MODEL NO. : __TM028HDH02__

ISSUED DATE: __2009-04-23__

VERSION : __Ver 2.1__

□ **Preliminary Specification**
■ **Final Product Specification**

Customer :_____

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

SHANGHAI TIANMA Confirmed :

| prepared by | Checked by | Approved by |
|---|---|---|
| 宋艳 2009.04.23 | | |
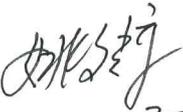
This technical specification is subjected to change without notice

# Table of Contents

# Record of Revision

| Rev | Issued Date | Description | |
|-----|-------------|-------------|---|
| 1.0 | 2008-07-24 | Rev 1.0 was issued | Xu Yun |
| 2.0 | 2009-03-17 | Final Specification | Gao Ming |
| 2.1 | 2009-04-23 | Modify the Chromaticity | Yan Song |
| | | | |
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## 1   General Specifications

| Feature | | Spec |
|---|---|---|
| **Display Spec.** | Size | 2.83 inch |
| | Resolution | 240(RGB) X 320 |
| | Interface | CPU |
| | Color Depth | 262K |
| | Technology Type | a-Si TFT |
| | Pixel Pitch (mm) | 0.180x0.180 |
| | Pixel Configuration | R.G.B. Vertical Stripe |
| | Display Mode | TM with Normally White |
| | Surface Treatment(Up Polarizer) | Clear Type (3H) |
| | Viewing Direction | 6 o'clock |
| | Gray Scale Inversion Direction | 12 o'clock |
| **Mechanical Characteristics** | LCM (W x H x D) (mm) | 50.0x70.0x2.15 |
| | Active Area(mm) | 43.2 x 57.6 |
| | With /Without TSP | Without TSP |
| | Weight（gram） | 15.28 |
| | LED Numbers | 5 LEDs |
| **Electronic** | Driver IC | ILI9325 |

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: RoHS

Note 3: LCD weight tolerance: $\pm$0.5%

## 2 Input/Output Terminals

2.1 TFT LCD Panel

| No | Symbol | I/O | Description | | | | | Remarks |
|----|--------|-----|-------------|---|---|---|---|---------|
| 1 | GND | P | Ground | | | | | |
| 2 | GND | P | Ground | | | | | |
| 3 | ID (IOVCC) | - | Identify pin or IOVCC | | | | | |
| 4 | IM0 | I | IM3 | IM0 | Interface mode | | DB Pin | |
| 5 | IM3 | I | 0 | 1 | 80-system 8-bit interface | | DB17-10 | |
| | | | 0 | 0 | 80-system 16-bit interface | | DB17-10 DB8-DB1 | |
| | | | 1 | 1 | 80-system 9-bit interface | | DB17-DB9 | |
| | | | 1 | 0 | 80-system 18-bit interface | | DB17-DB0 | |
| 6 | RESET | I | A RESET signal | | | | | |
| 7 | DB17 | I | Data input | | | | | |
| 8 | DB16 | I | Data input | | | | | |
| 9 | DB15 | I | Data input | | | | | |
| 10 | DB14 | I | Data input | | | | | |
| 11 | DB13 | I | Data input | | | | | |
| 12 | DB12 | I | Data input | | | | | |
| 13 | DB11 | I | Data input | | | | | |
| 14 | DB10 | I | Data input | | | | | |
| 15 | DB9 | I | Data input | | | | | |
| 16 | DB8 | I | Data input | | | | | |
| 17 | DB7 | I | Data input | | | | | |
| 18 | DB6 | I | Data input | | | | | |
| 19 | DB5 | I | Data input | | | | | |
| 20 | DB4 | I | Data input | | | | | |
| 21 | DB3 | I | Data input | | | | | |
| 22 | DB2 | I | Data input | | | | | |
| 23 | DB1 | I | Data input | | | | | |
| 24 | DB0 | I | Data input | | | | | |
| 25 | RD | I | A read strobe signal and actives when the signal is low | | | | | |
| 26 | WR | I | A write strobe signal and actives when the signal is low | | | | | |
| 27 | RS | I | A register select signal | | | | | |
| 28 | CS | I | A chip select signal | | | | | |
| 29 | IOVCC | P | Power Supply of Digital Circuit | | | | | |
| 30 | IOVCC | P | Power Supply of Digital Circuit | | | | | |
| 31 | VCC | P | Power Supply of Analog Circuit | | | | | |
| 32 | VCC | P | Power Supply of Analog Circuit | | | | | |
| 33 | NC | - | Not Connect | | | | | |
| 34 | AN | I | LED anode | | | | | |
| 35 | CA | I | LED cathode | | | | | Note 2-2 |

| 36 | VSYNC | I | Frame synchronous signal | |
|----|-------|---|--------------------------|--|
| 37 | FMARK | I | Frame head pulse signal | |
| 38 | NC | - | Not Connect | |
| 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.
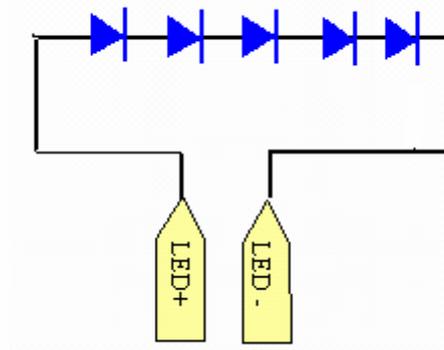
# 3  Absolute Maximum Ratings

## 3.1  Driving TFT LCD Panel

Ta = 25$^o$C

| Item | Symbol | MIN | MAX | Unit | Remark |
|------|--------|-----|-----|------|--------|
| Logic Supply Voltage | IOVCC | -0.3 | 4.6 | V | |
| Analog Supply Voltage | VCC | -0.3 | 4.6 | V | |
| Input Signal Voltage | | -0.3 | VCC +0.3 | V | |
| Touch Panel Pin Voltage | $V_{TP}$ | -- | 7 | V | |
| Back Light Forward Current | $I_{LED}$ | -- | 25 | mA | For each LED |
| Operating Temperature | $T_{OPR}$ | -20 | 70 | ℃ | |
| Storage Temperature | $T_{STG}$ | -30 | 80 | ℃ | |

