



# SPECIFICATION FOR TFT LCD MODULE

CUSTOMER : \_\_\_\_\_

CUSTOMER MODULE : \_\_\_\_\_

HG MODEL : HG156FH026-V1

☐ Preliminary Specification

☒ Final Specification

Customer Confirmation column:

Approved by : \_\_\_\_\_ Dept. : \_\_\_\_\_ Data : \_\_\_\_\_

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## 1. GENERAL DESCRIPTION

### 1.1 OVERVIEW

HG156FH026-V1 is a 15.6inch FHD TFT Liquid Crystal Display opencell with 30 pins eDP interface. This panel supports 1920×1080 FHD mode and can display 16.7M colors.

### 1.2 SPECIFICATION SUMMARY

| i  | Item                       | Specification          | Unit              | Note        |
|----|----------------------------|------------------------|-------------------|-------------|
| 1  | LCD size                   | 15.6                   | inch              |             |
| 2  | Resolution                 | 1920 × RGB ×1080       |                   |             |
| 3  | Pixel Arrangement          | RGB                    |                   |             |
| 4  | Model Type                 | FOB                    |                   |             |
| 5  | TFT Technology             | a-Si                   |                   |             |
| 6  | Display mode               | FFS, Normally Black    | --                |             |
| 7  | Active Area                | 344.16 (H)×193.59 (V)  | mm                |             |
| 8  | pixel pitch                | 179.25(H)×179.25(V)    | um                |             |
| 9  | Display Colors             | 16.7M(6bit+FRC)        |                   |             |
| 10 | Contrast Ratio             | 1000:1(Typ) @CSOT BL   |                   |             |
| 11 | Color Gamut                | NTSC 45% (Typ)@CSOT BL |                   |             |
| 12 | Transmission               | 6.20%@CSOT BL          | %                 |             |
| 13 | Surface treatment(UP)      | Anti-Glare             | --                | Pol.        |
| 14 | Interface                  | eDP 1.2                |                   | 2 lane@2.7G |
| 15 | HDR function               | NA                     |                   | -           |
| 16 | Method of Inversion        | 2 dot inversion (DLS)  |                   |             |
| 17 | Power consumption of Panel | 750(Max.)              | mW                | 3.3V@Mosaic |
| 18 | Luminance of White         | 1000                   | cd/m <sup>2</sup> |             |

Note (1) The specified power consumption (with converter efficiency) is under the conditions at VCCS =3.3 V, fv = 60 Hz, LED\_VCCS = 12V(Typ), fPWM = 200 Hz, Duty=100% and Ta = 25 ± 2 ℃, whereas mosaic pattern is displayed.

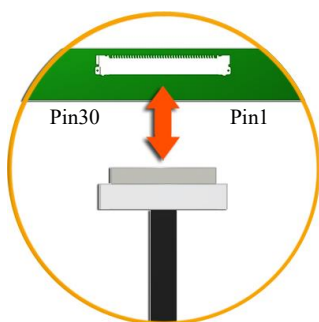
Note(2) Contrast Ratio is in CSOT BLU and after CSOT AutoVcom.



## 2. MECHANICAL SPECIFICATIONS

| Parameter               |        | Min.   | Typ.   | Max.   | Unit | Note         |
|-------------------------|--------|--------|--------|--------|------|--------------|
| Unit outline dimensions | Width  | 350.36 | 350.66 | 350.96 | mm   |              |
|                         | Height | 204.94 | 205.24 | 205.54 | mm   | Without PCBA |
|                         | Depth  | 2.80   | 3.00   | 3.20   | mm   | Without PCBA |
| Weight                  |        | -      | -      | -      | g    | With PCBA    |

### 2.1 INTERFACE CONNECTION



Please refer Appendix Outline Drawing for detail design.

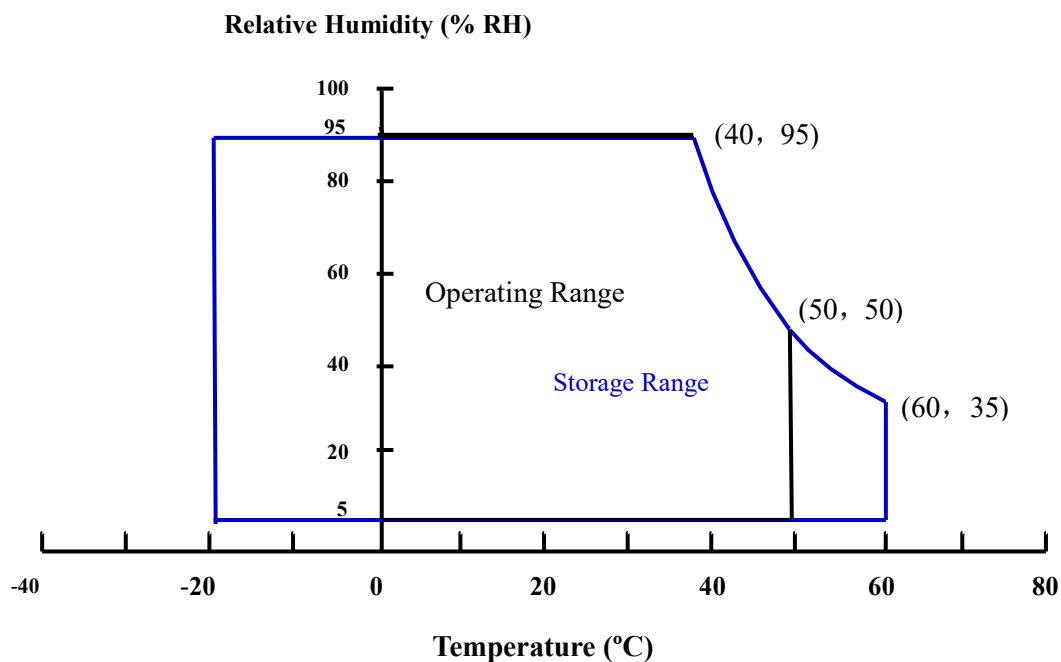
LCM Connector Part No.: 300E30-1010RC-G3(Starconn)

BLU Connector Part No.: 139D10-000000-A2-R

## 3. ABSOLUTE MAXIMUM RATINGS

### 3.1 ABSOLUTE RATINGS OF ENVIRONMENT

| Item                          | Symbol          | Value |      | Unit | Note     |
|-------------------------------|-----------------|-------|------|------|----------|
|                               |                 | Min.  | Max. |      |          |
| Storage Temperature           | T <sub>ST</sub> | -30   | +70  | °C   | (1)      |
| Operating Ambient Temperature | T <sub>OP</sub> | -20   | +70  | °C   | (1), (2) |



Note (1) (a) 95% RH Max. ( $T_a \leq 40^\circ\text{C}$ ).

