深圳市拓普微科技开发有限公司
SHENZHEN TOPWAY TECHNOLOGY CO.,LTD.

# LMT092DNPFWD

## LCD Module User Manual

| Prepared by: | Checked by: | Approved by: |
|---|---|---|
| **Sun Ouyang** | | |
| Date: 2016-12-26 | Date: | Date: |

| Rev. | Descriptions | Release Date |
|---|---|---|
| 0.1 | New release | 2016-12-26 |
| | | |
| | | |
| | | |
| | | |

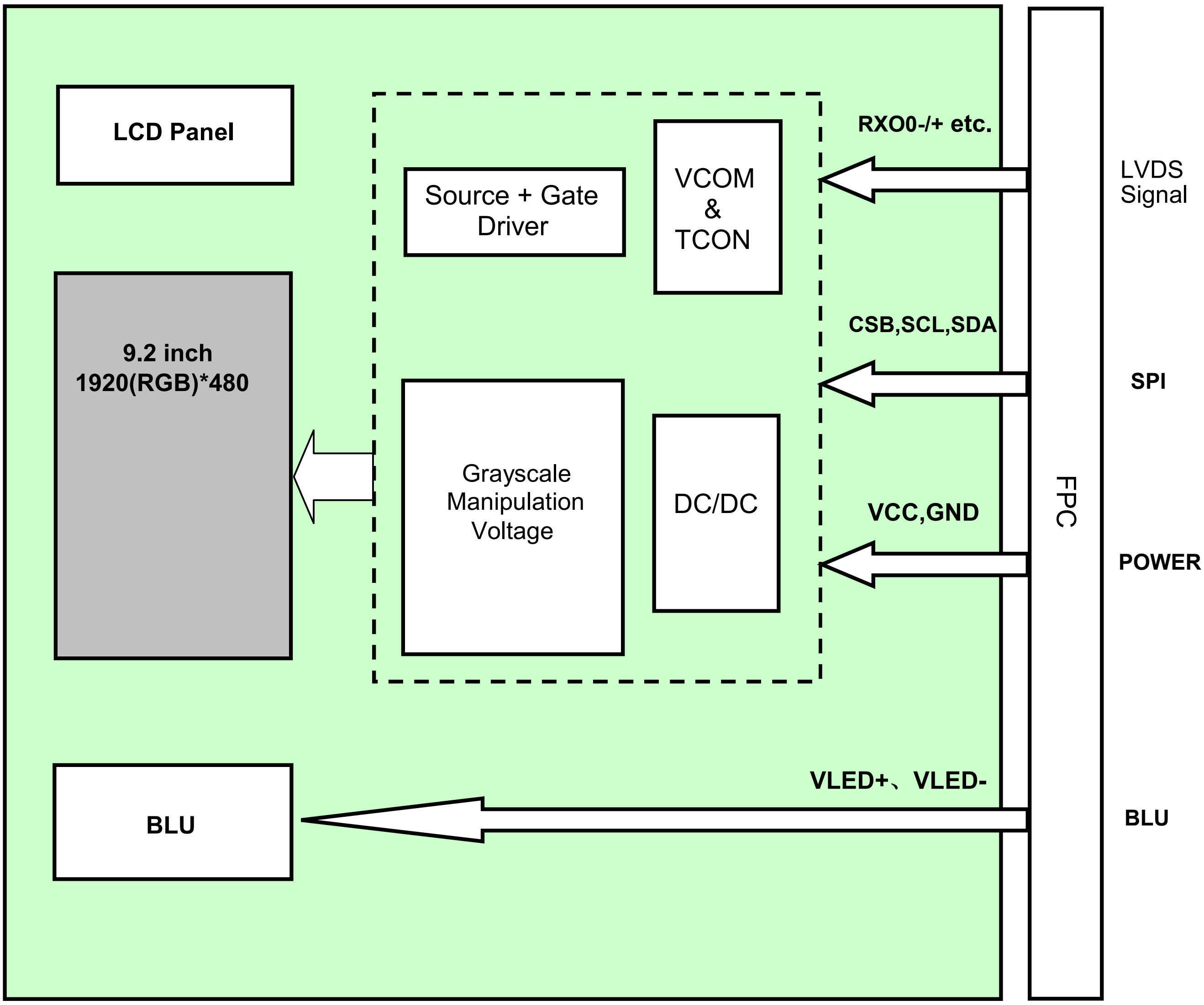
# Table of Content

# 1. General Specification

| | |
|---|---|
| Signal Interface : | LVDS (VESA standard, 24bit) + SPI(3-wire) |
| Display Mode : | Transmissive with Normally White |
| Screen Size : | 9.2 inch |
| Outline Dimension : | 237 x 72.3 x 5.8 (mm)<br>(see outline drawing for details) |
| Active Area : | 226.944 x 56.736 (mm) |
| Number of dots : | 1920x 3 (RGB) x 480 |
| Dot Pitch : | 0.1182×0.1182 (mm) |
| Pixel Configuration : | R.G.B. Vertical Stripe |
| Backlight : | White LED |
| Viewing Direction : | 12 o'clock ( Gray scale Inversion ) (*1)<br>6 o'clock (*2) |
| Operating Temperature : | -30 ~ +85°C |
| Storage Temperature : | -40 ~ +95°C |

Note:
*1. For saturated color display content (eg. pure-red, pure-green, pure-blue or pure-colors -combinations).
*2. For "color scales" display content.
*3. Color tone may slightly change by temperature and driving condition.

