



# **ORIENT DISPLAY**

Your Total LCD Solution Provider

## Specification for TFT

### AFR240240A1-1.3INTM

Revision V1.0



|        |  |
|--------|--|
| A      | Orient Display                             |
| FR     | TFT Type                                   |
| 240240 | Resolution 240 x 240                       |
| A1     | Serial A1                                  |
| 1.3    | 1.3", Module Dimension 26.16x29.22x1.79 mm |
| I      | IPS Display                                |
| N      | Top: -20~+70°C; Tstr: -30~+80°C            |
| T      | Transmissive/Normally Black                |
| M      | Medium Brightness, 470 cd/m2               |
| /      | No Touch Panel                             |
| /      | Controller ST7789V2                        |
| /      | 8/9/16/18Bit MCU; 3/4SPI+16/18Bit RGB      |





# Contents

|   |           |
|---|-----------|
| <b>1. Block Diagram.....</b>  | <b>5</b>  |
| <b>2. Outline dimension.....</b>  | <b>5</b>  |
| <b>3. Input terminal Pin Assignment.....</b>                                  | <b>7</b>  |
| <b>4. LCD Optical Characteristics.....</b>                                    | <b>9</b>  |
| 4.1 Optical specification .....   | 9         |
| <b>5. Electrical Characteristics .....</b>                                    | <b>12</b> |
| 5.1 Absolute Maximum Rating .....   | 12        |
| 5.2 DC Electrical Characteristics .....                                       | 12        |
| 5.3 LED Backlight Characteristics .....                                       | 13        |
| <b>6. AC Characteristic.....</b>  | <b>14</b> |
| 6.1 Display Parallel 18/16/9/8-bit Interface Timing Characteristics (8080).14 |           |
| 6.2 Display Serial Interface Timing Characteristics (3-line SPI system)...16  |           |
| 6.3 Display Serial Interface Timing Characteristics (4-line SPI system)...17  |           |
| 6.4 Parallel 18/16/6-bit RGB Interface Timing Characteristics19               |           |
| 6.5 Reset Timing Characteristics .....  | 19        |
| <b>7. LCD Module Out-Going Quality Level.....</b>                             | <b>22</b> |
| 7.1 VISUAL & FUNCTION INSPECTION STANDARD .....                               | 22        |
| 7.1.1 Inspection conditions .....   | 22        |
| 7.1.2 Definition .....  | 22        |
| 7.1.3 Sampling Plan .....   | 22        |
| 7.1.4 Criteria (Visual).....  | 23        |
| <b>8. Reliability Test Result.....</b>  | <b>27</b> |
| <b>9. Cautions and Handling Precautions.....</b>                              | <b>29</b> |
| 9.1 Handling and Operating the Module .....                                   | 29        |
| 9.2 Storage and Transportation.....   | 29        |
| <b>10. Packing .....</b>  | <b>29</b> |

**\* Description**

This is a color active matrix TFT (Thin Film Transistor) LCD (liquid crystal display) that uses a amorphous silicon TFT as a switching device. This module is composed of a Transmissive type TFT-LCD Panel, driver circuit , back-light unit. The resolution of a 1.3 " TFT-LCD contains 240x240 pixels, and can display up to 65K/262K colors.

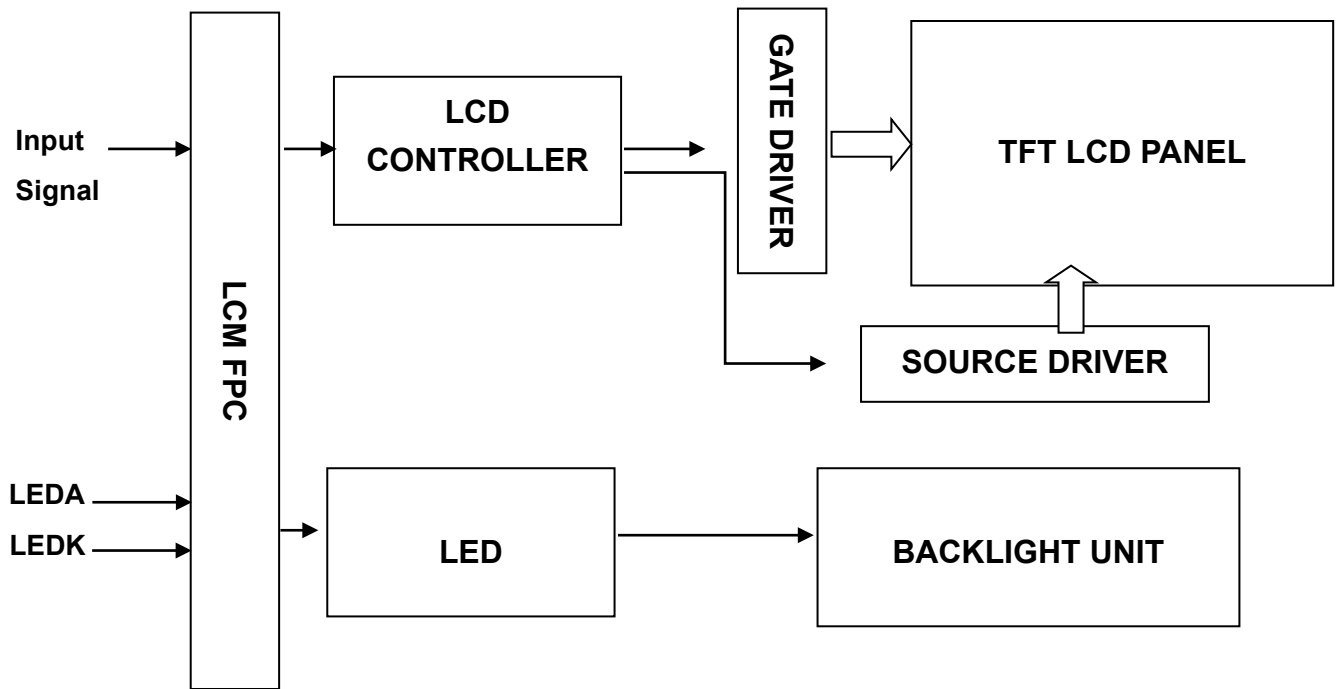
**\* Features**

| General Information Items | Specification   | Unit    | Note |
|---------------------------|---|---------|------|
|                           | Main Panel  |         |      |
| Display area(AA)          | 23.4(H)*23.4(V) (1.3 inch)  | mm      |      |
| Driver element            | TFT active matrix   | -       |      |
| Display colors            | 65K/262K  | colors  |      |
| Number of pixels          | 240(RGB)*240  | dots    |      |
| Pixel arrangement         | RGB vertical stripe   | -       |      |
| Pixel pitch               | 0.0975(H)*0.0975(V)   | mm      |      |
| Viewing angle             | ALL   | o'clock |      |
| Controller IC             | ST7789V2  | -       |      |
| LCM Interface             | 8/9/16/18bit MCU<br>3/4SPI+16/18BIT RGB<br>3-line/4-line Serial interface | -       |      |
| Display mode              | Transmissive /Normally Black  | -       |      |
| Operating temperature     | -20~+70   | °C      |      |
| Storage temperature       | -30~+80   | °C      |      |

**\* Mechanical Information**

| Item        |               | Min. | Typ.  | Max. | Unit | Note |
|-------------|---------------|------|-------|------|------|------|
| Module size | Horizontal(H) | -    | 26.16 | -    | mm   |      |
|             | Vertical(V)   | -    | 29.22 | -    | mm   |      |
|             | Depth(D)      | -    | 1.79  | -    | mm   |      |
| Weight      |               | -    | 2     | -    | g    |      |

# 1. Block Diagram



# 2. Outline dimension

|  |  |   |   |  |  |   |
|--|--|---|---|--|--|---|
| 1  | 2  | 3   | 4   | 5  | 6  |   |
| THIS DRAWING IS PROPERTY OF ORIENT DISPLAY. ALL RIGHTS RESERVED. | ITEM: DISPLAY TYPE<br>RESOLUTION (H*V)<br>POLARIZER TYPE | PARAMETERS: IPS/NORMAL BLACK<br>1.3" 240*240 PIXELS<br>TRANSMISSIVE | ITEM: VIEWING DIRECTION<br>OPERATION TEMPERATURE<br>STORAGE TEMPERATURE | PARAMETERS: FREE<br>-20°C TO +70°C<br>-30°C TO +80°C | ITEM: LCD OPERATING VOLTAGE<br>LOGIC VOLTAGE(VDD)<br>GREYSCALE SUPPORT | PARAMETERS: LSV ~3.3V<br>3.3V<br>/                          |
|  |  |   |   |  | ITEM: ITEAM<br>IC<br>BACKLIGHT<br>CONNECTOR                            | PARAMETERS: S17789V2<br>2 LED, WHITE, 40mA, 3.3*0.3V<br>ZIF |

注: Top frame window should be at least 0.3mm smaller than LCD P0L on each side, LCD VA is recommended window area.