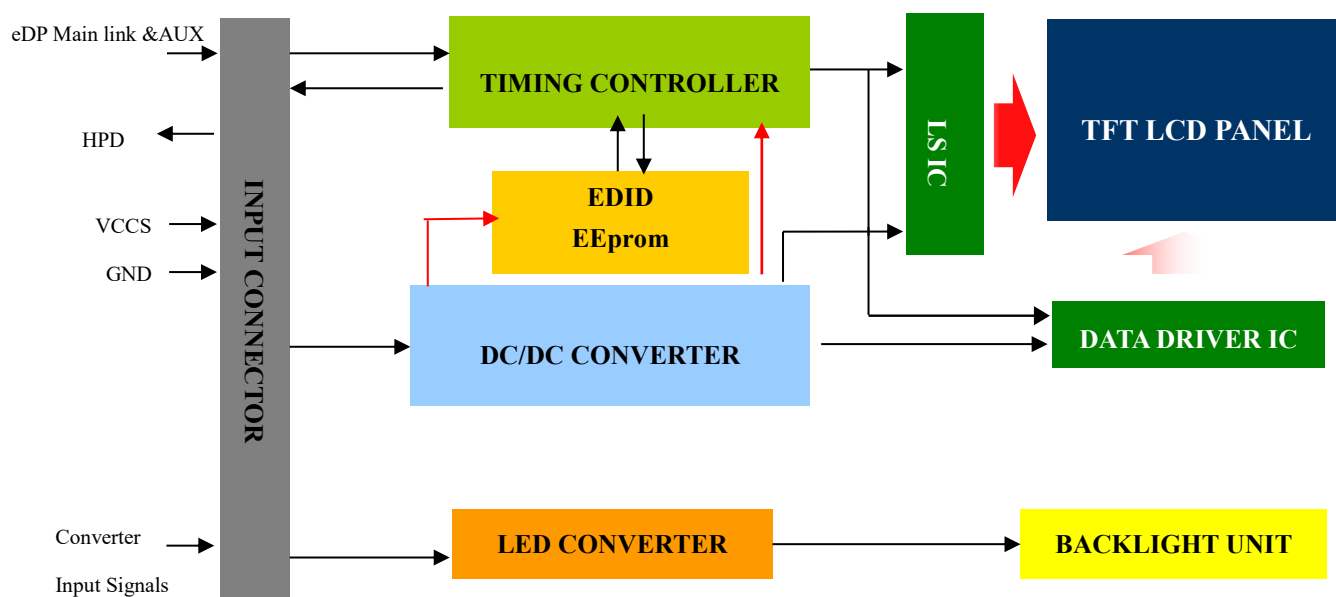
(b) Wet-bulb temperature should be  $39^\circ\text{C}$  Max. ( $T_a > 40^\circ\text{C}$ ).

(c) No condensation.

Note (2) The temperature of panel surface should be  $0^\circ\text{C}$  min. and  $60^\circ\text{C}$  max.

## 4. ELECTRICAL SPECIFICATIONS

### 4.1 FUNCTION BLOCK DIAGRAM



### 4.2 INTERFACE CONNECTIONS

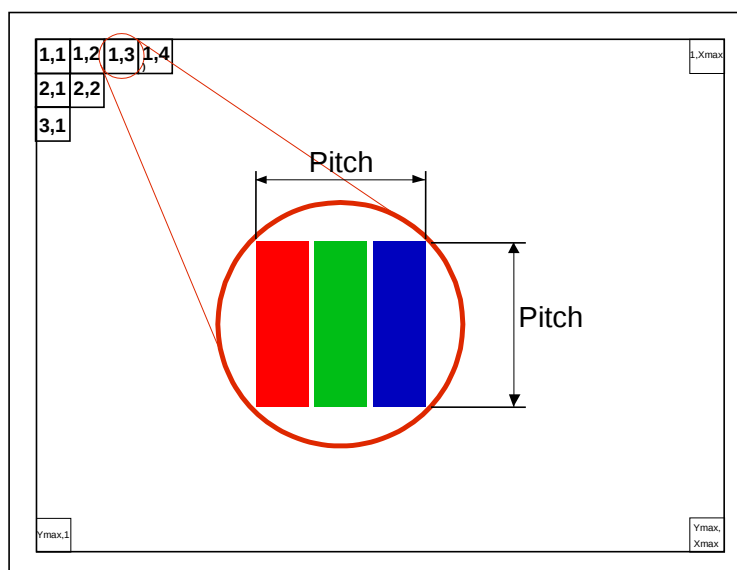
#### PIN ASSIGNMENT

| Pin | Symbol | Description                         | Note |
|-----|--------|-------------------------------------|------|
| 1   | NC     | No Connection , Please let it open  | (2)  |
| 2   | H_GND  | High Speed Ground                   |      |
| 3   | ML1-   | Complement Signal-Lane 1            |      |
| 4   | ML1+   | True Signal-Main Lane 1             |      |
| 5   | H_GND  | High Speed Ground                   |      |
| 6   | ML0-   | Complement Signal-Lane 0            |      |
| 7   | ML0+   | True Signal-Main Lane 0             |      |
| 8   | H_GND  | High Speed Ground                   |      |
| 9   | AUX+   | True Signal-Auxiliary Channel       |      |
| 10  | AUX-   | Complement Signal-Auxiliary Channel |      |
| 11  | H_GND  | High Speed Ground                   |      |
| 12  | VCCS   | Power Supply +3.3V (typical)        |      |
| 13  | VCCS   | Power Supply +3.3V (typical)        |      |

|    |      |                                  |  |
|----|------|----------------------------------|--|
| 14 | BIST | Built-In Self Test (active high) |  |
| 15 | GND  | Ground                           |  |
| 16 | GND  | Ground                           |  |
| 17 | HPD  | Hot Plug Detect                  |  |
| 18 | NC   | No Connection                    |  |
| 19 | NC   | No Connection                    |  |
| 20 | NC   | No Connection                    |  |
| 21 | NC   | No Connection                    |  |
| 22 | NC   | No Connection                    |  |
| 23 | NC   | No Connection                    |  |
| 24 | NC   | No Connection                    |  |
| 25 | NC   | No Connection                    |  |
| 26 | NC   | No Connection                    |  |
| 27 | NC   | No Connection                    |  |
| 28 | NC   | No Connection                    |  |
| 29 | NC   | No Connection                    |  |
| 30 | NC   | No Connection                    |  |

Note (1) The pixel is shown in the following figure.

Note(2) This pin used for CSOT internally, please let it floating on customer side.



## 4.3 ELECTRICAL CHARACTERISTICS

## 4.4 LCD ELETRONICS SPECIFICATION

| Parameter            | Symbol            | Value |      |      | Unit | Note   |
|----------------------|-------------------|-------|------|------|------|--------|
|                      |                   | Min.  | Typ. | Max. |      |        |
| Power Supply Voltage | VCCS              | 3.0   | 3.3  | 3.6  | V    | (1)    |
| BIST Control Level   | BIST on           | 2.2   | 3.3  | 3.6  | V    | (1)    |
|                      | BIST off          | 0     | -    | 0.5  | V    | (1)    |
| Ripple Voltage       | V <sub>RP</sub>   | -     | -    | 100  | mV   | (1)    |
| Inrush Current       | I <sub>RUSH</sub> | -     | -    | 1.5  | A    | (1)(2) |
| Power Supply Current | Mosaic            | -     | 180  | 228  | mA   | (3)    |

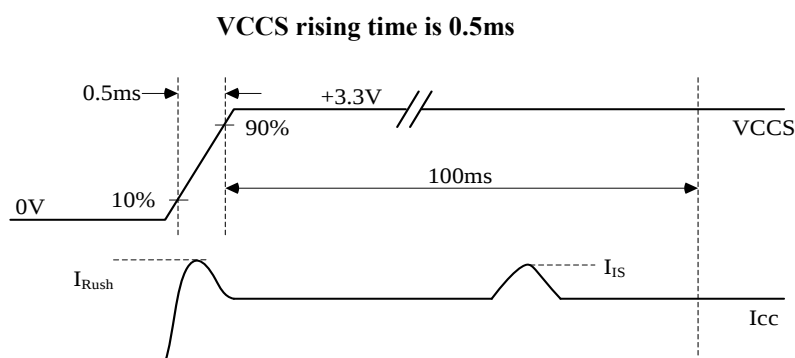
Note (1) The ambient temperature is Ta = 25 ± 2 °C.

