# MODEL NO. :   TM022HDHT1-00

# ISSUED DATE:   2010-5-28

# VERSION   :   Ver 1.1

■**Provisional Specification**
□**Final Product Specification**

**Customer :**

| Approved by | Notes |
|---|---|
|  |  |

**SHANGHAI TIANMA Confirmed :**

| prepared by | Checked by | Approved by |
|---|---|---|
|  |  |  |

This technical specification is subjected to change without notice

# Table of Contents

# Record of Revision

| Rev | Issued Date | Description | Editor |
|-----|-------------|-------------|--------|
| 1.0 | 2010-1-20 | Preliminary Specification Release | Jun Ma |
| 1.1 | 2010-5-28 | Update the IC from S6D04H0 to ILI9340; | Bencan Yang |
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## 1 General specifications

| Feature | | Spec |
|---|---|---|
| **Display Spec.** | Size | 2.2 inch |
| | Resolution | 240(RGB) X 320 |
| | Interface | RGB 18 bits+3SPI |
| | Color Depth | 262K |
| | Technology type | a-si TFT |
| | Pixel pitch (mm) | 0.141x0.141 |
| | Pixel Configuration | R.G.B. Vertical Stripe |
| | Display Mode | ECB   Transflective |
| | Surface Treatment(Up Polarizer) | Clear type (3H) |
| | Surface Treatment | Clear type (3H) |
| | Viewing Direction | 12 o'clock |
| | Gray Scale Inversion Direction | 6 o'clock |
| **Mechanical Characteristics** | DIM.   LCM (W x H x D) (mm) | 40.6x56.6x2.7 |
| | Active Area(mm) | 33.84 x45.12 |
| | With /Without TSP | Without TSP |
| | Weight (gram) | TBD |
| | LED Numbers | 4 LEDs (serial) |

Note 1：Viewing direction for best image quality is different from TFT definition, there is a 180 degree shift.

Note 2 : Requirements on Environmental Protection: Q/S0002

## 2  Input/Output terminals

2.1  TFT LCD Panel

**Recommended connector: FH23-39S-0.3SHW（HIROSE）**

| No | Symbol | I/O | Description | Remarks |
|----|--------|-----|-------------|---------|
| 1 | VL1（LED+） | I | Power supply for LED(High voltage) | |
| 2 | VL2（LED-） | I | Power supply for LED(Low voltage) | |
| 3 | GND | P | Ground | |
| 4 | VDD | P | Power supply of gate driver(high level) | |
| 5 | GND | P | Ground | |
| 6 | VSYNC | I | Vertical sync. signal | |
| 7 | RESET | I | Reset Enable | |
| 8 | GND | P | Ground | |
| 9 | CS | I | SPI Chip select | |
| 10 | SDO | O | SPI serial Data output | |
| 11 | SDI | I | SPI serial Data input | |
| 12 | GND | P | Ground | |
| 13 | SCL | I | SPI serial interface clock | |
| 14 | GND | P | Ground | |
| 15 | B5 | I | Blue data signal | |
| 16 | B4 | I | Blue data signal | |
| 17 | B3 | I | Blue data signal | |
| 18 | B2 | I | Blue data signal | |
| 19 | B1 | I | Blue data signal | |
| 20 | B0 | I | Blue data signal | |
| 21 | ENABLE | I | Data enable signal | |
| 22 | HSYNC | I | Horizontal sync signal | |
| 23 | GND | P | Ground | |
| 24 | DCLK | I | Data sampling clock signal | |
| 25 | GND | P | Ground | |
| 26 | G5 | I | Green data signal | |
| 27 | G4 | I | Green data signal | |
| 28 | G3 | I | Green data signal | |
| 29 | G2 | I | Green data signal | |
| 30 | G1 | I | Green data signal | |
| 31 | G0 | I | Green data signal | |
| 32 | GND | P | Ground | |
| 33 | R5 | I | Red data signal | |
| 34 | R4 | I | Red data signal | |
| 35 | R3 | I | Red data signal | |
| 36 | R2 | I | Red data signal | |
| 37 | R1 | I | Red data signal | |
| 38 | R0 | I | Red data signal | |
| 39 | GND | P | Ground | |

Note2-1:   I/O definition：

     I-----Input

    O---Output

    P----Power

Note 2-2: The figure below shows the connection of backlight LED.
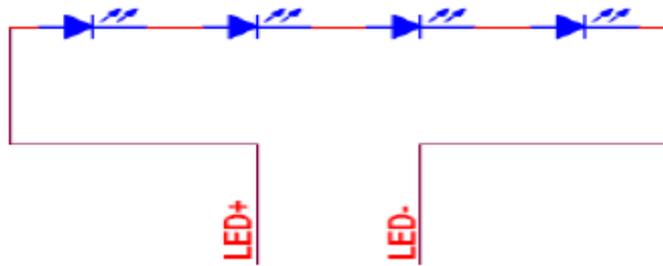
# 3   Absolute maximum ratings

## 3.1   Driving TFT LCD Panel

(VSS=0, Ta = 25℃)

| Item | Symbol | MIN | MAX | Unit | Remark |
|------|--------|-----|-----|------|--------|
| Logic Supply Voltage | VDD | -0.3 | 4.6 | V | |
| Input Signal Voltage | R0~R5,G0~G5,B0~B5，ENABLE,DCLK,HSYNC,VSYNC,/CS,SCL,SDI,SDO/RESET | -0.3 | VCC +0.5 | V | |
| Back Light Forward Current | $I_{LED}$ | -- | 25 | mA | |
| Operating Temperature | $T_{OPR}$ | -20 | 70 | ℃ | |
| Storage Temperature | $T_{STG}$ | -30 | 80 | ℃ | |

## 4  Electrical characteristics

4.1    Driving TFT LCD Panel

(VSS=0,Ta=25℃)

| Parameter | | Symbol | MIN | TYP | MAX | Unit | Remark |
|---|---|---|---|---|---|---|---|
| Digital supply Voltage | | VDD | 2.5 | 2.8 | 3.3 | V | |
| Input Signal Voltage | Low Level | VIL | VSS | - | 0.2xVDD | V | R0~R5,G0~G5,B0~B5，ENABLE,DCLK,HSYNC, VSYNC,/CS,SCL,SDI,SDO/RESET |
| | High Level | VIH | 0.8xVDD | - | VDD | V | |
| Output Signal Voltage | Low Level | VOL | VSS | - | 0.3xVDD | V | Output Signal Voltage |
| | High Level | VOH | 0.7xVDD | - | VDD | V | |
| Current of VDD Power supply | | $I_{CC}$ | - | TBD | - | mA | Note 1 |

Note1:To test the current dissipation,use"all Black Pattern".

