

# Model Name: P215HVN02.0

Issue Date: 2023/03/16

( ) Preliminary Specifications  
( \* ) Final Specifications

| Customer Signature       | Date | AUO   | Date |
|--------------------------|------|---|------|
| Approved By<br><br>_____ |      | Approval By PM Director<br>CT WU<br><br><i>CTWU</i>             |      |
| Note                     |      | Reviewed By RD Director<br>Lamy Chen<br><br><i>Lamy Chen</i>    |      |
|                          |      | Reviewed By Project Leader<br>Choc Chen<br><br><i>Choc Chen</i> |      |
|                          |      | Prepared By PM<br>Travis Huang<br><br><i>Travis Huang</i>       |      |

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## Record of Revision

| Version | Date       | Page      | Description  |
|---------|------------|-----------|--|
| 0.0     | 2021/4/12  | All       | Preliminary spec   |
| 0.1     | 2021/4/19  | 8         | Correct Screen Diagonal ; Correct PBLU from 7.5w to 8.8w                         |
|         |            |           | Correct Total Power from 9.08 to 10.4w   |
|         |            |           | Correct Y dimension from 284.4 to 284.5mm  |
|         |            |           | Add (D) is refer to CB Cover.  |
|         |            | 11        | Correct Y dimension from 284.4 to 284.5mm  |
|         |            | 12, 13    | Drawing Update   |
|         |            | 36        | Correct Y dimension from 284.4 to 284.5mm  |
| 0.2     | 2021/05/04 | 29        | Update LED LB Connector from Entery to Cvilux                                    |
|         |            | 31        | Correct LED String Current to 65mA   |
|         |            | 16, 30    | Correct Rear Drawing.  |
|         |            | 31        | Fill in LED relevant information.  |
|         |            | 32        | Correct Note 4-1 $V_F$ ; 4-2 $\Delta V_F$  |
|         |            | 5         | Update BLU Power Consumption @ 65mA condition.                                   |
| 0.3     | 2021/06/04 | 12, 13    | Drawing update   |
|         |            | 35,36     | Correct 13pcs/Box to 10pcs / Box .   |
|         |            | 37, 5, 11 | Correct Panel Outline dimension  |
| 0.4     | 2021/7/9   | 36        | Update Packing Method  |
| 0.5     | 2021/09/17 | 5, 13     | Update OP. Temp: 0 $\rightarrow$ -10 $^{\circ}$ C                                |
|         |            | 37        | Update Packing Size  |
|         |            | 6         | Update Colour Coordinate   |
|         |            | 5, 11     | Update Weight  |
|         |            | 34        | Update Packing label description.  |
|         |            | 32        | Update RA Test items and condition   |
| 0.6     | 2021/10/21 | 11,12     | Correct Drawing  |
| 1.0     | 2021/11/2  | 30        | Correct LED String Current 120 to 100  |
|         |            |           | Correct LED String Voltage Max. from 45.6w to 49.8w                              |
|         |            |           | Correct $\Delta V_s$ from 1.5 to 3; $P_{BLU}$ from 11.86 to 12.95                |
|         |            | 31        | Correct Note 4-1 $V_F$ (Min.) from 2.64 to 2.52 ; $V_F$ (Max.) from 3.04 to 3.32 |
|         |            |           | Correct Note 4-2 $\Delta V_F$ from 0.1V to 0.2V                                  |
|         |            | 10        | Correct weight from 1700 to 1650   |
|         |            |           | Correct RA   |
|         |            | 39        | Add Dust Resistance  |
|         |            | 17        | Correct IRUSH Current to 3A  |
|         |            | 14        | Update Block Diagram   |



# 1. General Description

This specification applies to the 21.45inch a-Si TFT-LCD Module P215HVN02.0. The display supports the Full HD - 1920(H) x 1080(V) screen format and 16.7M colors (8 bits RGB data input). The input interface is Dual channel LVDS and this module doesn't contain a driver board for backlights.

## \* General Information

### 1.1. Display Characteristics

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

| ITEMS  | Unit    | SPECIFICATIONS   |
|--|---------|--|
| Screen Diagonal                                    | [mm]    | 544.85 (21.45inch)   |
| Active Area  | [mm]    | 478.656 (H) x 260.28 (V)   |
| Pixels H x V                                       | -       | 1920(x3) x 1080  |
| Pixel Pitch  | [um]    | 249.3 (per one triad) x241   |
| Pixel Arrangement                                  | -       | R.G.B. Vertical Stripe   |
| Display Mode                                       | -       | VA Mode, Normally Black  |
| White Luminance ( Center )                         | [cd/m2] | 300 (Typ.)   |
| Contrast Ratio                                     | -       | 3000 (Typ.)  |
| Response Time                                      | [msec]  | 20ms (Typ., on/off)at surface 35 degree C  |
| Power Consumption<br>(LCD Module + Backlight unit) | [Watt]  | 13.55 (Typ.)<br>LCD Module: PDD(Typ.)=1.55 W@ White pattern , Fv=75Hz<br>Backlight unit : PBLU (Typ.) =12 @Is=65mA |
| Weight   | [Grams] | 1700   |
| Outline Dimension                                  | [mm]    | 501.9(H)× 284.8(V)×10.9(D); (D) is refer to front bezel to CB Cover.   |
| Electrical Interface                               | -       | Dual channel LVDS  |
| Support Color                                      | -       | 16.7M colors (RGB 6-bits +Hi-FRC)  |
| Surface Treatment                                  | -       | Anti-Glare, 3H, Haze 25 %  |
| Temperature Range                                  |         |  |
| Operating  | [oC]    | -10 to +50   |
| Storage (Shipping)                                 | [oC]    | -20 to +60   |

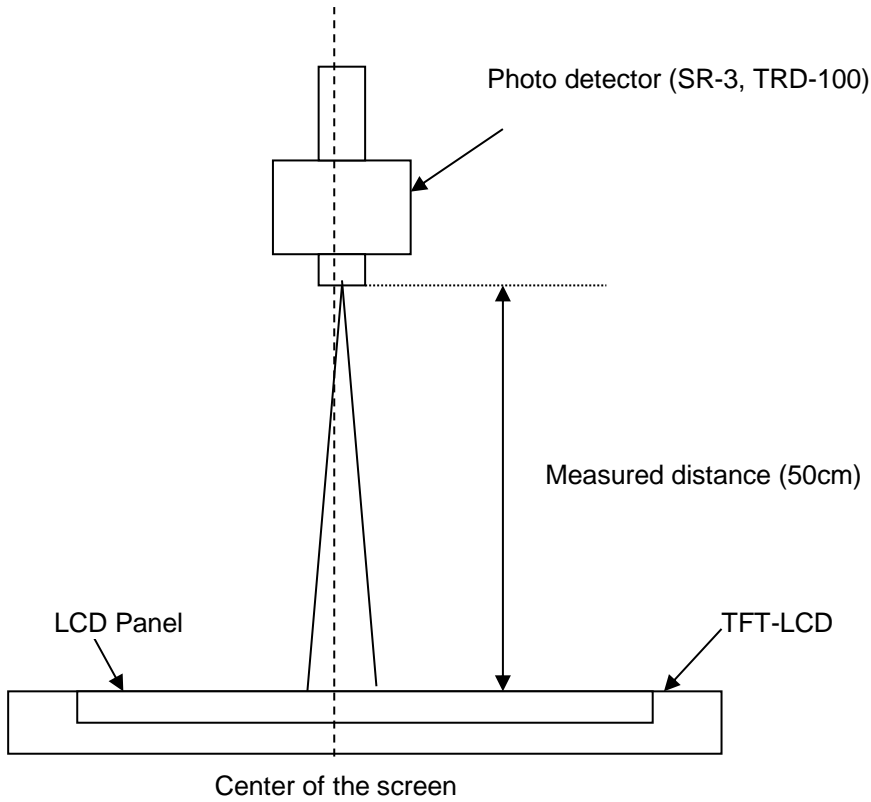
## 1.2. Optical Characteristics

The optical characteristics are measured on the following test condition. Test Condition:

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

| Symbol           | Description                         |              | Min.  | Typ.  | Max.  | Unit                 | Remark                 |
|------------------|-------------------------------------|--------------|-------|-------|-------|----------------------|------------------------|
| Lw               | White Luminance (Center of screen)  |              | 240   | 300   | -     | [cd/m <sup>2</sup> ] | Note 1-1<br>By SR-3    |
| Luni             | Luminance Uniformity (9 points)     |              | 75    | 80    | -     | [%]                  | Note 1-2<br>By SR-3    |
| CR               | Contrast Ratio (Center of screen)   |              | 2000  | 3000  | -     | -                    | Note 1-3<br>By SR-3    |
| θR               | Horizontal Viewing Angle<br>(CR=10) | Right        | 75    | 89    | -     | [degree]             | Note 1-4<br>By SR-3    |
| θL               |                                     | Left         | 75    | 89    | -     |                      |                        |
| ΦH               | Vertical Viewing Angle<br>(CR=10)   | Up           | 75    | 89    | -     |                      |                        |
| ΦL               |                                     | Down         | 75    | 89    | -     |                      |                        |
| θR               | Horizontal Viewing Angle<br>(CR=5)  | Right        | 75    | 89    | -     |                      |                        |
| θL               |                                     | Left         | 75    | 89    | -     |                      |                        |
| ΦH               | Vertical Viewing Angle<br>(CR=5)    | Up           | 75    | 89    | -     |                      |                        |
| ΦL               |                                     | Down         | 75    | 89    | -     |                      |                        |
| T <sub>GTG</sub> | Response Time                       | Gray To Gray | -     | 20    | -     | [msec]               | Note 1-5<br>By TRD-100 |
| Rx               | Color Coordinates<br>(CIE 1931)     | Red x        | 0.626 | 0.656 | 0.686 | -                    | By SR-3                |
| Ry               |                                     | Red y        | 0.304 | 0.334 | 0.364 |                      |                        |
| Gx               |                                     | Green x      | 0.291 | 0.321 | 0.351 |                      |                        |
| Gy               |                                     | Green y      | 0.589 | 0.619 | 0.649 |                      |                        |
| Bx               |                                     | Blue x       | 0.122 | 0.152 | 0.182 |                      |                        |
| By               |                                     | Blue y       | 0.046 | 0.076 | 0.106 |                      |                        |
| Wx               |                                     | White x      | 0.283 | 0.313 | 0.343 |                      |                        |
| Wy               |                                     | White y      | 0.299 | 0.329 | 0.359 |                      |                        |
| NTSC Area Ratio  |                                     |              |       | 72    |       | [%]                  | By SR-3                |
| CT               | Crosstalk                           |              | -     | -     | 2.0   | [%]                  | Note 1-6<br>By SR-3    |
| FdB              | Flicker (Center of screen)          |              | -     | -     | -20   | [dB]                 | Note 1-7<br>By SR-3    |

