ORIENT DISPLAY
MAKE THINGS POSSIBLE

# Specification for TFT

## AFA480480A0R-2.1INTM-C

Revision 2.0

| | |
|---|---|
| A | Orient Display |
| FA | TFT Type |
| 480480 | Resolution 480 x 480 |
| A0R | Serial A0, Round |
| 2.1 | 2.1”, Module Dimension 73.20 x 73.20 x 3.97 mm |
| I | IPS Display |
| N | Top: -20~+70°C; Tstr: -30~+80°C |
| T | Transmissive |
| M | Medium Brightness, 400cd/m2 |
| C | Capacitive Touch Panel |
| / | ST7701SN-G5 OR COMPATIBLE |
| / | RGB 24bit interface |

# Record of Revisions

| Version | Revise Date | Description | Page |
|---|---|---|---|
| 1.0 | 2022-12-12 | First Release | - |
| | 2022-12-23 | Add back glue and change FPC | 18 |
| | 2022-12-30 | Make chamfer radian for the back glue | 18 |
| | 2023-01-05 | 1:Add White screen print<br>2：Remove AF & explosion-proof film, coverlens using GG3 glass+AF surface treatment | 18 |
| | 2023-02-09 | Update LCD FPC | 18 |
| 2.0 | 2023-03-23 | Update the length of LCD FPC and add LCM ID reading function | 18 |
| | 2023-04-06 | Increase the theoretical number clicks of CTP | 4 |
| | 2023-04-21 | Add RED/GREEN/BLUE optical data | 16 |
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# Contents

# 1. General Specifications

## 1.1 LCM General Information

| Item | Specification | Unit |
|---|---|---|
| LCD Size | 2.1 | inch |
| Number of Pixels | 480 (H) RGB x 480 (V) | pixels |
| Display Mode | Normally Black | - |
| Viewing Direction | Free | o' clock |
| Interface | RGB | - |
| Display Colors | 16.7M | colors |
| Outline Dimension | 73.20 (H) x 73.20 (V) x 3.97 (D) | mm |
| Active Area | 53.28 (H) x 53.28 (V) | mm |
| Pixel Pitch | 0.111 (H) x 0.111 (V) | mm |
| Driver IC | ST7701SN-G5 | - |
| Operation Temperature | -20~70 | ℃ |
| Storage Temperature | -30~80 | ℃ |

## 1.2 Touch Panel Information

| Item | Specification |
|---|---|
| Touch Structure | G+FF |
| Bonding Type with LCM | OCA Optical Bonding |
| Driver IC | CST328 |
| Interface | I²C |
| Touch Count Max | 5 Points |
| Surface treatment | AF |
| Surface hardness | 6H |
| I2C slave address | 0x34 |
| Origin of coordinate | Top Left Corner |
| Theoretical clicks | ＞10000000 |

Note1:Requirements on environmental protection RoHS compliant.

# 2. Absolute Maximum Ratings

| Item | Symbol | MIN. | MAX. | Unit | Note |
|---|---|---|---|---|---|
| Analog Supply voltage | VDD | -0.3 | 5.0 | V | Note 1 |

Note 1:Permanent damage may occur to the LCD module if beyond this specification.
Functional operation should be restricted to the conditions described under normal operating conditions.

# 3. Elecrical Characteristics

### 3.1 Recommended Operating Condition for TFT LCD

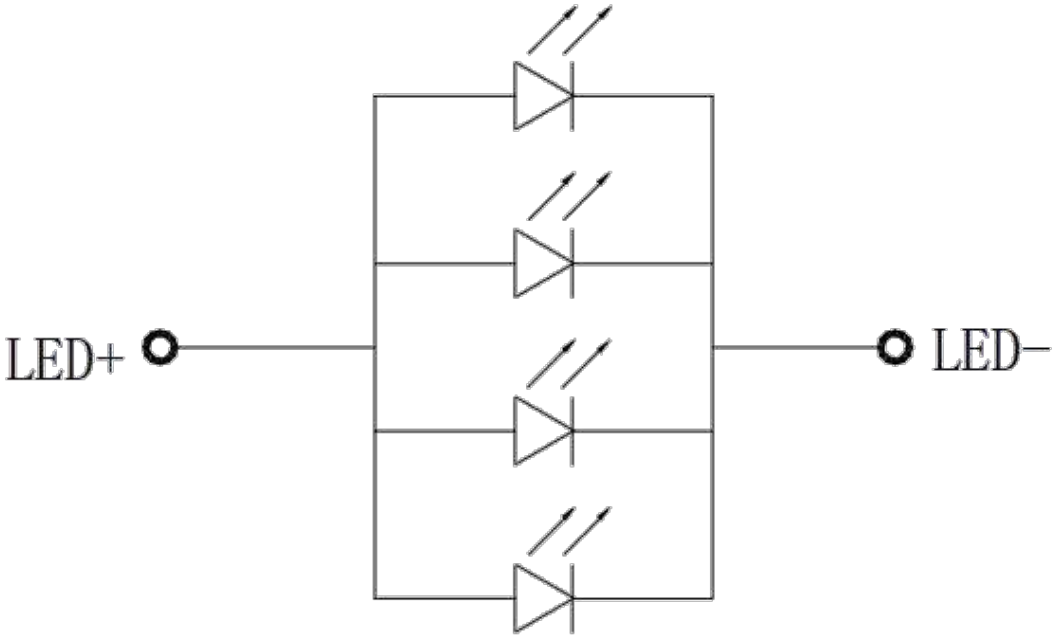
| Item | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Analog Supply voltage | VCC | 2.5 | 2.8 | 3.3 | V | |
| Analog supply current | $I_{VCC}$ | - | TBD | - | mA | VCC=2.8V |
| Logic input voltage | VIH | 0.7*VCC | - | VCC | V | |
| | VIL | GND | - | 0.3*VCC | V | |

### 3.2 Recommended Driving Condition for Backlight

| Item | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Driving Current | $I_F$ | - | 80 | - | mA | |
| Driving Voltage | $V_F$ | 2.7 | - | 3.4 | V | |
| Power consumption | $W_{BL}$ | 0.216 | - | 0.272 | W | |
| LED Life-Time | N/A | - | 50,000 | - | Hours | Ta=25℃<br>Note 1 |

Note 1:LED lifetime is defined as the module brightness decay 50% of original brightness at Ta=25 degree, typical current.