Note (2) I<sub>RUSH</sub>: the maximum current when VCCS is rising

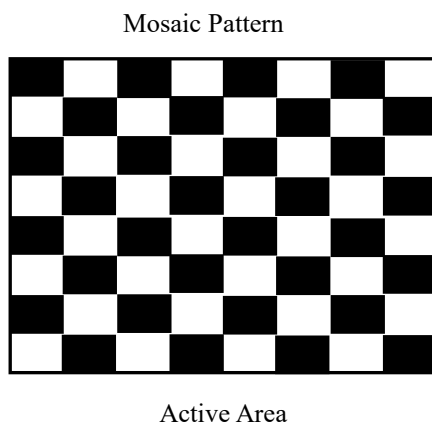
I<sub>IS</sub>: the maximum current of the first 100ms after power-on

Measurement Conditions: Shown as the following figure.

Test pattern: Mosaic



Note (3) The specified power supply current is under the conditions at VCCS = 3.3 V, Ta = 25 ± 2 °C, DC Current and f<sub>v</sub> = 60 Hz, whereas a power dissipation check pattern below is displayed.



#### 4.4.1 RECOMMENDED BACKLIGHT UNIT

Ta = 25 ± 2 °C

| Parameter                          | Symbol          | Value |      |      | Unit | Note                    |
|------------------------------------|-----------------|-------|------|------|------|-------------------------|
|                                    |                 | Min.  | Typ. | Max. |      |                         |
| LED Light Bar Power Supply Voltage | VL              | -     | 24   | -    | V    | (1)(2)(3)<br>(Duty100%) |
| LED Light Bar Power Supply Current | IL              | -     | 360  | -    | mA   |                         |
| LED Luminance                      | Y <sub>LI</sub> | -     | -    | -    | nit  |                         |

Note (1) LED current is measured by utilizing a high frequency current meter :

Note (2) For better LED light bar driving quality, it is recommended to utilize the adaptive boost converter with current balancing function to drive LED light-bar.

Note(3) Recommended B/L : 4S18P

#### INPUT SIGNAL TIMING SPECIFICATIONS



## 4.5.1 eDP AUX Channel Characteristics

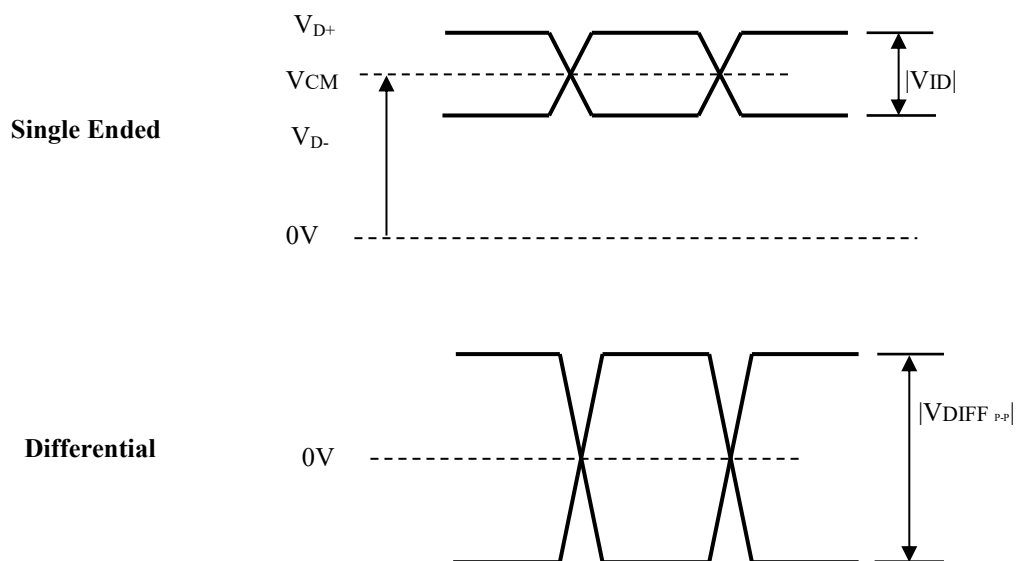
| Parameter                      | Symbol            | Min. | Typ. | Max. | Unit     | Note               |
|--------------------------------|-------------------|------|------|------|----------|--------------------|
| Unit Interval for AUX channel  | $UI_{AUX}$        | 0.4  | -    | 0.6  | $\mu S$  |                    |
| Peak-to-peak voltage at TP1    | $V_{AUX-DIFF-pp}$ | 0.39 | -    | 1.38 | V        |                    |
| AUX DC Common mode Voltage     | $V_{AUX-DC-CM}$   | 0    | -    | 2    | V        |                    |
| AUX Short current limit        | $I_{AUX\_SHORT}$  | -    | -    | 90   | mA       |                    |
| AUX CH termination DC resistor | $R_{AUX\_TERM}$   | 80   | 100  | 120  | $\Omega$ | Differential input |
| AUX AC coupling capacitor      | $C_{AUX}$         | 75   | -    | 200  | nF       |                    |
| Number of pre-charge pulses    | Pre-charge pulses | 10   | -    | 16   |          |                    |

## 4.5.2 eDP Main Link Receiver Characteristics

| Parameter                                                  | Symbol                                 | Min. | Typ. | Max. | Unit     | Note |
|------------------------------------------------------------|----------------------------------------|------|------|------|----------|------|
| Link clock down spreading                                  | Down_Spread_Amplitude                  | 0    |      | 0.5  | %        |      |
| Differential Peak-to-peak Input Voltage at Rx package pins | $V_{RX-DIFFp-p}$                       | 120  | -    | 1200 | mV       |      |
| Differential termination resistance                        | $R_{RX-TERM}$                          | 90   | 100  | 110  | $\Omega$ |      |
| RX short circuit Current Limit                             | $I_{RX-SHORT}$                         | -    | -    | 50   | mA       |      |
| Lane Intra-pair Skew at RX package pins                    | $T_{RX-SKEW-INTRA-PAIR-High-Bit-Rate}$ | -    | -    | 50   | ps       |      |

## 4.5.3 eDP AUX Channel Characteristics

| Parameter       | Symbol    | Min. | Typ. | Max. | Unit | Note |
|-----------------|-----------|------|------|------|------|------|
| Hot plug Detect | $V_{HPD}$ | 2.25 | -    | 3.6  | V    |      |





## 4.5.4 COLOR DATA INPUT ASSIGNMENT

The brightness of each primary color (red, green and blue) is based on the 8-bit gray scale data input for the color. The higher the binary input the brighter the color. The table below provides the assignment of color versus data input.

| Color               |               | Data Signal |    |    |    |    |    |    |    |       |    |    |    |    |    |    |    |      |    |    |    |    |    |    |    |
|---------------------|---------------|-------------|----|----|----|----|----|----|----|-------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
|                     |               | Red         |    |    |    |    |    |    |    | Green |    |    |    |    |    |    |    | Blue |    |    |    |    |    |    |    |
|                     |               | R7          | R6 | R5 | R4 | R3 | R2 | R1 | R0 | G7    | G6 | G5 | G4 | G3 | G2 | G1 | G0 | B7   | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| Basic Colors        | Black         | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | Red           | 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         | 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          | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1    | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
|                     | Cyan          | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
|                     | Magenta       | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1    | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
|                     | Yellow        | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | White         | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 1  | 1  | 1  | 1  |
| Gray Scale Of Red   | Red(0)/Dark   | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | Red(1)        | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | Red(2)        | 0           | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | :             | :           | :  | :  | :  | :  | :  | :  | :  | :     | :  | :  | :  | :  | :  | :  | :  | :    | :  | :  | :  | :  | :  | :  | :  |
|                     | :             | :           | :  | :  | :  | :  | :  | :  | :  | :     | :  | :  | :  | :  | :  | :  | :  | :    | :  | :  | :  | :  | :  | :  | :  |
|                     | Red(253)      | 1           | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | Red(254)      | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | Red(255)      | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
| Gray Scale Of Green | Green(0)/Dark | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | Green(1)      | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | Green(2)      | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | :             | :           | :  | :  | :  | :  | :  | :  | :  | :     | :  | :  | :  | :  | :  | :  | :  | :    | :  | :  | :  | :  | :  | :  | :  |
|                     | :             | :           | :  | :  | :  | :  | :  | :  | :  | :     | :  | :  | :  | :  | :  | :  | :  | :    | :  | :  | :  | :  | :  | :  | :  |
|                     | Green(253)    | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | Green(254)    | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |
|                     | Green(255)    | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0  |



|                    |              |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|--------------------|--------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gray Scale Of Blue | Blue(0)/Dark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |   |
|                    | Blue(1)      | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |   |
|                    | Blue(2)      | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |   |
|                    | :            | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |   |
|                    | :            | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |   |
|                    | Blue(253)    | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
|                    | Blue(254)    | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| Blue(255)          | 0            | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |   |

