INNOLUX 群創光電

# PRODUCT SPECIFICATION

**Doc. Number :**

☐ Tentative Specification
☐ Preliminary Specification
■ Approval Specification

# MODEL NO.: G156HCE
# SUFFIX: E01

**Customer:**

**APPROVED BY** **SIGNATURE**

**Name / Title**
Note

Please return 1 copy for your confirmation with your signature and comments.

| Approved By | Checked By | Prepared By |
|---|---|---|
| 陳立錚 | 林秋森 | 阮志昌 |

# CONTENTS

# REVISION HISTORY

| Version | Date | Page | Description |
|---|---|---|---|
| 2.0 | 2019.05.17 | ALL | Spec Ver.2.0 was first issued. |
| 2.1 | 2020.04.24 | 20 | Color Chromaticity White (Wx/ Wy)：from (0.313/0.329)±0.05 to (0.305/0.340) ±0.03 . |
| | 2020.04.24 | 30 | Modify 2D drawing |
| 2.2 | 2020.08.20 | 20 | Contrast Ratio min from 500:1 to 700:1. |
| | | 24 | High Temperature & High Humidity Operation Test from 60ºC, 90%RH to 50ºC, 80%RH. |
| 2.3 | 2021.03.5 | 5 | Power Consumption: Total from 10.38 W to 11.1W (Max.) |
| 2.4 | 2022.08.06 | 16 | Add Frame rate spec max to 70Hz . |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# 1. GENERAL DESCRIPTION

## 1.1 OVERVIEW

G156HCE-E01 is a 15.6” (15.6” diagonal) TFT Liquid Crystal Display IAV module with LED Backlight unit and 40 pins eDP interface. This module supports 1920 x 1080 FHD AAS mode and can display 16.7M colors

## 1.2 GENERAL SPECIFICATI0NS

| Item | Specification | Unit | Note |
|---|---|---|---|
| Screen Size | 15.6 diagonal | | |
| Driver Element | a-si TFT active matrix | - | - |
| Pixel Number | 1920 x R.G.B. x 1080 | pixel | - |
| Pixel Pitch | 0.17925 (H) x 0.17925 (V) | mm | - |
| Pixel Arrangement | RGB vertical stripe | - | - |
| Display Colors | 16.7M | color | - |
| Transmissive Mode | Normally Black | - | - |
| Surface Treatment | Hard coating (3H), Anti-Glare | - | - |
| Luminance, White | 450 | Cd/m2 | |
| Color Gamut | 72% | NTSC | |
| Power Consumption | Total 11.1 W (Max.)<br>@ cell 1.5W (Max.), (BL 9.6 W (Max.) | | (1) |

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

# 2. MECHANICAL SPECIFICATIONS

| Item | | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Module Size | Horizontal (H) | 351.54 | 351.84 | 352.14 | mm | (1)(2) |
| | Vertical (V) | 208.58 | 208.88 | 209.18 | mm | |
| | Thickness (T) | - | - | 6.5 | mm | |
| Active Area | Horizontal | - | 344.16 | - | mm | |
| | Vertical | - | 193.59 | - | mm | |
| Weight | | - | 550 | | g | |

Note (1) Please refer to the attached drawings for more information of front and back outline dimensions.

Note (2) Dimensions are measured by caliper.

## 2.1 CONNECTOR TYPE

Please refer appendix outline drawing for detail design.

Connector 1 Part No.: IPEX 20455-040E-76 User’s connector Part No: IPEX 20453-040T-03

Connector 2 Part No.: ACES 50620-00501-001

## 3. ABSOLUTE MAXIMUM RATINGS

### 3.1 ABSOLUTE RATINGS OF ENVIRONMENT

| Item | Symbol | Value | | Unit | Note |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| Storage Temperature | TST | -20 | +70 | ºC | (1)(2) |
| Operating Ambient Temperature | TOP | 0 | +60 | ºC | (1)(2) |

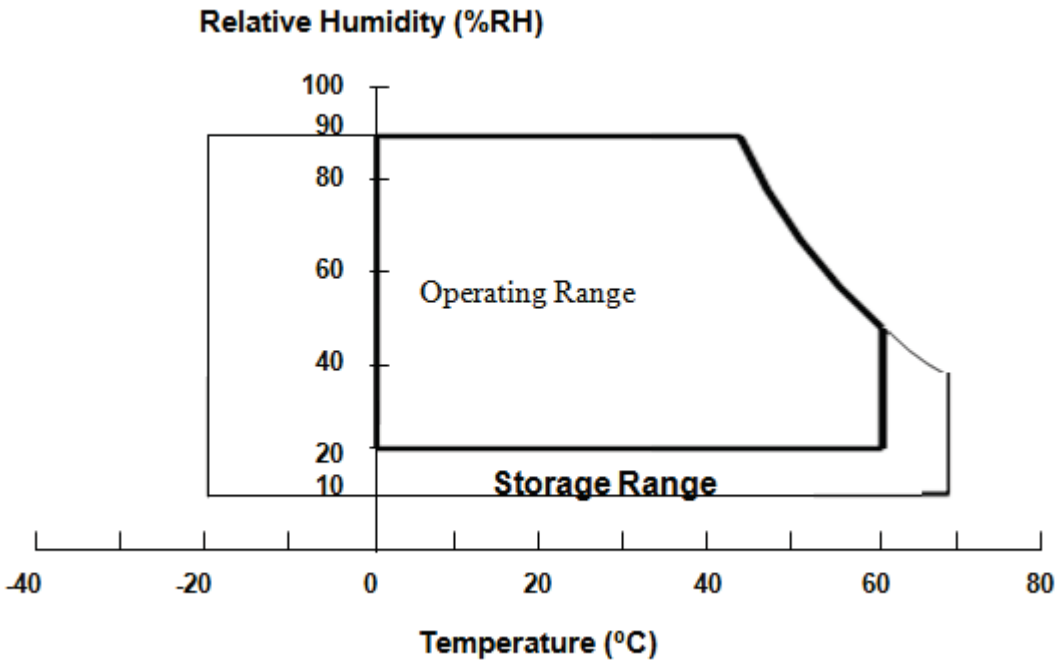
Note (1) Temperature and relative humidity range is shown in the figure below.

(a) 90 %RH Max. (Ta ≦ 40 ºC).

(b) Wet-bulb temperature should be 39 ºC Max. (Ta > 40 ºC).

(c) No condensation.

Note(2) The absolute maximum rating values of this product are not allowed to be exceeded at any times.The module should not be used over the absolute maximum rating value. It will causepermanently unrecoverable function fail in such an condition




### 3.2 ELECTRICAL ABSOLUTE RATINGS

#### 3.2.1 TFT LCD MODULE

| Item | Symbol | Value | | Unit | Note |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| Power Supply Voltage | Vcc | -0.3 | 4.0 | V | (1) |
| Logic Input Voltage | $V_{IN}$ | -0.3 | 4.0 | V | |

### 3.2.2 BACKLIGHT CONVERTER

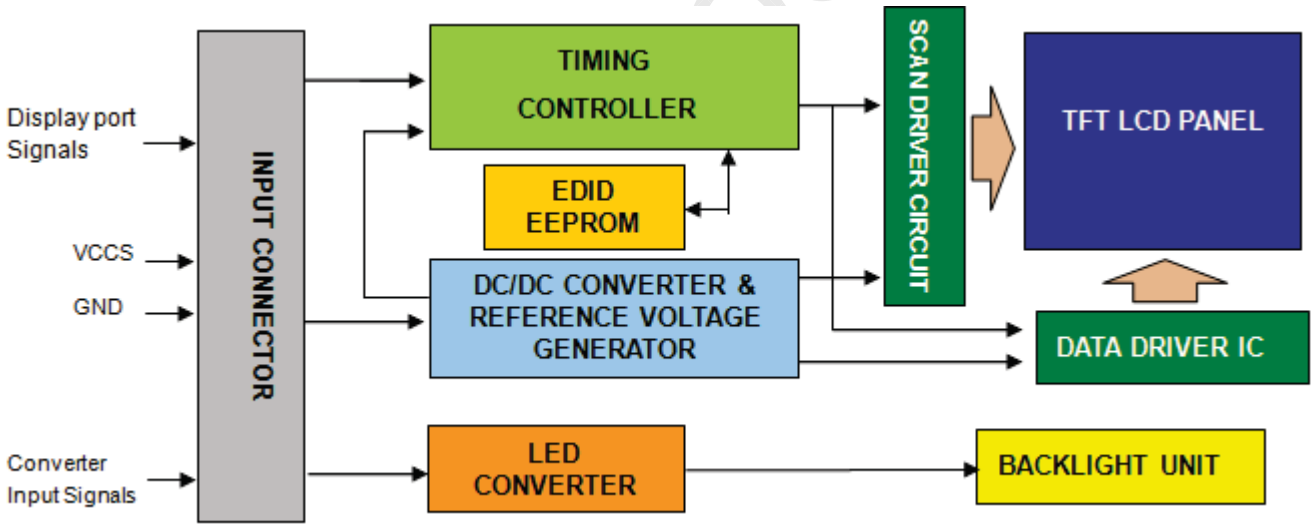
| Item | Symbol | Value | | | Unit | Note |
|---|---|---|---|---|---|---|
| | | Min. | Typ | Max. | | |
| Converter Voltage | LED_$V_{in}$ | 0 | 12.0 | 18.0 | V | (1), (2) Duty=100% |
| Enable Voltage | LED_EN | 0 | 3.3 | 5.5 | V | |
| Backlight Adjust | LED_PWM | 0 | 3.3 | 5.5 | V | (1), (2) Pulse Width≦10msec. and Duty≦10% |

