



**REVISION RECORD**

| REVISION      | REVISION DATE     | PAGE | CONTENTS            |
|---------------|-------------------|------|---------------------|
| <b>VER1.0</b> | <b>09/30-2020</b> |      | <b>FIRST ISSUED</b> |

**※ CONTENTS**

1. GENERAL SPECIFICATIONS
2. MECHANICAL SPECIFICATION
3. PIN ASSIGNMENT
4. OPERATING SPECIFICATIONS
5. OPTICAL SPECIFICATIONS
6. RELIABILITY TEST
7. MECHANICAL DRAWING
8. PRECAUTION FOR USING LCM
9. INSPECTION SPECIFICATION

## 1. GENERAL SPECIFICATIONS

ATM1560L1-CT is a 15.6" TFT Liquid Crystal Display module with LED backlight unit and a 40-pin LVDS interface. It features a PCAP touch interface that can be connected via USB or I2C bus. The LCD has a 1920 x 1080 FHD resolutions and is based the an IPS technology supporting 16,194,277 colors.

| Item                            | Specification                           | Remark |
|---------------------------------|-----------------------------------------|--------|
| 1. LCD size                     | 15.6 inch(Diagonal)                     |        |
| 2. Driver element               | a-Si TFT active matrix                  |        |
| 3. Resolution                   | 1920 x 1080                             |        |
| 4. Display mode                 | Normally black                          |        |
| 5. Dot Pitch (W*H)              | 0.17925 (H) x 0.17925 (V)               |        |
| 6. Active Area (W*H)            | 344.16 (H) x 193.59 (V)                 |        |
| 7. Module size (W*H)            | 387.73mm(W) x 237.09mm(H) x 12.05 mm(D) | Note 1 |
| 8. Surface treatment            | Glare                                   |        |
| 9. Color arrangement            | RGB-stripe                              |        |
| 10. Interface LCD               | LVDS                                    |        |
| 11. Interface touch             | USB, I2C                                |        |
| 12. Backlight power consumption | 12 W                                    |        |
| 13. Panel power consumption     | 4 W                                     |        |
| 14. Weight                      | 1520 g                                  |        |
| 15. RoHS                        | ROHS compliant                          |        |

**Note 1:** Please refer to mechanical drawing.

## 2.0 MECHANICAL SPECIFICATION

| Item            |                | Min.   | Typ.   | Max.   | Unit |
|-----------------|----------------|--------|--------|--------|------|
| LCD Module Size | Horizontal (H) | 363.3  | 363.8  | 364.3  | mm   |
|                 | Vertical (V)   | 215.4  | 215.9  | 216.4  | mm   |
| Assembly Size   | Horizontal (H) | 387.43 | 387.73 | 388.03 | mm   |
|                 | Vertical (V)   | 236.79 | 237.09 | 237.39 | mm   |
|                 | Thickness (T)  | 11.1   | 12.05  | 13.0   | mm   |

### 3. PIN ASSIGNMENT

#### 3.1 LVDS CONNECTOR

| Pin | Name    | Description                                              |
|-----|---------|----------------------------------------------------------|
| 1   | LED_Vcc | +12V Vi power supply                                     |
| 2   | LED_Vcc | +12V Vi power supply                                     |
| 3   | LED_Vcc | +12V Vi power supply                                     |
| 4   | LED_Vcc | +12V Vi power supply                                     |
| 5   | GND     | Ground                                                   |
| 6   | GND     | Ground                                                   |
| 7   | GND     | Ground                                                   |
| 8   | GND     | Ground                                                   |
| 9   | LED_EN  | Enable pin                                               |
| 10  | LED_PWM | Backlight Adjust                                         |
| 11  | LCD_VCC | LCD logic and driver power 3.3V                          |
| 12  | LCD_VCC | LCD logic and driver power 3.3V                          |
| 13  | LCD_VCC | LCD logic and driver power 3.3V                          |
| 14  | NC      | Not connection, this pin should be open                  |
| 15  | NC      | Not connection, this pin should be open                  |
| 16  | NC      | Not connection, this pin should be open                  |
| 17  | LCD GND | LCD logic and driver ground                              |
| 18  | RX00-   | Negative LVDS differential data input. Channel O0 (odd)  |
| 19  | RX00+   | Positive LVDS differential data input. Channel O0 (odd)  |
| 20  | RX01-   | Negative LVDS differential data input. Channel O1 (odd)  |
| 21  | RX01+   | Positive LVDS differential data input. Channel O1 (odd)  |
| 22  | RX02-   | Negative LVDS differential data input. Channel O2 (odd)  |
| 23  | RX02+   | Positive LVDS differential data input. Channel O2 (odd)  |
| 24  | LCD GND | LCD logic and driver ground                              |
| 25  | RXOC-   | Negative LVDS differential clock input. (odd)            |
| 26  | RXOC+   | Positive LVDS differential clock input. (odd)            |
| 27  | LCD GND | LCD logic and driver ground                              |
| 28  | RX03-   | Negative LVDS differential data input. Channel O3(odd)   |
| 29  | RX03+   | Positive LVDS differential data input. Channel O3 (odd)  |
| 30  | RXE0-   | Negative LVDS differential data input. Channel E0 (even) |
| 31  | RXE0+   | Positive LVDS differential data input. Channel E0 (even) |
| 32  | RXE1-   | Negative LVDS differential data input. Channel E1 (even) |
| 33  | RXE1+   | Positive LVDS differential data input. Channel E1 (even) |
| 34  | LCD GND | LCD logic and driver ground                              |
| 35  | RXE2-   | Negative LVDS differential data input. Channel E2 (even) |
| 36  | RXE2+   | Positive LVDS differential data input. Channel E2 (even) |
| 37  | RXEC-   | Negative LVDS differential clock input. (even)           |
| 38  | RXEC+   | Positive LVDS differential clock input. (even)           |
| 39  | RXE3-   | Negative LVDS differential data input. Channel E3 (even) |
| 40  | RXE3+   | Positive LVDS differential data input. Channel E3 (even) |

Note (1) Connector Part No.: I-PEX 20455-040E-76 or equivalent.

Note (2) User's connector Part No.: I-PEX 20453-040T-03 or equivalent.

