

TFT LCD Approval Specification

MODEL NO.: M156B1-L02

| | |
|--------------|-------|
| Customer: | _____ |
| Approved by: | _____ |
| Note: | |

| 記錄 | 工作 | 審核 | 角色 | 投票 |
|----------------------------|---------------------|-------------------------------|----------|--------|
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REVISION HISTORY

| Version | Date | Section | Description |
|----------------|--------------|----------------|---|
| Ver 2.0 | June.19, 08' | - | M156B1-L02 Approval specification was first issued. |
| Ver 2.1 | Dec. 28, 08' | 3.1.1 | Update the typ. and the max. value of below items: 1. Power Supply Current in White/Black/Vertical Stripe pattern. 2. Rush Current. |

1. GENERAL DESCRIPTION

1.1 OVERVIEW

M156B1-L02 is a 15.6" TFT Liquid Crystal Display module with 2 CCFL Backlight unit and 30pin 1ch-LVDS interface. This module supports 1366 x 768 WXGA mode and can display up to 16.7M colors. The inverter module for Backlight is not built in.

1.2 FEATURES

- Contrast ratio 500:1
- Response time 8ms.
- Brightness 250nits
- Color saturation NTSC 65%.
- WXGA (1366 x 768 pixels) resolution.
- DE (Data Enable) only mode.
- LVDS (Low Voltage Differential Signaling) interface.
- RoHS compliance.

1.3 APPLICATION

- TFT LCD Monitor

1.4 GENERAL SPECIFICATIONS

| Item | Specification | Unit | Note |
|--------------------|--|-------|------|
| Active Area | 344.232(H) x 193.536(V) (15.6" diagonal) | mm | (1) |
| Bezel Opening Area | 347.5(H)x196.8(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 | 16.7M | color | - |
| Transmissive Mode | Normally White | - | - |
| Surface Treatment | AG type, 3H hard coating, Haze 25 | - | - |

1.5 MECHANICAL SPECIFICATIONS

| Item | Min. | Typ. | Max. | Unit | Note | |
|-------------|---------------|-------|-------|-------|------|-----|
| Module Size | Horizontal(H) | 363.3 | 363.8 | 364.3 | mm | (1) |
| | Vertical(V) | 215.4 | 215.9 | 216.4 | mm | |
| | Depth(D) | 13.8 | 14.3 | 14.8 | mm | |
| Weight | - | | 1300 | g | - | |

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

2. ABSOLUTE MAXIMUM RATINGS

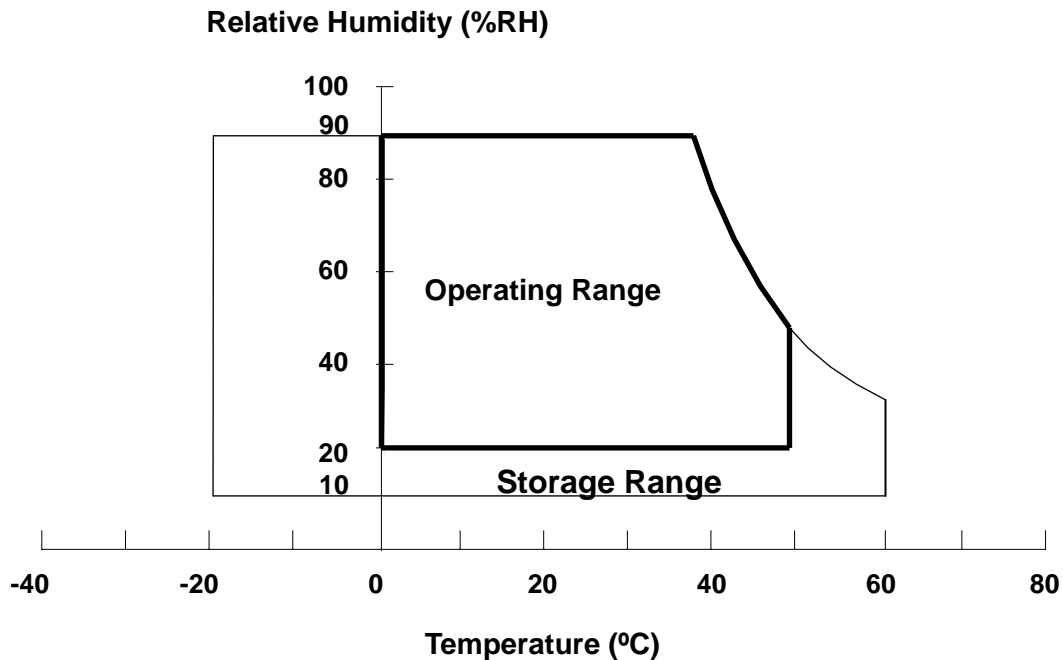
2.1 ABSOLUTE RATINGS OF ENVIRONMENT

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

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

- (a) 90 %RH Max. ($T_a \leq 40^\circ\text{C}$).
- (b) Wet-bulb temperature should be 39°C Max. ($T_a > 40^\circ\text{C}$).
- (c) No condensation.

Note (2) The temperature of panel display surface area should be 0°C Min. and 60°C Max.

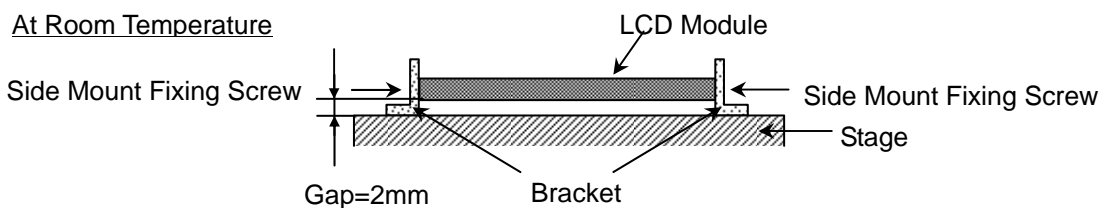


Note (3) 11ms, half sine wave, 1 time for $\pm X, \pm Y, \pm Z$.

Note (4) 10 ~ 300 Hz, 10min/cycle, 3 cycles each 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 | V _{CC} | -0.3 | +6.0 | V | (1) |
| Logic Input Voltage | V _{IN} | -0.3 | 4.3 | V | |

2.2.2 BACKLIGHT UNIT

| Item | Symbol | Value | | Unit | Note |
|----------------|----------------|-------|------|-------------------|---------------|
| | | Min. | Max. | | |
| Lamp Voltage | V _L | | 2.5K | V _{RMS} | (1), (2) |
| Lamp Current | I _L | 3 | 8 | mA _{RMS} | (1), (2) |
| Lamp Frequency | F _L | 50 | 60 | KHz | (1), (2), (3) |
| | | 40 | 80 | KHz | (1), (2), (4) |

Note (1) Permanent damage might occur if the module is operated at conditions exceeding the maximum values.

Note (2) Specified values are for lamp (Refer to 3.2 for further information).

Note (3) The frequency range can guarantee the optical and electrical characteristics.

Note (4) The frequency range will not effect the Lifetime and reliability characteristics.