**Note 1-1:** Equipment setup :

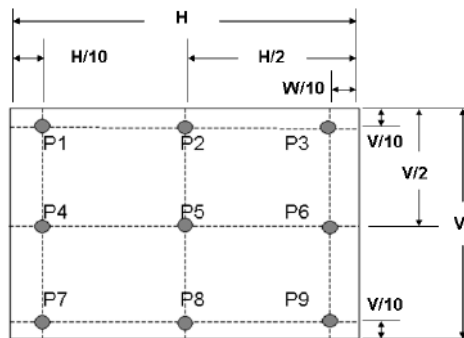


**Note 1-2:** Luminance Uniformity Measurement

**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 1-3: Contrast Ratio Measurement**

**Definition:**

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

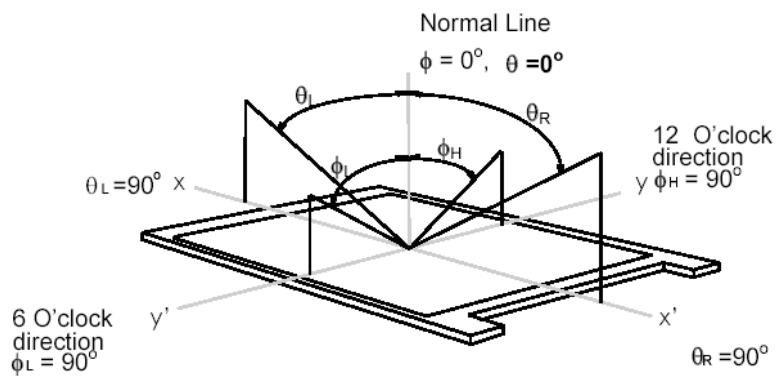
- a. Measured position: Center of screen (P5) & perpendicular to the screen ( $\theta = \Phi = 0^\circ$ )

**Note 1-4: Viewing angle measurement**

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

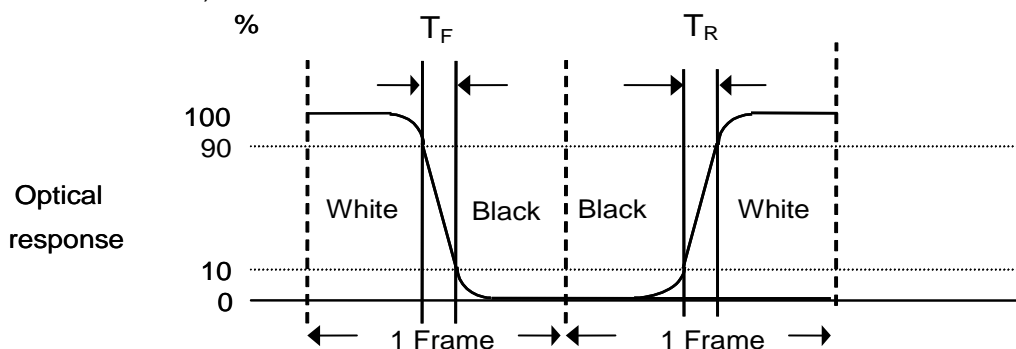
- a. Horizontal view angle: Divide to left & right ( $\theta_L$  &  $\theta_R$ )

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



**Note 1-5: Response time measurement**

The output signals of photo detector are measured when the input signals are changed from “Black” to “White” (rising time, TR), and from “White” to “Black” (falling time, TF), respectively. The response time is interval between the 10% and 90% of optical response. (Black & White color definition: Please refer section 3.4.3)



**Note 1-6: Crosstalk measurement**

**Definition:**

$CT = \text{Max. } (CTH, CTV);$

Where

a. Maximum Horizontal Crosstalk :

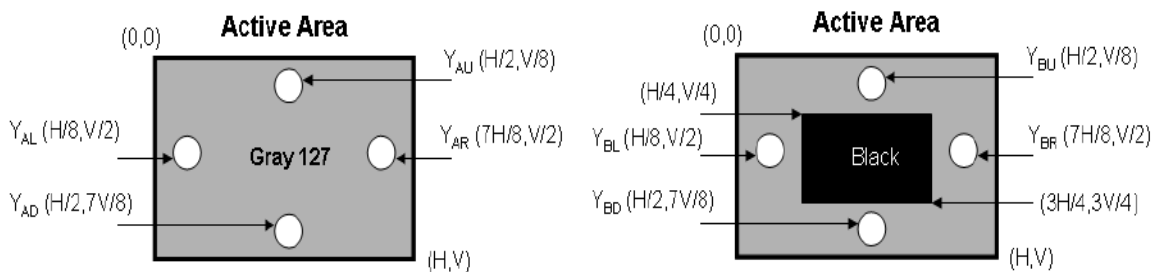
$CTH = \text{Max. } (|Y_{BL} - Y_{AL}| / Y_{AL} \times 100 \%, |Y_{BR} - Y_{AR}| / Y_{AR} \times 100 \%);$

Maximum Vertical Crosstalk:

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

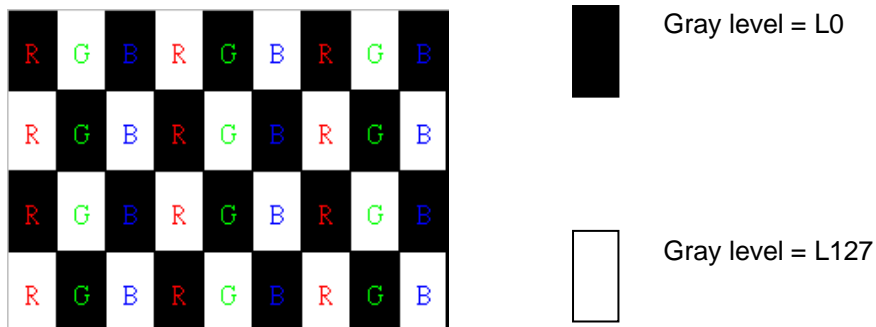
b.  $Y_{AU}, Y_{AD}, Y_{AL}, Y_{AR}$  = Luminance of measured location without Black pattern

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



**Note 1-7: 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 ( $\theta = \Phi = 0^\circ$ )

**1.3. Mechanical Characteristics**

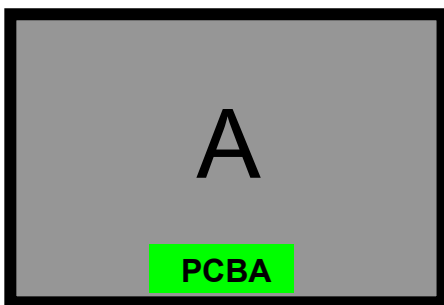
The contents provide general mechanical characteristics for the model P215HVN02.0 In addition the figures in the next page are detailed mechanical drawing of the LCD.

| Item              | Dimension    | Unit  | Note |                           |
|-------------------|--------------|-------|------|---------------------------|
| Outline Dimension | Horizontal   | 501.9 | mm   |                           |
|                   | Vertical     | 284.8 | mm   |                           |
|                   | Depth (Dmin) | 7.7   | mm   | front bezel to back bezel |
|                   | Depth (Dmax) | 10.9  | mm   | to wall mount             |
| Weight            | 1650         | g     |      |                           |

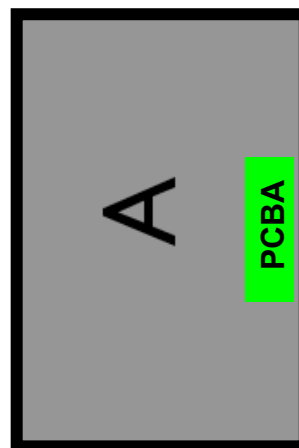
**1.3.1. Placement Suggestions**

1. Landscape Mode: The default placement is T-Con Side on the lower side and the image is shown upright via viewing from the front.
2. Portrait Mode: The default placement is that T-Con side has to be placed on the right side via viewing from the front.

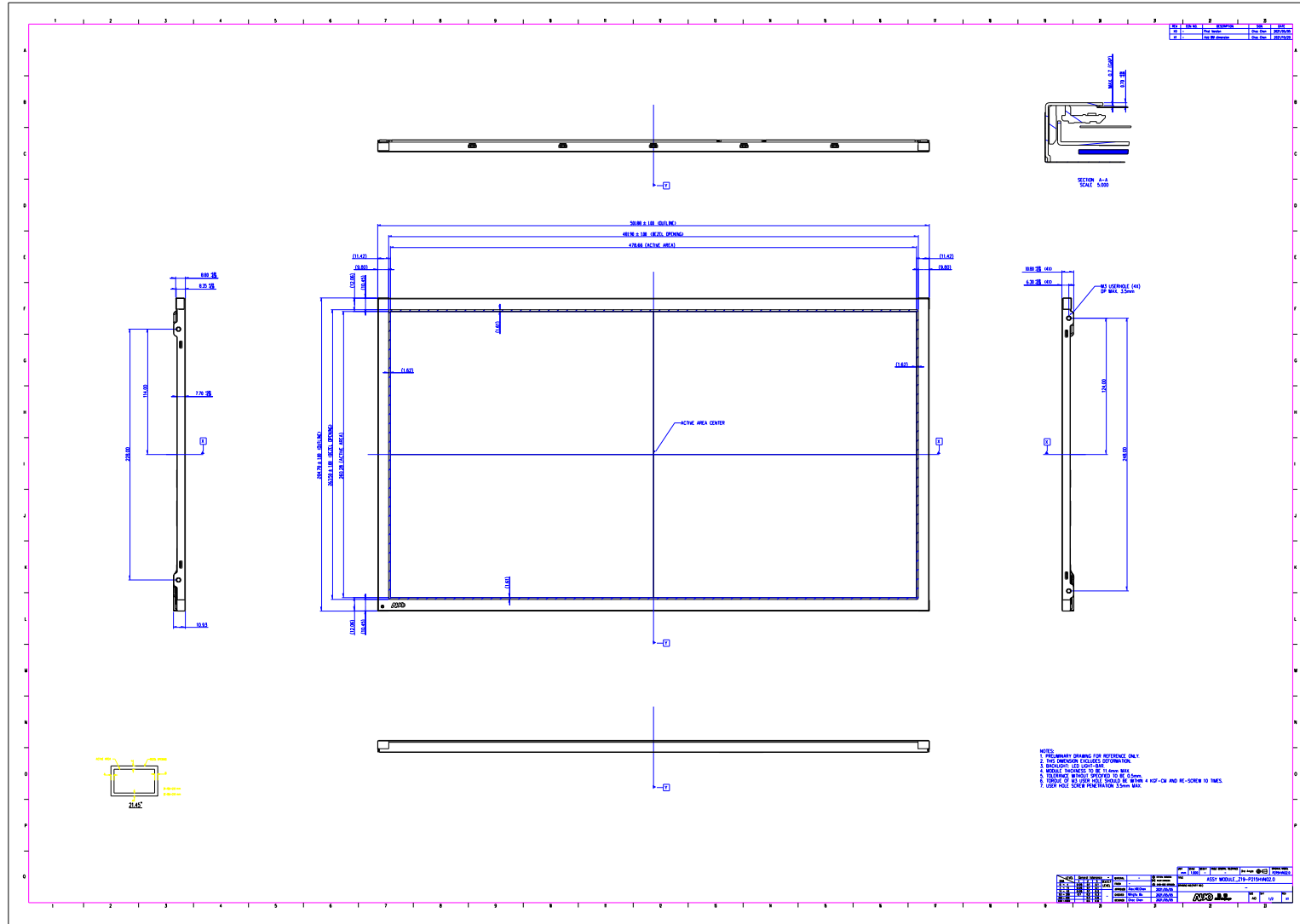
Landscape (Front view)