## 4  Electrical Characteristics

4.1   Driving TFT LCD Panel

GND=0V, Ta=25℃

| Item | | Symbol | MIN | TYP | MAX | Unit | Remark |
|---|---|---|---|---|---|---|---|
| Logic Supply Voltage | | IOVCC | 1.65 | 1.8 | 3.3 | V | |
| Analog Supply Voltage | | VCC | 2.5 | 2.8 | 3.3 | V | |
| Input Signal Voltage | Low Level | $V_{IL}$ | -0.3 | -- | 0.2xVCC | V | |
| | High Level | $V_{IH}$ | 0.8xVCC | -- | VCC | V | |
| Output Signal Voltage | Low Level | $V_{OL}$ | -- | -- | 0.2xVCC | V | |
| | High Level | $V_{OH}$ | 0.8xVCC | -- | -- | V | |
| (Panel+ LSI) Power Consumption | Black Mode (60Hz) | -- | 20 | 25 | mW | | |
| | Standby Mode | -- | 100 | -- | μ W | | |
| | Sleeping Mode | -- | 200 | -- | μ W | | |

4.2   Driving Backlight   Ta=25℃

| Item | Symbol | MIN | TYP | MAX | Unit | Remark |
|---|---|---|---|---|---|---|
| Forward Current | $I_F$ | -- | 20 | -- | mA | |
| Forward Voltage | $V_F$ | -- | 16 | -- | V | |
| Power Consumption | $W_{BL}$ | -- | 320 | -- | mW | 5 LEDs |

## 4.3  Block Diagram

**LCD PANEL**

**LCD Driver Chip (COG)**

RAM

VCOM& TCON

**2.83 inch 240 (RGB) X320**

Source+ Gate Driver

Grayscale Manipulation Voltage

DC/DC

DB0~DB17

CS, RS

WR, RD, RESET

Data Bus

CPU I/F

VCC
IOVCC
GND

FPC

BLU

AN, CA
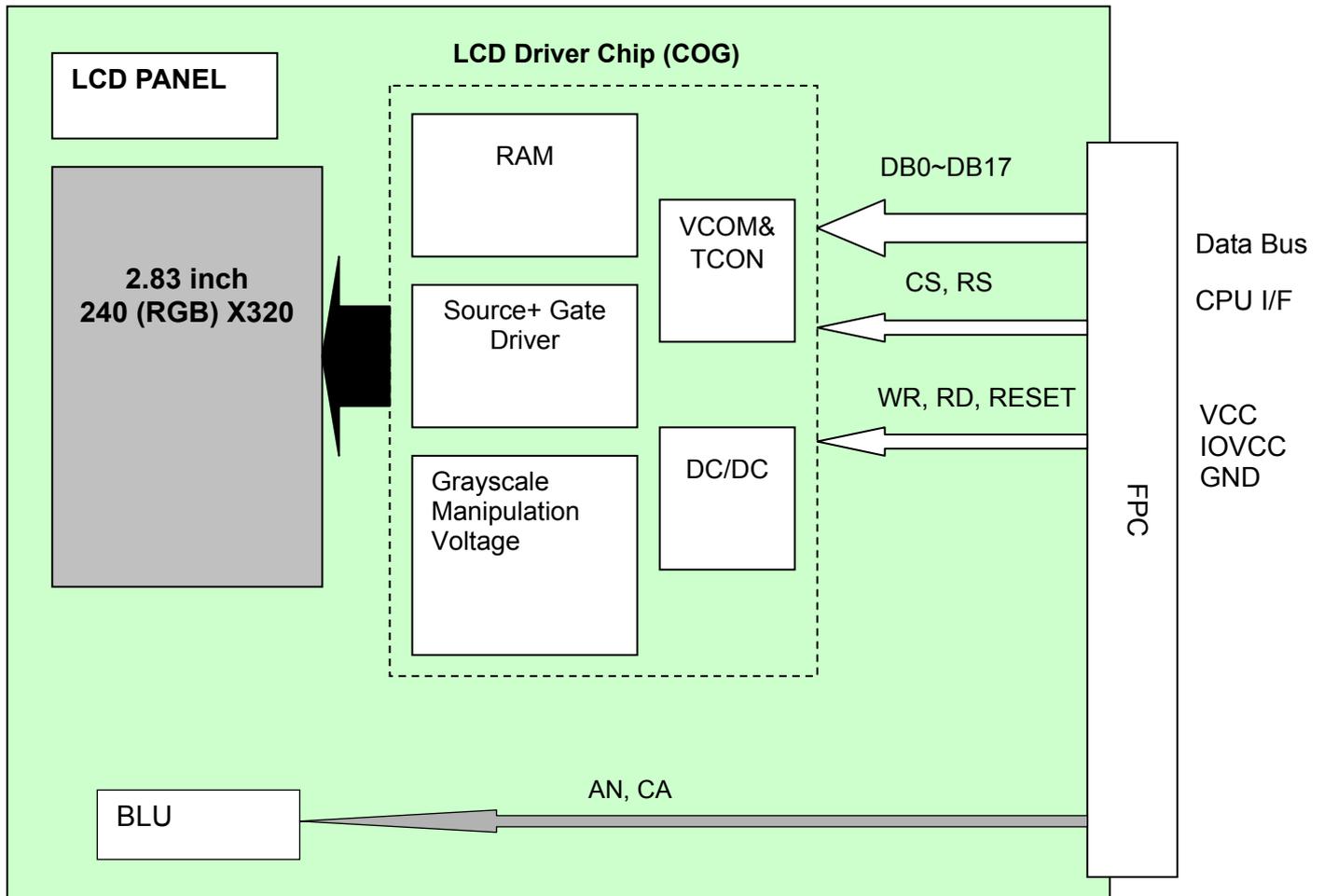
# 5 Timing Chart

### 5.1 Timing Parameter

| Item | | Symbol | Unit | Min | Typ | Max |
|---|---|---|---|---|---|---|
| Bus cycle time | Write | $t_{CYCW}$ | ns | 100 | - | - |
| | Read | $t_{CYCR}$ | ns | 300 | - | - |
| Write low-level pulse width | | $PW_{LW}$ | ns | 50 | - | 500 |
| Write high-level pulse width | | $PW_{HW}$ | ns | 50 | - | - |
| Read low-level pulse width | | $PW_{LR}$ | ns | 150 | - | - |
| Read high-level pulse width | | $PW_{HR}$ | ns | 150 | - | - |
| Write / Read rise / fall time | | $t_{WRr}$ / $t_{WRf}$ | ns | - | - | 25 |
| Setup time | Write ( RS to /CS, /WR ) | $t_{AS}$ | ns | 10 | - | - |
| | Read ( RS to /CS, /RD ) | | | 5 | - | - |
| Address hold time | | $t_{AH}$ | ns | 5 | - | - |
| Write data set up time | | $t_{DSW}$ | ns | 10 | - | - |
| Write data hold time | | $t_{H}$ | ns | 15 | - | - |
| Read data delay time | | $t_{DDR}$ | ns | - | - | 100 |
| Read data hold time | | $t_{DHR}$ | ns | 5 | - | - |

