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# SPECIFICATION FOR LCM Module

|            |              |
|------------|--------------|
| MODULE No: | ET040WX21-KT |
| CUSTOMER:  |              |

|             |         |      |
|-------------|---------|------|
| YOURITECH   | INITIAL | DATE |
| PREPARED BY |         |      |
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## 1.Basic Specifications

### \* 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 module is composed of a Transmissive type TFT-LCD Panel, driver circuit, back-light unit. The resolution of a 4.0 " TFT-LCD contains 480x480 pixels, and can display up to 65K/262K/16.7M colors.

#### 1.1 TFT Features

| General Information Items | Specification                           | Unit    | Note |
|---------------------------|-----------------------------------------|---------|------|
|                           | Main Panel                              |         |      |
| Display area(AA)          | 71.86(H)*70.18(V) (4.0 inch)            | mm      |      |
| Driver element            | TFT active matrix                       | -       |      |
| Display colors            | 65K/262K/16.7M                          | colors  |      |
| Number of pixels          | 480(RGB)*480                            | dots    |      |
| Pixel arrangement         | RGB vertical stripe                     | -       |      |
| Pixel pitch               | 0.1497(H)*0.1462(V)                     | mm      |      |
| Viewing angle             | ALL                                     | o'clock |      |
| Controller IC             | ST7701S                                 | -       |      |
| LCM Interface             | 16/18/24BIT RGB                         | -       |      |
| Display mode              | Transmissive /Normally Black            | -       |      |
| Operating temperature     | -30 ~ +85                               | °C      |      |
| Storage temperature       | -40 ~ +90                               | °C      |      |
| Module bonding technology | Use Optical bonding between LCM and CTP | -       |      |

#### 1.2 CTP Features

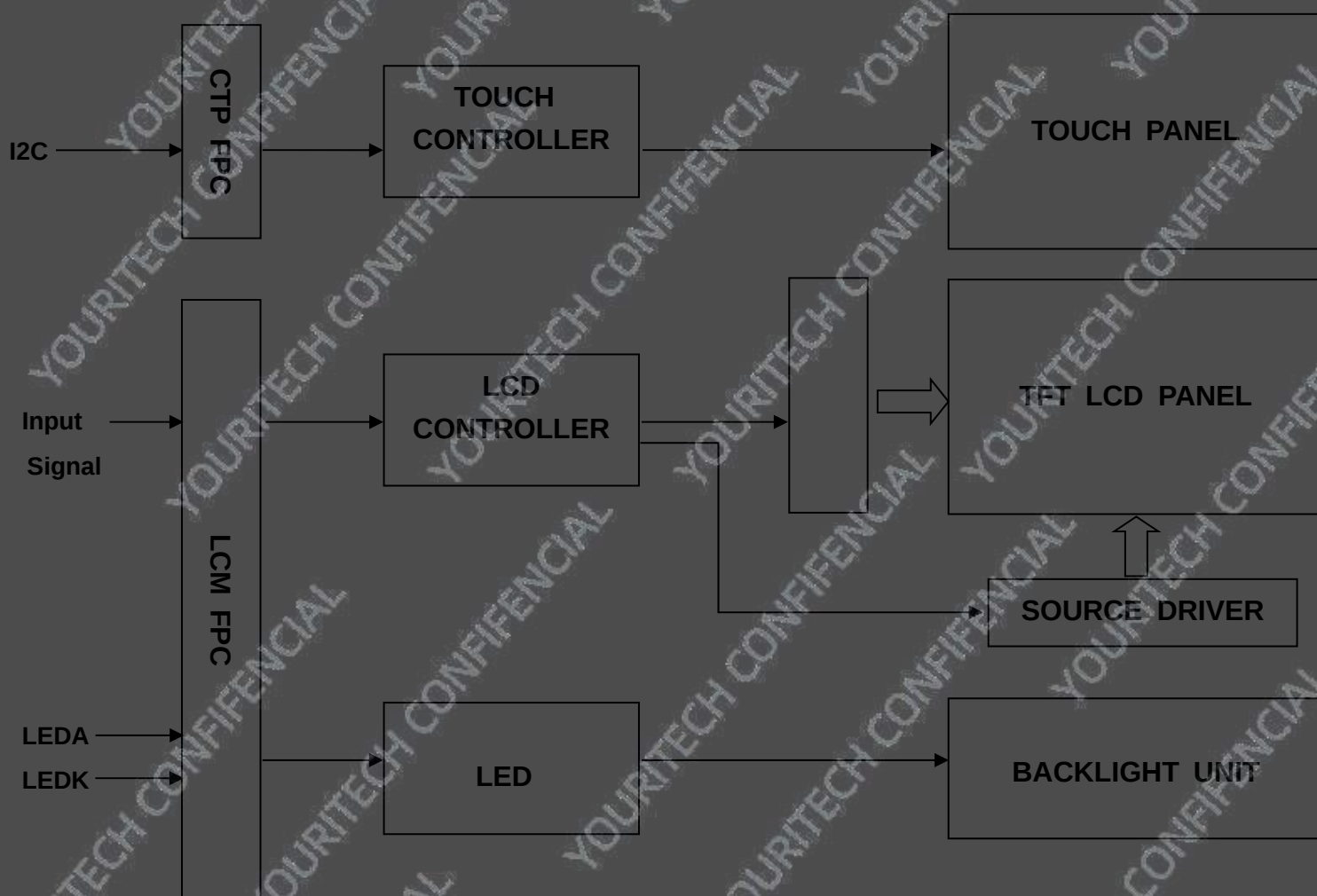
| General Information Items | Specification            | Unit | Note |
|---------------------------|--------------------------|------|------|
|                           | Main Panel               |      |      |
| Resolution                | 480(H)*480(V)            | -    |      |
| Structure                 | G+G                      | -    |      |
| Controller IC             | GT911                    | -    |      |
| Interface                 | I2C                      | -    |      |
| Slave Address             | 0x5D(7bit) or 0x14(7bit) | -    |      |
| Touch mode                | Five points and Gestures | -    | -    |
| Logic level               | 3.3                      | V    |      |



### 1.3 Mechanical Information

| Item        |               | Min. | Typ.  | Max. | Unit | Note |
|-------------|---------------|------|-------|------|------|------|
| Module size | Horizontal(H) | -    | 77.00 | -    | mm   |      |
|             | Vertical(V)   | -    | 80.00 | -    | mm   |      |
|             | Depth(D)      | -    | 4.51  | -    | mm   |      |
| Weight      |               | -    | TBD   | -    | g    |      |

### 2. Block Diagram





## 4. Input terminal Pin Assignment

### 4.1 TFT PIN Define

| NO.   | SYMBOL   | DISCRIPTION                                                                                                                                   | I/O |
|-------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 1     | XR/NC    | Touch panel Right Glass Terminal.<br>Leave the pin open when not in use.                                                                      | A/D |
| 2     | YD/NC    | Touch panel Bottom Film Terminal.<br>Leave the pin open when not in use.                                                                      | A/D |
| 3     | XL/NC    | Touch panel LIFT Glass Terminal.<br>Leave the pin open when not in use.                                                                       | A/D |
| 4     | YU/NC    | Touch panel Top Film Terminal.<br>Leave the pin open when not in use.                                                                         | A/D |
| 5     | GND      | Ground.                                                                                                                                       | P   |
| 6     | GND      | Ground.                                                                                                                                       | P   |
| 7     | VCI      | Supply voltage (3.3V).                                                                                                                        | P   |
| 8     | IOVCC    | Supply Voltage (Logic)(1.8~3.3V).                                                                                                             | P   |
| 9     | SDO      | Serial data output pin used for the SPI Interface.<br>Leave the pin open when not in use.                                                     | O   |
| 10    | SDI      | SDI: Serial data input/output bidirectional pin for SPI Interface.                                                                            | I/O |
| 11    | SCL      | SCL: Serial clock input for SPI interface.                                                                                                    | I   |
| 12    | CS       | - A chip select signal<br>Low: the chip is selected and accessible<br>High: the chip is not selected and not accessible                       | I   |
| 13    | RESET    | - The external reset input<br>- Initializes the chip with a low input. Be sure to execute a power-on reset after supplying power.             | I   |
| 14-37 | DB23-DB0 | 24-bit parallel data bus for RGB Interface.<br>Fix to IOVCC or GND level when not in use.                                                     | I/O |
| 38    | DE       | Data enable signal for RGB interface operation<br>Low: access enabled<br>High: access inhibited<br>Fix to IOVCC or GND level when not in use. | I   |
| 39    | PCLK     | Dot clock signal for RGB interface operation                                                                                                  | I   |
| 40    | HSYNC    | Line synchronizing signal for RGB interface operation                                                                                         | I   |
| 41    | VSNC     | Frame synchronizing signal for RGB interface operation                                                                                        | I   |
| 42    | NC       |                                                                                                                                               |     |



|    |      |                           |   |
|----|------|---------------------------|---|
| 43 | LEDK | Cathode pin of backlight. | P |
| 44 | NC   |                           |   |
| 45 | LEDA | Anode pin of backlight.   | P |

#### 4.2 CTP PIN Define

| NO. | SYMBOL    | DISCRIPTION                    | I/O |
|-----|-----------|--------------------------------|-----|
| 1   | GND       | Ground                         | P   |
| 2   | (VDDIO)NC | No Connection                  |     |
| 3   | VDD       | Supply voltage                 | P   |
| 4   | SCL       | I2C clock input                | I   |
| 5   | SDA       | I2C data input and output      | I   |
| 6   | INT       | External interrupt to the host | I   |
| 7   | RST       | External Reset, Low is active  | I   |
| 8   | GND       | Ground                         | P   |