3. ELECTRICAL CHARACTERISTICS

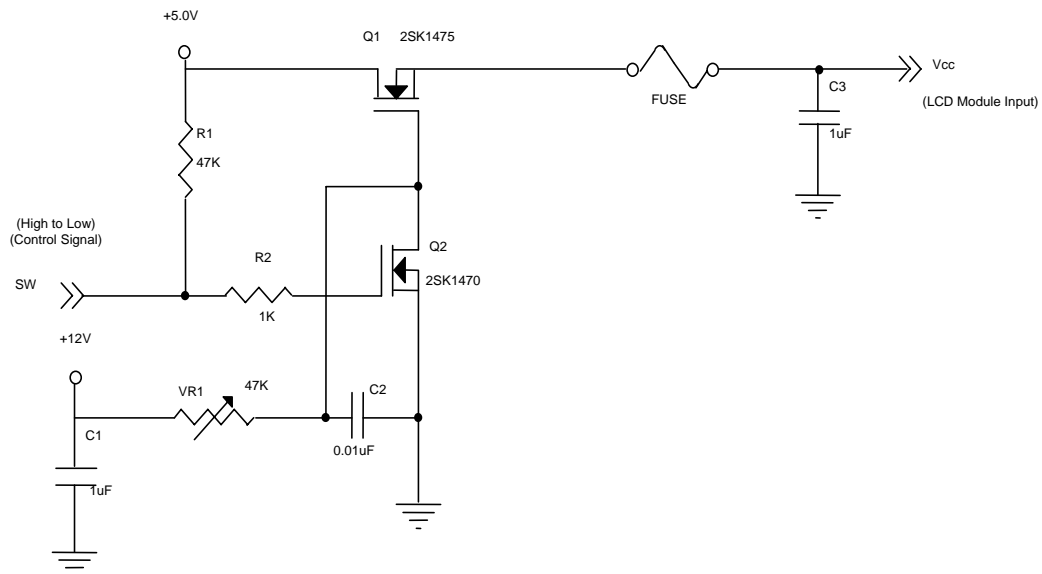
3.1.1 TFT LCD MODULE

Ta = 25 ± 2 °C

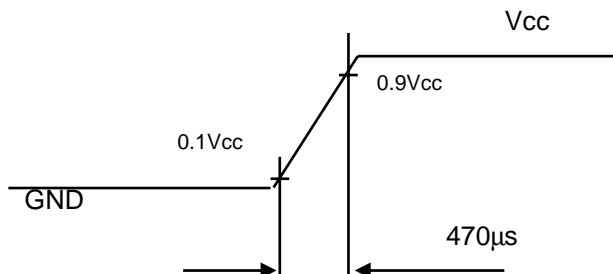
| Parameter | Symbol | Value | | | Unit | Note |
|---------------------------------|-------------------|-------|------|------|------|------|
| | | Min. | Typ. | Max. | | |
| Power Supply Voltage | V _{CC} | 4.5 | 5.0 | 5.5 | V | - |
| Ripple Voltage | V _{RP} | - | - | 100 | mV | - |
| Rush Current | I _{RUSH} | | | 1.5 | A | (2) |
| Power Supply Current | White | - | 0.34 | 0.40 | A | (3)a |
| | Black | - | 0.39 | 0.45 | A | (3)b |
| | Vertical Stripe | - | 0.43 | 0.48 | A | (3)c |
| LVDS differential input voltage | V _{id} | 100 | - | 600 | mV | |
| LVDS common input voltage | V _{ic} | - | 1.2 | - | V | |

Note (1) The module should be always operated within above ranges.

Note (2) Measurement Conditions:



Vcc rising time is 470µs



Note (3) The specified power supply current is under the conditions at $V_{cc} = 5.0\text{ V}$, $T_a = 25 \pm 2\text{ }^\circ\text{C}$, $f_v = 60\text{ Hz}$, whereas a power dissipation check pattern below is displayed.

a. White Pattern



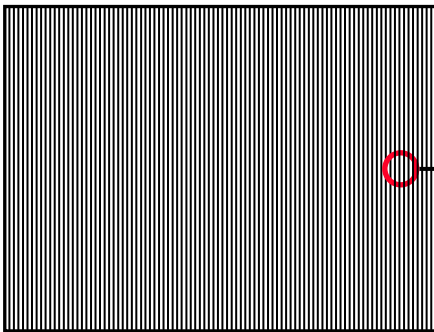
Active Area

b. Black Pattern

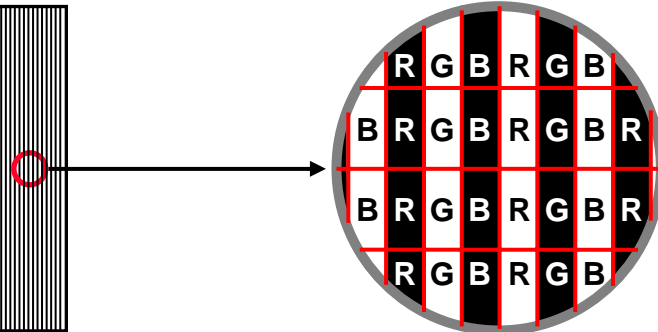


Active Area

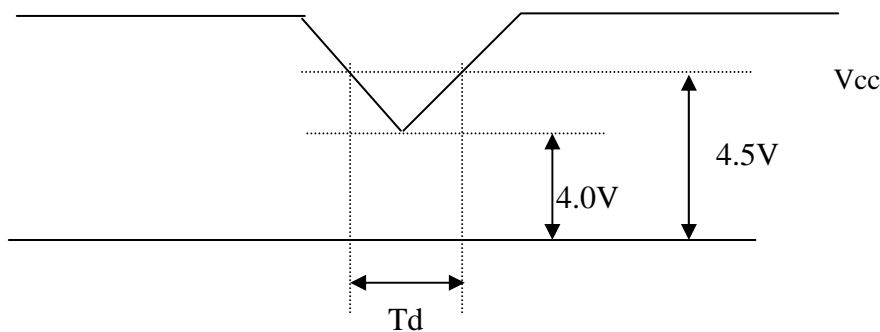
c. Vertical Stripe Pattern



Active Area



3.1.2 Vcc Power Dip Condition:



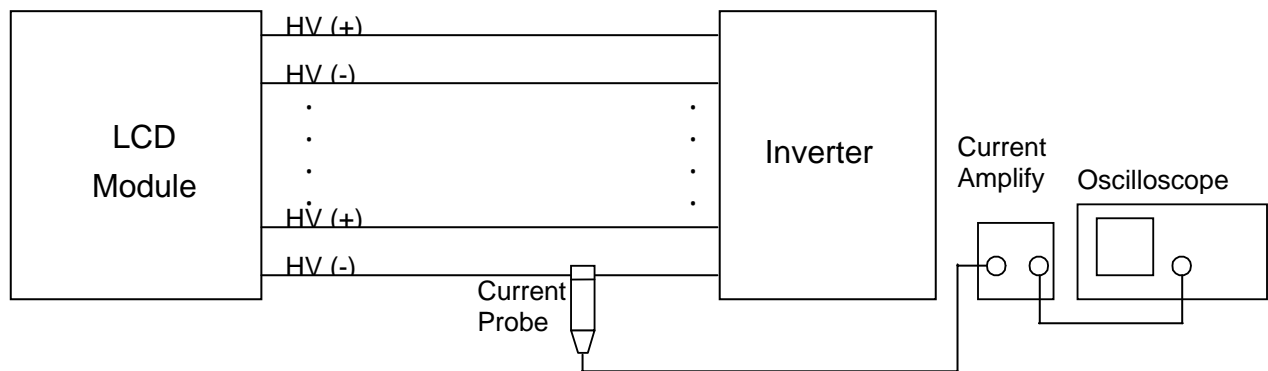
Dip condition: $4.0\text{V} \leq V_{cc} \leq 4.5\text{V}$, $T_d \leq 20\text{ms}$

3.2 BACKLIGHT UNIT

Ta = 25 ± 2 °C

| Parameter | Symbol | Value | | | Unit | Note |
|----------------------|-----------------|--------|--------|------------|-------------------|------------------------------|
| | | Min. | Typ. | Max. | | |
| Lamp Input Voltage | V _L | 585 | 650 | 715 | V _{RMS} | I _L = 7.0 mA |
| Lamp Current | I _L | 3.0 | 7.0 | 8.0 | mA _{RMS} | (1) |
| Lamp Turn On Voltage | V _s | | | 1200 (0) | V _{RMS} | (2) |
| | | | | 1100 (25) | V _{RMS} | (2) |
| Operating Frequency | F _L | 50 | 55 | 60 | KHz | (3)(7) |
| | | 40 | 55 | 80 | KHz | (3)(8) |
| Lamp Life Time | L _{BL} | 40,000 | 50,000 | | Hrs | (5), I _L = 7.0mA |
| Power Consumption | P _L | | 9.24 | | W | (4), I _L = 7.0 mA |

Note (1) Lamp current is measured by current amplifier & oscilloscope as shown below:



Measure equipment:
 Current Amplify: Tektronix TCPA300
 Current probe: Tektronix TCP312
 Oscilloscope: TDS3054B

Note (2) The voltage that must be larger than V_s should be applied to the lamp for more than 1 second after startup. Otherwise, the lamp may not be turned on normally.

