# TFT LCD Approval Specification

# MODEL NO.: N156B6-L0A

Customer : _____

Approved by : _____

Note :

| 核准時間 | 部門 | 審核 | 角色 | 投票 |
|---|---|---|---|---|
| 2010-06-28 14:23:38 | NB 產品管理處 | 楊 2010.06.28 竣 傑 | Director | Accept |

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## REVISION HISTORY

| Version | Date | Page (New) | Section | Description |
|---|---|---|---|---|
| Ver. 2.0 | Dec.24, 2009 | All | All | Approval spec 2.0 was first issued for N156B6-L0B. |
| Ver.2.1 | May.31,2010 | 10 | p.28 | Approval spec 2.1 was updated for packing. |

# 1. GENERAL DESCRIPTION

## 1.1 OVERVIEW

N156B6-L0B is a 15.6” (15.547” diagonal) TFT Liquid Crystal Display module with LED Backlight unit and 40 pins LVDS interface. This module supports 1366 x 768 HD mode and can display 262,144 colors. The optimum viewing angle is at 6 o’clock direction.

## 1.2 FEATURES

- HD (1366 x 768 pixels) resolution
- 3.3V LVDS (Low Voltage Differential Signaling) interface with 1 pixel/clock
- WLED
- LED converter embedded

## 1.3 APPLICATION

- TFT LCD Notebook

## 1.4 GENERAL SPECIFICATI0NS

| Item | Specification | Unit | Note |
|---|---|---|---|
| Active Area | 344.232 (H) x 193.536 (V) (15.547” diagonal) | mm | (1) |
| Bezel Opening Area | 349.58 (H) x 198.29 (V) | mm | |
| Driver Element | a-si TFT active matrix | - | - |
| Pixel Number | 1366 x R.G.B. x 768 | pixel | - |
| Pixel Pitch | 0.252 (H) x 0.252 (V) | mm | - |
| Pixel Arrangement | RGB vertical stripe | - | - |
| Display Colors | 262,144 | color | - |
| Transmissive Mode | Normally white | - | - |
| Surface Treatment | Hard coating (3H), Glare | - | - |

## 1.5 MECHANICAL SPECIFICATIONS

| Item | | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Module Size | Horizontal(H) | 358.8 | 359.3 | 359.8 | mm | (1) |
| | Vertical(V) | 209 | 209.5 | 210 | mm | |
| | Thickness(T) | - | 5.2 | 5.5 | mm | |
| Weight | | --- | 430 | 445 | g | - |

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

## 2. ABSOLUTE MAXIMUM RATINGS

### 2.1 ABSOLUTE RATINGS OF ENVIRONMENT

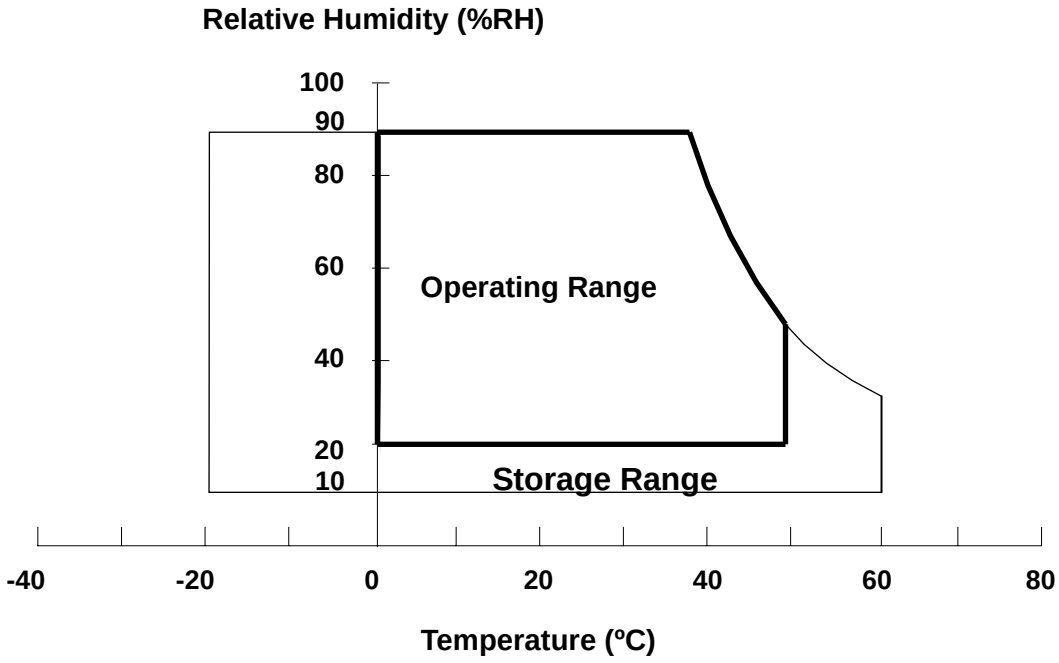
| Item | Symbol | Value | | Unit | Note |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| Storage Temperature | $T_{ST}$ | -20 | +60 | ºC | (1) |
| Operating Ambient Temperature | $T_{OP}$ | 0 | +50 | ºC | (1), (2) |
| Shock (Non-Operating) | $S_{NOP}$ | - | 220/2 | G/ms | (3), (5) |
| Vibration (Non-Operating) | $V_{NOP}$ | - | 1.5 | G | (4), (5) |

Note (1) (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 temperature of panel surface should be 0 ºC min. and 60 ºC max.

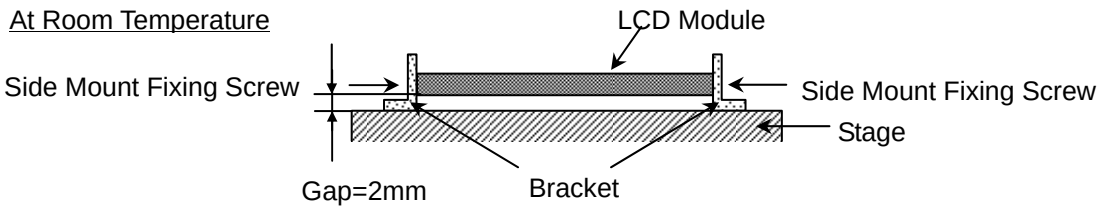



Note (3) 1 time for ± X, ± Y, ± Z. for Condition (220G / 2ms) is half Sine Wave,.

Note (4) 10~500 Hz, 0.5hr/cycle 1cycle for X,Y,Z

Note (5) 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.

The fixing condition is shown as below:



## 2.2 ELECTRICAL ABSOLUTE RATINGS

### 2.2.1 TFT LCD MODULE

| Item | Symbol | Value | | Unit | Note |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| Power Supply Voltage | VCCS | -0.3 | +4.0 | V | (1) |
| Logic Input Voltage | $V_I$ | -0.3 | VCCS+0.3 | V | |

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.

### 2.2.2 BACKLIGHT UNIT

| Item | Value | | Unit | Note |
|---|---|---|---|---|
| | Min | Max. | | |
| LED Light Bar Power Supply Voltage | -40 | 28 | $V_{DC}$ | (1), (2) |
| LED Light Bar Power Supply Current | 0 | 150 | $mA_{DC}$ | |

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 LED (Refer to Section 3.2 for further information).

# 3. ELECTRICAL CHARACTERISTICS

## 3.1 TFT LCD MODULE

Ta = 25 ± 2 ºC

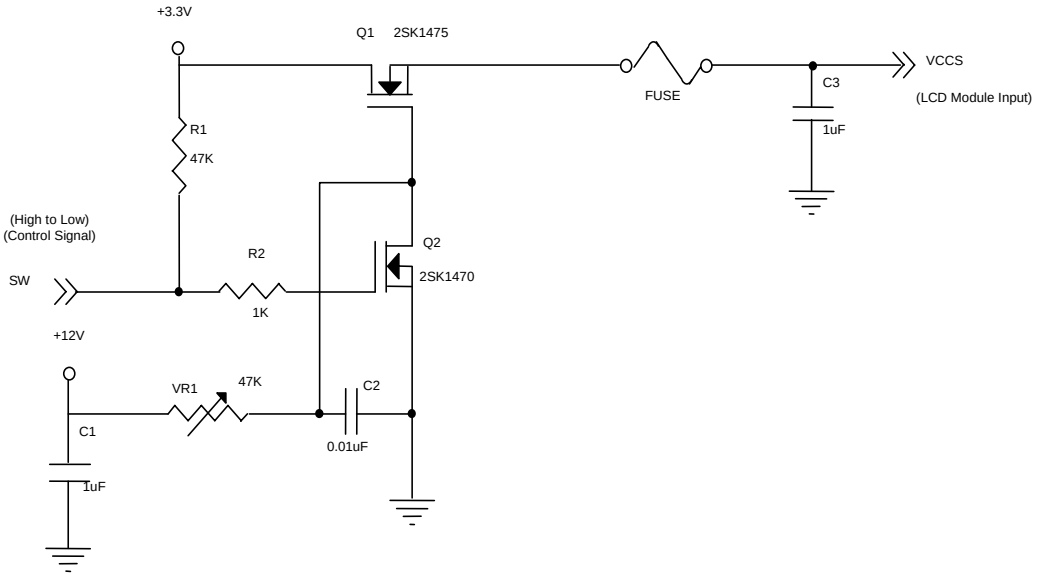
| Parameter | | Symbol | Value | | | Unit | Note |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | | |
| Power Supply Voltage | | VCCS | 3.0 | 3.3 | 3.6 | V | - |
| Ripple Voltage | | $V_{RP}$ | - | 50 | - | mV | - |
| Rush Current | | $I_{RUSH}$ | - | - | 1.5 | A | (2) |
| Initial Stage Current | | $I_{IS}$ | - | - | 1.0 | A | (2) |
| Power Supply Current | White | Icc | 185 | 215 | 245 | (3)a | (3)a |
| | Black | | 320 | 360 | 400 | (3)b | (3)b |
| LVDS Differential Input High Threshold | | $V_{TH(LVDS)}$ | - | - | +100 | mV | (4), $V_{CM}$=1.2V |
| LVDS Differential Input Low Threshold | | $V_{TL(LVDS)}$ | -100 | - | - | mV | (4) $V_{CM}$=1.2V |
| LVDS Common Mode Voltage | | $V_{CM}$ | 1.125 | - | 1.375 | V | (4) |
| LVDS Differential Input Voltage | | $\|V_{ID}\|$ | 100 | - | 600 | mV | (4) |
| Terminating Resistor | | $R_T$ | - | 100 | - | Ohm | - |
| Power per EBL WG | | PEBL | - | 1.97 | | W | (5) |