**Detail "A" 3:1**  
**FH26-45S-0.3SHW**

NOTE: MCU Interface SET for IM PINS.

| Pin No. | Interface type            | IO P Pin In use                       |                  |
|---------|---------------------------|---------------------------------------|------------------|
| 0       | 001 Tks. 10-bit interface | DB7-DB0, DB8-DB1                      |                  |
| 0       | 0                         | 001 Tks. 10-bit interface             | DB7-DB10         |
| 0       | 0                         | 101 Tks. 8-bit interface              | DB7-DB10         |
| 0       | 1                         | 001 Tks. 10-bit interface             | DB17-DB9         |
| 0       | 1                         | 001 Tks. 9-bit interface              | DB17-DB9         |
| 1       | 0                         | 1-8 Slave 9-bit data serial interface | SIM, SCL, CS     |
| 1       | 1                         | 0 interface                           | SIM, SCL, CS, RS |

NOTE:  
1. If not use PIN, fix to the GND, IOVCC or WC.  
2. If use RGB mode must select serial interface

|                      |      |                     |
|----------------------|------|---------------------|
| TITLE                | TFT  | AFR240240A1-1.3INTM |
| REV.                 | V0   | CUSTOMER NO.        |
| SCALE                | FIT  | UNIT mm             |
| ROHS/REACH COMPLIANT | YES  | CUSTOMER'S APPROVAL |
| UNMARKED TOLERANCE   | ±0.3 | SHEET 1 of 1        |

|                  |                  |                     |
|------------------|------------------|---------------------|
| V0 FIRST ISSUE   | DATE FEB-14-2023 | SHEET 1 of 1        |
| REV. DESCRIPTION | DATE             | CUSTOMER'S APPROVAL |

## 2. Input terminal Pin Assignment

| NO.   | SYMBOL     | DISCRIPTION  | I/O |
|-------|------------|--|-----|
| 1     | LEDA       | Anode pin of backlight   | P   |
| 2     | NC         | --   | --  |
| 3     | LEDK       | Cathode pin OF backlight   | P   |
| 4     | NC         | --   | --  |
| 5     | GND        | Ground.  | P   |
| 6     | GND        |  |     |
| 7     | VCC        | Supply voltage(3.3V).  | P   |
| 8     | VCC        |  |     |
| 9     | IOVCC      | Supply voltage(1.65-3.3V).   | P   |
| 10    | SDO        | SPI interface output pin.<br>The data is output on the falling edge of the SCL signal.<br>If not used, let this pin open.  | O   |
| 11-28 | DB17-DB0   | 18-bit parallel bi-directional data bus for MCU system and RGB interface mode .<br>Fix to GND level when not in use  | I/O |
| 29    | DIN(SDA)   | When IM3: Low, SPI interface input/output pin.<br>When IM3: High, SPI interface input pin.<br>The data is latched on the rising edge of the SCL signal.<br>If not used, please fix this pin at IOVCC or DGND level | I/O |
| 30    | PCLK       | Dot clock signal for RGB interface operation.<br>Fix this pin at IOVCC or GND when not in use.   | I   |
| 31    | DE         | Data enable signal for RGB interface operation.<br>fix this pin at IOVCC or GND when not in use.   | I   |
| 32    | HSYNC      | Line synchronizing signal for RGB interface operation.<br>fix this pin at IOVCC or GND when not in use.  | I   |
| 33    | VSYNC      | Frame synchronizing signal for RGB interface operation.<br>fix this pin at IOVCC or GND when not in use.   | I   |
| 34    | RD         | Serves as a read signal and MCU read data at the rising edge.<br>fix this pin at IOVCC or GND when not in use.   | I   |
| 35    | WR(SPI-RS) | Write enable in MCU parallel interface.<br>Display data/command selection pin in 4-line serial interface.<br>Second Data lane in 2 data lane serial interface.   | I   |

|       |             |  |    |
|-------|-------------|--|----|
|       |             | If not used, please fix this pin at IOVCC or DGND.   |    |
| 36    | RS(SPI-SCL) | Display data/command selection pin in parallel interface.<br>This pin is used to be serial interface clock.<br>RS='1': display data or parameter.<br>RS='0': command data.<br>If not used, please fix this pin at IOVCC or DGND. |    |
| 37    | CS          | Chip select input pin ("Low" enable).<br>fix this pin at IOVCC or GND when not in use.   |    |
| 38    | RESET       | This signal will reset the device and must be applied to properly initialize the chip.   |    |
| 39    | IM0         | MPU Parallel interface bus and serial interface select If use RGB Interface must select serial interface.<br>Fix this pin at IOVCC and GND.  |    |
| 40    | IM1         |  |    |
| 41    | IM2         |  |    |
| 42-45 | NC          | No Connection  | -- |

**NOTE: MCU interface SET for IM PINS.**

| IM2 | IM1 | IM0 | Interface type                      | DB Pin in use      |
|-----|-----|-----|-------------------------------------|--------------------|
| 0   | 0   | 0   | DBI Tyb_ 16-bit interface           | DB17-DB10, DB8-DB1 |
| 0   | 0   | 1   | DBI Tyb_ 8-bit interface            | DB17-DB10          |
| 0   | 1   | 0   | DBI Tyb_ 18-bit interface           | DB17-DB0           |
| 0   | 1   | 1   | DBI Tyb_ 9-bit interface            | DB17-DB9           |
| 1   | 0   | 1   | 3-Wire 9 BIT data serial interface. | SDA SCL CS         |
| 1   | 1   | 0   | 4-Wire 8 BIT data serial interface  | SDA SCL CS RS      |

**NOTE:**

1. If not use PIN, fix to the GND, IOVCC or NC.
2. If use RGB mode must select serial interface



## 4. LCD Optical Characteristics

### 4.1 Optical specification

| Item                      | Symbol  | Condition  | Min.   | Typ.   | Max.   | Unit. | Note             |
|---------------------------|---------|------------|--------|--------|--------|-------|------------------|
| Contrast Ratio            | CR      | $\Theta=0$ | 640    | 800    | --     |       | (1)(2)           |
| Response time             | Rising  | $T_{R+TF}$ | --     | 35     | 40     | msec  | (1)(3)           |
|                           | Falling |            |        |        |        |       |                  |
| Color Gamut               | S(%)    |            | 43     | 48     | --     | %     | *                |
| Color Filter Chromaticity | White   | $W_X$      | 0.265  | 0.305  | 0.345  |       | (1)(4)<br>CA-310 |
|                           |         | $W_Y$      | 0.2833 | 0.3233 | 0.3633 |       |                  |
|                           | Red     | $R_X$      | 0.5315 | 0.5715 | 0.6115 |       |                  |
|                           |         | $R_Y$      | 0.3056 | 0.3456 | 0.3856 |       |                  |
|                           | Green   | $G_X$      | 0.3172 | 0.3572 | 0.3972 |       |                  |
|                           |         | $G_Y$      | 0.5127 | 0.5527 | 0.5927 |       |                  |
|                           | Blue    | $B_X$      | 0.1149 | 0.1549 | 0.1949 |       |                  |
|                           |         | $B_Y$      | 0.0638 | 0.1038 | 0.1438 |       |                  |
| Viewing angle             | Hor.    | $\Theta_L$ | CR>10  | 70     | 80     | --    | (1)(4)           |
|                           |         | $\Theta_R$ |        | 70     | 80     | --    |                  |
|                           | Ver.    | $\Theta_U$ |        | 70     | 80     | --    |                  |
|                           |         | $\Theta_D$ |        | 70     | 80     | --    |                  |
| Option View Direction     | ALL     |            |        |        |        |       |                  |

\*The data comes from the LCD specification.

#### Measuring Condition

Measuring surrounding : dark room

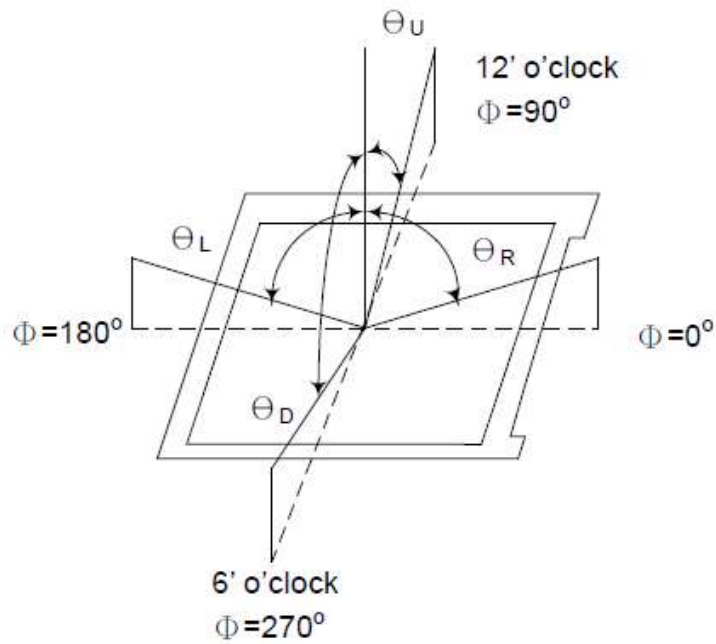
Ambient temperature :  $25\pm 2^\circ\text{C}$

15min. warm-up time.