Note (3) The lamp frequency may produce interference with horizontal synchronization frequency from the display, which might cause line flow on the display. In order to avoid interference, the lamp frequency should be detached from the horizontal synchronization frequency and its harmonics as far as possible.

Note (4) P_L = I_L × V_L × 2 (for 2 lamps)

Note (5) The lifetime of lamp can be defined as the time in which it continues to operate under the condition Ta = 25 ± 2 °C and I_L = **7.0** mA_{RMS} until one of the following events occurs:

- (a) When the brightness becomes 50% of its original value.
- (b) Effective lighting length decreases 80% under for initial. (Effective lighting length is a scope of luminance 80% over for average luminance at several point in lamp center.)

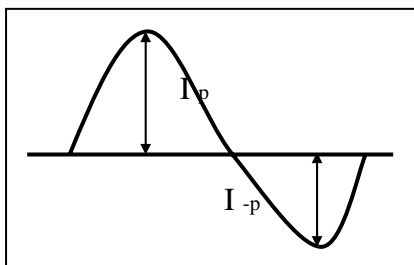
Note (6) The waveform of the voltage output of inverter must be area-symmetric and the design of the inverter must have specifications for the modularized lamp. The performance of the Backlight, such as lifetime or brightness, is greatly influenced by the characteristics of the DC-AC inverter for the lamp. All the parameters of an inverter should be carefully designed to avoid producing too

much current leakage from high voltage output of the inverter. When designing or ordering the inverter please make sure that a poor lighting caused by the mismatch of the Backlight and the inverter (miss-lighting, flicker, etc.) never occurs. If the above situation is confirmed, the module should be operated in the same manners when it is installed in your instrument.

The output of the inverter must have symmetrical (negative and positive) voltage waveform and symmetrical current waveform. (Unsymmetrical ratio is less than 10%) Please do not use the inverter which has unsymmetrical voltage and unsymmetrical current and spike wave. Lamp frequency may produce interface with horizontal synchronous frequency and as a result this may cause beat on the display. Therefore lamp frequency shall be as away possible from the horizontal synchronous frequency and from its harmonics in order to prevent interference.

Requirements for a system inverter design, which is intended to have a better display performance, a better power efficiency and a more reliable lamp. It shall help increase the lamp lifetime and reduce its leakage current.

- a. The asymmetry rate of the inverter waveform should be 10% below;
- b. The distortion rate of the waveform should be within $2 \pm 10\%$;
- c. The ideal sine wave form shall be symmetric in positive and negative polarities



* Asymmetry rate:

$$\frac{|I_p - I_{-p}|}{I_{rms}} * 100\%$$

* Distortion rate

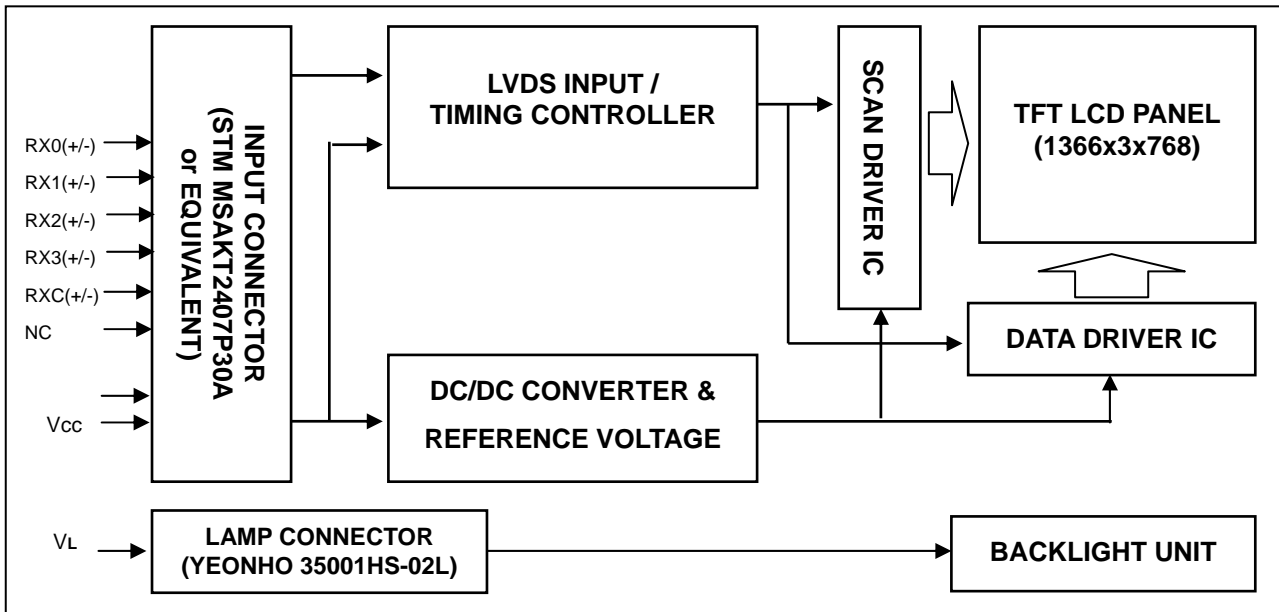
$$I_p \text{ (or } I_{-p}) / I_{rms}$$

Note (7) 50~60KHz, the frequency range can guarantee the optical and electrical characteristics.

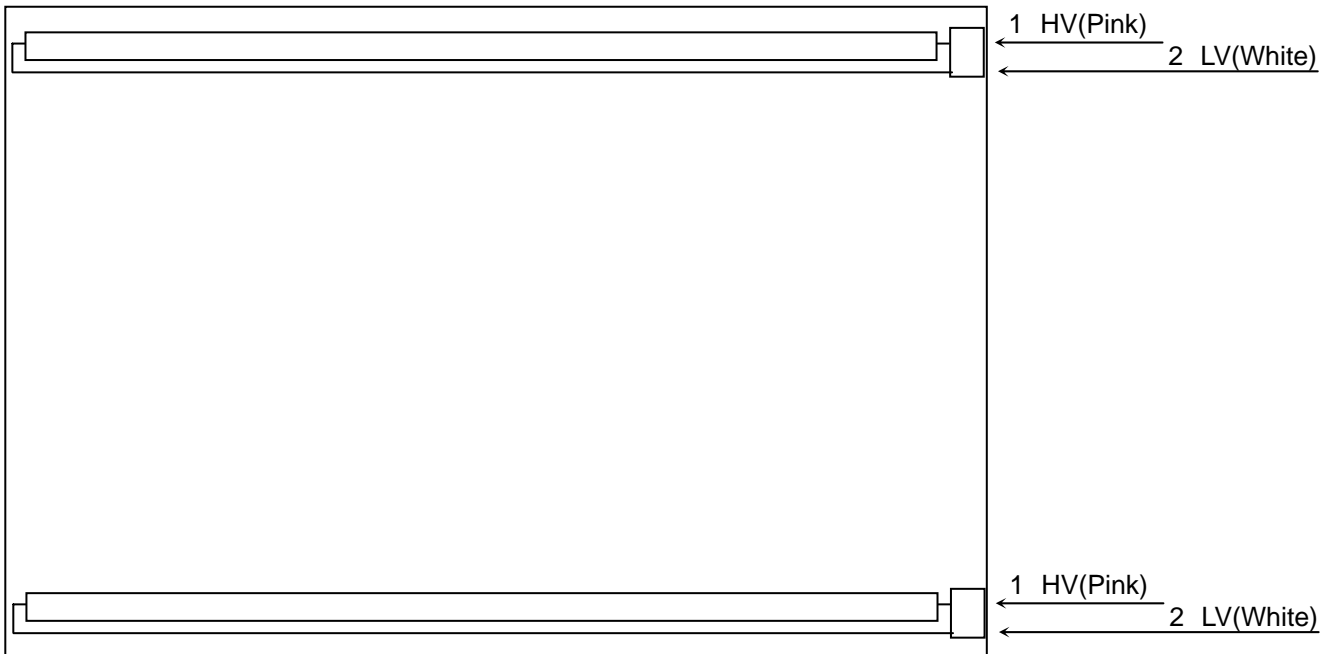
Note (8) 40~80KHz, the frequency range will not effect the Lifetime and reliability characteristics.