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

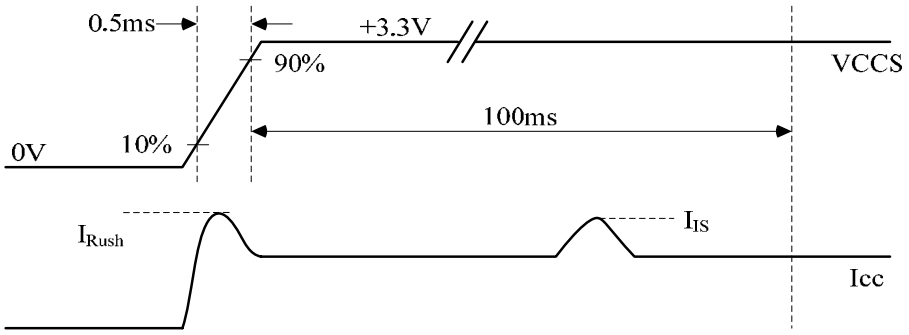
Note (2) $I_{RUSH}$: the maximum current when VCCS is rising

$I_{IS}$: 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. White Pattern

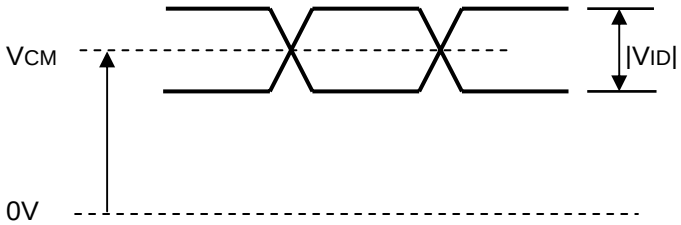
Active Area

b. Black Pattern

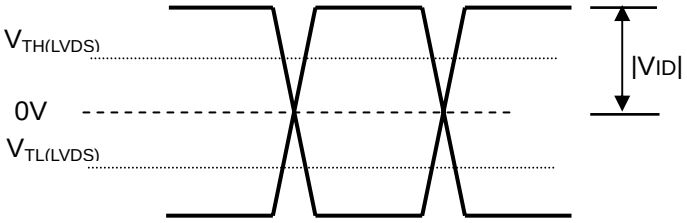
Active Area

Note (4) The parameters of LVDS signals are defined as the following figures.

**Single Ended**




**Differential**




Note (5) The specified power are the sum of LCD panel electronics input power and the converter input

power. Test conditions are as follows.

(a) VCCS = 3.3 V, Ta = 25 ± 2 ºC, $f_v$ = 60 Hz,

(b) The pattern used is a black and white 32 x 36 checkerboard, slide #100 from the VESA file "Flat Panel Display Monitor Setup Patterns", FPDMSU.ppt.

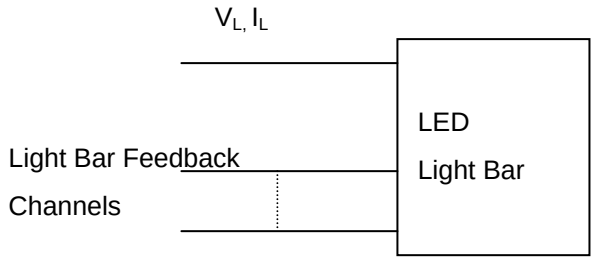
(c) Luminance: 60 nits.

3.2 BACKLIGHT UNIT

Ta = 25 ± 2 ºC

| Parameter | Symbol | Value | | | Unit | Note |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| LED Light Bar input Voltage | $V_L$ | 22.4 | 25.6 | 27.2 | V | (1) Duty 100% |
| LED Light Bar input Current | $I_L$ | 114 | 120 | 126 | mA | |
| Power Consumption | $P_L$ | 2.55 | 3.07 | 3.43 | W | (3) Duty=100% |
| LED Life Time | $L_{BL}$ | 15000 | | | Hrs | (4) |

Note (1) LED light bar configuration is shown as below.



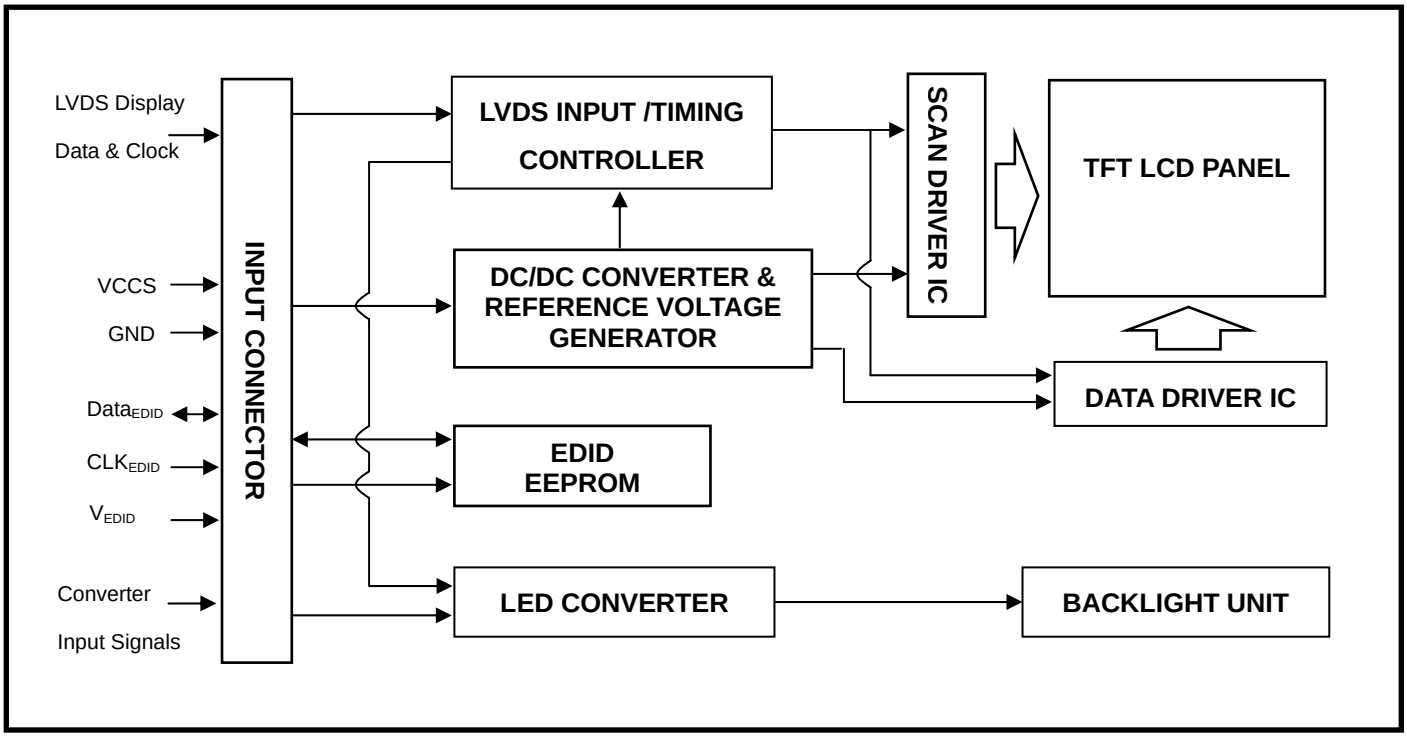

Note (2) For better LED light bar driving quality, it is recommended to utilize the adaptive boost converter with current balancing function to drive LED light-bar.

Note (3) $P_L = I_L \times V_L$

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 $I_L$ = 24.0mA (Per EA) until the brightness becomes ≦ 50% of its original value.