Note (1) Permanent damage to the device may occur if maximum values are exceeded. Function operation should be restricted to the conditions described under Normal Operating Conditions.

Note (2) Specified values are for input pin of LED light bar at Ta=25±2 ℃ (Refer to 4.3.3 and 4.3.4 for further information)

## 4. ELECTRICAL SPECIFICATIONS

### 4.1 FUNCTION BLOCK DIAGRAM



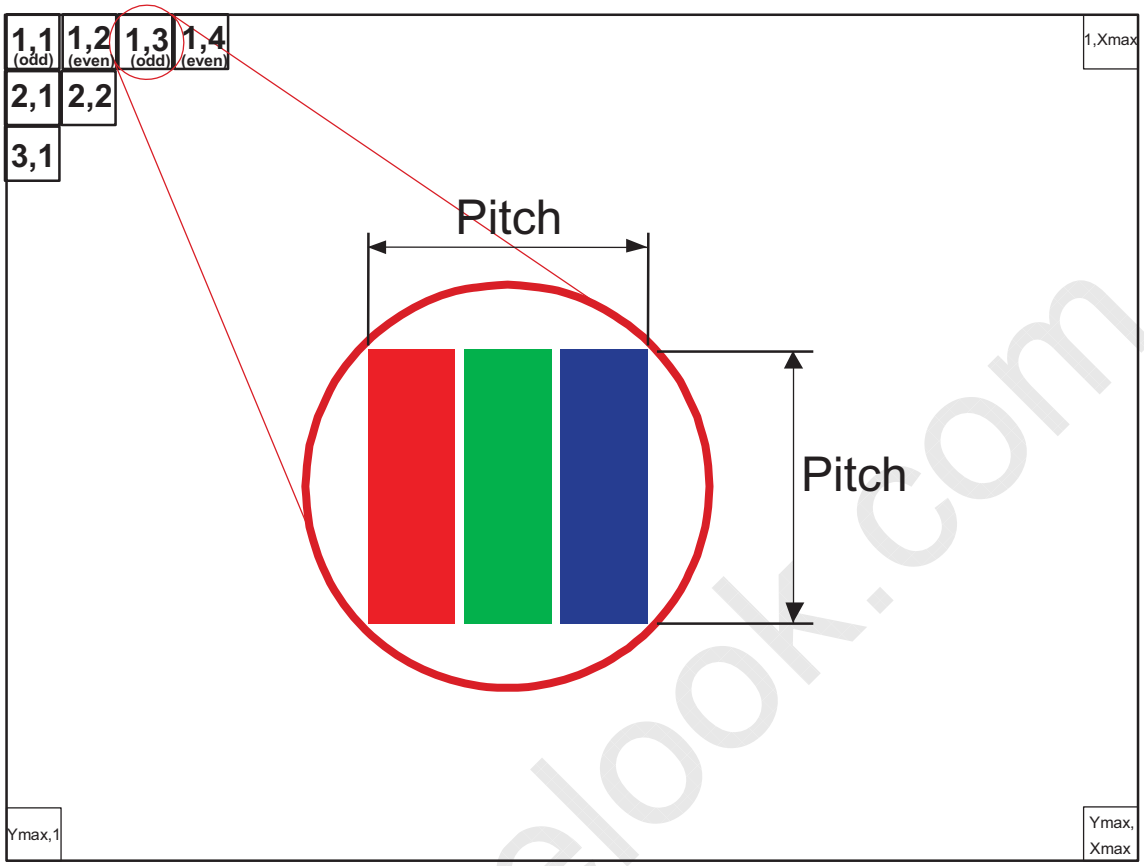

### 4.2. INTERFACE CONNECTIONS

PIN ASSIGNMENT

| Pin | Symbol | Description | Remark |
|---|---|---|---|
| 1 | NC | No Connection (Reserved for LCD test) | |
| 2 | NC | No Connection (Reserved for LCD test) | |
| 3 | NC | No Connection (Reserved for LCD test) | |
| 4 | NC | No Connection (Reserved for LCD test) | |
| 5 | NC | No Connection (Reserved for LCD test) | |
| 6 | VDD | USB power | |
| 7 | VDD | USB power | |
| 8 | VSS | USB GND | |

| | | | |
|---|---|---|---|
| 9 | D+ | USB D+ | |
| 10 | D- | USB D+ | |
| 11 | NC | No Connection (Reserved for LCD test) | |
| 12 | LED_VCCS | BL Power | |
| 13 | LED_VCCS | BL Power | |
| 14 | LED_VCCS | BL Power | |
| 15 | LED_VCCS | BL Power | |
| 16 | NC | No Connection (Reserved for LCD test) | |
| 17 | NC | No Connection (Reserved for LCD test) | |
| 18 | LED_PWM | PWM Dimming Control Signal of LED Converter | |
| 19 | LED_EN | BL_Enable Signal of LED Converter | |
| 20 | BL_GND | BL Ground | |
| 21 | BL_GND | BL Ground | |
| 22 | BL_GND | BL Ground | |
| 23 | BL_GND | BL Ground | |
| 24 | HPD | Hot Plug Detect | |
| 25 | GND | Ground | |
| 26 | GND | Ground | |
| 27 | NC | No Connection (Reserved for LCD test) | |
| 28 | VCCS | Power Supply +3.3 V (typical) | |
| 29 | VCCS | Power Supply +3.3 V (typical) | |
| 30 | GND | Ground | |
| 31 | AUX- | Complement Signal-Auxiliary Channel | |
| 32 | AUX+ | True Signal-Auxiliary Channel | |
| 33 | GND | Ground | |
| 34 | ML0+ | True Signal-Main Lane 0 | |
| 35 | ML0- | Complement Signal-Lane 0 | |
| 36 | GND | Ground | |
| 37 | ML1+ | True Signal-Main Lane 1 | |
| 38 | ML1- | Complement Signal-Lane 1 | |
| 39 | GND | Ground | |
| 40 | NC | No Connection (Reserved for LCD test) | |