Note 2:LED circuit :




### 3.3 Touch Panel

| Item | Symbol | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Power Supply voltage | VCC | - | 3.3 | - | V | |
| Analog supply current | $I_{VCC}$ | - | TBD | - | mA | VCC=3.3V |
| Input high-level voltage | VIH | 0.7*VCC | - | VCC | V | |
| Input low -level voltage | VIL | GND | - | 0.3*VCC | V | |

# 4. Interface Pin Assignment

## 4.1 LCM Pin Assignment

Recommended connector：TF31-40S-0.5SH manufactured by HIROSE

| No. | Symbol | Description |
|---|---|---|
| 1 | LED_A | Power for LED backlight (Anode) |
| 2 | LED_ K1 | Power for LED backlight (Cathode) |
| 3 | LED_ K2 | Power for LED backlight (Cathode) |
| 4 | GND | Ground |
| 5 | VCC | Power supply |
| 6 | RESET | Global reset pin |
| 7-8 | NC | No connection |
| 9 | SDA | Serial input signal |
| 10 | SCK | Serial clock signal |
| 11 | CS | Chip select input signal |
| 12 | PCLK | Dot clock signal input. Latching input data at its rising edge |
| 13 | DE | Data enable input. Active high to enable the input data bus under “DE Mode” |
| 14 | VSYNC | Vertical sync input. Negative polarity |
| 15 | HSYNC | Horizontal sync input. Negative polarity |
| 16 | DB0 | Data bus |
| 17 | DB1 | Data bus |
| 18 | DB2 | Data bus |
| 19 | DB3 | Data bus |
| 20 | DB4 | Data bus |
| 21 | DB5 | Data bus |
| 22 | DG0 | Data bus |
| 23 | DG1 | Data bus |
| 24 | DG2 | Data bus |
| 25 | DG3 | Data bus |
| 26 | DG4 | Data bus |

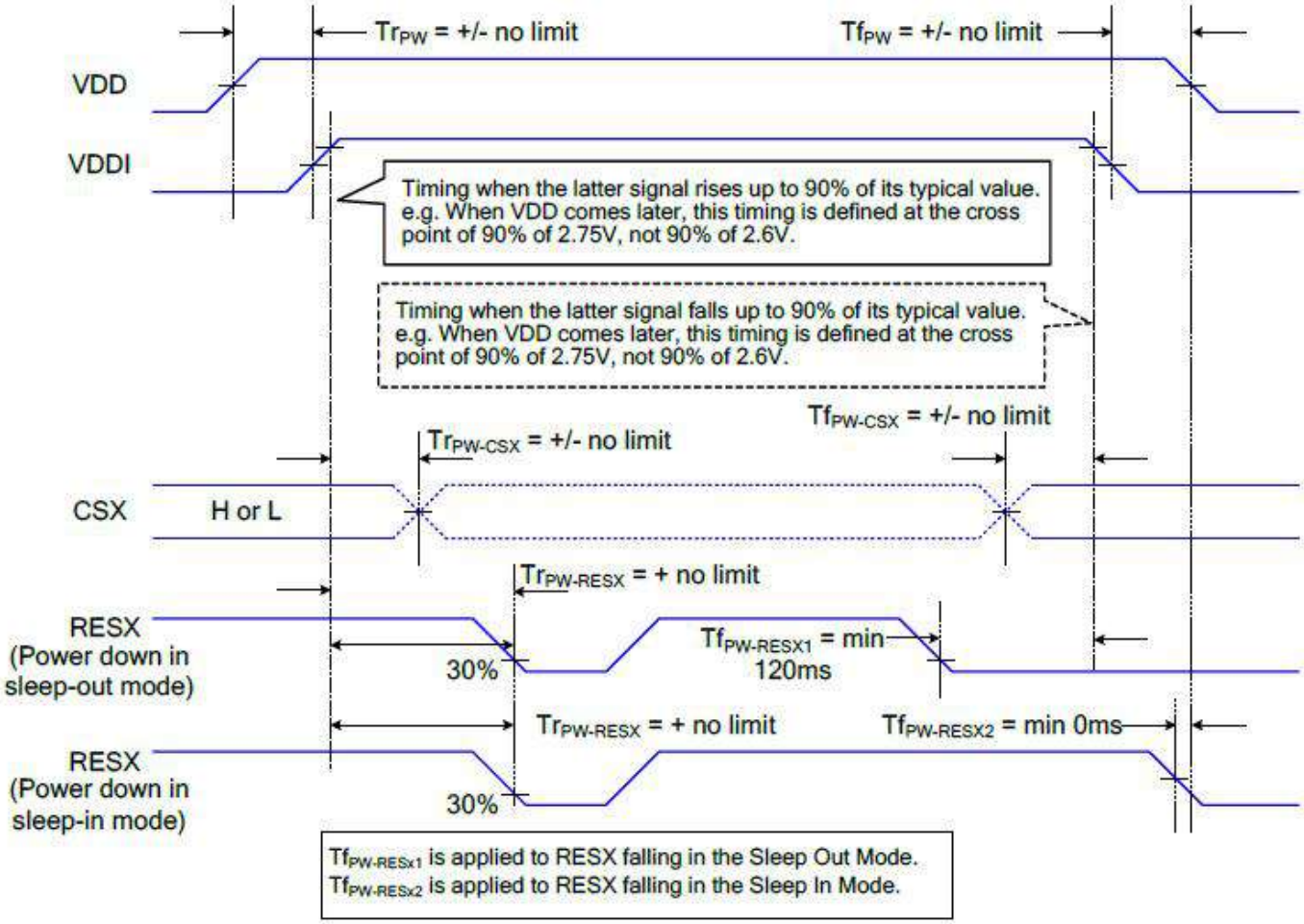
| | | |
|---|---|---|
| 27 | DG5 | Data bus |
| 28 | DR0 | Data bus |
| 29 | DR1 | Data bus |
| 30 | DR2 | Data bus |
| 31 | DR3 | Data bus |
| 32 | DR4 | Data bus |
| 33 | DR5 | Data bus |
| 34 | GND | Ground |
| 35 | TP_ INT | Interrupt signal for CTP (3.3V TYP) |
| 36 | TP_SDA | I2C data input and output for CTP (3.3V TYP) |
| 37 | TP_SCL | I2C clock input for CTP (3.3V TYP) |
| 38 | TP_RST | Reset Pin for CTP (3.3V TYP) |
| 39 | TP_VCC | Power supply for CTP (3.3V TYP) |
| 40 | GND | Ground |