# 4. BLOCK DIAGRAM

## 4.1 TFT LCD MODULE



## 5. INPUT TERMINAL PIN ASSIGNMENT

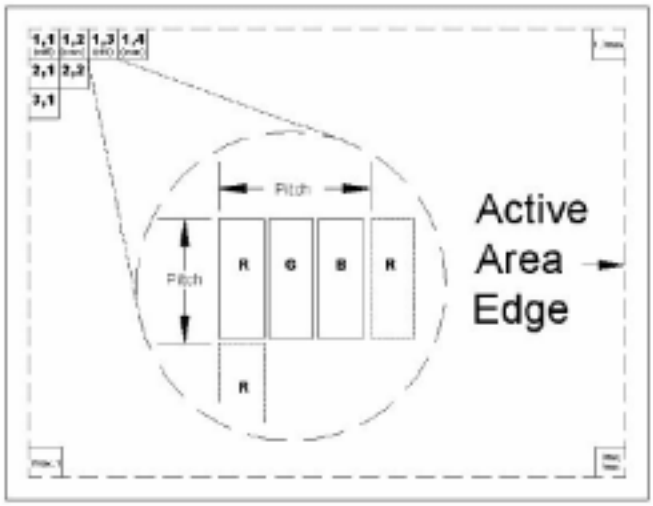
### .1 TFT LCD MODULE

| Pin | Symbol | Description | Polarity | Remark |
|---|---|---|---|---|
| 1 | NC | No Connection (Reserve) | | |
| 2 | VCCS | Power Supply (3.3V typ.) | | |
| 3 | VCCS | Power Supply (3.3V typ.) | | |
| 4 | VEDID | DDC 3.3V power | | |
| 5 | NC | No Connection (Reserved for CMO test) | | |
| 6 | CLKEDID | DDC clock | | |
| 7 | DATAEDID | DDC data | | |
| 8 | Rxin0- | LVDS differential data input | Negative | R0-R5, G0 |
| 9 | Rxin0+ | LVDS differential data input | Positive | |
| 10 | VSS | Ground | | |
| 11 | Rxin1- | LVDS differential data input | Negative | G1~G5, B0, B1 |
| 12 | Rxin1+ | LVDS differential data input | Positive | |
| 13 | VSS | Ground | | |
| 14 | Rxin2- | LVDS Differential Data Input | Negative | B2-B5,HS,VS, DE |
| 15 | Rxin2+ | LVDS Differential Data Input | Positive | |
| 16 | VSS | Ground | | |
| 17 | RxCLK- | LVDS differential clock input | | |
| 18 | RxCLK+ | LVDS differential clock input | | |
| 19 | VSS | Ground | | |
| 20 | NC | No Connection (Reserve) | | |
| 21 | NC | No Connection (Reserve) | | |
| 22 | VSS | Ground | | |
| 23 | NC | No Connection (Reserve) | | |
| 24 | NC | No Connection (Reserve) | | |
| 25 | VSS | Ground | | |
| 26 | NC | No Connection (Reserve) | | |
| 27 | NC | No Connection (Reserve) | | |
| 28 | VSS | Ground | | |
| 29 | NC | No Connection (Reserve) | | |
| 30 | NC | No Connection (Reserve) | | |
| 31 | LED_GND | LED Ground | | |
| 32 | LED_GND | LED Ground | | |
| 33 | LED_GND | LED Ground | | |
| 34 | NC | No Connection (Reserve) | | |
| 35 | LED_PWM | PWM Control Signal of LED Converter | | |
| 36 | LED_EN | Enable Control Signal of LED Converter | | |
| 37 | NC | No Connection (Reserve) | | |
| 38 | LED_VCCS | LED Power | | |
| 39 | LED_VCCS | LED Power | | |
| 40 | LED_VCCS | LED Power | | |

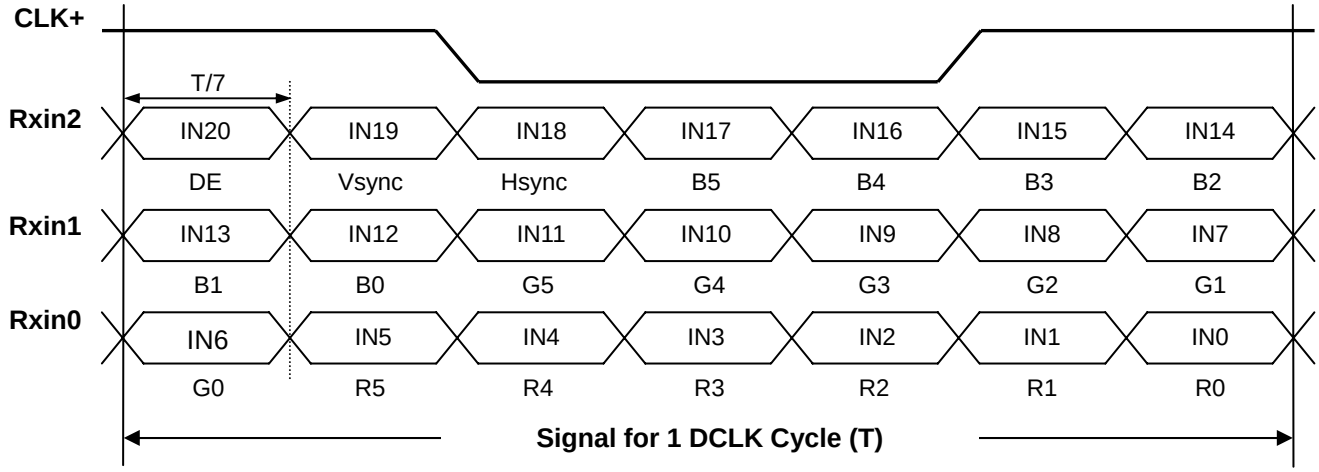
Note (1) Connector Part No.: IPEX-20455-040E-12 or equivalent

Note (2) User's connector Part No: IPEX-20453-040T-01 or equivalent

Note (3) The first pixel is odd as shown in the following figure.



5.2 TIMING DIAGRAM OF LVDS INPUT SIGNAL



## 5.3 COLOR DATA INPUT ASSIGNMENT

The brightness of each primary color (red, green and blue) is based on the 6-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 | | | | | |
| | | R5 | R4 | R3 | R2 | R1 | R0 | G5 | G4 | G3 | G2 | G1 | G0 | 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 |
| | Red | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Basic | Blue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| Colors | Cyan | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Magenta | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Yellow | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 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 |
| | Red(0)/Dark | 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 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gray | Red(2) | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scale | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Of | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Red | Red(61) | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red(62) | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red(63) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green(0)/Dark | 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 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Gray | Green(2) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scale | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Of | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Green | Green(61) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green(62) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green(63) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Blue(0)/Dark | 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 | 1 |
| Gray | Blue(2) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Scale | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Of | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : |
| Blue | Blue(61) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| | Blue(62) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| | Blue(63) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |

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

## 5.4 EDID DATA STRUCTURE

The EDID (Extended Display Identification Data) data formats are to support displays as defined in the VESA Plug & Display and FPDI standards.

| Byte #(decimal) | Byte #(hex) | Field Name and Comments | Value(hex) | Value(binary) |
|---|---|---|---|---|
| 0 | 0 | Header | 00 | 00000000 |
| 1 | 1 | Header | FF | 11111111 |
| 2 | 2 | Header | FF | 11111111 |
| 3 | 3 | Header | FF | 11111111 |
| 4 | 4 | Header | FF | 11111111 |
| 5 | 5 | Header | FF | 11111111 |
| 6 | 6 | Header | FF | 11111111 |
| 7 | 7 | Header | 00 | 00000000 |
| 8 | 8 | EISA ID manufacturer name (“CMO”) | 0D | 00001101 |
| 9 | 9 | EISA ID manufacturer name (Compressed ASCII) | AF | 10101111 |
| 10 | 0A | ID product code (N156B6-L0A) | 91 | 10010001 |
| 11 | 0B | ID product code (hex LSB first; N156B6-L0A) | 15 | 00010101 |
| 12 | 0C | ID S/N (fixed “0”) | 00 | 00000000 |
| 13 | 0D | ID S/N (fixed “0”) | 00 | 00000000 |
| 14 | 0E | ID S/N (fixed “0”) | 00 | 00000000 |
| 15 | 0F | ID S/N (fixed “0”) | 00 | 00000000 |
| 16 | 10 | Week of manufacture (fixed “00H”) | 35 | 00110101 |
| 17 | 11 | Year of manufacture (fixed “00H”) | 13 | 00010011 |
| 18 | 12 | EDID structure version # (“1”) | 01 | 00000001 |
| 19 | 13 | EDID revision # (“3”) | 03 | 00000011 |
| 20 | 14 | Video I/P definition (“digital”) | 80 | 10000000 |
| 21 | 15 | Max H image size (“35cm”) | 23 | 00100011 |
| 22 | 16 | Max V image size (“19cm”) | 13 | 00010011 |
| 23 | 17 | Display Gamma (Gamma = ”2.2”) | 78 | 01111000 |
| 24 | 18 | Feature support (“Active off, RGB Color”) | 0A | 00001010 |
| 25 | 19 | Red/Green (Rx1, Rx0, Ry1, Ry0, Gx1, Gx0, Gy1, Gy0) | 07 | 00000111 |
| 26 | 1A | Blue/White (Bx1, Bx0, By1, By0, Wx1, Wx0, Wy1, Wy0) | F5 | 11110101 |
| 27 | 1B | Red-x (Rx = “0.602”) | 9A | 10011010 |
| 28 | 1C | Red-y (Ry = “0.340”) | 57 | 01010111 |
| 29 | 1D | Green-x (Gx = ”0.306”) | 4E | 01001110 |
| 30 | 1E | Green-y (Gy = ”0.530”) | 87 | 10000111 |
| 31 | 1F | Blue-x (Bx = ”0.151”) | 26 | 00100110 |
| 32 | 20 | Blue-y (By = ”0.120”) | 1E | 00011110 |
| 33 | 21 | White-x (Wx = ”0.313”) | 50 | 01010000 |
| 34 | 22 | White-y (Wy = ”0.329”) | 54 | 01010100 |
| 35 | 23 | Established timings 1 | 00 | 00000000 |
| 36 | 24 | Established timings 2 | 00 | 00000000 |
| 37 | 25 | Manufacturer’s reserved timings | 00 | 00000000 |
| 38 | 26 | Standard timing ID # 1 | 01 | 00000001 |
| 39 | 27 | Standard timing ID # 1 | 01 | 00000001 |
| 40 | 28 | Standard timing ID # 2 | 01 | 00000001 |