#### Measuring Equipment

FPM520 of Westar Display technologies, INC., which utilized SR-3 for Chromaticity and BM-5A for other optical characteristics.

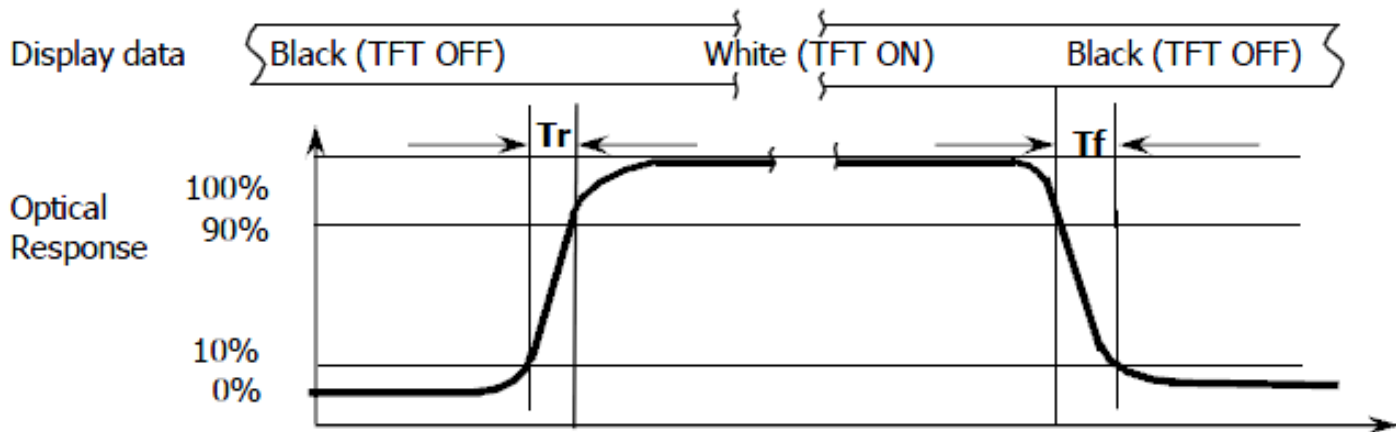
**Note (1):** Definition of Viewing Angle :



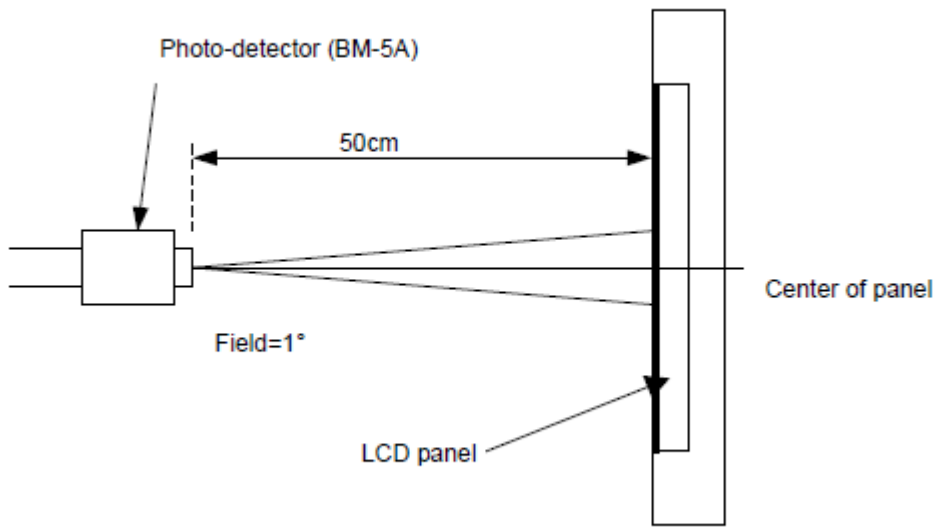
**Note (2):** Definition of Contrast Ratio(CR) :measured at the center point of panel

$$CR = \frac{\text{Luminance with all pixels white}}{\text{Luminance with all pixels black}}$$

**Note (3):** Response Time



**Note (4):** Definition of optical measurement setup



## 5. Electrical Characteristics

### 5.1 Absolute Maximum Rating

| Characteristics          | Symbol          | Min. | Max. | Unit | Note  |
|--------------------------|-----------------|------|------|------|-------|
| Digital Supply Voltage   | VCC             | -0.3 | 4.6  | V    | Note1 |
| Digital interface supply | IOVCC           | -0.3 | 4.6  | V    |       |
| Operating temperature    | T <sub>OP</sub> | -20  | +70  | °C   |       |
| Storage temperature      | T <sub>ST</sub> | -30  | +80  | °C   |       |

NOTE1: If the absolute maximum rating of even is one of the above parameters is exceeded even momentarily,

the quality of the product may be degraded. Absolute maximum ratings, therefore, specify the values

exceeding which the product may be physically damaged. Be sure to use the product within the range

of the absolute maximum ratings.

### 5.2 DC Electrical Characteristics

| Characteristics                  | Symbol          | Min.      | Typ. | Max.      | Unit | Note |
|----------------------------------|-----------------|-----------|------|-----------|------|------|
| Digital Supply Voltage           | VCC             | 2.4       | 3.3  | 3.6       | V    |      |
| Digital interface supply Voltage | IOVCC           | 1.65      | 1.8  | 3.3       | V    |      |
| Normal mode Current consumption  | IDD             | --        | 7    | --        | mA   |      |
| Level input voltage              | V <sub>IH</sub> | 0.7*IOVCC | --   | IOVCC     | V    |      |
|                                  | V <sub>IL</sub> | GND       | --   | 0.3*IOVCC | V    |      |
| Level output voltage             | V <sub>OH</sub> | 0.8*IOVCC | --   | IOVCC     | V    |      |
|                                  | V <sub>OL</sub> | GND       | --   | 0.2*IOVCC | V    |      |

### 5.3 LED Backlight Characteristics

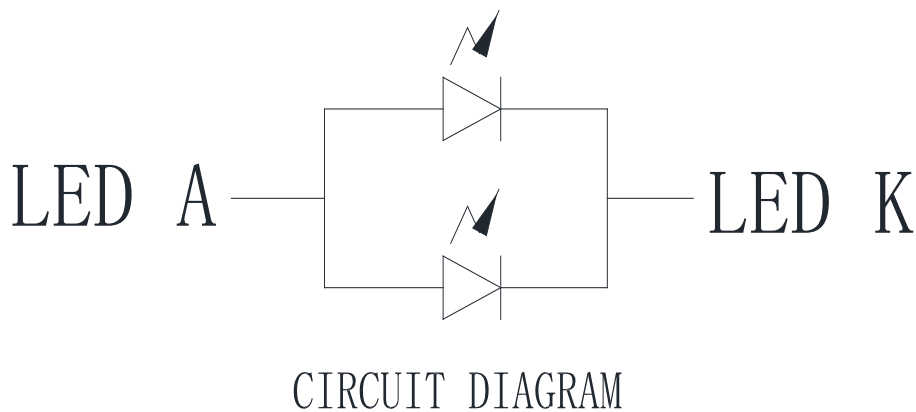
The back-light system is edge-lighting type with 2 chips LED

| Item            | Symbol | Min.  | Typ. | Max. | Unit              | Note    |
|-----------------|--------|-------|------|------|-------------------|---------|
| Forward Current | $I_F$  | 35    | 40   | --   | mA                |         |
| Forward Voltage | $V_F$  | --    | 3.3  | --   | V                 |         |
| LCM Luminance   | LV     | 420   | 470  | --   | cd/m <sup>2</sup> | Note3   |
| LED life time   | Hr     | 50000 | --   | --   | Hour              | Note1,2 |
| Uniformity      | Avg    | 80    | --   | --   | %                 | Note3   |