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




## 4.3 ELECTRICAL CHARACTERISTICS

### 4.3.1 LCD ELETRONICS SPECIFICATION

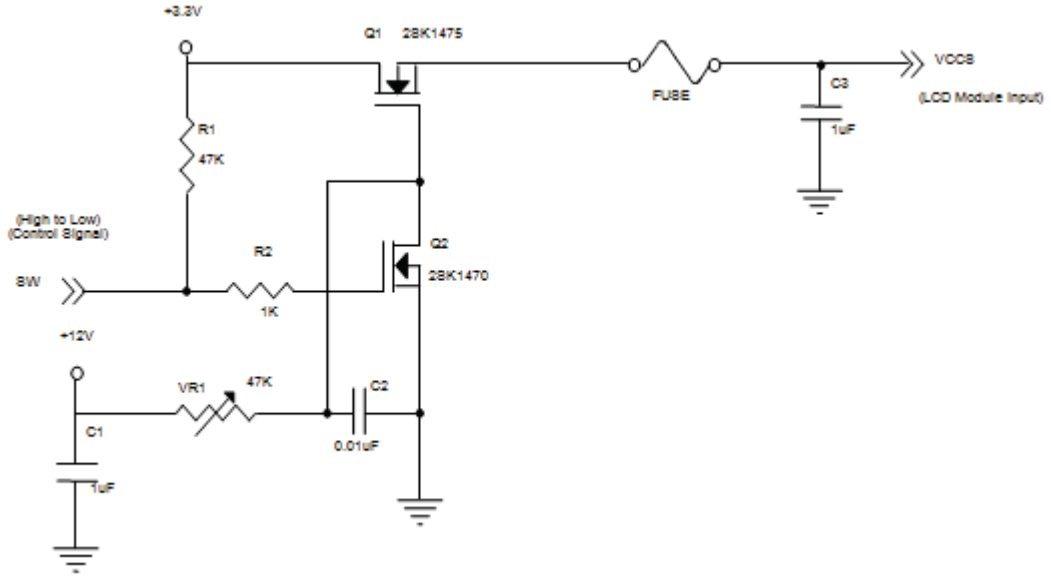
| Parameter | | Symbol | Value | | | Unit | Note |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | | |
| Power Supply Voltage | | VCCS | 3.0 | 3.3 | 3.6 | V | (1) |
| Ripple Voltage | | $V_{RP}$ | - | 50 | - | mV | (1) |
| Inrush Current | | $I_{RUSH}$ | - | - | 1.5 | A | (1),(2) |
| Peak Current | | $I_{Peak}$ | | | 1.5 | A | (1),(2) |
| Power Supply Current | Mosaic | | | 198 | 237 | mA | (3)a |
| | Black | | | 176 | 211 | mA | (3) |
| HPD | High Level | | 2.25 | - | 2.75 | V | (5) |
| | Low Level | | 0 | - | 0.4 | V | (5) |
| HPD Impedance | | $R_{HPD}$ | 30K | | | ohm | (4) |

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

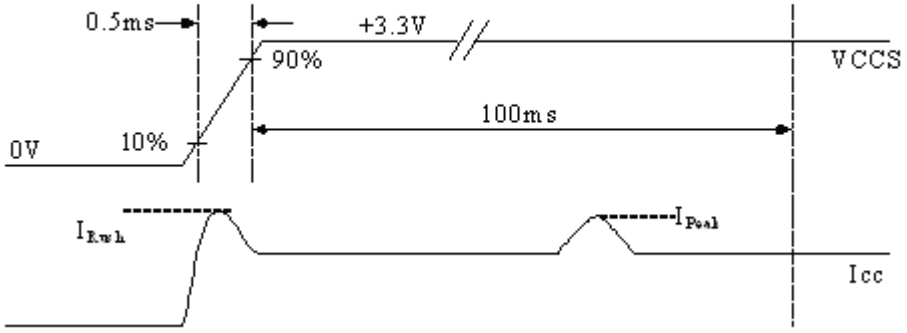
Note (2) $I_{RUSH}$: the maximum current when VCCS is rising

$I_{Peak}$: the maximum current of the first 100ms after power-on

Measurement Conditions: Shown as the following figure. Test pattern: black.

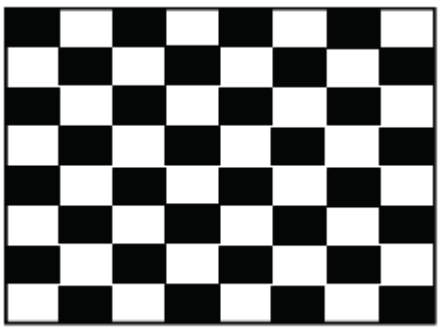



**VCCS rising time is 0.5ms**




Note (3) The specified power supply current is under the conditions at VCCS = 3.3 V, Ta = 25 ± 2 ºC, DC Current and $f_v$ = 60 Hz, whereas a power dissipation check pattern below is displayed.

a. Mosaic Pattern



Active Area

Note (4) The specified signals have equivalent impedances pull down to ground in the LCD module respectively. Customers should keep the input signal level requirement with the load of LCD module. Please refer to Note (4) of 4.3.2 LED CONVERTER SPECIFICATION to obtain more information.

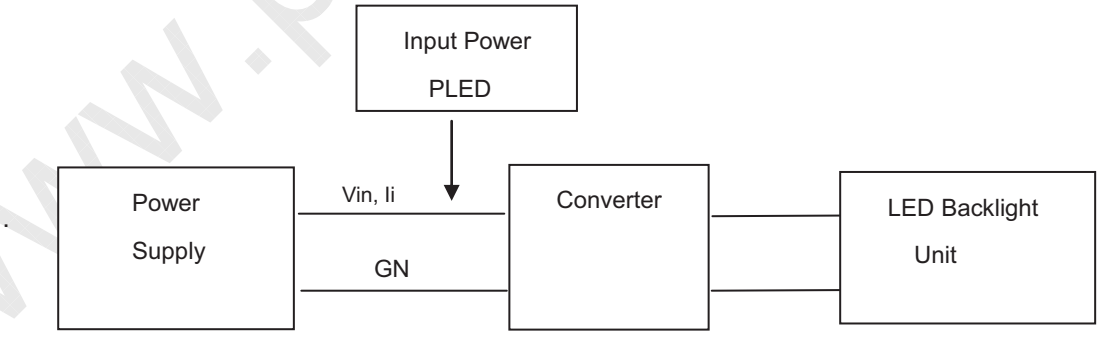
Note (5) When a source detects a low-going HPD pulse, it must be regarded as a HPD event. Thus, the source must read the link / sink status field or receiver capability field of the DPCD and take corrective action.

### 4.3.2 LED CONVERTER SPECIFICATION

| Parameter | | Symbol | Value | | | Unit | Note |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | | |
| Converter Power Supply Voltage | | LED_Vin | 10.8 | 12.0 | 13.2 | V | |
| Converter Power Supply Current | | Ii | 0.6 | 0.8 | 1.0 | A | @LED_Vin= 12V Duty=100% |
| Converter Input Rush Current | | Iirsh | | | 2 | A | @LED_Vin rising = 1mS |
| Power Consumption | | $P_{LED}$ | | | 9.6 | W | @ LED_Vin = 12V Duty=100% |
| EN Control Level | Backlight on | LED_EN | 2.0 | 3.3 | 5.5 | V | |
| | Backlight off | | 0 | 0 | 0.15 | | |
| PWM Control Level | PWM High Level | LED_PWM | 2.0 | 3.3 | 5.5 | V | |
| | PWM Low Level | | 0 | 0 | 0.15 | | |
| PWM Control Duty Ratio | | | 10 | -- | 100 | % | |
| PWM Control Frequency | | $f_{PWM}$ | 190 | 200 | 20k | Hz | |
| LED Life Time | | $L_L$ | 50,000 | | | Hrs | (2) |

Note (1) LED light bar input voltage and current are measured by utilizing a true RMS multimeter as shown below:

Note (2) The lifetime of LED is estimated data and defined as the time when it continues to operate under the conditions at Ta = 25±2℃ and Duty 100% until the brightness becomes ≦ 50% of its original value. Operating LED under high temperature environment will reduce life time and lead to color shift..



### 4.3.3 BACKLIGHT UNIT

Ta = 25 ± 2 ºC

| Parameter | Symbol | Value | | | Unit | Note |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| LED Light Bar Power Supply Voltage | VL | 23.8 | 28.4 | 19.7 | V | (1)(2)(Duty100%) |
| LED Light Bar Power Supply Current | IL | -- | 47 | -- | mA | |
| Power Consumption | PL | | | 8.63 | W | (3) |
| LED Life Time | LBL | 50000 | - | - | Hrs | (4) |

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

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) $P_L = I_L \times V_L$ (Without LED converter transfer efficiency)

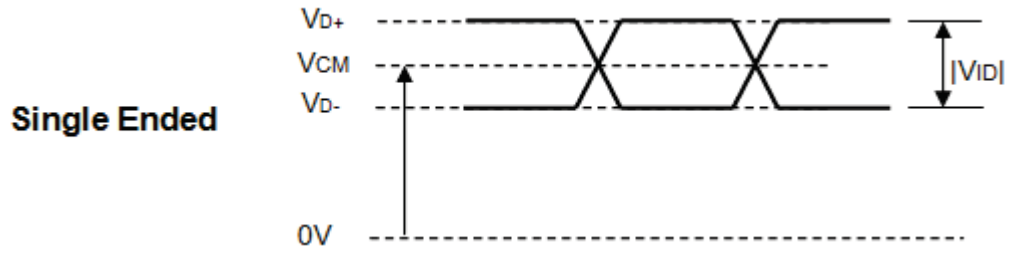
Note (4) The lifetime of LED is defined as the time when it continues to operate under the conditions at Ta = 25 ±2 °C and $I_L$ = 20.5 mA (Per EA) until the brightness becomes ≦ 50% of its original value.