# 5. Interface Characteristics

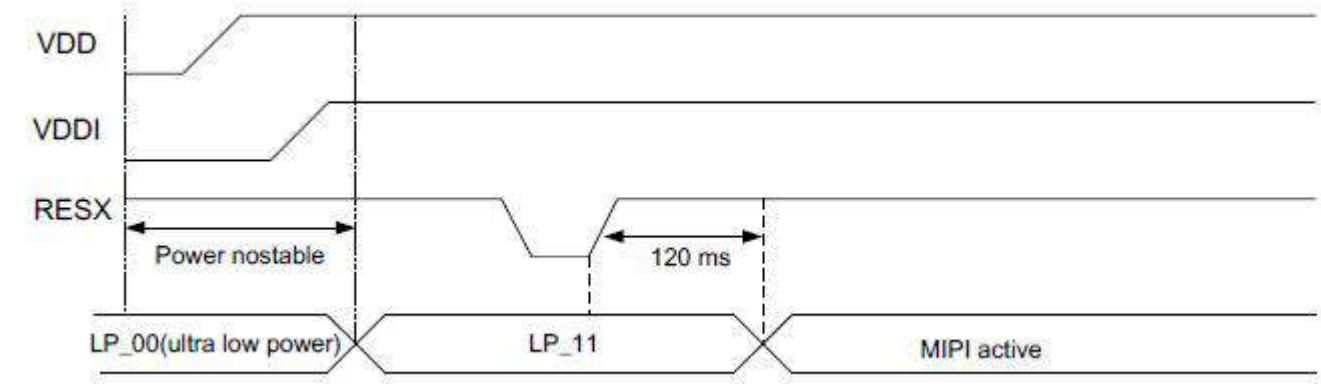
## 5.1 POWER ON/OFF SEQUENCE

VDDI and VDDA can be applied or powered down in any order. During the Power Off sequence, if the LCD is in the Sleep Out mode, VDDA and VDDI must be powered down with minimum 120msec. If the LCD is in the Sleep In mode, VDDA and VDDI can be powered down with minimum 0msec after the RESX is released.
CSX can be applied at any timing or can be permanently grounded. RESX has high priority over CSX.
Notes:
1. There will be no damage to the ST7701SN if the power sequences are not met.
2. There will be no abnormal visible effects on the display panel during the Power On/Off Sequences.
3. There will be no abnormal visible effects on the display between the end of Power On Sequence and before receiving the Sleep Out command, and also between receiving the Sleep In command and the Power Off Sequence.
4. If the RESX line is not steadily held by the host during the Power On Sequence as defined in Sections 9.1 , then it will be necessary to apply the Hardware Reset (RESX) after the completion of the Host Power On Sequence to ensure correct operations. Otherwise, all the functions are not guaranteed.
5. When VDDA is in power off State , the MIPI must set in Ultra Low Power Mode (GND Level).