# 2. Block Diagram



# 3. Terminal Function

## 3.1 CN1 pin assignment(LVDS interface)

**FPC down Connector type: FH52E-40S-0.5SH**

| Pin | Symbol | I/O | Description | Remark |
|---|---|---|---|---|
| 1 | GND | P | Ground | |
| 2 | GND | P | Ground | |
| 3 | RXO0- | I | Negative LVDS differential data input. Channel O0 (odd) | |
| 4 | RXO0+ | I | Positive LVDS differential data input. Channel O0 (odd) | |
| 5 | GND | P | Ground | |
| 6 | RXO1- | I | Negative LVDS differential data input. Channel O1 (odd) | |
| 7 | RXO1+ | I | Positive LVDS differential data input. Channel O1 (odd) | |
| 8 | GND | P | Ground | |
| 9 | RXO2- | I | Negative LVDS differential data input. Channel O2 (odd) | |
| 10 | RXO2+ | I | Positive LVDS differential data input. Channel O2 (odd) | |
| 11 | GND | P | Ground | |
| 12 | RXOC- | I | Negative LVDS differential clock input. (odd) | |
| 13 | RXOC+ | I | Positive LVDS differential clock input. (odd) | |
| 14 | GND | P | Ground | |
| 15 | RXO3- | I | Negative LVDS differential data input. Channel O3(odd) | |
| 16 | RXO3+ | I | Positive LVDS differential data input. Channel O3 (odd) | |
| 17 | GND | P | Ground | |
| 18 | RXE0- | I | Negative LVDS differential data input. Channel E0 (even) | |
| 19 | RXE0+ | I | Positive LVDS differential data input. Channel E0 (even) | |
| 20 | GND | P | Ground | |
| 21 | RXE1- | I | Negative LVDS differential data input. Channel E1 (even) | |
| 22 | RXE1+ | I | Positive LVDS differential data input. Channel E1 (even) | |
| 23 | GND | P | Ground | |
| 24 | RXE2- | I | Negative LVDS differential data input. Channel E2 (even) | |
| 25 | RXE2+ | I | Positive LVDS differential data input. Channel E2 (even) | |
| 26 | GND | P | Ground | |
| 27 | RXEC- | I | Negative LVDS differential clock input. (even) | |
| 28 | RXEC+ | I | Positive LVDS differential clock input. (even) | |
| 29 | GND | P | Ground | |
| 30 | RXE3- | I | Negative LVDS differential data input. Channel E3 (even) | |
| 31 | RXE3+ | I | Positive LVDS differential data input. Channel E3 (even) | |
| 32 | GND | P | Ground | |
| 33 | GND | P | Ground | |
| 34 | CSB | I | Chip select, Serial interface chip enable signal.<br>CSB=0:Selected. CSB=1: Not selected. | |
| 35 | SCL | I | SPI clock | |
| 36 | SDA | I/O | Serial interface address and data input/output. | |
| 37 | NC | - | Dummy | |
| 38 | VCC | P | Power Input | |
| 39 | VCC | P | Power Input | |
| 40 | VCC | P | Power Input | |

**I---Input, O---Output, P--- Power/Ground, “-” ---No connection**

**Table 3.1 terminal pin assignments**

### 3.2 CN2 pin assignment (Backlight interface)

**Connector type: BHSR-02VS-1**
**Mating Connector: SBHT-002T-P0.5 or equivalent**

| Pin | Symbol | I/O | Description | Remark |
|---|---|---|---|---|
| 1 | LED+(Anode) | P | LED power supply (high voltage) | |
| 2 | LED-(Cathode) | P | LED power supply (low voltage) | |

**Table 3.2 Backlight terminal pin assignments**

## 4. Absolute Maximum Ratings

GND=0V, Ta = 25℃

| Item | Symbol | MIN | MAX | Unit | Remark |
|---|---|---|---|---|---|
| Power Voltage | VCC | -0.5 | 5.0 | V | |
| Data Input voltage | $V_{IN}$ | -0.5 | 5.0 | V | Note2 |
| Backlight forward current | $I_{LED}$ | - | 100 | mA | For each LED |
| Operating Temperature | Top | -30 | 85 | ℃ | Note1 |
| Storage Temperature | Tst | -40 | 95 | ℃ | Note1 |
| Relative Humidity Note2 | RH | -- | ≤95 | % | Ta≤40℃ |
| | | -- | ≤85 | % | 40℃<Ta≤50℃ |
| | | -- | ≤55 | % | 50℃<Ta≤60℃ |
| | | -- | ≤36 | % | 60℃<Ta≤70℃ |
| | | -- | ≤24 | % | 70℃<Ta≤80℃ |
| Absolute Humidity | AH | -- | ≤70 | $g/m^3$ | Ta>70℃ |

**Table 4 absolute maximum rating**

Note1: Input voltage include R0~R5, G0~G5, B0~B5, Dotclk, Hsync, Vsync, Enable, R/L, U/D.(For your reference)

Note2: Ta means the ambient temperature.
It is necessary to limit the relative humidity to the specified temperature range.
Condensation on the module is not allowed.

