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

# LMT043DNFFWD-NND

LCD Module User Manual

| Prepared by: | Checked by: | Approved by: |
|---|---|---|
| **SongMao** | | |
| Date: 2019-07-15 | Date: | Date: |

| Rev. | Descriptions | Release Date |
|---|---|---|
| 0.1 | Preliminary | 2019-07-15 |
| | | |
| | | |
| | | |
| | | |

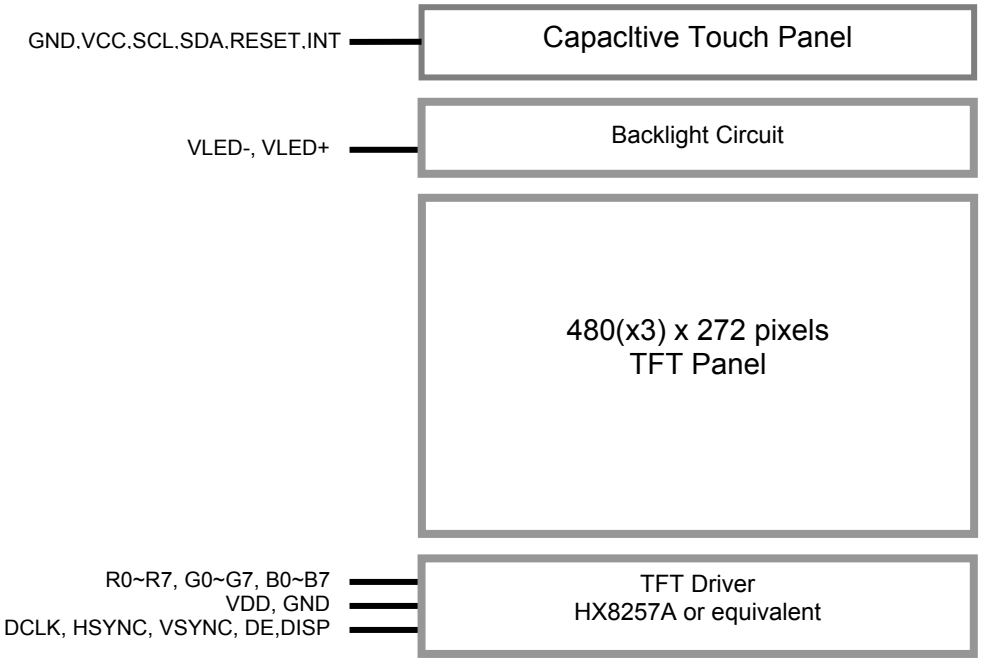
# Table of Content

# 1. General Specification

| | |
|---|---|
| Signal Interface : | RGB-24bits |
| Display Technology : | a-Si TFT active matrix |
| Display Mode : | Transmissive / Positive (normal white) |
| Screen Size(Diagonal) : | 4.3 inch |
| Outline Dimension : | 105.5 x 67.2 x 2.9 (mm)<br>(exclude FPC, see attached drawing for details) |
| Active Area : | 95.04 x 53.86 (mm) |
| Number of dots : | 480*272 |
| Dot Pitch : | 0.198 x 0.198 (mm) |
| Pixel Configuration : | R.G.B. Vertical Stripe |
| Backlight : | White LED |
| Surface Treatment : | Anti-Glare Treatment |
| Viewing Direction : | 6 o'clock( Gray scale Inversion )(*1)<br>12 o' clock(*2) |
| Touch Panel: | Capacltive Touch Panel |
| Operating Temperature : | -20 ~ +70°C |
| Storage Temperature : | -30 ~ +80°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 Functions