| | | | | |
|---|---|---|---|---|
| 41 | 29 | Standard timing ID # 2 | 01 | 00000001 |
| 42 | 2A | Standard timing ID # 3 | 01 | 00000001 |
| 43 | 2B | Standard timing ID # 3 | 01 | 00000001 |
| 44 | 2C | Standard timing ID # 4 | 01 | 00000001 |
| 45 | 2D | Standard timing ID # 4 | 01 | 00000001 |
| 46 | 2E | Standard timing ID # 5 | 01 | 00000001 |
| 47 | 2F | Standard timing ID # 5 | 01 | 00000001 |
| 48 | 30 | Standard timing ID # 6 | 01 | 00000001 |
| 49 | 31 | Standard timing ID # 6 | 01 | 00000001 |
| 50 | 32 | Standard timing ID # 7 | 01 | 00000001 |
| 51 | 33 | Standard timing ID # 7 | 01 | 00000001 |
| 52 | 34 | Standard timing ID # 8 | 01 | 00000001 |
| 53 | 35 | Standard timing ID # 8 | 01 | 00000001 |
| 54 | 36 | Detailed timing description # 1 Pixel clock (“69.3MHz”, According to VESA CVT Rev1.1) | 12 | 00010010 |
| 55 | 37 | # 1 Pixel clock (hex LSB first) | 1B | 00011011 |
| 56 | 38 | # 1 H active (“1366”) | 56 | 01010110 |
| 57 | 39 | # 1 H blank (“100”) | 64 | 01100100 |
| 58 | 3A | # 1 H active : H blank (“1366 :100”) | 50 | 01010000 |
| 59 | 3B | # 1 V active (”768”) | 00 | 00000000 |
| 60 | 3C | # 1 V blank (”20”) | 14 | 00010100 |
| 61 | 3D | # 1 V active : V blank (”768 :20”) | 30 | 00110000 |
| 62 | 3E | # 1 H sync offset (”16”) | 10 | 00010000 |
| 63 | 3F | # 1 H sync pulse width ("34”) | 22 | 00100010 |
| 64 | 40 | # 1 V sync offset : V sync pulse width (”2 : 6”) | 26 | 00100110 |
| 65 | 41 | # 1 H sync offset : H sync pulse width : V sync offset : V sync width (”16: 34 : 2 : 6”) | 00 | 00000000 |
| 66 | 42 | # 1 H image size (”344 mm”) | 58 | 01011000 |
| 67 | 43 | # 1 V image size (”193 mm”) | C1 | 11000001 |
| 68 | 44 | # 1 H image size : V image size (”344 : 193”) | 10 | 00010000 |
| 69 | 45 | # 1 H boarder (”0”) | 00 | 00000000 |
| 70 | 46 | # 1 V boarder (”0”) | 00 | 00000000 |
| 71 | 47 | # 1 Non-interlaced, Normal, no stereo, Separate sync, H/V pol Negatives | 18 | 00011000 |
| 72 | 48 | Detailed timing description # 2 | 00 | 00000000 |
| 73 | 49 | # 2 Flag | 00 | 00000000 |
| 74 | 4A | # 2 Reserved | 00 | 00000000 |
| 75 | 4B | # 2 FE (hex) defines ASCII string (Model Name “N156B6-L0A”, ASCII) | FE | 11111110 |
| 76 | 4C | # 2 Flag | 00 | 00000000 |
| 77 | 4D | # 2 1st character of name (“N”) | 4E | 01001110 |
| 78 | 4E | # 2 2nd character of name (“1”) | 31 | 00110001 |
| 79 | 4F | # 2 3rd character of name (“5”) | 35 | 00110101 |
| 80 | 50 | # 2 4th character of name (“6”) | 36 | 00110110 |
| 81 | 51 | # 2 5th character of name (“B”) | 42 | 01000010 |
| 82 | 52 | # 2 6th character of name (“6”) | 36 | 00110110 |
| 83 | 53 | # 2 7th character of name (“-”) | 2D | 00101101 |
| 84 | 54 | # 2 8th character of name (“L”) | 4C | 01001100 |
| 85 | 55 | # 2 9th character of name (“0”) | 30 | 00110000 |

| | | | | |
|---|---|---|---|---|
| 86 | 56 | # 2 9th character of name (“A”) | 41 | 01000001 |
| 87 | 57 | # 2 New line character indicates end of ASCII string | 0A | 00001010 |
| 88 | 58 | # 2 Padding with “Blank” character | 20 | 00100000 |
| 89 | 59 | # 2 Padding with “Blank” character | 20 | 00100000 |
| 90 | 5A | Detailed timing description # 3 | 00 | 00000000 |
| 91 | 5B | # 3 Flag | 00 | 00000000 |
| 92 | 5C | # 3 Reserved | 00 | 00000000 |
| 93 | 5D | # 3 FE (hex) defines ASCII string (Vendor “CMO”, ASCII) | FE | 11111110 |
| 94 | 5E | # 3 Flag | 00 | 00000000 |
| 95 | 5F | # 3 1st character of string (“C”) | 43 | 01000011 |
| 96 | 60 | # 3 2nd character of string (“M”) | 4D | 01001101 |
| 97 | 61 | # 3 3rd character of string (“O”) | 4F | 01001111 |
| 98 | 62 | # 3 New line character indicates end of ASCII string | 0A | 00001010 |
| 99 | 63 | # 3 Padding with “Blank” character | 20 | 00100000 |
| 100 | 64 | # 3 Padding with “Blank” character | 20 | 00100000 |
| 101 | 65 | # 3 Padding with “Blank” character | 20 | 00100000 |
| 102 | 66 | # 3 Padding with “Blank” character | 20 | 00100000 |
| 103 | 67 | # 3 Padding with “Blank” character | 20 | 00100000 |
| 104 | 68 | # 3 Padding with “Blank” character | 20 | 00100000 |
| 105 | 69 | # 3 Padding with “Blank” character | 20 | 00100000 |
| 106 | 6A | # 3 Padding with “Blank” character | 20 | 00100000 |
| 107 | 6B | # 3 Padding with “Blank” character | 20 | 00100000 |
| 108 | 6C | Detailed timing description # 4 | 00 | 00000000 |
| 109 | 6D | # 4 Flag | 00 | 00000000 |
| 110 | 6E | # 4 Reserved | 00 | 00000000 |
| 111 | 6F | # 4 FE (hex) defines ASCII string (Model Name“N156B6-L0A”, ASCII) | FE | 11111110 |
| 112 | 70 | # 4 Flag | 00 | 00000000 |
| 113 | 71 | # 4 1st character of name (“N”) | 4E | 01001110 |
| 114 | 72 | # 4 2nd character of name (“1”) | 31 | 00110001 |
| 115 | 73 | # 4 3rd character of name (“5”) | 35 | 00110101 |
| 116 | 74 | # 4 4th character of name (“6”) | 36 | 00110110 |
| 117 | 75 | # 4 5th character of name (“B”) | 42 | 01000010 |
| 118 | 76 | # 4 6th character of name (“6”) | 36 | 00110110 |
| 119 | 77 | # 4 7th character of name (“-”) | 2D | 00101101 |
| 120 | 78 | # 4 8th character of name (“L”) | 4C | 01001100 |
| 121 | 79 | # 4 9th character of name (“0”) | 30 | 00110000 |
| 122 | 7A | # 4 9th character of name (“A”) | 41 | 01000001 |
| 123 | 7B | # 4 New line character indicates end of ASCII string | 0A | 00001010 |
| 124 | 7C | # 4 Padding with “Blank” character | 20 | 00100000 |
| 125 | 7D | # 4 Padding with “Blank” character | 20 | 00100000 |
| 126 | 7E | Extension flag | 00 | 00000000 |
| 127 | 7F | Checksum | 23 | 00100011 |

# 6. CONVERTER SPECIFICATION

## 6.1 ABSOLUTE MAXIMUM RATINGS

| Symbol | Ratings |
|---|---|
| LED_VCCS | -0.3V~25V |
| LED_PWM | -0.3~5.0V |
| ,LED_EN | -0.3V~5.0V |