**Table 5.1 timing parameter**
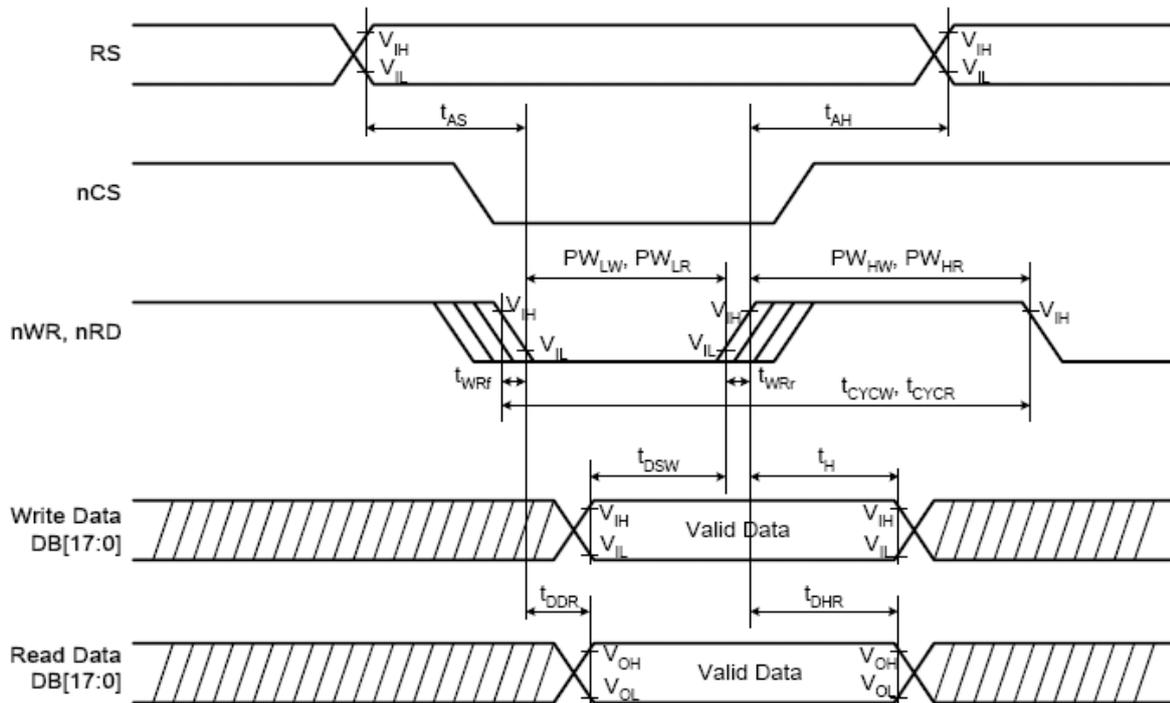


**Figure 5.1 i80 System Bus Timing**

5.2 Register write/read timing in I80 series system

**a. Write to register**

nCS

RS

nRD

nWR

DB[17:0]    Write register "index"    Write register "data"

**b. Read from register**

nCS

RS

nRD

nWR

DB[17:10]    "00h"    Write register "index"    Write register "high byte data"    Write register "low byte data"
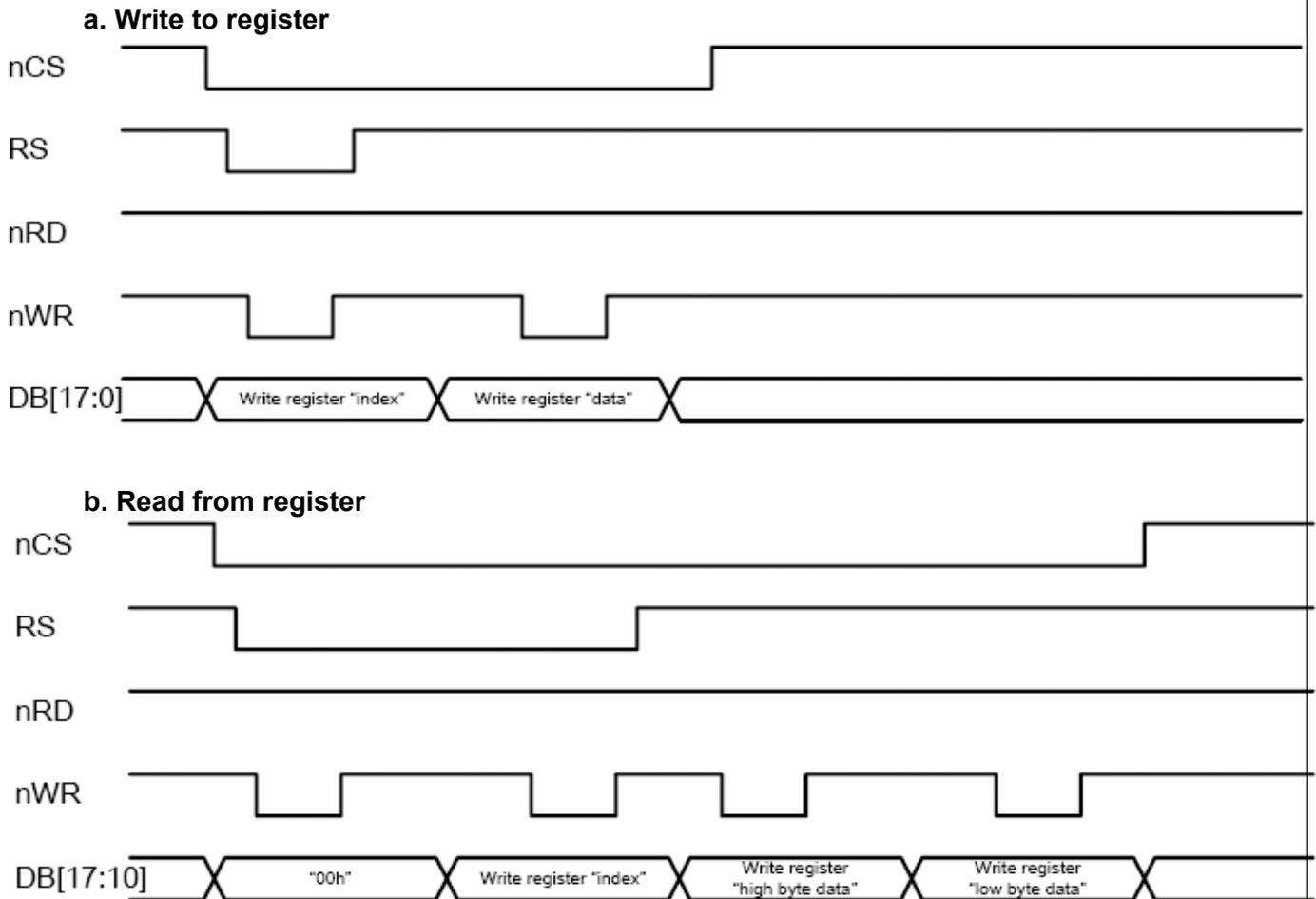
**Figure 5.2 i80 18-bit System Bus Interface Timing**