### 3.2 TOUCH PANEL

| Pin No. | Symbol               | Function |
|---------|----------------------|----------|
| 1       | GND                  | Ground   |
| 2       | I <sup>2</sup> C-SDA | SDA      |
| 3       | I <sup>2</sup> C-SCL | SCL      |
| 4       | VDD                  | 5V       |
| 5       | I <sup>2</sup> C-INT | INT      |
| 6       | /RST                 | RESET    |

Connector: E&T (3802K-E06N-01X)

| Pin No. | Symbol    | Function     |
|---------|-----------|--------------|
| 1       | GND-EARTH | GROUND EARTH |
| 2       | VDD       | 5V           |
| 3       | GND       | Ground       |
| 4       | D+        | USB signal + |
| 5       | D-        | USB signal - |

Connector: E&T (3802K-E05N-01X)

## 4. OPERATING SPECIFICATIONS

### 4.1 ABSOLUTE MAXIMUM RATINGS

| Item                  | Symbol              | Values |      | Unit | Remark                            |
|-----------------------|---------------------|--------|------|------|-----------------------------------|
|                       |                     | Min.   | Max. |      |                                   |
| Power Voltage         | V <sub>CC</sub>     | -0.3   | 3.6  | V    | Note 1                            |
| Logic Input Voltage   | V <sub>IN</sub>     | -0.3   | 4.0  | V    | Note 1                            |
| Operation Temperature | T <sub>OP</sub>     | -20    | 70   | °C   |                                   |
| Storage Temperature   | T <sub>ST</sub>     | -40    | 80   | °C   | Note 1, 2                         |
| LED Voltage           | LED V <sub>IN</sub> | 0      | 18   | V    | Note 1                            |
| LED Forward Current   | I <sub>LED</sub>    | 0.8    | 1.2  | A    | V <sub>in</sub> =12V<br>100% duty |

**Note 1:** The absolute maximum rating values of this product are not allowed to be exceeded at any times. Should a module be used with any of the absolute maximum ratings exceeded, the characteristics of the module may not be recovered, or in an extreme case, the module may be permanently destroyed.

**Note 2:** Temperature and relative humidity range is shown in the figure below.

(a) 90 %RH Max. (T<sub>a</sub> ≤ 40 °C).

(b) Wet-bulb temperature should be 39 °C Max. (T<sub>a</sub> > 40 °C).

(c) No condensation.

#### 4.1.1 Typical Operation Conditions

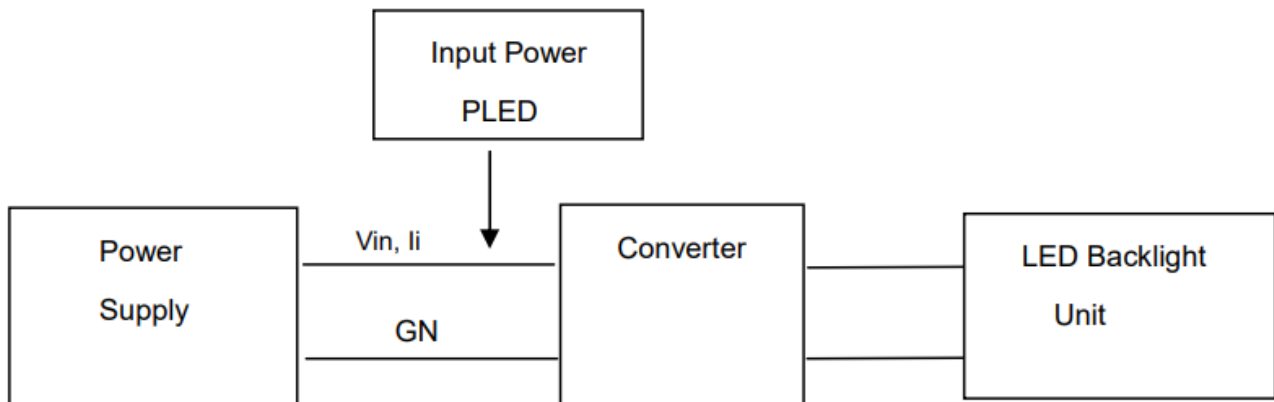
| Item                            | Symbol           | Values |      |      | Unit | Remark |
|---------------------------------|------------------|--------|------|------|------|--------|
|                                 |                  | Min.   | Typ. | Max. |      |        |
| Power Voltage                   | DV <sub>DD</sub> | 3.15   | 3.3  | 3.6  | V    |        |
|                                 | V <sub>RP</sub>  | -      | -    | 150  | V    |        |
|                                 | I <sub>RP</sub>  | -      | -    | 3    | A    |        |
| POWER CONSUMPTION               | PLCD             | -      | 4    | 5    | Watt |        |
| LVDS differential input voltage | V <sub>id</sub>  | 200    |      | 600  | mV   |        |
| LVDS common input voltage       | V <sub>ic</sub>  | 1.0    | 1.2  | 1.4  | V    |        |
| LVDS terminating resistor       | R <sub>t</sub>   |        | 100  |      | Ohm  |        |

#### 4.1.2 Backlight driving conditions

| 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 |                | li               | 0.8    | 1.0  | 1.2  | A    | @LED_Vin= 12V<br>Duty=100%      |
| Converter Input Rush Current   |                | lirsh            |        |      | 3    | A    | @LED_Vin rising<br>= 1mS        |
| Power Consumption              |                | P <sub>LED</sub> |        | 12   |      | W    | @ LED_Vin =<br>12V<br>Duty=100% |
| EN Control Level               | Backlight on   | LED_EN           | 2.0    | 5    | 5.5  | V    |                                 |
|                                | Backlight off  |                  | 0      | 0    | 0.8  |      |                                 |
| PWM Control Level              | PWM High Level | LED_PWM          | 2.0    | 3.3  | 5.0  | V    |                                 |
|                                | PWM Low Level  |                  | 0      | 0    | 0.15 |      |                                 |
| PWM Control Duty Ratio         |                |                  | 10     | --   | 100  | %    |                                 |
| PWM Control Frequency          |                | f <sub>PWM</sub> | 190    | 200  | 20k  | Hz   |                                 |
| LED Life Time                  |                | L <sub>L</sub>   | 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°C 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.