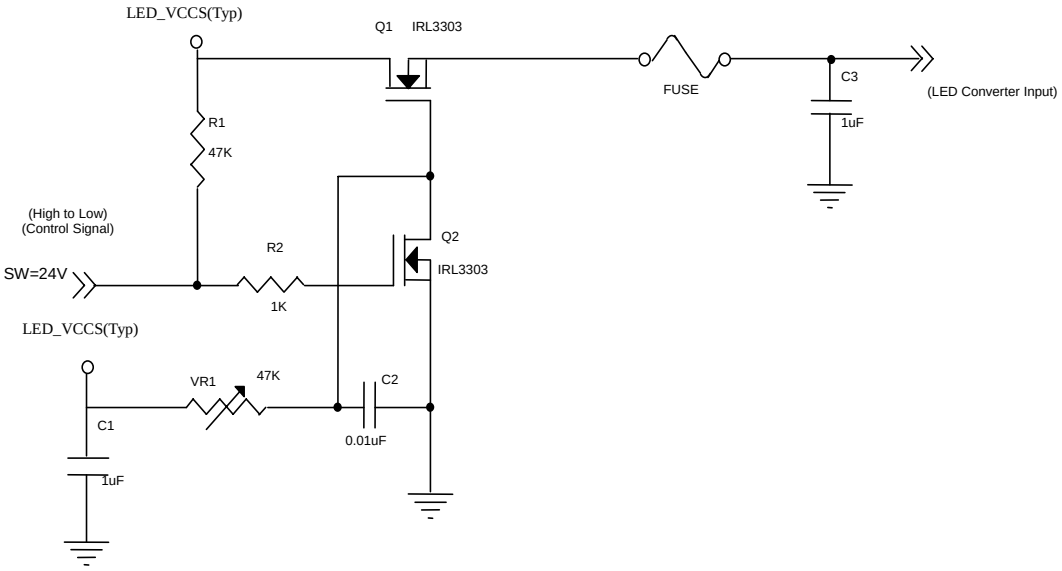
## 6.2 RECOMMENDED OPERATING RATINGS

| Parameter | | Symbol | Value | | | Unit | Note |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | | |
| Converter Input power supply voltage | | LED_Vccs | 6.0 | 12.0 | 21.0 | V | |
| Converter Rush Current | | $ILED_{RUSH}$ | - | - | 1.5 | A | (1) |
| Converter Initial Stage Current | | $ILED_{IS}$ | - | - | 1.5 | A | (1) |
| EN Control Level | Backlight On | | 2.3 | | 5.0 | V | |
| | Backlight Off | | 0.0 | | 0.5 | V | |
| PWM Control Level | PWM High Level | | 2.3 | | 5.0 | V | |
| | PWM Low Level | | 0.0 | | 0.5 | V | |
| PWM Control Duty Ratio | | | 10 | - | 100 | % | |
| | | | 5 | | 100 | % | (2) |
| PWM Control Permissive Ripple Voltage | | VPWM_pp | - | - | 100 | mV | |
| PWM Control Frequency | | $f_{PWM}$ | 190 | | 2K | Hz | (3) |
| LED Power Current | LED_VCCS =Min. | ILED | 507 | 602 | 714 | mA | (4) |
| | LED_VCCS =Typ. | | 253 | 301 | 357 | mA | (4) |
| | LED_VCCS =Max. | | 145 | 172 | 204 | mA | (4) |

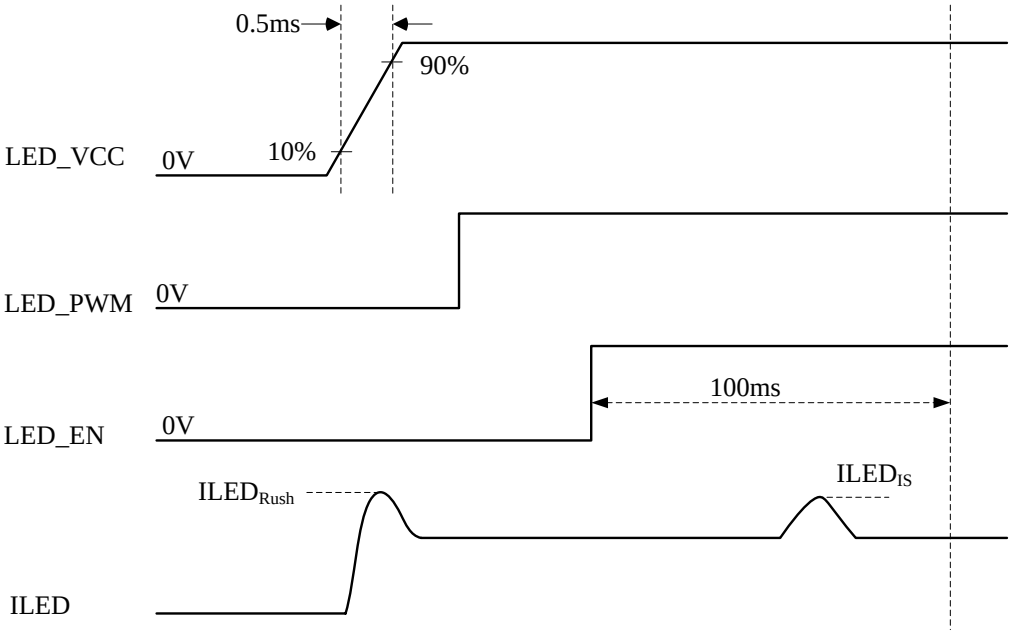
Note (1) $ILED_{RUSH}$: the maximum current when LED_VCCS is rising,

$ILED_{IS}$: the maximum current of the first 100ms after power-on,

Measurement Conditions: Shown as the following figure. LED_VCCS = Typ, Ta = 25 ± 2 ºC, $f_{PWM}$ = 200 Hz, Duty=100%.



**VLED rising time is 0.5ms**




Note (2) If the PWM control duty ratio is less than 10%, there is some possibility that acoustic noise or backlight flash can be found. And it is also difficult to control the brightness linearity.

Note (3) If PWM control frequency is applied in the range less than 1KHz, the "waterfall" phenomenon on the screen may be found. To avoid the issue, it's a suggestion that PWM control frequency should follow the criterion as below.

PWM control frequency $f_{PWM}$ should be in the range

$$(N+0.4)*f \leq f_{PWM} \leq (N+0.6)*f$$

$N$ : Integer $(N \geq 3)$

$f$ : Frame rate

Note (4) The specified LED power supply current is under the conditions at "LED_VCCS = Min., Typ., Max.", Ta = 25 ± 2 ºC, $f_{PWM}$ = 200 Hz, Duty=100%.

# 7. INTERFACE TIMING

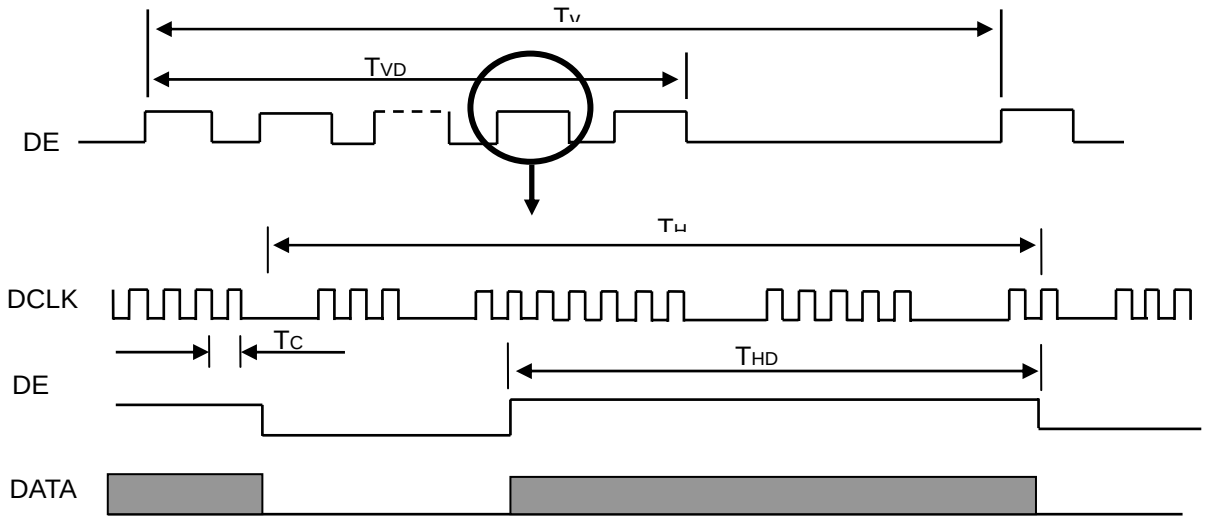
## 7.1 INPUT SIGNAL TIMING SPECIFICATIONS

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

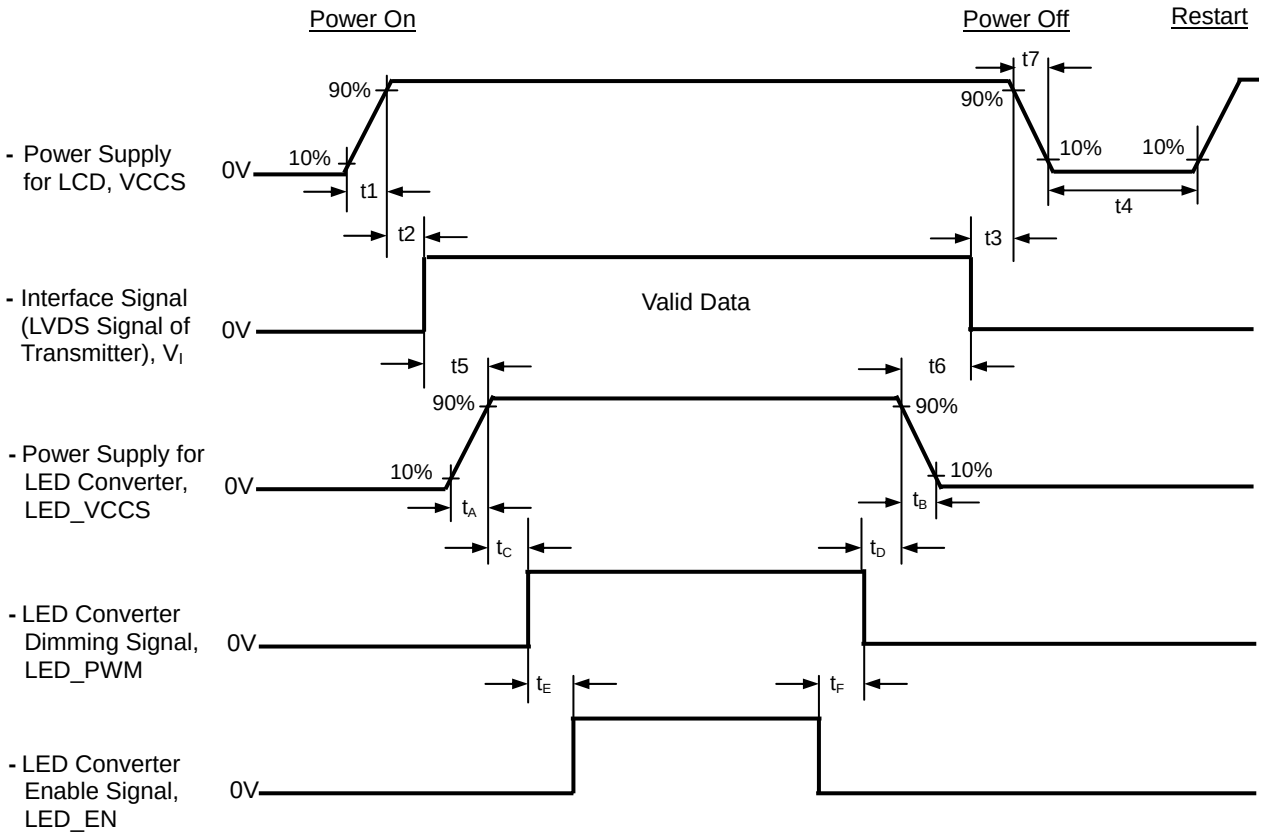
| Signal | Item | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|---|
| DCLK | Frequency | 1/Tc | 62.4 | 69.3 | 72.8 | MHz | - |
| DE | Vertical Total Time | TV | 772 | 788 | 793 | TH | - |
| | Vertical Active Display Period | TVD | 768 | 768 | 768 | TH | - |
| | Vertical Active Blanking Period | TVB | TV-TVD | 20 | TV-TVD | TH | - |
| | Horizontal Total Time | TH | 1456 | 1466 | 1492 | Tc | - |
| | Horizontal Active Display Period | THD | 1366 | 1366 | 1366 | Tc | - |
| | Horizontal Active Blanking Period | THB | TH-THD | 100 | TH-THD | Tc | - |