Note (1) 0: Low Level Voltage, 1: High Level Voltage

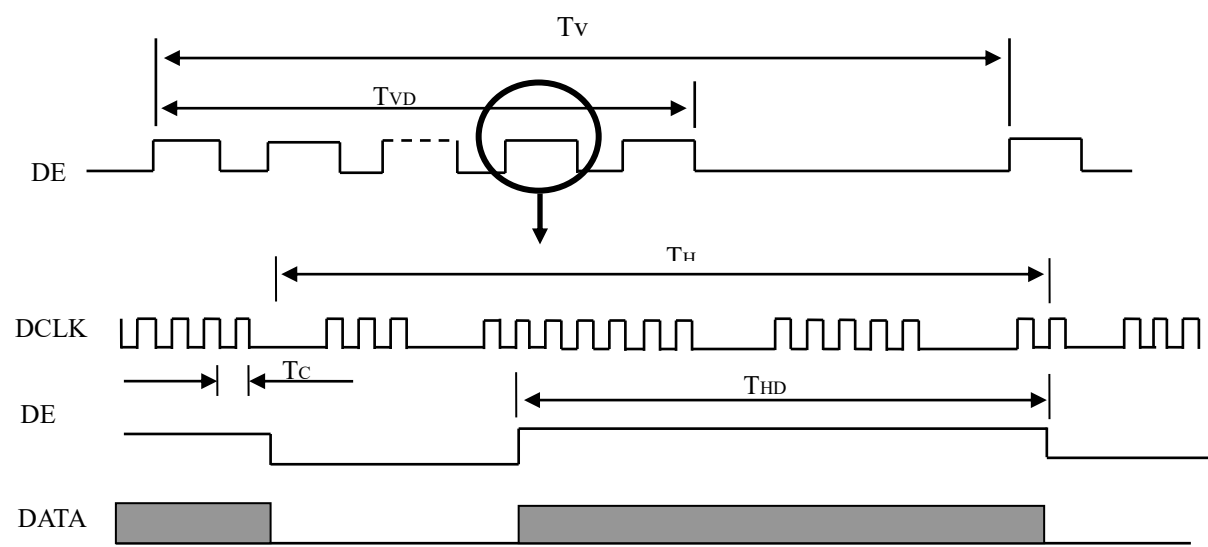
### 4.6 DISPLAY TIMING SPECIFICATIONS

The input signal timing specification is showed as the following table and timing diagram.

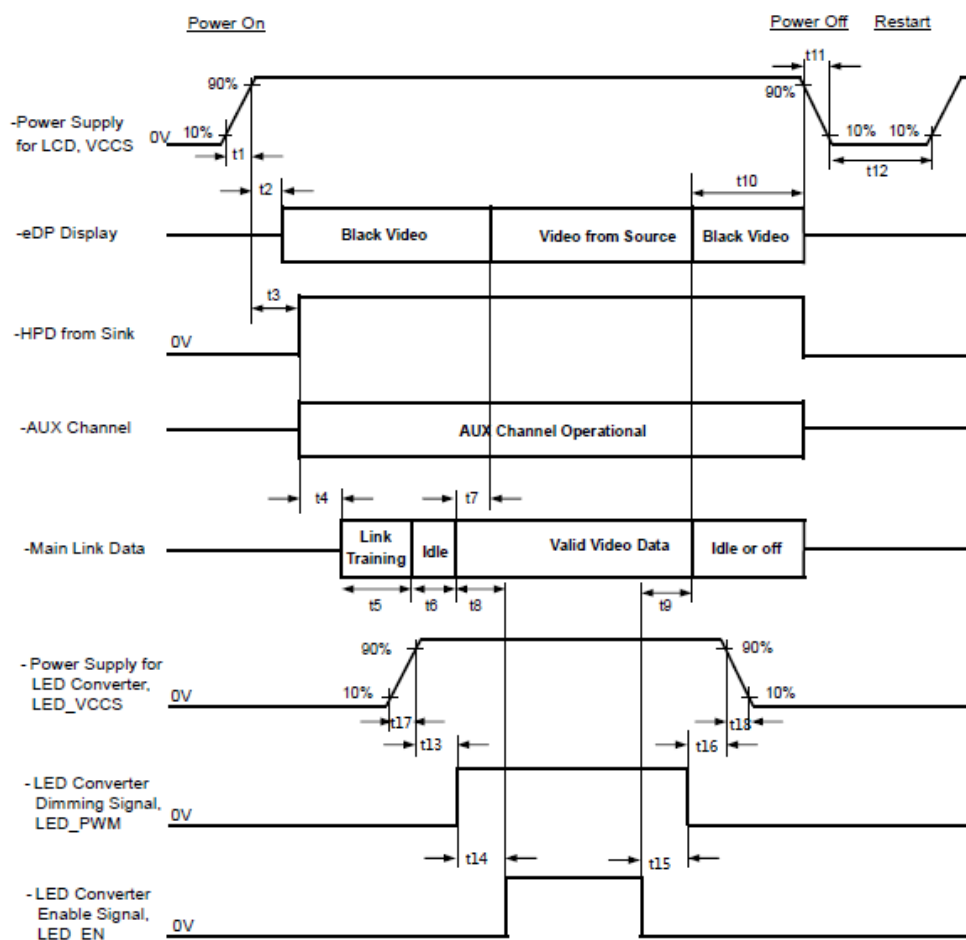
| Signal | Item                              | Symbol | Min. | Typ.   | Max. | Unit | Note |
|--------|-----------------------------------|--------|------|--------|------|------|------|
| DCLK   | Frequency                         | 1/Tc   | -    | 147.84 | -    | MHz  | -    |
| DE     | Vertical Total Time               | TV     | -    | 1120   | -    | TH   | -    |
|        | Vertical Active Display Period    | TVD    | 1080 | 1080   | 1080 | TH   | -    |
|        | Vertical Active Blanking Period   | TVB    | -    | 40     | -    | TH   | -    |
|        | Horizontal Total Time             | TH     | -    | 2200   | -    | Tc   | -    |
|        | Horizontal Active Display Period  | THD    | 1920 | 1920   | 1920 | Tc   | -    |
|        | Horizontal Active Blanking Period | THB    | -    | 280    | -    | Tc   | -    |

Note (1) Display timing signal should be contained and transferred by Display Port Main Link stream data packing described in VESA Display Port Standard V1.4b.