## 4.2 LVDS INPUT SIGNAL SPECIFICATIONS

|                 |             |     |     |     |     |     |     |     |
|-----------------|-------------|-----|-----|-----|-----|-----|-----|-----|
| LVDS Channel O0 | LVDS output | D7  | D6  | D4  | D3  | D2  | D1  | D0  |
|                 | Data order  | OG0 | OR5 | OR4 | OR3 | OR2 | OR1 | OR0 |
| LVDS Channel O1 | LVDS output | D18 | D15 | D14 | D13 | D12 | D9  | D8  |
|                 | Data order  | OB1 | OB0 | OG5 | OG4 | OG3 | OG2 | OG1 |
| LVDS Channel O2 | LVDS output | D26 | D25 | D24 | D22 | D21 | D20 | D19 |
|                 | Data order  | DE  | NA  | NA  | OB5 | OB4 | OB3 | OB2 |
| LVDS Channel O3 | LVDS output | D23 | D17 | D16 | D11 | D10 | D5  | D27 |
|                 | Data order  | NA  | OB7 | OB6 | OG7 | OG6 | OR7 | OR6 |
| LVDS Channel E0 | LVDS output | D7  | D6  | D4  | D3  | D2  | D1  | D0  |
|                 | Data order  | EG0 | ER5 | ER4 | ER3 | ER2 | ER1 | ER0 |
| LVDS Channel E1 | LVDS output | D18 | D15 | D14 | D13 | D12 | D9  | D8  |
|                 | Data order  | EB1 | EB0 | EG5 | EG4 | EG3 | EG2 | EG1 |
| LVDS Channel E2 | LVDS output | D26 | D25 | D24 | D22 | D21 | D20 | D19 |
|                 | Data order  | DE  | NA  | NA  | EB5 | EB4 | EB3 | EB2 |
| LVDS Channel E3 | LVDS output | D23 | D17 | D16 | D11 | D10 | D5  | D27 |
|                 | Data order  | NA  | EB7 | EB6 | EG7 | EG6 | ER7 | ER6 |

### 4.3 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  | 1  | 0  |
|                     | 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  | 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

#### 4.4 DISPLAY TIMING SPECIFICATIONS

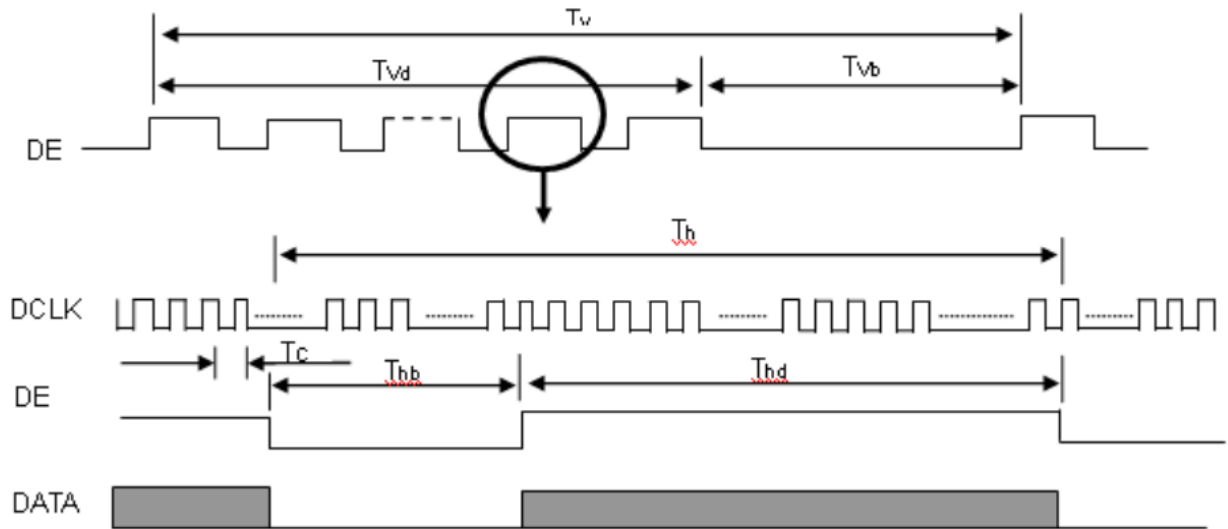
The input signal timing specifications are shown as the following table and timing diagram.

| Signal                  | Item                                 | Symbol          | Min.              | Typ.  | Max.             | Unit | Note                    |
|-------------------------|--------------------------------------|-----------------|-------------------|-------|------------------|------|-------------------------|
| LVDS Clock              | Frequency                            | $F_c$           | (60)              | 70.93 | (75)             | MHz  | -                       |
|                         | Period                               | $T_c$           |                   | 14.1  |                  | ns   |                         |
|                         | Input cycle to cycle jitter          | $T_{rci}$       | $-0.02 \cdot T_c$ |       | $0.02 \cdot T_c$ | ns   | (3)                     |
|                         | Input clock to data skew             | TLVCCS          | $-0.02 \cdot T_c$ |       | $0.02 \cdot T_c$ | ns   | (4)                     |
|                         | Spread spectrum modulation range     | $F_{ckin\_mod}$ | $FC \cdot 98\%$   |       | $FC \cdot 102\%$ | MHz  | (5)                     |
|                         | Spread spectrum modulation frequency | $F_{SSM}$       |                   |       | 200              | KHz  |                         |
| Vertical Display Term   | Frame Rate                           | $F_r$           | (50)              | 60    | 60               | Hz   | $T_v = T_{vd} + T_{vb}$ |
|                         | Total                                | $T_v$           | (1090)            | 1110  | (1130)           | Th   | -                       |
|                         | Active Display                       | $T_{vd}$        | 1080              | 1080  | 1080             | Th   | -                       |
|                         | Blank                                | $T_{vb}$        | $T_v - T_{vd}$    | 30    | $T_v - T_{vd}$   | Th   | -                       |
| Horizontal Display Term | Total                                | $T_h$           | (1050)            | 1065  | (1075)           | Tc   | $T_h = T_{hd} + T_{hb}$ |
|                         | Active Display                       | $T_{hd}$        | 960               | 960   | 960              | Tc   | -                       |
|                         | Blank                                | $T_{hb}$        | $T_h - T_{hd}$    | 105   | $T_h - T_{hd}$   | Tc   | -                       |