4.2    Driving Backlight    Ta=25℃

| Item | Symbol | MIN | TYP | MAX | Unit | Remark |
|---|---|---|---|---|---|---|
| Forward Current | $I_F$ | | 80 | -- | mA | 4 LEDs serial |
| Forward Voltage | $V_F$ | -- | 12.8 | | V | |
| Power Consumption | $W_{BL}$ | -- | 1024 | -- | mW | |
| Operating Life Time | - | 10000 | (20000) | - | Hrs | |

Note1:    Figure below shows the connection of backlight LED.
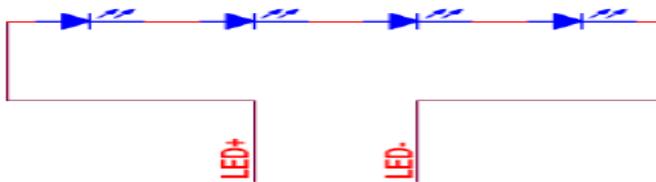


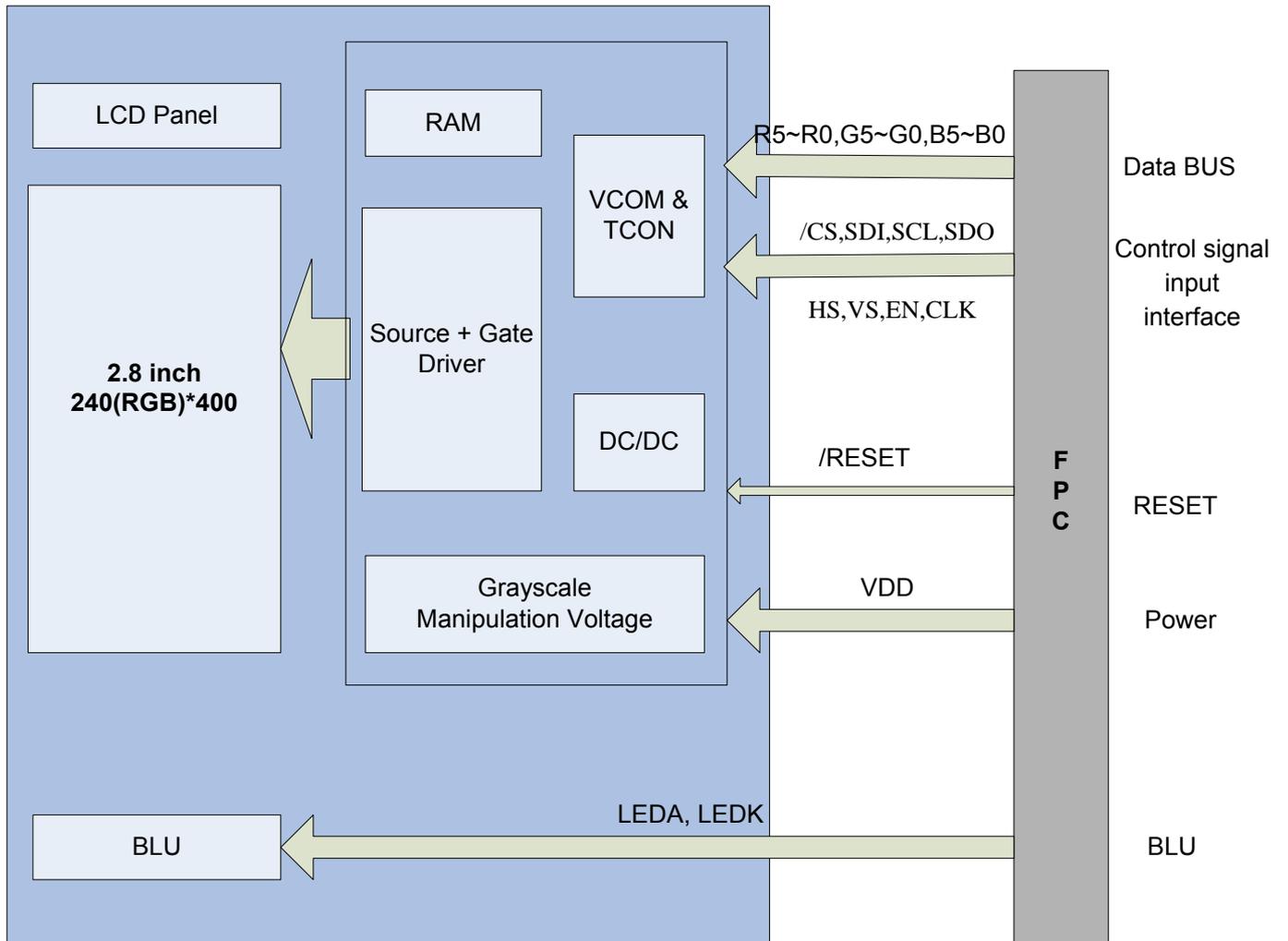Note 2: One LED: $I_F$ =80 mA, $V_F$ =12.8V

Note 3: : $I_F$ is defined for one channel LED.
    Optical performance should be evaluated at Ta=25℃ only.
    If LED is driven by high current, high ambient temperature & humidity condition. The life time of LED will be reduced. Operating life means brightness goes down to 50% initial brightness. Typical operating life time is estimated data.
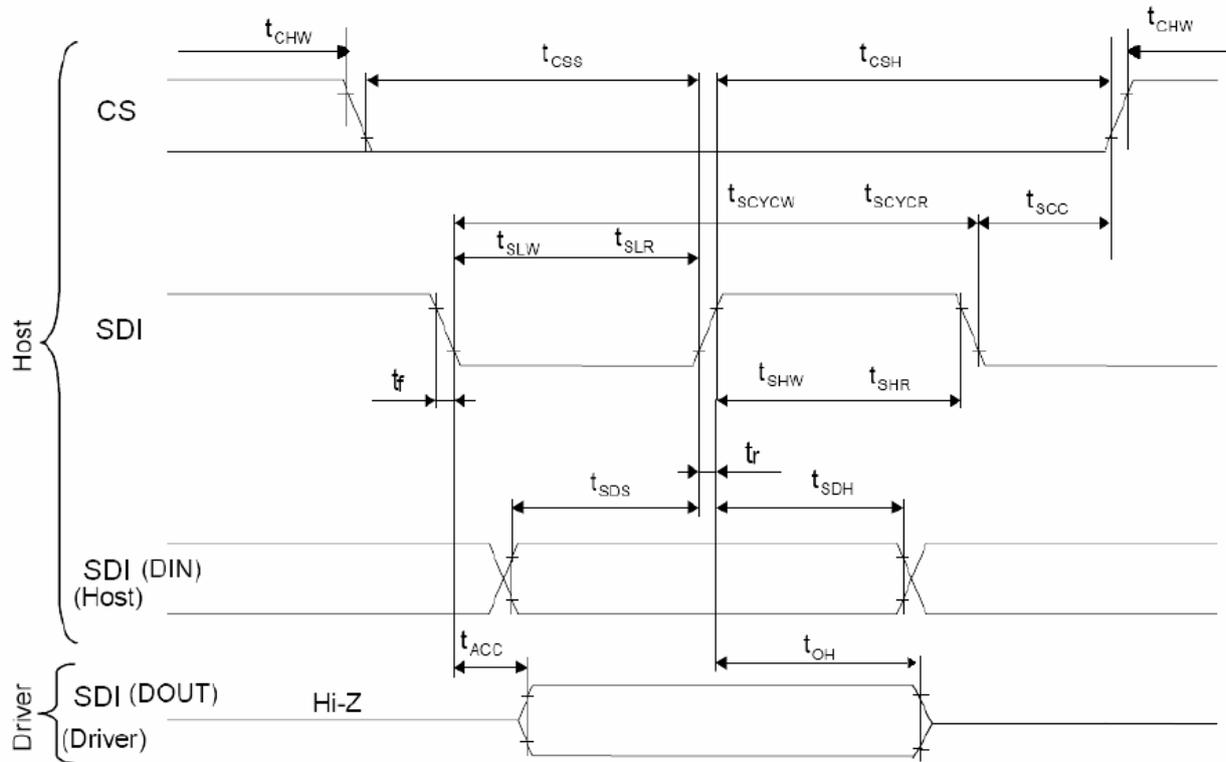
## 4.3   Block Diagram