# 5. Electrical Characteristics

## 5.1 Recommended Operating Condition

VCC=3.3V，GND=0V，Ta = 25℃

| Item | Symbol | Min | Typ | Max | Unit | Remark |
|---|---|---|---|---|---|---|
| Supply Voltage | VCC | 3.0 | 3.3 | 3.6 | V | |
| Power supply ripple | Vp-p | - | - | 200 | mV | |
| Power supply current | Icc | - | TBD | TBD | mA | Note1 |
| Differential input voltage | \|Vid\| | 250 | 350 | 450 | mV | |
| Differential Input threshold voltage for LVDS receiver — Low | Vtl | -100 | -- | -- | mV | Vcm=1.25V |
| Differential Input threshold voltage for LVDS receiver — High | Vth | -- | -- | +100 | mV | Vcm=1.25V |
| Common Voltage | Vcm | 1.0 | 1.25 | 1.4 | V | |
| LVDS terminal Resistance | R | -- | 100 | -- | Ω | |

**Table 5.1 LCD module electrical characteristics**

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

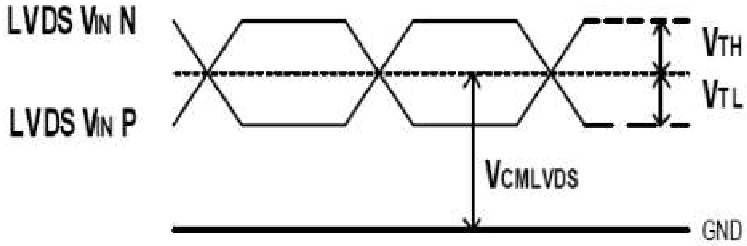



**Figure 5.1 LVDS DC timing diagram**

## 5.2 Backlight Unit Driving Condition

LED_GND=GND=0V, Ta = 25℃

| Item | Symbol | Min | Typ | Max | Unit | Remark |
|---|---|---|---|---|---|---|
| Channel1 | If | - | 360 | - | mA | Note 1 |
| Forward Voltage | Vf | - | 12 | - | V | |
| Backlight Power Consumption | Wbl | - | 4320 | - | mW | |
| Life Time | - | | 50,000 | | Hrs | Note 3 |

**Table 5.2 LED backlight characteristics**

Note 1: 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 an estimated data.

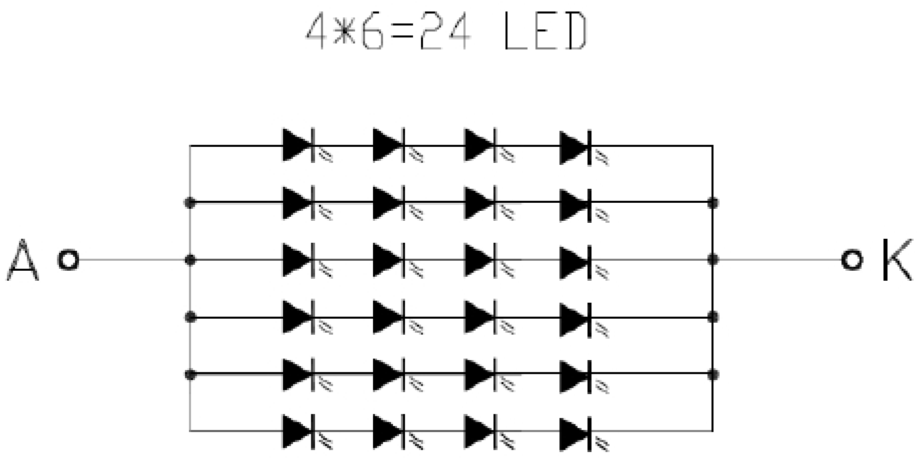



**Figure 5.2 LED connection of backlight**

# 6. Timing Chart

## 6.1 POWER ON/OFF SEQUENCE

| Item | Symbol | Min | Typ | Max | Unit | Remark |
|---|---|---|---|---|---|---|
| VCC 3.3V to signal starting | Tp1 | 5 | - | 50 | ms | |
| VCC rising time | Tr | 0.1 | - | 5 | ms | Note1 |
| Signal starting to backlight on | Tp2 | 150 | - | - | ms | |
| Signal off to VCC 0V | Tp3 | 5 | - | 50 | ms | |
| Backlight off to signal off | Tp4 | 150 | - | - | ms | |