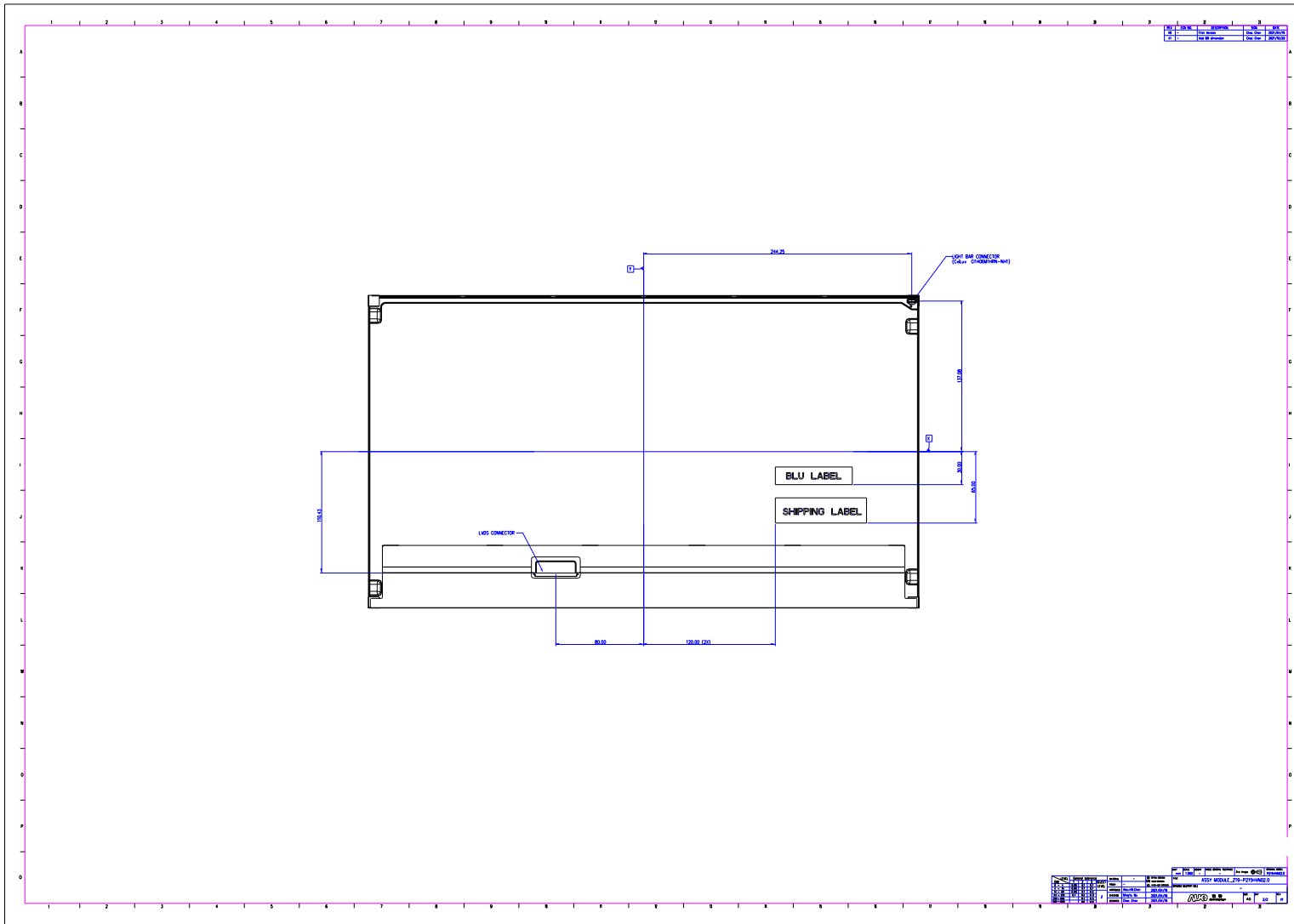
Portrait (Front view)



**Front View**



# Back View



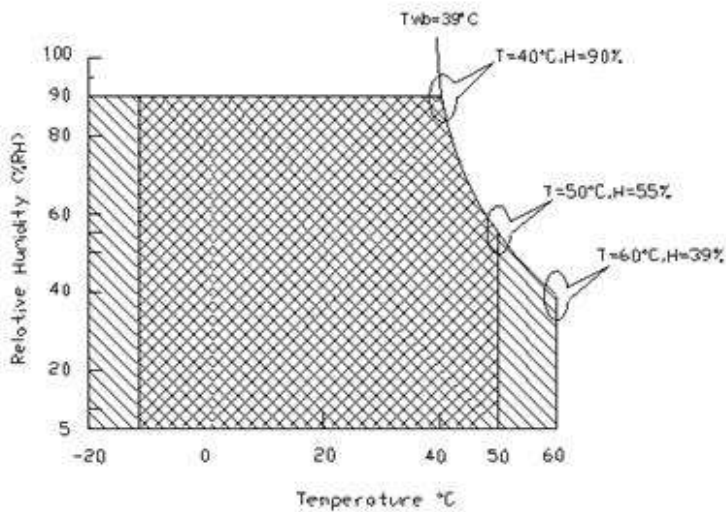
## 2. Absolute Maximum Ratings

The followings are maximum values which, if exceeded, may cause faulty operation or damage to the unit  
Permanent damage may occur if exceeding the following maximum rating.

| Symbol | Description                           | Min. | Max. | Unit  | Remark                           |
|--------|---------------------------------------|------|------|-------|----------------------------------|
| TOP    | Operating Temperature                 | -10  | +50  | [oC]  | Note 2-1                         |
| TGS    | Glass surface temperature (operation) | 0    | +65  | [oC]  | Note 2-1<br>Function judged only |
| HOP    | Operation Humidity                    | 5    | 90   | [%RH] | Note 2-1                         |
| TST    | Storage Temperature                   | -20  | +60  | [oC]  |                                  |
| HST    | Storage Humidity                      | 5    | 90   | [%RH] |                                  |

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

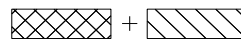
1. 90% RH Max (  $T_a \leq 39^\circ\text{C}$  )
2. Max wet-bulb temperature at  $39^\circ\text{C}$  or less. (  $T_a \leq 39^\circ\text{C}$  )
3. No condensation



Operating Range



Storage Range

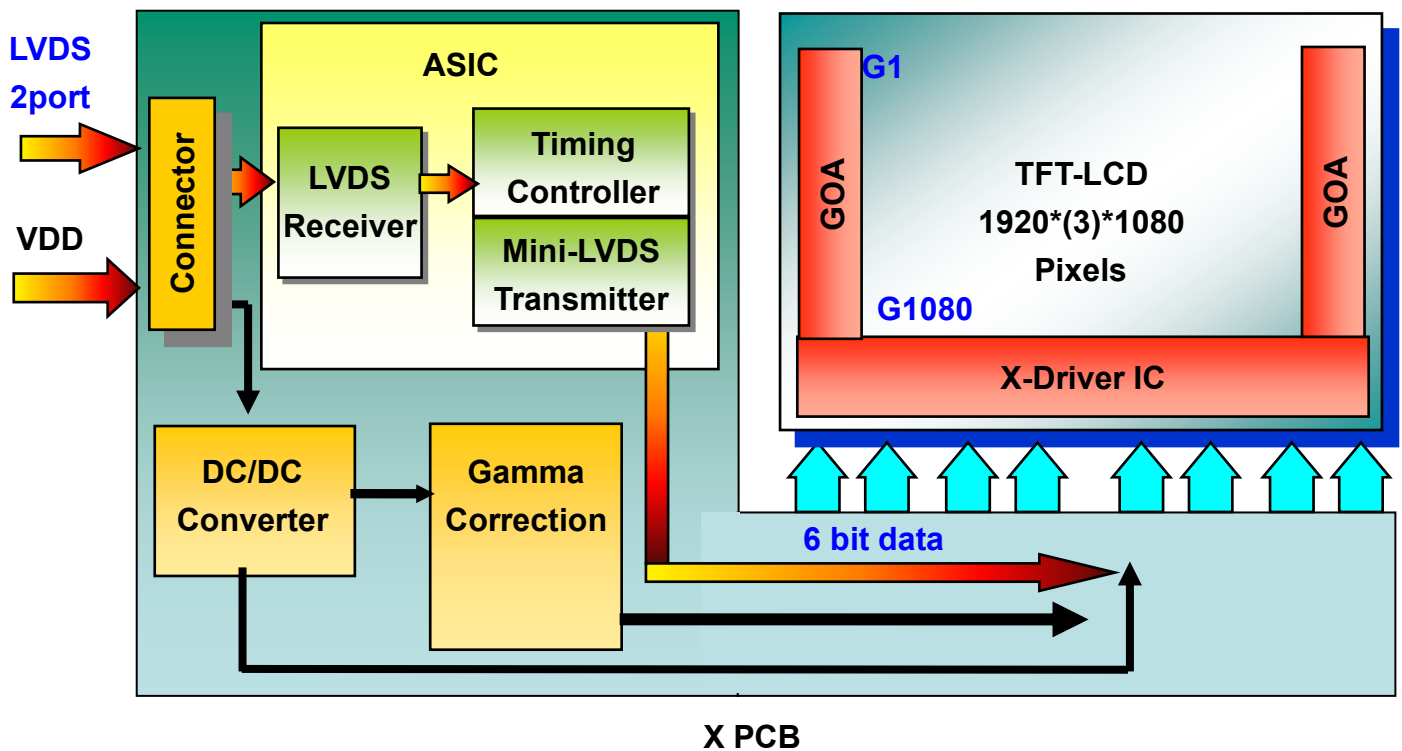


### 3. Electrical Specification

The P215HVN02.0 requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The other is to power Back Light Unit.

