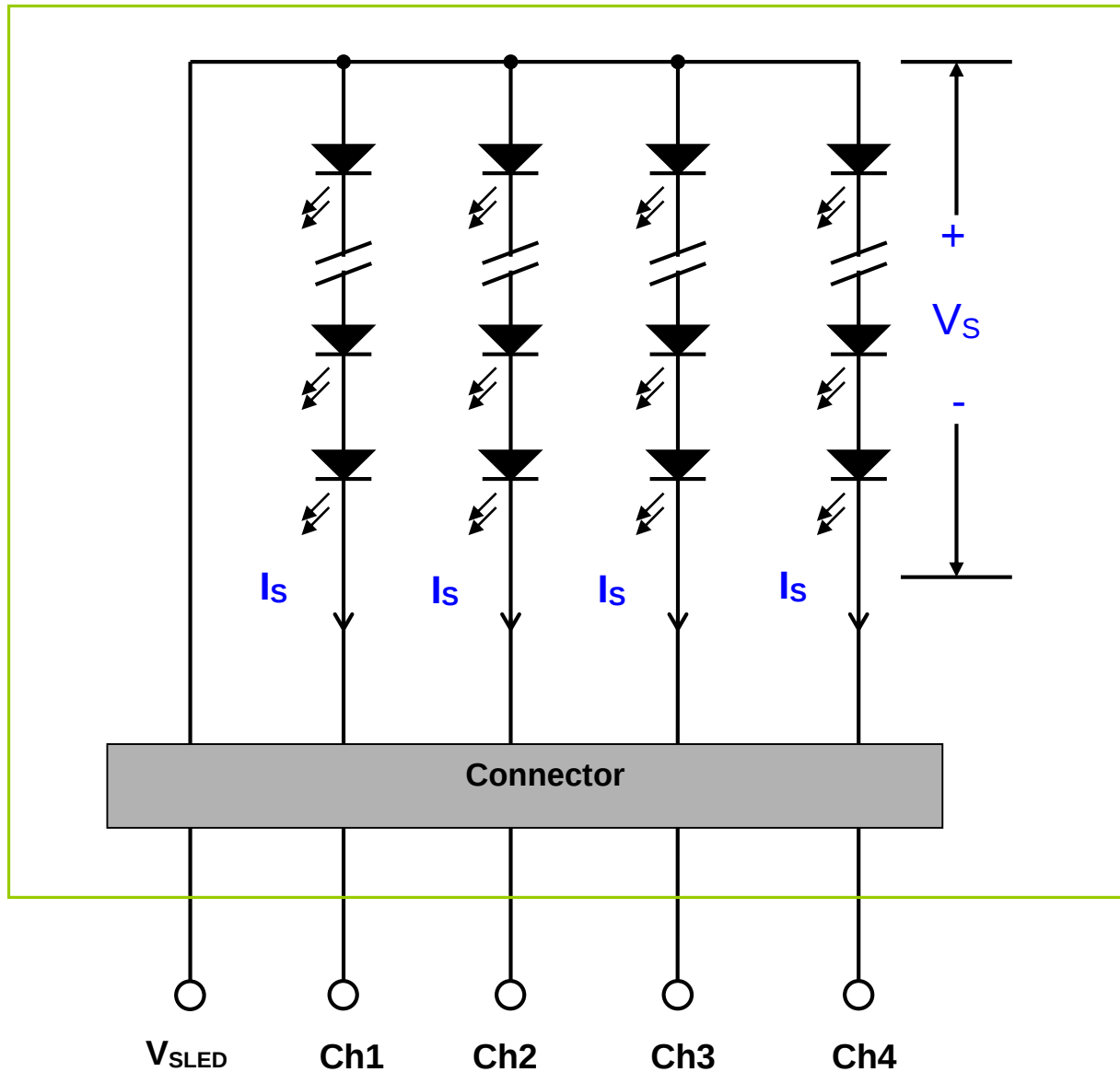
**Note 3-8 :** If T4 < 100ms, there will be no reliability concern, but the display may momentarily show abnormal screen.

