



# FOCUS LCDs

LCDs MADE SIMPLE®

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TFT | OLED | CHARACTER | GRAPHIC | UWVD | SEGMENT | CUSTOM

## TFT Display Module

Part Number

E50RA1-FW500-C

### Overview:

- 5.0-inch TFT (78.56x135.65mm)
- 3SPI+16/18/24-bit RGB Interfaces
- 480x854 pixels
- I2C CTP Interface
- White LED back-light
- Transmissive/ Normally Black
- Capacitive Touch Panel
- 500 NITS
- Controllers: ILI9806E, GT911
- RoHS Compliant

## Description

This is a color active matrix TFT (Thin Film Transistor) LCD (Liquid Crystal Display) that uses amorphous silicon TFT as a switching device. This model is composed of a transmissive type TFT-LCD Panel, driver circuit, capacitive touch panel and backlight unit. The resolution of the 5.0" TFT-LCD contains 480x854 pixels and can display up to 16.7M colors.

## Features

Low Input Voltage: 3.3V (TYP)

Display Colors: 16.7M colors

TFT Interface: 3-SPI+16/18/24-bit RGB

CTP Interface: I2C

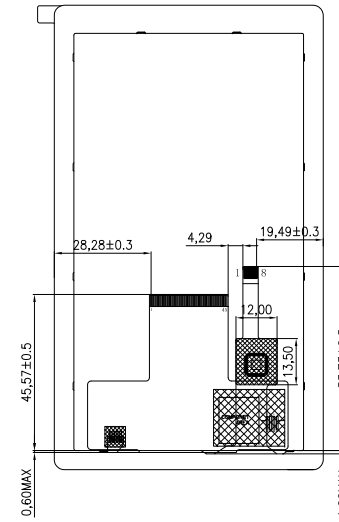
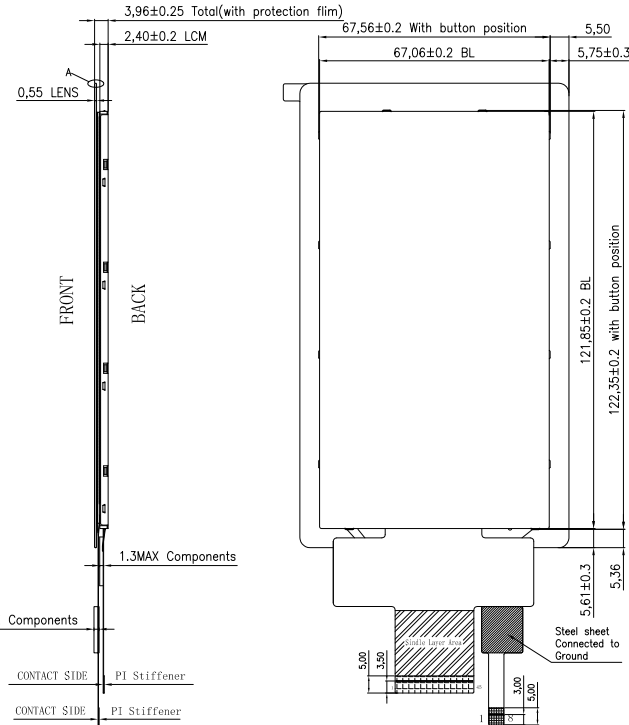
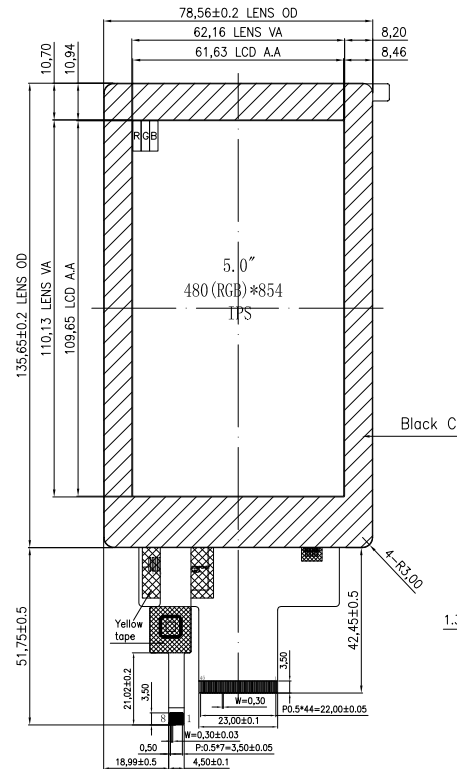
| General Information Items | Specification                   | Unit    | Note |
|---------------------------|---------------------------------|---------|------|
|                           | Main Panel                      |         |      |
| TFT Display Area (AA)     | 61.63(H) x 109.65(V) (5.0 inch) | mm      | -    |
| CTP View Area             | 62.16(H) x 110.13(V)            | mm      | -    |
| Driver Element            | TFT active matrix               | -       | -    |
| Display Colors            | 16.7M                           | colors  | -    |
| Number of Pixels          | 480(RGB)x854                    | dots    | -    |
| TFT Pixel Arrangement     | RGB vertical stripe             | -       | -    |
| Pixel Pitch               | 0.128 (H) x 0.128 (V)           | mm      | -    |
| Viewing Angle             | ALL                             | o'clock | -    |
| TFT Controller IC         | ILI9806E                        | -       | -    |
| CTP Driver IC             | GT911                           | -       | -    |
| Display Mode              | Transmissive/Normally Black     | -       | -    |
| Touch Points              | 5-point and Gestures            | -       | -    |
| Operating Temperature     | -20~+70                         | °C      | -    |
| Storage Temperature       | -30~+80                         | °C      | -    |

## Mechanical Information

| Item        |              | Min | Typ.   | Max | Unit | Note |
|-------------|--------------|-----|--------|-----|------|------|
| Module Size | Height (H)   |     | 78.56  |     | mm   | -    |
|             | Vertical (V) |     | 135.65 |     | mm   | -    |
|             | Depth (D)    |     | 4.40   |     | mm   | -    |
| Weight      |              |     | TBD    |     | g    | -    |

# 1. Outline Dimensions

| Rev | Revision content description | Date       |
|-----|------------------------------|------------|
| V0  | FIRST                        | 2018.09.29 |
|     |                              |            |



FPC bending diagram

NOTE: RGB interface DB Used.