## 4.4 DISPLAY PORT INPUT SIGNAL TIMING SPECIFICATIONS

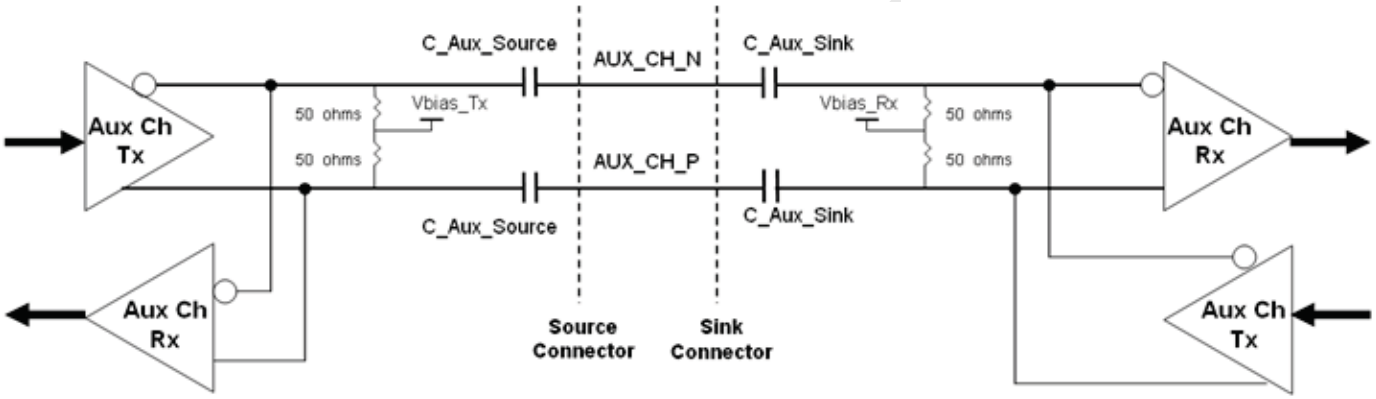
### 4.4.1 ELECTRICAL SPECIFICATIONS

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Notes |
|---|---|---|---|---|---|---|
| Differential Signal Common Mode Voltage(MainLink and AUX) | VCM | 0 | | 2 | V | (1)(4) |
| AUX AC Coupling Capacitor | C_Aux_Source | 75 | | 200 | nF | (2) |
| Main Link AC Coupling Capacitor | C_ML_Source | 75 | | 200 | nF | (3) |
| DPCD Version (Address 00000h) | - | 0x11h | | | - | (5) |

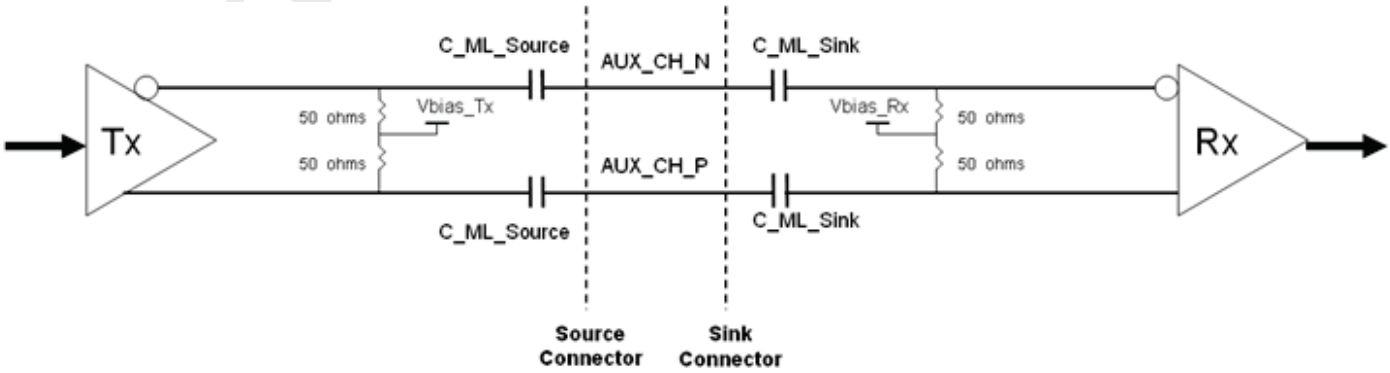
Note (1)Display port interface related AC coupled signals should follow VESA DisplayPort Standard Version1. Revision 1a and VESA Embedded DisplayPortTM Standard Version 1.2. There are many optional items described in eDP1.2. If some optional item is requested, please contact us.




Note (2) Recommended eDP AUX Channel topology is as below and the AUX AC Coupling Capacitor (C_Aux_Source) should be placed on the source device.




Note (3) Recommended Main Link Channel topology is as below and the Main Link AC Coupling Capacitor (C_ML_Source) should be placed on the source device.




Note(4) The source device should pass the test criteria described in DisplayPortCompliance Test Specification (CTS) 1.1

### 4.4.2 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 | 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 | 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 | 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 |

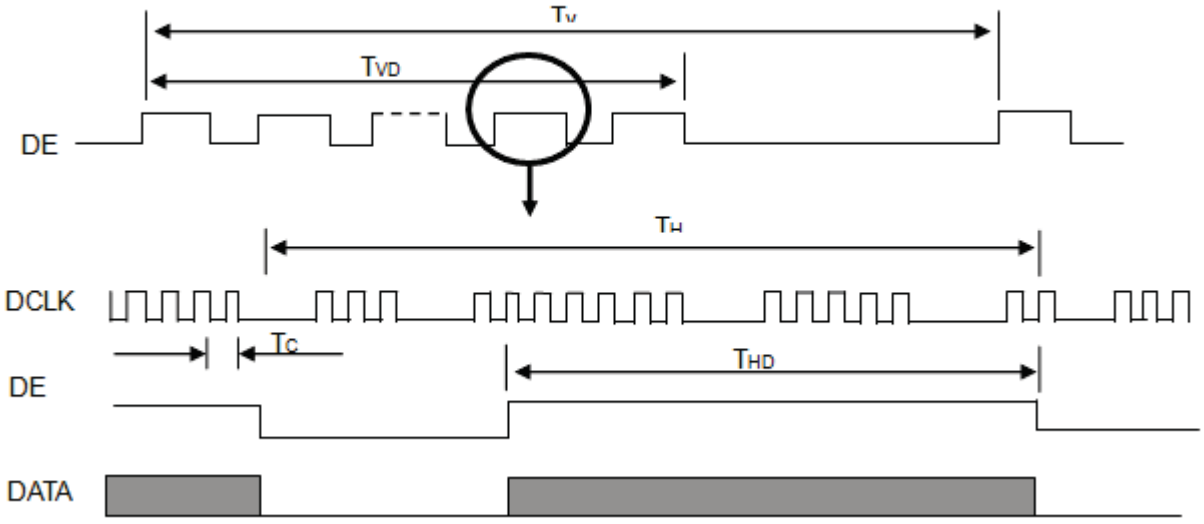
Note (1) 0: Low Level Voltage, 1: High Level Voltage

## 4.5 DISPLAY TIMING SPECIFICATIONS

The input signal timing specifications are shown as the following table and timing diagram.

| Signal | Item | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|---|
| DCLK | Frequency | 1/Tc | 148.9 | 152.82 | 175 | MHz | - |
| DE | Frame rate | Fr | 60 | 60 | 70 | Hz | |
| | Vertical Total Time | TV | 1128 | 1132 | 1136 | TH | - |
| | Vertical Active Display Period | TVD | 1080 | 1080 | 1080 | TH | - |
| | Vertical Active Blanking Period | TVB | 48 | 52 | 56 | TH | - |
| | Horizontal Total Time | TH | 2200 | 2250 | 2260 | Tc | - |
| | Horizontal Active Display Period | THD | 1920 | 1920 | 1920 | Tc | - |
| | Horizontal Active Blanking Period | THB | 280 | 330 | 340 | Tc | - |