## 5. LCD Optical Characteristics

### 5.1 Optical specification

| Item                         |         | Symbol      | Condition                             | Min.  | Typ.  | Max.  | Unit.   | Note               |
|------------------------------|---------|-------------|---------------------------------------|-------|-------|-------|---------|--------------------|
| Contrast Ratio               |         | CR          | $\Theta=0$<br>Normal viewing<br>angle | 640   | 800   | --    |         | *(1)(2)            |
| Response time                | Rising  | $T_{R+T_F}$ |                                       | --    | 25    | 35    | msec    | *(1)(3)            |
|                              | Falling |             |                                       |       |       |       |         |                    |
| Uniformity                   |         | S(%)        |                                       | 55    | 60    | --    | %       | *                  |
| Color Filter<br>Chromaticity | White   | $W_X$       |                                       | 0.250 | 0.290 | 0.330 |         | CA-<br>310<br>Test |
|                              |         | $W_Y$       |                                       | 0.276 | 0.316 | 0.356 |         |                    |
|                              | Red     | $R_X$       |                                       | 0.571 | 0.611 | 0.651 |         |                    |
|                              |         | $R_Y$       |                                       | 0.323 | 0.363 | 0.403 |         |                    |
|                              | Green   | $G_X$       |                                       | 0.277 | 0.317 | 0.357 |         |                    |
|                              |         | $G_Y$       |                                       | 0.530 | 0.570 | 0.610 |         |                    |
|                              | Blue    | $B_X$       |                                       | 0.110 | 0.150 | 0.190 |         |                    |
|                              |         | $B_Y$       |                                       | 0.060 | 0.100 | 0.140 |         |                    |
| 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         |                                       |       |       |       |         | *(5)               |

\*The data comes from the LCD specification.

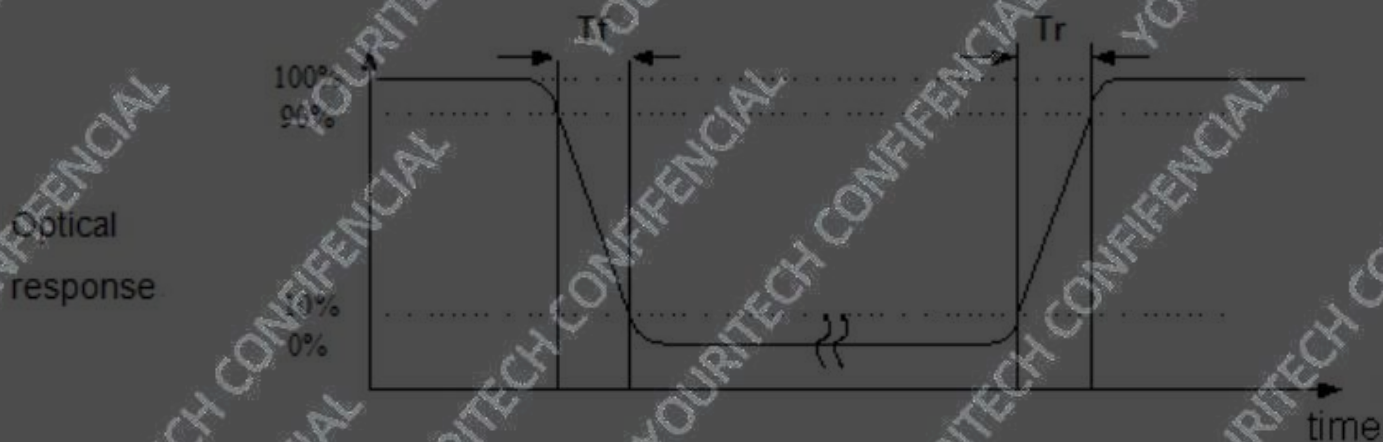
### 5.2 Measuring Condition

- Measuring surrounding: dark room
- Ambient temperature:  $25 \pm 2^\circ\text{C}$
- 15min. warm-up time.

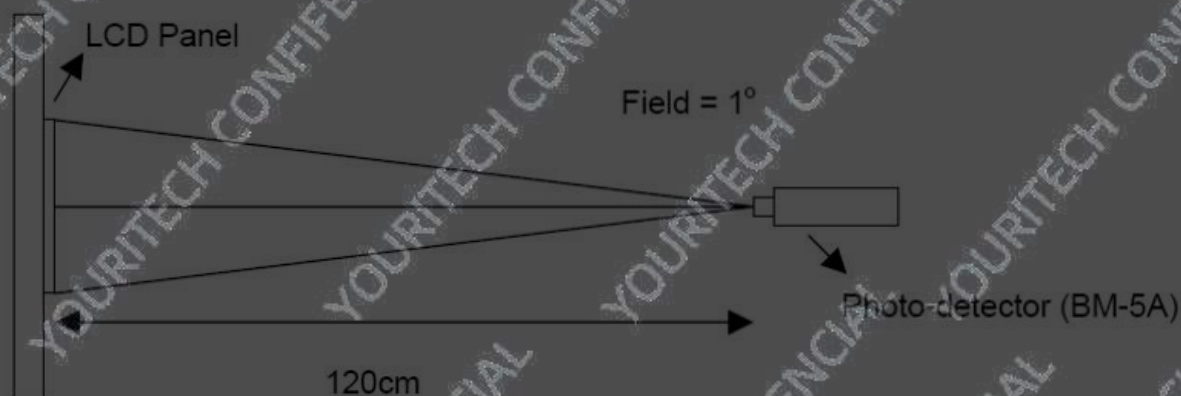




Note (3) Definition of Response Time Sum of  $T_R$  and  $T_F$



Note (4) Definition of optical measurement setup



## 6. Electrical Characteristics

### 6.1 Absolute Maximum Rating

| Characteristics                  | Symbol          | Min. | Max. | Unit | Note  |
|----------------------------------|-----------------|------|------|------|-------|
| Digital Supply Voltage           | V <sub>CI</sub> | -0.3 | 4.6  | V    | Note1 |
| Digital Interface Supply Voltage | IOVCC           | -0.3 | 4.6  | V    |       |
| Operating temperature            | T <sub>OP</sub> | -30  | +85  | °C   |       |
| Storage temperature              | T <sub>ST</sub> | -40  | +90  | °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.

### 6.2 DC Electrical Characteristics

| Characteristics                  | Symbol          | Min.       | Typ. | Max.       | Unit | Note |
|----------------------------------|-----------------|------------|------|------------|------|------|
| Digital Supply Voltage           | V <sub>CI</sub> | 2.5        | 3.3  | 3.6        | V    |      |
| Digital interface supply Voltage | IOVCC           | 1.65       | 1.8  | 3.3        | V    |      |
| Normal mode Current              | ICC             | --         | 30   | 60         | 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    |      |



### 6.3 LED Backlight Characteristics

The back-light system is edge-lighting type with 12 chips LED

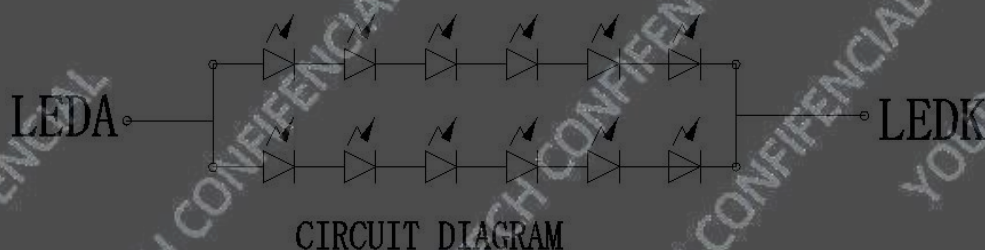
| Item                                     | Symbol | Min. | Typ.  | Max. | Unit              | Note    |
|------------------------------------------|--------|------|-------|------|-------------------|---------|
| Forward Current                          | $I_F$  | 35   | 40    | --   | mA                |         |
| Forward Voltage                          | $V_F$  | --   | 18.6  | --   | V                 |         |
| LCM Luminance<br>( $I_F = 40\text{mA}$ ) | $L_V$  | 800  | 850   | --   | 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:

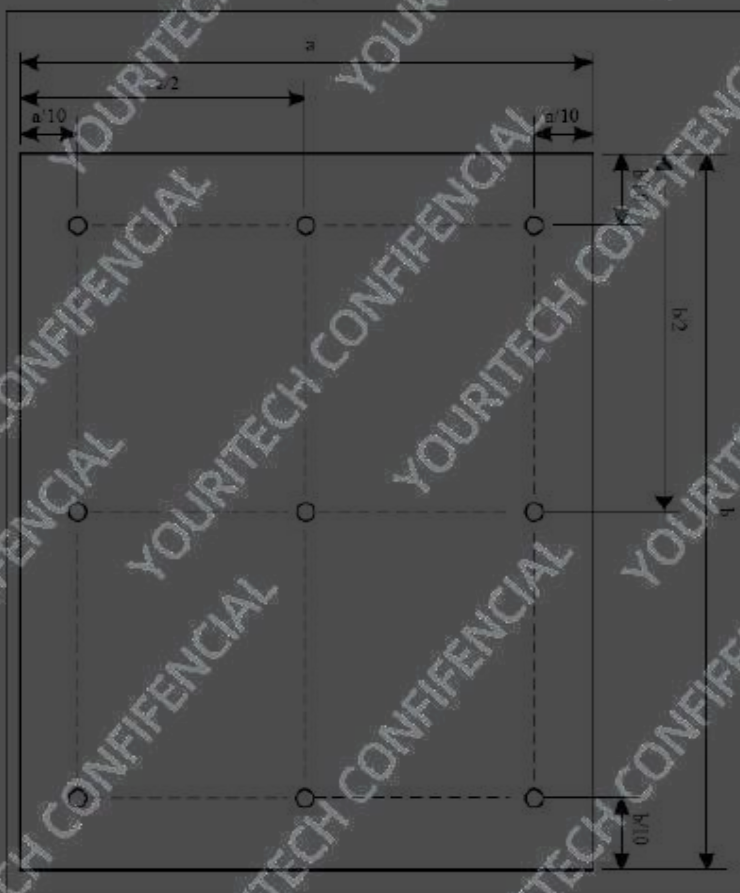
$T_a = 25 \pm 3^\circ\text{C}$ , typical IL value indicated in the above table until the brightness becomes less than 50%.