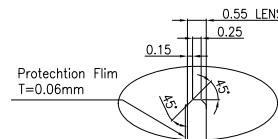
| RGB Interface        | DB Pin in use                 |
|----------------------|-------------------------------|
| 16 Bit RGB interface | DB20-DB16, DB13-DB8, DB4-DB0, |
| 18 Bit RGB interface | DB21-DB16, DB13-DB8, DB5-DB0, |
| 24 Bit RGB interface | DB23-DB0                      |

NOTE: If used RGB mode must select serial interface!

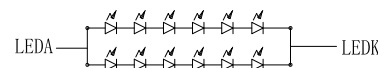
| NO. | Pin Name |
|-----|----------|
| 1   | XR       |
| 2   | YD       |
| 3   | XL       |
| 4   | YU       |
| 5   | GND      |
| 6   | GND      |
| 7   | VCI      |
| 8   | IOVCC    |
| 9   | SDO      |
| 10  | SDI      |
| 11  | SCL      |
| 12  | CS       |
| 13  | RESET    |
| 14  | DB23(R7) |
| 15  | DB22(R6) |
| 16  | DB21(R5) |
| 17  | DB20(R4) |
| 18  | DB19(R3) |
| 19  | DB18(R2) |
| 20  | DB17(R1) |
| 21  | DB16(R0) |
| 22  | DB15(G7) |
| 23  | DB14(G6) |
| 24  | DB13(G5) |
| 25  | DB12(G4) |
| 26  | DB11(G3) |
| 27  | DB10(G2) |
| 28  | DB9(G1)  |
| 29  | DB8(G0)  |
| 30  | DB7(B7)  |
| 31  | DB6(B6)  |
| 32  | DB5(B5)  |
| 33  | DB4(B4)  |
| 34  | DB3(B3)  |
| 35  | DB2(B2)  |
| 36  | DB1(B1)  |
| 37  | DB0(B0)  |
| 38  | DE       |
| 39  | PCLK     |
| 40  | HSYNC    |
| 41  | VSYNC    |
| 42  | NC       |
| 43  | LEDK     |
| 44  | NC       |
| 45  | LEDA     |

## NOTES:

1. DISPLAY TYPE: 5.0", TFT-LCD, 65K/262K/16.7M COLORS
2. DISPLAY MODE: NORMALLY BLACK
3. VIEWING DIRECTION: FREE
4. TFT DRIVER IC: ILI9806E  
CTP DRIVER IC: GT911
5. Touch type: CTP
6. TFT Interface: 3SPI+16/18/24BIT RGB
7. CTP Interface: I2C
8. Touch and LCM Bonding technology: OPTICAL BONDING
9. CTP IIC Communication voltage: 3.3V
10. VDD/VCI: 3.3V; IOVCC: 1.8~3.3V
11. OPERATING TEMP: -20°C TO 70°C  
STORAGE TEMP: -30°C TO 80°C
12. BACK LIGHT: LED WHITE, 12 LED, 40mA, 19.2±0.3V
13. RoHS COMPLIANT.



Detail A  
Scale : 10:1



B/L Circuit

## CTP FPC Logic

| PIN | Logic |
|-----|-------|
| 1   | GND   |
| 2   | NC    |
| 3   | VDD   |
| 4   | SCL   |
| 5   | SDA   |
| 6   | INT   |
| 7   | RST   |
| 8   | GND   |

|   |                     |              |  |                |  |
|---|---------------------|--------------|--|----------------|--|
| <b>FOCUS LCDs</b><br>LCDs MADE SIMPLE®        |                     | DRAWING NAME |  | E50RA1-FW500-C |  |
|   |                     | PARTS NO.    |  |                |  |
| TOLERANCE<br>UNLESS<br>OTHERWISE<br>SPECIFIED | X.X±0.3<br>X.XX±0.2 | Drawn        |  | Unit           |  |
|   |                     | Checked      |  | mm             |  |
| Scale 1:1                                     |                     | Approve      |  | Page 1/1       |  |

## 2. Input Terminal Pin Assignment

### 2.1 TFT

| NO.   | Symbol   | Description  | I/O |
|-------|----------|--|-----|
| 1     | XR(NC)   | Touch panel right glass terminal   | A/D |
| 2     | YD(NC)   | Touch panel bottom film terminal   | A/D |
| 3     | XL(NC)   | Touch panel left glass terminal  | A/D |
| 4     | YU(NC)   | Touch panel top film terminal  | A/D |
| 5     | GND      | Ground   | P   |
| 6     | GND      | Ground   | P   |
| 7     | VCI      | Supply voltage (3.3V)  | P   |
| 8     | IOVCC    | I/O power supply voltage   | P   |
| 9     | SDO      | SPI interface output pin. The data is output on the falling edge of the SCL signal. If not used, leave this pin open.  | O   |
| 10    | SDI      | Data lane in 1 data lane serial interface. The data is latched on the rising edge of the SCL signal.   | I   |
| 11    | SCL      | Select "Data or Command" in parallel interface. D/CX='1'; data is selected. D/CX='0'; command is selected. This pin is used as serial interface clock in 3-wire 9-bit/4-wire 8-bit serial data interface. Fix to VCI or GND when not used. | I   |
| 12    | CS       | Chip select input pin (low enabled). Fix to VCI or GND when not used.  | I   |
| 13    | RESET    | Reset pin. Setting low initializes the LSI. Must be reset after power is supplied.   | I   |
| 14-37 | DB23-DB0 | 24-bit parallel bi-directional data bus for MCU system and RGB interface mode. Fix to GND when not used.   | I/O |
| 38    | DE       | Data enable signal for RGB interface operation. Fix to VCI or GND when not in use.   | I   |
| 39    | DOTCLK   | Dot clock signal for RGB interface operation. Fix to VCI or GND when not used.   | I   |
| 40    | HSYNC    | Line synchronizing signal for RGB interface operation.   | I   |
| 41    | VSYSNC   | Frame synchronizing signal for RGB interface. Fix to VCI or GND when not used.   | I   |
| 42    | NC       | Not connected  |     |
| 43    | LEDK     | Cathode pin of backlight   | P   |
| 44    | NC       | Not connected  |     |
| 45    | LEDA     | Anode pin of backlight   | P   |