INPUT SIGNAL TIMING DIAGRAM



## 4.7 POWER ON/OFF SEQUENCE



| Symbol | Description                                                 | Min | Typ. | Max | Unit | Note |
|--------|-------------------------------------------------------------|-----|------|-----|------|------|
| t1     | Power rail rise time, 10% to 90%                            | 0.5 |      | 10  | ms   |      |
| t2     | Delay from LCD,VCCS to eDP Display                          | 0   |      | 200 | ms   |      |
| t3     | Delay from LCD,VCCS to HPD high                             | 0   |      | 200 | ms   |      |
| t4     | Delay from Sink AUX to link training initialization         | -   |      | -   | ms   | (5)  |
| t5     | Link training duration                                      | -   |      | -   | ms   | (5)  |
| t6     | Link idle                                                   | -   |      | -   | ms   | (5)  |
| t7     | Delay from valid video data from Source to video on display | 0   |      | 50  | ms   |      |
| t8     | Delay from valid video data from Source to backlight on     | 50  |      | -   | ms   | (5)  |
| t9     | Delay from backlight off to end of valid video data         | 0   |      | -   | ms   |      |
| t10    | Delay from end of valid video data from Source to power off | 0   |      | 500 | ms   |      |
| t11    | VCCS power rail fall time, 90% to 10%                       | 0.5 |      | 10  | ms   | (1)  |
| t12    | VCCS Power off time                                         | 500 |      | -   | ms   |      |
| t13    | Delay from VCC to PWM                                       | 0   |      | -   | ms   |      |
| t14    | Delay from PWM to LED ENABLE                                | 0   |      | -   | ms   |      |
| t15    | Delay from LED ENABLE to PWM Disable                        | 0   |      | -   | ms   |      |
| t16    | Delay from PWM Disable to VBL 90%                           | 0   |      | -   | ms   |      |
| t17    | Delay from VBL 10% to VBL 90%                               | 0.5 |      | -   | ms   |      |
| t18    | VBL power rail fall time, 90% to 10%                        | 0.5 |      | -   | ms   |      |

Note (1) Please follow the power on/off sequence described above. Otherwise, the LCD module might abnormal display or be damaged.

Note (2) Please avoid floating state of interface signal at invalid period. When the interface signal is invalid, be sure to pull down the power supply of LCD VCCS to 0 V.

Note (3) The backlight must be turned on after the power supply for the logic and the interface signal is valid.

The backlight must be turned off before the power supply for the logic and the interface signal is invalid.

Note (4) Please follow the LED backlight power sequence as above. If the customer could not follow, it might cause backlight flash issue during display ON/OFF or damage the LED backlight controller

Note (5)  $T4+T5+T6+T8 > 80\text{ms}$

## 5. Optical characteristics

Ta=25°C

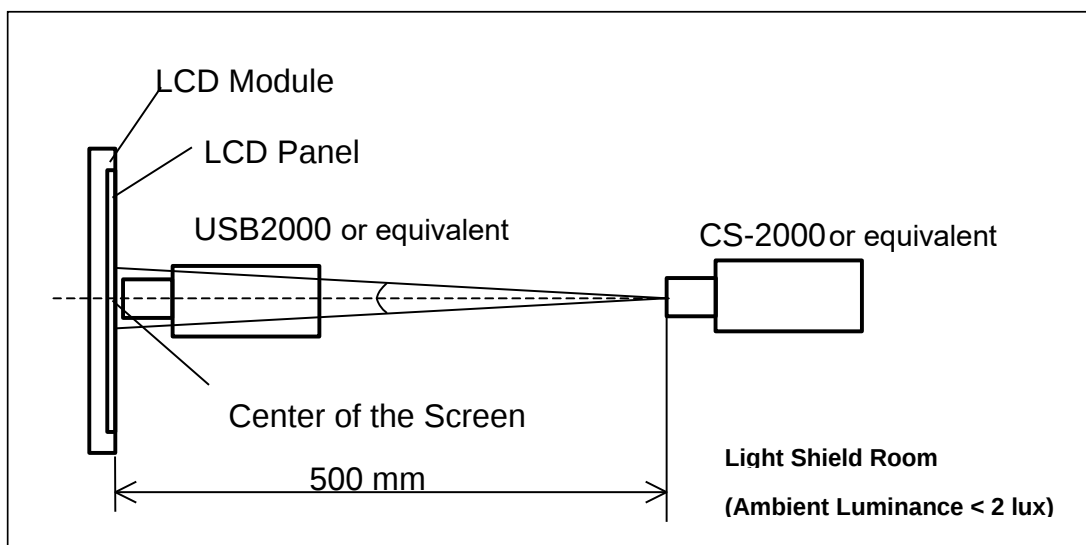
| Parameter                                   |            | Symbol                         | Condition | Min.          | Typ.    | Max.          | Unit              | Note                                     |
|---------------------------------------------|------------|--------------------------------|-----------|---------------|---------|---------------|-------------------|------------------------------------------|
| Viewing angle range                         | Horizontal | θ21                            | CR>10     | -             | 89      | -             | Deg.              | (1), (3), (4), (6)                       |
|                                             |            | θ22                            |           | -             | 89      | -             |                   |                                          |
|                                             | Vertical   | θ11                            |           | -             | 89      | -             | Deg.              |                                          |
|                                             |            | θ12                            |           | -             | 89      | -             | Deg.              |                                          |
| Contrast ratio                              |            | CR                             |           | 800           | 1000    | -             | -                 | (2), (4), (6)<br>@CSOT BL                |
| Luminance of White                          |            | Y <sub>w</sub>                 |           | 800           | 1000    | -             | cd/m <sup>2</sup> |                                          |
| Response time                               |            | τ <sub>r</sub> +τ <sub>d</sub> | θ=0 deg.  | -             | 20      | 25            | ms                | (5)                                      |
| Chromaticity of white                       |            | x                              |           | Typ.<br>-0.03 | 0.313   | Typ.<br>+0.03 | -                 | (2), (6)<br>Normal operation<br>@CSOT BL |
|                                             |            | y                              |           |               | 0.329   |               | -                 |                                          |
| Chromaticity of red                         |            | x                              |           |               | 0.578   |               | -                 |                                          |
|                                             |            | y                              |           |               | 0.361   |               | -                 |                                          |
| Chromaticity of green                       |            | x                              |           |               | 0.351   |               | -                 |                                          |
|                                             |            | y                              |           |               | 0.582   |               | -                 |                                          |
| Chromaticity of blue                        |            | x                              |           |               | 0.163   |               | -                 |                                          |
|                                             |            | y                              |           |               | 0.117   |               | -                 |                                          |
| Gamut                                       |            | %                              |           | NTSC42%       | NTSC45% |               | %                 |                                          |
| Half brightness viewing angle (Left/Right)  |            | --                             |           |               | 20/20   |               | [deg]             | (3)1                                     |
| Half brightness viewing angle (Upper/Lower) |            |                                |           |               | 20/20   |               | [deg]             | (3)                                      |
| gamma                                       |            | -                              |           | 2.0           | 2.2     | 2.4           |                   |                                          |
| Surface hardness                            |            | [H]                            |           |               | 3       |               | H                 |                                          |
| White uniformity 5pt                        |            | δ <sub>w</sub>                 | θ=0 deg.  |               | -       | 125           | %                 | (2), (8) @CSOT BL                        |
| White uniformity 13pt                       |            | δ <sub>w</sub>                 | θ=0 deg.  |               | -       | 150           | %                 | (2), (8) @CSOT BL                        |

※The measurement shall be taken 5 minutes after lighting the LCM at the following rating.

※The optical characteristics shall be measured in a dark room or equivalent, and CR need to do Auto Vcom.