## 3.1 TFT Pin Assignment

| Pin No. | Pin Name | I/O | Descriptions |
|---|---|---|---|
| 1 | VLED- | P | Backlight LED Cathode supply |
| 2 | VLED+ | P | Backlight LED Anode supply |
| 3 | GND | P | Power Ground (0V) |
| 4 | VDD | P | Positive Power Supply |
| 5 | R0 | I | Red color data input |
| : | : | | |
| 12 | R7 | | |
| 13 | G0 | I | Green color data input |
| : | : | | |
| 20 | G7 | | |
| 21 | B0 | I | Blue color data input |
| : | : | | |
| 28 | B7 | | |
| 29 | GND | P | Power Ground (0V) |
| 30 | DCLK | I | Data clock signal input, rising edge trigger |
| 31 | DISP | I | Display on/of control (internally pull high)<br>DISP=1: normal operation<br>DISP=0: standby mode |
| 32 | HSYNC | I | Horizontal Sync signal input<br>(negative polarity, internally pull high)<br>(If not using, pull high) |
| 33 | VSYNC | I | Vertical Sync Signal Input<br>(negative polarity, internally pull high)<br>(If not using, pull high) |
| 34 | DE | I | Data Enable Signal Input<br>(internal pull low)<br>(If not using, pull low) |
| 35 | NC | - | No connection, leave open |
| 36 | GND | P | Power Ground (0V) |
| 37 | NC | - | No connection, leave open |
| 38 | NC | | |
| 39 | NC | | |
| 40 | NC | | |

Note1: The LMT043DNFFWD-NND both supports DE mode and Sync mode timing.
SYNC mode, DE pull-lo, HSYNC and VSYNC for timing control.
DE mode, HSYNC and VSYNC pull-hi, DE for timing control.
Note2：I－－Input, O－－Output, P－－Power/Ground

## 3.2 CTP Pin Assignment

| Pin No. | Pin Name | I/O | Descriptions |
|---|---|---|---|
| 1 | GND | P | Ground |
| 2 | RESET | I | System reset signal input, active low |
| 3 | VCC | P | CTP power supply |
| 4 | INT | I/O | Indicate coordinate data ready |
| 5 | SCL | I/O | I2C serial clock |
| 6 | SDA | I/O | I2C serial data |
| 7,8,9,10 | NC | - | No connection |

Note1：I－－Input, O－－Output, P－－Power/Ground

# 4. Absolute Maximum Ratings

| Items | Symbol | Min. | Max. | Unit | Condition |
|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | -0.3 | +4.0 | V | GND = 0V |
| Operating Temperature | $T_{OP}$ | -20 | +70 | ° C | No Condensation |
| Storage Temperature | $T_{ST}$ | -30 | +80 | ° C | No Condensation |

Cautions:
Any Stresses exceeding the Absolute Maximum Ratings may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

# 5. Electrical Characteristics

## 5.1 DC Characteristics (MCU terminal)

GND=0V, $V_{DD}$ =3.3V, $T_{OP}$ =25° C

| Items | Symbol | MIN. | TYP. | MAX. | Unit | Applicable Pin |
|---|---|---|---|---|---|---|
| Operating Voltage | $V_{DD}$ | 3.0 | 3.3 | 3.6 | V | VDD |
| Input High Voltage | $V_{IH}$ | 0.7VDD | - | VDD | V | Input pins |
| Input Low Voltage | $V_{IL}$ | GND | - | 0.3VDD | V | Input pins |
| Frame Freq | $F_{FRAME}$ | - | 60 | - | Hz | |
| Dot Data Clock | $f_{DOTCLK}$ | - | 9.0 | 15 | MHz | |
| Operating Current (*1) | $I_{DD}$ | - | 22.4 | - | mA | VDD |
| Standby Current (*2) | $I_{DD}$ | - | 15.2 | - | uA | VDD |

Note：
*1. test image is Black Mode, Frame Freq=60Hz
*2. DISP=0

## 5.2 DC Characteristics For CTP

(TA= 25℃,VCC=3.3 V)

| Items | MIN. | TYP. | MAX. | Unit | Note |
|---|---|---|---|---|---|
| Power supply voltage | 3.0 | 3.3 | 3.6 | V | |
| IO voltage | 3.0 | 3.3 | 3.6 | V | Note 1 |
| Operating Current | - | 16.1 | - | mA | |
| Idle Current | - | 8.1 | - | mA | |
| Power Down Current | - | - | 20 | uA | |