**The power on/off sequence is illustrated below：**

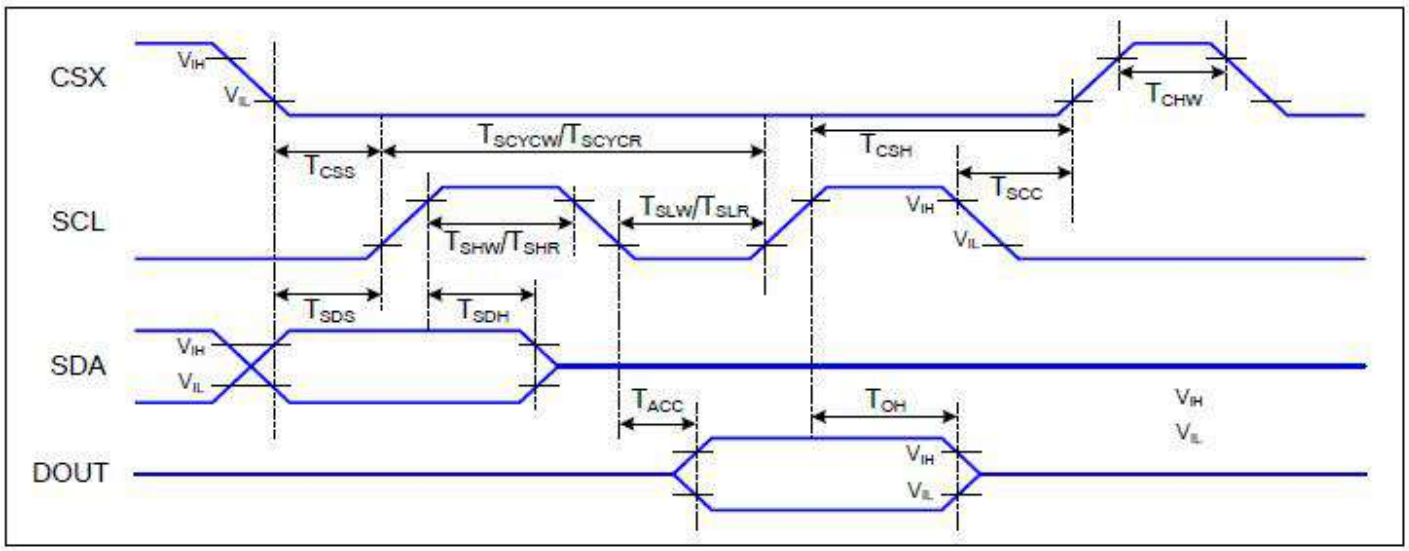



*Note5:*



## 5.2 AC Characteristics

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

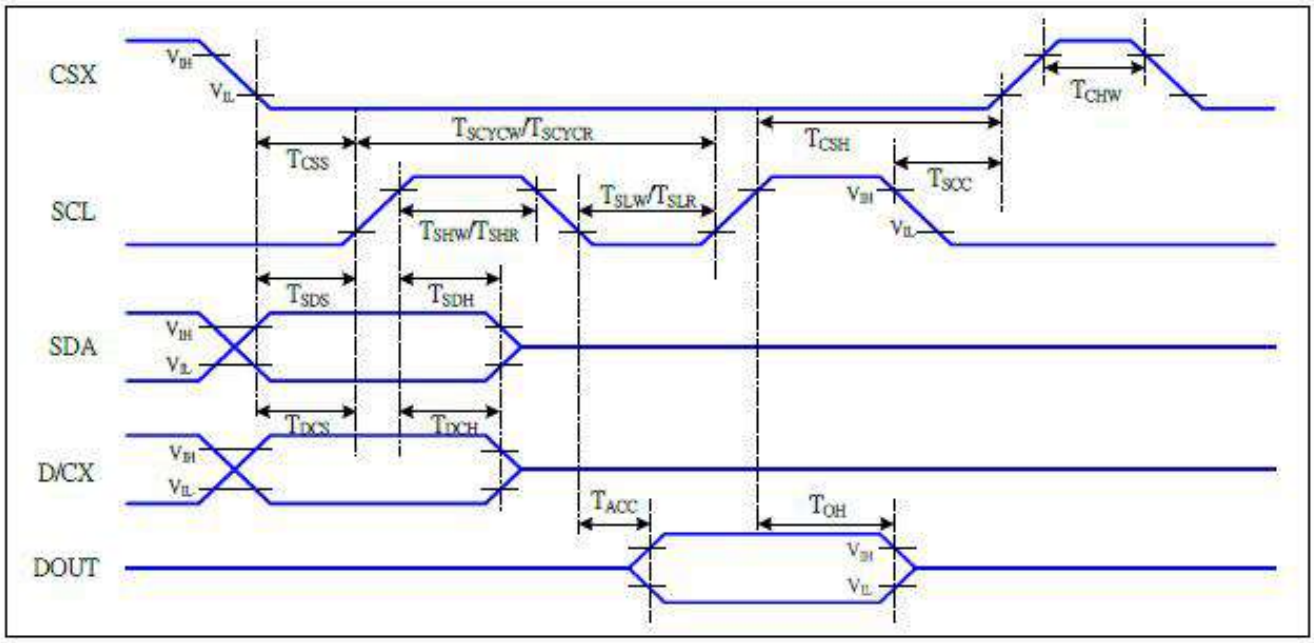



**3-line serial Interface Timing Characteristics**

| 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) | 60 | | 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 (DIN) | $T_{SDS}$ | Data setup time | 10 | | ns | |
| | $T_{SDH}$ | Data hold time | 10 | | ns | |
| SDO (DOUT) | $T_{ACC}$ | Access time | 20 | 50 | ns | Max: CL=30pF |
| | $T_{OH}$ | Output disable time | 50 | 50 | ns | Min: CL=8pF |