4. BLOCK DIAGRAM

4.1 TFT LCD MODULE



4.2 BACKLIGHT UNIT



5. INPUT TERMINAL PIN ASSIGNMENT

5.1 TFT LCD MODULE

| Pin | Name | Description |
|-----|--------|--|
| 1 | NC | No connection. |
| 2 | NC | No connection. |
| 3 | NC | No connection. |
| 4 | GND | Ground |
| 5 | RX0- | Negative LVDS differential data input. Channel 0 |
| 6 | RX0+ | Positive LVDS differential data input. Channel 0 |
| 7 | GND | Ground |
| 8 | RX1- | Negative LVDS differential data input. Channel 1 |
| 9 | RX1+ | Positive LVDS differential data input. Channel 1 |
| 10 | GND | Ground |
| 11 | RX2- | Negative LVDS differential data input. Channel 2 |
| 12 | RX2+ | Positive LVDS differential data input. Channel 2 |
| 13 | GND | Ground |
| 14 | RXCLK- | Negative LVDS differential clock input. |
| 15 | RXCLK+ | Positive LVDS differential clock input. |
| 16 | GND | Ground |
| 17 | RX3- | Negative LVDS differential data input. Channel 3 |
| 18 | RX3+ | Positive LVDS differential data input. Channel 3 |
| 19 | GND | Ground |
| 20 | NC | Not connection, this pin should be open. |
| 21 | NC | Not connection, this pin should be open. |
| 22 | NC | Reserved. (For internal test used) |
| 23 | GND | Ground |
| 24 | GND | Ground |
| 25 | GND | Ground |
| 26 | VCC | +5.0V power supply |
| 27 | VCC | +5.0V power supply |
| 28 | VCC | +5.0V power supply |
| 29 | VCC | +5.0V power supply |
| 30 | VCC | +5.0V power supply |

Note (1) Connector Part No.: STM MSAKT2407P30A or STARCONN 093G30-B0001A

5.2 LVDS mapping table

| | | | | | | | | |
|----------------|-------------|-----|-----|-----|-----|-----|-----|-----|
| LVDS Channel 0 | LVDS output | D7 | D6 | D4 | D3 | D2 | D1 | D0 |
| | Data order | G0 | R5 | R4 | R3 | R2 | R1 | R0 |
| LVDS Channel 1 | LVDS output | D18 | D15 | D14 | D13 | D12 | D9 | D8 |
| | Data order | B1 | B0 | G5 | G4 | G3 | G2 | G1 |
| LVDS Channel 2 | LVDS output | D26 | D25 | D24 | D22 | D21 | D20 | D19 |
| | Data order | DE | NA | NA | B5 | B4 | B3 | B2 |
| LVDS Channel 3 | LVDS output | D23 | D17 | D16 | D11 | D10 | D5 | D27 |
| | Data order | NA | B7 | B6 | G7 | G6 | R7 | R6 |

5.3 BACKLIGHT UNIT:

| Pin | Symbol | Description | Remark |
|-----|--------|--------------|--------|
| 1 | HV | High Voltage | Pink |
| 2 | LV | Low Voltage | White |

Note (1): Connector Part No.: YEONHO 35001HS-02L or equivalent

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 | R7 | R6 | G5 | G4 | G3 | G2 | G1 | G0 | R7 | R6 | 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 | |
| | 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 | |
| | 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 | |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | |
| | 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 | |
| | 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 | |
| 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 | | |
| 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 | |
| | Green(1) | 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 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | |
| | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | : | |
| | Green(253) | 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 | 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 | 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 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | |
| | Blue(254) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | |
| Blue(255) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | |

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

6. INTERFACE TIMING

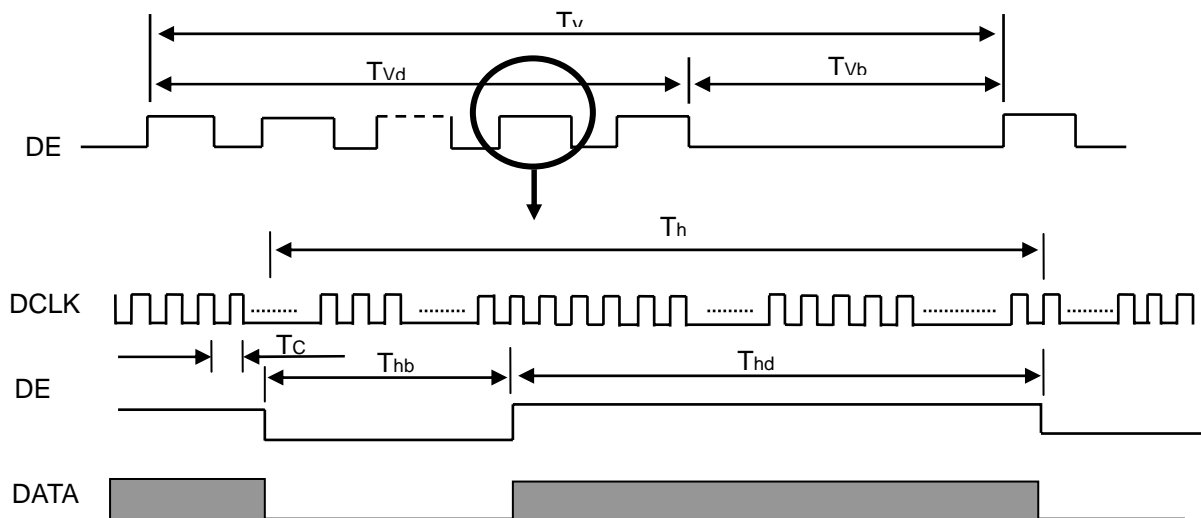
6.1 INPUT SIGNAL TIMING SPECIFICATIONS

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

| Signal | Item | Symbol | Min. | Typ. | Max. | Unit | Note |
|--------------------------------|------------|-----------|----------------|------|----------------|-------|-------------------------|
| LVDS Clock | Frequency | F_c | 50.0 | 76 | 85 | MHz | - |
| | Period | T_c | - | 13.0 | - | ns | - |
| | High Time | T_{ch} | - | 4/7 | - | T_c | - |
| | Low Time | T_{cl} | - | 3/7 | - | T_c | - |
| LVDS Data | Setup Time | T_{lvs} | 600 | - | - | ps | - |
| | Hold Time | T_{lvh} | 600 | - | - | ps | - |
| Vertical Active Display Term | Frame Rate | F_r | 40 | 60 | 76 | Hz | $T_v = T_{vd} + T_{vb}$ |
| | Total | T_v | 778 | 806 | 888 | T_h | - |
| | Display | T_{vd} | 768 | 768 | 768 | T_h | - |
| | Blank | T_{vb} | $T_v - T_{vd}$ | 38 | $T_v - T_{vd}$ | T_h | - |
| Horizontal Active Display Term | Total | T_h | 1446 | 1560 | 1936 | T_c | $T_h = T_{hd} + T_{hb}$ |
| | Display | T_{hd} | 1366 | 1366 | 1366 | T_c | - |
| | Blank | T_{hb} | $T_h - T_{hd}$ | 194 | $T_h - T_{hd}$ | T_c | - |