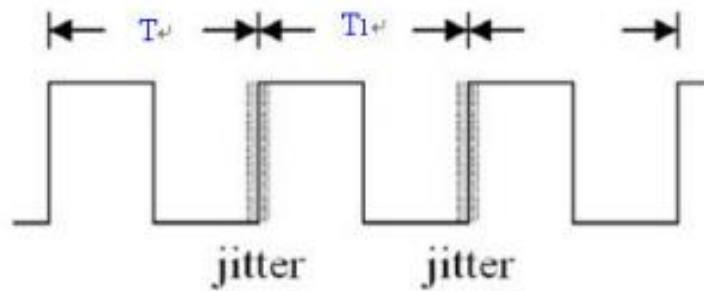
Note (1) Because this module is operated by DE only mode, Hsync and Vsync input signals are ignored.

Note (2) The  $T_v(T_{vd} + T_{vb})$  must be integer, otherwise, this module would operate abnormally.

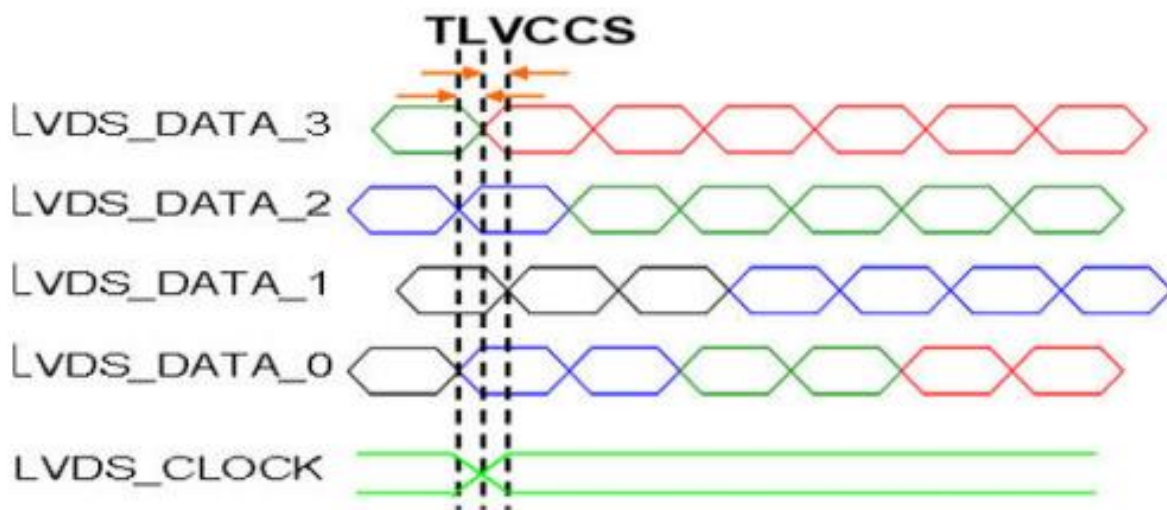
INPUT SIGNAL TIMING DIAGRAM



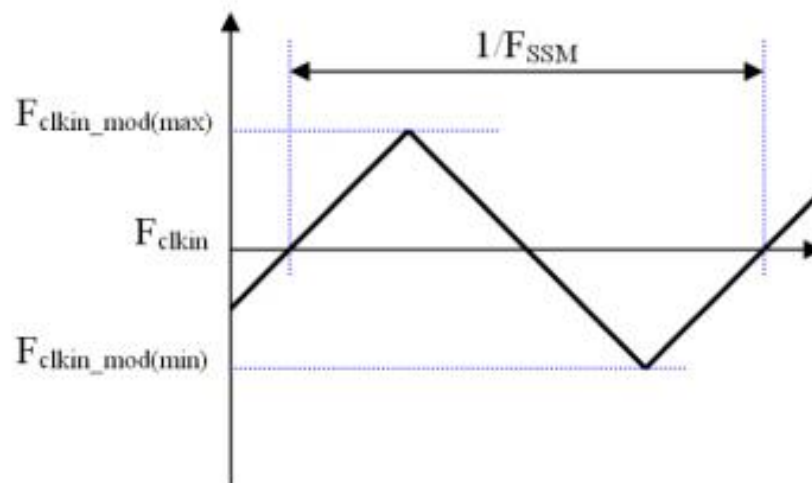
Note (3) The input clock cycle-to-cycle jitter is defined as below figures.  $Trcl = |T_1 - T_1'|$



Note (4) Input Clock to data skew is defined as below figures.

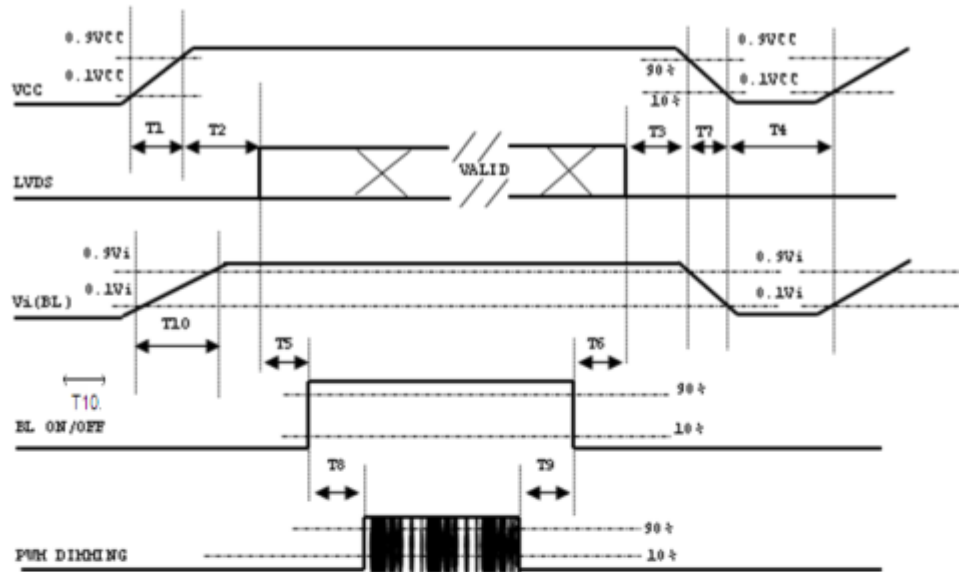


Note (5) The SSCG (Spread spectrum clock generator) is defined as below figures.