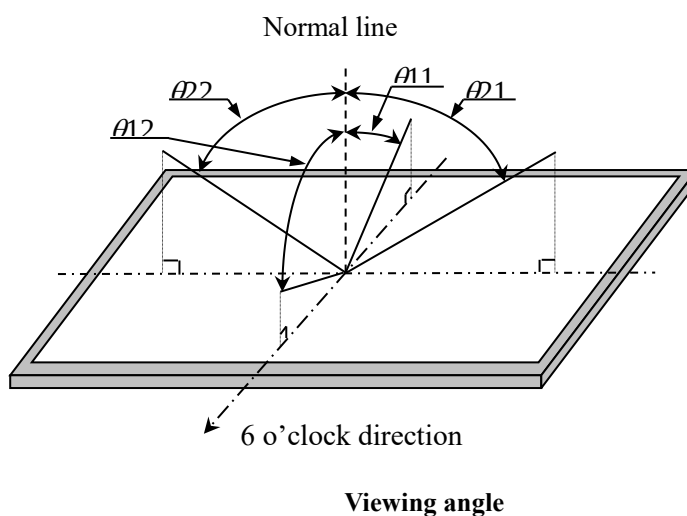
Note (1) Measurement of viewing angle range

Note (2) Measurement of luminance and Chromaticity and Contrast.



Measurement of Contrast, Luminance, Chromaticity, White variation, Crosstalk and Color temperature variation

Note (3) Definitions of viewing angle range:



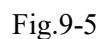
Note (4) Definition of contrast ratio:

The contrast ratio is defined as the following.

$$\text{Contrast Ratio} = \frac{\text{Luminance(Brightness) with all pixels white}}{\text{Luminance(Brightness) with all pixels Black}}$$



White uniformity of 5 points is defined as the following with 5 measurements(4,5,7,9,10).



$$\delta_{w2} = \frac{\text{Maximum Luminance of 13 Points(Brightness)}}{\text{Minimum Luminance of 13 Points(Brightness)}}$$

## 6. Reliability Test Items

| No. | Test Item                                       | Conditions                                                                                                                                    |
|-----|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Low temperature storage test                    | -30±2°C, 240 hours                                                                                                                            |
| 2   | High temperature storage test                   | 70±2°C, 240 hours                                                                                                                             |
| 3   | Low temperature operation test                  | -20±2 °C, 240 hours                                                                                                                           |
| 4   | High temperature operation test                 | 70±2°C, 240 hours                                                                                                                             |
| 5   | High temperature & high humidity operation test | 50°C±2°C/80±3%%RH, 240 hours                                                                                                                  |
| 6   | Thermal shock test                              | -20±2°C/30minutes±5%、70±2°C/30minutes±5% 100cycles                                                                                            |
| 7   | Packing Vibration                               | Temp. / Humi.: 25±5°C, 40%~70%RH;<br>Module Operation: Packaged / Non-Operation;<br>Test Type: Random 1.3Grms, 1~200Hz, 30mins / axis (X、Y、Z) |
| 8   | Packing Drop                                    | Temp. / Humi.: 25±5°C, 40%~70%RH;<br>Module Operation: Packaged / Non-Operation;<br>Test Type: Drop Height 200 mm;                            |

[Result Evaluation Criteria] Under the display quality test condition with normal operation state.

Do not change these condition as such changes may affect practical display function.

[Normal operation state] temperature : + 15°C ~ + 35°C · Humidity : 45~75% · Atmospheric pressure : 86~106kPa

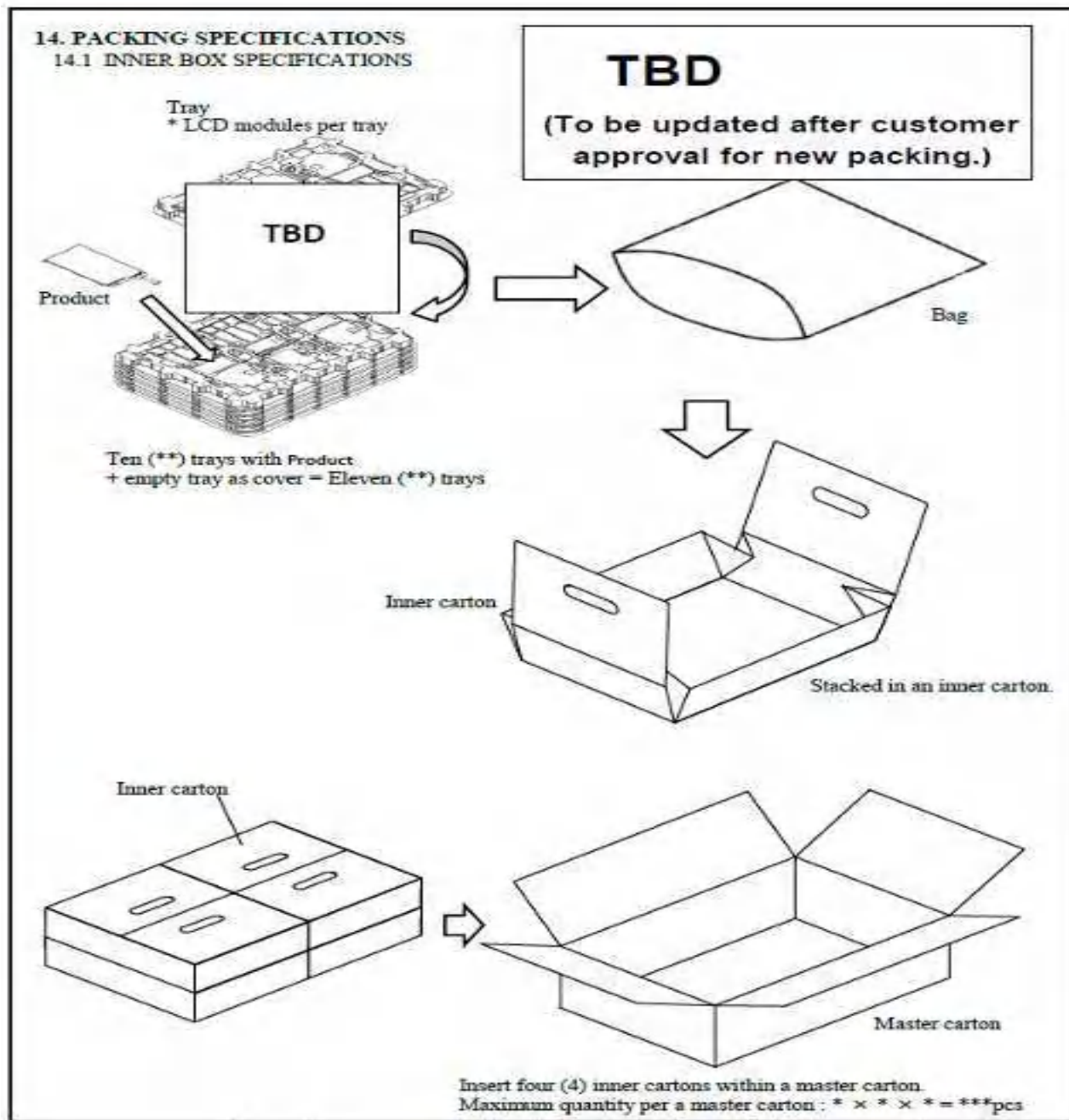
## 7. Display Quality

The display quality of the color TFT-LCD Module shall be in compliance with the Incoming Inspection Standard.



## 8. Packaging Condition

### 8.1 Carton Packing:



## 9. RoHS Directive

This LCD Module is compliant with RoHS Directive.