**Table 6.1 POWER ON/OFF SEQUENCE**

**Note1: Tr means the time of input voltage rise from 10% to 90%.**

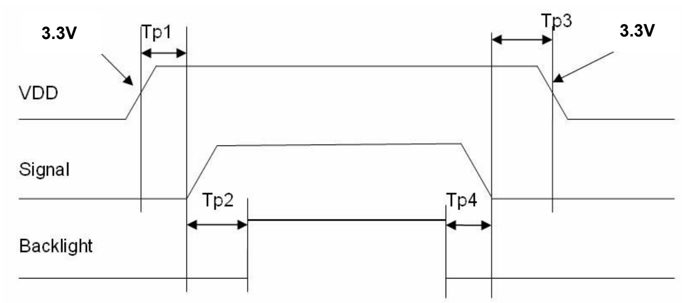



**Figure 6.1 Interface power on/off sequence**

## 6.2 Input Timing Characterustics

VCC=3.3V, GND=0V, Ta=25℃

| Parameter | | Symbol | Min | Typ | Max | Unit | Remark |
|---|---|---|---|---|---|---|---|
| DCLK(Frame rate=60HZ) | | Fclk | | 35.11 | | MHz | Tclk=1/Fclk |
| | | Tclk | | 28.5 | | ns | |
| Horizontal section | Horizontal total | Th | - | 992 | - | Tclk | |
| | Valid Data Width | Thd | - | 960 | - | Tclk | |
| | Horizontal blanking | Thb | - | 32 | - | Tclk | |
| Vertical section | Vertical total | TV | - | 590 | - | TH | |
| | Valid Data Width | Tvd | - | 480 | - | TH | |
| | Vertical blanking | Tvb | - | 110 | - | TH | |