LCD Panel

RAM

VCOM & TCON

R5~R0,G5~G0,B5~B0

Data BUS

/CS,SDI,SCL,SDO

Control signal input interface

HS,VS,EN,CLK

2.8 inch
240(RGB)*400

Source + Gate Driver

DC/DC

/RESET

RESET

Grayscale Manipulation Voltage

VDD

Power

F P C

BLU

LEDA, LEDK

BLU

# 5 Timing chart

## 5.1 3wire INTERFACE CHARACTERISTICS



| Signal | Symbol | Parameter | min | max | Unit | Description |
|---|---|---|---|---|---|---|
| SCL | tscycw | Serial Clock Cycle (Write) | 100 | - | ns | |
| | tshw | SCL "H" Pulse Width (Write) | 40 | - | ns | |
| | tslw | SCL "L" Pulse Width (Write) | 40 | - | 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) | 30 | - | ns | |
| | tsdh | Data hold time (Write) | 30 | - | ns | |
| SDA / SDO (Output) | tacc | Access time (Read) | 10 | - | ns | |
| | toh | Output disable time (Read) | 10 | 50 | ns | |
| CS | tscc | SCL-CSX | 20 | - | ns | |
| | tchw | CSX "H" Pulse Width | 40 | - | ns | |
| | tcss | CSX-SCL Time | 60 | - | ns | |
| | tcsh | | 65 | - | ns | |

Note: Ta = 25 °C, VDDI=1.65V to 3.3V, VCI=2.5V to 3.3V, AGND=VSS=0V
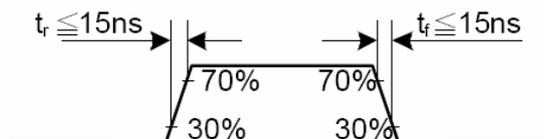
## 5.2 Parallel 18/16/6-bit RGB Interface Timing Characteristics
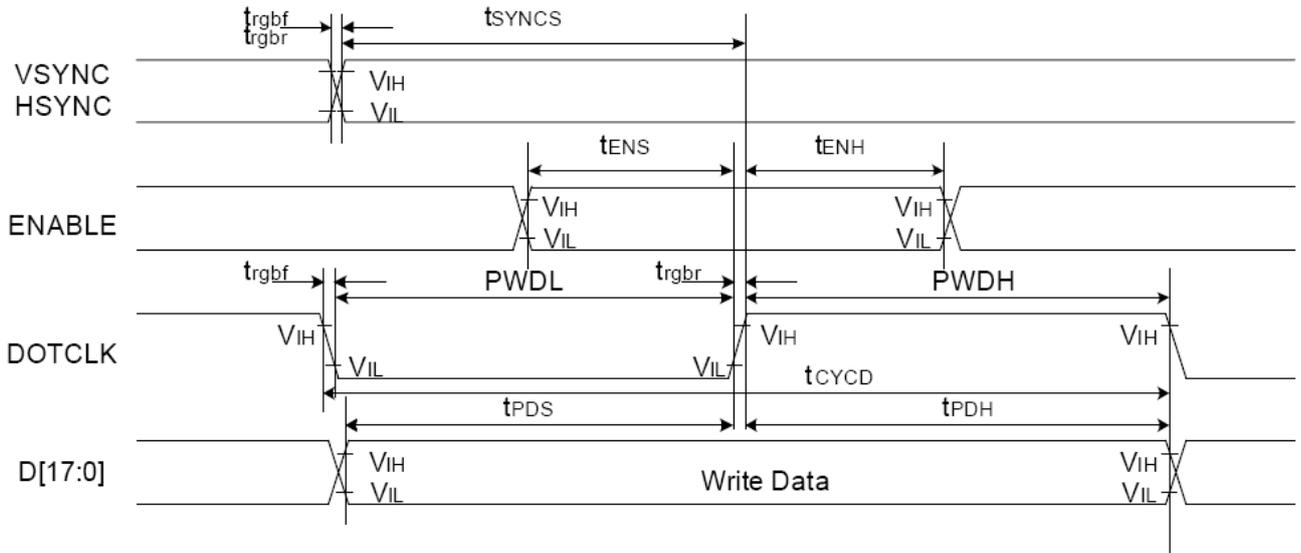


| Signal | Symbol | Parameter | min | max | Unit | Description |
|--------|--------|-----------|-----|-----|------|-------------|
| VSYNC / HSYNC | $t_{SYNCS}$ | VSYNC/HSYNC setup time | 15 | - | ns | 18/16-bit bus RGB interface mode |
| | $t_{SYNCH}$ | VSYNC/HSYNC hold time | 15 | - | ns | |
| DE | $t_{ENS}$ | DE setup time | 15 | - | ns | |
| | $t_{ENH}$ | DE hold time | 15 | - | ns | |
| D[17:0] | $t_{POS}$ | Data setup time | 15 | - | ns | |
| | $t_{PDH}$ | Data hold time | 15 | - | ns | |
| DOTCLK | PWDH | DOTCLK high-level period | 15 | - | ns | |
| | PWDL | DOTCLK low-level period | 15 | - | ns | |
| | $t_{CYCD}$ | DOTCLK cycle time | 100 | - | ns | |
| | $t_{rgbr}, t_{rgbf}$ | 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 | |
| | $t_{PDH}$ | Data hold time | 15 | - | ns | |
| DOTCLK | PWDH | DOTCLK high-level pulse period | 15 | - | ns | |
| | PWDL | DOTCLK low-level pulse period | 15 | - | ns | |
| | $t_{CYCD}$ | DOTCLK cycle time | 100 | - | ns | |
| | $t_{rgbr}, t_{rgbf}$ | DOTCLK,HSYNC,VSYNC rise/fall time | - | 15 | ns | |

Note: Ta = -30 to 70 °C, VDDI=1.65V to 3.3V, VCI=2.5V to 3.3V, AGND=VSS=0V
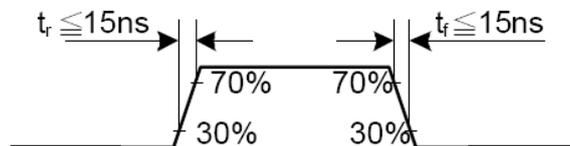
## 5.3 3-line Serial Interface Protocol

3-line Serial Interface Protocol

CS

Host
(MCU to Driver)