**Note 3-9 :** Voltage of VDD must decay smoothly after Power-off (customer system decide this value)

## 4 Backlight Unit

### 4.1 Block Diagram

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



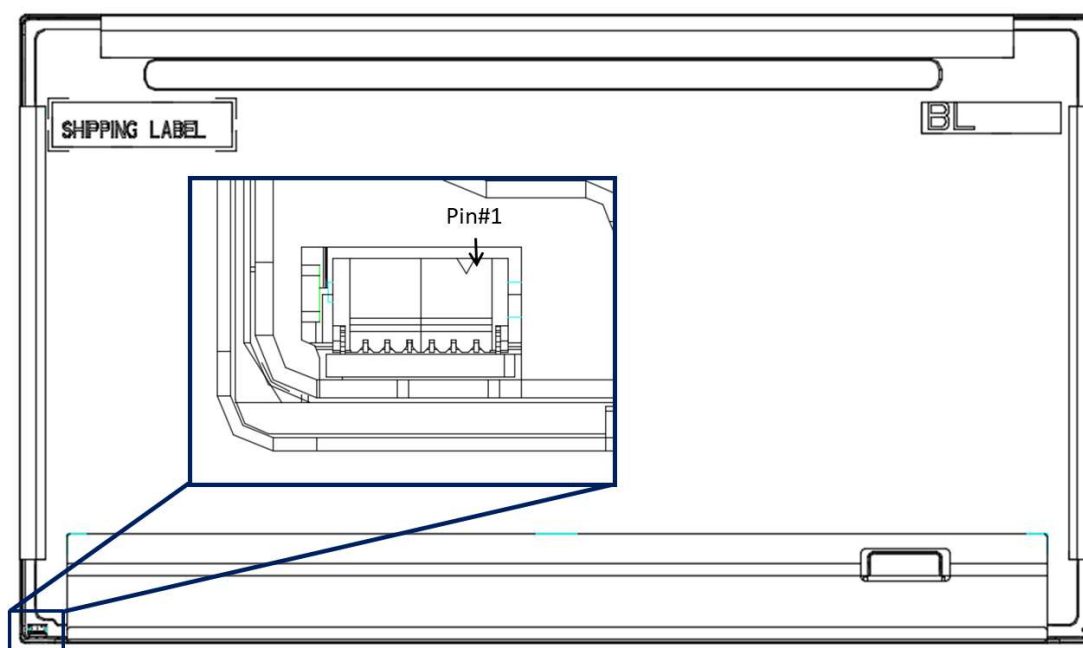
## 4.2 Interface Connection

### 4.2.1 Connector Type

|                            |              |                       |                |
|----------------------------|--------------|-----------------------|----------------|
| <b>Backlight Connector</b> | Manufacturer | ENTERY                | CVILUX         |
|                            | Part Number  | 3709K-Q06C-04L        | CII406MIVLD-NH |
| <b>Mating Connector</b>    | Manufacturer | CVILUX or Compatible  |                |
|                            | Part Number  | CII406SL000-NH (Lock) |                |

### 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          |
|----------------|--------------------|-----|-----|------|-----------------|
| I <sub>s</sub> | LED String Current | 0   | 70  | [mA] | 100% duty ratio |

### 4.3.2 Recommended Operating Condition

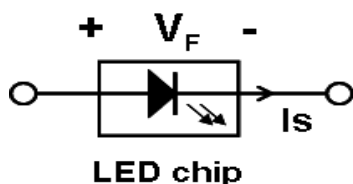
(Ta=25°C)

| Symbol            | Description                                           | Min.                   | Typ.  | Max.  | Unit   | Remark                                                                      |
|-------------------|-------------------------------------------------------|------------------------|-------|-------|--------|-----------------------------------------------------------------------------|
| I <sub>s</sub>    | LED String Current                                    | -                      | 65    | 70    | [mA]   | 100% duty ratio of LED chip, <b>Note 4-6</b>                                |
| V <sub>s</sub>    | LED String Voltage                                    | 43.35                  | 49.3  | 56.95 | [Volt] | I <sub>s</sub> =65mA @ 100% duty ratio; <b>Note 4-1, Note 4-5, Note 4-7</b> |
| ΔV <sub>s</sub>   | Maximum V <sub>s</sub> Voltage Deviation of light bar | -                      | -     | -     | [Volt] | I <sub>s</sub> =65mA @ 100% duty ratio; <b>Note 4-2</b>                     |
| P <sub>BLU</sub>  | LED Light Bar Power Consumption                       | -                      | 12.82 | 14.81 | [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% V <sub>smax</sub> | -     | -     | [Volt] | <b>Note 4-5</b>                                                             |