**Table 6.2 AC characteristics**

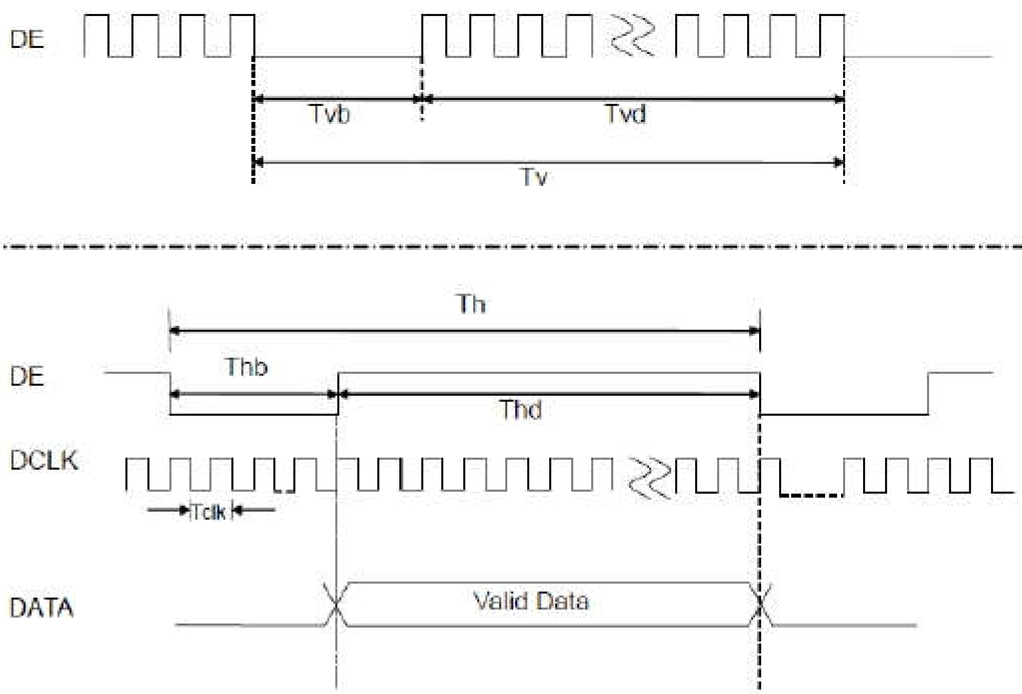



**Figure 6.2 AC characteristics**

## 6.3 LVDS input data format

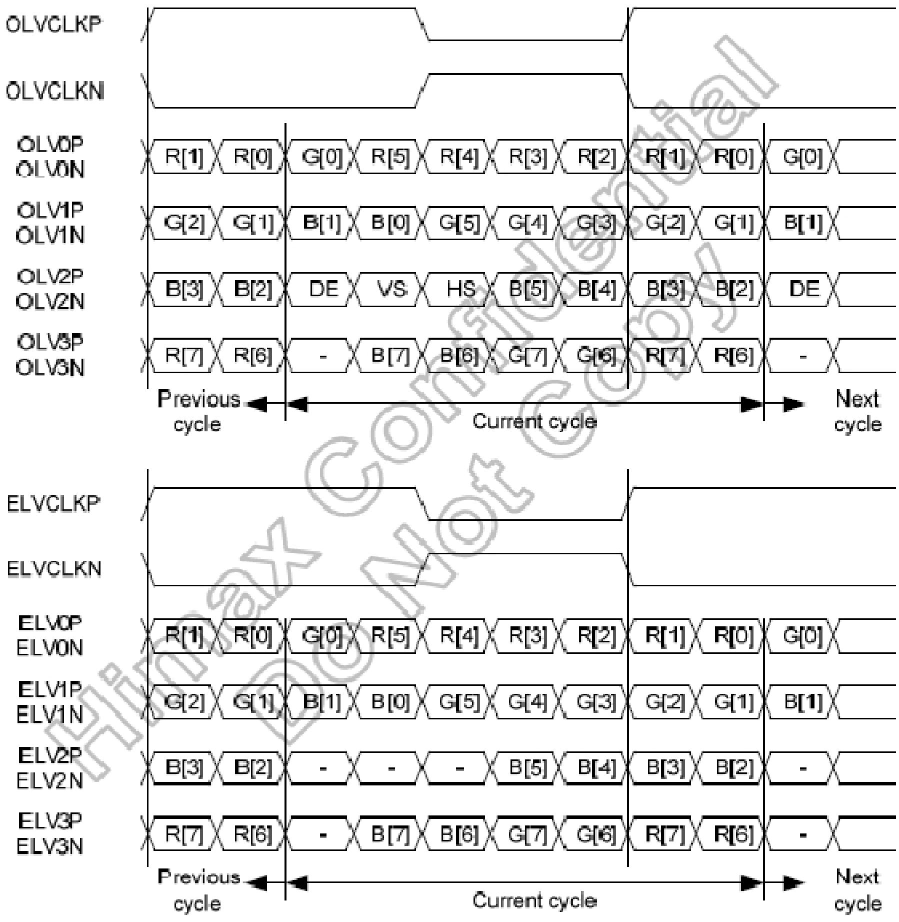



**Figure 6.3 LVDS data format (VESA standard, 24bit)**

## 6.4 SPI interface characteristics(3-WIRE)

| Parameter | Symbol | Conditions | Spec. Min. | Spec. Typ. | Spec. Max. | Unit |
|---|---|---|---|---|---|---|
| SDA Setup Time | $t_{S0}$ | CSB to SCL | 60 | - | - | ns |
| | $t_{S1}$ | SDA to SCL | 60 | - | - | ns |
| SDA Hold Time | $t_{H0}$ | CSB to SCL | 60 | - | - | ns |
| | $t_{H1}$ | SDA to SCL | 60 | - | - | ns |
| Pulse Width | $t_{W1L}$ | SCL pulse width | 75 | - | - | ns |
| | $t_{W1H}$ | SCL pulse width | 75 | - | - | ns |
| | $t_{W2}$ | CSB pulse width | 1 | - | - | µs |
| Clock duty | - | - | 40 | 50 | 60 | % |