Note (1) Because this module is operated by DE only mode, Hsync and Vsync are ignored.

**INPUT SIGNAL TIMING DIAGRAM**



## 7.2 POWER ON/OFF SEQUENCE




Timing Specifications:

0.5≦t1≦ 10 ms
0 ≦t2≦ 50 ms
0 ≦t3≦ 50 ms
t4 ≧ 500 ms
t5 ≧ 200 ms
t6 ≧ 200 ms
0.5≦t7≦ 10 ms
0.5≦$t_A$≦ 10 ms
0 ＜ $t_B$≦ 10 ms
$t_C$ ≧ 10 ms
$t_D$ ≧ 10 ms
$t_E$ ≧ 10 ms
$t_F$ ≧ 10 ms

Note (1) Please follow the power on/off sequence described above. Otherwise, the LCD module might 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 converter power must be turned on after the power supply for the logic and the interface signal is valid. The Backlight converter power must be turned off before the power supply for the logic and the interface signal is invalid.

Note (4) Please follow the LED converter 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

# 8. OPTICAL CHARACTERISTICS

## 8.1 TEST CONDITIONS

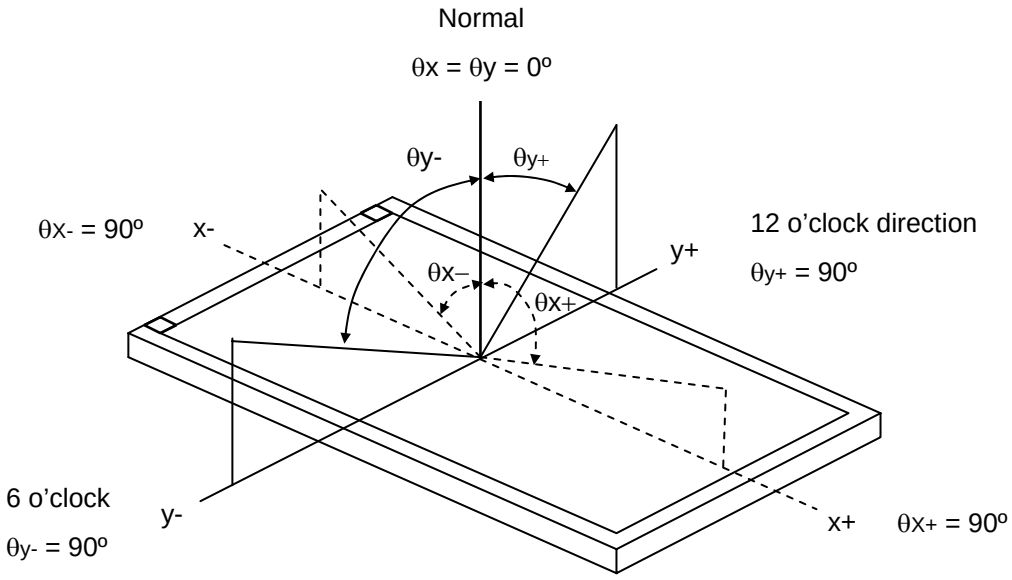
| Item | Symbol | Value | Unit |
|---|---|---|---|
| Ambient Temperature | Ta | 25±2 | °C |
| Ambient Humidity | Ha | 50±10 | %RH |
| Supply Voltage | $V_{CC}$ | 3.3 | V |
| Input Signal | According to typical value in "3. ELECTRICAL CHARACTERISTICS" | | |
| LED Light Bar Input Current | $I_L$ | 120 | mA |

The measurement methods of optical characteristics are shown in Section 8.2. The following items should be measured under the test conditions described in Section 8.1 and stable environment shown in Note (5).

## 8.2 OPTICAL SPECIFICATIONS

| Item | | Symbol | Condition | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|---|---|
| Contrast Ratio | | CR | $\theta_x$=0°, $\theta_Y$ =0° Viewing Normal Angle | 400 | 500 | - | - | (2), (5) |
| Response Time | | $T_R$ | | - | 3 | 8 | ms | (3) |
| | | $T_F$ | | - | 8 | 13 | ms | |
| Average Luminance of White | | $L_{AVE}$ | | 185 | 220 | - | cd/m$^2$ | (4), (6) |
| Color Chromaticity | Red | Rx | | Typ – 0.03 | 0.617 | Typ – 0.03 | - | (1), ( 7) |
| | | Ry | | | 0.340 | | - | |
| | Green | Gx | | | 0.320 | | - | |
| | | Gy | | | 0.598 | | - | |
| | Blue | Bx | | | 0.160 | | - | |
| | | By | | | 0.084 | | - | |
| | White | Wx | | | 0.313 | | - | |
| | | Wy | | | 0.329 | | - | |
| Viewing Angle | Horizontal | $\theta_x$+ | CR≥10 | 40 | 45 | | Deg. | (1),(5) |
| | | $\theta_x$- | | 40 | 45 | - | | |
| | Vertical | $\theta_Y$+ | | 15 | 20 | - | | |
| | | $\theta_Y$- | | 40 | 45 | - | | |
| White Variation of 5 Points | | $\delta W_{5p}$ | $\theta_x$=0°, $\theta_Y$ =0° | 80 | - | - | % | (5),(6) |

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

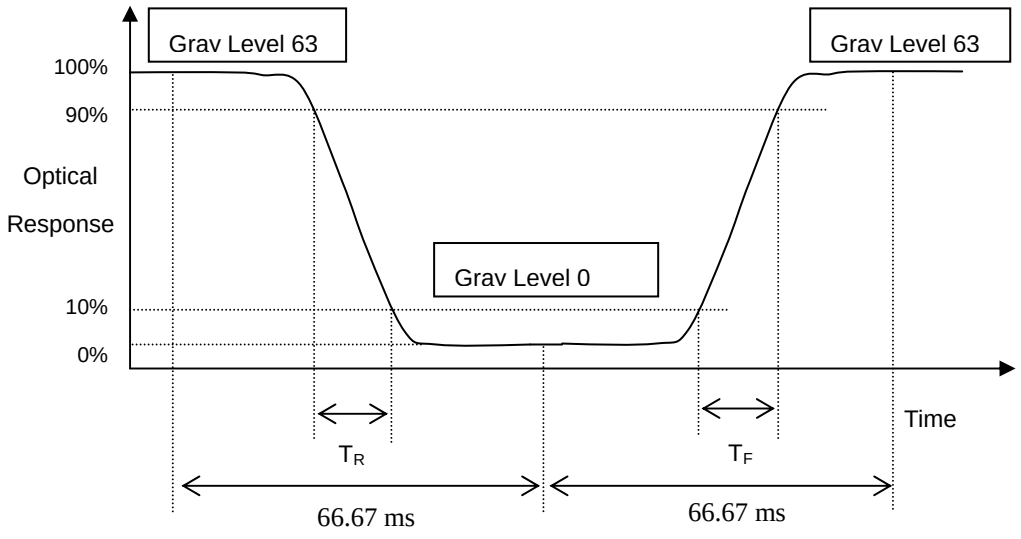
L63: Luminance of gray level 63

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 ($L_{AVE}$):