#### 3.1. Block Diagram

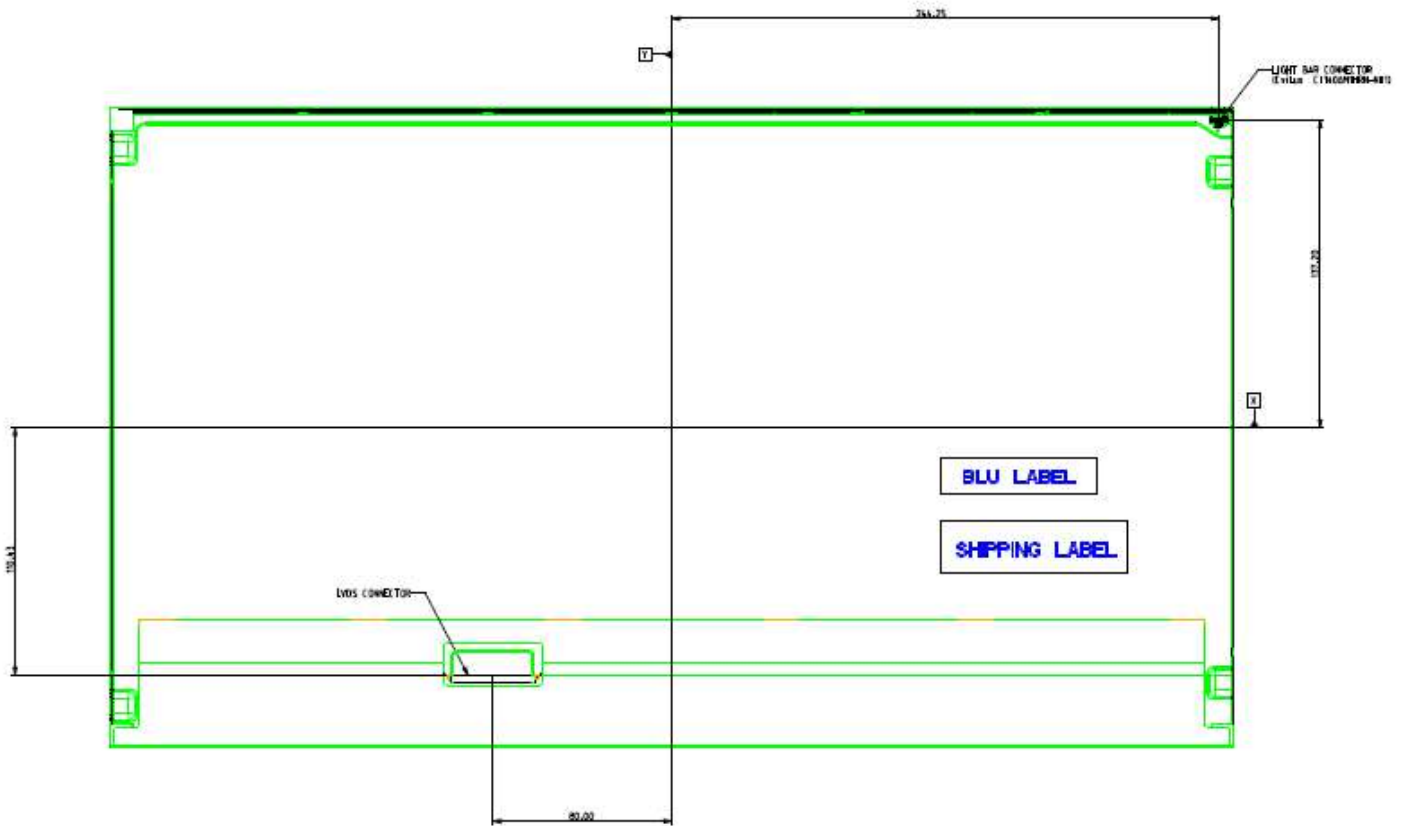
The following shows the block diagram of the 21.5 inch Color TFT-LCD Module.



**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 Compatible      |                |
|                   | 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     | Ground  |        |
| 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 |

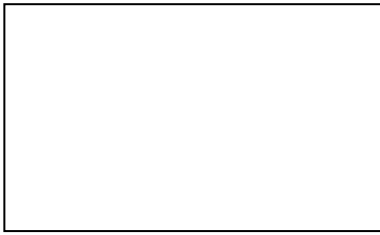
#### 3.3.2. Recommended Operating Condition

| Symbol | 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    | -    | 0.28 | 0.34   | [A]                                       | <b>Note3-1</b> |
|        |                              | Black    | -    | 0.28 | 0.34   | [A]                                       |                |
|        |                              | H-stripe | -    | 0.56 | 0.67   | [A]                                       |                |
|        | Current of Power Supply@75Hz | White    | -    | 0.31 | 0.37   | [A]                                       |                |
|        |                              | Black    | -    | 0.31 | 0.37   | [A]                                       |                |
|        |                              | H-stripe | -    | 0.63 | 0.76   | [A]                                       |                |
| PDD    | VDD Power Consumption@60Hz   | -        | 1.41 | 1.70 | [Watt] | White                                     |                |
|        | VDD Power Consumption@75Hz   | -        | 3.15 | 3.78 | [Watt] | H-stripe                                  |                |
| IRUSH  | Inrush current               | -        | -    | 3    | [A]    | <b>Note3-2</b>                            |                |
| VDDrp  | Allowable VDD Ripple Voltage |          |      | 500  | [mV]   | VDD=12.0V, White Pattern @Maxi Frame rate |                |

**Note 3-1:** Test Condition:

- (1) V<sub>DD</sub> = Typical, (2) Temperature = 25 °C
- (3) Power dissipation check pattern. (Only for power design)

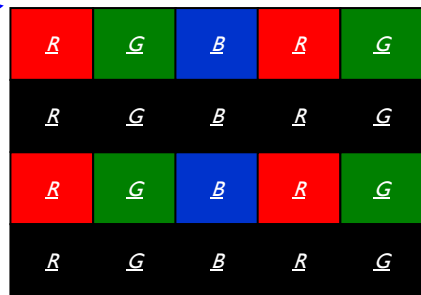
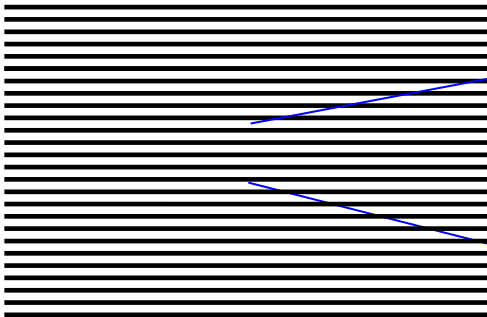
A. White



B. Black

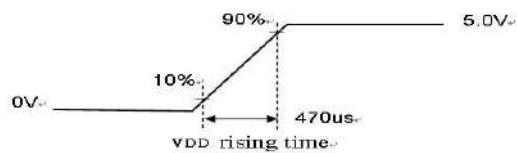
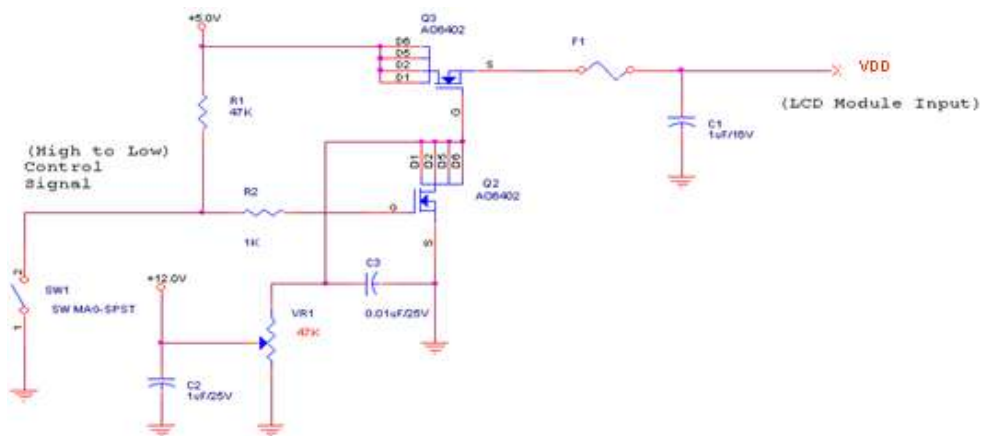


C. H-Stripe



**Note 3-2:** Inrush Current measurement:

Test circuit:



The duration of VDD rising time: 470µs.