### 2.2 CTP

| NO. | Symbol | Description                    | I/O |
|-----|--------|--------------------------------|-----|
| 1   | GND    | Ground                         | P   |
| 2   | NC     | Not connected                  |     |
| 3   | VDD    | Supply voltage                 | P   |
| 4   | SCL    | I2C clock input                | I   |
| 5   | SDA    | I2C data input and output      | I/O |
| 6   | INT    | External interrupt to the host | I   |
| 7   | RST    | External reset. Low is active  | I   |
| 8   | GND    | Ground                         | P   |

### 3. LCD Optical Characteristics

#### 3.1 Optical Specifications

| Optical specifications       |               |                |                                |       |       |     |      |        |
|------------------------------|---------------|----------------|--------------------------------|-------|-------|-----|------|--------|
| Item                         |               | Symbol         | Condition                      | Min   | Typ.  | Max | Unit | Note   |
| Contrast Ratio               |               | CR             | Normal<br>Viewing Angle<br>θ=0 | 640   | 800   | --  | --   | (2)    |
| Response Time                | Rising        | TR             |                                | --    | 16    | 21  | ms   | (4)    |
|                              | Falling       | TF             |                                | --    | 19    | 24  | ms   | (4)    |
| Color Gamut                  |               | S(%)           |                                | --    | 70    | --  | %    | (5)    |
| Color Filter<br>Chromaticity | White         | W <sub>x</sub> |                                | --    | 0.305 | --  | --   | (5)(6) |
|                              |               | W <sub>y</sub> |                                | --    | 0.340 | --  |      |        |
|                              | Red           | R <sub>x</sub> |                                | --    | --    | --  |      |        |
|                              |               | R <sub>y</sub> |                                | --    | --    | --  |      |        |
|                              | Green         | G <sub>x</sub> |                                | --    | --    | --  |      |        |
|                              |               | G <sub>y</sub> |                                | --    | --    | --  |      |        |
|                              | Blue          | B <sub>x</sub> |                                | --    | --    | --  |      |        |
|                              |               | B <sub>y</sub> |                                | --    | --    | --  |      |        |
|                              | Viewing Angle | Hor.           | Θ <sub>L</sub>                 | CR>10 | --    | 80  |      |        |
| Θ <sub>R</sub>               |               |                | --                             |       | 80    | --  |      |        |
| Ver.                         |               | Θ <sub>T</sub> | --                             |       | 80    | --  |      |        |
|                              |               | Θ <sub>B</sub> | --                             |       | 80    | --  |      |        |
| Option View Direction        |               | FREE           |                                |       |       |     |      | (1)    |

#### 4.2 Measuring Conditions

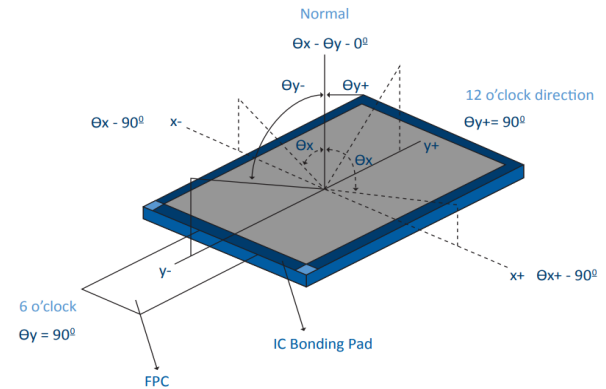
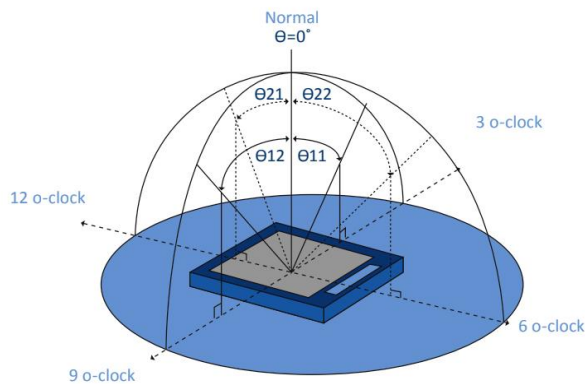
Measuring surrounding: dark room

Ambient temperature:  $25 \pm 2^\circ\text{C}$

15 min. warm-up time

### Optical Specification Reference Notes:

(1) Definition of Viewing Angle: The viewing angle is the angle at which the contrast ratio is greater than 10. The viewing angles are determined for the horizontal or 3,9 o'clock direction and the vertical or 6,12 o'clock direction with respect to the optical axis which is normal to the LCD surface.

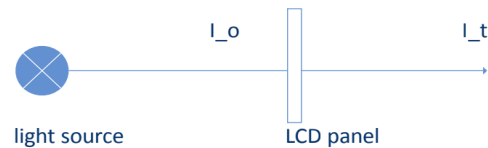


(2) Definition of Contrast Ratio (Cr): measured at the center point of panel. The contrast ratio (Cr) measured on a module, is the ratio between the luminance (Lw) in a full white area (R=G=B=1) and the luminance (Ld) in a dark area (R=G=B=0).

$$Cr = \frac{Lw}{Ld}$$

(3) Definition of transmittance (T%): The transmittance of the panel including the polarizers is measured with electrical driving. The equation for transmittance Tr is:

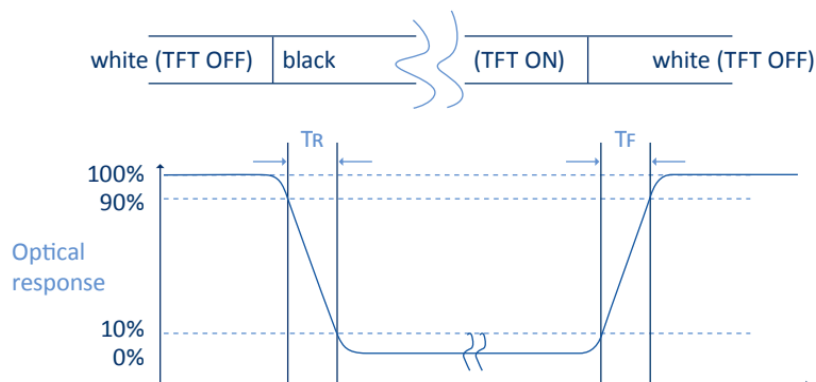
$$Tr = \frac{I_t}{I_o} \times 100\%$$



$I_o$  = the brightness of the light source.