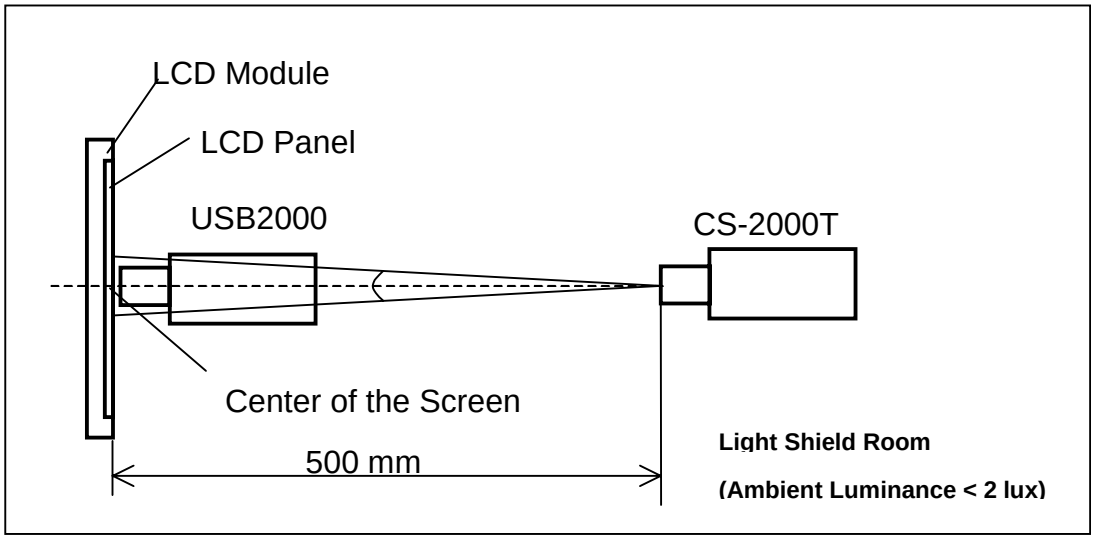
Measure the luminance of gray level 63 at 5 points

$L_{AVE}$ = [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:

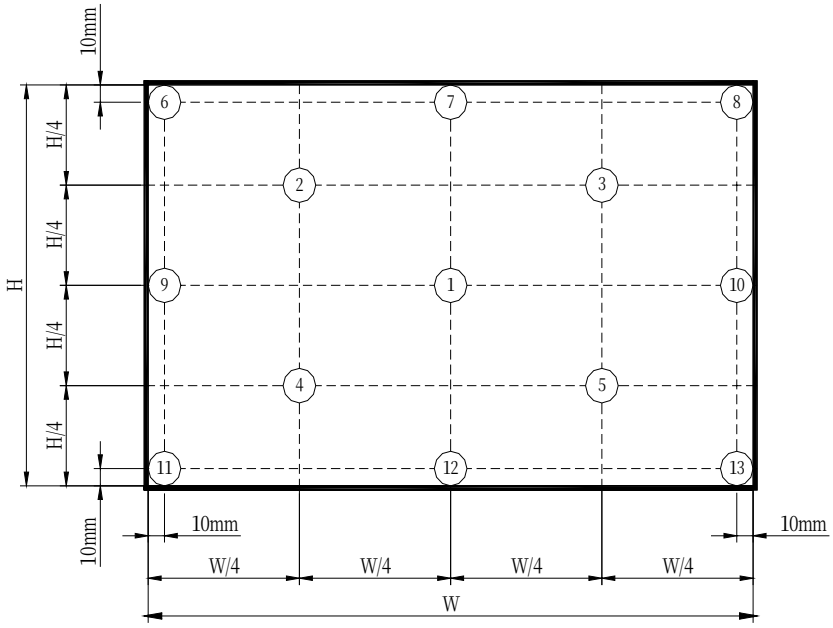
The LCD module should be stabilized at given temperature for 20 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting Backlight for 20 minutes in a windless room.




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

Measure the luminance of gray level 63 at 13 points

$\delta W_{5p}$ = { Maximum [L (1)~ L (5)] / Minimum [L (1)~ L (5)]}*100%




Ⓧ : Test Point

X=1 to 13

Note(7) The listed optical specifications refer to the initial value of manufacture, but the condition of the specifications after long-term operation will not be warranted.

# 9. PRECAUTIONS

## 9.1 HANDLING PRECAUTIONS

(1) The module should be assembled into the system firmly by using every mounting hole. Be careful not to twist or bend the module.

(2) While assembling or installing modules, it can only be in the clean area. The dust and oil may cause electrical short or damage the polarizer.

(3) Use fingerstalls or soft gloves in order to keep display clean during the incoming inspection and assembly process.

(4) Do not press or scratch the surface harder than a HB pencil lead on the panel because the polarizer is very soft and easily scratched.

(5) If the surface of the polarizer is dirty, please clean it by some absorbent cotton or soft cloth. Do not use Ketone type materials (ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanently damage the polarizer due to chemical reaction.

(6) Wipe off water droplets or oil immediately. Staining and discoloration may occur if they left on panel for a long time.

(7) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contacting with hands, legs or clothes, it must be washed away thoroughly with soap.

(8) Protect the module from static electricity, it may cause damage to the C-MOS Gate Array IC.

(9) Do not disassemble the module.

(10) Do not pull or fold the LED wire.

(11) Pins of I/F connector should not be touched directly with bare hands.

## 9.2 STORAGE PRECAUTIONS

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

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

(3) It may reduce the display quality if the ambient temperature is lower than 10 ºC. For example, the response time will become slowly, and the starting voltage of LED will be higher than the room temperature.

## 9.3 OPERATION PRECAUTIONS

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

(2) Always follow the correct power on/off sequence when LCD module is connecting and operating. This can prevent the CMOS LSI chips from damage during latch-up.

(3) The startup voltage of Backlight is approximately 1000 Volts. It may cause electrical shock while assembling with converter. Do not disassemble the module or insert anything into the Backlight unit.

# 10. PACKING

## 10.1 CARTON

Box Dimensions : 442(L)*392(W)*300(H)
Weight: Approx. 10.5kg(20 module .per. 1 box)