**3-line serial Interface Characteristics**

### 5.2.2 Serial Interface Characteristics (4-line serial):



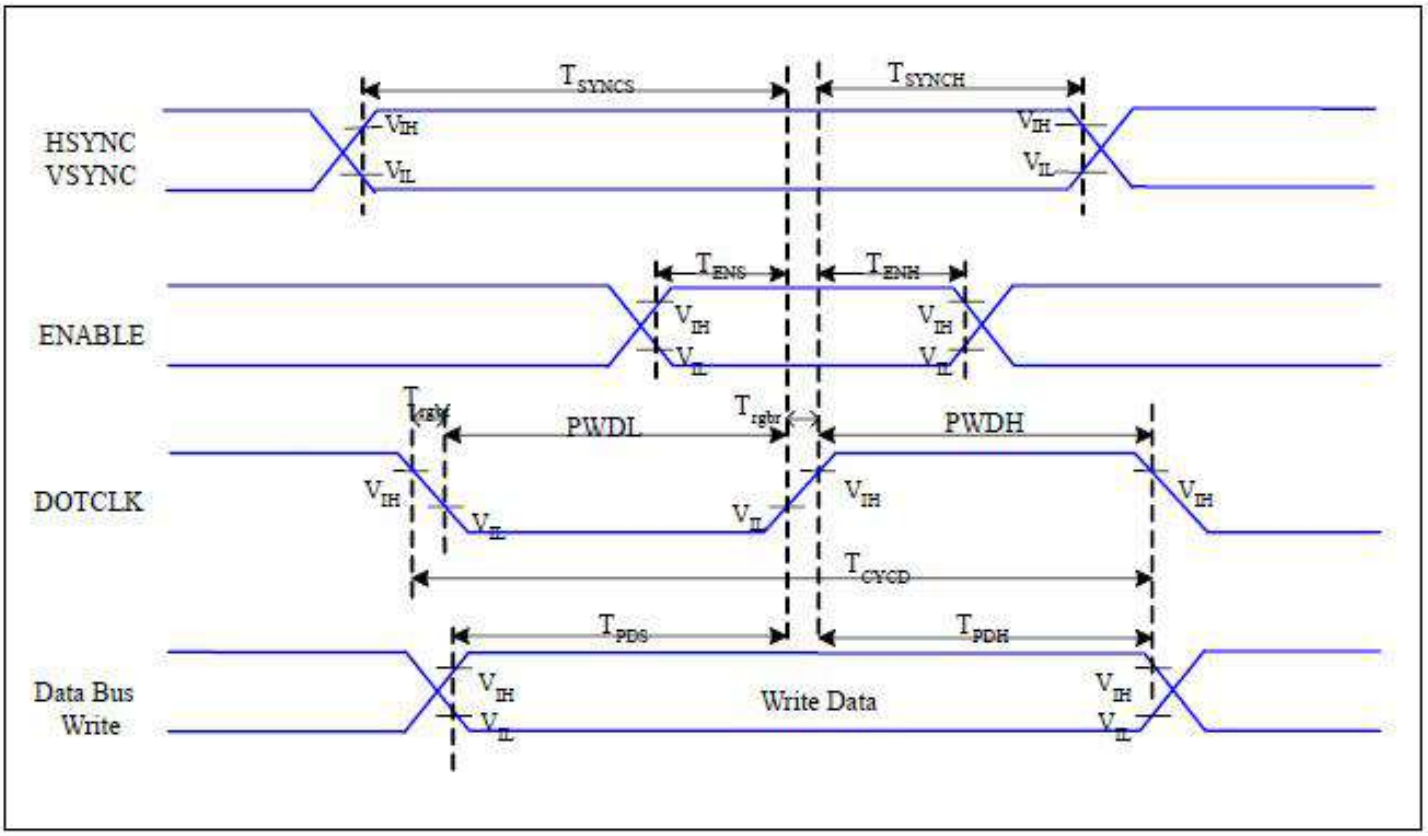

**4-line serial Interface Timing Characteristics**

*VDDI=1.8,VDD=2.8, AGND=DGND=0V, Ta=25 ℃*

| 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) | 60 | | ns | |
| | $T_{SCC}$ | Chip select hold time (read) | 65 | | 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 | -write command |
| | $T_{SLW}$ | SCL "L" pulse width (Write) | 15 | | ns | |
| | $T_{SCYCR}$ | Serial clock cycle (Read) | 150 | | ns | |
| | $T_{SHR}$ | SCL "H" pulse width (Read) | 60 | | ns | -read command |
| | $T_{SLR}$ | SCL "L" pulse width (Read) | 60 | | ns | |
| D/CX | $T_{DCS}$ | D/CX setup time | 10 | | ns | |
| | $T_{DCH}$ | D/CX hold time | 10 | | ns | |
| SDA (DIN) | $T_{SDS}$ | Data setup time | 10 | | ns | |
| | $T_{SDH}$ | Data hold time | 10 | | ns | |
| SDO (DOUT) | $T_{ACC}$ | Access time | 20 | 50 | ns | Max: CL=30pF |
| | $T_{OH}$ | Output disable time | 50 | 50 | ns | Min: CL=8pF |

**4-line serial Interface Characteristics**

### 5.2.3 RGB Interface Characteristics :




**RGB Interface Timing Characteristics**

*VDDI=1.8,VDD=2.8, AGND=DGND=0V, Ta=25 ℃*

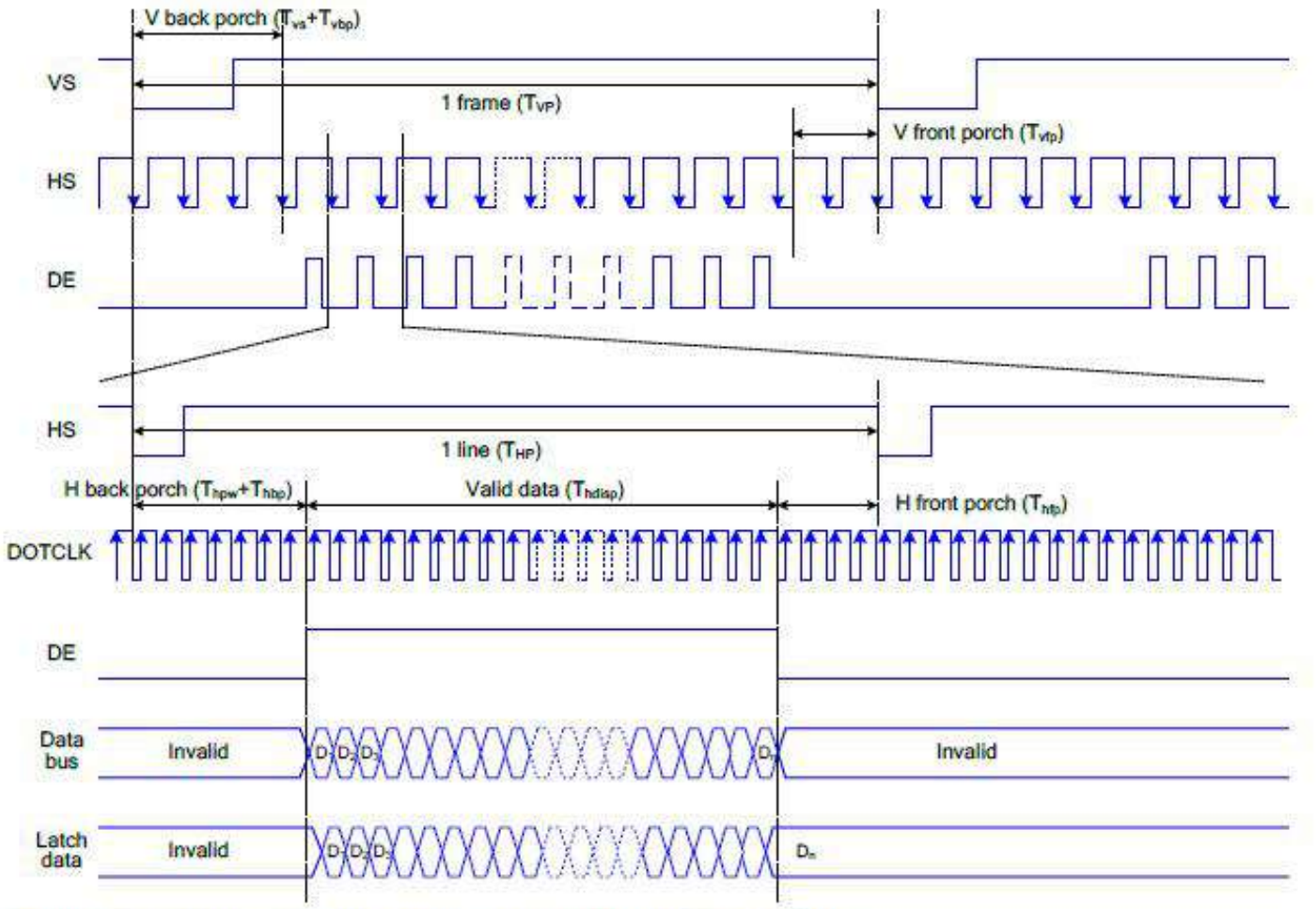
| Signal | Symbol | Parameter | MIN | MAX | Unit | Description |
|---|---|---|---|---|---|---|
| HSYNC, VSYNC | $T_{SYNCS}$ | VSYNC, HSYNC Setup Time | 5 | - | ns | |
| ENABLE | $T_{ENS}$ | Enable Setup Time | 5 | - | ns | |
| | $T_{ENH}$ | Enable Hold Time | 5 | - | ns | |
| DOTCLK | PWDH | DOTCLK High-level 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 | |