$I_t$  = the brightness after panel transmission

(4) Definition of Response Time ( $T_r$ ,  $T_f$ ): The rise time ' $T_r$ ' is defined as the time for luminance to change from 90% to 10% as a result of a change of the electrical condition. The fall time ' $T_f$ ' is defined as the time for luminance to change from 10% to 90% as a result of a change of the electrical condition.



##### (5) Definition of Color Gamut:

Measuring machine CFT-01. NTSC's Primaries:

$R(x,y,Y), G(x,y,Y), B(x,y,Y)$ . FPM520 of Westar Display Technologies, INC., which utilized SR-3 for Chromaticity and BM-5A for other optical characteristics. The color chromaticity shall be calculated from the spectral data measured with all pixels first in red, green, blue and white. Measurements shall be made at the center of the panel.

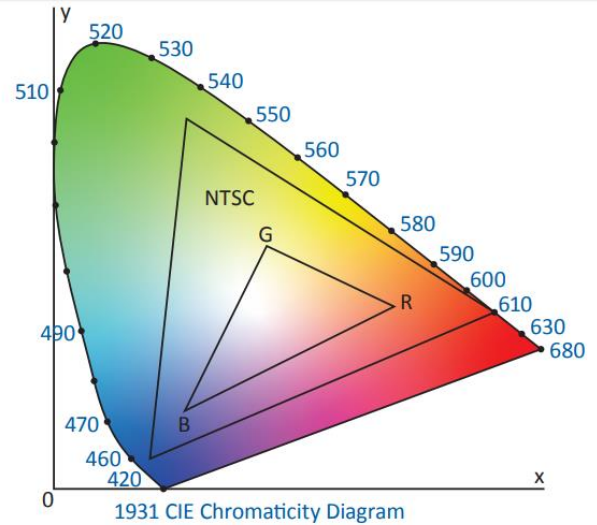
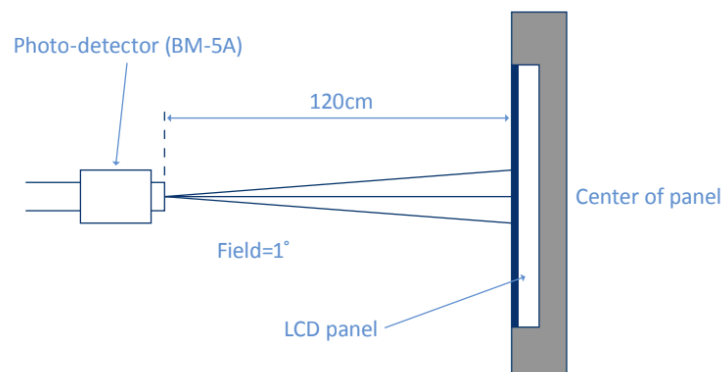
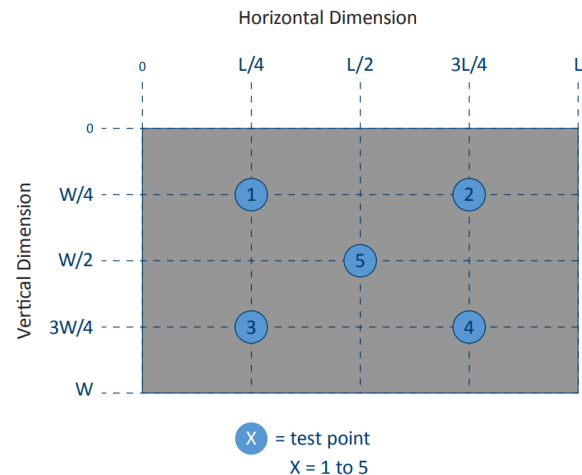
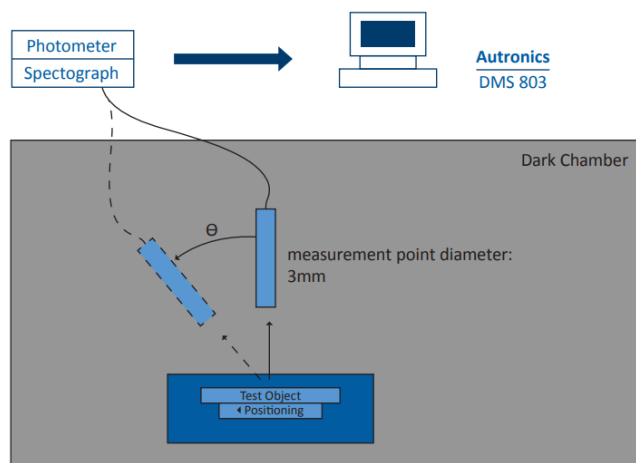


Fig. 1931 CIE chromacity diagram

$$\text{Color gamut: } S = \frac{\text{Area of RGB triangle}}{\text{Area of NTSC triangle}} \times 100\%$$

##### (6) Definition of Optical Measurement Setup:

The LCD module should be stabilized at a 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.



## 4. TFT Electrical Characteristics

### 4.1 Absolute Maximum Rating (Ta=25 °C, VSS=0V)

| Characteristics                  | Symbol | Min  | Max | Unit |
|----------------------------------|--------|------|-----|------|
| Digital Supply Voltage           | VDD    | -0.3 | 4.6 | V    |
| Digital Interface Supply Voltage | IOVCC  | -0.3 | 4.6 | V    |
| Operating Temperature            | TOP    | -20  | +70 | °C   |
| Storage Temperature              | TST    | -30  | +80 | °C   |

*NOTE: If the absolute maximum rating of the above parameters is exceeded, even momentarily, the quality of the product may be degraded. Absolute maximum ratings specify the values which the product may be physically damaged if exceeded. Be sure to use the product within the range of the absolute maximum ratings.*

### 4.2 DC Electrical Characteristics

| Characteristics                  | Symbol | Min      | Typ.    | Max      | Unit | Note |
|----------------------------------|--------|----------|---------|----------|------|------|
| Digital Supply Voltage           | VDD    | 2.5      | 2.8/3.3 | 3.6      | V    |      |
| Digital Interface Supply Voltage | VDDIO  | 1.65     | 1.8     | 3.6      | V    |      |
| Normal Mode Current Consumption  | IDD    | --       | 30      | --       | mA   |      |
| Level Input Voltage              | VIH    | 0.7VDDIO | --      | VDDIO    | V    |      |
|                                  | VIL    | -0.3     | --      | 0.3VDDIO | V    |      |
| Level Output Voltage             | VOH    | 0.8VDDIO | --      | VDDIO    | V    |      |
|                                  | VOL    | GND      | --      | 0.2VDDIO | V    |      |



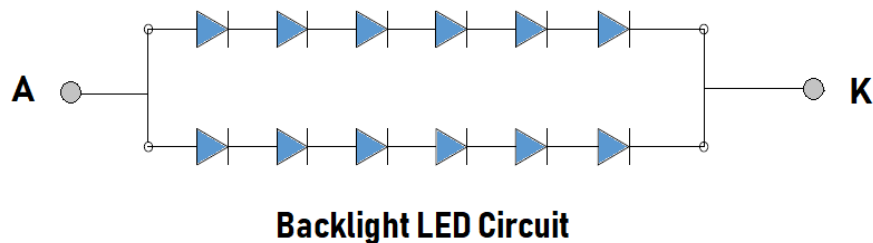
### 4.3 LED Backlight Characteristics

The backlight system is edge lighting type with 12 chips white LED.