5.3 GRAM write/read timing in I80 series system



**Table 5.3.1 GRAM Data and display data of 16- bit system interface**



**Table 5.3.2 GRAM Data and display data of 8- bit system interface**
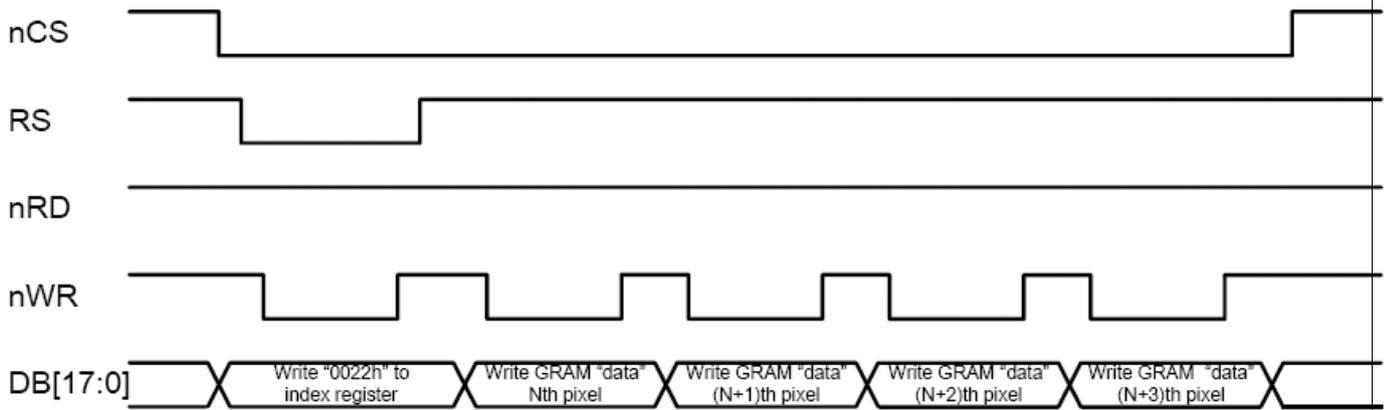
**GRAM Write Timing**