## 4.5 POWER ON/OFF SEQUENCE

The power sequence specifications are shown as the following table and diagram.



Timing Specifications:

| Parameter | Value |     |     | Units |
|-----------|-------|-----|-----|-------|
|           | Min   | Typ | Max |       |
| T1        | 0.5   | -   | 10  | ms    |
| T2        | 0     | -   | 50  | ms    |
| T3        | 0     | -   | 50  | ms    |
| T4        | 500   | -   | -   | ms    |
| T5        | 450   | -   | -   | ms    |
| T6        | 200   | -   | -   | ms    |
| T7        | 10    | -   | 100 | ms    |
| T8        | 10    | -   | -   | ms    |
| T9        | 10    | -   | -   | ms    |
| T10       | 20    | -   | 50  | ms    |

Note:

- (1) The supply voltage of the external system for the module input should be the same as the definition of Vcc.
- (2) When the backlight turns on before the LCD operation of the LCD turns off, the display may momentarily become abnormal screen.

- (3) In case of VCC = off level, please keep the level of input signals on the low or keep a high impedance.
- (4) T4 should be measured after the module has been fully discharged between power off and on period.
- (5) Interface signal shall not be kept at high impedance when the power is on.
- (6) INX won't take any responsibility for the products which are damaged by the customers not following the Power Sequence.
- (7) There might be slight electronic noise when LCD is turned off (even backlight unit is also off). To avoid this symptom, we suggest "Vcc falling timing" to follow "T7 spec".

**Note:** Data include R0~R7, B0~B7, GO~G7, U/D, L/R, DCLK, HS,VS,DE.

## 5.0 OPTICAL SPECIFICATIONS

### 5.1 TEST CONDITIONS

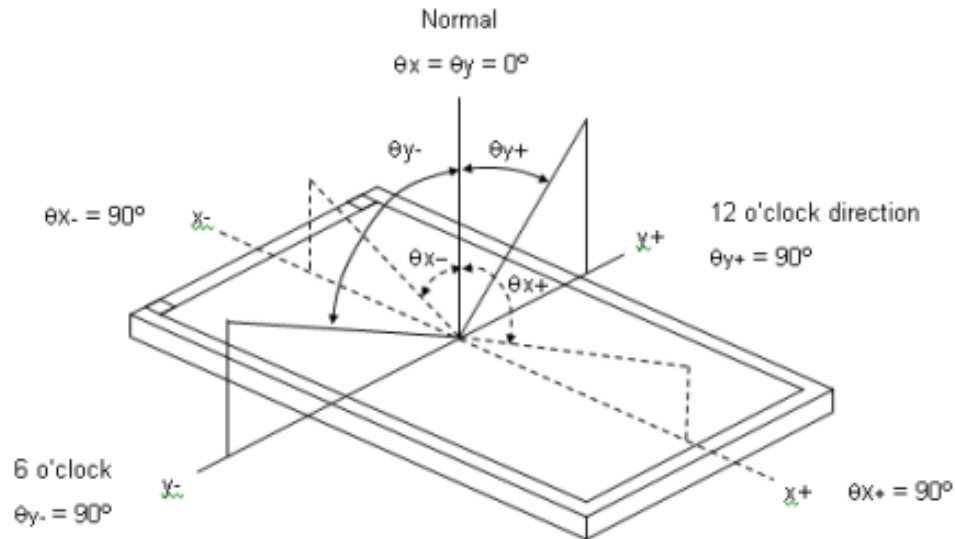
| Item                                      | Symbol                                                     | Value | Unit |
|-------------------------------------------|------------------------------------------------------------|-------|------|
| Ambient Temperature                       | Ta                                                         | 25±2  | °C   |
| 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 |                                                            |       |      |

### 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        | R <sub>x</sub> | $\theta_x=0^\circ, \theta_Y=0^\circ$<br>CS-2000<br>R=G=B=255<br>Gray scale | Typ – 0.05 | 0.652 | Typ + 0.05 | -                 | (1), (5) |
|                               |            | R <sub>y</sub> |                                                                            |            | 0.338 |            |                   |          |
|                               | Green      | G <sub>x</sub> |                                                                            |            | 0.333 |            |                   |          |
|                               |            | G <sub>y</sub> |                                                                            |            | 0.613 |            |                   |          |
|                               | Blue       | B <sub>x</sub> |                                                                            |            | 0.150 |            |                   |          |
|                               |            | B <sub>y</sub> |                                                                            |            | 0.050 |            |                   |          |
|                               | White      | W <sub>x</sub> |                                                                            |            | 0.313 |            |                   |          |
|                               |            | W <sub>y</sub> |                                                                            |            | 0.329 |            |                   |          |
| Center Luminance of White     |            | L <sub>C</sub> |                                                                            | 360        | 450   | -          | cd/m <sup>2</sup> | (4), (5) |
| Contrast Ratio                |            | CR             |                                                                            | 600        | 800   | -          | -                 | (2), (5) |
| Response Time                 |            | T <sub>R</sub> | $\theta_x=0^\circ, \theta_Y=0^\circ$                                       | -          | 13    | 18         | ms                | (3)      |
|                               |            | T <sub>F</sub> |                                                                            | -          | 12    | 17         |                   |          |
| White Variation               |            | W              | $\theta_x=0^\circ, \theta_Y=0^\circ$                                       | 70         | -     | -          | %                 | (5), (6) |
| Viewing Angle                 | Horizontal | $\theta_x+$    | CR ≥ 10                                                                    | 80         | 85    | ---        | Deg.              | (1), (5) |
|                               |            | $\theta_x-$    |                                                                            | 80         | 85    |            |                   |          |
|                               | Vertical   | $\theta_Y+$    |                                                                            | 80         | 85    |            |                   |          |
|                               |            | $\theta_Y-$    |                                                                            | 80         | 85    | ---        |                   |          |

Note (1) Definition of Viewing Angle ( $\theta_x, \theta_y$ ):



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

The contrast ratio can be calculated by the following expression.