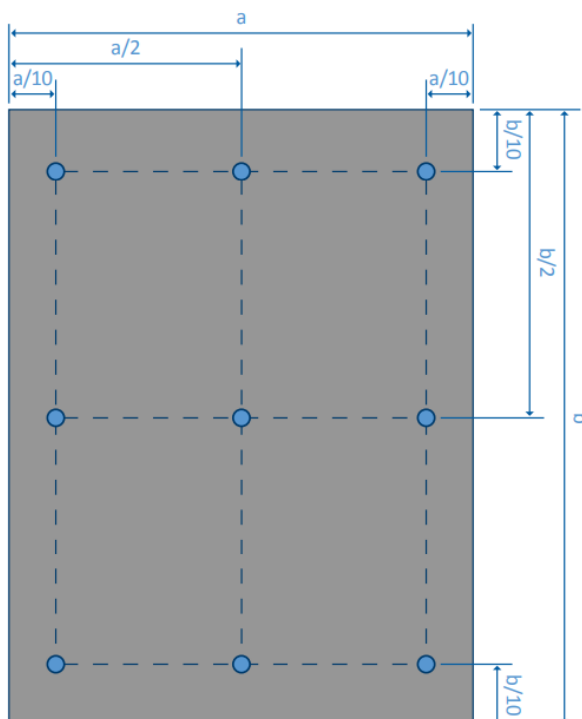
| Item            | Symbol | Min   | Typ. | Max | Unit              | Note      |
|-----------------|--------|-------|------|-----|-------------------|-----------|
| Forward Current | $I_F$  | 30    | 40   | --  | mA                |           |
| Forward Voltage | $V_F$  | --    | 19.2 | --  | V                 |           |
| LCM Luminance   | LV     | 430   | 500  | --  | cd/m <sup>2</sup> | Note 3    |
| LED lifetime    | Hr     | 50000 | --   | --  | hour              | Note1 & 2 |
| Uniformity      | AVg    | 80    | --   | --  | %                 | Note 3    |

Note 1: LED lifetime (Hr) can be defined as the time in which it continues to operate under the condition:  $T_a=25 \pm 3^\circ\text{C}$ , typical IL value indicated in the above table until the brightness becomes less than 50%.

Note 2: The "LED lifetime" is defined as the module brightness decrease to 50% original brightness at  $T_a=25^\circ\text{C}$  and  $I_L = 40\text{mA}$ . The LED lifetime could be decreased if operating  $I_L$  is larger than 40mA. The constant current driving method is suggested.



Note 3: Luminance Uniformity of these 9 points is defined as below:



$$\text{Luminance} = \frac{(\text{Total Luminance of 9 points})}{9}$$

$$\text{Uniformity} = \frac{\text{minimum luminance in 9 points(1-9)}}{\text{maximum luminance in 9 points(1-9)}}$$