**Figure 5.3.3 GRAM Read/Write Timing of i80 18/16-bit System Interface**
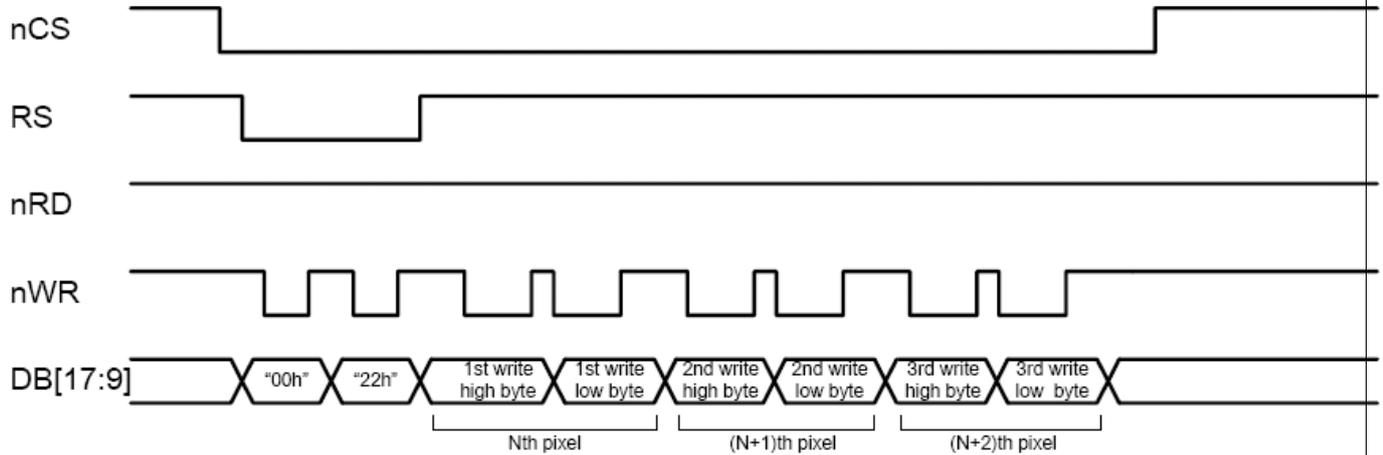


**Figure 5.3.4 GRAM Read/Write Timing of i80 9/8-bit System Interface**

5.4 Power On/Off sequence

5.4.1 Power on Sequence
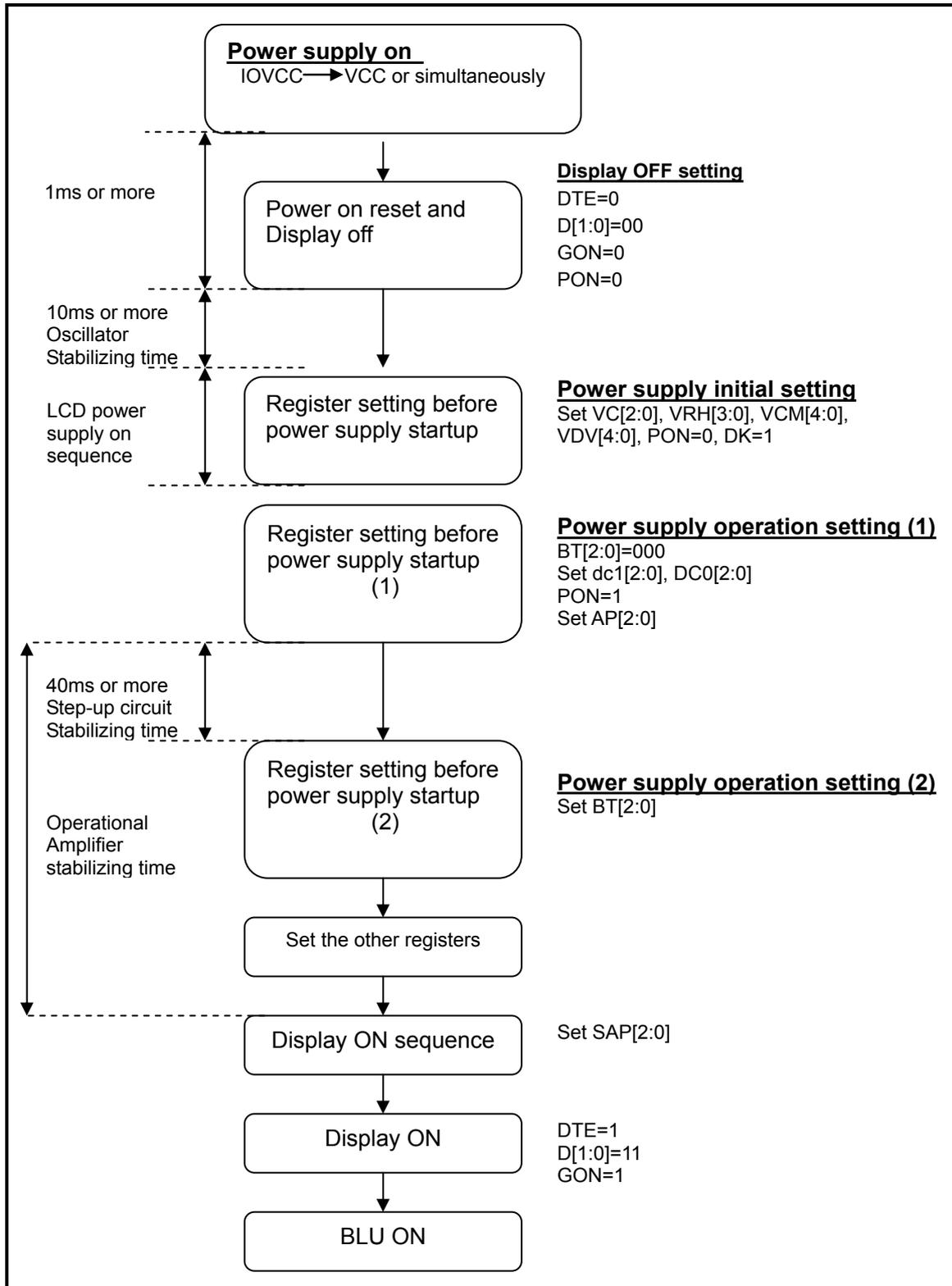
```
                    ┌─────────────────────────────┐
                    │  Power supply on            │
                    │  IOVCC ──► VCC or           │
                    │  simultaneously             │
                    └─────────────────────────────┘
                                   │
1ms or more                        ▼
                    ┌─────────────────────────┐   Display OFF setting
                    │  Power on reset and     │   DTE=0
                    │  Display off            │   D[1:0]=00
                    │                         │   GON=0
                    └─────────────────────────┘   PON=0
10ms or more
Oscillator                         │
Stabilizing time                   ▼
                    ┌─────────────────────────┐   Power supply initial setting
LCD power           │  Register setting before│   Set VC[2:0], VRH[3:0], VCM[4:0],
supply on           │  power supply startup   │   VDV[4:0], PON=0, DK=1
sequence            └─────────────────────────┘
                                   │
                                   ▼
                    ┌─────────────────────────┐   Power supply operation setting (1)
                    │  Register setting before│   BT[2:0]=000
                    │  power supply startup   │   Set dc1[2:0], DC0[2:0]
                    │           (1)           │   PON=1
                    └─────────────────────────┘   Set AP[2:0]
40ms or more                       │
Step-up circuit                    ▼
Stabilizing time    ┌─────────────────────────┐   Power supply operation setting (2)
                    │  Register setting before│   Set BT[2:0]
Operational         │  power supply startup   │
Amplifier           │           (2)           │
stabilizing time    └─────────────────────────┘
                                   │
                                   ▼
                    ┌─────────────────────────┐
                    │  Set the other registers│
                    └─────────────────────────┘
                                   │
                                   ▼
                    ┌─────────────────────────┐   Set SAP[2:0]
                    │  Display ON sequence    │
                    └─────────────────────────┘
                                   │
                                   ▼
                    ┌─────────────────────────┐   DTE=1
                    │  Display ON             │   D[1:0]=11
                    │                         │   GON=1
                    └─────────────────────────┘
                                   │
                                   ▼
                    ┌─────────────────────────┐
                    │  BLU ON                 │
                    └─────────────────────────┘
```