**3.3.3 Input control signal threshold voltage definition**

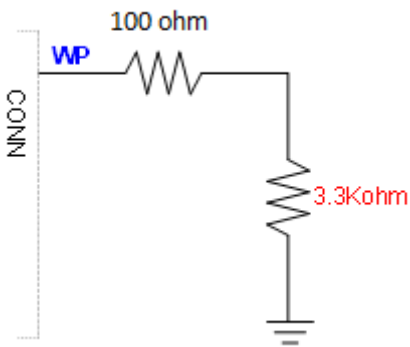
| Item                         | Symbol | Min. | Typ. | Max. | Unit |
|------------------------------|--------|------|------|------|------|
| Input High Threshold Voltage | VIH    | 2.7  | -    | 3.6  | V    |
| Input Low Threshold Voltage  | VIL    | 0    | -    | 0.6  | V    |

**3.3.4 Write Protection mode selection**

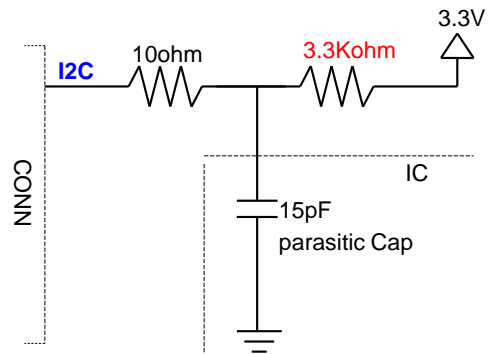
| WP        | Note       |
|-----------|------------|
| L or OPEN | Protection |
| H         | Writable   |

**3.3.5 Input equivalent impedance**

1. Input equivalent impedance of WP pin



2. Input equivalent impedance of SDA/SCL pin

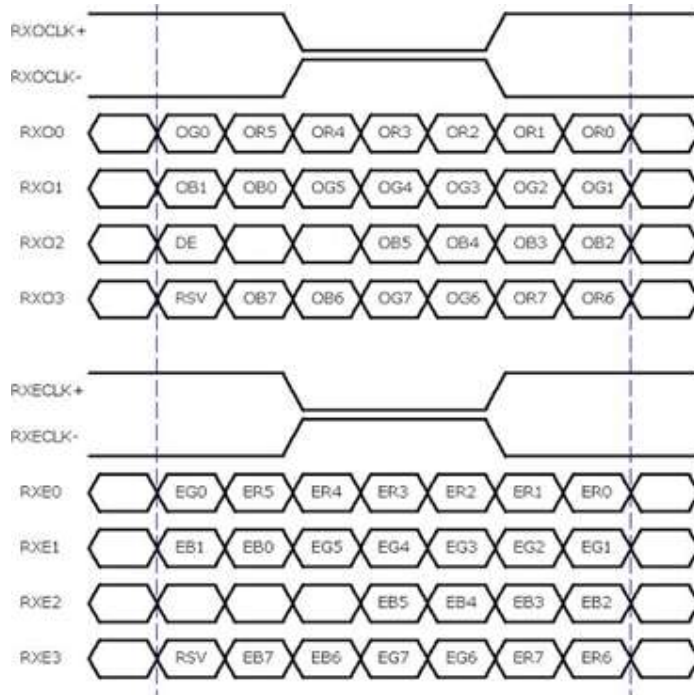


**3.4. Signal Characteristics**

**3.4.1 LCD Pixel Format**

|           | 1 | 2 | ... | 1919 | 1920 |   |
|-----------|---|---|-----|------|------|---|
| 1st Line  | R | G | B   | R    | G    | B |
|           | . | . | .   | .    | .    |   |
|           | . | . | .   | .    | .    |   |
|           | . | . | .   | .    | .    |   |
|           | . | . | .   | .    | .    |   |
|           | . | . | .   | .    | .    |   |
|           | . | . | .   | .    | .    |   |
|           | . | . | .   | .    | .    |   |
|           | . | . | .   | .    | .    |   |
| 1080 Line | R | G | B   | R    | G    | B |

**3.4.2 LVDS Data Format**



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

**Note 3-2:**

- a. O = "Odd Pixel Data"    E = "Even Pixel Data"
- b. 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>(MSB:R7, LSB:R0) |    |    |    |    |    |    |    | GREEN data<br>(MSB:G7, LSB:G0) |    |    |    |    |    |    |    | BLUE data<br>(MSB:B7, LSB: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  |       |

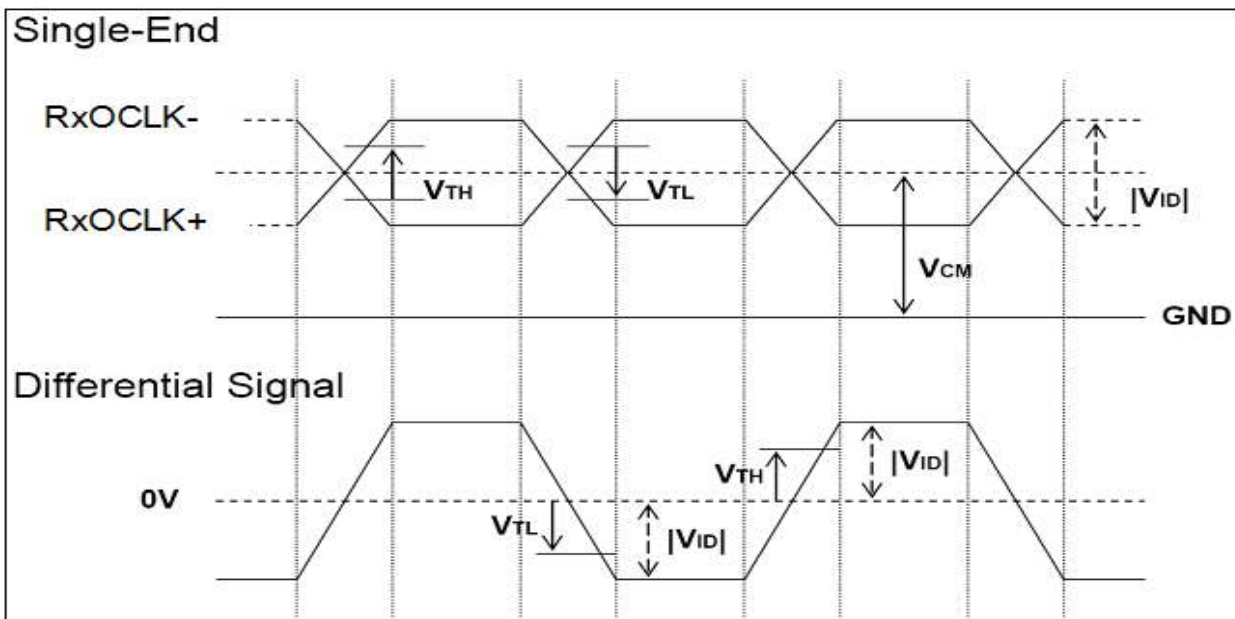
### 3.4.4 LVDS Specification

a. DC Characteristics:

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

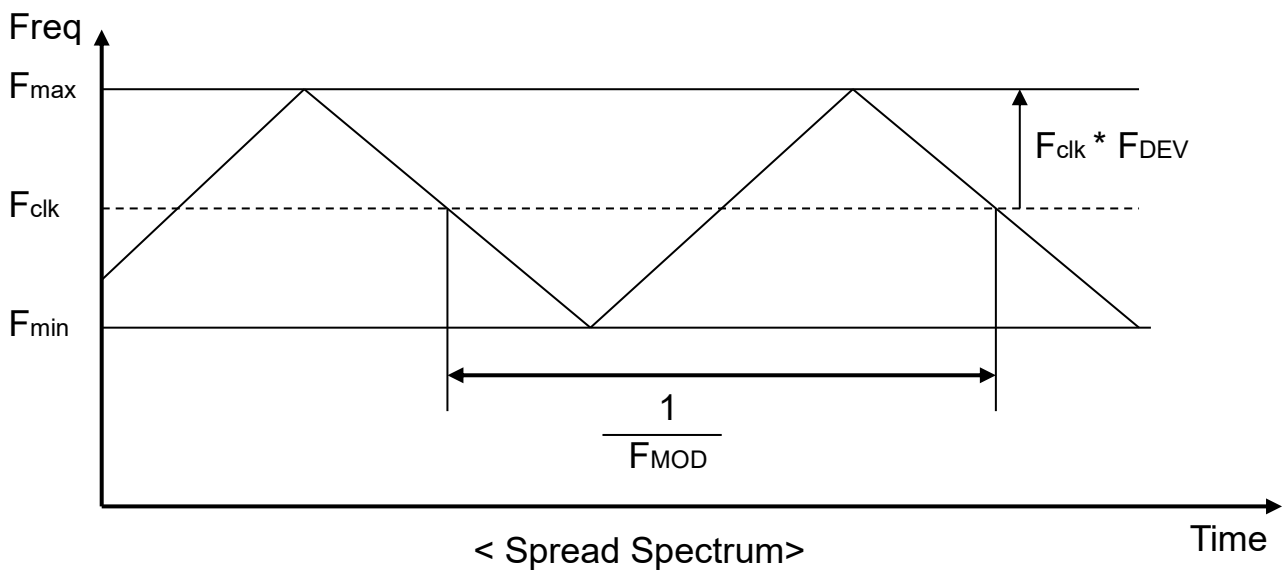
**LVDS Signal Waveform:**

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  |        |



Fclk: LVDS Clock Frequency



### 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   | <b>Note 3-3</b> |
| 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   | 1/Fclk          |
| Fclk      |                    | Frequency | 54.6 | 73.1 | 94.0 | MHz  | <b>Note 3-5</b> |