## 5. AC Characteristics

### 5.1 Display Serial Interface Timing Characteristics (3-line SPI system)

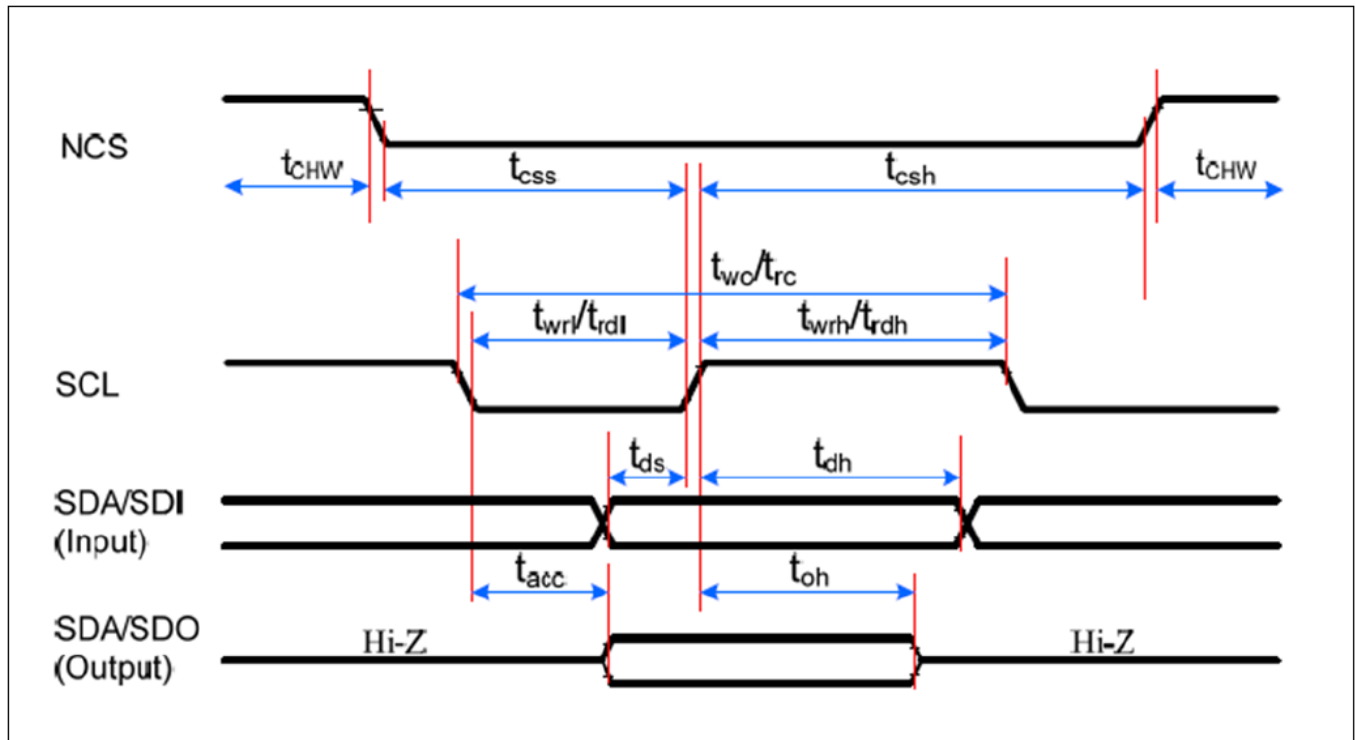


Figure 5.1: 3-line SPI Interface Timing Diagram

| Parameter        | Symbol           | Parameter                    | Min | Max | Unit | Note                              |
|------------------|------------------|------------------------------|-----|-----|------|-----------------------------------|
| CSX              | t <sub>css</sub> | Chip select time (write)     | 15  | --  | ns   |                                   |
|                  | t <sub>csh</sub> | Chip select hold time (read) | 15  | --  | ns   |                                   |
|                  | t <sub>CHW</sub> | CS "H" pulse width           | 40  | --  | ns   |                                   |
| SCL              | t <sub>wc</sub>  | Serial clock cycle (write)   | 30  | --  | ns   |                                   |
|                  | t <sub>wrh</sub> | SCL "H" pulse width (write)  | 10  | --  | ns   |                                   |
|                  | t <sub>wrl</sub> | SCL "L" pulse width (write)  | 10  | --  | ns   |                                   |
|                  | t <sub>rc</sub>  | Serial clock cycle (read)    | 150 | --  | ns   |                                   |
|                  | t <sub>rdh</sub> | SCL "H" pulse width (read)   | 60  | --  | ns   |                                   |
|                  | t <sub>rdl</sub> | SCL "L" pulse width (read)   | 60  | --  | ns   |                                   |
| SDA/SDO (Output) | t <sub>acc</sub> | Access time (read)           | 10  | 100 | ns   | For max CL=30pF<br>For min CL=8pF |
|                  | t <sub>oh</sub>  | Output disable time (read)   | 15  | 100 | ns   |                                   |
| SDA/SDI (Input)  | t <sub>ds</sub>  | Data setup time (write)      | 10  | --  | ns   |                                   |
|                  | t <sub>dh</sub>  | Data hold time (write)       | 10  | --  | ns   |                                   |

Table 5.1: 3-line SPI Interface Timing Characteristics

Note: Ta= -30 to 70°C, IOVCC=1.65 to 3.6V, VCI=2.5V to 3.6V, T=10±0.5ns. Does not include signal rise and fall times.

## 5.2 Parallel 24/18/16-bit RGB Interface Timing Characteristics

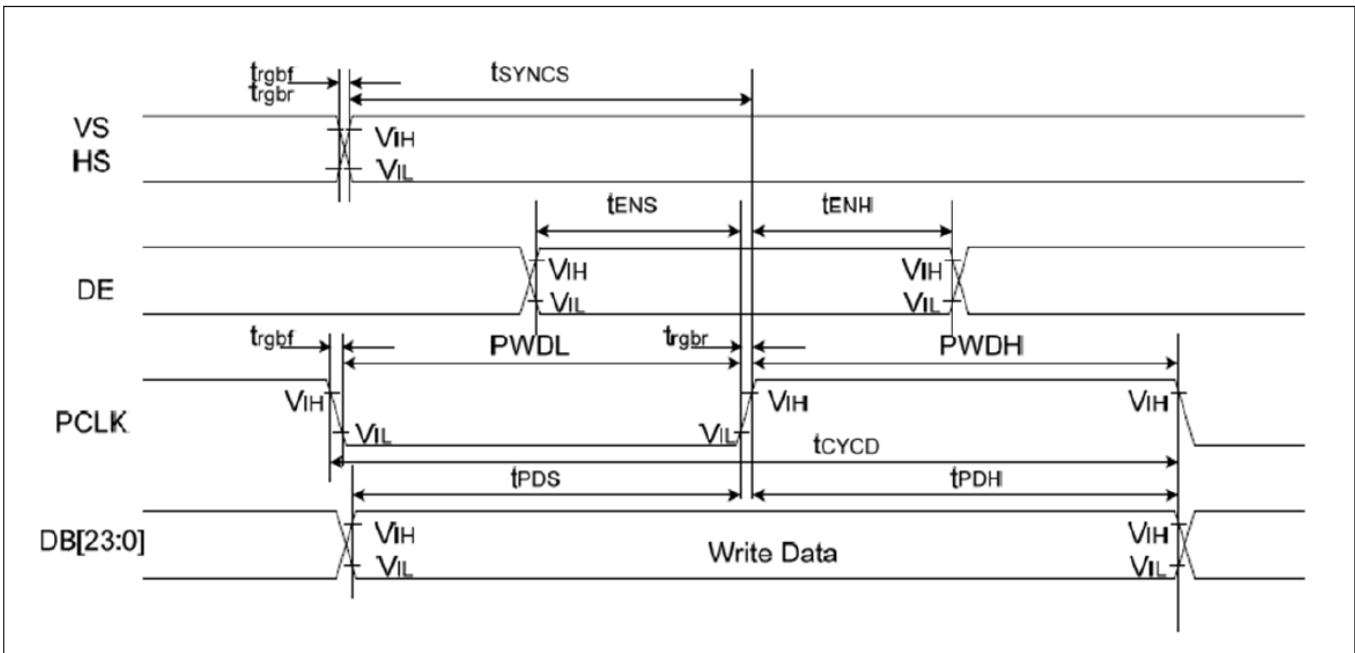


Figure 5.2: Parallel 24/18/16-bit RGB Interface Timing Diagram

| Parameter | Symbol       | Parameter                   | Min | Max | Unit | Note                                      |
|-----------|--------------|-----------------------------|-----|-----|------|---|
| VS/HS     | tSYNCS       | VS/HS setup time            | 5   | --  | ns   | 24/18/16-bit bus<br>RGB interface<br>mode |
|           | tSYNCH       | VS/HS hold time             | 5   | --  | ns   |   |
| DE        | tENS         | DE setup time               | 5   | --  | ns   |   |
|           | tENH         | DE hold time                | 5   | --  | ns   |   |
| DB[23:0]  | tPOS         | Data setup time             | 5   | --  | ns   |   |
|           | tpDH         | Data hold time              | 5   | --  | ns   |   |
| PCLK      | PWDH         | PCLK high-level period      | 13  | --  | ns   |   |
|           | PWDL         | PCLK low-level period       | 13  | --  | ns   |   |
|           | tCYCD        | PCLK cycle time             | 28  | --  | ns   |   |
|           | trgbr, trgbf | PCLK, HS, VS rise/fall time | --  | 15  | ns   |   |