5.4.2   Power off Sequence

```
          ┌─────────────────────┐     Display ON setting
          │   Normal Display    │     DTE=1
          └─────────────────────┘     D[1:0]=11
                     │                 GON=1
                     ▼
          ┌─────────────────────┐
          │      BLU OFF        │
          └─────────────────────┘
                     │
                     ▼
          ┌─────────────────────┐
          │   Display OFF       │
          │   Sequence          │
          └─────────────────────┘
                     │
                     ▼
          ┌─────────────────────┐
          │   Display OFF       │
          └─────────────────────┘
                     │
                     ▼
          ┌─────────────────────┐     SAP[2:0]=000
          │   Power Supply      │     AP[2:0]=000
          │   Halt Setting      │     PON=0
          └─────────────────────┘
                     │
                     ▼
          ┌─────────────────────┐
          │  Power Supply OFF   │
          │ IOVCC──►VCC or simultaneously │
          └─────────────────────┘
```
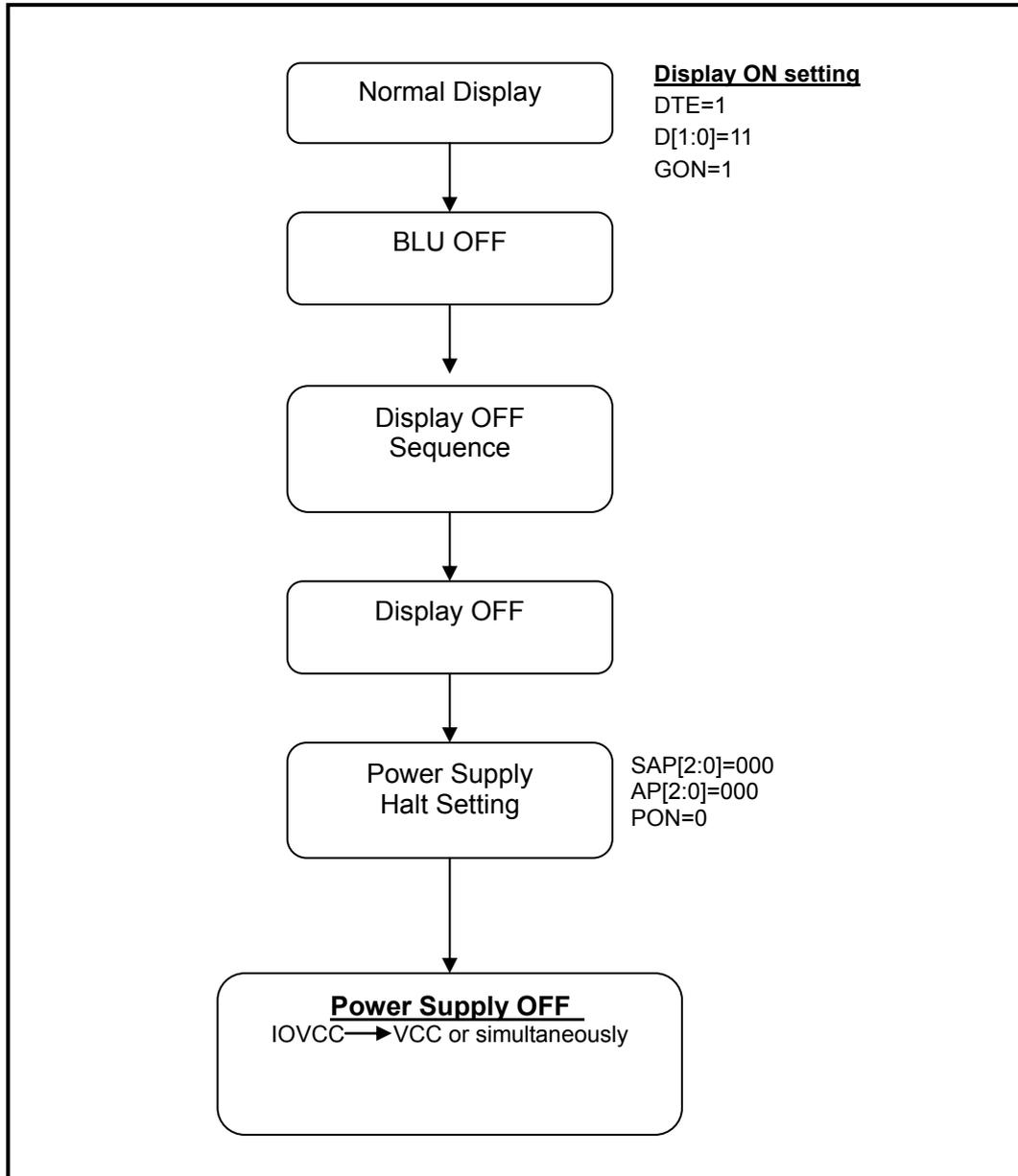
## 6    Optical Characteristics

6.1 Optical Specification

Ta=25℃

| Item | | Symbol | Condition | Min | Typ. | Max. | Unit | Remark |
|---|---|---|---|---|---|---|---|---|
| View Angles | | θT | CR≧10 | 55 | 60 | - | Degree | Note 2 |
| | | θB | | 50 | 55 | - | | |
| | | θL | | 55 | 60 | - | | |
| | | θR | | 55 | 60 | - | | |
| Contrast Ratio | | CR | θ=0° | 200 | 400 | - | | Note1 Note3 |
| Response Time | | Ton | 25℃ | - | 25 | 40 | ms | Note1 Note4 |
| | | Toff | | | | | | |
| Chromaticity | White | x | Backlight is on | 0.240 | 0.290 | 0.340 | | Note5, Note1 |
| | | y | | 0.260 | 0.310 | 0.360 | | |
| | RED | x | | 0.541 | 0.591 | 0.641 | | |
| | | y | | 0.269 | 0.319 | 0.369 | | |
| | GREEN | x | | 0.281 | 0.331 | 0.381 | | |
| | | y | | 0.535 | 0.585 | 0.635 | | |
| | BLUE | x | | 0.093 | 0.143 | 0.193 | | |
| | | y | | 0.048 | 0.098 | 0.148 | | |
| Uniformity | | U | | 75 | 80 | - | % | Note1 Note6 |
| NTSC | | | | - | 55 | - | % | Note 5 |
| Luminance | | L | | 200 | 300 | - | cd/m$^2$ | Note1 Note7 |

Test Conditions:

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

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

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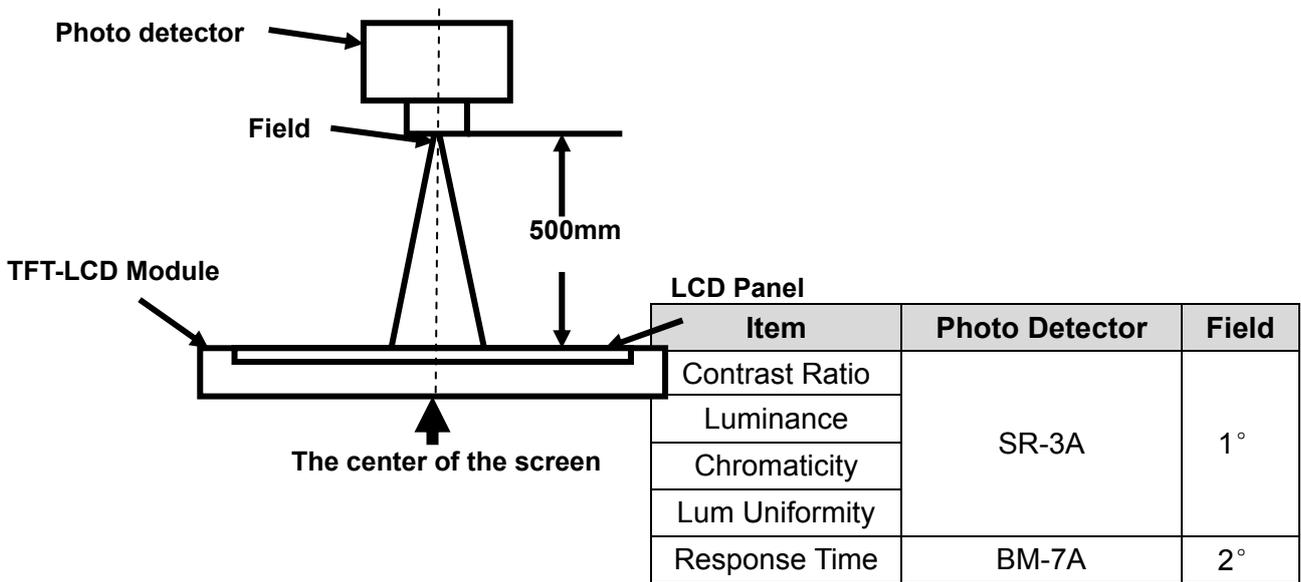
Note 2: Definition of viewing angle range and measurement system.

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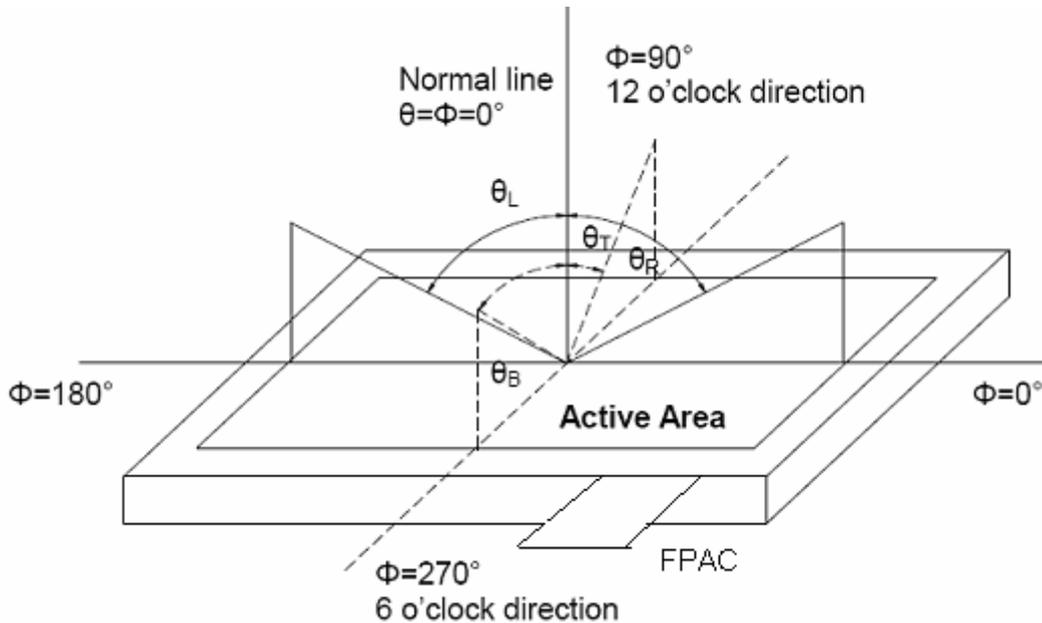


Fig. 1 Definition of viewing angle

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%.
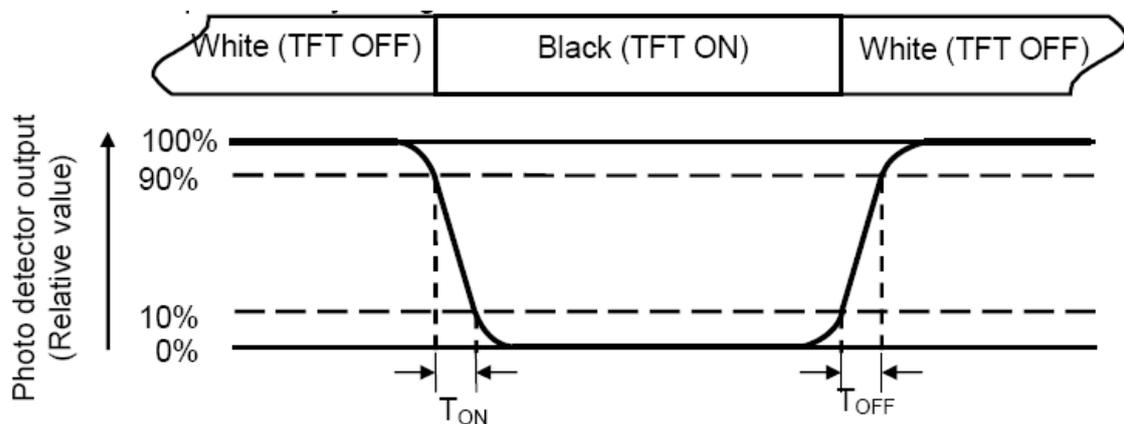


Note 5: Definition of color chromaticity (CIE1931)