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:



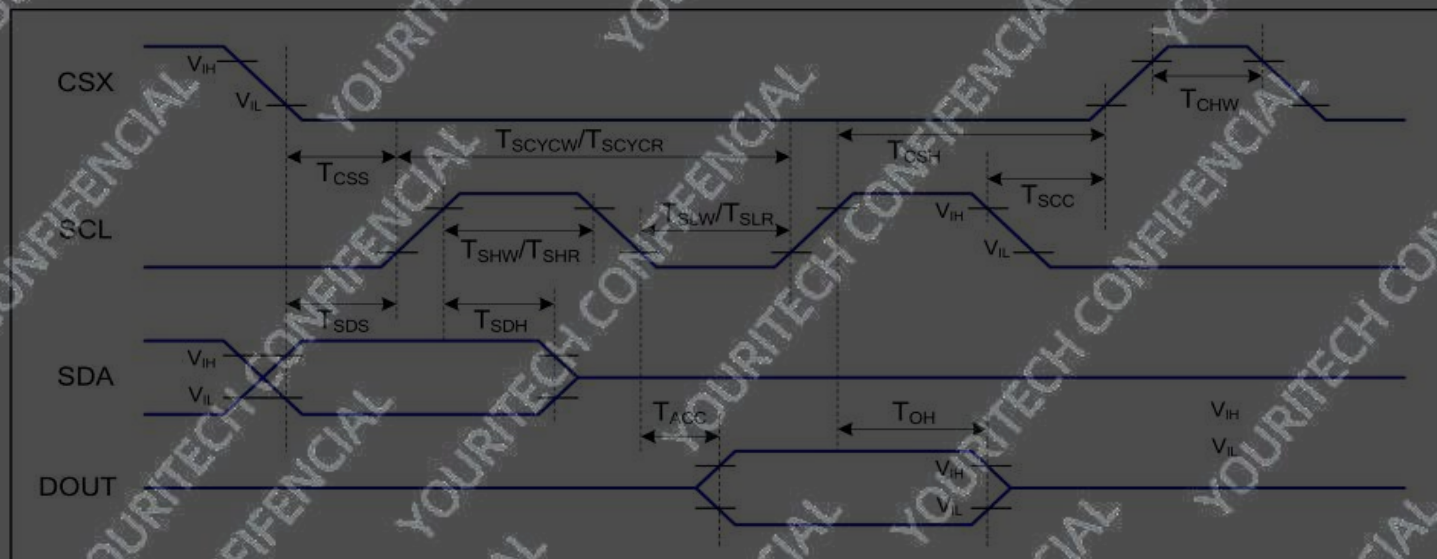
$$\text{Uniformity} = \frac{\text{minimum luminance in 9 points (1-9)}}{\text{maximum luminance in 9 points (1-9)}}$$

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



## 7. AC Characteristics

### 7.1 Serial Interface Characteristics (3-line serial):



**3-line serial Interface Timing Characteristics**

$IOVCC=1.8V, VCI=2.8V, T_a=25^\circ C$

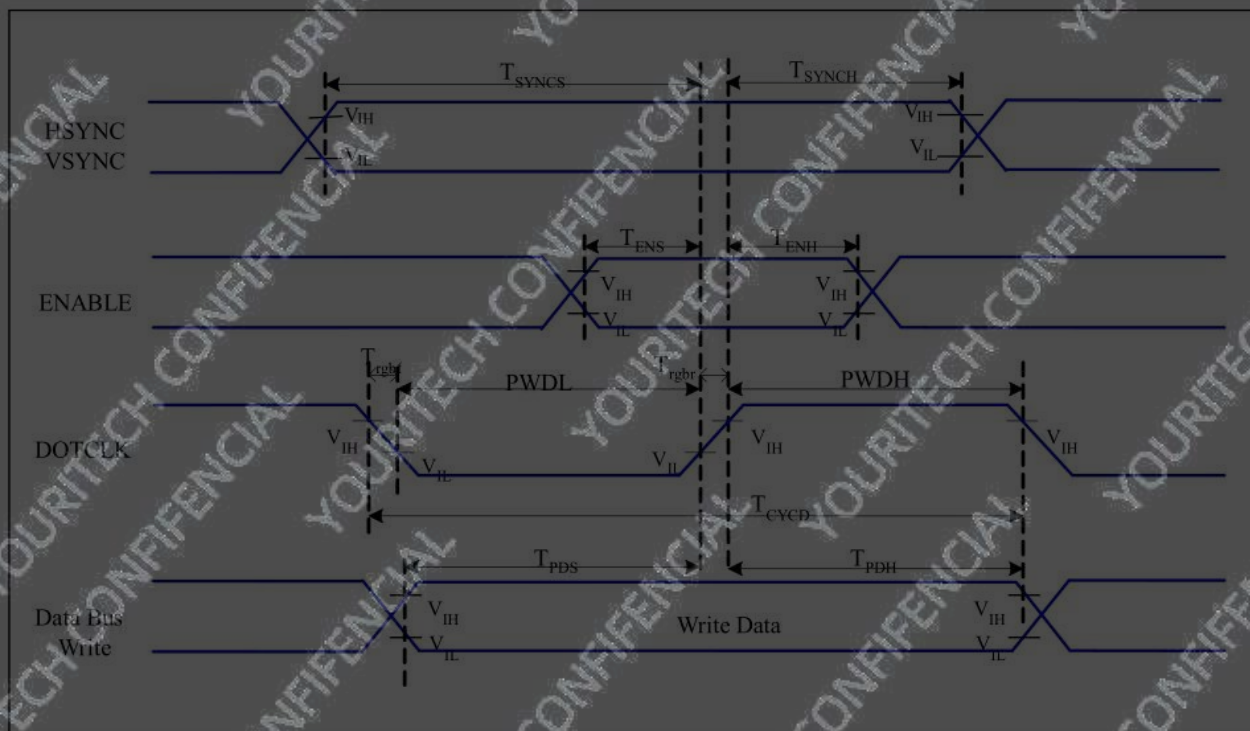
| Signal       | Symbol      | Parameter                      | Min | Max | Unit | Description |
|--------------|-------------|--------------------------------|-----|-----|------|-------------|
| CSX          | $T_{CSS}$   | Chip select setup time (write) | 15  |     | ns   |             |
|              | $T_{CSH}$   | Chip select hold time (write)  | 15  |     | ns   |             |
|              | $T_{CSS}$   | Chip select setup time (read)  | 50  |     | ns   |             |
|              | $T_{SCC}$   | Chip select hold time (read)   | 60  |     | ns   |             |
|              | $T_{CHW}$   | Chip select "H" pulse width    | 40  |     | ns   |             |
| SCL          | $T_{SCYCW}$ | Serial clock cycle (Write)     | 66  |     | ns   |             |
|              | $T_{SHW}$   | SCL "H" pulse width (Write)    | 15  |     | ns   |             |
|              | $T_{SLW}$   | SCL "L" pulse width (Write)    | 15  |     | ns   |             |
|              | $T_{SCYCR}$ | Serial clock cycle (Read)      | 150 |     | ns   |             |
|              | $T_{SHR}$   | SCL "H" pulse width (Read)     | 60  |     | ns   |             |
|              | $T_{SLR}$   | SCL "L" pulse width (Read)     | 60  |     | ns   |             |
| SDA<br>(DIN) | $T_{SDS}$   | Data setup time                | 10  |     | ns   |             |
|              | $T_{SDH}$   | Data hold time                 | 10  |     | ns   |             |

Note : The rising time and falling time ( $T_r$ ,  $T_f$ ) of input signal are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of IOVCC for Input signals.