**Note 4-1:** V<sub>s</sub> (Typ.) = V<sub>F</sub> (Typ.) X LED No. (one string);

a. V<sub>F</sub>: LED chip forward voltage, V<sub>F</sub> (Min.)= 2.55, V<sub>F</sub>(Typ.)= 2.90, V<sub>F</sub>(Max.)= 3.35

b. The same equation to calculate V<sub>s</sub>(Min.) & V<sub>s</sub> (Max.) for respective V<sub>F</sub> (Min.) & V<sub>F</sub>(Max.);



**Note 4-2:** ΔV<sub>s</sub> (Max.) = ΔV<sub>F</sub> X LED No. (one string);

a. ΔV<sub>F</sub>: LED chip forward voltage deviation; (0.2 V , each Bin of LED V<sub>F</sub>)

**Note 4-3:** P<sub>BLU</sub> (Typ.) = V<sub>s</sub> (Typ.) X I<sub>s</sub> (Typ.) X 4 ; ( 4 is total String No. of LED Light bar)

P<sub>BLU</sub> (Max.) = V<sub>s</sub> (Max.) X I<sub>s</sub> (Typ.) X 4 ;

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

- a. Brightness of LED becomes to 50% of its original value
- b. Test condition:  $I_s = 65\text{mA}$  and  $25^\circ\text{C}$  (Room Temperature)

**Note 4-5:** 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 (Vs) 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.

**Note 4-7:** Ensure that the LED light bar is not subjected either forward or reverse voltage while monitor set is on standby mode or not in use.

## 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, 50%RH, 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 5-1</b> |
| On/Off Test                       | On/10sec, Off/10sec, 30,000 cycles                                                                            |                 |
| ESD (Electro Static Discharge)    | Contact Discharge: ± 15KV, 150pF(330Ω ) 1sec,<br>8 points, 25 times/ point.                                   | <b>Note 5-2</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 5-1:**

- 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 5-2:** EN61000-4-2, ESD class B: Certain performance degradation allowed

No data lost  
Self-recoverable  
No hardware failures.

ESD discharged points should avoid display area and periphery front bezel of display area. Suggest points were 4 side parallel edge of display area surface. Metal front bezel must cover half area of BM (black matrix), and metal front bezel must connect with metal back bezel to protect source IC of panel by ESD damaged.

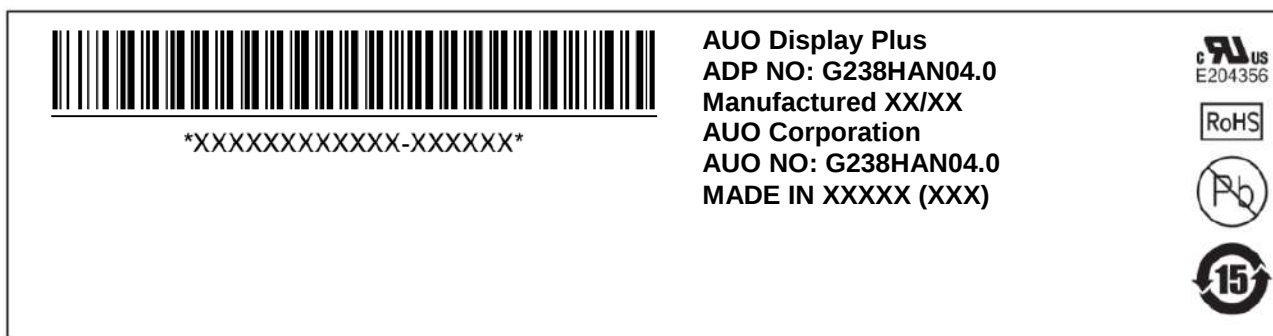
**Note 5-3:** Result Evaluation Criteria:

TFT-LCD panels test should take place after gradually cooling enough at room temperature  
In the normal application, there should be no particular problems that may affect the display function.

**Note 5-4:** Panel can pass THB test (Tilt (-35°/+80°) & Pivot (+/-180°) usage) and meet MTBF 30000hrs with no panel peel off.