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
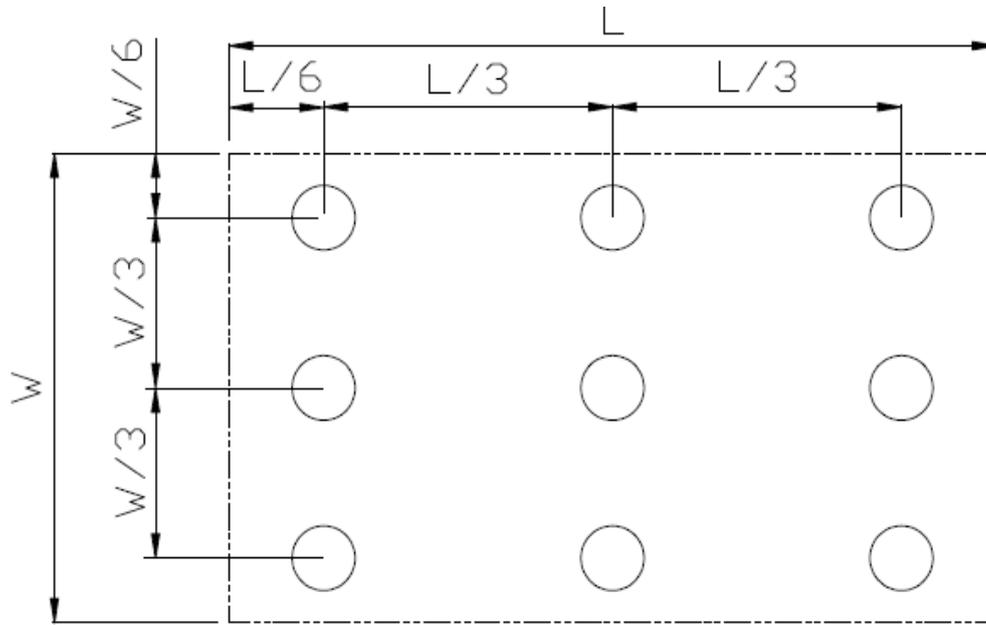


Fig. 2 Definition of uniformity

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.

# 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 | Ta=+60℃, 90% RH<br>240 hours | Note2<br>IEC60068-2-3,<br>GB/T2423.3—2006 |
| 6 | Thermal Shock (Non-operation) | -30℃ 30 min~+80℃ 30 min,<br>Change time:5min, 20 Cycles | Start with cold temperature,<br>End with high temperature,<br>IEC60068-2-14,GB2423.22—87 |
| 7 | Electro Static Discharge (Operation) | C=150pF, R=330Ω，5points/panel<br>Air:± 15KV, 5times;<br>Contact:± 8KV, 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 2 hours<br>for each direction of X.Y.Z.<br>(6 hours for total)(Package condition) | IEC60068-2-6<br>GB/T2423.10—1995 |
| 9 | Shock (Non-operation) | 60G 6ms, ±X,± Y,± Z 3times,<br>for each direction | IEC60068-2-27<br>GB/T2423.5—1995 |
| 10 | Package Drop Test | Height:80 cm,<br>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.Viewing direction: 6:00 o'clock
3.Driver IC:ILI9325
4.VDD: 2.8V
5.Backlight : 5 LED Serial
6.General Tolerance:± 0.2

| Pin | Pin Name |
|-----|----------|
| 1 | GND |
| 2 | GND |
| 3 | ID |
| 4 | IM0 |
| 5 | IM1 |
| 6 | RESET |
| 7 | IM3 |
| 8 | DB17 |
| 9 | DB16 |
| 10 | DB15 |
| 11 | DB13 |
| 12 | DB12 |
| 13 | DB11 |
| 14 | DB10 |
| 15 | DB9 |
| 16 | DB8 |
| 17 | DB7 |
| 18 | DB5 |
| 19 | DB6 |
| 20 | DB4 |
| 21 | DB3 |
| 22 | DB2 |
| 23 | DB1 |
| 24 | DB0 |
| 25 | RD |
| 26 | WR |
| 27 | RS |
| 28 | CS |
| 29 | VDDI/O |
| 30 | VDDI/O |
| 31 | Vcc |
| 32 | Vcc |
| 33 | NC |
| 34 | AN |
| 35 | CA |
| 36 | VSYNC |
| 37 | FLM |
| 38 | NC |
| 39 | GND |

240(RGB)X320 DOTS

VIEWING DIRECTION

70.00 ±0.2
60.60
57.60 (A/A)
1.70 ±0.3
3.20 ±0.3
1.90 ±0.3
3.40 ±0.3
50.00 ±0.2
46.20
43.20 (A/A)
0.2±0.03
2-1.0
2-0.5
2-2.0
2.35 ±0.3
2.65 ±0.3
4.00 ±0.5
2.15 ±0.15

Connector NO.
FH26-39S-0.3SHW
9.00 ±0.3
2-5.65 ±0.3
2.50 ±0.3
0.30
44.43 ±0.3
12.0 ±0.05
39
2-1.0
(3.0)

| | | |
|--|--|--|
| CONTROL DIMENTION: | | |
| REFERENCE DIMENTION: | ( ) | |
| APPROVED: | Yao Wenhui 2009.03.17 | |
| CHECKED: | Lei Peng 2009.03.17 | |
| DESIGNED: | Gao Ming 2009.03.17 | |

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

| MODEL NAME | TM028HDH02 | 3rd ANGLE |
| PART NAME | LCM | UNIT mm |
| DRAWING NUMBER | YGT 1-00 | SCALE 1:1 |
| METERIAL NUMBER | TM028HDH02-20 | PAGE 1/1 |

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

## 9  Packing Drawing

9.1 Packaging Material Table

| No | Item | Model (Material) | Dimensions(mm) | Unit Weight(Kg) | Quantity | Remark |
|----|------|------------------|----------------|-----------------|----------|--------|
| 1 | LCM module | TM028HDH02-20 | 50x70x2.15 | 0.0153 | 360 | |
| 2 | Tray | PET(Transmit) | 315x247x11.8 | 0.082 | 36 | Anti-static |
| 3 | EPE | EPE | 315x247x5 | 0.009 | 12 | |
| 4 | DUST-PROOF Bag | PE | 700x545 | 0.046 | 1 | |
| 5 | Box | Corrugated Paper | 345x260x70 | 0.227 | 6 | |
| 6 | Carton | Corrugated Paper | 544x365x250 | 1.01 | 1 | |
| 7 | DUST-PROOF Bag | PE | 440x327 | 0.021 | 6 | |
| 8 | Total Weight(Kg) | 11.112 | | | | |

## 9.2 Packaging Drawing

Use empty tray
+
Put products into the trays

A

Use package bag
料号：1680001930

dust-proof bag

Use strop

EPE
+
dust-proof bag
+
EPE

Box

6 Box

Detail A

Tray 4
Tray 3
Tray 2
Tray 1

Rotate tray 180 degrees and place on top of stack.
Check the tray using Fig.A

Use the tape to seal Carton

Put into Cartion

Use strop

Use package bag
料号：1680000520

dust-proof bag

# 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.