## 7.2.RGB Interface Characteristics :

$IOVCC=1.8V, VCI=2.8V, T_a=25^\circ C$

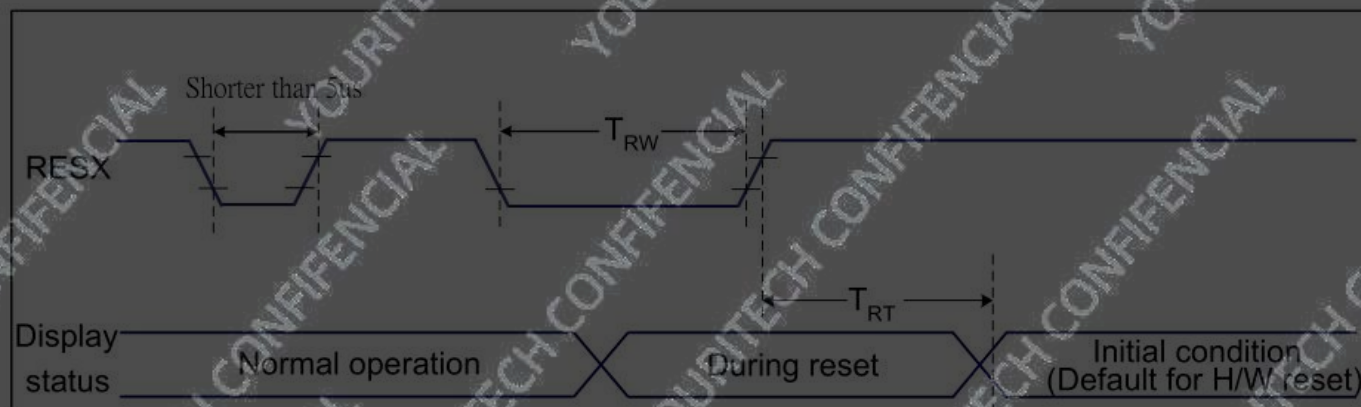


**RGB Interface Timing Characteristics**

| Signal       | Symbol       | Parameter                     | MIN | MAX | Unit | Description |
|--------------|--------------|-------------------------------|-----|-----|------|-------------|
| HSYNC, VSYNC | $T_{SYNCS}$  | VSYNC, HSYNC Setup Time       | 5   | -   | ns   |             |
| ENABLE       | $T_{ENS}$    | Enable Setup Time             | 5   | -   | ns   |             |
|              | $T_{ENH}$    | Enable Hold Time              | 5   | -   | ns   |             |
| DOTCLK       | PWDH         | DOTCLK High-level Pulse Width | 15  | -   | ns   |             |
|              | PWDL         | DOTCLK Low-level Pulse Width  | 15  | -   | ns   |             |
|              | $T_{CYCD}$   | DOTCLK Cycle Time             | 33  | -   | ns   |             |
|              | Trghr, Trghf | DOTCLK Rise/Fall time         | -   | 15  | ns   |             |
| DB           | $T_{PDS}$    | PD Data Setup Time            | 5   | -   | ns   |             |
|              | $T_{PDH}$    | PD Data Hold Time             | 5   | -   | ns   |             |



### 7.3 Reset input timing:



**Reset Timing**

| 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   |

**Reset Timing**

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.

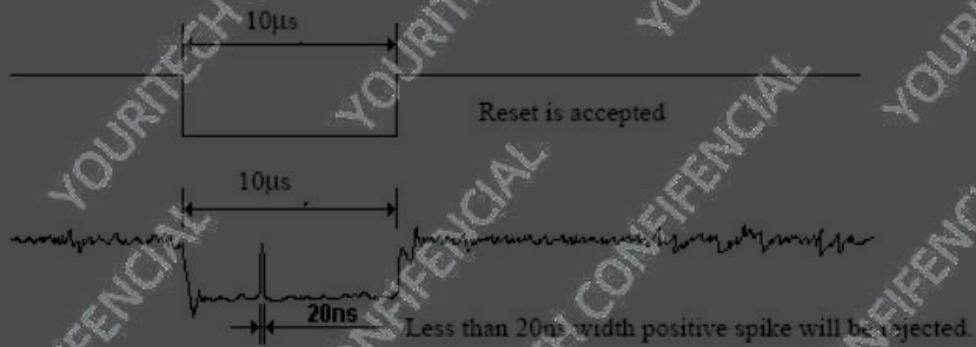
2. Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below:

| 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.



## 8. RGB Interface

The ST7701 support RGB interface Mode 1 and Mode 2. The interface signals as shown in ST7701S datasheet table 6.3.1. The Mode 1 and Mode 2 function is select by setting in the Command 2, please reference application note. In RGB Mode 1, writing data to line buffer is done by PCLK and Video Data Bus (D[23:0]), when DE is high state. The external clocks (PCLK, VS and HS) are used for internal displaying clock. So, controller must always transfer

PCLK, VS and HS signal to ST7701. In RGB Mode 2, back porch of Vsync is defined by VBP[5:0] of RGBPRCTR command. And back porch of Hsync is defined by HBP[5:0] of RGBPRCTR command. Front porch of Vsync is defined by VFP[5:0] of RGBPRCTR command. And front porch of Hsync is defined by HFP[5:0] of RGBPRCTR command.

| RGB I/F Mode | PCLK | DE       | VS   | HS   | DB[23:0] | Register for Blanking Porch setting |
|--------------|------|----------|------|------|----------|-------------------------------------|
| RGB Mode 1   | Used | Used     | Used | Used | Used     | Not Used                            |
| RGB Mode 2   | Used | Not Used | Used | Used | Used     | Used                                |

| Symbol   | Name            | Description                                           |
|----------|-----------------|-------------------------------------------------------|
| PCLK     | Pixel clock     | Pixel clock for capturing pixels at display interface |
| HS       | Horizontal sync | Horizontal synchronization timing signal              |
| VS       | Vertical sync   | Vertical synchronization timing signal                |
| DE       | Data enable     | Data enable signal (assertion indicates valid pixels) |
| DB[23:0] | Pixel data      | Pixel data in 16-bit, 18-bit and 24-bit format        |

The interface signals of RGB interface



### 8.1.1 RGB Color Format

ST7701 supports two kinds of RGB interface, DE mode (mode 1) and HV mode (mode 2), and 16bit/18bit and 24 bit data format. When DE mode is selected and the VSYNC, HSYNC, DOTCLK, DE, D[17:0] pins can be used; when HV mode is selected and the VSYNC, HSYNC, DOTCLK, D[17:0] pins can be used. When using RGB interface, only serial interface can be selected.

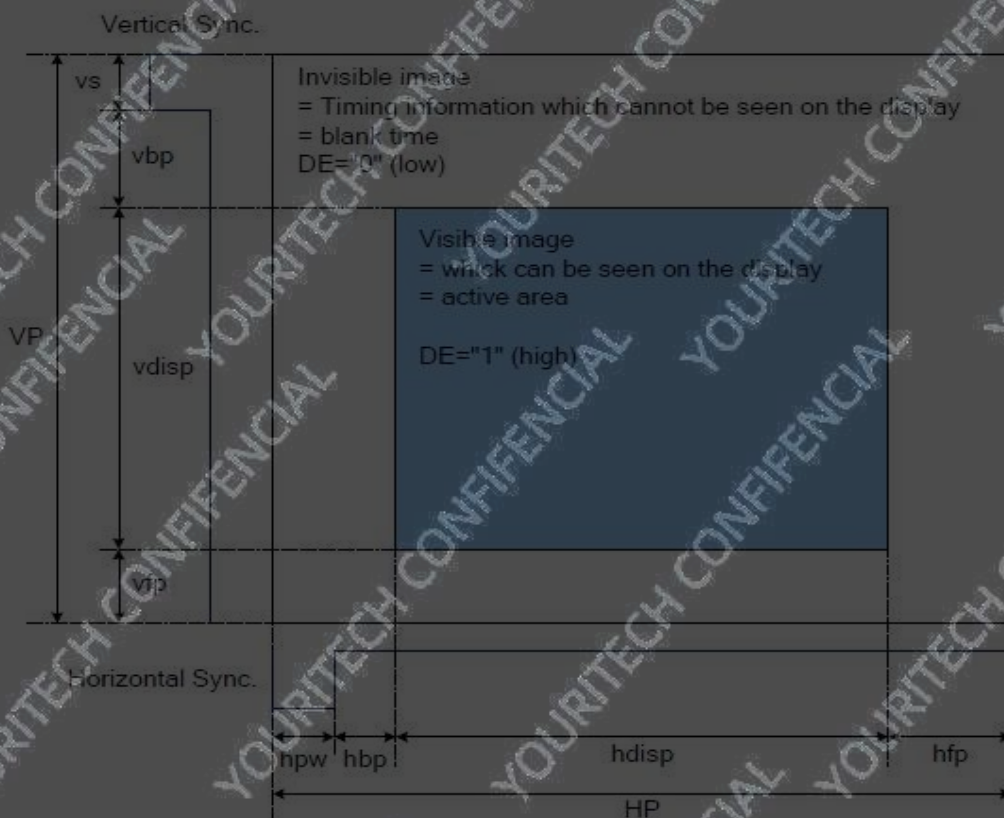
| Pad name | 24 bits configuration<br>VIPF[3:0]=0111 | 18 bits configuration<br>VIPF[3:0]=0110 |          | 16 bits configuration<br>VIPF[3:0]=0101 |
|----------|-----------------------------------------|-----------------------------------------|----------|-----------------------------------------|
|          |                                         | MDT=0                                   | MDT=1    |                                         |
| DB[23]   | R7                                      | Not used                                | Not used | Not used                                |
| DB[22]   | R6                                      | Not used                                | Not used | Not used                                |
| DB[21]   | R5                                      | R5                                      | Not used | Not used                                |
| DB[20]   | R4                                      | R4                                      | Not used | R4                                      |
| DB[19]   | R3                                      | R3                                      | Not used | R3                                      |
| DB[18]   | R2                                      | R2                                      | Not used | R2                                      |
| DB[17]   | R1                                      | R1                                      | R5       | R1                                      |
| DB[16]   | R0                                      | R0                                      | R4       | R0                                      |
| DB[15]   | G7                                      | Not used                                | R3       | Not used                                |
| DB[14]   | G6                                      | Not used                                | R2       | Not used                                |
| DB[13]   | G5                                      | G5                                      | R1       | G5                                      |
| DB[12]   | G4                                      | G4                                      | R0       | G4                                      |
| DB[11]   | G3                                      | G3                                      | G7       | G3                                      |
| DB[10]   | G2                                      | G2                                      | G6       | G2                                      |
| DB[09]   | G1                                      | G1                                      | G5       | G1                                      |
| DB[08]   | G0                                      | G0                                      | G4       | G0                                      |
| DB[07]   | B7                                      | Not used                                | G1       | Not used                                |
| DB[06]   | B6                                      | Not used                                | G0       | Not used                                |
| DB[05]   | B5                                      | B5                                      | B5       | Not used                                |
| DB[04]   | B4                                      | B4                                      | B4       | B4                                      |
| DB[03]   | B3                                      | B3                                      | B3       | B3                                      |
| DB[02]   | B2                                      | B2                                      | B2       | B2                                      |
| DB[01]   | B1                                      | B1                                      | B1       | B1                                      |
| DB[00]   | B0                                      | B0                                      | B0       | B0                                      |