Table 5.2: Parallel 24/18/16-bit RGB Interface Timing Characteristics

### 5.3 Reset Timing

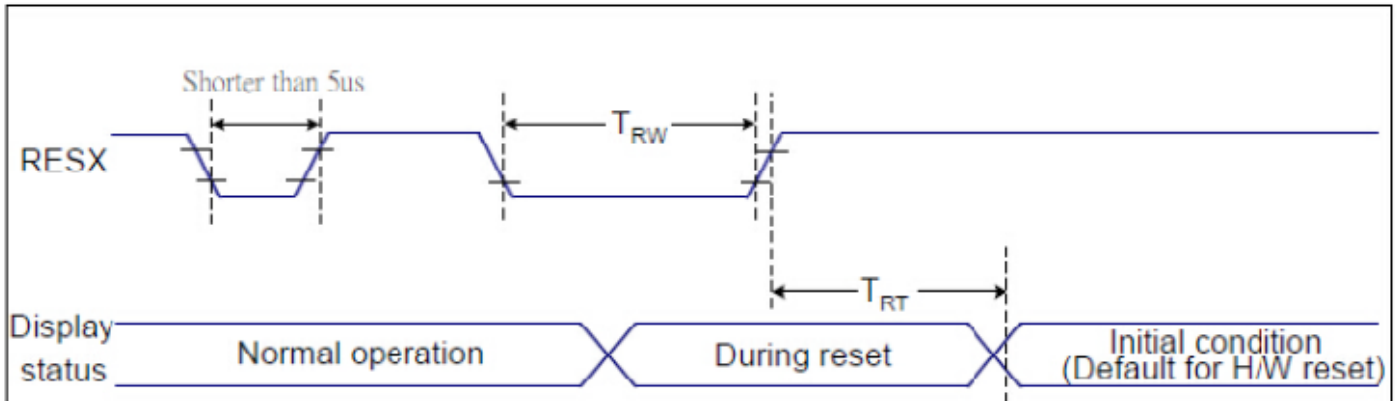


Figure 5.3: Reset Timing Diagram

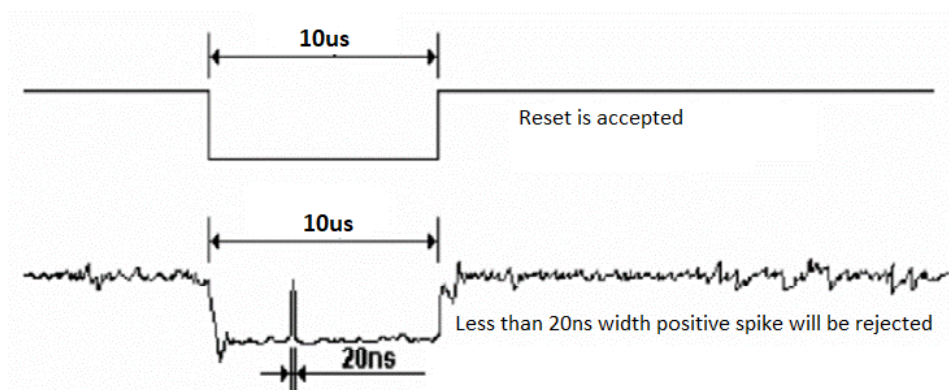
| Related Pins | Symbol | Parameter            | Min | Max                | Unit |
|--------------|--------|----------------------|-----|--------------------|------|
| RESX         | TRW    | Reset pulse duration | 10  | -                  | us   |
|              | TRT    | Reset cancel         | -   | 5 (Note 1,5)       | ms   |
|              |        |                      |     | 120 (Note 1, 6, 7) | ms   |

Notes:

1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (tRT) within 5ms after a rising edge of RESX.
2. Spike due to an electrostatic discharge on RESX line does not because irregular system reset according to the table below:

| RESX Pulse           | Action         |
|----------------------|----------------|
| Shorter than 5us     | Reset Rejected |
| Longer than 9us      | Reset          |
| Between 5us and 9 us | Reset starts   |

3. During the resetting period, the display will be blanked (the display is entering blanking sequence, which maximum time is 120ms, when reset starts in Sleep Out mode. The display remains the blank state in Sleep in mode) and then return to Default condition for Hardware Reset.
4. Spike Rejection also applies during a valid reset pulse as shown below:



5. When Reset applied during Sleep In Mode.
6. When Reset applied during Sleep Out Mode.
7. It is necessary to wait 5ms after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120ms.

## 6. CTP Electrical Characteristics

### 6.1 Absolute Maximum Rating

| Item                                 | Symbol | Min  | Max  | Unit | Note |
|--------------------------------------|--------|------|------|------|------|
| Power Supply Voltage                 | VDD    | 2.66 | 3.47 | V    |      |
| Operating Temperature                | Top    | -20  | +70  | °C   |      |
| Storage Temperature                  | Tst    | -30  | +80  | °C   |      |
| ESD Protection Voltage<br>(HB Model) | --     | --   | ±2   | kV   |      |