SDI   0  D7 D6 D5 D4 D3 D2 D1 D0   D/C  D7 D6 D5 D4 D3 D2 D1 D0

SCL

Command

Data / Command / Parameter

The CSX can be high level between the data and
next command.The SDA and SCL are invalid during
CSX is high level
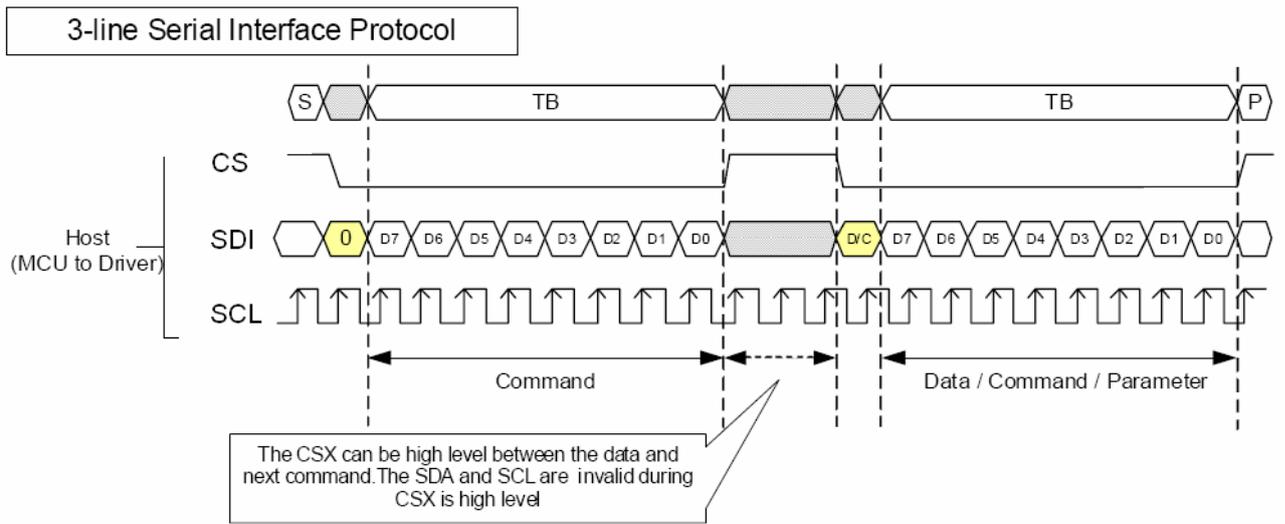
### 5.4 RGB Interface Timing
### The timing chart of 18-/16-bit RGB interface mode is shown as below
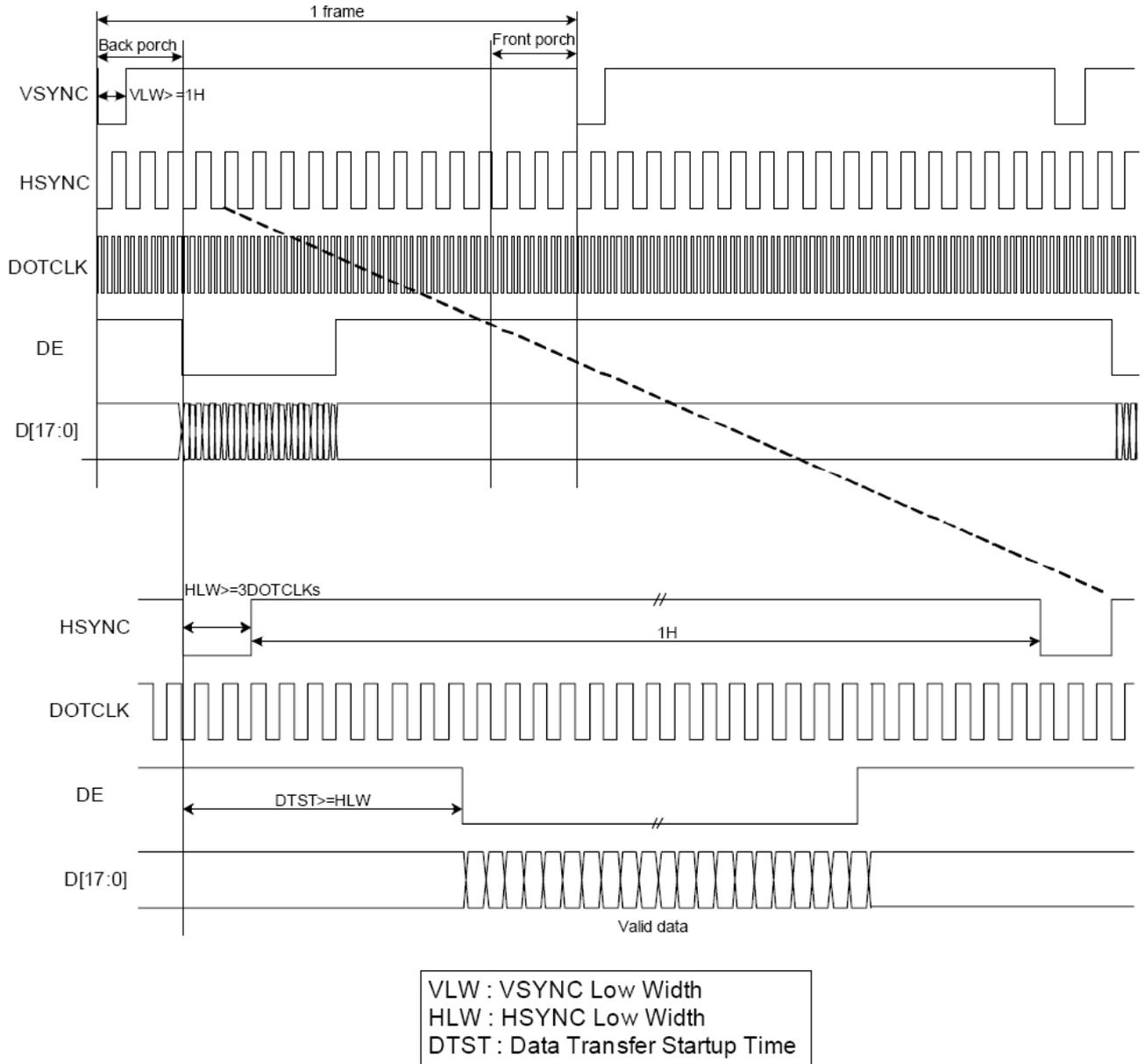


VLW : VSYNC Low Width
HLW : HSYNC Low Width
DTST : Data Transfer Startup Time

Note 1: The DE signal is not needed when RGB interface SYNC mode is selected.

Note 2: VSPL='0', HSPL='0', DPL='0' and EPL='1' of "Interface Mode Control (B0h)" command.

Fig.5-3 RGB Interface Timing

**The timing chart of 6-bit RGB interface mode is shown as below:**



VLW : VSYNC Low Width
HLW : HSYNC Low Width
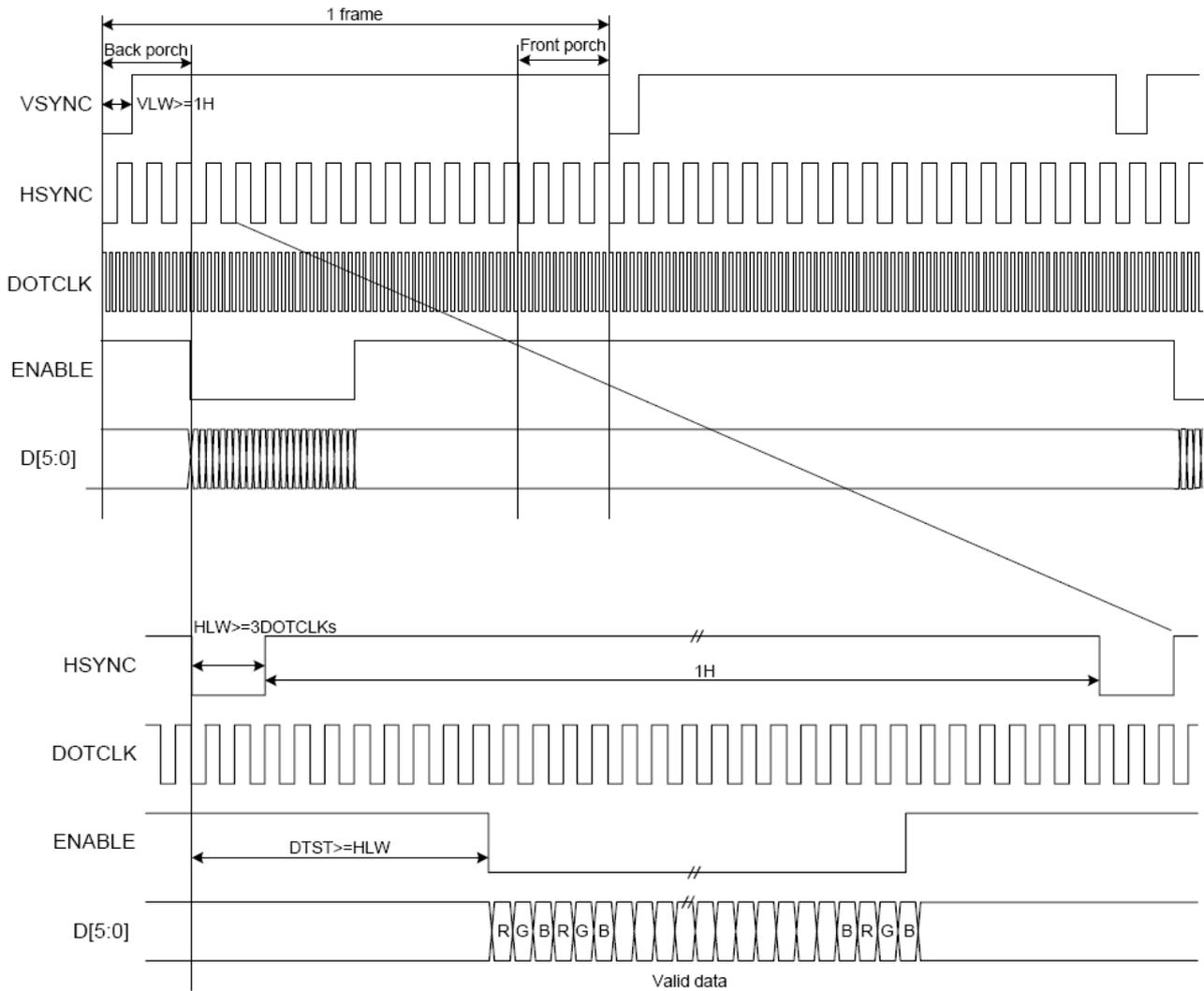DTST : Data Transfer Startup Time