## 6 Shipping Label

The label is on the panel as shown below:



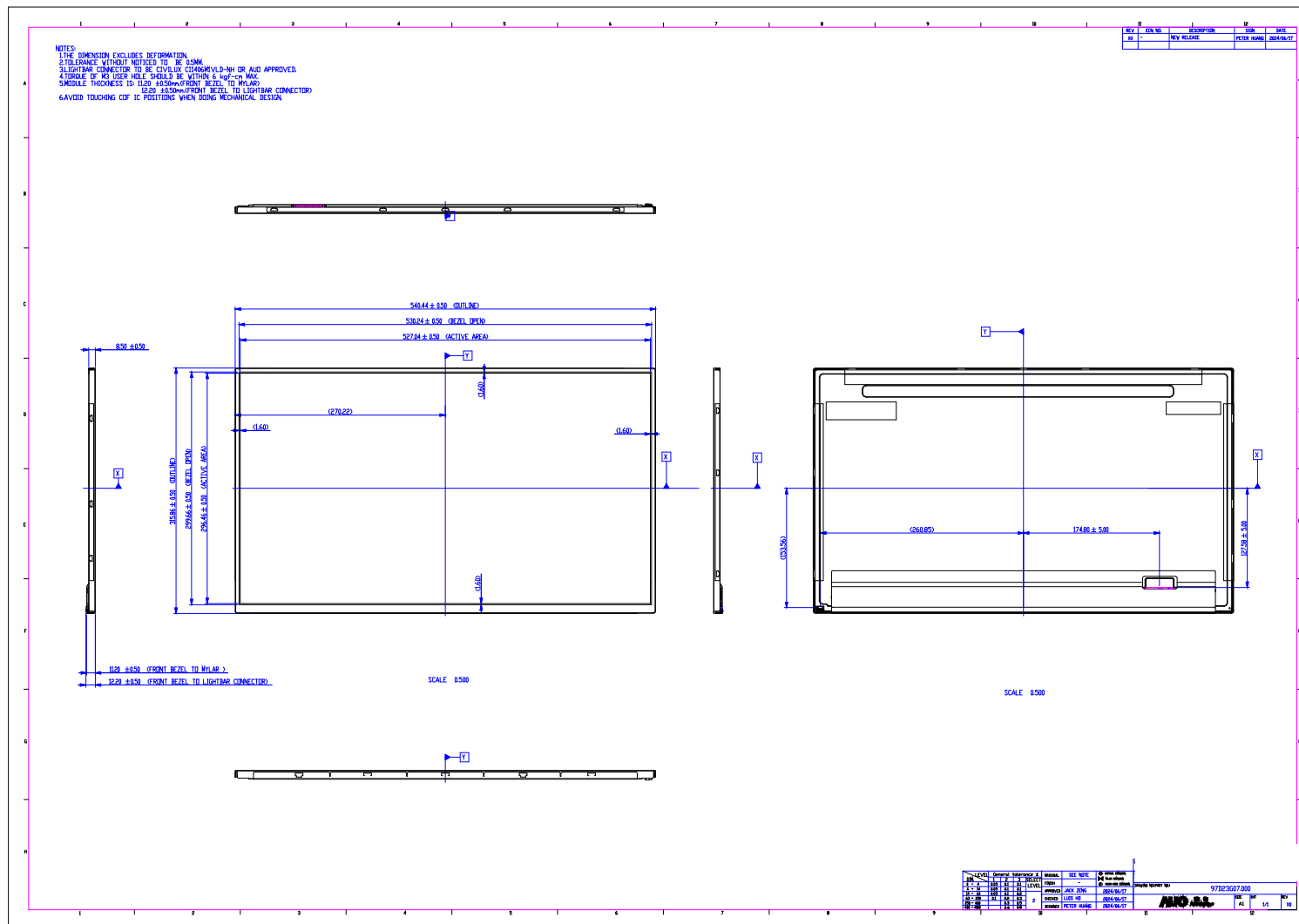
**Note 6-1:** For Pb Free products, AUO will add  for identification.