**Table 6.4 SPI timing parameter**

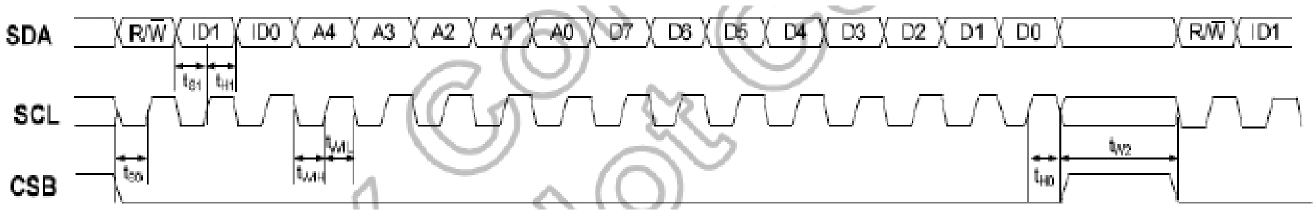



**Figure 6.4 SPI timing chart**

## 6.5 SPI Initial Code（example）

```
#ifndef  _LMT092DNPFWD_
#define  _LMT092DNPFWD_

#define  LCM_PCLK      65
#define  LCM_HACT      1920
#define  LCM_VACT      480
#define  LCM_HFP       10
#define  LCM_HBP       8
#define  LCM_HSA       8
#define  LCM_VFP       1
#define  LCM_VBP       1
#define  LCM_VSA       4
#define  LCM_NLANE     4
//MIPI Lane
#define  LCM_VDOMODE   0
//0:Pulses(no Burst)  1:Events  2:Burst
#define  LCM_MIPISPEED  420

void LCM_Init()
{
//Page0:Normal function
SPI_WriteCmd(0x0000); Delay_ms(5);
SPI_WriteCmd(0x02b0); Delay_ms(5);
 //1port,8bit
SPI_WriteCmd(0x03f1);Delay_ms(5);
//1920*1080,DOT inversion
SPI_WriteCmd(0x0480); Delay_ms(5);
SPI_WriteCmd(0x05cf);  Delay_ms(5);
SPI_WriteCmd(0x1435); Delay_ms(5);
SPI_WriteCmd(0x16c8); Delay_ms(5);
SPI_WriteCmd(0x1720); Delay_ms(5);
SPI_WriteCmd(0x1820); Delay_ms(5);
SPI_WriteCmd(0x1cb7); Delay_ms(5);
//vcom
SPI_WriteCmd(0x1ed0); Delay_ms(5);
SPI_WriteCmd(0x1f00);  Delay_ms(5);

//Page1:Positive gamma correction for red color
SPI_WriteCmd(0x0001);Delay_ms(5);
SPI_WriteCmd(0x0100);Delay_ms(5);
SPI_WriteCmd(0x0230);Delay_ms(5);
SPI_WriteCmd(0x035a);Delay_ms(5);
SPI_WriteCmd(0x047a);Delay_ms(5);
SPI_WriteCmd(0x0594);Delay_ms(5);
SPI_WriteCmd(0x06d6);Delay_ms(5);
SPI_WriteCmd(0x0715);Delay_ms(5);
SPI_WriteCmd(0x0838);Delay_ms(5);
SPI_WriteCmd(0x0974);Delay_ms(5);
SPI_WriteCmd(0x0aae);Delay_ms(5);
SPI_WriteCmd(0x0bee);Delay_ms(5);
SPI_WriteCmd(0x0c40);Delay_ms(5);
SPI_WriteCmd(0x0db8);Delay_ms(5);
SPI_WriteCmd(0x0e1c);Delay_ms(5);
SPI_WriteCmd(0x0f6c);Delay_ms(5);
SPI_WriteCmd(0x10a8);Delay_ms(5);
SPI_WriteCmd(0x11fc);Delay_ms(5);
SPI_WriteCmd(0x1200);Delay_ms(5);
SPI_WriteCmd(0x1350);Delay_ms(5);
SPI_WriteCmd(0x1495);Delay_ms(5);
SPI_WriteCmd(0x15fe);Delay_ms(5);
SPI_WriteCmd(0x1603);Delay_ms(5);

//Page2:Negative gamma correction for red color
SPI_WriteCmd(0x0002);Delay_ms(5);
SPI_WriteCmd(0x0100);Delay_ms(5);
SPI_WriteCmd(0x0230);Delay_ms(5);
SPI_WriteCmd(0x035a);Delay_ms(5);
SPI_WriteCmd(0x047a);Delay_ms(5);
SPI_WriteCmd(0x0594);Delay_ms(5);
SPI_WriteCmd(0x06d6);Delay_ms(5);
SPI_WriteCmd(0x0715);Delay_ms(5);
SPI_WriteCmd(0x0838);Delay_ms(5);
SPI_WriteCmd(0x0974);Delay_ms(5);
SPI_WriteCmd(0x0aae);Delay_ms(5);
SPI_WriteCmd(0x0bee);Delay_ms(5);
SPI_WriteCmd(0x0c40);Delay_ms(5);
SPI_WriteCmd(0x0db8);Delay_ms(5);
SPI_WriteCmd(0x0e1c);Delay_ms(5);
SPI_WriteCmd(0x0f6c);Delay_ms(5);
SPI_WriteCmd(0x10a8);Delay_ms(5);
SPI_WriteCmd(0x11fc);Delay_ms(5);
SPI_WriteCmd(0x1200);Delay_ms(5);
SPI_WriteCmd(0x1350);Delay_ms(5);
SPI_WriteCmd(0x1495);Delay_ms(5);
SPI_WriteCmd(0x15fe);Delay_ms(5);
SPI_WriteCmd(0x1603);Delay_ms(5);

//Page3:Positive gamma correction for green color
SPI_WriteCmd(0x0003);Delay_ms(5);
SPI_WriteCmd(0x0100);Delay_ms(5);
SPI_WriteCmd(0x0230);Delay_ms(5);
SPI_WriteCmd(0x035a);Delay_ms(5);
SPI_WriteCmd(0x047a);Delay_ms(5);
SPI_WriteCmd(0x0594);Delay_ms(5);
SPI_WriteCmd(0x06d6);Delay_ms(5);
SPI_WriteCmd(0x0715);Delay_ms(5);
SPI_WriteCmd(0x0838);Delay_ms(5);
SPI_WriteCmd(0x0974);Delay_ms(5);
SPI_WriteCmd(0x0aae);Delay_ms(5);
SPI_WriteCmd(0x0bee);Delay_ms(5);
SPI_WriteCmd(0x0c40);Delay_ms(5);
SPI_WriteCmd(0x0db8);Delay_ms(5);
SPI_WriteCmd(0x0e1c);Delay_ms(5);
SPI_WriteCmd(0x0f6c);Delay_ms(5);
SPI_WriteCmd(0x10a8);Delay_ms(5);
SPI_WriteCmd(0x11fc);Delay_ms(5);
SPI_WriteCmd(0x1200);Delay_ms(5);
SPI_WriteCmd(0x1350);Delay_ms(5);
SPI_WriteCmd(0x1495);Delay_ms(5);
SPI_WriteCmd(0x15fe);Delay_ms(5);
SPI_WriteCmd(0x1603);Delay_ms(5);

//Page4:Negative gamma correction for rgreen color
SPI_WriteCmd(0x0004);Delay_ms(5);
SPI_WriteCmd(0x0100);Delay_ms(5);
SPI_WriteCmd(0x0230);Delay_ms(5);
SPI_WriteCmd(0x035a);Delay_ms(5);
SPI_WriteCmd(0x047a);Delay_ms(5);
SPI_WriteCmd(0x0594);Delay_ms(5);
SPI_WriteCmd(0x06d6);Delay_ms(5);
SPI_WriteCmd(0x0715);Delay_ms(5);
SPI_WriteCmd(0x0838);Delay_ms(5);
SPI_WriteCmd(0x0974);Delay_ms(5);
SPI_WriteCmd(0x0aae);Delay_ms(5);
SPI_WriteCmd(0x0bee);Delay_ms(5);
SPI_WriteCmd(0x0c40);Delay_ms(5);
SPI_WriteCmd(0x0db8);Delay_ms(5);
SPI_WriteCmd(0x0e1c);Delay_ms(5);
SPI_WriteCmd(0x0f6c);Delay_ms(5);
SPI_WriteCmd(0x10a8);Delay_ms(5);
SPI_WriteCmd(0x11fc);Delay_ms(5);
SPI_WriteCmd(0x1200);Delay_ms(5);
SPI_WriteCmd(0x1350);Delay_ms(5);
SPI_WriteCmd(0x1495);Delay_ms(5);
SPI_WriteCmd(0x15fe);Delay_ms(5);
SPI_WriteCmd(0x1603);Delay_ms(5);

//Page5:Positive gamma correction for blue color
SPI_WriteCmd(0x0005);Delay_ms(5);
SPI_WriteCmd(0x0100);Delay_ms(5);
SPI_WriteCmd(0x0230);Delay_ms(5);
SPI_WriteCmd(0x035a);Delay_ms(5);
SPI_WriteCmd(0x047a);Delay_ms(5);
SPI_WriteCmd(0x0594);Delay_ms(5);
SPI_WriteCmd(0x06d6);Delay_ms(5);
SPI_WriteCmd(0x0715);Delay_ms(5);
SPI_WriteCmd(0x0838);Delay_ms(5);
SPI_WriteCmd(0x0974);Delay_ms(5);
SPI_WriteCmd(0x0aae);Delay_ms(5);
SPI_WriteCmd(0x0bee);Delay_ms(5);
SPI_WriteCmd(0x0c40);Delay_ms(5);
SPI_WriteCmd(0x0db8);Delay_ms(5);
SPI_WriteCmd(0x0e1c);Delay_ms(5);
SPI_WriteCmd(0x0f6c);Delay_ms(5);
SPI_WriteCmd(0x10a8);Delay_ms(5);
SPI_WriteCmd(0x11fc);Delay_ms(5);
SPI_WriteCmd(0x1200);Delay_ms(5);
SPI_WriteCmd(0x1350);Delay_ms(5);
SPI_WriteCmd(0x1495);Delay_ms(5);
SPI_WriteCmd(0x15fe);Delay_ms(5);
SPI_WriteCmd(0x1603);Delay_ms(5);

//Page6:Negative gamma correction for blue color
SPI_WriteCmd(0x0006);Delay_ms(5);
SPI_WriteCmd(0x0100);Delay_ms(5);
SPI_WriteCmd(0x0230);Delay_ms(5);
SPI_WriteCmd(0x035a);Delay_ms(5);
SPI_WriteCmd(0x047a);Delay_ms(5);
SPI_WriteCmd(0x0594);Delay_ms(5);
SPI_WriteCmd(0x06d6);Delay_ms(5);
SPI_WriteCmd(0x0715);Delay_ms(5);
SPI_WriteCmd(0x0838);Delay_ms(5);
SPI_WriteCmd(0x0974);Delay_ms(5);
SPI_WriteCmd(0x0aae);Delay_ms(5);
SPI_WriteCmd(0x0bee);Delay_ms(5);
SPI_WriteCmd(0x0c40);Delay_ms(5);
SPI_WriteCmd(0x0db8);Delay_ms(5);
SPI_WriteCmd(0x0e1c);Delay_ms(5);
SPI_WriteCmd(0x0f6c);Delay_ms(5);
SPI_WriteCmd(0x10a8);Delay_ms(5);
SPI_WriteCmd(0x11fc);Delay_ms(5);
SPI_WriteCmd(0x1200);Delay_ms(5);
SPI_WriteCmd(0x1350);Delay_ms(5);
SPI_WriteCmd(0x1495);Delay_ms(5);
SPI_WriteCmd(0x15fe);Delay_ms(5);
SPI_WriteCmd(0x1603);Delay_ms(5);

//Page6:LVDS function
SPI_WriteCmd(0x0007);Delay_ms(5);
SPI_WriteCmd(0x0115);Delay_ms(5);

}

void LCM_SetVCOM(uint16_t nVCOM)
{
  uint16_t  CMDnVCOM;
  CMDnVCOM=0x1C00|(nVCOM&0x00FF);
  SPI_WriteCmd(0x0000);  Delay_ms(5);
   //Page0

   SPI_WriteCmd(CMDnVCOM); Delay_ms(10);
   //VCOM
  }
#endif
```