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

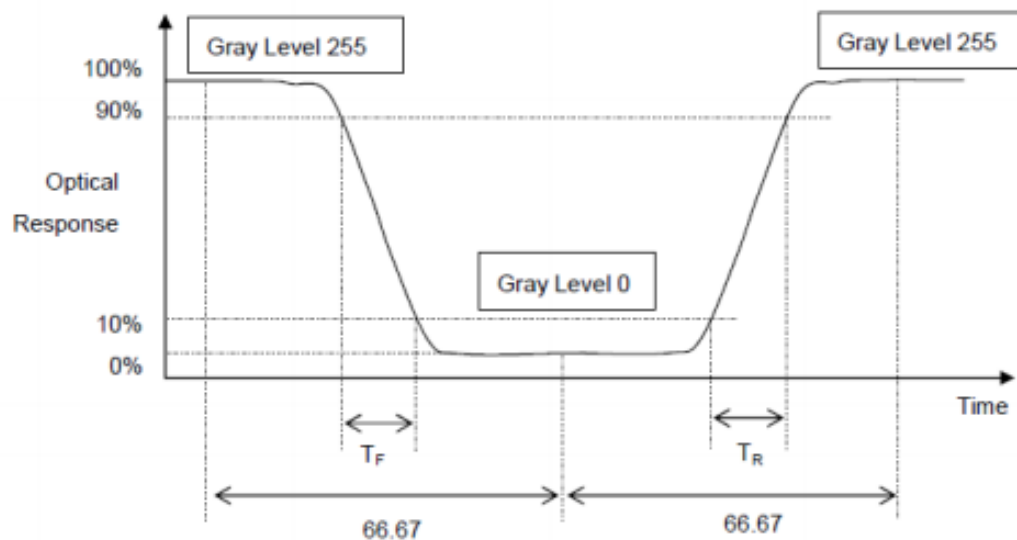
$L_{255}$ : Luminance of gray level 255

$L_0$ : Luminance of gray level 0

$$CR = CR(5)$$

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 ( $L_C$ ):**

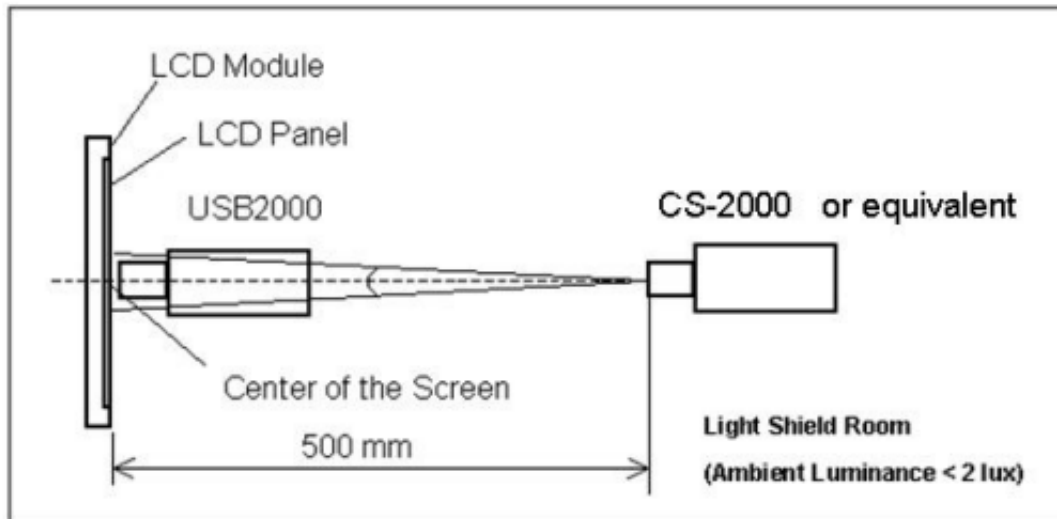
Measure the luminance of gray level 255 at center point

$$L_C = L(5)$$

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

**Note (5) Measurement Setup:**

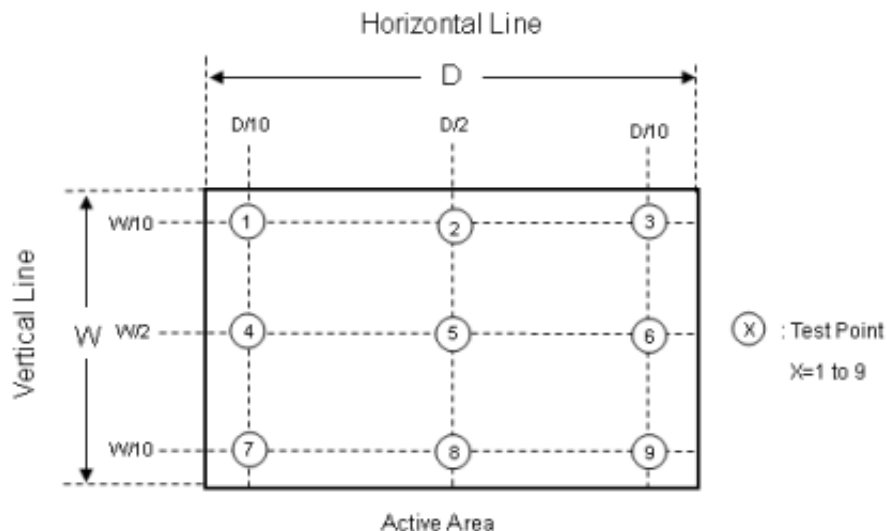
The LCD module should be stabilized at given temperature for 30 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting Backlight for 30 minutes in a windless room.