The interface color mapping of RGB interface



## 8.1.2 RGB Interface Definition

The display operation via the RGB interface is synchronized with the VSYNC, HSYNC, and DOTCLK signals. The data can be written only within the specified area with low power consumption by using window address function. The back porch and front porch are used to set the RGB interface timing.



### DRAM Access Area by RGB Interface

Please refer to the following table for the setting limitation of RGB interface signals.

| Parameter                    | Symbol | Min. | Typ. | Max. | Unit  |
|------------------------------|--------|------|------|------|-------|
| DCLK frequency               | FCLK   | --   | (17) | --   | MHz   |
| Horizontal Sync. Width       | hbw    | 1    | (8)  | 255  | Clock |
| Horizontal Sync. Back Porch  | hbp    | 1    | (50) | 255  | Clock |
| Horizontal Sync. Front Porch | hfp    | 1    | (10) | --   | Clock |
| Vertical Sync. Width         | vs     | 1    | (8)  | 254  | Line  |
| Vertical Sync. Back Porch    | vbp    | 1    | (20) | 254  | Line  |
| Vertical Sync. Front Porch   | vfp    | 1    | (10) | --   | Line  |

Note:

1. Typical value are related to the setting frame rate is 60Hz..s



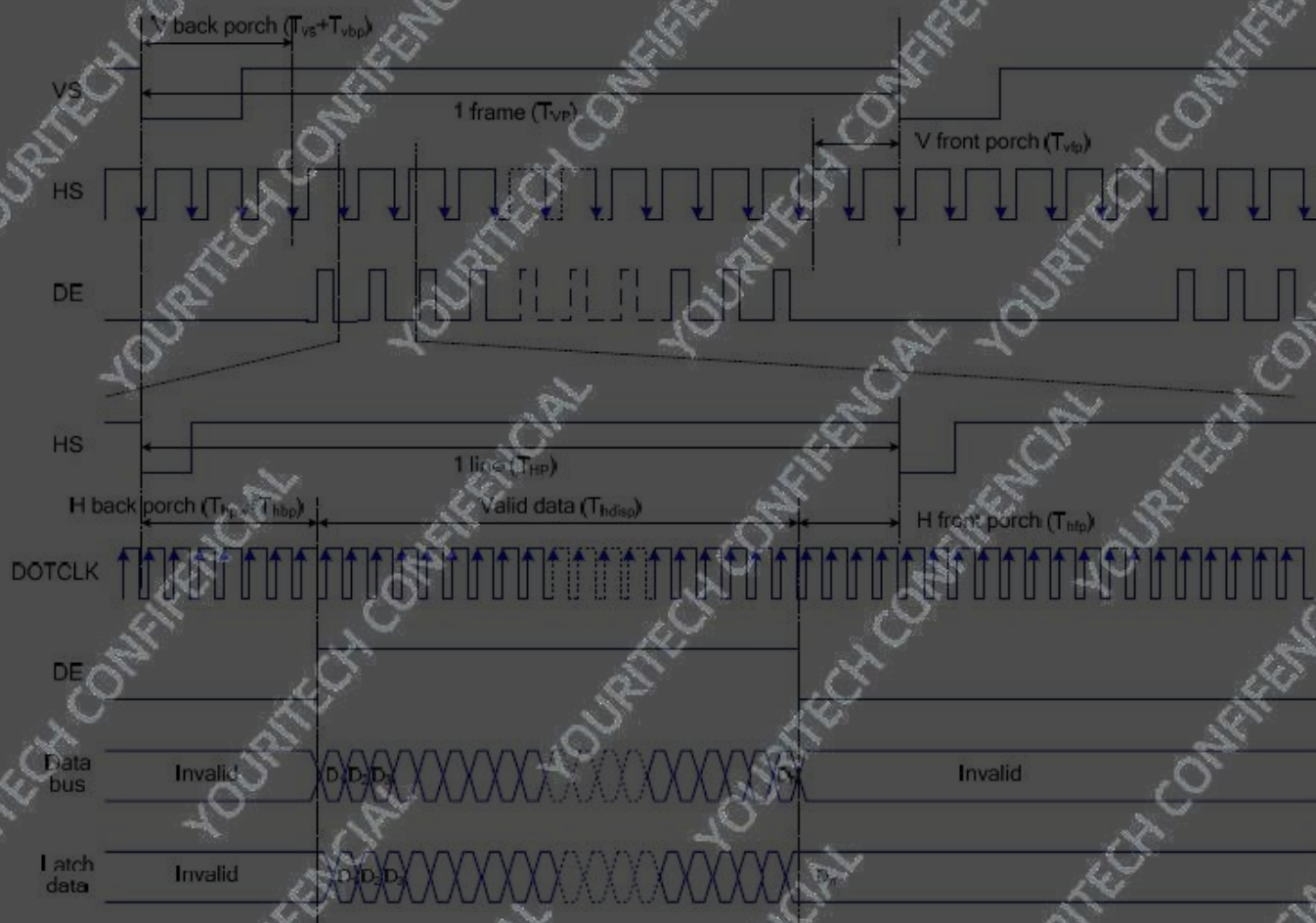
### 8.1.3 RGB Interface Mode Selection

ST7701 supports two kinds of RGB interface, DE mode and HV mode. The table shown below uses command C3h to select RGB interface mode.

| DE/Sync | RGB Mode |
|---------|----------|
| 0       | DE mode  |
| 1       | HV mode  |

### 8.1.4 RGB Interface Timing

The timing chart of RGB interface DE mode is shown as follows.