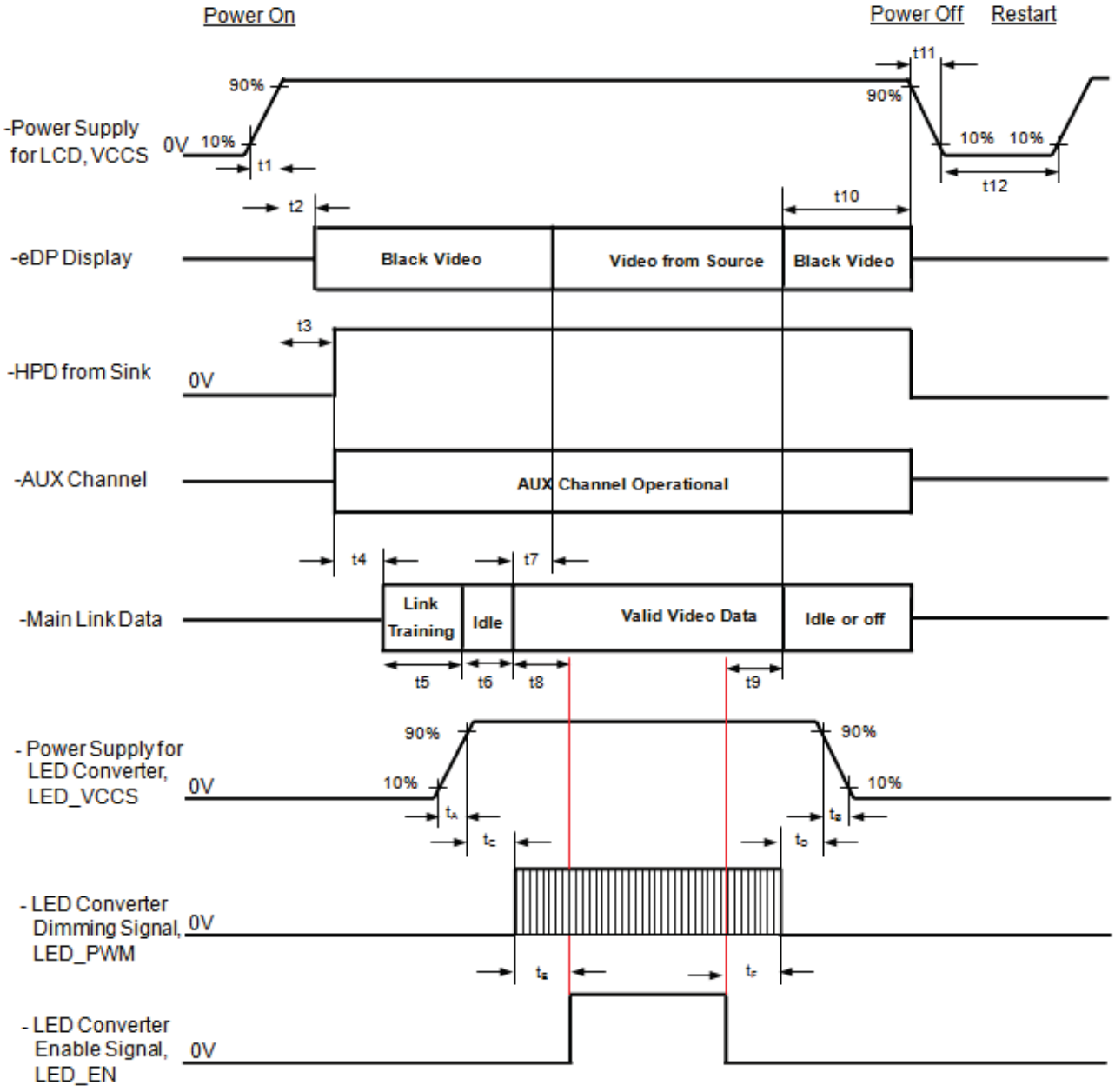
**INPUT SIGNAL TIMING DIAGRAM**




Note(2) The Input Signal must operate at eDP 2 lane.

Note(3) The TV(=TVD+TVB) must be integer, otherwise, this module would operate abnormally

## 4.6 POWER ON/OFF SEQUENCE



Timing Specifications

| Parameter | Description | Reqd. By | Value | | Unit | Notes |
|---|---|---|---|---|---|---|
| | | | Min | Max | | |
| t1 | Power rail rise time, 10% to 90% | Source | 0.5 | 10 | ms | - |
| t2 | Delay from LCD,VCCS to black video generation | Sink | 0 | 200 | ms | Automatic Black Video generation prevents display noise until valid video data is received from the Source (see Notes:2 and 3 below) |
| t3 | Delay from LCD,VCCS to HPD high | Sink | 0 | 200 | ms | Sink AUX Channel must be operational upon HPD high (see Note:4 below ) |
| t4 | Delay from HPD high to link training initialization | Source | 0 | - | ms | Allows for Source to read Link capability and initialize |
| t5 | Link training duration | Source | 0 | - | ms | Dependant on Source link training protocol |
| t6 | Link idle | Source | 0 | - | ms | Min Accounts for required BS-Idle pattern. Max allows for Source frame synchronization |
| t7 | Delay from valid video data from Source to video on display | Sink | 0 | 50 | ms | Max value allows for Sink to validate video data and timing. At the end of T7, Sink will indicate the detection of valid video data by setting the SINK_STATUS bit to logic 1 (DPCD 00205h, bit 0), and Sink will no longer generate automatic Black Video |
| t8 | Delay from valid video data from Source to backlight on | Source | 80 | - | ms | Source must assure display video is stable<br>*: Recommended by INX. To avoid garbage image. |
| t9 | Delay from backlight off to end of valid video data | Source | 50 | - | ms | Source must assure backlight is no longer illuminated. At the end of T9, Sink will indicate the detection of no valid video data by setting the SINK_STATUS bit to logic 0 (DPCD 00205h, bit 0), and Sink will automatically display Black Video. (See Notes: 2 and 3 below)<br>*: Recommended by INX. To avoid garbage image. |
| t10 | Delay from end of valid video data from Source to power off | Source | 0 | 500 | ms | Black video will be displayed after receiving idle or off signals from Source |
| t11 | VCCS power rail fall time, 90% to 10% | Source | 0.5 | 10 | ms | - |
| t12 | VCCS Power off time | Source | 500 | - | ms | - |
| tA | LED power rail rise time, 10% to 90% | Source | 0.5 | 10 | ms | - |
| tB | LED power rail fall time, 90% to 10% | Source | 0 | 10 | ms | - |
| tC | Delay from LED power rising to LED dimming signal | Source | 1 | - | ms | - |
| tD | Delay from LED dimming signal to LED power falling | Source | 1 | - | ms | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| tE | Delay from LED dimming signal to LED enable signal | Source | 0 | - | ms | - |
| tF | Delay from LED enable signal to LED dimming signal | Source | 0 | - | ms | - |

Note (1) Please don't plug or unplug the interface cable when system is turned on.

Note (2) The Sink must include the ability to automatically generate Black Video autonomously. The Sink must automatically enable Black Video under the following conditions:

- Upon LCDVCC power-on (within T2 max)
- When the "NoVideoStream_Flag" (VB-ID Bit 3) is received from the Source (at the end of T9)

Note (3) The Sink may implement the ability to disable the automatic Black Video function, as described in Note (2), above, for system development and debugging purposes.

Note (4) The Sink must support AUX Channel polling by the Source immediately following LCDVCC power-on without causing damage to the Sink device (the Source can re-try if the Sink is not ready). The Sink must be able to response to an AUX Channel transaction with the time specified within T3 max.