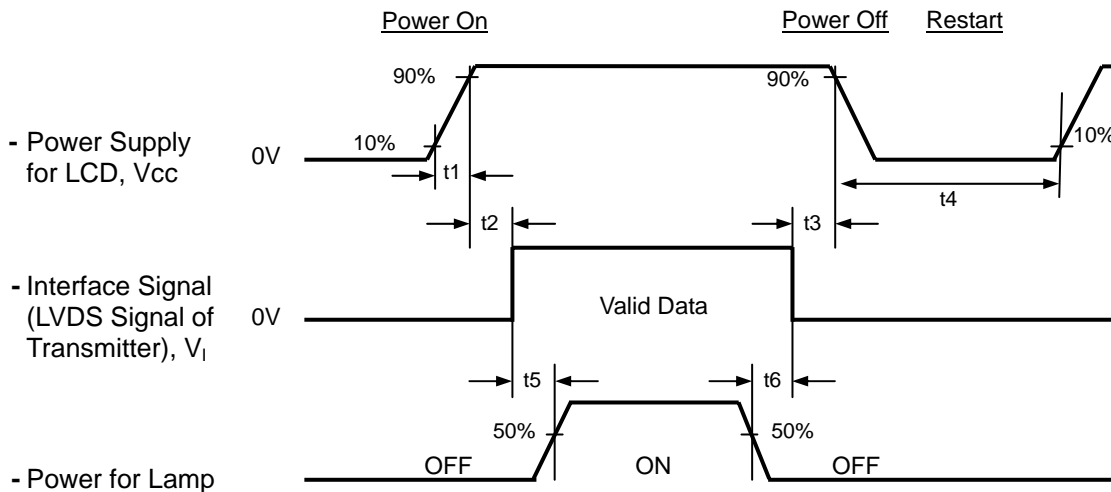
Note: Because this module is operated by DE only mode, Hsync and Vsync input signals should be set to low logic level or ground. Otherwise, this module would operate abnormally.

INPUT SIGNAL TIMING DIAGRAM



6.2 POWER ON/OFF SEQUENCE

To prevent a latch-up or DC operation of LCD module, the power on/off sequence should be as the diagram below.



Timing Specifications:

| | |
|----------------------|----------|
| 0.5 < t ₁ | 10 msec |
| 0 < t ₂ | 50 msec |
| 0 < t ₃ | 50 msec |
| t ₄ | 500 msec |
| t ₅ | 450 msec |
| t ₆ | 90 msec |
| 5 t ₇ | 100 msec |

7. OPTICAL CHARACTERISTICS

7.1 TEST CONDITIONS

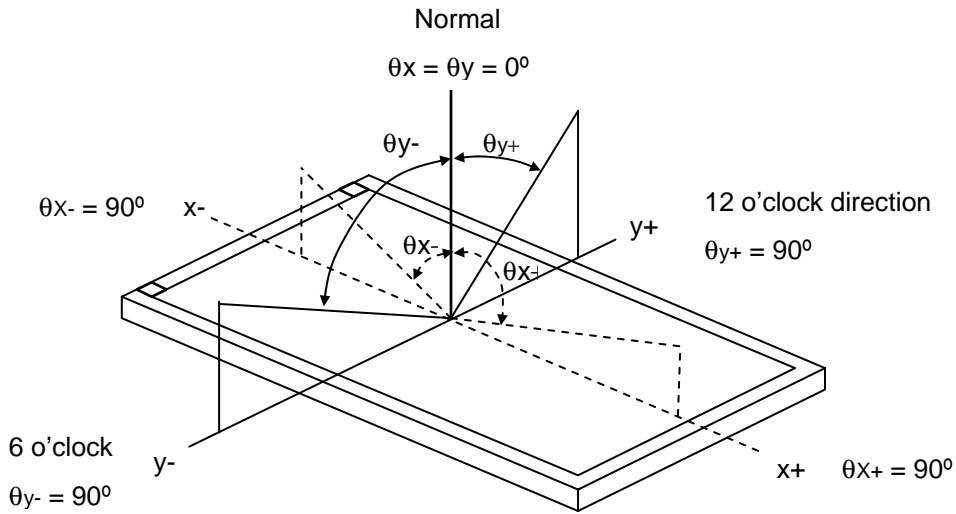
| Item | Symbol | Value | Unit |
|------------------------------|---|-------|------|
| Ambient Temperature | Ta | 25±2 | °C |
| Ambient Humidity | Ha | 50±10 | %RH |
| Supply Voltage | V _{CC} | 5V | V |
| Input Signal | According to typical value in "3. ELECTRICAL CHARACTERISTICS" | | |
| Lamp Current | I _L | 7.0 | mA |
| Inverter Operating Frequency | F _L | 55±5 | KHz |
| Inverter | Darfon VK12164.101 | | |

7.2 OPTICAL SPECIFICATIONS

The relative measurement methods of optical characteristics are shown in 7.2. The following items should be measured under the test conditions described in 7.1 and stable environment shown in Note (5).

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit | Note | | |
|--|----------------------|--|------------|------------|------|-------------------|----------|-----------------|-------|
| Color Chromaticity (CIE 1931) | Red | $\theta_x=0^\circ, \theta_y=0^\circ$ CS-1000T | Typ - 0.03 | Typ + 0.03 | - | - | (1), (5) | | |
| | | | | | | | | Rx | 0.639 |
| | Ry | | | | | | | 0.334 | |
| | Green | | | | | | | Gx | 0.285 |
| | | | | | | | | Gy | 0.597 |
| | Blue | | | | | | | Bx | 0.154 |
| | | | | | | | | By | 0.085 |
| | White | | | | | | | Wx | 0.283 |
| Wy | | 0.299 | 0.329 | 0.359 | | | | | |
| Center Luminance of White (Center of Screen) | L _c | | 210 | 250 | - | cd/m ² | (4), (5) | | |
| Contrast Ratio | CR | | 350 | 500 | - | - | (2), (5) | | |
| Response Time | T _R | $\theta_x=0^\circ, \theta_y=0^\circ$ | - | 2 | 4 | ms | (3), (7) | | |
| | T _F | | - | 6 | 12 | | | | |
| | T _{GIG AVE} | | - | - | - | | | | |
| White Variation | δW | $\theta_x=0^\circ, \theta_y=0^\circ$ USB2000 | - | 1.4 | 1.5 | - | (5), (6) | | |
| Viewing Angle | Horizontal | CR 10 USB2000 | 75 | 85 | - | Deg. | (1), (5) | | |
| | | | | | | | | θ _{x+} | |
| | θ _{x-} | | | | | | | | |
| | Vertical | | | | | | | θ _{y+} | 70 |
| θ _{y-} | | 70 | 80 | - | | | | | |

Note (1) Definition of Viewing Angle (θ_x , θ_y):



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

The contrast ratio can be calculated by the following expression.