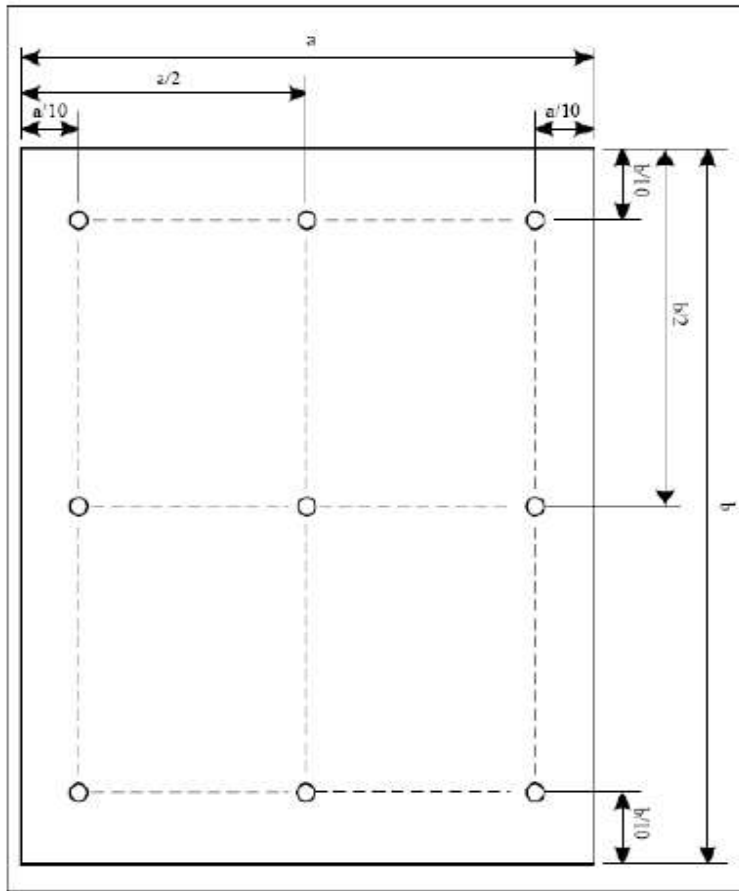
Note1: LED life time (Hr) can be defined as the time in which it continues to operate under the condition:

$T_a=25\pm 3$  °C, typical IL value indicated in the above table until the brightness becomes less than 50%.

Note 2: The “LED life time” 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:

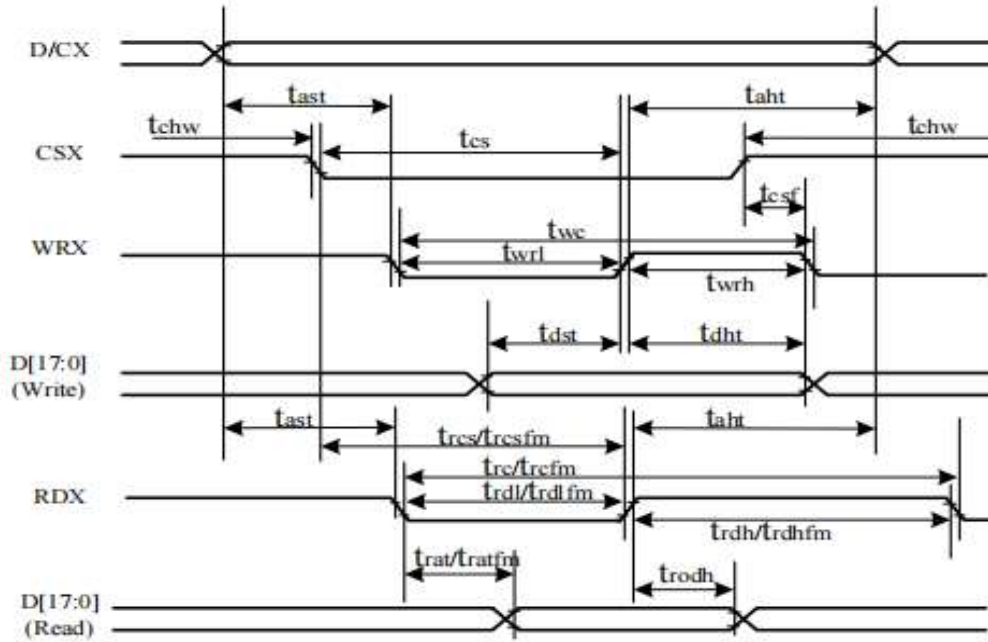


$$\text{Uniformity} = \frac{\text{minimum luminance in 9 points (1-9)}}{\text{maximum luminance in 9 points (1-9)}}$$

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

## 6. AC Characteristic

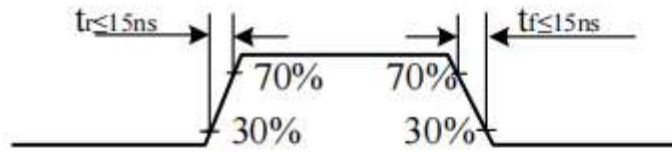
### 6.1 Display Parallel 18/16/9/8-bit Interface Timing Characteristics (8080)



| Signal              | Symbol                        | Parameter                          | min | max | Unit | Description            |
|---------------------|-------------------------------|------------------------------------|-----|-----|------|------------------------|
| DCX                 | t <sub>ast</sub>              | Address setup time                 | 0   | -   | ns   |                        |
|                     | t <sub>ahw</sub>              | Address hold time(Write/Read)      | 0   | -   | ns   |                        |
| CSX                 | t <sub>chw</sub>              | CSX "H" pulse width                | 0   | -   | ns   |                        |
|                     | t <sub>cs</sub>               | Chip Select setup time(Write)      | 15  | -   | ns   |                        |
|                     | t <sub>rcs</sub>              | Chip Select setup time(Read ID)    | 45  | -   | ns   |                        |
|                     | t <sub>rcs<sub>fm</sub></sub> | Chip Select setup time(Read FM)    | 355 | -   | ns   |                        |
|                     | t <sub>csf</sub>              | Chip Select Wait time (Write/Read) | 10  | -   | ns   |                        |
| WRX                 | t <sub>wc</sub>               | Write Cycle                        | 66  | -   | ns   |                        |
|                     | t <sub>wrh</sub>              | Write Control pulse H duration     | 15  | -   | ns   |                        |
|                     | t <sub>wrl</sub>              | Write Control pulse L duration     | 15  | -   | ns   |                        |
| RDX(FM)             | t <sub>rc<sub>fm</sub></sub>  | Read Cycle (FM)                    | 380 | -   | ns   |                        |
|                     | t <sub>rdh<sub>fm</sub></sub> | Read Control H duration(FM)        | 180 | -   | ns   |                        |
|                     | t <sub>rdl<sub>fm</sub></sub> | Read Control L duration(FM)        | 200 | -   | ns   |                        |
| RDX(ID)             | t <sub>rc</sub>               | Read Cycle (ID)                    | 160 | -   | ns   |                        |
|                     | t <sub>rdh</sub>              | Read Control H pulse duration      | 90  | -   | ns   |                        |
|                     | t <sub>rdl</sub>              | Read Control L pulse duration      | 70  | -   | ns   |                        |
| D[17:0],<br>D[15:0] | t <sub>dst</sub>              | Write data setup time              | 10  | -   | ns   | For maximum<br>CL=30pF |
|                     | t <sub>dht</sub>              | Write data hold time               | 10  | -   | ns   |                        |
| D[8:0],<br>D[7:0]   | t <sub>rat</sub>              | Read access time                   | -   | 40  | ns   | For minimum<br>CL=8pF  |
|                     | t <sub>rat<sub>fm</sub></sub> | Read access time                   | -   | 340 | ns   |                        |
|                     | t <sub>trod</sub>             | Read output disable time           | 20  | 80  | ns   |                        |

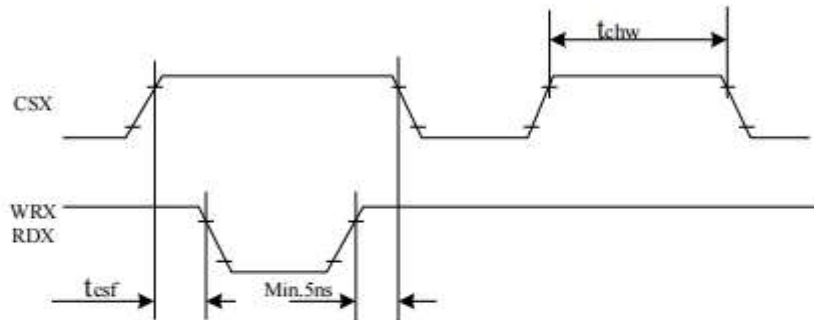
Note:  $T_a = -30$  to  $70$  °C,  $I_{OVCC}=1.65V$  to  $3.3V$ ,  $V_{CI}=2.5V$  to  $3.3V$ ,  $V_{SS}=0V$

**Figure91.**



CSX timings :

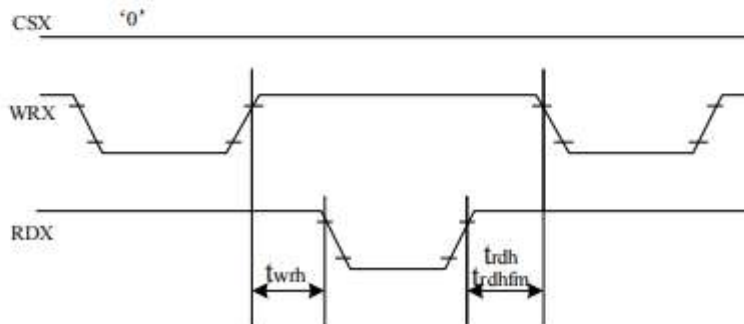
**Figure92.**



*Note: Logic high and low levels are specified as 30% and 70% of IOVCC for Input signals.*

Write to read or read to write timings:

**Figure92.**



*Note: Logic high and low levels are specified as 30% and 70% of IOVCC for Input signals.*

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



Figure97.