**Note (6) Definition of White Variation ( $\delta W$ ):**

Measure the luminance of gray level 255 at 9 points

$$\delta W = ( \text{Minimum } [L(1) \sim L(9)] / \text{Maximum } [L(1) \sim L(9)] ) * 100\%$$



## 6. RELIABILITY TEST

### 6.1 LCD TEST

| Test Item                                       | Test Condition                                                             | Note             |
|-------------------------------------------------|----------------------------------------------------------------------------|------------------|
| High Temperature Storage Test                   | 85°C, 240 hours                                                            | (1)(2)<br>(4)(5) |
| Low Temperature Storage Test                    | -30°C, 240 hours                                                           |                  |
| Thermal Shock Storage Test                      | -30°C, 0.5hour $\longleftrightarrow$ 85°C, 0.5hour; 1hour/cycle, 100cycles |                  |
| High Temperature Operation Test                 | 85°C, 240 hours                                                            |                  |
| Low Temperature Operation Test                  | -30°C, 240 hours                                                           |                  |
| High Temperature & High Humidity Operation Test | 60°C, 90%RH, 240hours                                                      | (1)(2)<br>(4)(6) |
| Shock (Non-Operating)                           | 50G, 11ms, half sine wave, 1 time for $\pm X$ , $\pm Y$ , $\pm Z$ .        | (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 90 °C Max.

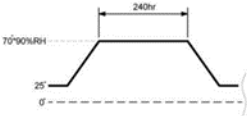
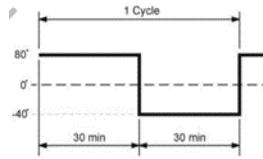
Note (3) At testing Vibration and Shock, the fixture in holding the module has to be hard and rigid enough so that the module would not be twisted or bent by the fixture.

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

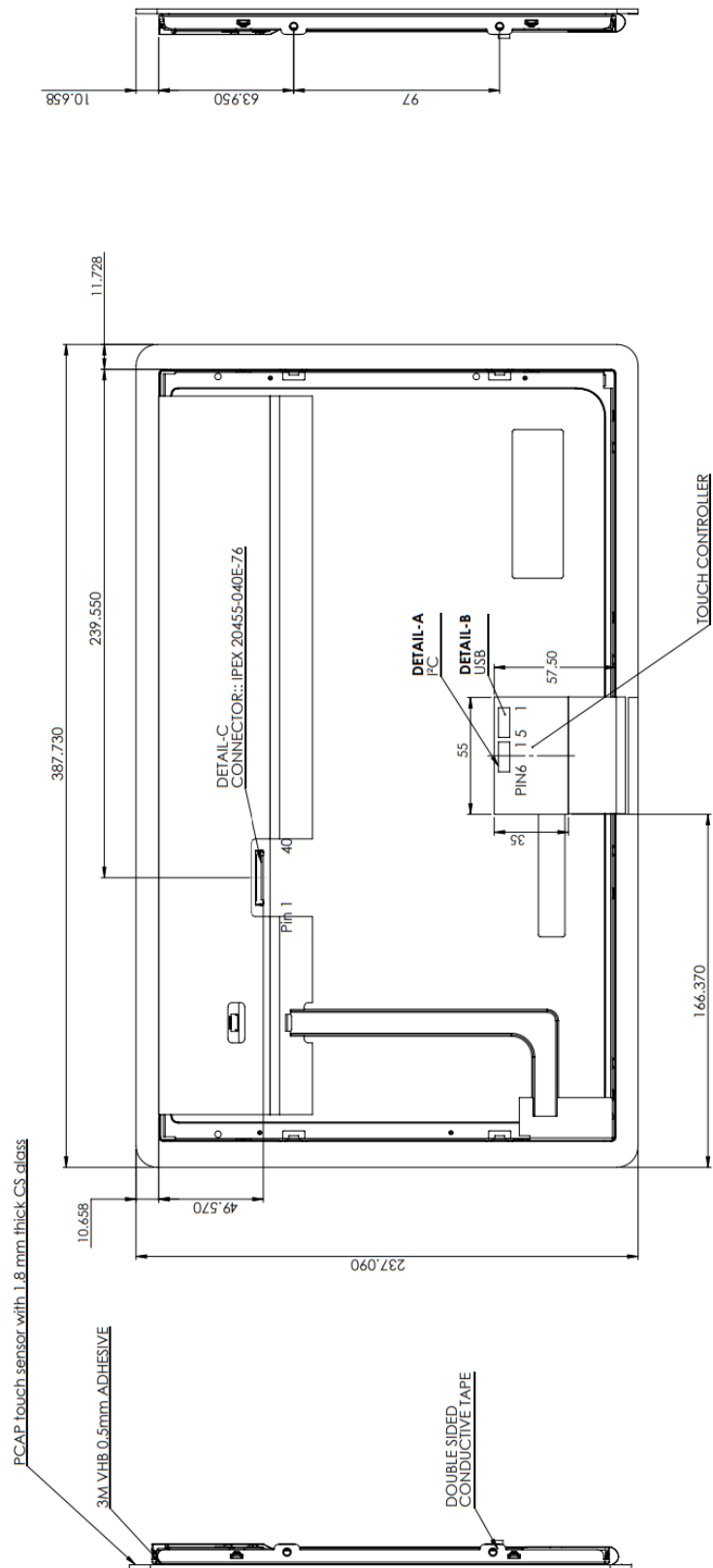
Note (5) Before cosmetic and function test, the product must have enough recovery time, at least 2 hours at room temperature.

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

## 6.2 TOUCH TEST

| Item |                                 | Condition                                                                            | Specification                               |
|------|---------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------|
| (1)  | Constant Temperature / Humidity | 70°C X 90%RH, 240 hrs and normalized for 4 hrs                                       | Satisfy<br>1.Electrical<br>Characteristics. |
|      |                                 |    |                                             |
| (2)  | High Temperature storage        | 80°C /240 hrs and normalized for 4 hrs                                               |                                             |
| (3)  | Low Temperature storage         | -40°C /240 hrs and normalized for 4 hrs                                              |                                             |
| (4)  | Thermal Cycle                   | -40°C ~80°C [60 min./cycle] *50 cycles and normalized for 4 hrs                      |                                             |
|      |                                 |  |                                             |

## 7. MECHANICAL DRAWINGS



## 8. 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°C 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°C to 35°C 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°C  
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. INSPECTION SPECIFICATION

### 1. SCOPE SPECIFICATIONS CONTAIN

- 1.1 DISPLAY QUALITY EVALUATION
- 1.2 MECHANICS SPECIFICATION

### 2. SAMPLING PLAN

UNLESS THERE IS OTHER AGREEMENT, THE SAMPLING PLAN FOR INCOMING INSPECTION SHALL FOLLOW MIL-STD-105E.