# 5. OPTICAL CHARACTERISTICS

## 5.1 TEST CONDITIONS

| Item | Symbol | Value | Unit |
|---|---|---|---|
| Ambient Temperature | Ta | 25±2 | ℃ |
| Ambient Humidity | Ha | 50±10 | %RH |
| Supply Voltage | According to typical value in "ELECTRICAL CHARACTERISTICS" | | |
| Input Signal | | | |
| LED Light Bar Input Current Per Input Pin | | | |

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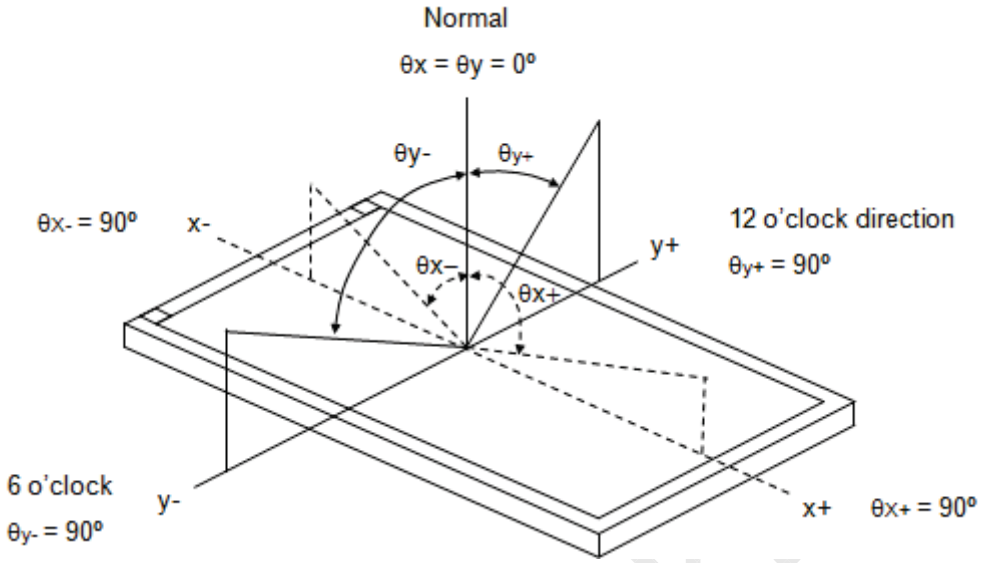
## 5.2 OPTICAL SPECIFICATIONS

The relative measurement methods of optical characteristics are shown in 5.2 and all items are measured at the center point of screen except white variation. The following items should be measured under the test conditions described in 5.1 and stable environment shown in Note (5).

| Item | | Symbol | Condition | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|---|---|
| Color Chromaticity (CIE 1931) | Red | Rx | $\theta_x$=0°, $\theta_Y$ =0° CS-2000 R=G=B=255 Gray scale | Typ – 0.03 | 0.648 | Typ + 0.03 | - | (1), (5) |
| | | Ry | | | 0.338 | | | |
| | Green | Gx | | | 0.313 | | | |
| | | Gy | | | 0.600 | | | |
| | Blue | Bx | | | 0.153 | | | |
| | | By | | | 0.050 | | | |
| | White | Wx | | | 0.305 | | | |
| | | Wy | | | 0.340 | | | |
| Color gamut | | C.G | | 68 | 72 | - | % | (7) |
| Center Luminance of White | | $L_C$ | | 360 | 450 | - | cd/m$^2$ | (4), (5) |
| Contrast Ratio | | CR | | 700 | 1000 | - | - | (2), (5) |
| Response Time | | $T_R$ | $\theta_x$=0°, $\theta_Y$ =0° | - | 14 | 19 | ms | (3) |
| | | $T_F$ | | - | 11 | 16 | | |
| White Variation | | W | $\theta_x$=0°, $\theta_Y$ =0° | 70 | - | - | % | (5), (6) |
| Viewing Angle | Horizontal | $\theta_x$+ | CR ≧ 10 | 80 | 89 | - | Deg. | (1), (5) |
| | | $\theta_x$- | | 80 | 89 | - | | |
| | Vertical | $\theta_Y$+ | | 80 | 89 | - | | |
| | | $\theta_Y$- | | 80 | 89 | - | | |

Note (1) Definition of Viewing Angle (θx, θy):




Note (2) Definition of Contrast Ratio (CR):

The contrast ratio can be calculated by the following expression.

Contrast Ratio (CR) = L63 / L0

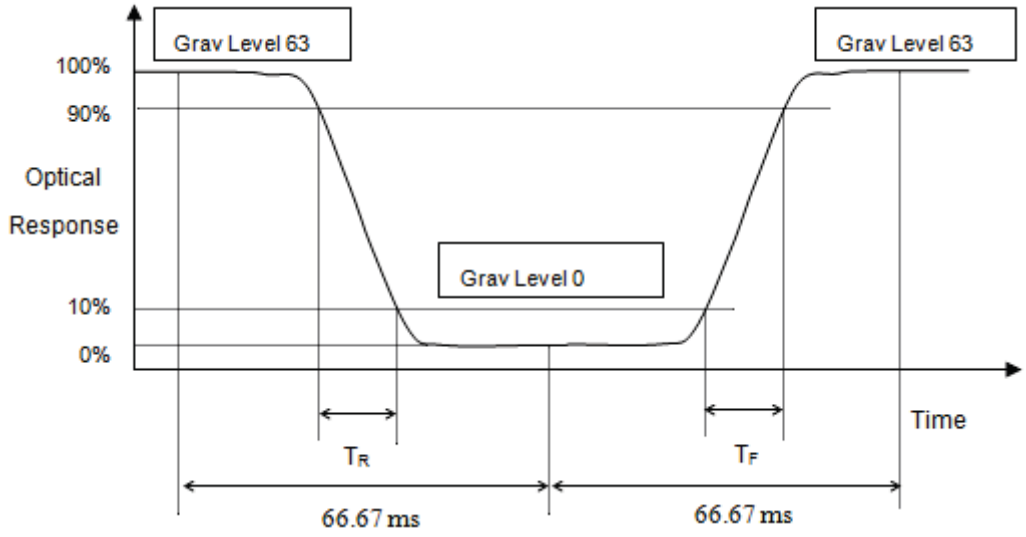
L63: Luminance of gray level 63

L 0: Luminance of gray level 0

CR = CR (1)

CR (X) is corresponding to the Contrast Ratio of the point X at Figure in Note (6).

Note (3) Definition of Response Time ($T_R$, $T_F$):




Note (4) Definition of Average Luminance of White ($L_{AVE}$):

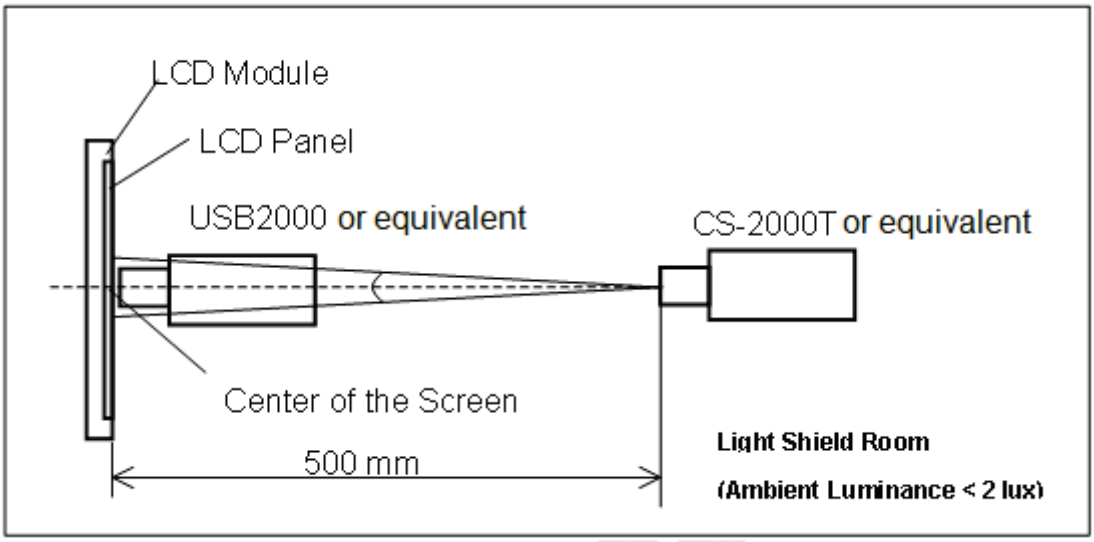
Measure the luminance of gray level 63 at 5 points

$L_{AVE}$ = [L (1)+ L (2)+ L (3)+ L (4)+ L (5)] / 5

L (x) is corresponding to the luminance of the point X at Figure in Note (6)

Note (5) Measurement Setup:

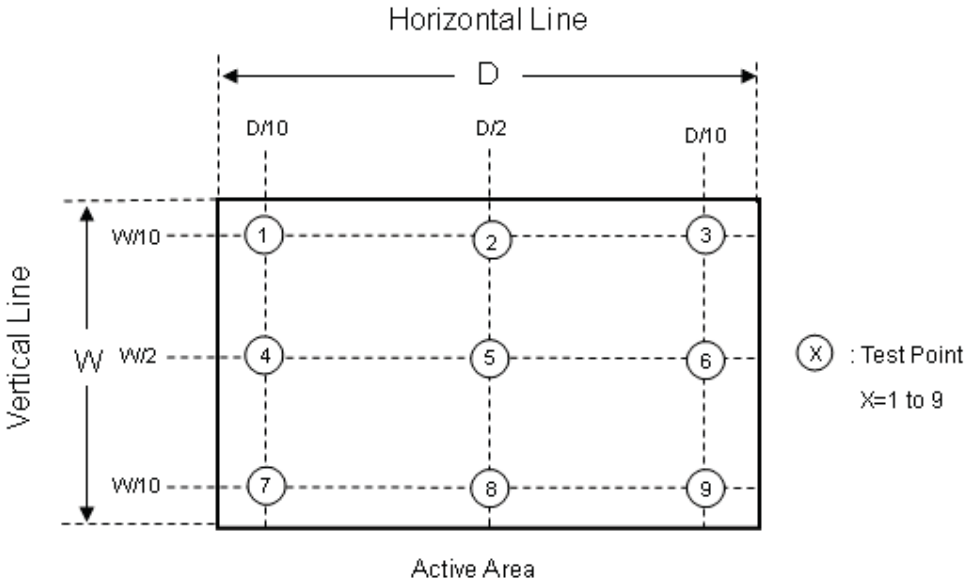
The LCD module should be stabilized at given temperature for 30 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting Backlight for 30 minutes in a windless room.




Note (6)Definition of White Variation (δW):

Measure the luminance of gray level 63 at 9 points

δW = ( Minimum [L (1) ~ L (9)] / Maximum [L (1) ~ L (9)] ) *100%



Note (7) Definition of color gamut (C.G%):

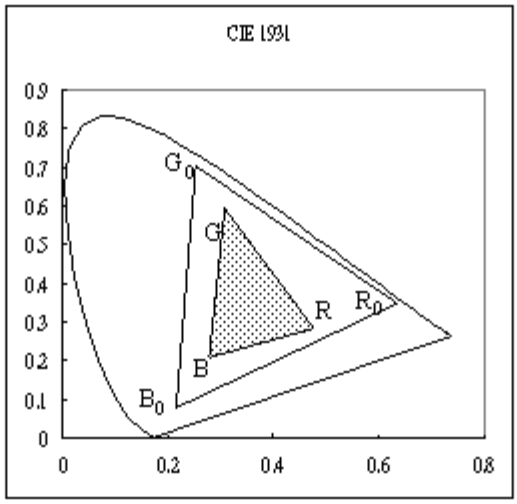
C.G%= R G B / $R_0$ $G_0$ $B_0$,*100%

$R_0$, $G_0$, $B_0$ : color coordinates of red, green, and blue defined by NTSC, respectively.

R, G, B : color coordinates of module on 63 gray levels of red, green, and blue, respectively.

$R_0$ $G_0$ $B_0$ : area of triangle defined by $R_0$, $G_0$, $B_0$

**R G B: area of triangle**




**defined by R, G, B**

## 6. RELIABILITY TEST ITEM

| Test Item | Test Condition | Note |
|---|---|---|
| High Temperature Storage Test | 70ºC, 240 hours | (1)(2) (4)(5) |
| Low Temperature Storage Test | -20ºC, 240 hours | |
| Thermal Shock Storage Test | -20ºC, 0.5hour←70℃, 0.5hour; 1hour/cycle,100cycles | |
| High Temperature Operation Test | 60ºC, 240 hours | |
| Low Temperature Operation Test | 0ºC, 240 hours | |
| High Temperature & High Humidity Operation Test | 50ºC, 80%RH, 240hours | (1)(2) (4)(6) |
| Shock (Non-Operating) | 50G, 11ms, half sine wave, 1 time for ± X, ± Y, ± Z. | (2)(3) |
| Vibration (Non-Operating) | 1.5G, 10 ~ 300 Hz, 10min/cycle, 3 cycles each X, Y, Z | (2)(3) |

Note (1) There should be no condensation on the surface of panel during test.

Note (2) Temperature of panel display surface area should be 98 ºC Max.

Note (3) At testing Vibration and Shock, the fixture in holding the module has to be hard and rigid enough so that the module would not be twisted or bent by the fixture.

Note (4) In the standard conditions, there is no function failure issue occurred. All the cosmetic specification is judged before reliability test.

Note (5) Before cosmetic and function test, the product must have enough recovery time, at least 2 hours at room temperature.

Note (6) Before cosmetic and function test, the product must have enough recovery time, at least 24 hours at room temperature.

# 7. PACKING

## 7.1 PACKING SPECIFICATIONS

(1) 18 pcs LCD modules / 1 Box

(2) Box dimensions: 490 (L) X 350 (W) X 320 (H) mm

(3) Weight: approximately 16.3Kg (18 modules per box)