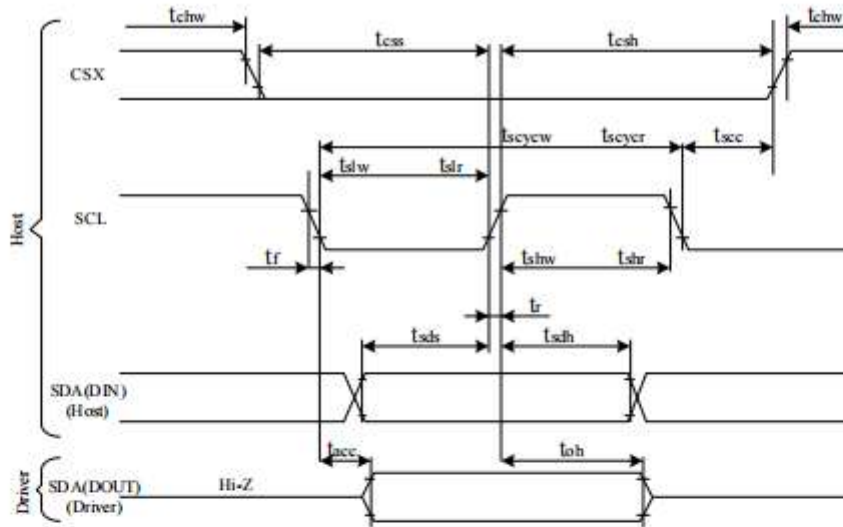
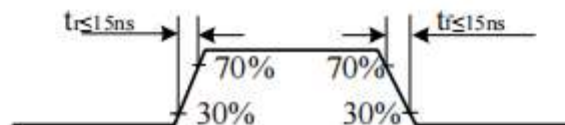


Table47.

| Signal          | Symbol | Parameter                   | min | max | Unit | Description |
|-----------------|--------|-----------------------------|-----|-----|------|-------------|
| SCL             | tscycw | Serial Clock Cycle (Write)  | 10  | -   | ns   |             |
|                 | tshw   | SCL "H" Pulse Width (Write) | 5   | -   | ns   |             |
|                 | tslw   | SCL "L" Pulse Width (Write) | 5   | -   | ns   |             |
|                 | tscycr | Serial Clock Cycle (Read)   | 150 | -   | ns   |             |
|                 | tshr   | SCL "H" Pulse Width (Read)  | 60  | -   | ns   |             |
|                 | tslr   | SCL "L" Pulse Width (Read)  | 60  | -   | ns   |             |
| SDA/SDI (Input) | tsds   | Data setup time (Write)     | 5   | -   | ns   |             |
|                 | tsdh   | Data hold time (Write)      | 5   | -   | ns   |             |
| SDA/SD0(Outp )  | tacc   | Access time (Read)          | 10  | -   | ns   |             |
| CSX             | tsec   | SCL-CSX                     | 10  | -   | ns   |             |
|                 | tchw   | CSX "H" Pulse Width         | 10  | -   | ns   |             |
|                 | tcss   |                             | 20  | -   | ns   |             |
|                 | tchsh  | CSX-SCL Time                | 40  | -   | ns   |             |

Note:  $T_a = 25\text{ }^\circ\text{C}$ ,  $IOVCC=1.65\text{V to }3.3\text{V}$ ,  $VCI=2.5\text{V to }3.3\text{V}$ ,  $VSSA=VSSC=0\text{V}$

Figure98.



### 6.3 Display Serial Interface Timing Characteristics (4-line SPI system)

Figure98.

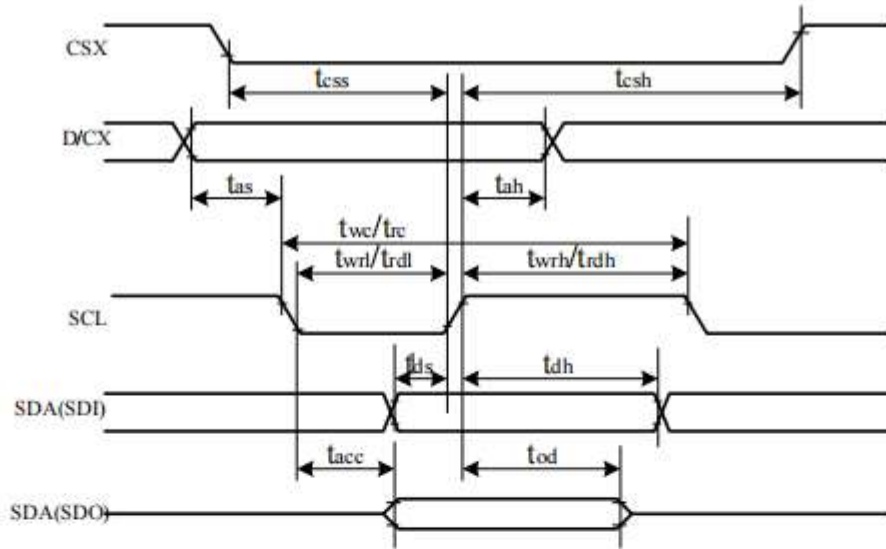
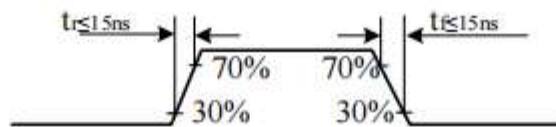


Table48.

| Signal              | Symbol    | Parameter                    | min | max | Unit | Description |
|---------------------|-----------|------------------------------|-----|-----|------|-------------|
| CSX                 | $t_{css}$ | Chip select time (Write)     | 20  | -   | ns   |             |
|                     | $t_{csh}$ | Chip select hold time (Read) | 40  | -   | ns   |             |
| SCL                 | $t_{wc}$  | Serial Clock Cycle (Write)   | 10  | -   | ns   |             |
|                     | $t_{wrh}$ | SCL "H" Pulse Width (Write)  | 5   | -   | ns   |             |
|                     | $t_{wrl}$ | SCL "L" Pulse Width (Write)  | 5   | -   | ns   |             |
|                     | $t_{rc}$  | Serial Clock Cycle (Read)    | 150 | -   | ns   |             |
|                     | $t_{rdh}$ | SCL "H" Pulse Width (Read)   | 60  | -   | ns   |             |
|                     | $t_{rdl}$ | SCL "L" Pulse Width (Read)   | 60  | -   | ns   |             |
| D/CX                | $t_{tas}$ | D/CX setup time              | 10  | -   | ns   |             |
|                     | $t_{tah}$ | D/CX hold time (Write/Read)  | 10  | -   | ns   |             |
| SDA/SDI<br>(Input)  | $t_{ds}$  | Data setup time (Write)      | 5   | -   | ns   |             |
|                     | $t_{dh}$  | Data hold time (Write)       | 5   | -   | ns   |             |
| SDA/SD0<br>(Output) | $t_{acc}$ | Access time (Read)           | 10  | -   | ns   |             |

Note:  $T_a = 25\text{ }^\circ\text{C}$ ,  $IOVCC=1.65V\text{ to }3.3V$ ,  $VCI=2.5V\text{ to }3.3V$ ,  $AGND=VSS=0V$

Figure99.



#### 6.4 Parallel 18/16/6-bit RGB Interface Timing Characteristics

Figure100.