**18/16 Bits RGB Interface Timing Characteristics**

## 5.3 RGB Interface Timing

### 5.3.1 Timing Chart of Signals in RGB Interface DE Mode

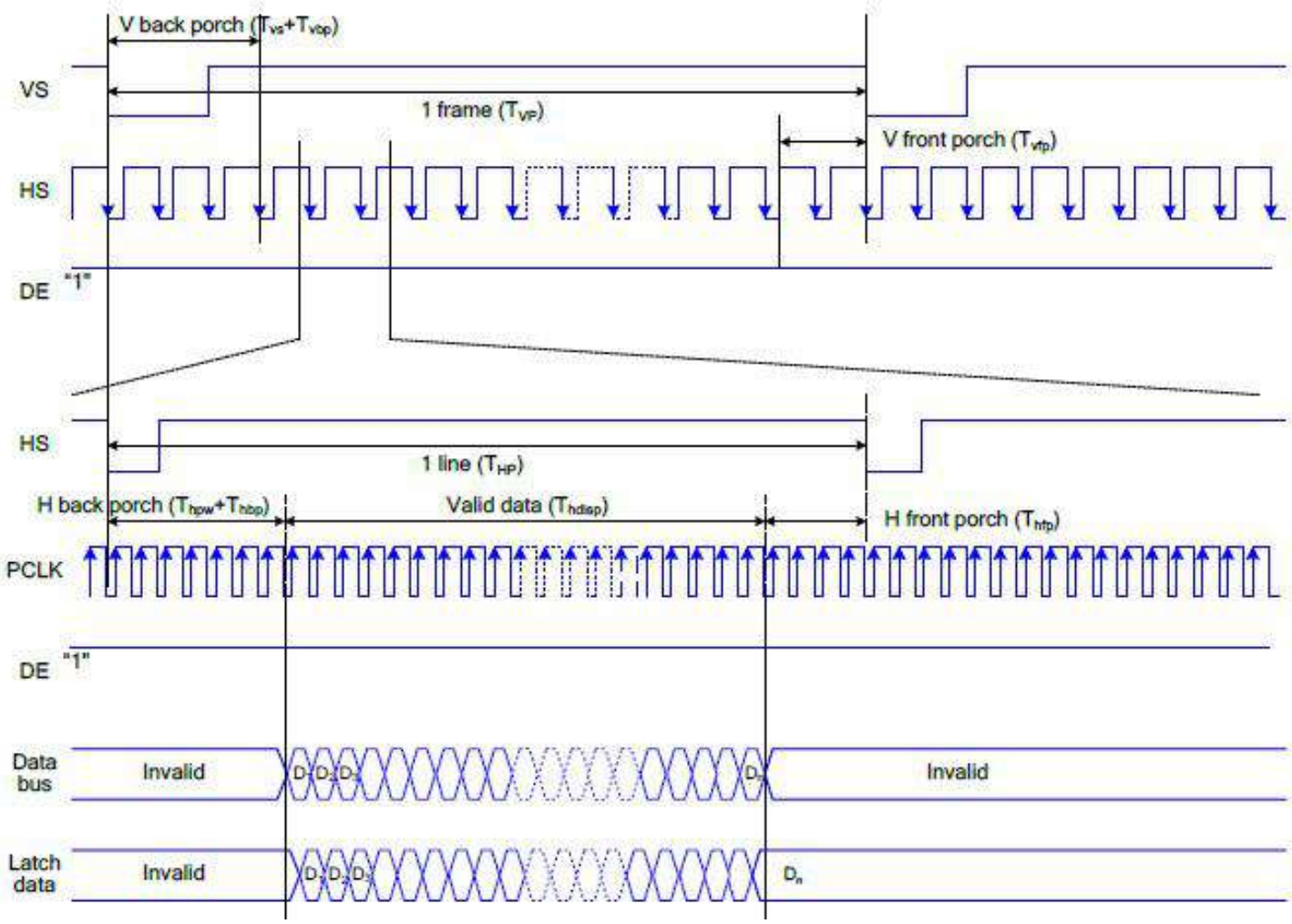
The timing chart of RGB interface DE mode is shown as follows.




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

### 5.3.2 Timing chart of RGB interface HV mode

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

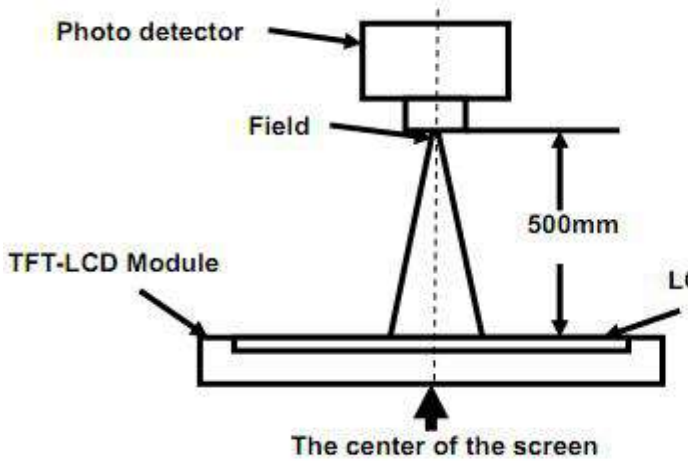


# 6. Optical Specifications

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|---|
| Viewing Angle (CR≥10) B/L ON | $\theta_T$ | Φ=90°(12 o'clock) | 80 | 85 | - | deg | Note2 |
| | $\theta_B$ | Φ=270°(6 o'clock) | 80 | 85 | - | deg | Note2 |
| | $\theta_L$ | Φ=180°(9 o'clock) | 80 | 85 | - | deg | Note2 |
| | $\theta_R$ | Φ=0°(3 o'clock) | 80 | 85 | - | deg | Note2 |
| Response Time | $T_{ON}$ | Normal θ=Φ=0° | - | 15 | 17 | msec | Note4 |
| | $T_{OFF}$ | | - | 15 | 17 | msec | Note4 |
| Contrast Ratio | CR | | 800:1 | 1000:1 | - | - | Note1 Note3 |
| Color Chromaticity | $W_X$ | | 0.250 | 0.300 | 0.350 | - | Note1 Note5 |
| | WY | | 0.276 | 0.326 | 0.376 | - | Note1 Note5 |
| | Rx | | 0.608 | 0.638 | 0.668 | - | Note1 Note5 |
| | Ry | | 0.300 | 0.330 | 0.360 | - | Note1 Note5 |
| | Gx | | 0.324 | 0.354 | 0.354 | - | Note1 Note5 |
| | Gy | | 0.557 | 0.587 | 0.617 | - | Note1 Note5 |
| | Bx | | 0.110 | 0.140 | 0.170 | - | Note1 Note5 |
| | By | | 0.042 | 0.072 | 0.102 | - | Note1 Note5 |
| Luminance | L | | 350 | 400 | - | $cd/m^2$ | Note1 Note7 |
| Luminance Uniformity | YU | | 75 | 80 | - | % | Note1 Note6 |
| NTSC | - | | 64 | 69 | - | % | - |

Note 1:Definition of optical measurement system

The optical characteristics should be measured in dark room. After 5 minutes operation, the optical properties are measured at the center point of the LCD screen. All input terminals LCD panel must be ground when measuring the center area of the panel.




| Item | Photo detector | Field |
|---|---|---|
| Contrast Ratio | SR-3A | 1° |
| Luminance | | |
| Chromaticity | | |
| Lum Uniformity | | |
| Response Time | BM-7A | 2° |

Note 2:Definition of viewing angle range and measurement system

Viewing angle is measured at the center point of the LCD by CONOSCOPE(ergo-80).