## 7.2 PACKING METHOD

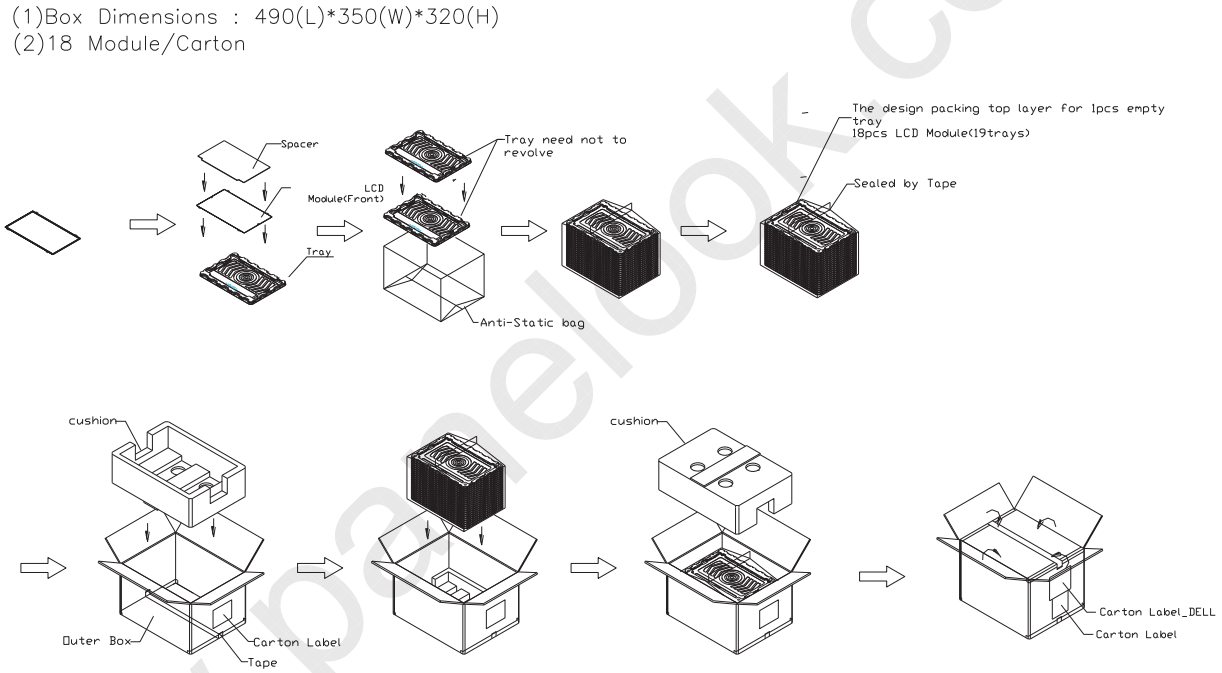



Figure. 7-2 Packing method

## 7.3 PALLET

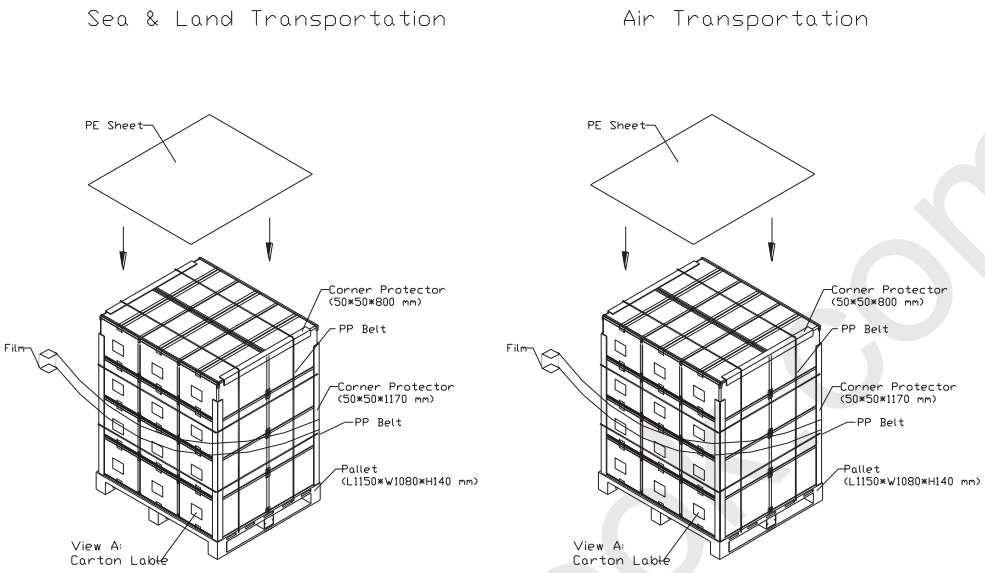



Figure. 7-3 Packing method

## 7.4 UN-PACK METHOD

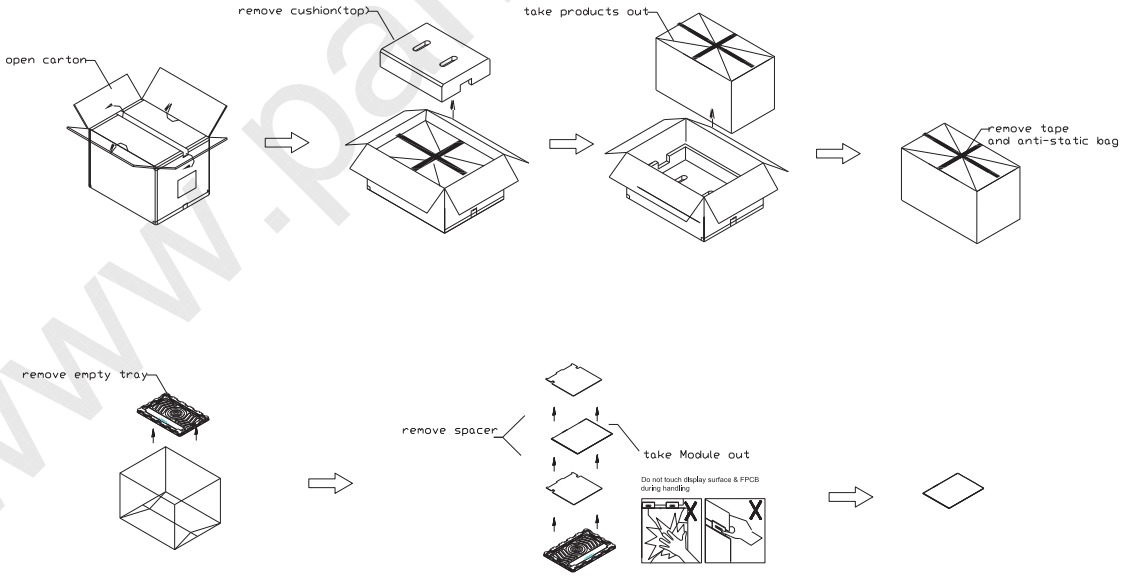
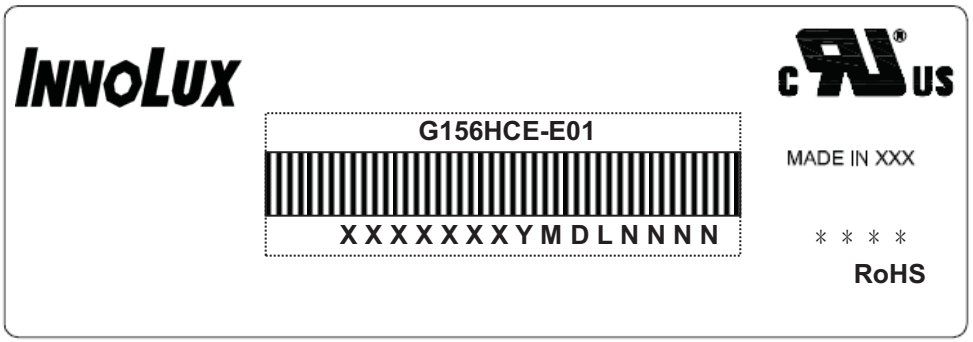



Figure. 7-4 Un-Packing method

# 8. MODULE LABEL

## 8.1 INX MODULE LABEL

The barcode nameplate is pasted on each module as illustration, and its definitions are as following explanation.

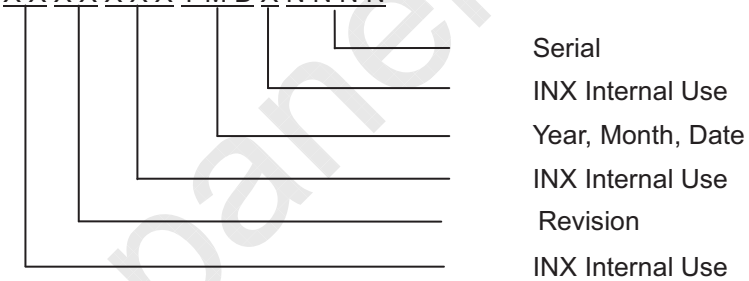



(a) Model Name: G156HCE-E01

(b) Revision: Rev. XX, for example: A1, B1, C1, C2 …etc.

(c) ＊＊＊＊ : Factory ID

(d) Serial ID: X X X X X X X Y M D X N N N N




Serial ID includes the information as below:

(a) Manufactured Date: Year: 1~9, for 2021~2029

Month: 1~9, A~C, for Jan. ~ Dec.

Day: 1~9, A~Y, for 1st to 31st, exclude I , O and U

(b) Revision Code: cover all the change

(c) Serial No.: Manufacturing sequence of product

# 9. PRECAUTIONS

## 9.1 ASSEMBLY AND HANDLING PRECAUTIONS

(1) Do not apply rough force such as bending or twisting to the module during assembly.

(2) To assemble or install module into user's system can be only in clean working areas. The dust and oil may cause electrical short or worsen the polarizer.

(3) It's not permitted to have pressure or impulse on the module because the LCD panel and Backlight will be damaged.

(4) Always follow the correct power sequence when LCD module is connecting and operating. This can prevent damage to the CMOS LSI chips during latch-up.

(5) Do not pull the I/F connector in or out while the module is operating.

(6) Do not disassemble the module.

(7) Use a soft dry cloth without chemicals for cleaning, because the surface of polarizer is very soft and easily scratched.

(8) It is dangerous that moisture come into or contacted the LCD module, because moisture may damage LCD module when it is operating.

(9) High temperature or humidity may reduce the performance of module. Please store LCD module within the specified storage conditions.

(10)When ambient temperature is lower than 10℃ may reduce the display quality. For example, the response time will become slowly.

## 9.2 STORAGE PRECAUTIONS

(1) Do not leave the module in high temperature, and high humidity for a long time. It is highly recommended to store the module with temperature from 0℃ to 35℃ and relative humidity of less than 70%

(2) Do not store the TFT – LCD module in direct sunlight

(3) The module should be stored in dark place. It is prohibited to apply sunlight or fluorescent light in storing

## 9.3 OPERATION PRECAUTIONS

(1) The LCD product should be operated under normal condition.

Normal condition is defined as below :

Temperature : 20±15℃

Humidity: 65±20%

Display pattern : continually changing pattern(Not stationary)

(2) If the product will be used in extreme conditions such as high temperature,high humidity,high altitude ,display pattern or operation time etc…It is strongly recommended to contact CMI for application engineering advice . Otherwise , Its reliability and function may not be guaranteed.

## 9.4 SAFETY PRECAUTIONS

(1) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contact with hands, skin or clothes, it has to be washed away thoroughly with soap.

(2) After the module's end of life, it is not harmful in case of normal operation and storage.

## 9.5 SAFETY STANDARDS

The LCD module should be certified with safety regulations as follows:

(1) UL60950-1 or updated standard.

(2) IEC60950-1 or updated standard.

## 9.6 OTHER

When fixed patterns are displayed for a long time, remnant image is likely to occur

## Appendix. OUTLINE DRAWING