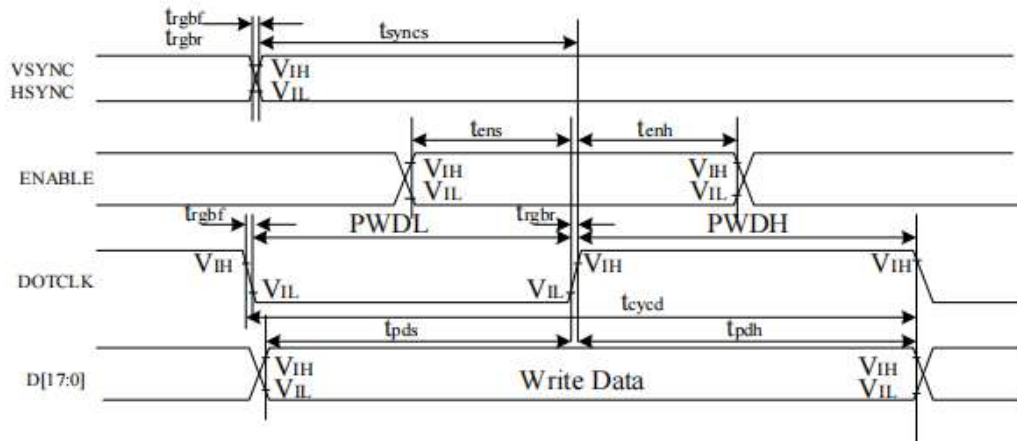
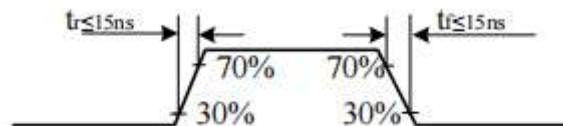


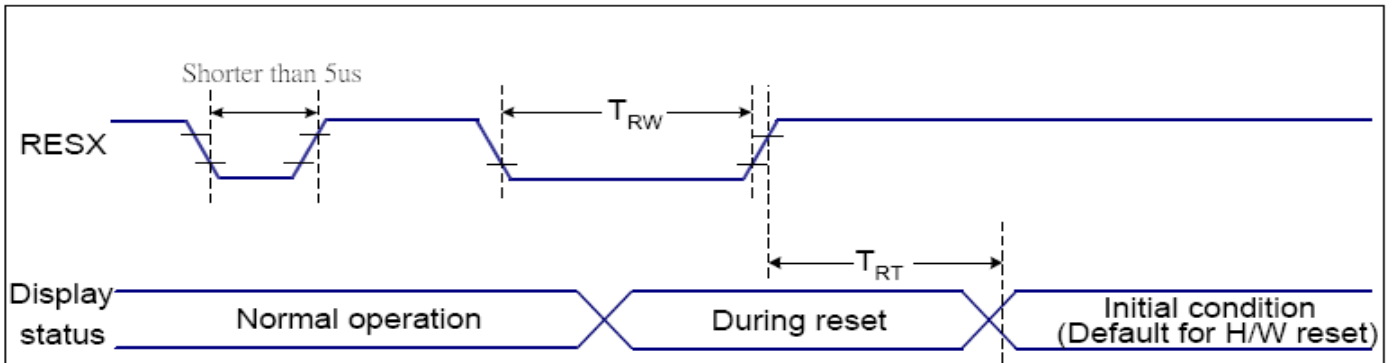
Table49.

| Signal      | Symbol             | Parameter                         | min | max | Unit | Description                      |                              |
|-------------|--------------------|-----------------------------------|-----|-----|------|----------------------------------|------------------------------|
| VSYNC/HSYNC | $t_{syncs}$        | VSYNC/HSYNC setup time            | 15  | -   | ns   | 18/16-bit bus RGB interface mode |                              |
|             | $t_{synch}$        | VSYNC/HSYNC hold time             | 15  | -   | ns   |                                  |                              |
| DE          | $t_{ens}$          | DE setup time                     | 15  | -   | ns   |                                  |                              |
|             | $t_{enh}$          | DE hold time                      | 15  | -   | ns   |                                  |                              |
| D[17:0]     | $t_{pos}$          | Data setup time                   | 15  | -   | ns   |                                  |                              |
|             | $t_{pdh}$          | Date hold time                    | 15  | -   | ns   |                                  |                              |
| DOTCLK      | $PWDH$             | DOTCLK high-level period          | 15  | -   | ns   |                                  |                              |
|             | $PWDL$             | DOTCLK low-level period           | 15  | -   | ns   |                                  |                              |
|             | $t_{cyed}$         | DOTCLK cycle time                 | 100 | -   | ns   |                                  |                              |
|             | $t_{rgrbr, trgbf}$ | DOTCLK,HSYNC,VSYNC rise/fall time | -   | 15  | ns   |                                  |                              |
| VSYNC/HSYNC | $t_{syncs}$        | VSYNC/HSYNC setup time            | 15  | -   | ns   |                                  | 6-bit bus RGB interface mode |
|             | $t_{synch}$        | VSYNC/HSYNC hold time             | 15  | -   | ns   |                                  |                              |
| DE          | $t_{ens}$          | DE setup time                     | 15  | -   | ns   |                                  |                              |
|             | $t_{enh}$          | DE hold time                      | 15  | -   | ns   |                                  |                              |
| D[17:0]     | $t_{pos}$          | Data setup time                   | 15  | -   | ns   |                                  |                              |
|             | $t_{pdh}$          | Date hold time                    | 15  | -   | ns   |                                  |                              |
| DOTCLK      | $PWDH$             | DOTCLK high-level pulse period    | 15  | -   | ns   |                                  |                              |
|             | $PWDL$             | DOTCLK low-level pulse period     | 15  | -   | ns   |                                  |                              |
|             | $t_{cyed}$         | DOTCLK cycle time                 | 100 | -   | ns   |                                  |                              |
|             | $t_{rgrbr, trgbf}$ | DOTCLK,HSYNC,VSYNC rise/fall time | -   | 15  | ns   |                                  |                              |

Note:  $T_a = -30$  to  $70$  °C,  $IOVCC=1.65V$  to  $3.3V$ ,  $VCI=2.5V$  to  $3.3V$ ,  $AGND=VSS=0V$



## 6.5 Reset Timing Characteristics



VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V,  $T_a = -30 \sim 70 \text{ }^\circ\text{C}$

| 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:

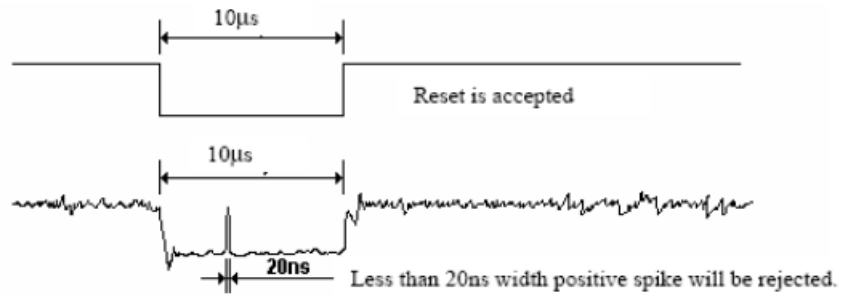
1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time ( $t_{RT}$ ) within 5 ms after a rising edge of RESX.

2. Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below:

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

3. During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, 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 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

## 7. LCD Module Out-Going Quality Level

### 7.1 VISUAL & FUNCTION INSPECTION STANDARD

#### 7.1.1 Inspection conditions

Inspection performed under the following conditions is recommended.

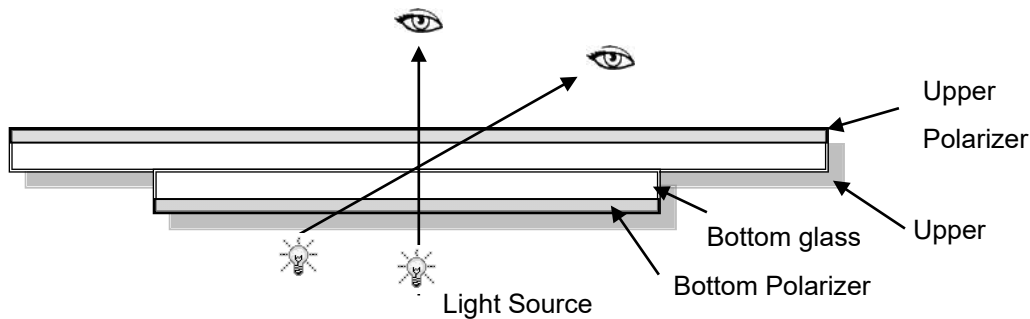
Temperature :  $25\pm 5^{\circ}\text{C}$

Humidity :  $65\%\pm 10\%\text{RH}$

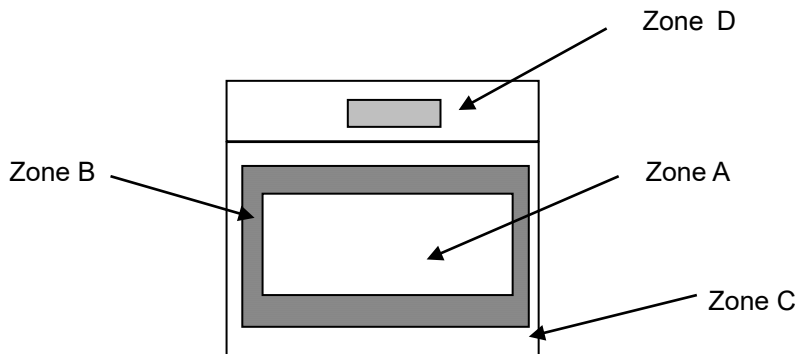
Viewing Angle : Normal viewing Angle.