$$\text{Contrast Ratio (CR)} = L_{255} / L_0$$

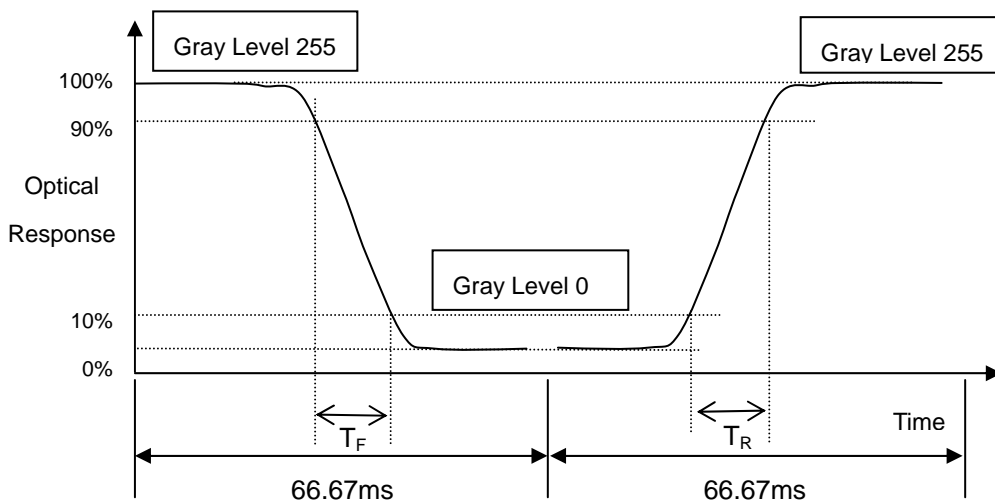
L255: Luminance of gray level 255

L 0: Luminance of gray level 0

$$\mathbf{CR = CR (1)}$$

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 Luminance of White (L_c):

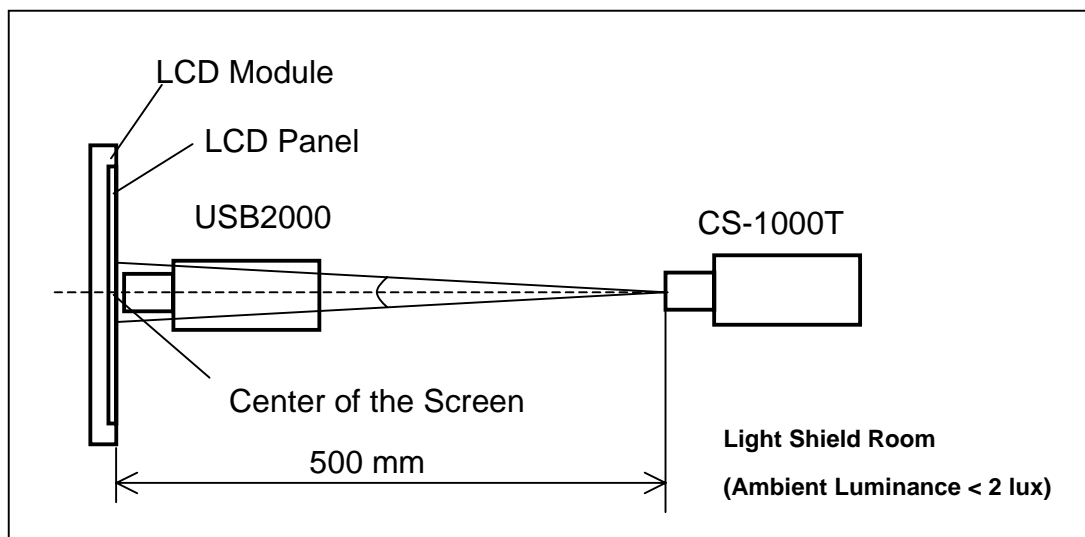
Measure the luminance of gray level 255 at center point

$$L_c = L(1)$$

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

Note (5) Measurement Setup:

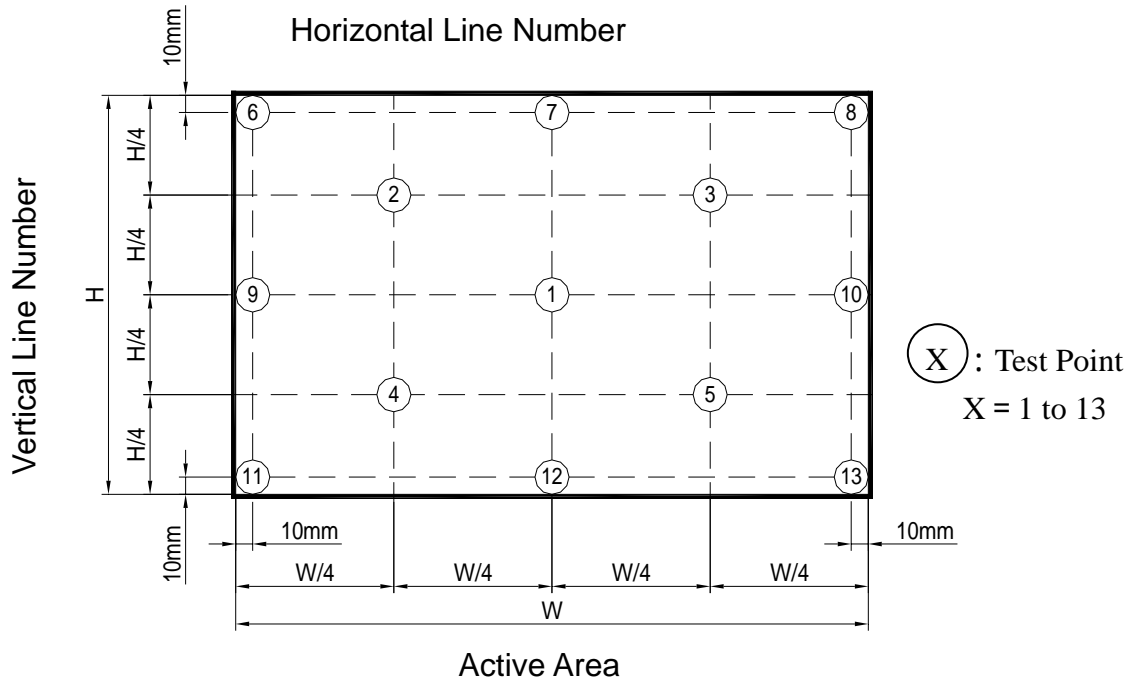
The LCD module should be stabilized at given temperature for 20 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting Backlight for 20 minutes in a windless room.



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

Measure the luminance of gray level 255 at 13 points

$$\delta W = \frac{\text{Maximum [L(1), L(2), L(3), L(4), L(5), L(6), L(7), L(8), L(9), L(10), L(11), L(12), L(13)]}}{\text{Minimum [L(1), L(2), L(3), L(4), L(5), L(6), L(7), L(8), L(9), L(10), L(11), L(12), L(13)]}}$$



Note (7) Definition of Response Time (T_{GTG_AVE}):

T_{GTG_AVE} is defined as the total average response time for "Gray To Gray".