**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.

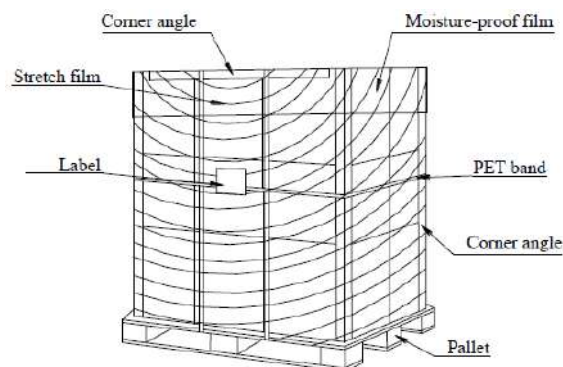
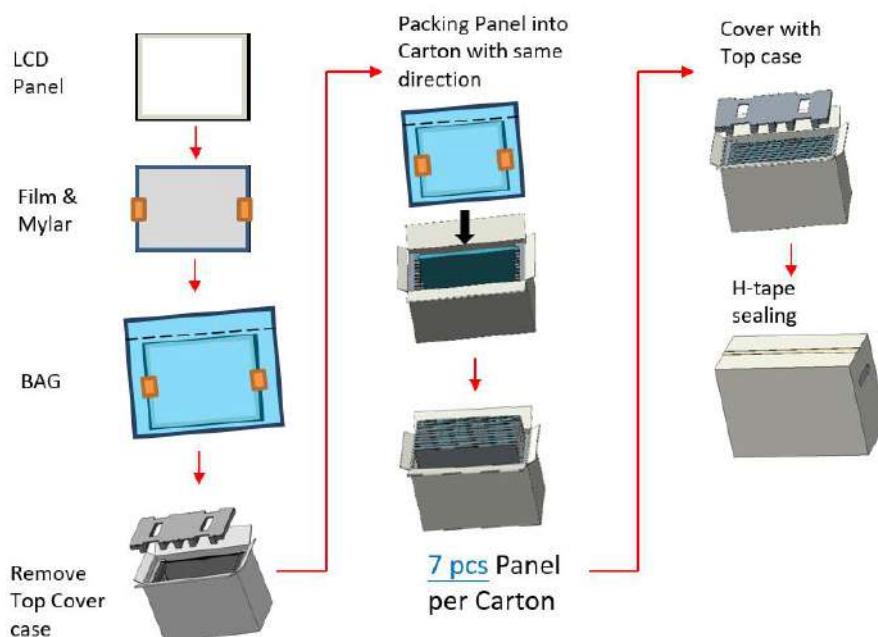
**Note 6-4:** The Green Mark will be presented only when the green documents have been ready by AUO Internal Green Team.

## 7 Mechanical Characteristics



## 8 Packing Specification

### 8.1 Packing Flow



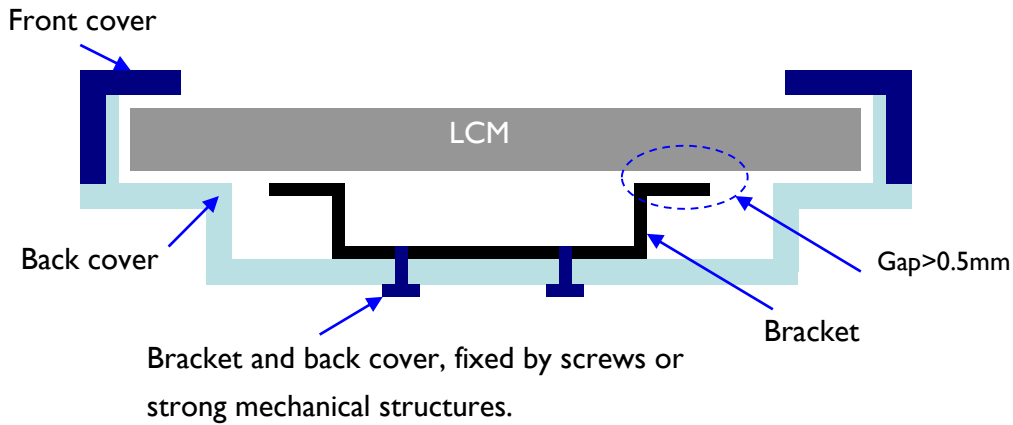
### 8.2 Pallet and shipment information

| Item                 | Specification  |                                 |            | Remark               |
|----------------------|----------------|---------------------------------|------------|----------------------|
|                      | Q'ty           | Dimension                       | Weight(Kg) |                      |
| Panel                | 1              | 540.24(H) x 315.66(V) x 12.5(D) | 2.18       |                      |
| Cushion              | 1              | —                               | 2.16       |                      |
| BOX                  | 1              | 650(L)mm x 265(W)mm x 420(H)mm  |            | without Panel        |
| Packing BOX          | 7pcs/BOX       | 650(L)mm x 265(W)mm x 420(H)mm  | 17.42      | with Panel & cushion |
| Pallet               | 1              | 1150(L)mm x 690(W)mm x 132(H)mm | 11         |                      |
| Pallet after Packing | 8 Boxes/Pallet | 1150(L)mm x 690(W)mm x 972(H)mm | 150.36     |                      |