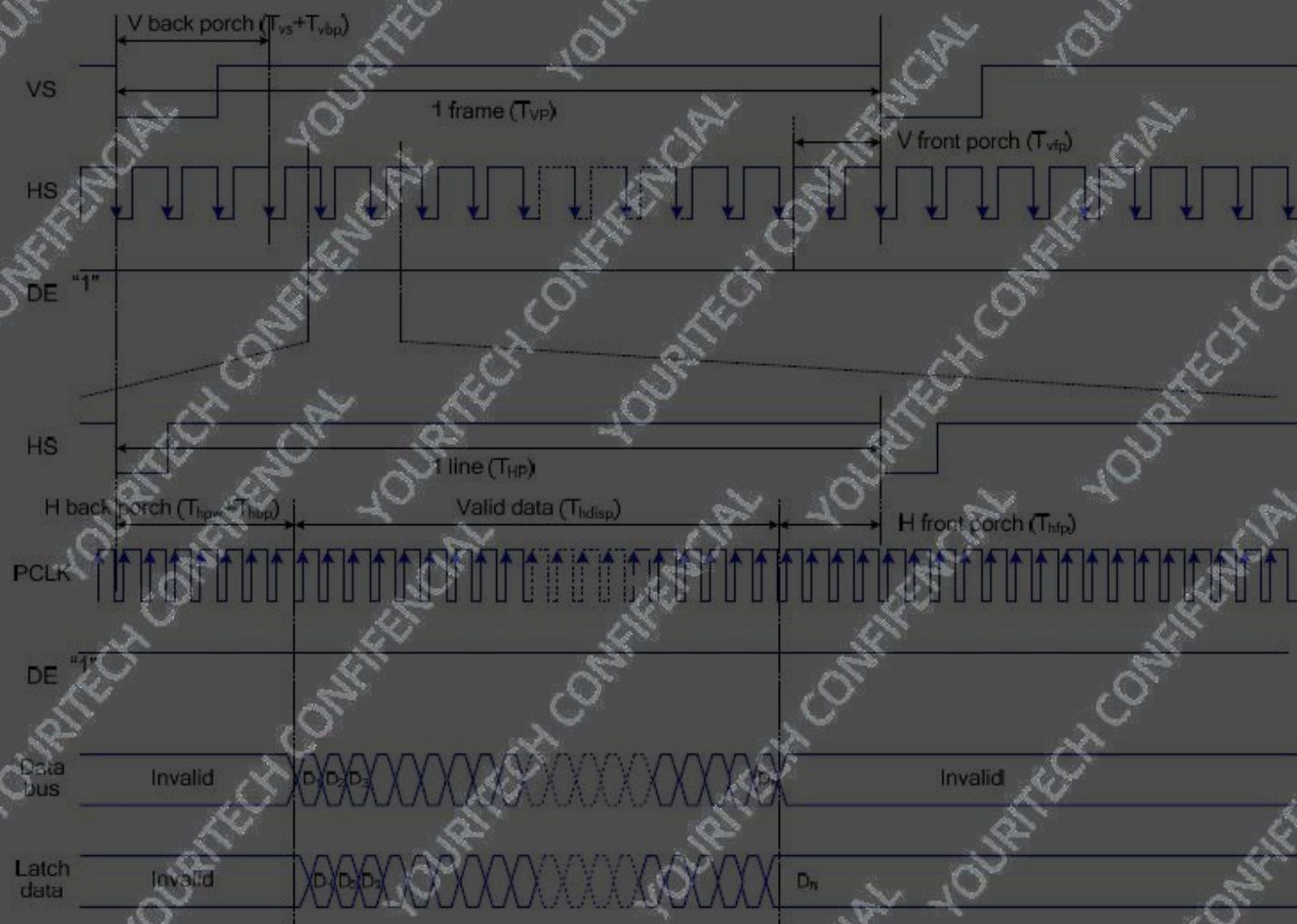


Note: The setting of front porch and back porch in host must match that in IC as this mode.

Timing Chart of Signals in RGB Interface DE Mode



The timing chart of RGB interface HV mode is shown as follows.



Timing chart of RGB interface HV mod



## 9. CTP Specification

### 9.1 Electrical Characteristics

#### 9.1.1 Absolute Maximum Rating

| Item                  | Symbol          | Min. | Max. | Unit | Note |
|-----------------------|-----------------|------|------|------|------|
| Power Supply Voltage  | VDD             | 2.66 | 3.47 | V    |      |
| Operating temperature | T <sub>OP</sub> | -30  | +85  | °C   |      |
| Storage temperature   | T <sub>ST</sub> | -30  | +85  | °C   |      |

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

(Ambient temperature:25°C, VDD=2.8V, VDDIO=1.8V or VDDIO=VDD)

| Item                            | Min.     | Typ. | Max.     | Unit | Note |
|---------------------------------|----------|------|----------|------|------|
| Power Supply Voltage/VDD        | 2.66     | 3.3  | 3.47     | V    |      |
| Normal mode operating current   | --       | 8    | 14.5     | mA   |      |
| Green mode operating current    | --       | 3.3  | --       | mA   |      |
| Sleep mode operating current    | 70       | --   | 120      | uA   |      |
| Doze mode operating current     | --       | 0.78 | --       | mA   |      |
| Digital Input low voltage/VIL   | -0.3     | --   | 0.25*VDD | V    |      |
| Digital Input high voltage/VIH  | 0.75*VDD | --   | VDD+0.3  | V    |      |
| Digital Output low voltage/VOL  | --       | --   | 0.15*VDD | V    |      |
| Digital Output high voltage/VOH | 0.85*VDD | --   | --       | V    |      |



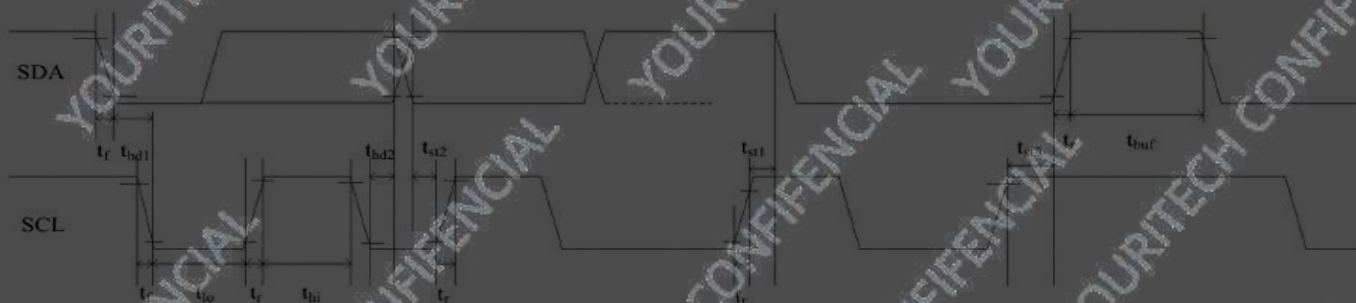
### 9.1.3 AC Characteristics

(Ambient temperature:25°C, VDD=2.8V, VDDIO=1.8V)

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

## 9.2 I2C Timing

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 strongly recommended that transmission rate be kept at or below 400Kbps. The I2C timing is shown below:



**Test condition 1: 1.8V host interface voltage, 400Kbps transmission rate, 2K pull-up resistor**

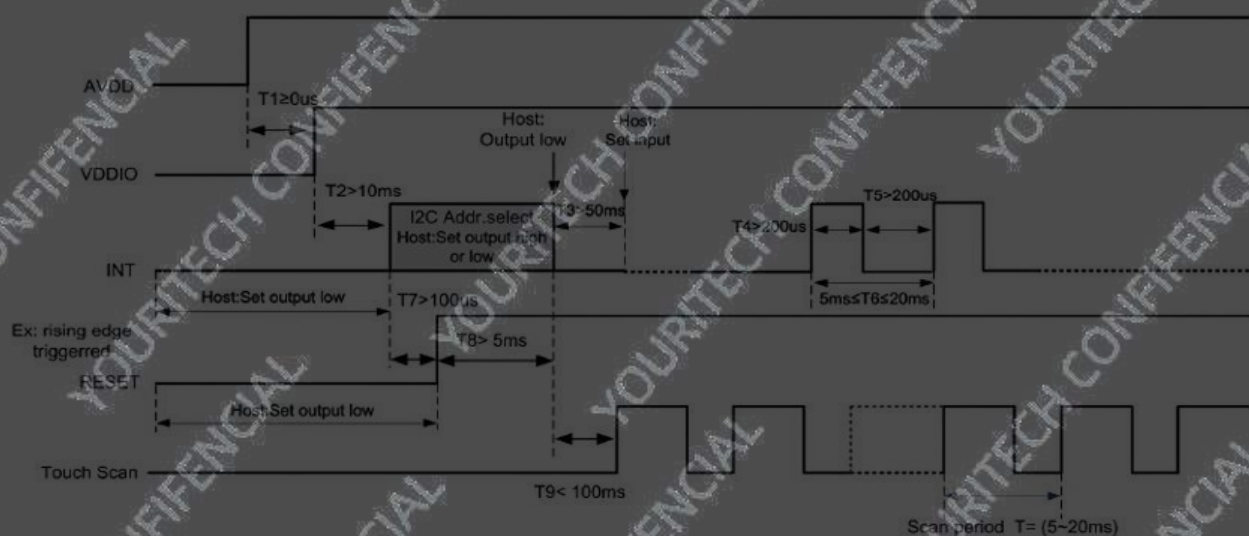
| Parameter                          | Symbol    | Min. | Max. | Unit |
|------------------------------------|-----------|------|------|------|
| SCL low period                     | $t_{lo}$  | 1.3  | -    | us   |
| SCL high period                    | $t_{hi}$  | 0.6  | -    | us   |
| SCL setup time for Start condition | $t_{st1}$ | 0.6  | -    | us   |
| SCL setup time for Stop condition  | $t_{st3}$ | 0.6  | -    | us   |
| SCL hold time for Start condition  | $t_{hd1}$ | 0.6  | -    | us   |
| SDA setup time                     | $t_{st2}$ | 0.1  | -    | us   |
| SDA hold time                      | $t_{hd2}$ | 0    | -    | us   |

**Test condition 2: 3.3V host interface voltage, 400Kbps transmission rate, 2K pull-up resistor**

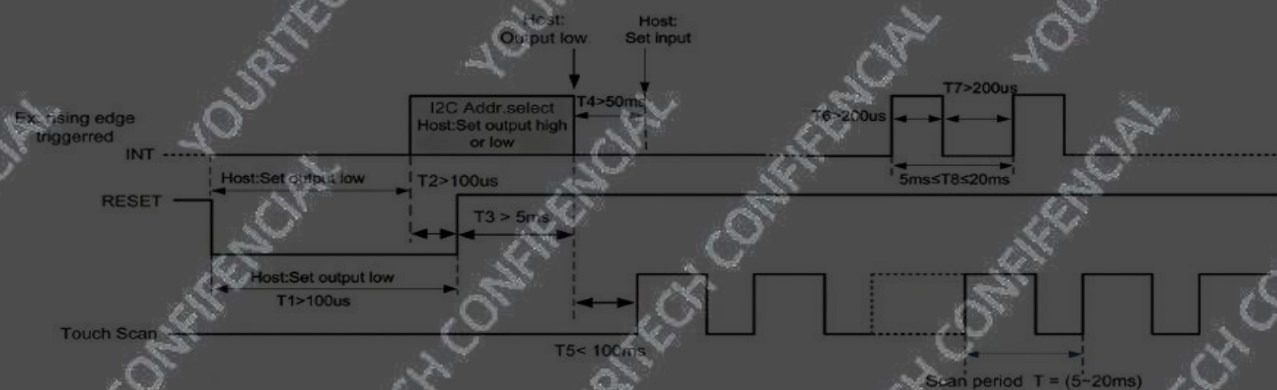
| Parameter                          | Symbol    | Min. | Max. | Unit |
|------------------------------------|-----------|------|------|------|
| SCL low period                     | $t_{lo}$  | 1.3  | -    | us   |
| SCL high period                    | $t_{hi}$  | 0.6  | -    | us   |
| SCL setup time for Start condition | $t_{st1}$ | 0.6  | -    | us   |
| SCL setup time for Stop condition  | $t_{st3}$ | 0.6  | -    | us   |
| SCL hold time for Start condition  | $t_{hd1}$ | 0.6  | -    | us   |
| SDA setup time                     | $t_{st2}$ | 0.1  | -    | us   |
| SDA hold time                      | $t_{hd2}$ | 0    | -    | us   |