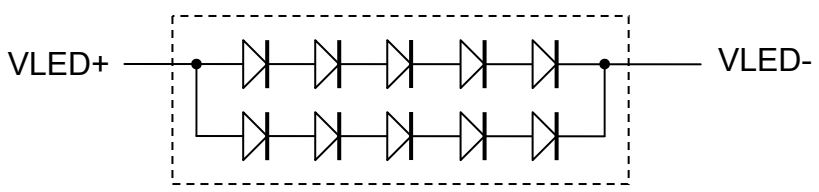
Note1： If there are other voltage requirements, can be realized by changing the design, the adjustable range is 1.6V to 3.6V.
Note2: All current measurement is average current at Operating mode.

## 5.3 LED Backlight Circuit Characteristics

$If_{VLED+}$=40mA, $T_{OP}$=25° C

| Items | Symbol | MIN. | TYP. | MAX. | Unit | Note |
|---|---|---|---|---|---|---|
| Forward Voltage | Vf | - | 16.0 | - | V | |
| Forward Current | $If_{VLED+}$ | - | 40 | 50 | mA | |
| Life Time | - | 10,000 | (20,000) | - | hr | |

Cautions:
Exceeding the recommended driving current could cause substantial damage to the backlight and shorten its lifetime.




No. of LEDs = 2x5 pcs

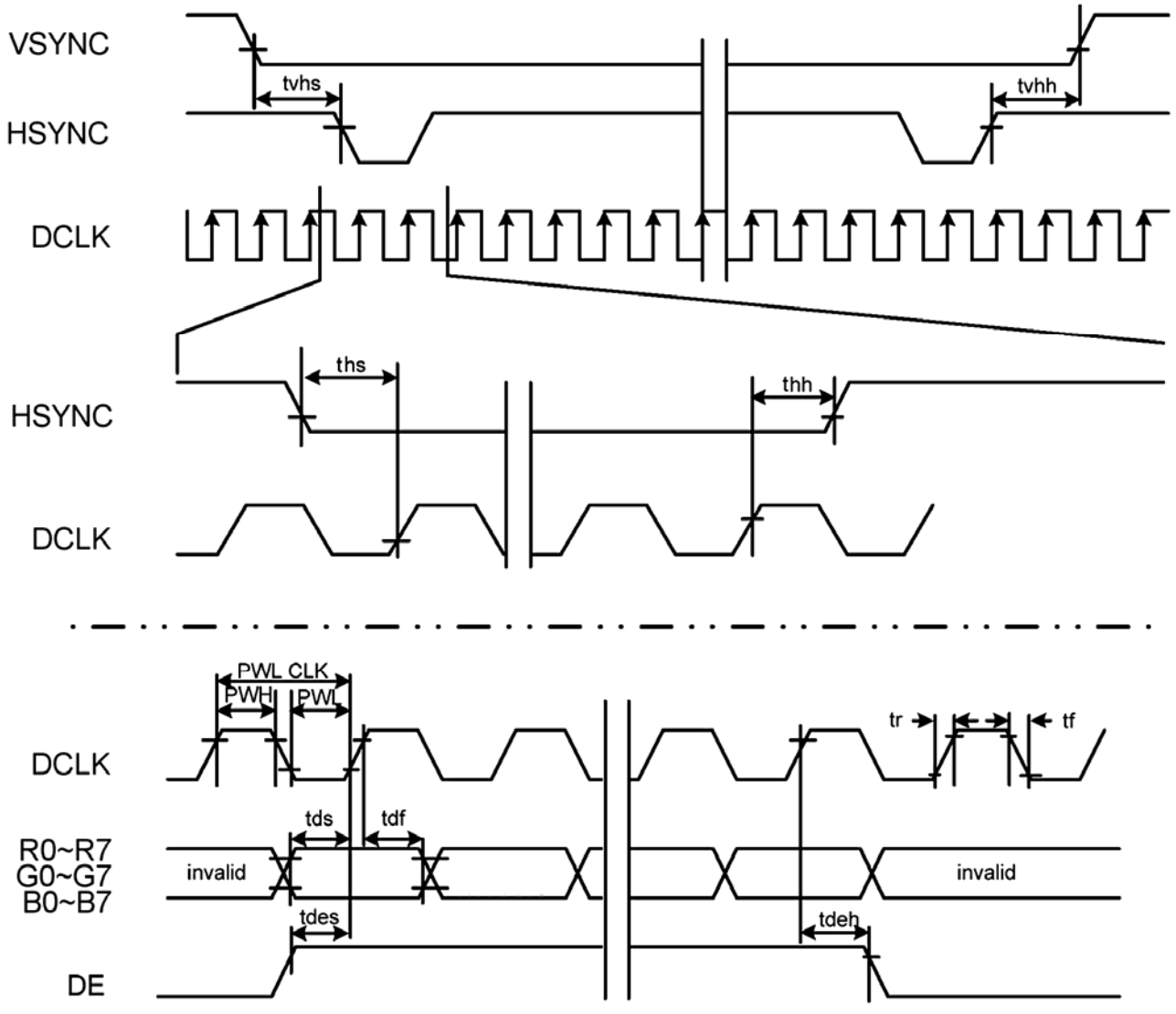
## 5.4 AC Characteristics

### 5.4.1 AC Timing

GND=0V, $V_{DD}$ =3.3V, $T_{OP}$ =25° C

| Parameter | Symbol | Spec. | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| Clock period | $PW_{CLK}$ (2) | 66.7 | - | - | ns |
| Clock pulse high period | PWH (2) | 26.7 | - | - | ns |
| Clock pulse low period | PWL (2) | 26.7 | - | - | ns |
| Hsync setup time | $t_{hs}$ | 10 | - | - | ns |
| Hsync hold time | $t_{hh}$ | 10 | - | - | ns |
| Data setup time | $t_{ds}$ | 10 | - | - | ns |
| Data hold time | $t_{dh}$ | 10 | - | - | ns |
| DE setup time | $t_{des}$ | 10 | - | - | ns |
| DE hold time | $t_{deh}$ | 10 | - | - | ns |
| Vsync setup time | $t_{vhs}$ | 10 | - | - | ns |
| Vsync hold time | $t_{vhh}$ | 10 | - | - | ns |

Note:
*1. tr, tf ≤2ns, which defined 10% ~90% fo signal amplitude
*2. DCLK ≤ 15MHz