# 7. Optical Characteristics

Ta=25℃

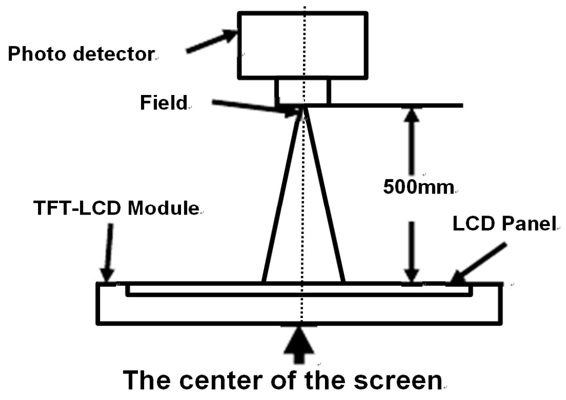
| Item | | Symbol | Condition | Min | Typ | Max | Unit | Remark |
|---|---|---|---|---|---|---|---|---|
| View Angles | | θT | CR≧10 | 60 | 70 | - | Degree | Note 2 |
| | | θB | | 50 | 60 | - | | |
| | | θL | | 70 | 80 | - | | |
| | | θR | | 70 | 80 | - | | |
| Contrast Ratio | | CR | θ=0° | 400 | 600 | - | | Note1 Note3 |
| Response Time | | $T_{ON}$ | 25℃ | - | 20 | 30 | ms | Note1 Note4 |
| | | $T_{OFF}$ | | | | | | |
| Chromaticity | White | x | Backlight is on | TBD | TBD | TBD | | Note1 Note5 |
| | | y | | TBD | TBD | TBD | | |
| | Red | x | | TBD | TBD | TBD | | |
| | | y | | TBD | TBD | TBD | | |
| | Green | x | | TBD | TBD | TBD | | |
| | | y | | TBD | TBD | TBD | | |
| | Blue | x | | TBD | TBD | TBD | | |
| | | y | | TBD | TBD | TBD | | |
| Uniformity | | U | | 75 | 80 | - | % | Note1 Note6 |
| NTSC | | | | 60 | 75 | - | % | Note 5 |
| Luminance（Without TP） | | L | | 450 | 500 | - | $cd/m^2$ | Note1 Note7 |