The Gray to Gray response time is defined as the following chart.

| Gray to Gray | | Target Gray | | | | | | | | |
|--------------|------|-------------|-----|-----|-----|------|------|------|------|------|
| | | G0 | G32 | G64 | G96 | G128 | G160 | G192 | G224 | G255 |
| Initial Gray | G0 | | | | | | | | | |
| | G32 | | | | | | | | | |
| | G64 | | | | | | | | | |
| | G96 | | | | | | | | | |
| | G128 | | | | | | | | | |
| | G160 | | | | | | | | | |
| | G192 | | | | | | | | | |
| | G224 | | | | | | | | | |
| G255 | | | | | | | | | | |

8. PACKAGING :

8.1 PACKING SPECIFICATIONS

- (1) 10 LCD modules / 1 Box
- (2) Box dimensions: 489(L) X 382(W) X 330(H) mm
- (3) Weight: approximately 15.7Kg (10 modules per box)

8.2 PACKING METHOD

- (1) Carton Packing should have no failure in the following reliability test items.

| Test Item | Test Conditions | Note |
|---------------|--|---------------|
| Vibration | ISTA STANDARD Random, Frequency Range: 1 – 200 Hz Top & Bottom: 30 minutes (+Z), 10 min (-Z), Right & Left: 10 minutes (X) Back & Forth 10 minutes (Y) | Non Operation |
| Dropping Test | 1 Angle, 3 Edge, 6 Face, 60cm | Non Operation |

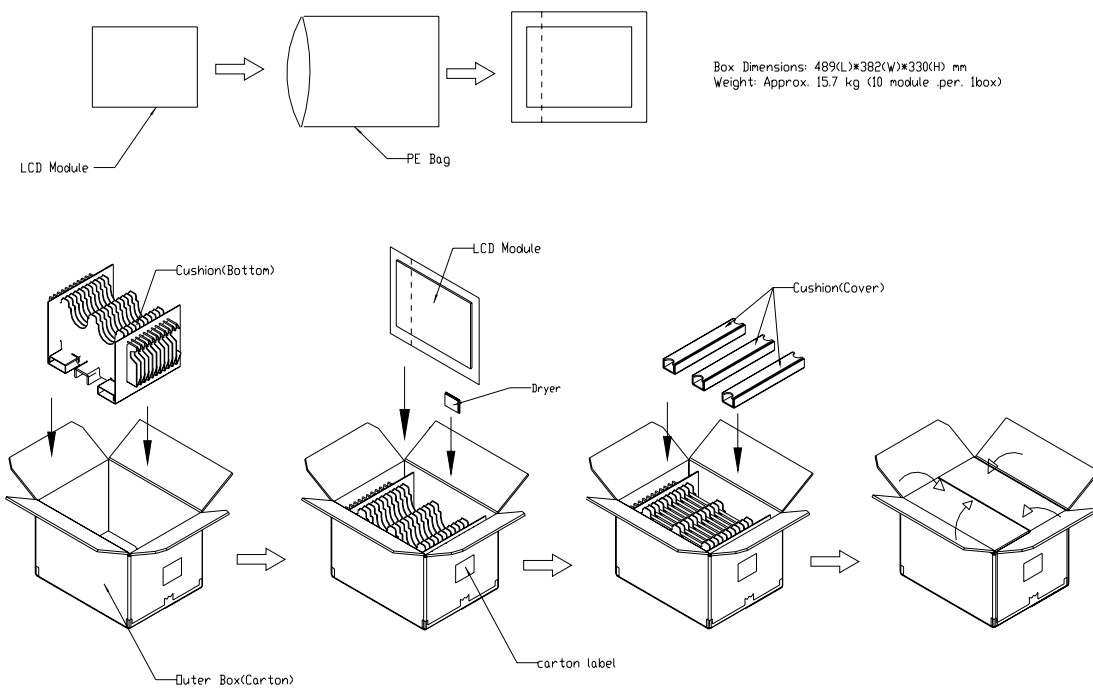


Figure. 8-1 Packing method

Sea and land transportation

Sea and land transportation

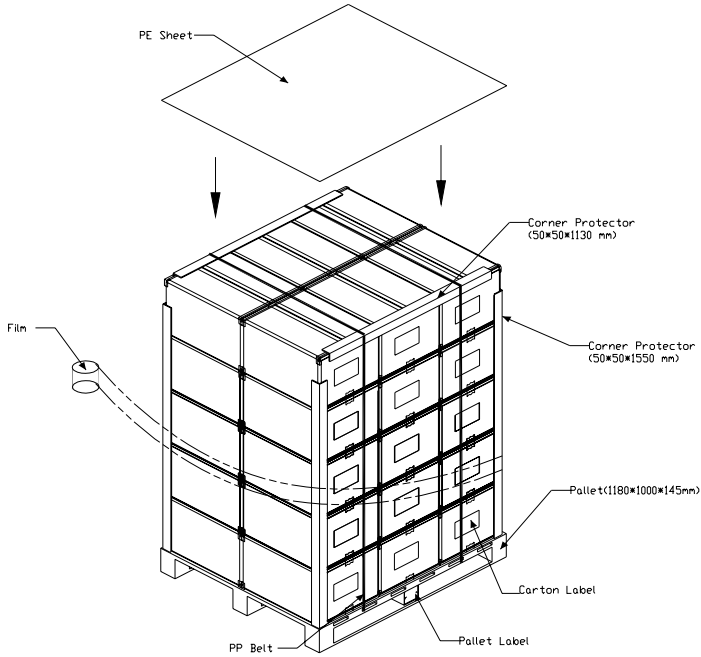


Figure. 8-2 Packing method

Air transportation

Air transportation

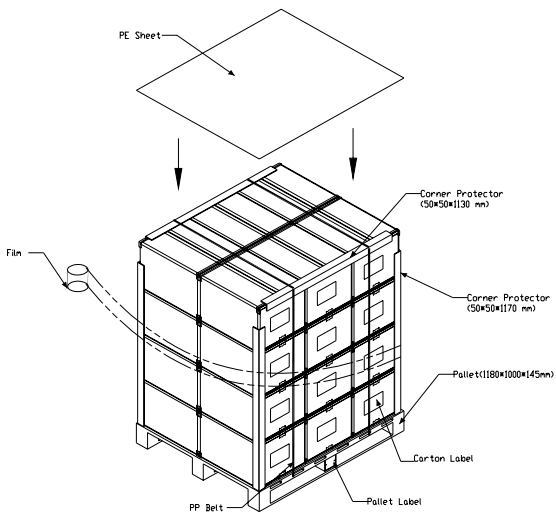


Figure. 8-3 Packing method

9. DEFINITION OF LABELS

9.1 CMO MODULE LABEL

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



- (a) Model Name: M156B1-L02
- (b) Revision: Rev. XX, for example: A0, A1... B1, B2... or C1, C2...etc.
- (c) CMO barcode definition:

Serial ID: XX-XX-X-XX-YMD-L-NNNN

| Code | Meaning | Description |
|------|------------------|---|
| XX | CMO internal use | - |
| XX | Revision | Cover all the change |
| X | CMO internal use | - |
| XX | CMO internal use | - |
| YMD | Year, month, day | Year: 2001=1, 2002=2, 2003=3, 2004=4... Month: 1~12=1, 2, 3, ~, 9, A, B, C Day: 1~31=1, 2, 3, ~, 9, A, B, C, ~, W, X, Y, exclude I, O, and U. |
| L | Product line # | Line 1=1, Line 2=2, Line 3=3, ... |
| NNNN | Serial number | Manufacturing sequence of product |

- (d) Customer's barcode definition:

Serial ID: CM-15B12-X-X-X-XX-L-XX-L-YMD-NNNN

| Code | Meaning | Description |
|-------|-----------------------|---|
| CM | Supplier code | CMO=CM |
| 15B11 | Model number | M156B1-L02 = 15B12 |
| X | Revision code | Non ZBD: 1,~,9,0 / ZBD: A~Z |
| X | Source driver IC code | Century=1, CLL=2, Demos=3, Epson=4, Fujitsu=5, Himax=6, Hitachi=7, Hynix=8, LDI=9, Matsushita=A, NEC=B, Novatec=C, OKI=D, Philips=E, Renesas=F, Samsung=G, Sanyo=H, Sharp=I, TI=J, Topro=K, Toshiba=L, Windbond=M |
| X | Gate driver IC code | |
| XX | Cell location | Tainan Taiwan=TN, Ningbo China=NP |
| L | Cell line # | 1~12=1~C |
| XX | Module location | Tainan Taiwan=TN, Ningbo China=NP |
| L | Module line # | 1~12=1~C |
| YMD | Year, month, day | Year: 2001=1, 2002=2, 2003=3, 2004=4... Month: 1~12=1, 2, 3, ~, 9, A, B, C Day: 1~31=1, 2, 3, ~, 9, A, B, C, ~, T, U, V |
| NNNN | Serial number | By LCD supplier |

10. PRECAUTIONS

10.1 ASSEMBLY AND HANDLING PRECAUTIONS

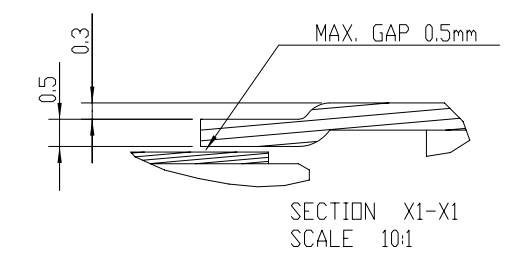
- (1) Do not apply rough force such as bending or twisting to the module during assembly.
- (2) To assemble or install module into user's system can be only in clean working areas. The dust and oil may cause electrical short or worsen the polarizer.
- (3) It's not permitted to have pressure or impulse 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°C may reduce the display quality. For example, the response time will become slowly, and the starting voltage of CCFL will be higher than room temperature.