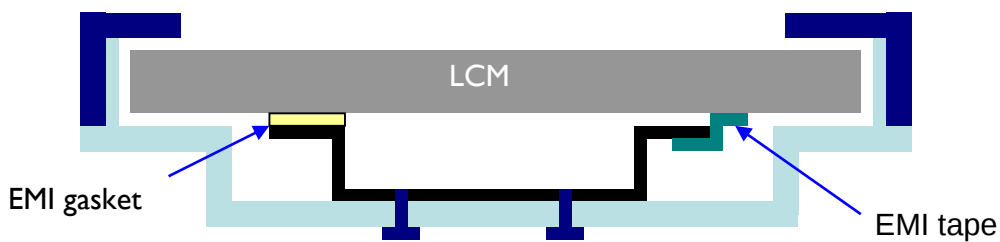
## 9 Design Guide for System

**9.1 The gap between LCM and system rear bracket should be bigger than 0.5mm.**

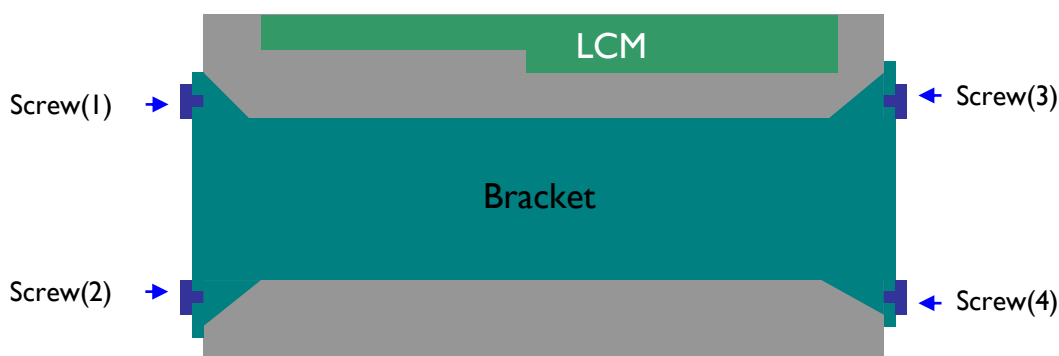
**9.2 The system bracket should be fixed on back cover firmly.**



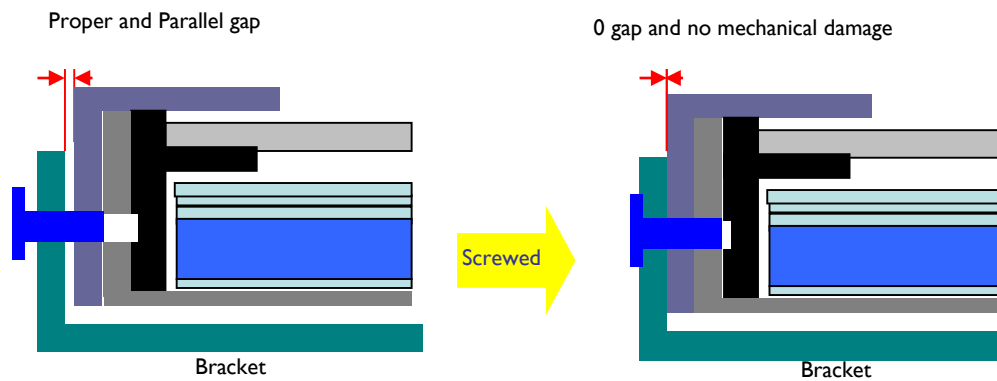
**9.3 The EMI gasket should be uniform and not push panel strongly.**



**9.4 For stable assembly, the system bracket should use 4 screws to fix system and panel by dual sides.**



**9.5 The system bracket and panel should be in parallel with having no gap after inserting screws.**



**9.6 Avoid scratching LCM, the rib on system front-cover should not exceed the bottom edge of LCM's front-bezel.**