GT911 supports two I2C slave addresses: 0xBA/0xBB and 0x28/0x29. The host can select the address by changing the status of Reset and INT pins during the power-on initialization phase. See the diagram below for configuration methods and timings:

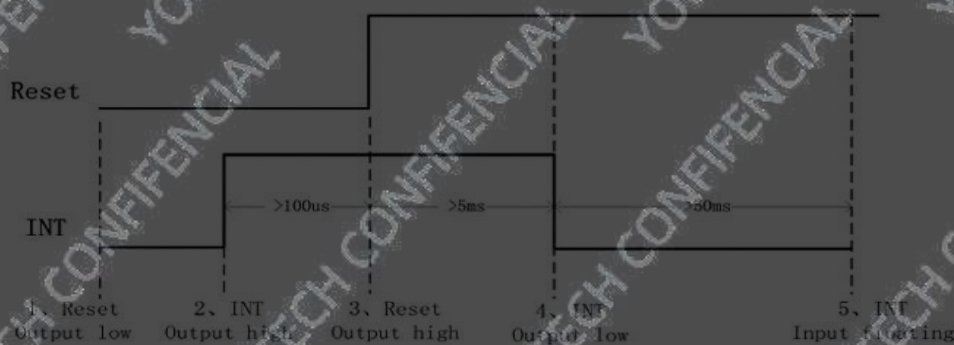
### Power-on Timing:



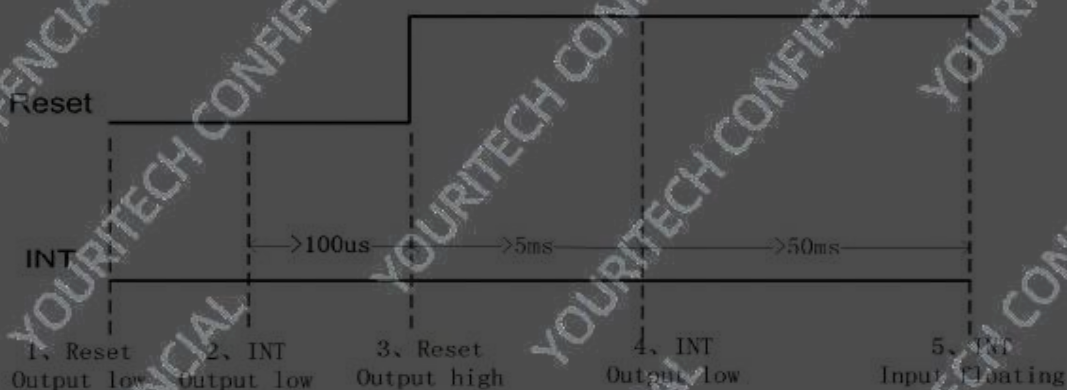
### Timing for host resetting GT911:



### Timing for setting slave address to 0x28/0x29:



### Timing for setting slave address to 0xBA/0xBB:



### a) Data Transmission

(For example: device address is 0xBA/0xBB)

Communication is always initiated by the host. Valid Start condition is signaled by pulling SDA line from "high" to "low" when SCL line is "high". Data flow or address is transmitted after the Start condition.

All slave devices connected to I<sup>2</sup>C bus should detect the 8-bit address issued after Start condition and send the correct ACK. After receiving matching address, GT911 acknowledges by configuring SDA line as output port and pulling SDA line low during the ninth SCL cycle. When receiving unmatched address, namely, not 0xBA or 0xBB, GT911 will stay in an idle state.

For data bytes on SDA, each of 9 serial bits will be sent on nine SCL cycles. Each data byte consists of 8 valid data bits and one ACK or NACK bit sent by the recipient. The data transmission is valid when SCL line is "high".

When communication is completed, the host will issue the STOP condition. Stop condition implies the transition of SDA line from "low" to "high" when SCL line is "high".

### b) Writing Data to GT911

(For example: device address is 0xBA/0xBB)



**Timing for Write Operation**

The diagram above displays the timing sequence of the host writing data onto GT911. First, the host issues a Start condition. Then, the host sends 0xBA (address bits and R/W bit; R/W bit as 0 indicates Write operation) to the slave device.

After receiving ACK, the host sends the 16-bit register address (where writing starts) and the 8-bit data bytes (to be written onto the register).

The location of the register address pointer will automatically add 1 after every Write Operation. Therefore, when the host needs to perform Write Operations on a group of registers of continuous addresses, it is able to write continuously. The Write Operation is terminated when the host issues the Stop condition.



### c) Reading Data from GT911

(For example: device address is 0xBA/0xBB)



### Timing for Read Operation

The diagram above is the timing sequence of the host reading data from GT911. First, the host issues a Start condition and sends 0xBA (address bits and R/W bit; R/W bit as 0 indicates Write operation) to the slave device.

After receiving ACK, the host sends the 16-bit register address (where reading starts) to the slave device. Then the host sets register addresses which need to be read.

Also after receiving ACK, the host issues the Start condition once again and sends 0xBB (Read Operation). After receiving ACK, the host starts to read data.

GT911 also supports continuous Read Operation and, by default, reads data continuously. Whenever receiving a byte of data, the host sends an ACK signal indicating successful reception. After receiving the last byte of data, the host sends a NACK signal followed by a STOP condition which terminates communication.



## 10. LCD Module Out-Going Quality Level

### 10.1 VISUAL & FUNCTION INSPECTION STANDARD

#### 10.1.1 Inspection conditions

Inspection performed under the following conditions is recommended.

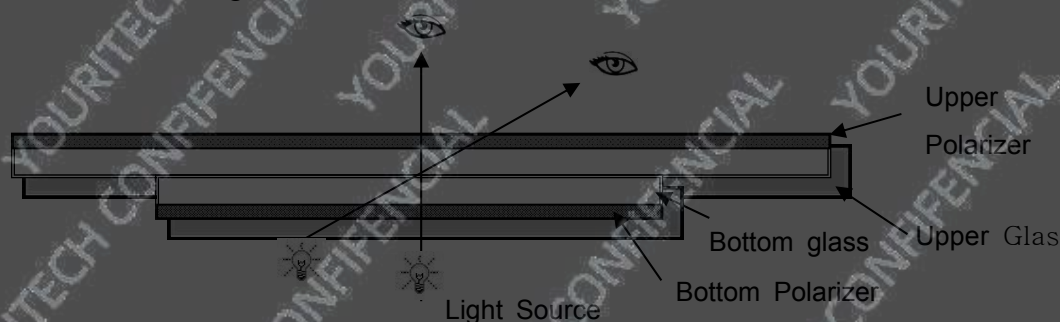
Temperature :  $25 \pm 5^{\circ}\text{C}$

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

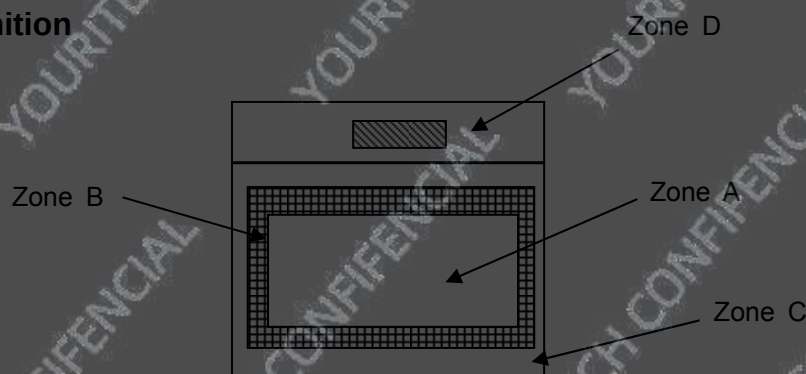
Viewing Angle : Normal viewing Angle

Illumination: Single fluorescent lamp (300 to 700Lux)

Viewing distance: 30-50cm



#### 10.1.2 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



### 10.1.3 Sampling Plan

According to GB/T 2828.1-2003 ; , normal inspection, Class II

AQL:

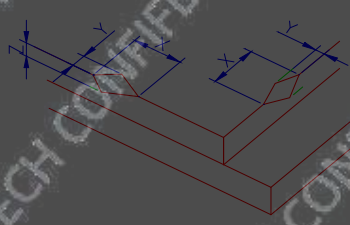
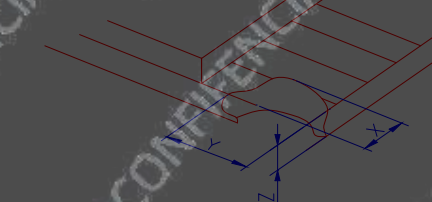
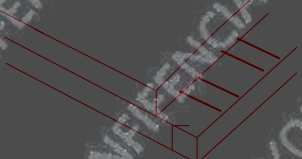
| Major defect | Minor defect |
|--------------|--------------|
| 0.65         | 1.5          |