**Note 3-3:** The optimal Vertical Frequency is 50~76 Hz for best picture quality

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

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

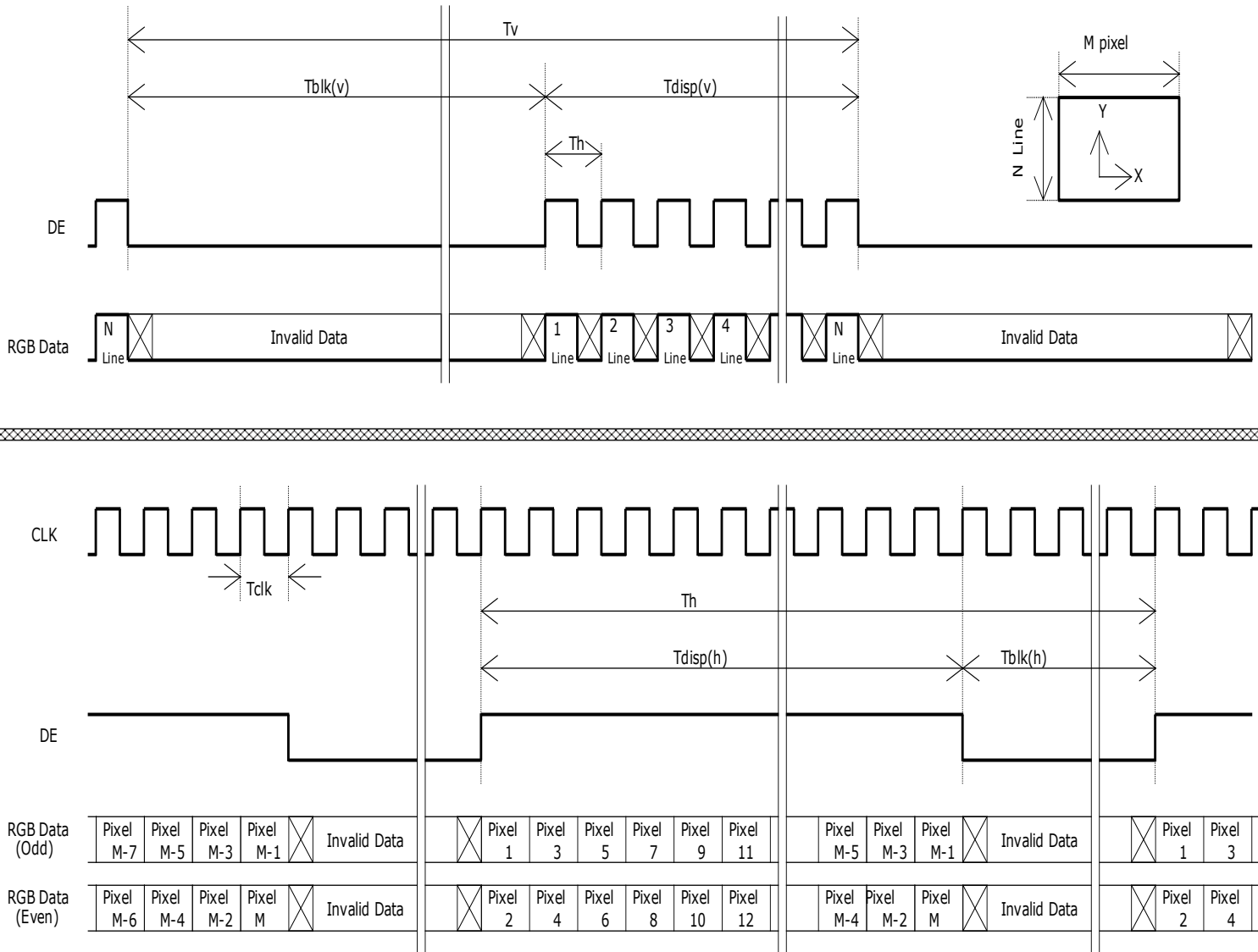
$$Fh (\text{Typ.}) = Fclk (\text{Typ.}) / Th (\text{Typ.});$$

$$Fh (\text{min}) < Fh < Fh (\text{max})$$

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

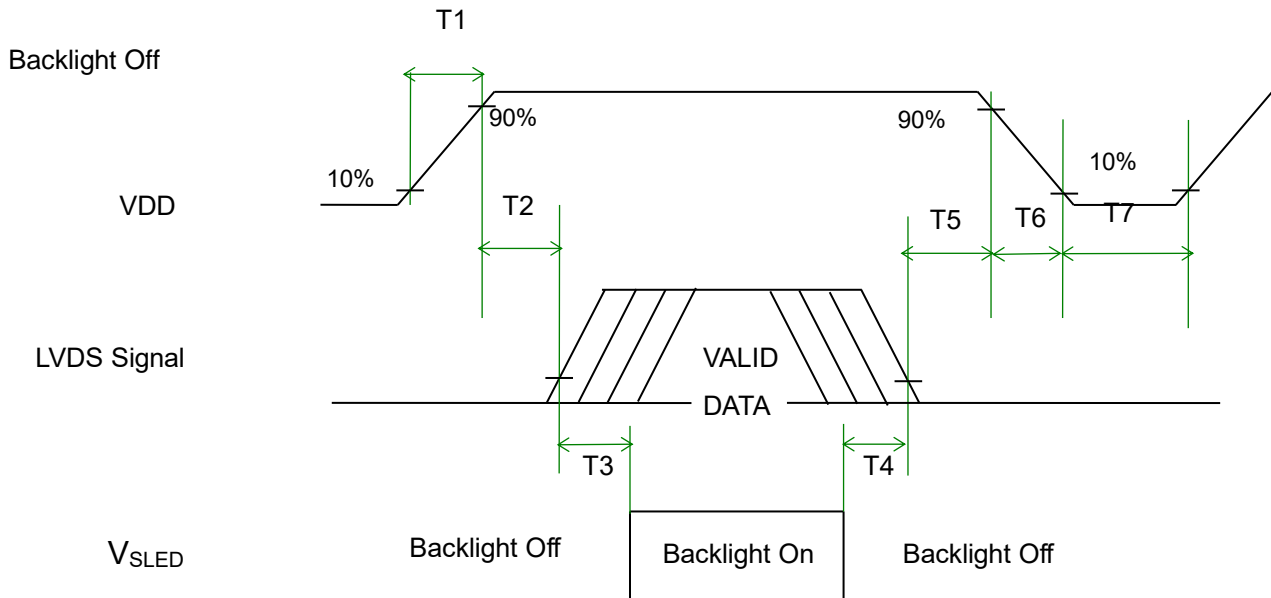
$$Fclk (\text{min}) < Fclk < Fclk (\text{max})$$

**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] | Note 3-6<br>Note 3-7 |
| T6     | 0     | -    | 200  | [ms] | Note 3-7<br>Note 3-8 |
| T7     | 1000  | -    | -    | [ms] |                      |

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

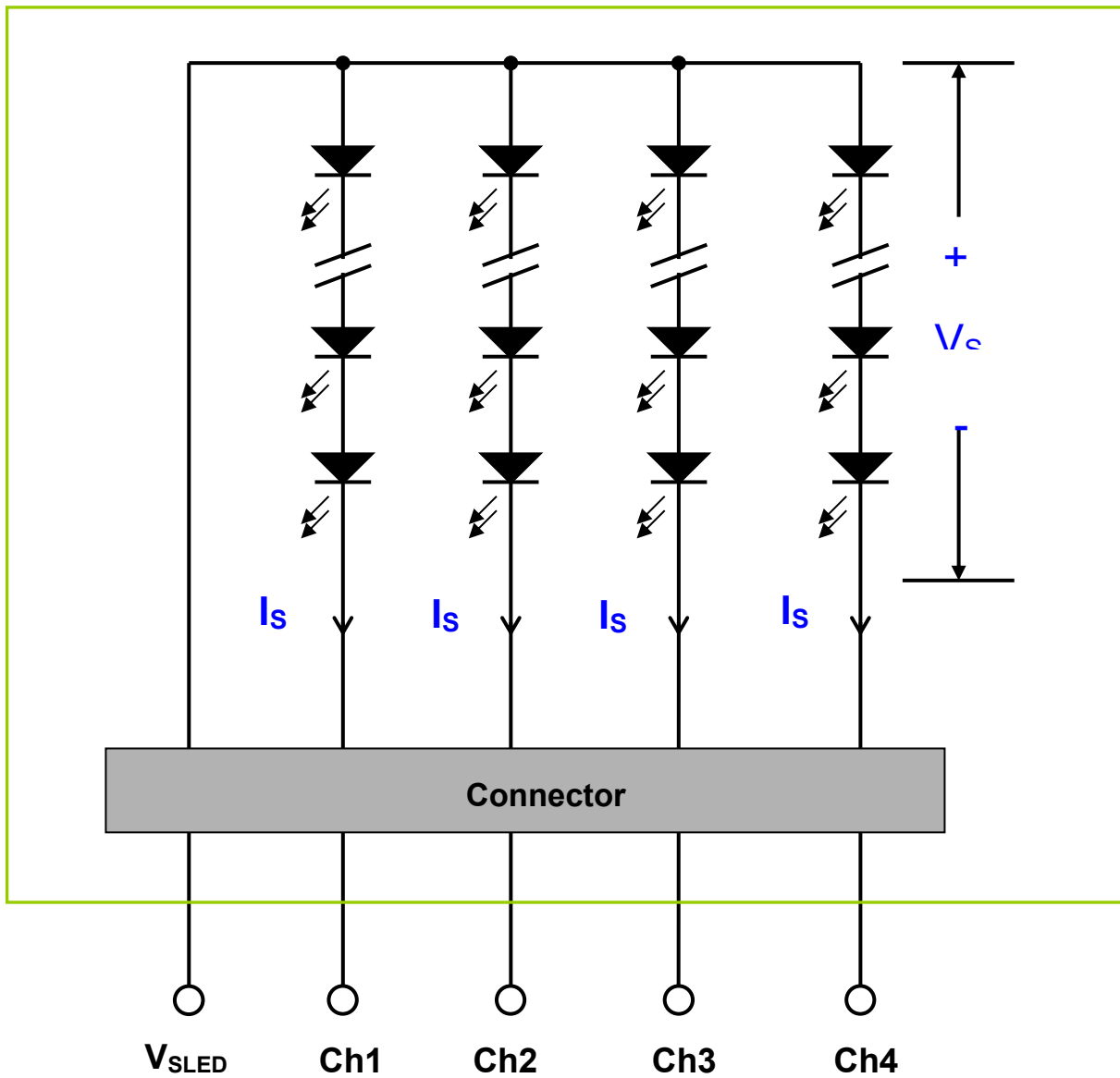
**Note 3-7 :** During T5 and T6 period , please keep the level of input LVDS signals with Hi-Z state.

**Note 3-8 :** 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 21.45 inch Backlight Unit. And it includes 60 pcs LED in the LED light bar. (4 strings and 15 pcs LED of one string).