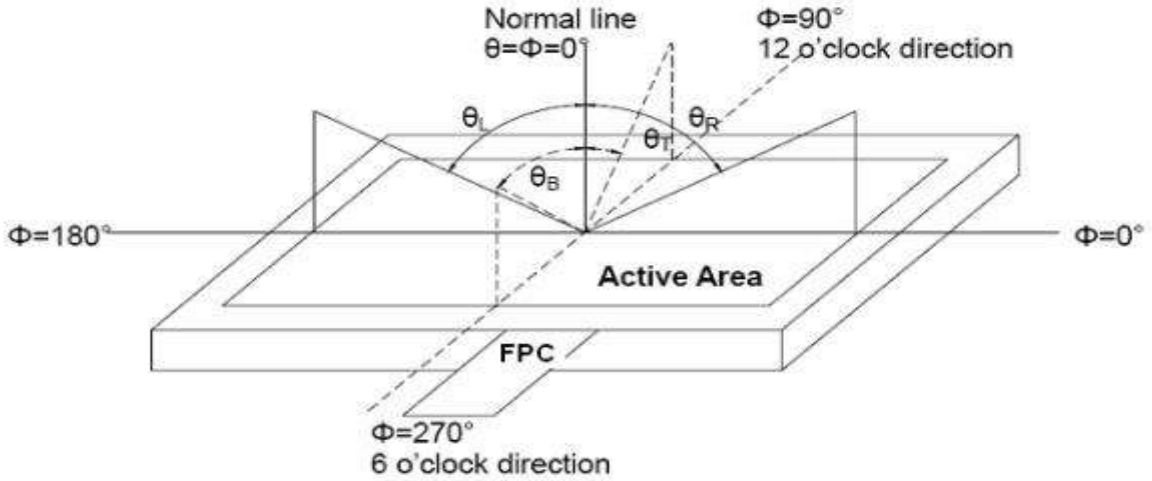


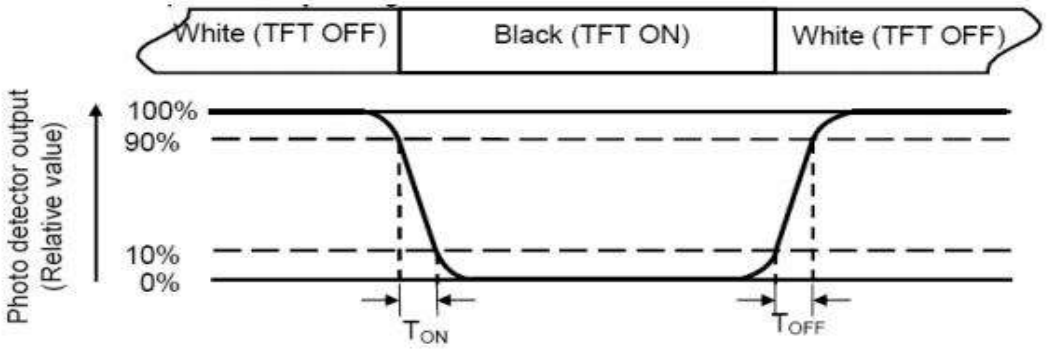

Fig. 1 Definition of viewing angle

Note 3: Definition of contrast ratio

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

Note 4: Definition of Response time

The response time is defined as the LCD optical switching time interval between “White” state and “Black”state. Rise time (TON) is the time between photo detector output intensity changed from 90% to 10%. And fall time (TOFF) is the time between photo detector output intensity changed from 10% to 90%.




Note 5:Definition of color chromaticity (CIE1931)

Color coordinates measured at center point of LCD.

Note 6:Definition of Luminance Uniformity

The luminance uniformity in surface luminance is determined by measuring luminance at each test position 1 through n, and then dividing the maximum luminance of n points luminance by minimum luminance of n points luminance. For more information see FIG.2.

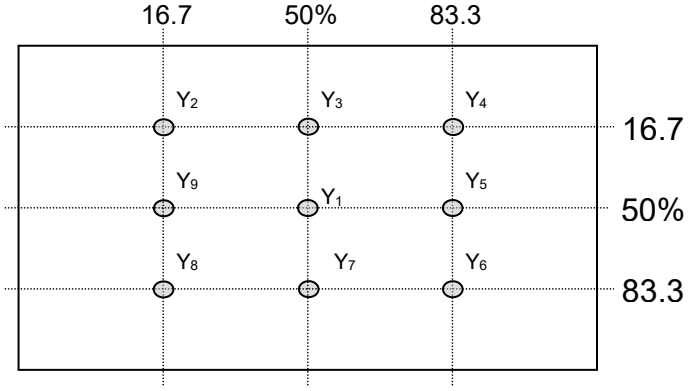



Fig. 2 Definition of points

Note 7:Definition of Luminance (Refer Fig. 2)

Surface luminance is the luminance with all pixels displaying white.

Lv = Average Surface Luminance with all white pixels(P1,P2,P3, .....,Pn).