Note 1: The DE signal is not needed when RGB interface SYNC mode is selected.

Note 2: VSPL='0', HSPL='0', DPL='0' and EPL='1' of "Interface Mode Control (B0h)" command.

Note 3: In 6-bit RGB interface mode, each dot of one pixel (R, G and B) is transferred in synchronization with DOTCLK.

Note 4: In 6-bit RGB interface mode, set the cycles of VSYNC, HSYNC and DE to 3 multiples of DOTCLK.
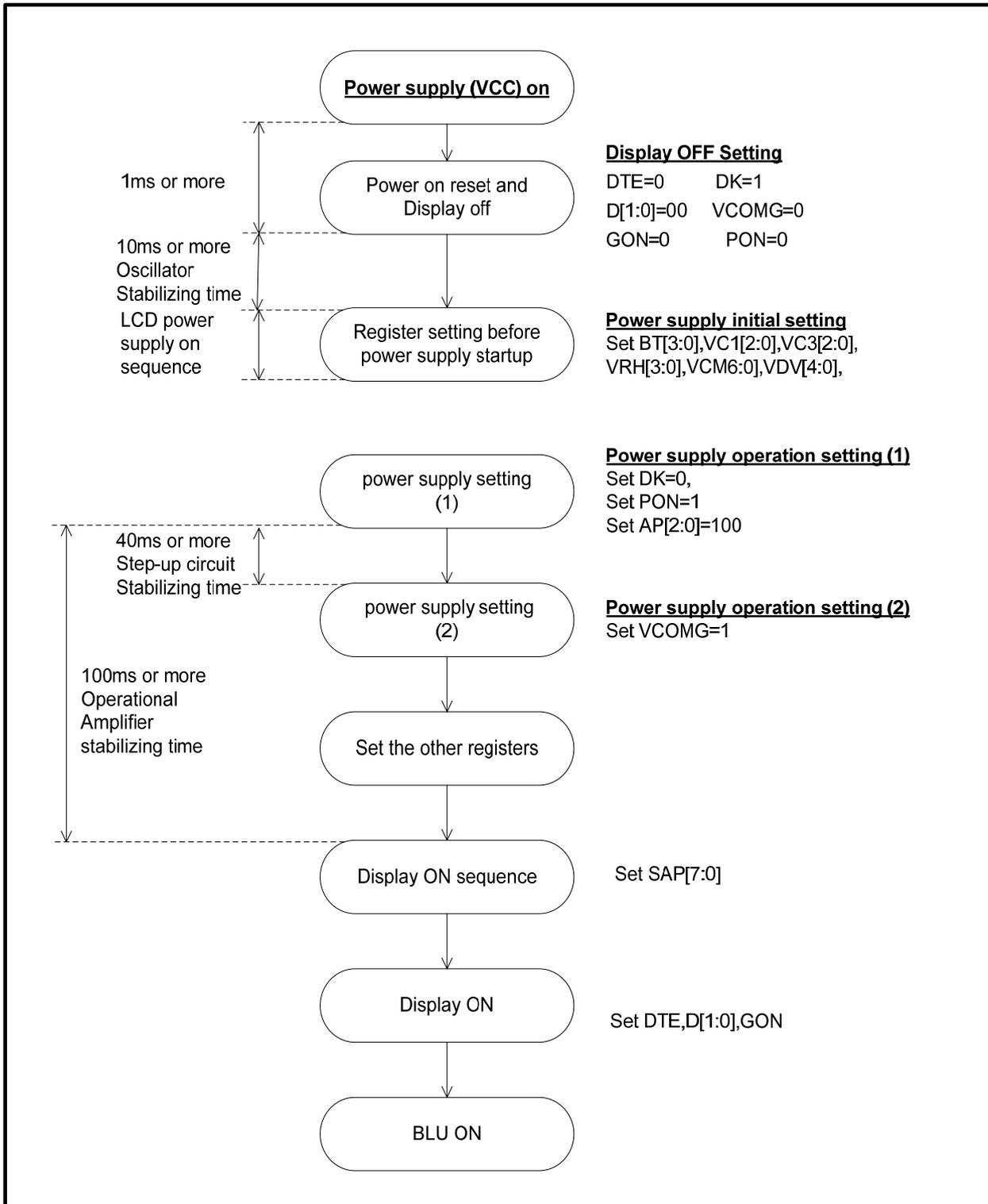
## 5.5 Reset Timing
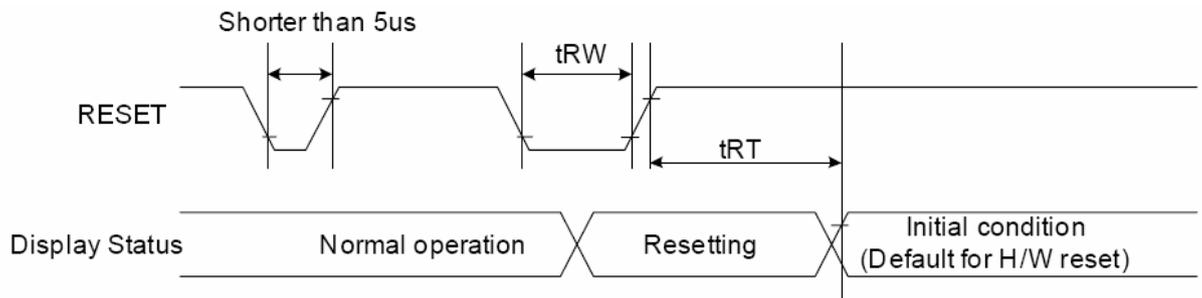


| Signal | Symbol | Parameter | Min | Max | Unit |
|--------|--------|-----------|-----|-----|------|
| RESET | tRW | Reset pulse duration | 10 | | uS |
| | tRT | Reset cancel | | 5 | mS |
| | | | | 120 | mS |

## 5. 4  Power on/off Sequence
### 5.4.1  Power on Sequence

**Power supply (VCC) on**

↓

1ms or more

**Power on reset and Display off**

**Display OFF Setting**
DTE=0          DK=1
D[1:0]=00     VCOMG=0
GON=0          PON=0

10ms or more
Oscillator
Stabilizing time
LCD power
supply on
sequence

↓

**Register setting before power supply startup**

**Power supply initial setting**
Set BT[3:0],VC1[2:0],VC3[2:0],
VRH[3:0],VCM6:0],VDV[4:0],

↓

**power supply setting (1)**

**Power supply operation setting (1)**
Set DK=0,
Set PON=1
Set AP[2:0]=100

40ms or more
Step-up circuit
Stabilizing time

↓

**power supply setting (2)**

**Power supply operation setting (2)**
Set VCOMG=1

100ms or more
Operational
Amplifier
stabilizing time

↓

**Set the other registers**

↓

**Display ON sequence**

Set SAP[7:0]