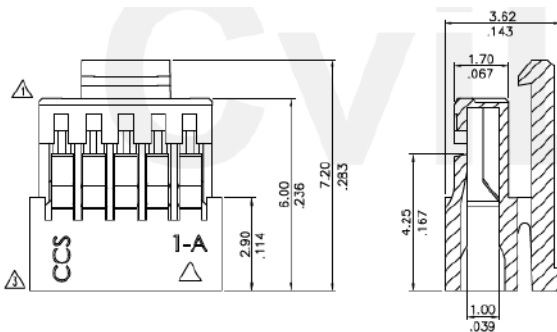
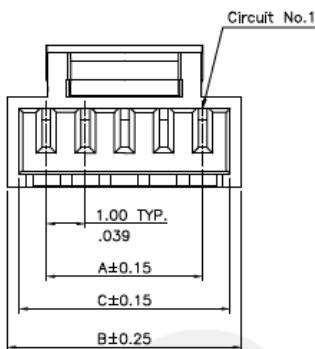
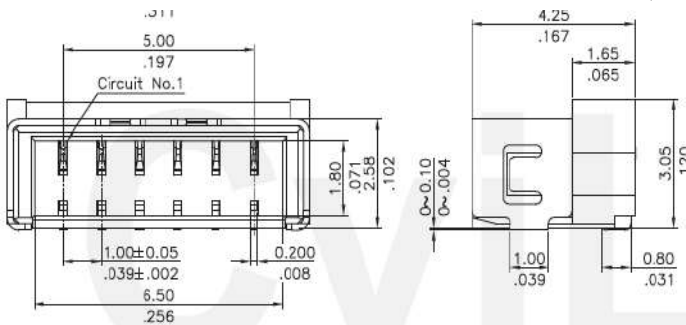
## 4.2 Interface Connection

### 4.2.1 Connector Type

|                     |              |                            |
|---------------------|--------------|----------------------------|
| Backlight Connector | Manufacturer | CviLux                     |
|                     | Part Number  | CII406MIHRN-NHI            |
| Mating Connector    | Manufacturer | CviLux                     |
|                     | Part Number  | CII406SL000-NH (Lock type) |

#### Backlight Connector dimension:

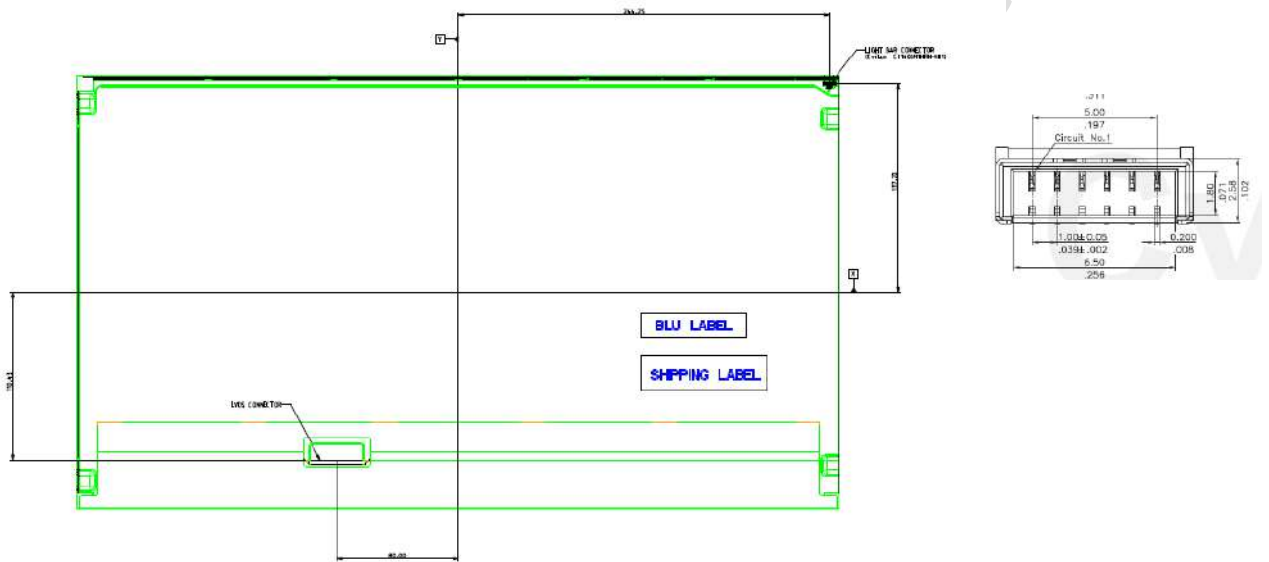
$H \times V \times D = HxVxD = 7.9 \times 3.05 \times 4.25$ , Pitch = 1.0 (unit = mm)





**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     | LED String Current | 0   | 100 | [mA] | 100% duty ratio |

#### 4.3.2 Recommended Operating Condition

(Ta=25°C)

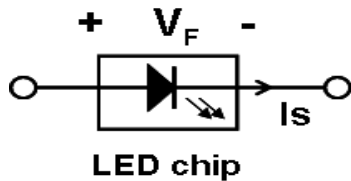
| Symbol            | Description                               | Min.       | Typ.  | Max.  | Unit   | Remark   |
|-------------------|---|------------|-------|-------|--------|--|
| Is                | LED String Current                        | -          | 65    | 72    | [mA]   | 100% duty ratio of LED chip                          |
| Vs                | LED String Voltage                        | -          | 42.8  | 49.8  | [Volt] | Is=65mA @ 100% duty ratio; <b>Note 4-1, Note 4-5</b> |
| $\Delta V_s$      | Maximum Vs Voltage Deviation of light bar | -          | -     | 3     | [Volt] | Is=65mA @ 100% duty ratio; <b>Note 4-2</b>           |
| P <sub>BLU</sub>  | LED Light Bar Power Consumption           | -          | 11.12 | 12.95 | [Watt] | <b>Note 4-3</b>                                      |
| LT <sub>LED</sub> | LED life                                  | 50,000     | -     | -     | [Hour] | <b>Note 4-4</b>                                      |
| OVP               | Over Voltage Protection in system board   | 110% Vsmax | -     | -     | [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,  $V_F (\text{Min.}) = 2.52\text{V}$ ,  $V_F (\text{Typ.}) = 2.85\text{V}$ ,  $V_F (\text{Max.}) = 3.32\text{V}$

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; (0.2V , 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:  $I_s = 65\text{mA}$  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 ( $V_s$ ) 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 Items

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= -10°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) |                 |
| 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.                                    |                 |

**Note 5-1:** a. 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.  
b. 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.

## **6 International Standard**

### **6.3 Safety**

- (1) UL 60950-1; Standard for Safety of Information Technology Equipment Including electrical Business Equipment.
- (2) IEC 60950-1; Standard for Safety of International Electrotechnical Commission
- (3) EN 60950-1; European Committee for Electrotechnical Standardization (CENELEC), EUROPEAN STANDARD for Safety of Information Technology Equipment Including Electrical Business Equipment.

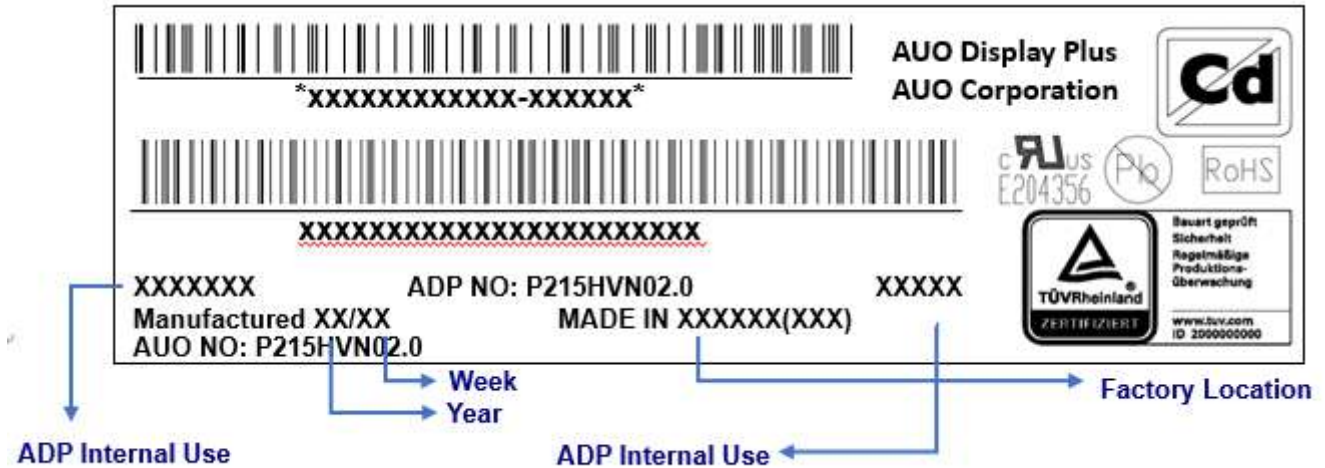
### **6.4 EMC**

- (1) ANSI C63.4 “Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electrical Equipment in the Range of 9kHz to 40GHz. “American National standards Institute(ANSI), 1992
- (2) C.I.S.P.R “Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment.” International Special committee on Radio Interference.
- (3) EN 55022 “Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment.” European Committee for Electrotechnical Standardization. (CENELEC), 1998