LCD: Liquid Crystal Display , TP: Touch Panel , LCM: Liquid Crystal Module

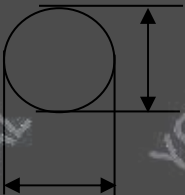
| No | Items to be inspected | Criteria                                                                                                                             | Classification of defects |
|----|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------|-----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



#### 10.1.4 Criteria (Visual)

| Number                                                                                                              | Items                          | Criteria(mm)                                                                                                                                                                                                                      |   |   |   |        |                                |    |
|---------------------------------------------------------------------------------------------------------------------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|--------|--------------------------------|----|
| 1.0 LCD<br>Crack/Broken<br>NOTE:<br>X: Length<br>Y: Width<br>Z: Height<br>L: Length of IT<br>O,<br>T: Height of LCD | (1) The edge of LCD broken     | <div></div> <table><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                                                                                                                                                                                                                                |   |   |   |        |                                |    |
|                                                                                                                     | (2)LCD corner broken           | <div></div> <table><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                                                                                                                                                                                                                                |   |   |   |        |                                |    |
|                                                                                                                     | (3) LCD crack                  | <div></div> <div>Crack<br/>Not allowed</div>                                                                                                  |   |   |   |        |                                |    |



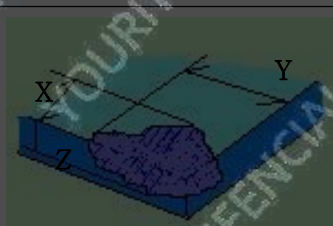
|     |                                                                                   |                                                                                   |  |  |  |
|-----|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--|--|--|
| 2.0 | Spot defect                                                                       | ① light dot (LCD/TP/Polarizer black/white spot , light dot, pinhole, dent, stain) |  |  |  |
|     |  |                                                                                   |  |  |  |
|     | $\Phi=(X+Y)/2$                                                                    |                                                                                   |  |  |  |
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|          |                                                                                      |                                                                                                                                                                                                                                                    |                |                |   |   |        |
|----------|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|---|---|--------|
| 3.0      | Line defect (LCD/TP<br>/Polarizer backligh<br>t black/white line,<br>scratch, stain) | Width(mm)                                                                                                                                                                                                                                          | Length(m<br>m) | Acceptable Qty |   |   |        |
|          |                                                                                      |                                                                                                                                                                                                                                                    |                | A              | B | C |        |
|          |                                                                                      | $\Phi\leq0.05$                                                                                                                                                                                                                                     | Ignore         | Ignore         |   |   | Ignore |
|          |                                                                                      | $0.05<W\leq0.06$                                                                                                                                                                                                                                   | $L\leq3.0$     | $N\leq2$       |   |   |        |
|          |                                                                                      | $0.07<W\leq0.08$                                                                                                                                                                                                                                   | $L\leq2.0$     | $N\leq1$       |   |   |        |
| $0.08<W$ | Define as spot defect                                                                |                                                                                                                                                                                                                                                    |                |                |   |   |        |
| 4.0      | Electronic Comp<br>onents SMT                                                        | Not allow missing parts, solderless connection, cold solder joint, mis<br>match. The positive and negative polarity opposite                                                                                                                       |                |                |   |   |        |
| 5.0      | Display color& B<br>rightness                                                        | 1. Color: Measuring the color coordinates, The measurement standar<br>d according to the datasheet or samples.<br><br>2. Brightness: Measuring the brightness of White screen, The measu<br>rement standard according to the datasheet or Samples. |                |                |   |   |        |
| 6.0      | LCD Mura                                                                             | By 5% ND filter invisible                                                                                                                                                                                                                          |                |                |   |   |        |

|              |                |                                                              |                         |                                  |   |   |        |
|--------------|----------------|--------------------------------------------------------------|-------------------------|----------------------------------|---|---|--------|
| 7.0          | CTP<br>Related | CTP Cover<br>sensor acc<br>identified<br>black/white<br>spot |                         |                                  |   |   |        |
|              |                |                                                              | Size $\Phi$ (mm)        | Acceptable Qty                   |   |   |        |
|              |                |                                                              |                         | A                                | B | C |        |
|              |                |                                                              | $\Phi \leq 0.1$         | Ignore                           |   |   | Ignore |
|              |                |                                                              | $0.1 < \Phi \leq 0.2$   | 3 (distance $\geq 10\text{mm}$ ) |   |   |        |
|              |                |                                                              | $0.20 < \Phi \leq 0.25$ | 2                                |   |   |        |
| $\Phi > 0.3$ | 0              |                                                              |                         |                                  |   |   |        |



|                                                          |                                                  |                                      |                              |                                                                                       |                |   |   |  |
|----------------------------------------------------------|--------------------------------------------------|--------------------------------------|------------------------------|---------------------------------------------------------------------------------------|----------------|---|---|--|
|                                                          |                                                  | CTP Cover<br><br>scratch             | Width(mm)                    | Ignore (mm)                                                                           | Acceptable Qty |   |   |  |
|                                                          |                                                  |                                      | $\Phi \leq 0.05$             | Ignore                                                                                | A              | B | C |  |
|                                                          |                                                  |                                      | $0.05 < W \leq 0.06$         | $L \leq 4.0$                                                                          | Ignore         |   |   |  |
|                                                          |                                                  |                                      | $0.07 < W \leq 0.08$         | $L \leq 3.0$                                                                          | $N \leq 3$     |   |   |  |
|                                                          |                                                  |                                      | $0.08 < W$                   | $N \leq 2$                                                                            |                |   |   |  |
|                                                          |                                                  | Define as spot defect                |                              |                                                                                       |                |   |   |  |
|                                                          |                                                  | CTP Cover<br>Pinhole/ Lack of ink    | Zone<br>Size (mm)            |                                                                                       | Acceptable Qty |   |   |  |
|                                                          |                                                  |                                      |                              |                                                                                       | C              |   |   |  |
|                                                          |                                                  |                                      | $\Phi \leq 0.1$              | Ignore                                                                                |                |   |   |  |
|                                                          |                                                  |                                      | $0.1 < \Phi \leq 0.2$        | 3(distance $\geq 10\text{mm}$ )                                                       |                |   |   |  |
|                                                          |                                                  |                                      | $0.25 < \Phi \leq 0.3$       | 2                                                                                     |                |   |   |  |
|                                                          |                                                  |                                      | $\Phi > 0.35$                | 0                                                                                     |                |   |   |  |
|                                                          |                                                  | CTP Bonding bubble/<br>accident spot | Size $\Phi(\text{mm})$       |                                                                                       | Acceptable Qty |   |   |  |
|                                                          |                                                  |                                      |                              |                                                                                       | A              |   | B |  |
|                                                          |                                                  |                                      | $\Phi \leq 0.1$              | Ignore                                                                                |                |   |   |  |
|                                                          |                                                  |                                      | $0.15 < \Phi \leq 0.2$       | 3(distance $\geq 10\text{mm}$ )                                                       |                |   |   |  |
|                                                          |                                                  |                                      | $0.2 < \Phi \leq 0.25$       | 2                                                                                     |                |   |   |  |
|                                                          |                                                  |                                      | $\Phi > 0.25$                | 0                                                                                     |                |   |   |  |
| Assembly deflection                                      | beyond the edge of backlight $\leq 0.2\text{mm}$ |                                      |                              |                                                                                       |                |   |   |  |
| TP cover broken<br>X : length<br>Y : width<br>Z : height | X                                                | Y                                    | Z                            |  |                |   |   |  |
|                                                          | $X \leq 0.5\text{mm}$                            | $Y \leq 0.5\text{mm}$                | $Z < \text{cover thickness}$ |                                                                                       |                |   |   |  |
|                                                          | Circuitry broken is not allowed.                 |                                      |                              |                                                                                       |                |   |   |  |



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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   |
| 5      | TP no function        | Not allowed   |



## 11. Reliability Test Result

| Item                                       | Condition                                                                                                                                      | Inspection after test                                                                                                                                                                                                                                      |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| High Temperature Operating                 | 85°C,96H                                                                                                                                       | Inspection after 2~4hours<br>storage at room temperature,<br>the sample shall be free from<br>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<br>than initial value. |
| Low Temperature Operating                  | -30°C, 96HR                                                                                                                                    |                                                                                                                                                                                                                                                            |
| High Temperature Storage                   | 90°C, 96HR                                                                                                                                     |                                                                                                                                                                                                                                                            |
| Low Temperature Storage                    | -40°C, 96HR                                                                                                                                    |                                                                                                                                                                                                                                                            |
| High Temperature & High Humidity Operating | +60°C, 90% RH ,96 hours.                                                                                                                       |                                                                                                                                                                                                                                                            |
| Thermal Shock (Non-operation)              | -30°C,30 min ↔ +85°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<br>X.Y.Z. (6 hours for total) (Package condition). |                                                                                                                                                                                                                                                            |
| Box Drop Test                              | 1 Corner 3 Edges 6 faces,80cm(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.



## 12. Cautions and Handling Precautions

### 12.1 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.

(14) Power supply should always be turned on/off by the item 6.1 Power On Sequence & 6.2 Power Off Sequence

### 12.2 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.