↓

**Display ON**

Set DTE,D[1:0],GON

↓

**BLU ON**

Power On Sequence

### 5.4.2 Power off Sequence

| | |
|---|---|
| **Normal Display** | **Display ON setting**<br>DTE=1<br>D[1:0]=11<br>GON=1 |
| **BLU OFF** | |
| **Display OFF Sequence** | Set GON,DET,<br>D[1:0] |
| **Power Supply Halt Setting** | SAP[7:0]=0<br>AP[2:0]=0<br>PON=0<br>DK=1<br>VCOMG=0 |
| **Power Supply (VCC,VCI) OFF**<br>Vcc->vci or simultaneously | |
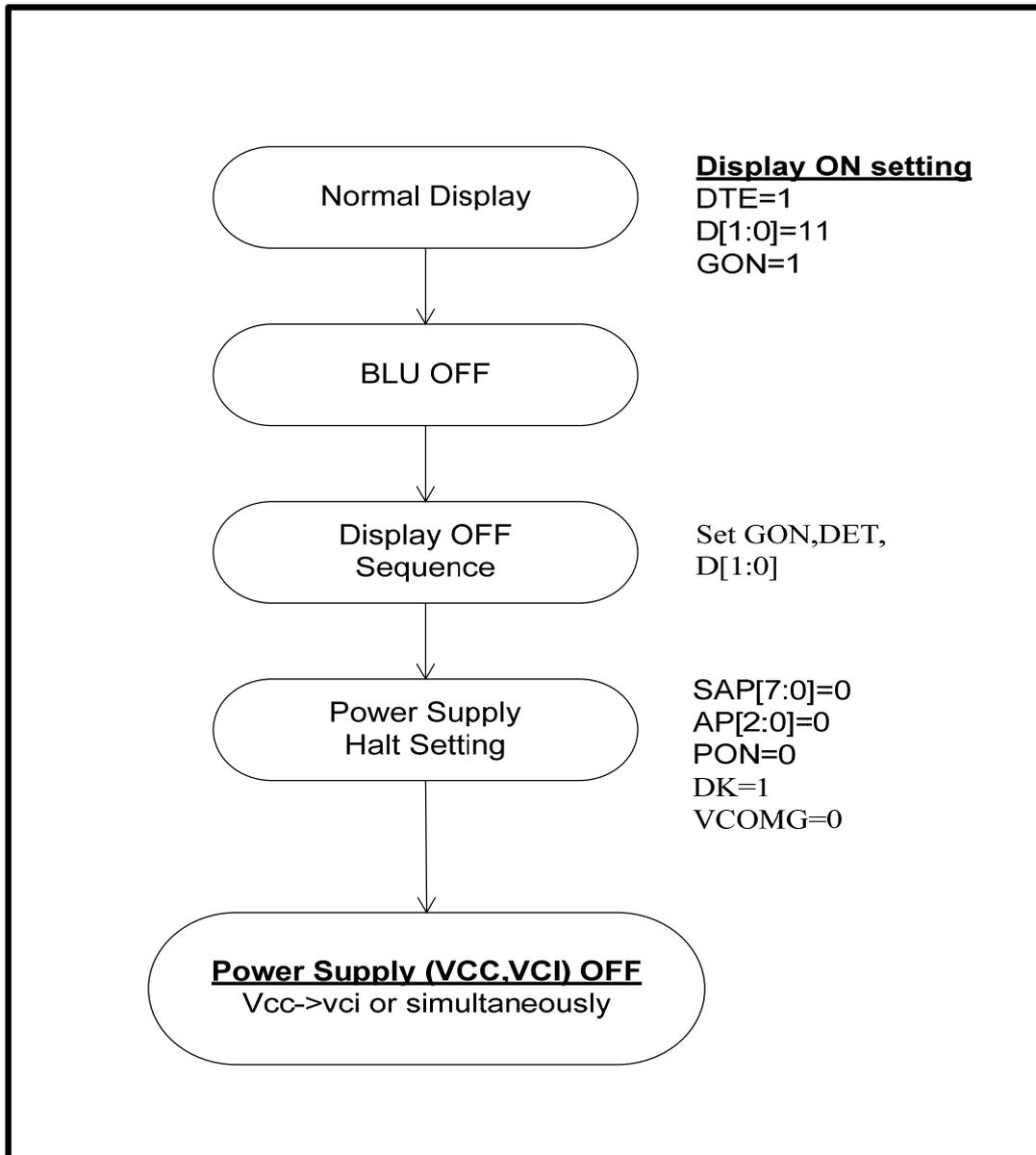
Power OFF Sequence

# 6  Optical characteristics

6.1 Optical Specification

Ta=25℃

| Item | | Symbol | Condition | Min | Typ. | Max. | Unit | Remark |
|---|---|---|---|---|---|---|---|---|
| View Angles | | $\ominus$T | CR$\geqq$10 | -- | 48 | 53 | Degree | Note 2 |
| | | $\ominus$B | | -- | 45 | 50 | | |
| | | $\ominus$L | | -- | 40 | 45 | | |
| | | $\theta$R | | -- | 45 | 50 | | |
| Contrast Ratio | | CR | $\theta$=0° | 100 | 120 | - | | Note1 Note3 |
| Response Time | | Ton | 25℃ | - | 35 | | ms | Note1 Note4 |
| | | Toff | | | | | | |
| Chromaticity | White | x | Brightness is on | | 0.31 | | | Note5, Note1 |
| | | y | | | 0.30 | | | |
| Uniformity | | U | | | 80 | - | % | Note1 Note6 |
| NTSC | | | | - | 30 | - | % | Note 5 |
| Luminance | | L | | 80 | 90 | - | cd/m$^2$ | Note1 Note7 |
| Reflectance | | | | | 6.8 | | % | Note8 |

Test Conditions:

1.   VDD=2.8V, I$_L$=20mA( One LED current), the ambient temperature is 25℃.

2.   The test systems refer to Note 1 , Note 2 and Note 8.

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.
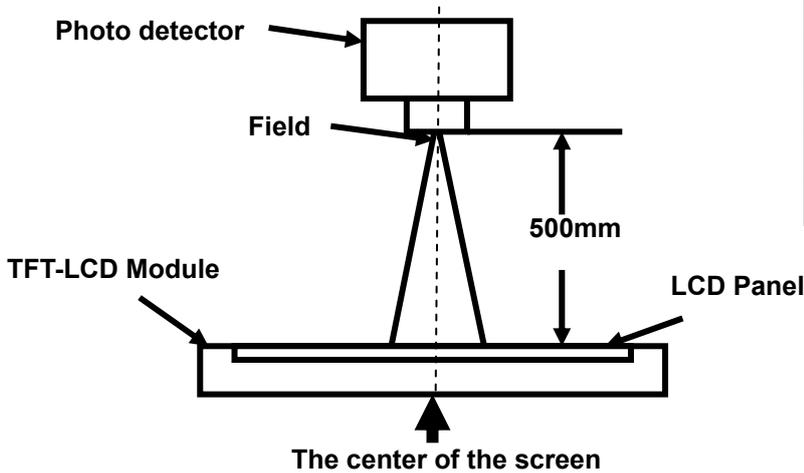


| Item | Photo detector | Field |
|------|----------------|-------|
| Contrast Ratio | SR-3A | 1° |
| Luminance | | |
| Chromaticity | | |
| Lum Uniformity | | |
| Response Time | BM-7A | 2° |

Note 2: Definition of viewing angle range and measurement system.