10.2 SAFETY PRECAUTIONS

- (1) The startup voltage of Backlight is approximately 1000 Volts. It may cause electrical shock while assembling with inverter. Do not disassemble the module or insert anything into the Backlight unit.
- (2) 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.
- (3) After the module's end of life, it is not harmful in case of normal operation and storage.

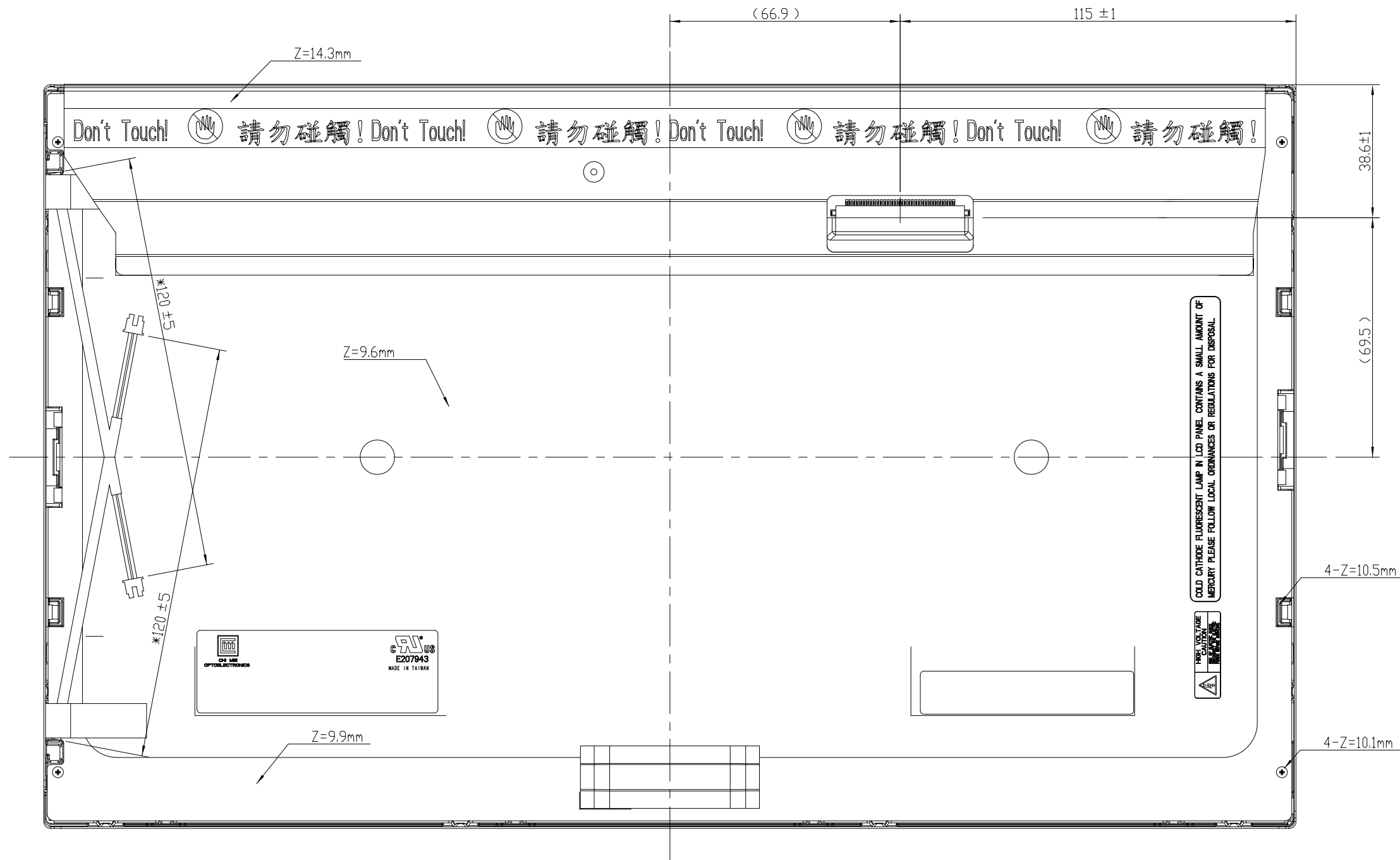


NOTES:
 1. OUTLINE TOLERANCE: ±0.5mm.
 2. I/F CONNECTOR SPEC: STM MSAKT2407P30A OR EQUIVALENT.
 3. LAMP CONNECTOR: YEONHO_LOCKING_TYPE 35001HS-02L OR EQUIVALENT.
 4. SIDE MOUNT HOLE TORQUE : 5Kgf-cm (MAX.).



| | | | | | |
|----------|--------------|------------------------------|-------------|---|----------|
| TITLE | | ASSY_MODULE_M156B1-L01 / L02 | | 2D REV. A | |
| | | | | 3D REV. 1.8 | |
| Approved | Tiger Chang | Drawing No. | M15614101A | | |
| Checked | Alan Lee | Part No. | TBD | | |
| Drawer | Honglong Hsu | Material | TBD | Sheet | 1 / 2 A2 |
| Designer | Honglong Hsu | Date | 16-May-2008 | Scale | 1:1 |
| | | | | Unit:mm | |
| | | | | CHI MEI OPTOELECTRONICS CORP. ALL RIGHTS RESERVED, COPYING FORBIDDEN. | |

| Mark | Description | Date | Changed_By | Approved_By | ECN No. | Remark |
|------|-------------|------|------------|-------------|---------|--------|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |
| 7 | | | | | | |
| 8 | | | | | | |



NOTES:
 1. OUTLINE TOLERANCE: ±0.5mm.
 2. I/F CONNECTOR SPEC: STM MSAKT2407P30A OR EQUIVALENT.
 3. LAMP CONNECTOR: YEDNHO_LOCKING_TYPE 35001HS-02L OR EQUIVALENT.
 4. SIDE MOUNT HOLE TORQUE : 5Kgf-cm(MAX.).

| | | | | | |
|---|--------------|------------------------------|-------------|-------------|----------|
| TITLE | | ASSY_MODULE_M156B1-L01 / L02 | | 2D REV. A | |
| | | | | 3D REV. 1.8 | |
| Approved | Tiger Chang | Drawing No. | M15614101A | | |
| Checked | Alan Lee | Part No. | TBD | | |
| Drawer | Honglong Hsu | Material | TBD | Sheet | 2 / 2 A2 |
| Designer | Honglong Hsu | Date | 16-May-2008 | Scale | 1:1 |
| | | | | Unit | mm |
| | | | | | |
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| Mark | Description | Date | Changed_By | Approved_By | ECN No. | Remark |
|------|-------------|------|------------|-------------|---------|--------|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |
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| 8 | | | | | | |