## 10. Handling Precautions

- a) Be sure to turn off the power supply when inserting or disconnecting the cable.  
Please insert for too much stress not to join a connector in the case of insertion of a connector.
- b) Be sure to design the cabinet so that the Module can be installed without any extra stress such as warp or twist.
- c) Since the front polarizer is easily damaged, pay attention not to scratch it.
- d) Wipe off water drop immediately. Long contact with water may cause discoloration or spots.
- e) When the panel surface is soiled, wipe it with absorbent cotton or other soft cloth.
- f) Since the panel is made of glass, it may break or crack if dropped or bumped on hard surface. Handle with care.
- g) Since CMOS LSI is used in this Module, take care of static electricity and injure the human earth when handling. Observe all other precautionary requirements in handling components.
- h) This Open-cell has its circuitry PCBs on the side and should be handled carefully in order not to be stressed.
- i) Laminate film is attached to the Module surface to prevent it from being scratched. Peel the laminate film off slowly just before the use with strict attention to electrostatic charges. Ionized air shall be blown over during the action. Blow off the 'dust' on the polarizer by using an ionized nitrogen gun, etc. Working under the following environments is desirable.
  - All workers wear conductive shoes, conductive clothes, conductive fingerstalls and grounding belts without fail.
  - Use Ionized blower for electrostatic removal, and peel of the laminate film with a constant speed. (Peeling of it at over 2 seconds)

- j) The polarizer surface on the panel is treated with Anti Glare . In case of attaching protective board over the LCD, be careful about the optical interface fringe etc. which degrades display quality.
- k) Do not expose the LCD Module to a direct sunlight, for a long period of time to protect the Module from the ultra violet ray.
- l) When handling LCD Modules and assembling them into cabinets, please be noted that long-term storage in the environment of oxidization or deoxidization gas and the use of such materials as reagent, solvent, adhesive, resin, etc. which generate these gasses, may cause corrosion and discoloration of the Modules.
- m) Liquid crystal contained in the panel may leak if the LCD is broken. Rinse it as soon as possible if it gets inside your eye or mouth by mistake.
- n) Disassembling the Module can cause permanent damage and should be strictly avoided.  
(Except for protection film of the panel.)
- o) Be careful when using it for long time with fixed pattern display as it may cause afterimage.  
(Please use a screen saver etc., in order to avoid an afterimage.)
- p) If a minute particle enters in the Module and adheres to an optical material, it may cause display non-uniformity issue, etc. Therefore, fine-pitch filters have to be installed to cooling and inhalation hole if you intend to install a fan.
- q) Epoxy resin (amine series curing agent), silicone adhesive material (dealcoholization series and oxime series), tray forming agent (azo compound) etc, in the cabinet or the packing materials may induce abnormal display with polarizer film deterioration regardless of contact or noncontact to polarizer film.  
Be sure to confirm the component of them.
- r) Do not use polychloroprene. If you use it, there is some possibility of generating  $\text{Cl}_2$  gas that influences the reliability of the connection between LCD panel and driver IC.
- s) Do not put a laminate film on LCD Module, after peeling of the original one. If you put on it, it may cause discoloration or spots because of the occurrence of air gaps between the polarizer and the film.
- t) Ground module bezel to stabilize against EMI and external noise.

## Appendix. EDID DATA STRUCTURE

| Address | Address | Field Name & Comments | Set Value | Set Value | Set Value |
|---------|---------|-----------------------|-----------|-----------|-----------|
| (DEC)   | (HEX)   |                       | (HEX)     | (BIN)     | (DEC)     |
| 0       | 0       | Header                | 00        | 00000000  | 0         |
| 1       | 1       | Header                | FF        | 11111111  | 255       |
| 2       | 2       | Header                | FF        | 11111111  | 255       |
| 3       | 3       | Header                | FF        | 11111111  | 255       |
| 4       | 4       | Header                | FF        | 11111111  | 255       |
| 5       | 5       | Header                | FF        | 11111111  | 255       |
| 6       | 6       | Header                | FF        | 11111111  | 255       |
| 7       | 7       | Header                | 00        | 00000000  | 0         |
| 8       | 8       | EISA Manuf. Code LSB  | 0E        | 00001110  | 14        |
| 9       | 9       | Compressed ASCII      | 6F        | 01101111  | 111       |
| 10      | 0A      | Product Code          | 10        | 00010000  | 16        |
| 11      | 0B      | hex, LSB first        | 15        | 00010101  | 21        |
| 12      | 0C      | 32-bit ser #          | 00        | 00000000  | 0         |
| 13      | 0D      | ID S/N – option       | 00        | 00000000  | 0         |
| 14      | 0E      | ID S/N – option       | 00        | 00000000  | 0         |
| 15      | 0F      | ID S/N – option       | 00        | 00000000  | 0         |
| 16      | 10      | Week of manufacture   | 21        | 00100001  | 33        |
| 17      | 11      | Year of manufacture   | 21        | 00100001  | 33        |
| 18      | 12      | EDID Structure Ver    | 01        | 00000001  | 1         |
| 19      | 13      | EDID revision #       | 04        | 00000100  | 4         |



|    |    |                                                           |    |          |     |
|----|----|-----------------------------------------------------------|----|----------|-----|
| 20 | 14 | Video input def.                                          | A5 | 10100101 | 165 |
| 21 | 15 | Max H image size                                          | 22 | 00100010 | 34  |
| 22 | 16 | Max V image size                                          | 13 | 00010011 | 19  |
| 23 | 17 | Display Gamma                                             | 78 | 01111000 | 120 |
| 24 | 18 | Feature support ( no DPMS, Active off, RGB, timing BLK 1) | 03 | 00000011 | 3   |
| 25 | 19 | Red/Green Low bits (RxRy/GxGy)                            | 2C | 00101100 | 44  |
| 26 | 1A | Blue/White Low bits (BxBy/WxWy)                           | C5 | 11000101 | 197 |
| 27 | 1B | Red X Rx                                                  | 94 | 10010100 | 148 |
| 28 | 1C | Red Y Ry                                                  | 5C | 01011100 | 92  |
| 29 | 1D | Green X Gx                                                | 59 | 01011001 | 89  |
| 30 | 1E | Green Y Gy                                                | 95 | 10010101 | 149 |
| 31 | 1F | Blue X Bx                                                 | 29 | 00101001 | 41  |
| 32 | 20 | Blue Y By                                                 | 1E | 00011110 | 30  |
| 33 | 21 | White X Wx                                                | 50 | 01010000 | 80  |
| 34 | 22 | White Y Wy                                                | 54 | 01010100 | 84  |
| 35 | 23 | Established timings 1                                     | 00 | 00000000 | 0   |
| 36 | 24 | Established timing 2                                      | 00 | 00000000 | 0   |
| 37 | 25 | Established timing 3                                      | 00 | 00000000 | 0   |
| 38 | 26 | Standard timing #1                                        | 01 | 00000001 | 1   |
| 39 | 27 | Standard timing #1                                        | 01 | 00000001 | 1   |
| 40 | 28 | Standard timing #2                                        | 01 | 00000001 | 1   |
| 41 | 29 | Standard timing #2                                        | 01 | 00000001 | 1   |
| 42 | 2A | Standard timing #3                                        | 01 | 00000001 | 1   |
| 43 | 2B | Standard timing #3                                        | 01 | 00000001 | 1   |
| 44 | 2C | Standard timing #4                                        | 01 | 00000001 | 1   |
| 45 | 2D | Standard timing #4                                        | 01 | 00000001 | 1   |
| 46 | 2E | Standard timing #5                                        | 01 | 00000001 | 1   |
| 47 | 2F | Standard timing #5                                        | 01 | 00000001 | 1   |