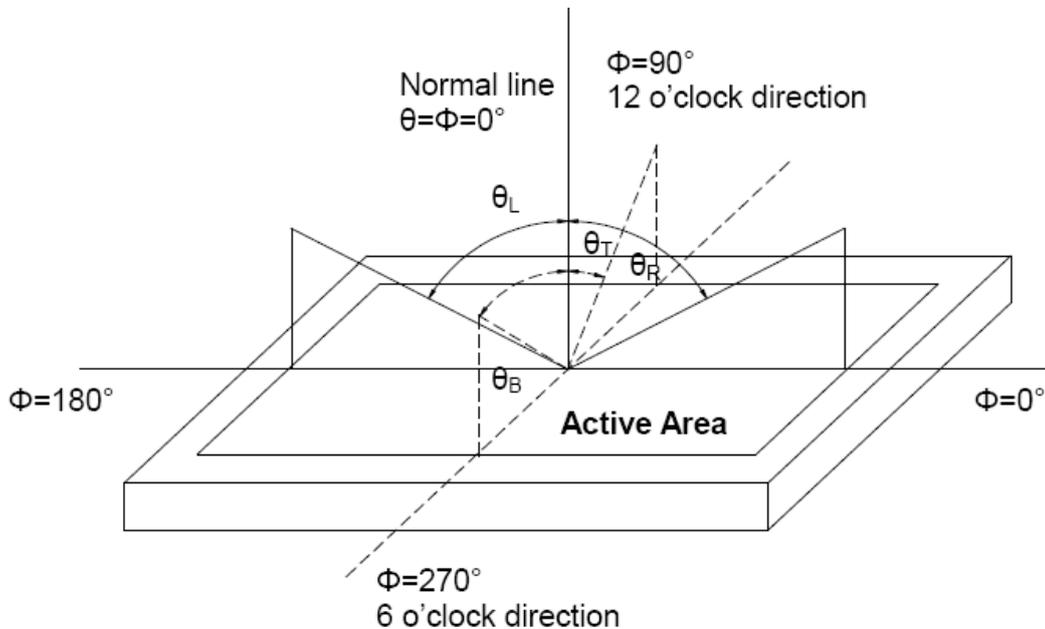viewing angle is measured at the center point of the LCD by CONOSCOPE(ergo-80)。



Fig. 1 Definition of viewing angle

---

Note 3: Definition of contrast ratio

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD is on the "White" state}}{\text{Luminance measured when LCD is on the "Black" state}}$$

"White state ":The state is that the LCD should driven by Vwhite.

"Black state": The state is that the LCD should driven by Vblack.

Vwhite: To be determined     Vblack: To be determined.

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%.
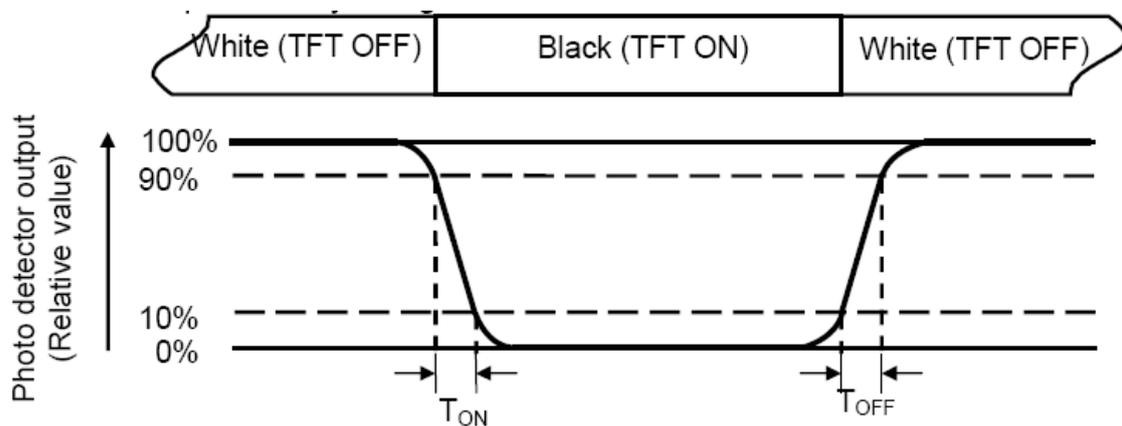
Note 5: Definition of color chromaticity (CIE1931)

Color coordinates measured at center point of LCD.

## Note 6: Definition of Luminance Uniformity

Active area is divided into 9 measuring areas (Refer Fig. 2). Every measuring point is placed at the center of each measuring area.

Luminance Uniformity(U) = Lmin/ Lmax

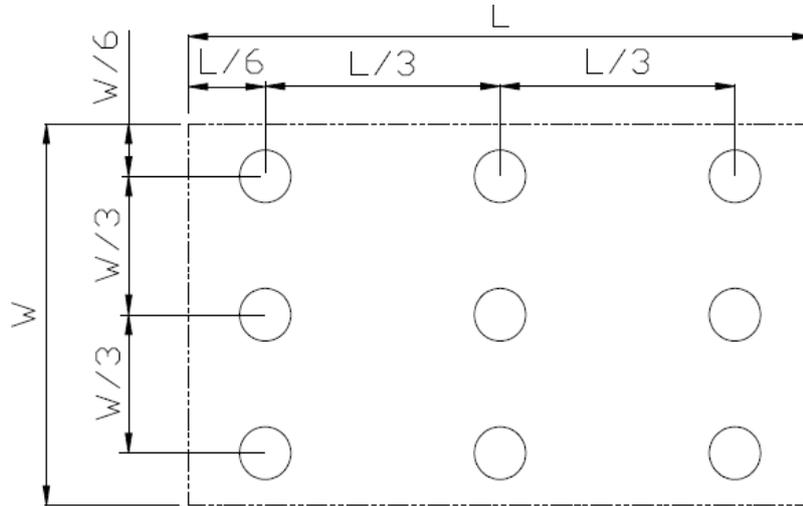L-------Active area length W----- Active area width



Fig. 2 Definition of uniformity

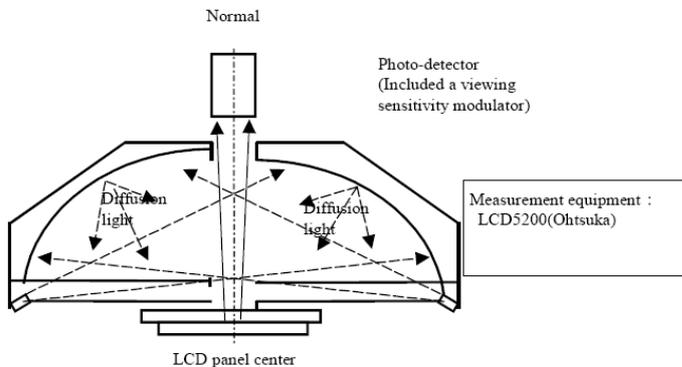Lmax: The measured maximum luminance of all measurement position.

Lmin: The measured minimum luminance of all measurement position.

## Note 7: Definition of Luminance :

Measure the luminance of white state at center point.