Illumination: Single fluorescent lamp (300 to 700Lux)

Viewing distance:30-50cm



#### 7.1.2 Definition



Zone A : Effective Viewing Area(Character or Digit can be seen)

Zone B : Viewing Area except Zone A

Zone C : Outside (Zone A+Zone B) which can not be seen after assembly by customer

Zone D : IC Bonding Area

Note:As a general rule ,visual defects in Zone C can be ignored when it doesn't effect product function or appearance after assembly by customer

#### 7.1.3 Sampling Plan

According to GB/T 2828-2003 ; , normal inspection, Class II

AQL:

|              |              |
|--------------|--------------|
| Major defect | Minor defect |
| 0.65         | 1.5          |

LCD: Liquid Crystal Display , LCM: Liquid Crystal Module,

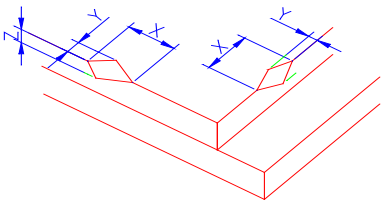
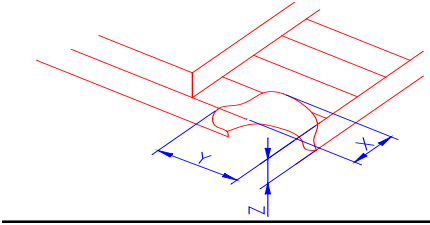
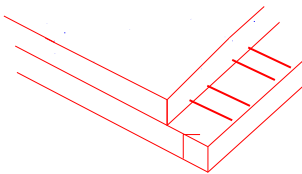
| No | Items to be inspected | Criteria   | Classification of defects |
|----|-----------------------|--|---------------------------|
| 1  | Functional defects    | 1) No display, Open or miss line<br>2) Display abnormally, Short<br>3) Backlight no lighting, abnormal lighting.<br>etc... | Major                     |
| 2  | Missing               | Missing components and etc...  |                           |
| 3  | Outline dimension     | Overall outline dimension beyond the drawing is not allowed, deformation and etc...  |                           |
| 4  | Color tone            | Color unevenness, refer to limited sample  | Minor                     |
| 5  | Spot/Line defect      | Light dot, Dim spot, (Note1)<br>Polarizer Air Bubble,<br>Polarizer accidented spot and etc.                                |                           |
| 6  | Soldering appearance  | Good soldering , Peeling off is not allowed and etc.   |                           |
| 7  | LCD/Polarizer         | Black/White spot/line, scratch, crack, etc.  |                           |

**Note1:** a) Light dot: Dots appear bright and unchanged in size in which LCD panel is displaying under black pattern.

b) Dim dot: Dots appear dark and unchanged in size in which LCD panel is displaying under pure red, green, blue picture.

#### 7.1.4 Criteria (Visual)

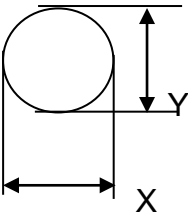
| Number | Items | Criteria(mm) |
|--------|-------|--------------|
|--------|-------|--------------|

|  |                                   |   |   |   |   |        |                                |    |
|--|-----------------------------------|---|---|---|---|--------|--------------------------------|----|
| <p>1.0 LCD<br/>Crack/Broken</p> <p>NOTE:<br/>X: Length<br/>Y: Width<br/>Z: Height<br/>L: Length of ITO,<br/>T: Height of LCD</p> | <p>(1) The edge of LCD broken</p> |  <table border="1"> <tr> <td>X</td> <td>Y</td> <td>Z</td> </tr> <tr> <td>≤3.0mm</td> <td>&lt;Inner border line of the seal</td> <td>≤T</td> </tr> </table> | X | Y | Z | ≤3.0mm | <Inner border line of the seal | ≤T |
| X  | Y                                 | Z   |   |   |   |        |                                |    |
| ≤3.0mm   | <Inner border line of the seal    | ≤T  |   |   |   |        |                                |    |
|  | <p>(2) LCD corner broken</p>      |  <table border="1"> <tr> <td>X</td> <td>Y</td> <td>Z</td> </tr> <tr> <td>≤3.0mm</td> <td>≤L</td> <td>≤T</td> </tr> </table>                               | X | Y | Z | ≤3.0mm | ≤L                             | ≤T |
| X  | Y                                 | Z   |   |   |   |        |                                |    |
| ≤3.0mm   | ≤L                                | ≤T  |   |   |   |        |                                |    |
|  | <p>(3) LCD crack</p>              |  <p>Crack<br/>Not allowed</p>   |   |   |   |        |                                |    |



2.0

Spot defect



$\Phi=(X+Y)/2$

① light dot ( black/white spot , pinhole, stain, etc.)

| Zone<br>Size (mm)       | Acceptable Qty          |   |   |
|-------------------------|-------------------------|---|---|
|                         | A                       | B | C |
| $\Phi \leq 0.15$        | Ignore                  |   |   |
| $0.15 < \Phi \leq 0.25$ | 3(distance $\geq 6$ mm) |   |   |
| $0.25 < \Phi \leq 0.4$  | 2(distance $\geq 6$ mm) |   |   |
| $\Phi > 0.4$            | 0                       |   |   |

② Dim spot (light leakage, dent, dark spot, etc)


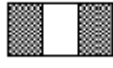

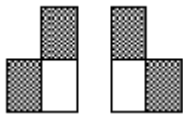
| Zone<br>Size (mm)       | Acceptable Qty           |   |   |
|-------------------------|--------------------------|---|---|
|                         | A                        | B | C |
| $\Phi \leq 0.15$        | Ignore                   |   |   |
| $0.15 < \Phi \leq 0.25$ | 3( distance $\geq 6$ mm) |   |   |
| $0.25 < \Phi \leq 0.4$  | 2( distance $\geq 6$ mm) |   |   |
| $\Phi > 0.4$            | 0                        |   |   |


③ Polarizer accidented spot

| Zone<br>Size (mm)     | Acceptable Qty           |   |   |
|-----------------------|--------------------------|---|---|
|                       | A                        | B | C |
| $\Phi \leq 0.2$       | Ignore                   |   |   |
| $0.2 < \Phi \leq 0.5$ | 2( distance $\geq 6$ mm) |   |   |
| $\Phi > 0.5$          | 0                        |   |   |

④ Polarizer Bubble

| Zone<br>Size (mm)     | Acceptable Qty          |   |   |
|-----------------------|-------------------------|---|---|
|                       | A                       | B | C |
| $\Phi \leq 0.2$       | Ignore                  |   |   |
| $0.2 < \Phi \leq 0.4$ | 3(distance $\geq 6$ mm) |   |   |
| $\Phi > 0.4$          | 0                       |   |   |