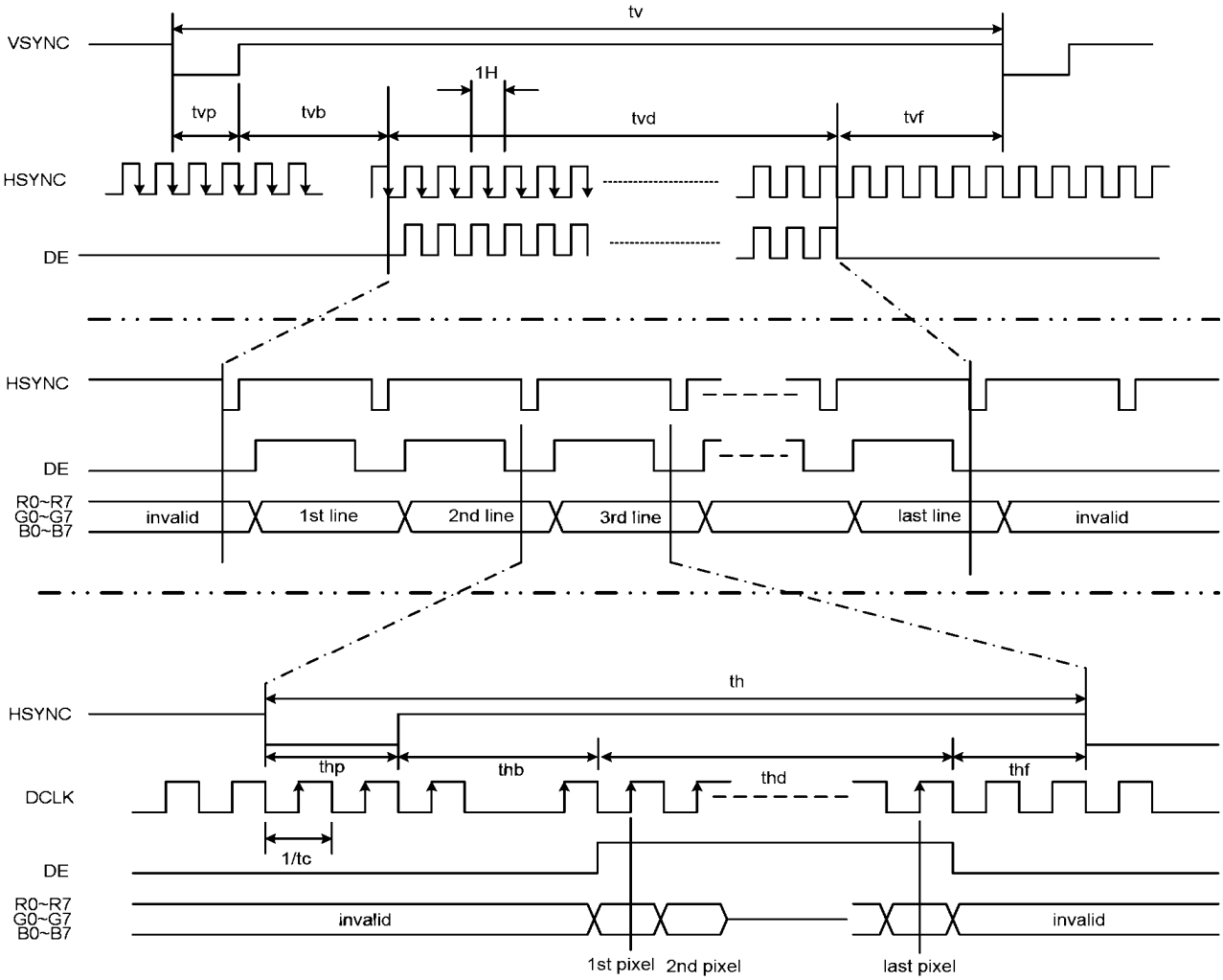



Timing Diagram

### 5.4.2 Data Timing

| Parameter | Symbol | Spec. | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| Clock cycle | $f_{CLK}$ (1) | - | 9 | 15 | MHz |
| Hsync cycle | 1/th | - | 17.14 | - | KHz |
| Vsync cycle | 1/tv | - | 59.94 | - | Hz |
| Horizontal Signal | | | | | |
| Horizontal cycle | th | 525 | 525 | 605 | CLK |
| Horizontal display period | thd | 480 | 480 | 480 | CLK |
| Horizontal front porch | thf | 2 | 2 | 82 | CLK |
| Horizontal pulse width | thp (2) | 2 | 41 | 41 | CLK |
| Horizontal back porch | thb (2) | 2 | 2 | 41 | CLK |
| Vertical Signal | | | | | |
| Vertical cycle | tv | 285 | 286 | 399 | H (1) |
| Vertical display period | tvd | 272 | 272 | 272 | H (1) |
| Vertical front porch | tvf | 1 | 2 | 227 | H (1) |
| Vertical pulse width | tvp (2) | 1 | 10 | 11 | H (1) |
| Vertical back porch | tvb (2) | 1 | 2 | 11 | H (1) |

Note:
*1 Unit: C:L=1/$f_{CLK}$, H=th
*2. It is necessary to keep tvp+tvb=12 and thp+thb=43 in SYNC mode.
But not necessary for DE mode.
*3. The LMT043DNFFWD both supports DE mode and Sync mode timing.
SYNC mode, DE pull-lo, HSYNC and VSYNC for timing control
DE mode, HSYNC and VSYNC pull-hi, DE for timing control