## Note 8: Definition of Reflectance measurement system

Note 5) Reflectance is defined as follows:
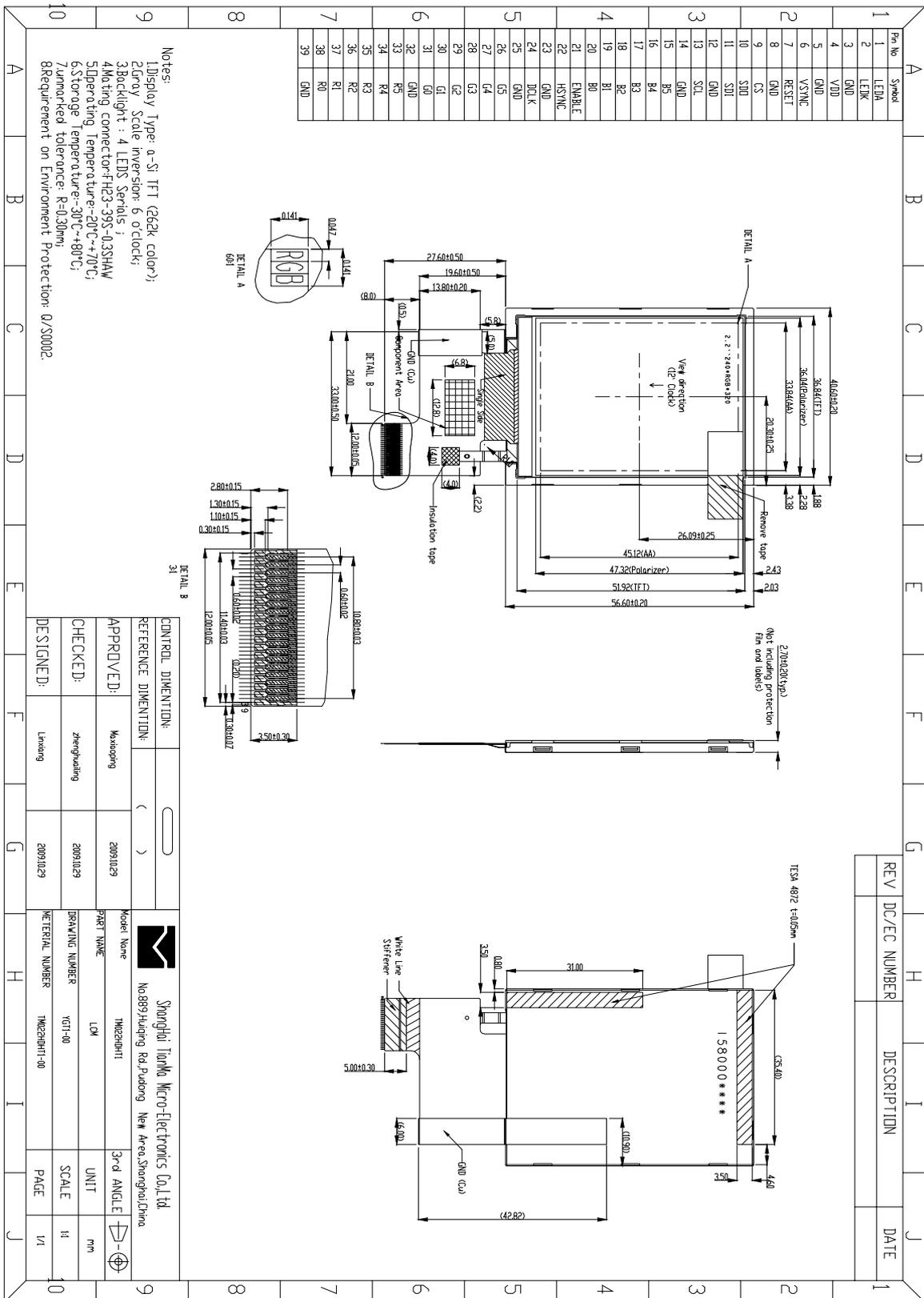
## 7 Environmental / Reliability tests

| No | Test Item | Condition | Remarks |
|----|-----------|-----------|---------|
| 1 | High Temperature Operation | Ts=+70℃, 240hrs | Note1<br>IEC60068-2-2,GB2423.2—89 |
| 2 | Low Temperature Operation | Ta=-20℃, 240hrs | IEC60068-2-1<br>GB2423.1—89 |
| 3 | High Temperature Storage | Ta=+80℃, 240hrs | IEC60068-2-2,<br>GB2423.2—89 |
| 4 | Low Temperature Storage | Ta=-30℃, 240hrs | IEC60068-2-1<br>GB2423.1—89 |
| 5 | High Temperature & High Humidity Storage | +60℃, 90% RH max,240 hours | Note2<br>IEC60068-2-3,<br>GB/T2423.3—2006 |
| 6 | Thermal Shock (Non-operation) | -30℃ 30 min~+80℃ 30 min, Change time:5min, 20 Cycle | Start with cold temperature, End with high temperature, IEC60068-2-14,GB2423.22—87 |
| 7 | Electro Static Discharge (Operation) | C=150pF, R=330Ω，5points/panel<br>Air:± 8KV, 5times;<br>Contact:± 4KV, 5 times;<br>（Environment: 15℃～35℃,<br>30%～60%, 86Kpa～106Kpa） | IEC61000-4-2<br>GB/T17626.2—1998 |
| 8 | Vibration (Non-operation) | Frequency range:10~55Hz,<br>Stroke:1.5mm<br>Sweep:10Hz~55Hz~10Hz 1 hours<br>for each direction of X.Y.Z.(3 hours for total) | IEC60068-2-6<br>GB/T2423.10—1995 |
| 9 | Shock (Non-operation) | 60G 6ms, ± X,± Y,± Z 3times for each direction | IEC60068-2-27<br>GB/T2423.5—1995 |
| 10 | Package Drop Test | Height:80 cm，1 corner, 3 edges, 6 surfaces | IEC60068-2-32<br>GB/T2423.8—1995 |

Note1: Ts is the temperature of panel's surface.

Note2: Ta is the ambient temperature of sample.

# 8 Mechanical drawing

**Notes:**
1. Display Type: a-Si TFT (262k color);
2. Gray Scale inversion: 6 o'clock;
3. Backlight : 4 LEDs Serials；
4. Mating connector:FH23-39S-0.3SHAW
5. Operating Temperature:-20℃~+70℃；
6. Storage Temperature:-30℃~+80℃；
7. unmarked tolerance: R=0.30mm;
8. Requirement on Environment Protection: 0/S0002.

Pin table:

| Pin No | Symbol |
|---|---|
| 1 | LEDA |
| 2 | LEDK |
| 3 | GND |
| 4 | VDD |
| 5 | GND |
| 6 | VSYNC |
| 7 | RESET |
| 8 | GND |
| 9 | CS |
| 10 | SDO |
| 11 | SDI |
| 12 | SCL |
| 13 | GND |
| 14 | GND |
| 15 | B5 |
| 16 | B4 |
| 17 | B3 |
| 18 | B2 |
| 19 | B1 |
| 20 | B0 |
| 21 | ENABLE |
| 22 | HSYNC |
| 23 | GND |
| 24 | DCLK |
| 25 | GND |
| 26 | G5 |
| 27 | G4 |
| 28 | G3 |
| 29 | G2 |
| 30 | G1 |
| 31 | G0 |
| 32 | GND |
| 33 | R5 |
| 34 | R4 |
| 35 | R3 |
| 36 | R2 |
| 37 | R1 |
| 38 | R0 |
| 39 | GND |

Title block:

Shanghai TianMa Micro-Electronics Co.,Ltd.
No.889,Huiqing Rd,Pudong New Area,Shanghai,China

| | |
|---|---|
| Model Name | TM022HDHT1 |
| PART NAME | LCM |
| DRAWING NUMBER | YGTT-00 |
| METERIAL NUMBER | TM022HDHT1-00 |
| DESIGNED: | Linxiang 2009.10.29 |
| CHECKED: | zhenghualing 2009.10.29 |
| APPROVED: | Moxiaoping 2009.10.29 |
| REFERENCE DIMENTION: | |
| CONTROL DIMENTION: | |

3rd ANGLE
UNIT: mm
SCALE: 1:1
PAGE: 1/1

| REV | DC/EC NUMBER | DESCRIPTION | DATE |
|---|---|---|---|

## 9  Packing drawing(TBD)

# 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

- Ketone

- 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.