- 2.1 LOT SIZE: QUANTITY PER SHIPMENT AS ONE LOT (DIFFERENT MODEL AS DIFFERENT LOT ).
- 2.2 SAMPLING TYPE: NORMAL INSPECTION, SINGLE SAMPLING.
- 2.3 SAMPLING LEVEL: LEVEL II.
- 2.4 AQL: ACCEPTABLE QUALITY LEVEL
  - MAJOR DEFECT: AQL=0.65
  - MINOR DEFECT: AQL=1.0

### 3. PANEL INSPECTION CONDITION

- 3.1 ENVIRONMENT:
  - ROOM TEMPERATURE: 25±5°C.
  - HUMIDITY: 65±5% RH.
  - ILLUMINATION: 300 ~ 700 LUX.
- 3.2 INSPECTION DISTANCE:
  - 35±5 CM
- 3.3 INSPECTION ANGLE:
  - THE VISION OF INSPECTOR SHOULD BE PERPENDICULAR TO THE SURFACE OF THE MODULE.
- 3.4 INSPECTION TIME:
  - PERCEPTIBILITY TEST TIME: 20 SECONDS MAX.

### 4. DISPLAY QUALITY

- 4.1 FUNCTION RELATED:
  - THE FUNCTION DEFECTS OF LINE DEFECT, ABNORMAL DISPLAY, AND NO DISPLAY ARE CONSIDERED MAJOR DEFECTS.
- 4.2 BRIGHT/DARK DOTS:

| Defect Type                | Specification | Major | Minor |
|----------------------------|---------------|-------|-------|
| Bright Dots                | $N \leq 2$    |       | ●     |
| Dark Dots                  | $N \leq 3$    |       | ●     |
| Total Bright and Dark Dots | $N \leq 4$    |       | ●     |

Note: 1:

The definition of dot: The size of a defective dot over 1/2 of whole dot is regarded as one defective dot.

Bright dot: Dots appear bright and unchanged in size in which LCD panel is displaying under black pattern.

The bright dot defect must be visible through 2% ND filter

Dark dot: Dots appear dark and unchanged in size in which LCD panel is displaying under pure red, green, blue pattern.

4.3 Pixel Definition:

|   |   |   |   |   |   |   |   |   |  |                                                                                     |                     |
|---|---|---|---|---|---|---|---|---|--|-------------------------------------------------------------------------------------|---------------------|
| R | G | B | R | G | B | R | G | B |  |  | Dot Defect          |
| R | G | B | R | G | B | R | G | B |  |  | Adjacent Dot Defect |
| R | G | B | R | G | B | R | G | B |  |  | Cluster             |

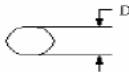
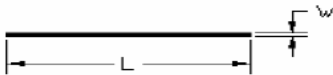
Note 1:

If pixel or partial sub-pixel defects exceed 50% of the affected pixel or sub-pixel area, it shall be considered as 1 defect.

Note 2:

There should be no distinct non-uniformity visible through 2% ND Filter within 2 sec inspection times.

## 4.4 Visual Inspection specifications:

| Defect Type                                                                                                                                              |                   | Specification Size             | Count(N) | Major | Minor |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------------------|----------|-------|-------|
| Dot Shape<br>(Particle、Scratch and Bubbles in display area)<br>         |                   | D ≤0.25 mm                     | Ignored  |       | •     |
|                                                                                                                                                          |                   | 0.25mm < D ≤ 0.5mm             | N ≤ 3    |       |       |
|                                                                                                                                                          |                   | D > 0.5mm                      | N=0      |       |       |
| Newton Ring (Only for Touch panel)                                                                                                                       |                   | D≤70mm                         | N≤4      |       | •     |
|                                                                                                                                                          |                   | D>70mm                         | N=0      |       |       |
| TSP Fish Eyes (Only for Touch panel)<br>(Bubble/Dent)                                                                                                    |                   | 0.1mm<D≤0.2mm                  | N≤4      |       | •     |
|                                                                                                                                                          |                   | 0.2mm<D≤0.3mm                  | N≤3      |       |       |
|                                                                                                                                                          |                   | 0.3<D≤0.4                      | N≤2      |       |       |
| Line Shape<br>(Particles、Scratch、Lint and Bubbles in display area)<br> |                   | W ≤ 0.01 mm                    | Ignored  |       | •     |
|                                                                                                                                                          |                   | 0.01mm< W ≤ 0.05mm and L ≤ 3mm | N ≤ 3    |       |       |
|                                                                                                                                                          |                   | W > 0.05mm or L > 3 mm         | N=0      |       |       |
| Bubble in cell (active area)                                                                                                                             |                   | It should be found by eyes     |          |       | •     |
| Bezel                                                                                                                                                    | Scratch           | No harm                        |          |       | •     |
|                                                                                                                                                          | Dirt              |                                |          |       | •     |
|                                                                                                                                                          | Wrap              |                                |          |       | •     |
|                                                                                                                                                          | Sunken            |                                |          |       | •     |
| Label                                                                                                                                                    | No label          | No                             |          |       | •     |
|                                                                                                                                                          | Inverted label    |                                |          |       | •     |
|                                                                                                                                                          | Broken            |                                |          |       | •     |
|                                                                                                                                                          | Dirt              | Word can be read.              |          |       | •     |
|                                                                                                                                                          | Not clear         | No                             |          |       | •     |
|                                                                                                                                                          | Word out of shape |                                |          |       | •     |
|                                                                                                                                                          | Mistake           |                                |          |       | •     |
|                                                                                                                                                          | Position          | Be attached on right position  |          |       | •     |
| Screw                                                                                                                                                    | Not enough        | No                             |          |       | •     |
|                                                                                                                                                          | Limp              | No                             |          |       | •     |

|           |                   |                            |  |   |
|-----------|-------------------|----------------------------|--|---|
| Connector | Connection status | No bend on pins and damage |  | • |
| FPC/FFC   | Broken            | No                         |  | • |

Note: Extraneous substance and scratch not affecting the display of image, for instance, extraneous substance under polarizer film but outside the display area, or scratch on metal bezel and backlight module or polarizer film outside the display area, shall not be considered as defective or non-conforming.