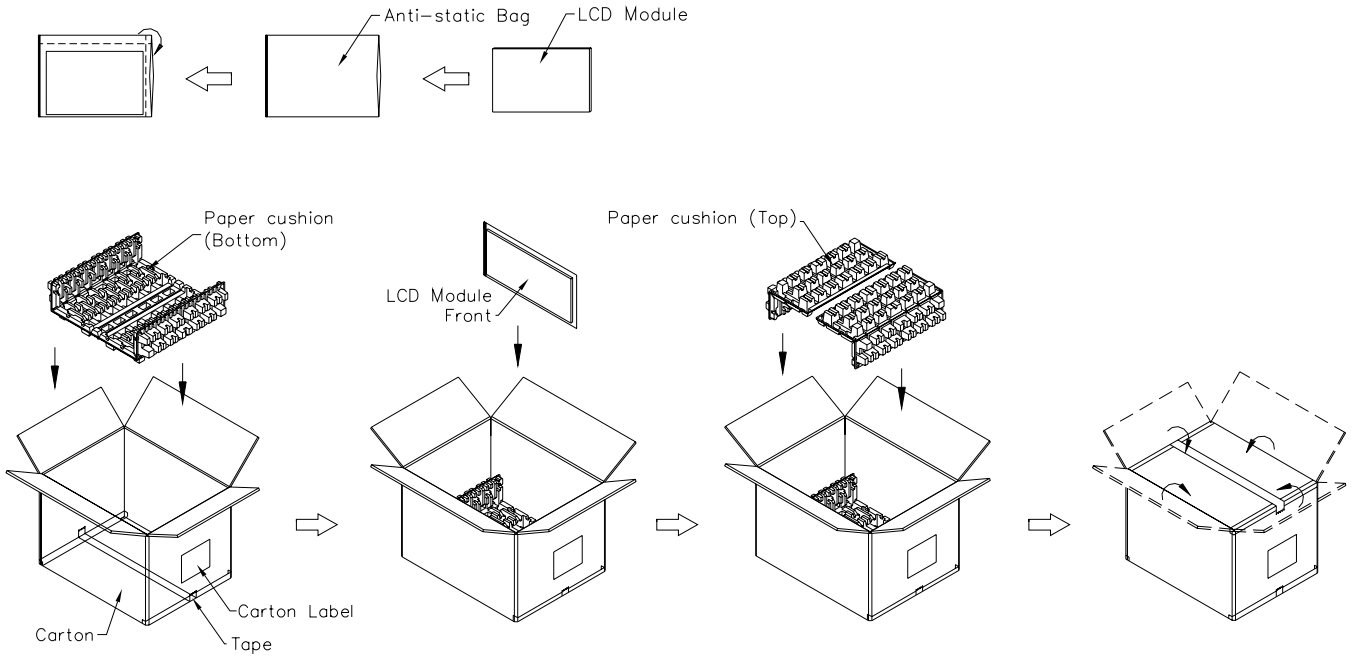



**Figure. 10-1 Packing method**

10.2 PALLET

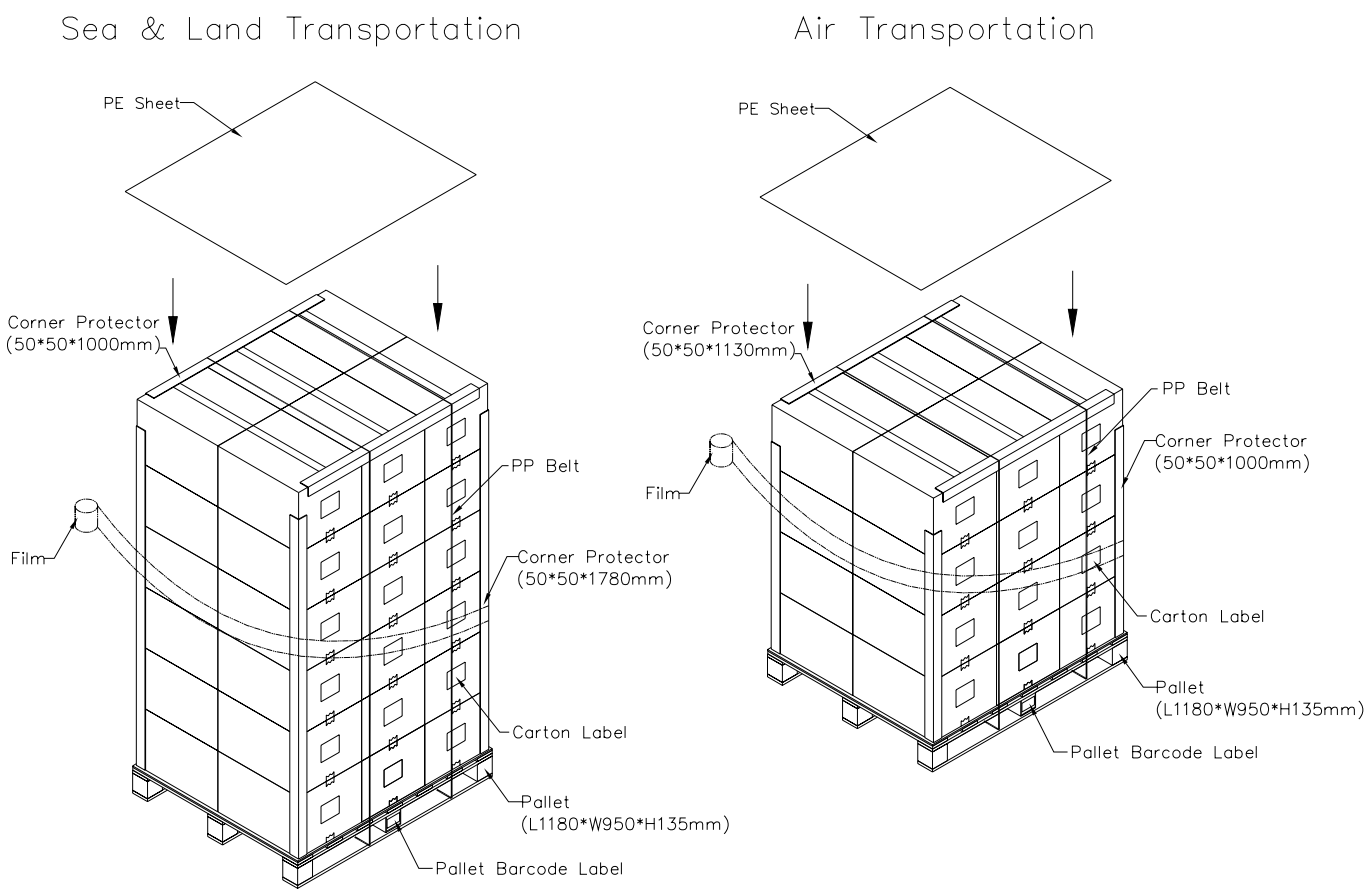
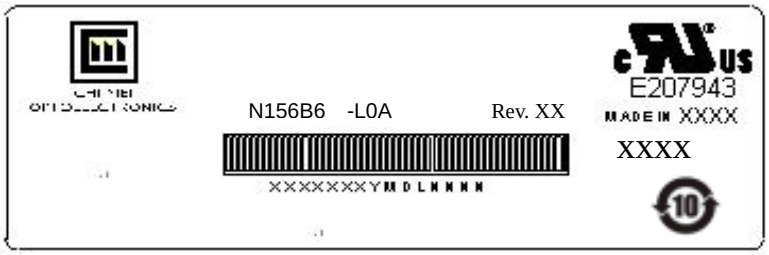



**Figure. 10-2 Packing method**

# 11. DEFINITION OF LABELS

## 11.1 CMO MODULE LABEL

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




(a) Model Name: N156B6 - L0A

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

(c) Serial ID: X X X X X X Y M D L N N N N

- Serial No.
- Product Line
- Year, Month, Date
- CMO Internal Use
- Revision
- CMO Internal Use

Serial ID includes the information as below:

(a) Manufactured Date: Year: 1~9, for 2001~2009

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

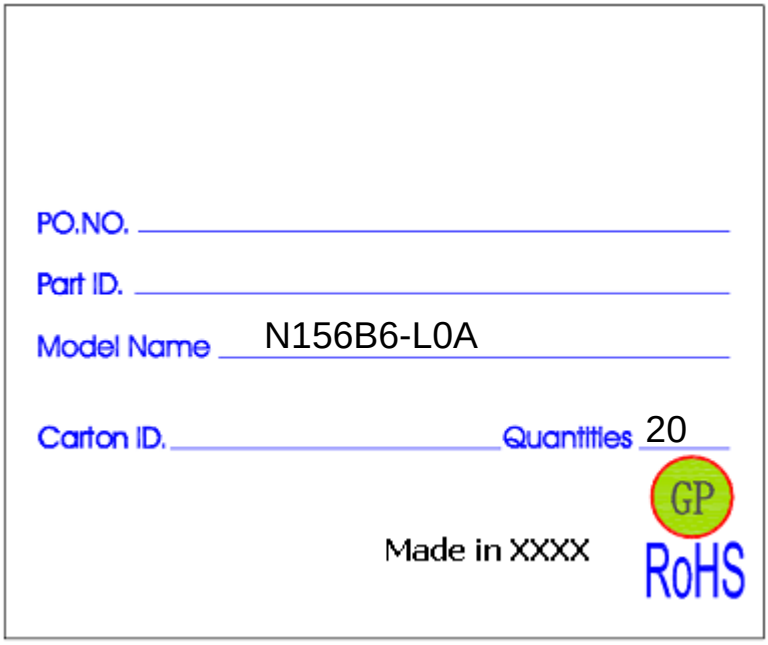
Day: 1~9, A~Y, for 1st to 31st, exclude I , O and U

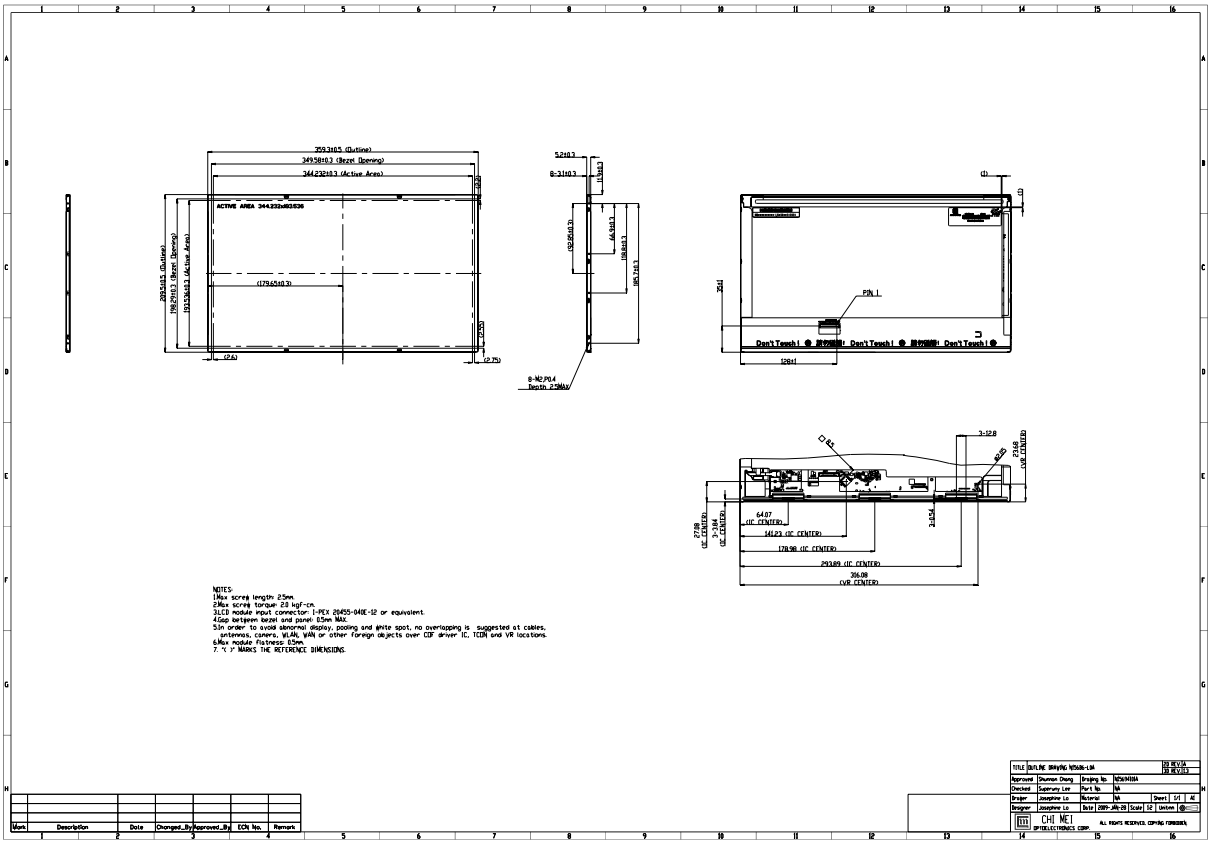
(b) Revision Code: cover all the change

(c) Serial No.: Manufacturing sequence of product

(d) Product Line: 1 -> Line1, 2 -> Line 2, …etc.

11.2 CARTON LABEL




NOTES:
1.Max screw length: 2.5mm
2.Max screw torque: 2.0 kgf-cm
3.LCD module input connector: I-PEX 20455-040E-12 or equivalent.
4.Gap between bezel and panel: 0.5mm MAX.
5.In order to avoid abnormal display, pooling and white spot, no overlapping is suggested at cables, antennas, camera, WLAN, WAN or other foreign objects over COF driver IC, TCON and VR locations.
6.Max module flatness: 0.5mm.
7. " * " MARKS THE REFERENCE DIMENSIONS.