## 7 Packing

### 7.1 Definition of Label

#### A. Panel Label:

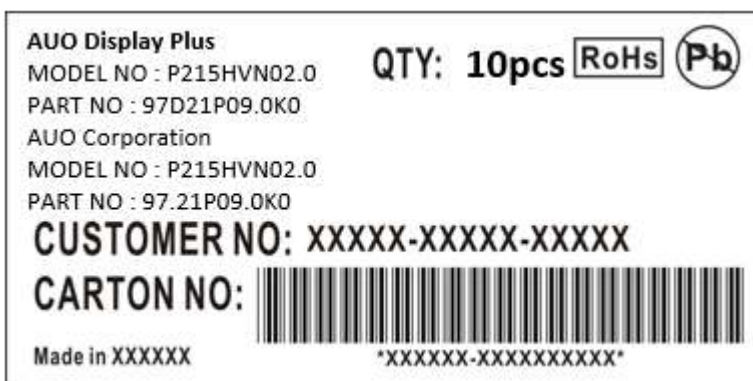


#### Green mark description

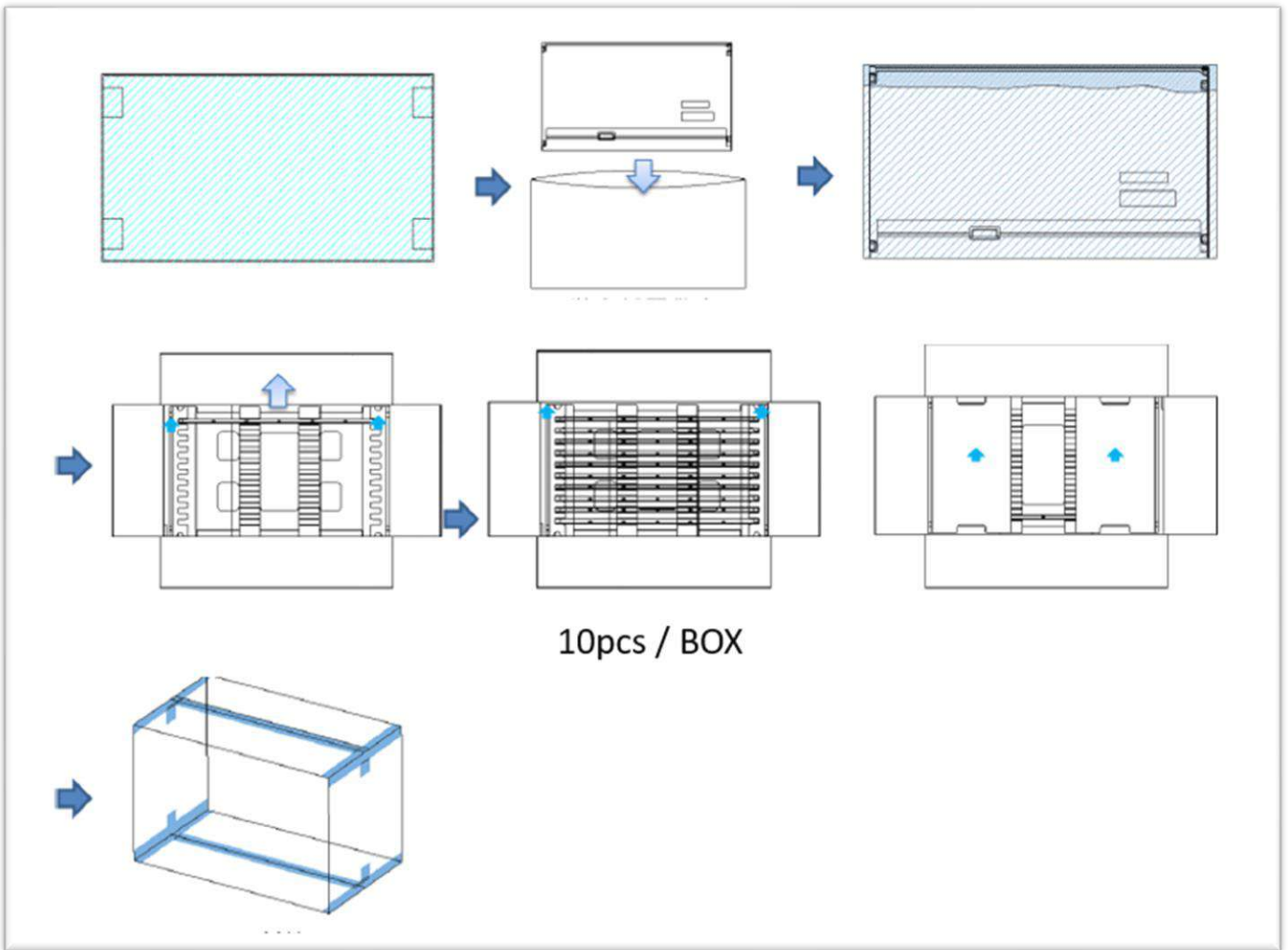
- (1) For Pb Free Product, AUO will add  &  for identification.
- (2) For RoHs compatible products, AUO will add  for identification.

Note: The green Mark will be present only when the green documents have been ready by AUO internal green team. (definition of green design follows the AUO green design checklist.)

#### B. Carton Label:



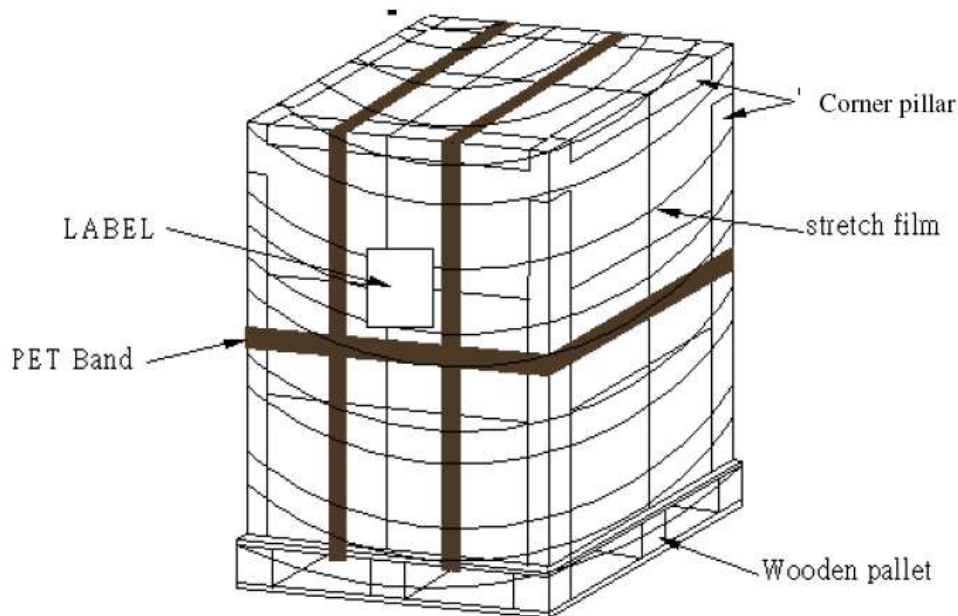
**7.2 Packing Methods**



**7.3 Pallet and Shipment Information**

| Item                 | Specification     |                                   |            | Remark   |
|----------------------|-------------------|-----------------------------------|------------|--|
|                      | Q'ty              | Dimension                         | Weight(kg) |  |
| Panel                | 1                 | 501.5(H)× 284.5(V)×10.9(D)mm      | 1.7        | <b>Note 1</b>                                  |
| Cushion              | 1                 | -                                 | 0.55       | <b>Note 1</b>                                  |
| Box                  | 1                 | 565mm*345mm*375mm                 | 1.4        | without Panel<br><b>Note 1</b>                 |
| Packing Box          | 10pcs/Box         | 565mm*345mm*375mm                 | 18.95      | with panel & Box<br>& cushion<br><b>Note 1</b> |
| Pallet               | 1                 | 1150mm*1070mm*132mm               | 14.2       | <b>Note 1</b>                                  |
| Pallet after Packing | 18 Boxes / Pallet | 1150(L)mm x 1070(W)mm x 1257(H)mm | 410        | <b>Note 1</b>                                  |

**Note 1:** Estimated value which is subject to change based on real measured data.



**Single pallet stack Illustration**

## 8 Precautions

Please pay attention to the followings when you use this TFT LCD module.

### 8.1 Mounting Precautions

- (1) You must mount a module using holes arranged in four corners or four sides.
- (2) You should consider the mounting structure so that uneven force (ex. twisted stress) is not applied to module. And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
- (3) Please attach the surface transparent protective plate to the surface in order to protect the polarizer. Transparent protective plate should have sufficient strength in order to resist external force.
- (4) You should adopt radiation structure to satisfy the temperature specification.
- (5) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter cause circuit broken by electro-chemical reaction.
- (6) Do not touch, push or rub the exposed polarizer 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 polarizer. 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.

### 8.2 Operating Precautions

- (1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage:  
 $V = \pm 200\text{mV}$  (Over and under shoot voltage)
- (2) Response time depends on the temperature. (In lower temperature, it becomes longer..)
- (3) Brightness depends on the temperature. (In lower temperature, it may become lower.) And in lower temperature, response time (required time that brightness is stable after turned on) becomes longer.
- (4) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
- (5) When fixed patterns are displayed for a long time, remnant image is likely to occur.
- (6) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimize the interface.

### 8.3 Operating Condition for Public Information Display

The device listed in the product specification is designed and manufactured for PID (Public Information

Display) application. To optimize module's lifetime and function, below operating usages are required.

- (1) Normal operating condition
  - A. Operating temperature: 0~50°C
  - B. Operating humidity: 10~90%
  - C. Display pattern: dynamic pattern (Real display).  
Note) Long-term static display would cause image sticking.
- (2) Operation usage to protect against image sticking due to long-term static display.
  - A. Suitable operating time: 20 hours or less a day.
  - B. Liquid Crystal refresh time is required. Cycling display between 5 minutes' information (static) display and 10 seconds' moving image.
  - C. Periodically change background and character (image) color.
  - D. Avoid combination of background and character with large different luminance.
- (3) Periodically adopt one of the following actions after long time display.
  - A. Running the screen saver (motion picture or black pattern)
  - B. Power off the system for a while
- (4) LCD system is required to place in well-ventilated environment. Adapting active cooling system is highly recommended.
- (5) Product reliability and functions are only guaranteed when the product is used under right operation usages. If product will be used in extreme conditions, such as high temperature/ humidity, display stationary patterns, or long operation time etc..., it is strongly recommended to contact AUO for filed application engineering advice. Otherwise, its reliability and function may not be guaranteed. Extreme conditions are commonly found at airports, transit stations, banks, stock market and controlling systems.

#### **8.4 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 wristband etc. And don't touch interface pin directly.

#### **8.5 Precautions for Strong Light Exposure**

Strong light exposure causes degradation of polarizer and color filter.

#### **8.6 Storage**

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

- (1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
- (2) The polarizer surface should not come in contact with any other object. It is recommended that they be stored in the container in which they were shipped.
- (3) Storage condition is guaranteed under packing conditions.
- (4) The phase transition of Liquid Crystal in the condition of the low or high storage temperature will be recovered when the LCD module returns to the normal condition.

#### **8.7 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 or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.

### 8.8 Dust Resistance

- (1) AUO module dust tests are conducted with marked areas (e.g., holes and slits around the front bezel and back cover) sealed, to comply with JIS D0207 (see Figure 1).
- (2) To prevent particles from entering the module, please ensure the set has all the highlighted areas (holes and slits) adequately sealed or covered by set mechanism.
- (3) AUO's testing procedure cannot replicate all real world operation scenarios. It is up to the module user to apply the most appropriate dust resistance solution for its particular application.

Figure 1