|    |    |                                                       |    |          |     |
|----|----|-------------------------------------------------------|----|----------|-----|
| 48 | 30 | Standard timing #6                                    | 01 | 00000001 | 1   |
| 49 | 31 | Standard timing #6                                    | 01 | 00000001 | 1   |
| 50 | 32 | Standard timing #7                                    | 01 | 00000001 | 1   |
| 51 | 33 | Standard timing #7                                    | 01 | 00000001 | 1   |
| 52 | 34 | Standard timing #8                                    | 01 | 00000001 | 1   |
| 53 | 35 | Standard timing #8                                    | 01 | 00000001 | 1   |
| 54 | 36 | Pixel Clock LSB                                       | C0 | 11000000 | 192 |
| 55 | 37 | Pixel Clock HSB                                       | 39 | 00111001 | 57  |
| 56 | 38 | Horizontal Active (lower 8 bits)                      | 80 | 10000000 | 128 |
| 57 | 39 | Hor blanking (lower 8 bits)                           | 18 | 00011000 | 24  |
| 58 | 3A | Horizontal Active/Horizontal blanking (upper4:4 bits) | 71 | 01110001 | 113 |
| 59 | 3B | Vertical active(lower 8 bits)                         | 38 | 00111000 | 56  |
| 60 | 3C | Vertical blanking(lower 8 bits)                       | 28 | 00101000 | 40  |
| 61 | 3D | Vertical Active : Vertical Blanking (upper4:4 bits)   | 40 | 01000000 | 64  |
| 62 | 3E | Horizontal Sync Offset                                | 30 | 00110000 | 48  |
| 63 | 3F | Horizontal Sync Pulse Width                           | 20 | 00100000 | 32  |
| 64 | 40 | Vertical Sync Offset , Sync Width                     | 36 | 00110110 | 54  |
| 65 | 41 | Horizontal Vertical Sync Offset/Width upper 2 bits    | 00 | 00000000 | 0   |
| 66 | 42 | Horizontal Image Size                                 | 58 | 01011000 | 88  |
| 67 | 43 | Vertical image Size                                   | C1 | 11000001 | 193 |
| 68 | 44 | Horizontal Image Size / Vertical image size           | 10 | 00010000 | 16  |
| 69 | 45 | Horizontal Border = (0 for Notebook LCD)              | 00 | 00000000 | 0   |
| 70 | 46 | Vertical Border = (0 for Notebook LCD)                | 00 | 00000000 | 0   |
| 71 | 47 | Signal (non-intr, norm, no stereo, sep sync, neg pol) | 1A | 00011010 | 26  |
| 72 | 48 | Pixel Clock LSB                                       | 00 | 00000000 | 0   |
| 73 | 49 | Pixel Clock HSB                                       | 00 | 00000000 | 0   |
| 74 | 4A | Horizontal Active (lower 8 bits)                      | 00 | 00000000 | 0   |
| 75 | 4B | Hor blanking (lower 8 bits)                           | FD | 11111101 | 253 |



|     |    |                                                       |    |          |     |
|-----|----|-------------------------------------------------------|----|----------|-----|
| 76  | 4C | Horizontal Active/Horizontal blanking (upper4:4 bits) | 00 | 00000000 | 0   |
| 77  | 4D | Vertical active(lower 8 bits)                         | 28 | 00101000 | 40  |
| 78  | 4E | Vertical blanking(lower 8 bits)                       | 3C | 00111100 | 60  |
| 79  | 4F | Vertical Active : Vertical Blanking (upper4:4 bits)   | 43 | 01000011 | 67  |
| 80  | 50 | Horizontal Sync Offset                                | 43 | 01000011 | 67  |
| 81  | 51 | Horizontal Sync Pulse Width                           | 0F | 00001111 | 15  |
| 82  | 52 | Vertical Sync Offset , Sync Width                     | 01 | 00000001 | 1   |
| 83  | 53 | Horizontal Vertical Sync Offset/Width upper 2 bits    | 0A | 00001010 | 10  |
| 84  | 54 | Horizontal Image Size                                 | 20 | 00100000 | 32  |
| 85  | 55 | Vertical image Size                                   | 20 | 00100000 | 32  |
| 86  | 56 | Horizontal Image Size / Vertical image size           | 20 | 00100000 | 32  |
| 87  | 57 | Horizontal Border = (0 for Notebook LCD)              | 20 | 00100000 | 32  |
| 88  | 58 | Vertical Border = (0 for Notebook LCD)                | 20 | 00100000 | 32  |
| 89  | 59 | Signal (non-intr, norm, no stero, sep sync, neg pol)  | 20 | 00100000 | 32  |
| 90  | 5A | descriptor#3                                          | 00 | 00000000 | 0   |
| 91  | 5B | Reserved for definition                               | 00 | 00000000 | 0   |
| 92  | 5C | Reserved for definition                               | 00 | 00000000 | 0   |
| 93  | 5D | ASCII String                                          | FE | 11111110 | 254 |
| 94  | 5E | Reserved for definition                               | 00 | 00000000 | 0   |
| 95  | 5F | Manufacture                                           | 43 | 01000011 | 67  |
| 96  | 60 | Manufacture                                           | 53 | 01010011 | 83  |
| 97  | 61 | Manufacture                                           | 4F | 01001111 | 79  |
| 98  | 62 | Manufacture                                           | 54 | 01010100 | 84  |
| 99  | 63 | Manufacture                                           | 20 | 00100000 | 32  |
| 100 | 64 | Manufacture                                           | 54 | 01010100 | 84  |
| 101 | 65 | Manufacture                                           | 39 | 00111001 | 57  |
| 102 | 66 | Reserved for definition                               | 0A | 00001010 | 10  |
| 103 | 67 | Reserved for definition                               | 20 | 00100000 | 32  |



|     |    |                                                           |    |          |     |
|-----|----|-----------------------------------------------------------|----|----------|-----|
| 104 | 68 | Reserved for definition                                   | 20 | 00100000 | 32  |
| 105 | 69 | Reserved for definition                                   | 20 | 00100000 | 32  |
| 106 | 6A | Reserved for definition                                   | 20 | 00100000 | 32  |
| 107 | 6B | Reserved for definition                                   | 20 | 00100000 | 32  |
| 108 | 6C | descriptor #4                                             | 00 | 00000000 | 0   |
| 109 | 6D | Reserved for definition                                   | 00 | 00000000 | 0   |
| 110 | 6E | Reserved for definition                                   | 00 | 00000000 | 0   |
| 111 | 6F | Reserved for definition                                   | FE | 11111110 | 254 |
| 112 | 70 | Reserved for definition                                   | 00 | 00000000 | 0   |
| 113 | 71 | Manufacture P/N                                           | 53 | 01010011 | 83  |
| 114 | 72 | Manufacture P/N                                           | 4E | 01001110 | 78  |
| 115 | 73 | Manufacture P/N                                           | 46 | 01000110 | 70  |
| 116 | 74 | Manufacture P/N                                           | 36 | 00110110 | 54  |
| 117 | 75 | Manufacture P/N                                           | 30 | 00110000 | 48  |
| 118 | 76 | Manufacture P/N                                           | 31 | 00110001 | 49  |
| 119 | 77 | Manufacture P/N                                           | 42 | 01000010 | 66  |
| 120 | 78 | Manufacture P/N                                           | 53 | 01010011 | 83  |
| 121 | 79 | Manufacture P/N                                           | 31 | 00110001 | 49  |
| 122 | 7A | Manufacture P/N                                           | 2D | 00101101 | 45  |
| 123 | 7B | Manufacture P/N                                           | 32 | 00110010 | 50  |
| 124 | 7C | Reserved for definition                                   | 0A | 00001010 | 10  |
| 125 | 7D | Reserved for definition                                   | 20 | 00100000 | 32  |
| 126 | 7E | Extension Flag                                            | 00 | 00000000 | 0   |
| 127 | 7F | Checksum                                                  | 79 | 01111001 | 121 |
|     |    | Default Value. This will calculated based on color values |    |          |     |



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[illegible]