Test Conditions:

1.IF= 360mA, VF=12 V and the ambient temperature is 25±2℃.humidity is 65±7%
2.The test systems refer to Note 1 and Note 2.

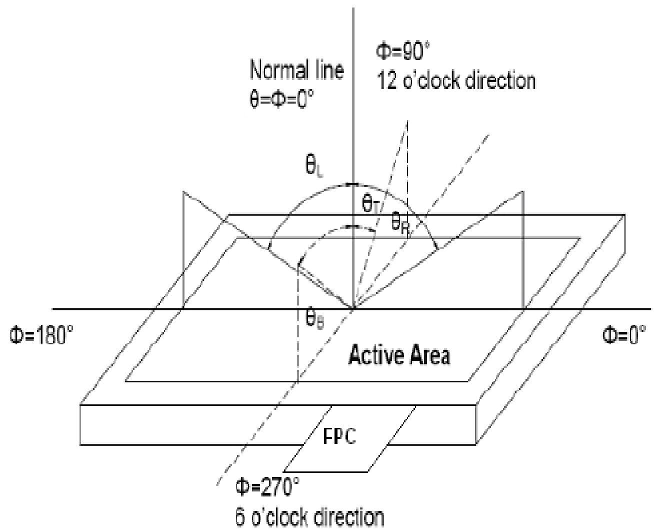
Note 1: Definition of optical measurement system.

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.




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

viewing angle is measured at the center point of the LCD。




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 drive by Vwhite.

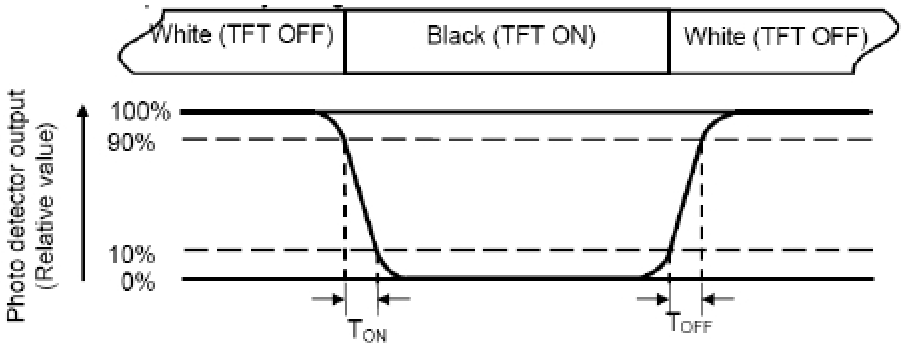
“Black state”: The state is that the LCD should drive by Vblack.

Vwhite: To be determined

Vblack: To be determined.

Note 4: Definition of Response time

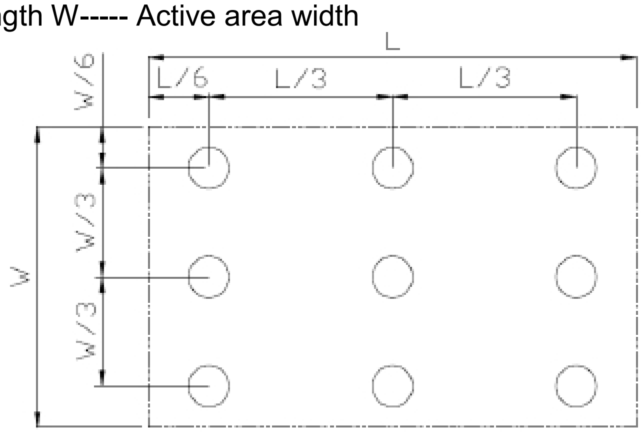
The response time is defined as the LCD optical switching time interval between "White" state and "Black" state. Rise time (TON) is the time between photo detector output intensity changed from 90% to 10%. And fall time (TOFF) is the time between photo detector output intensity changed from 10% to 90%.




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




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.

# 8. Precautions for Use of LCD Modules

## 8.1 Handling Precautions

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

8.1.2 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.

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

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

8.1.5 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

8.1.6 Do not attempt to disassemble the LCD Module.

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

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

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

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

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

8.1.8.4 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.

## 8.2 Storage precautions

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

8.2.2 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%

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

## 8.3 Transportation Precautions

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