| 3.0                       | LCD Pixel defect  | <p>Pixel bad points</p> <table border="1"> <thead> <tr> <th>Item</th> <th>Zone A</th> <th>Acceptable Qty</th> </tr> </thead> <tbody> <tr> <td rowspan="3">Bright dot</td> <td>Random</td> <td>N≤2</td> </tr> <tr> <td>2 dots adjacent</td> <td>N≤0</td> </tr> <tr> <td>3 dots adjacent</td> <td>N≤0</td> </tr> <tr> <td rowspan="3">Dark dot</td> <td>Random</td> <td>N≤2</td> </tr> <tr> <td>2 dots adjacent</td> <td>N≤0</td> </tr> <tr> <td>3 dots adjacent</td> <td>N≤0</td> </tr> <tr> <td>Distance</td> <td>           1. Minimum Distance Between Bright dots.<br/>           2. Minimum Distance Between dark dots<br/>           3. Minimum Distance Between dark and bright dot.         </td> <td>5mm</td> </tr> <tr> <td colspan="2">Total bright and dark dot</td> <td>N≤4</td> </tr> </tbody> </table> <p>Note:</p> <p>A) Bright dot: Dots appear bright and unchanged in size in which LCD panel is displaying under black pattern.</p> <p>B) Dark dot: Dots appear dark and unchanged in size in which LCD panel is displaying under pure red, green, blue picture.</p> <p>C) 2 dot adjacent = 1 pair = 2 dots</p> <p>Picture:</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>2 dot adjacent</p> </div> <div style="text-align: center;">  <p>2 dot adjacent</p> </div> <div style="text-align: center;">  <p>2 dot adjacent (vertical)</p> </div> <div style="text-align: center;">  <p>2 dot adjacent (slant)</p> </div> </div> | Item | Zone A | Acceptable Qty | Bright dot | Random | N≤2 | 2 dots adjacent | N≤0 | 3 dots adjacent | N≤0 | Dark dot | Random | N≤2 | 2 dots adjacent | N≤0 | 3 dots adjacent | N≤0 | Distance | 1. Minimum Distance Between Bright dots.<br>2. Minimum Distance Between dark dots<br>3. Minimum Distance Between dark and bright dot. | 5mm | Total bright and dark dot |  | N≤4 |
|---------------------------|---|--|------|--------|----------------|------------|--------|-----|-----------------|-----|-----------------|-----|----------|--------|-----|-----------------|-----|-----------------|-----|----------|---|-----|---------------------------|--|-----|
| Item                      | Zone A  | Acceptable Qty   |      |        |                |            |        |     |                 |     |                 |     |          |        |     |                 |     |                 |     |          |   |     |                           |  |     |
| Bright dot                | Random  | N≤2  |      |        |                |            |        |     |                 |     |                 |     |          |        |     |                 |     |                 |     |          |   |     |                           |  |     |
|                           | 2 dots adjacent   | N≤0  |      |        |                |            |        |     |                 |     |                 |     |          |        |     |                 |     |                 |     |          |   |     |                           |  |     |
|                           | 3 dots adjacent   | N≤0  |      |        |                |            |        |     |                 |     |                 |     |          |        |     |                 |     |                 |     |          |   |     |                           |  |     |
| Dark dot                  | Random  | N≤2  |      |        |                |            |        |     |                 |     |                 |     |          |        |     |                 |     |                 |     |          |   |     |                           |  |     |
|                           | 2 dots adjacent   | N≤0  |      |        |                |            |        |     |                 |     |                 |     |          |        |     |                 |     |                 |     |          |   |     |                           |  |     |
|                           | 3 dots adjacent   | N≤0  |      |        |                |            |        |     |                 |     |                 |     |          |        |     |                 |     |                 |     |          |   |     |                           |  |     |
| Distance                  | 1. Minimum Distance Between Bright dots.<br>2. Minimum Distance Between dark dots<br>3. Minimum Distance Between dark and bright dot. | 5mm  |      |        |                |            |        |     |                 |     |                 |     |          |        |     |                 |     |                 |     |          |   |     |                           |  |     |
| Total bright and dark dot |   | N≤4  |      |        |                |            |        |     |                 |     |                 |     |          |        |     |                 |     |                 |     |          |   |     |                           |  |     |

| 4.0                  | Line defect (LCD /Polarizer backlight black/white line, scratch, stain)<br><br>W: width, L : length<br>N : Count | <table border="1"> <thead> <tr> <th rowspan="2">Width(mm)</th> <th rowspan="2">Length(m)</th> <th colspan="3">Acceptable Qty</th> </tr> <tr> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td><math>\Phi \leq 0.03</math></td> <td>Ignore</td> <td colspan="2">Ignore</td> <td rowspan="3">Ignore</td> </tr> <tr> <td><math>0.03 &lt; W \leq 0.04</math></td> <td><math>L \leq 3.0</math></td> <td colspan="2"><math>N \leq 2</math></td> </tr> <tr> <td><math>0.04 &lt; W \leq 0.05</math></td> <td><math>L \leq 2.0</math></td> <td colspan="2"><math>N \leq 1</math></td> </tr> <tr> <td><math>W &gt; 0.05</math></td> <td colspan="4">Define as spot defect</td> </tr> </tbody> </table> | Width(mm)    | Length(m)  | Acceptable Qty |                |  | A | B | C | $\Phi \leq 0.03$ | Ignore | Ignore |  | Ignore | $0.03 < W \leq 0.04$ | $L \leq 3.0$ | $N \leq 2$ |  | $0.04 < W \leq 0.05$ | $L \leq 2.0$ | $N \leq 1$ |  | $W > 0.05$ | Define as spot defect |  |  |  |
|----------------------|---|--|--------------|------------|----------------|----------------|--|---|---|---|------------------|--------|--------|--|--------|----------------------|--------------|------------|--|----------------------|--------------|------------|--|------------|-----------------------|--|--|--|
|                      |   | Width(mm)  |              |            | Length(m)      | Acceptable Qty |  |   |   |   |                  |        |        |  |        |                      |              |            |  |                      |              |            |  |            |                       |  |  |  |
|                      |   |  | A            | B          |                | C              |  |   |   |   |                  |        |        |  |        |                      |              |            |  |                      |              |            |  |            |                       |  |  |  |
|                      |   | $\Phi \leq 0.03$   | Ignore       | Ignore     |                | Ignore         |  |   |   |   |                  |        |        |  |        |                      |              |            |  |                      |              |            |  |            |                       |  |  |  |
|                      |   | $0.03 < W \leq 0.04$   | $L \leq 3.0$ | $N \leq 2$ |                |                |  |   |   |   |                  |        |        |  |        |                      |              |            |  |                      |              |            |  |            |                       |  |  |  |
| $0.04 < W \leq 0.05$ | $L \leq 2.0$  | $N \leq 1$   |              |            |                |                |  |   |   |   |                  |        |        |  |        |                      |              |            |  |                      |              |            |  |            |                       |  |  |  |
| $W > 0.05$           | Define as spot defect   |  |              |            |                |                |  |   |   |   |                  |        |        |  |        |                      |              |            |  |                      |              |            |  |            |                       |  |  |  |
| 5.0                  | Electronic Components SMT.  | Not allow missing parts, solderless connection, cold solder joint, mismatch, The positive and negative polarity opposite   |              |            |                |                |  |   |   |   |                  |        |        |  |        |                      |              |            |  |                      |              |            |  |            |                       |  |  |  |
| 6.0                  | Display color & Brightness.   | 1. Color: Measuring the color coordinates, The measurement standard according to the datasheet or samples.<br>2. Brightness: Measuring the brightness of White screen, The measurement standard according to the datasheet or Samples.   |              |            |                |                |  |   |   |   |                  |        |        |  |        |                      |              |            |  |                      |              |            |  |            |                       |  |  |  |
| 7.0                  | LCD Mura/Waving/ Hot spot   | Not visible through 5% ND filter in 50% gray or judge by limit sample if necessary.  |              |            |                |                |  |   |   |   |                  |        |        |  |        |                      |              |            |  |                      |              |            |  |            |                       |  |  |  |

Criteria ( functional items)

| Number | Items                 | Criteria (mm) |
|--------|-----------------------|---------------|
| 1      | No display            | Not allowed   |
| 2      | Missing segment       | Not allowed   |
| 3      | Short                 | Not allowed   |
| 4      | Backlight no lighting | Not allowed   |

## 8. Reliability Test Result

| Item                                       | Condition   | Inspection after test  |
|--|---|--|
| High Temperature Operating                 | 70°C, 96H   | Inspection after 2~4hours storage at room temperature, the sample shall be free from defects:<br>1.Air bubble in the LCD;<br>2.Non-display;<br>3.Missing segments/line;<br>4.Glass crack;<br>5.Current IDD is twice higher than initial value. |
| Low Temperature Operating                  | -20°C, 96HRS  |  |
| High Temperature Storage                   | 80°C, 96HR  |  |
| Low Temperature Storage                    | -30°C, 96HR   |  |
| High Temperature & High Humidity Operating | +60°C, 90% RH ,96 hours.  |  |
| Thermal Shock (Non-operation)              | -10°C, 30 min ↔ +60°C, 30 min,<br>Change time: 5min 20CYC.  |  |
| ESD test                                   | C=150pF, R=330, 5points/panel<br>Air: ±8KV, 5times; Contact: ±6KV, 5 times;<br>(Environment: 15°C~35°C, 30%~60%).                             |  |
| Vibration (Non-operation)                  | Frequency range: 10~55Hz, Stroke: 1.5mm<br>Sweep: 10Hz~55Hz~10Hz 2 hours for each direction of X.Y.Z. (6 hours for total) (Package condition) |  |
| Box Drop Test                              | 1 Corner 3 Edges 6 faces, 80 <sub>cm</sub> (MEDIUM BOX)   |  |

Remark:

1. The test samples should be applied to only one test item.
2. Sample size for each test item is 5~10pcs.
3. For Damp Proof Test, Pure water (Resistance > 10MΩ) should be used.
4. In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judged as a good part.
5. Failure Judgment Criterion: Basic Specification, Electrical Characteristic, Mechanical Characteristic, Optical Characteristic.
6. The color fading mura of polarizing filter should not care.

## 9. Cautions and Handling Precautions

### 9.1 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 CMOS ICs.

(9) Use finger-stalls 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.

### 9.2 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.

## 10. Packing

----TBD-----