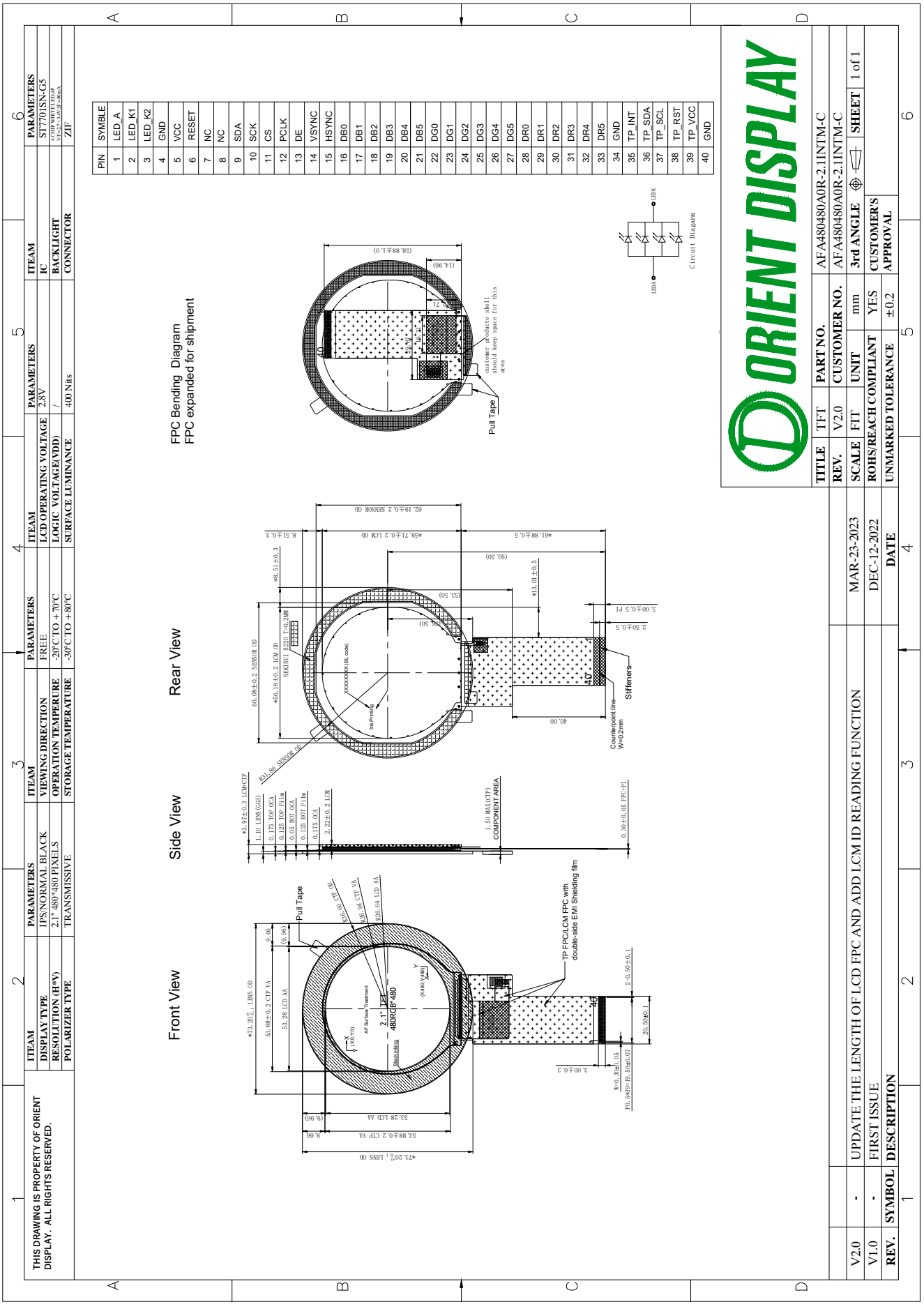
# 7. Reliability Test Items

| Test Item | Test Conditions | |
|---|---|---|
| High Temperature Storage | Ta= +80℃ | 96hrs |
| Low Temperature Storage | Ta= -30℃ | 96hrs |
| High Temperature Operation | Ta= +70℃ | 96hrs |
| Low Temperature Operation | Ta= -20℃ | 96hrs |
| High Temperature and Humidity Storage | Ta= +60℃, 90% RH | 96hrs |
| Thermal Shock (Non-operation) | -30℃/30 min ~ +80℃/30 min for 20 cycles<br>Start with cold temperature<br>end with high temperature | |
| Electro Static Discharge | Contact = ± 4 kV, class B<br>Air = ± 8 kV, class B<br>R=330Ω,C=150pF | |
| Vibration | Sweep: 10Hz~55Hz~10Hz<br>Stroke: 1.5mm<br>2 hrs for each direction of X .Y. Z. | |
| Mechanical Shock | 60G 6ms,±X,±Y,±Z<br>3 times for each direction | |
| Package Drop Test | Height: 60 cm<br>1 corner, 3 edges, 6 surfaces | |

Notes: The test result shall be evaluated after the sample has been left at room temperature and humidity for 2 hours without load. No condensation shall be accepted. The sample will not be accepted if appear these defects:

1). Air bubble in the LCD
2). Seal leak or Glass crack
3). Non display or abnormal display
4). Brightness reduction >50%

# 8. Mechanical Drawing



# 9. Packing

TBA

# 10. Precautions for Use of LCD modules

## 10.1 Handling Precautions

10.1.1. The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.

10.1.2. If the display panel is damaged and the liquid crystal substance inside it leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes, promptly wash it off using soap and water.

10.1.3. Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

10.1.4. The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

10.1.5. If the display surface is contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If still not completely clear, moisten cloth with one of the following solvents:

- Isopropyl alcohol
- Ethyl alcohol

Solvents other than those mentioned above may damage the polarizer. Especially, do not use the following:

- Water
- Ketene
- Aromatic solvents

10.1.6. Do not attempt to disassemble the LCD Module.

10.1.7. If the logic circuit power is off, do not apply the input signals.

10.1.8. To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

10.1.8.1. Be sure to ground the body when handling the LCD Modules.

10.1.8.2. Tools required for assembly, such as soldering irons, must be properly ground.

10.1.8.3. To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.

10.1.8.4. The LCD Module is coated with a film to protect the display surface. Be care when peeling off this protective film since static electricity may be generated.

## 10.2 Storage Precautions

10.2.1.When storing the LCD modules,avoid exposure to direct sunlight or to the light of fluorescent lamps.

10.2.2.The LCD modules should be stored under the storage temperature range if the LCD modules will be stored for a long time,the recommend condition is :

Temperature : 0℃ ~40℃ Relatively humidity: ≤80%

10.2.3.The LCD modules should be stored in the room without acid, alkali and harmful gas.

## 10.3 Transportation Precautions

The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.