### 6.2 DC Electrical Characteristics (Ta=25°C)

Ambient temperature: 25°C, AVDD=2.8V, VDDIO=1.8V or VDDIO=AVDD

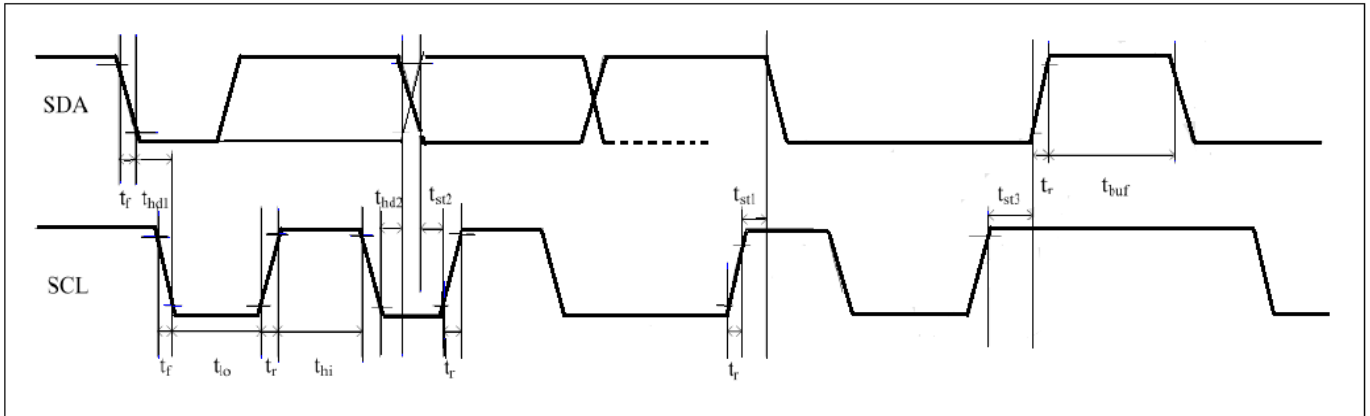
| Item                          | Symbol | Min       | Typ. | Max       | Unit | Note |
|-------------------------------|--------|-----------|------|-----------|------|------|
| Normal Mode Operating Current | Iopr   | --        | 8    | 14.5      | mA   |      |
| Green Mode Operating Current  | Imon   | --        | 3.3  | --        | mA   |      |
| Sleep Mode Operating Current  | Isip   | 70        | --   | 120       | uA   |      |
| Doze Mode Operating Current   | --     | --        | 0.78 | --        | mA   |      |
| Digital Input Low Voltage     | VIL    | -0.3      | --   | 0.25VDDIO | V    |      |
| Digital Input High Voltage    | VIH    | 0.75VDDIO | --   | VDDIO+0.3 | V    |      |
| Digital Output Low Voltage    | VOL    | --        | --   | 0.15VDDIO | V    |      |
| Digital Output High Voltage   | VOH    | 0.85VDDIO | --   | --        | V    |      |

### 6.3 AC Characteristics

| Parameter                         | Min | Typ. | Max | Unit |
|-----------------------------------|-----|------|-----|------|
| OSC oscillation frequency         | 59  | 60   | 61  | MHz  |
| I/O output rise time, low to high | --  | 14   | --  | ns   |
| I/O output fall time, high to low | --  | 14   | --  | ns   |

## 6.4 I2C Interface Characteristics

GT911 provides a standard I2C interface for SCL and SDA to communicate with the host. GT911 always serves as slave device in the system with all communication being initialized by the host. It is recommended that transmission rate be kept at or below 400kbps. The figure shown below is the I2C timing:



| Parameter                          | Symbols   | Condition | Min | Max | Units |
|------------------------------------|-----------|-----------|-----|-----|-------|
| SCL low period                     | $t_{lo}$  |           | 1.3 |     | us    |
| SCL high period                    | $t_{hi}$  |           | 0.6 |     | us    |
| SCL setup time for start condition | $t_{st1}$ |           | 0.6 |     | us    |
| SCL setup time for stop condition  | $t_{st2}$ |           | 0.6 |     | us    |
| SCL hold time for start condition  | $t_{hd1}$ |           | 0.6 |     | us    |
| SDA setup time                     | $t_{st3}$ |           | 0.1 |     | us    |
| SDA hold time                      | $t_{tr}$  |           | 0   |     | us    |

Table 6.3: I2C AC Characteristics, 1.8V interface voltage, 400kbps transmission rate, 2k pull-up resistor

| Parameter                          | Symbols   | Condition | Min | Max | Units |
|------------------------------------|-----------|-----------|-----|-----|-------|
| SCL low period                     | $t_{lo}$  |           | 1.3 |     | us    |
| SCL high period                    | $t_{hi}$  |           | 0.6 |     | us    |
| SCL setup time for start condition | $t_{st1}$ |           | 0.6 |     | us    |
| SCL setup time for stop condition  | $t_{st2}$ |           | 0.6 |     | us    |
| SCL hold time for start condition  | $t_{hd1}$ |           | 0.6 |     | us    |
| SDA setup time                     | $t_{st3}$ |           | 0.1 |     | us    |
| SDA hold time                      | $t_{tr}$  |           | 0   |     | us    |

Table 6.4: I2C AC Characteristics, 3.3V interface voltage, 400kbps transmission rate, 2k pull-up resistor

## **7. Cautions and Handling Precautions**

### **7.1 Handling and Operating the Module**

1. When the module is assembled, it should be attached to the system firmly. Do not warp or twist the module during assembly work.
2. Protect the module from physical shock or any force. In addition to damage, this may cause improper operation or damage to the module and back-light unit.
3. Note that polarizer is very fragile and could be easily damaged. Do not press or scratch the surface.
4. Do not allow drops of water or chemicals to remain on the display surface. If you have the droplets for a long time, staining and discoloration may occur.
5. If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.
6. The desirable cleaners are water, IPA (Isopropyl Alcohol) or Hexane. Do not use ketene type materials (ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.
7. 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, legs, or clothes, it must be washed away thoroughly with soap.
8. Protect the module from static; it may cause damage to the CMOSICs.
9. Use fingerstalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
10. Do not disassemble the module.
11. Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.
12. Pins of I/F connector shall not be touched directly with bare hands.
13. Do not connect, disconnect the module in the "Power ON" condition.
14. Power supply should always be turned on/off by the item Power On Sequence & Power Off Sequence.

### **7.2 Storage and Transportation.**

1. Do not leave the panel in high temperature, and high humidity for a long time. It is highly recommended to store the module with temperature from 0 to 35 °C and relative humidity of less than 70%
2. Do not store the TFT-LCD module in direct sunlight.
3. The module shall be stored in a dark place. When storing the modules for a long time, be sure to adopt effective measures for protecting the modules from strong ultraviolet radiation, sunlight, or fluorescent light.
4. It is recommended that the modules should be stored under a condition where no condensation is allowed. Formation of dewdrops may cause an abnormal operation or a failure of the module. In particular, the greatest possible care should be taken to prevent any module from being operated where condensation has occurred inside.
5. This panel has its circuitry FPC on the bottom side and should be handled carefully in order not to be stressed.