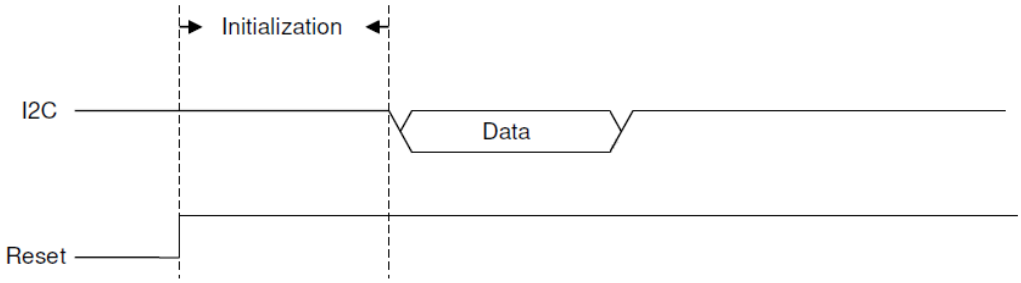



Input Data Timing Diagram

# 6. CTP Function Characteristics

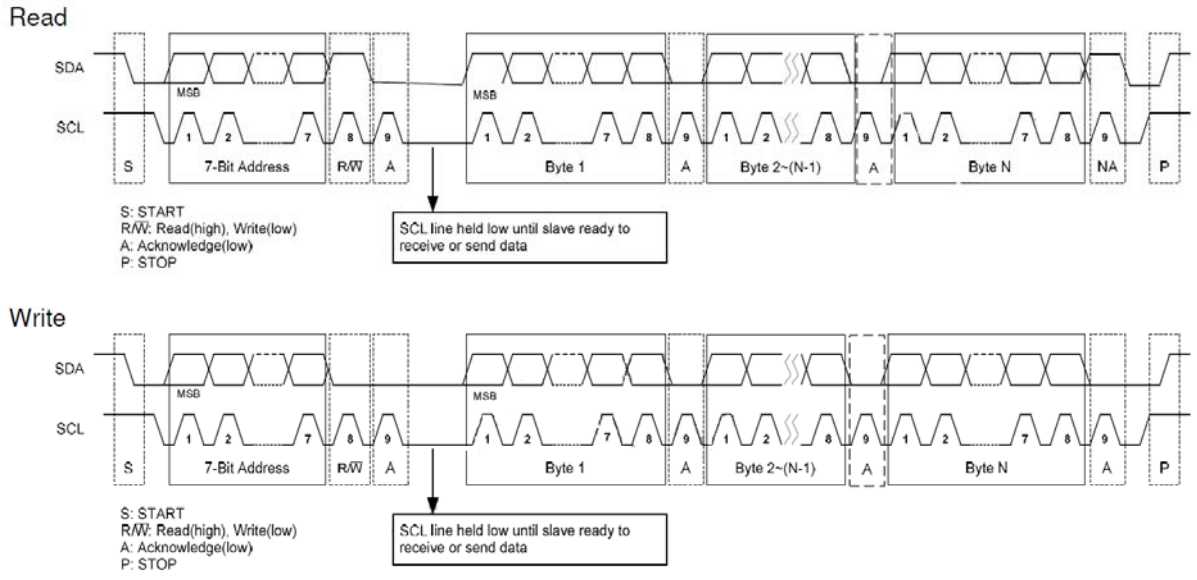
## 6.1 Initialization

After hardware reset, touch controller needs some time for initialization. The touch controller can be accessed via I2C interface after initialization. Initialization time is 50ms.




## 6.2 I2C Slave Interface

Touch IC equipped with I2C provides two wires, serial data (SDA) and serial clock (SCL), to carry transferring information at up to 400 kbit/s(Fast mode). I2C address is default to 0x70 (7-bits address). Touch IC plays the slave role in I2C transfer. Both SDA and SCL are bidirectional lines, connected to IOVDD via pull-up resistors. All transactions begin with a START (S) and can be terminated by a STOP (P). 7-bits address follows START to recognize device. Each bye is 8-bits length and followed by an acknowledge bit. A HIGH to LOW transition on the SDA line while SCL is HIGH defines a START condition. A LOW to HIGH transition on the SDA line while SCL is HIGH defines a STOP condition. The data on the SDA line must be stable during the HIGH period of the clock. The HIGH or LOW state of the data line can only change when the clock signal on the SCL line is LOW.




I2C Waveform

## 6.3 Register Read

For reading register value from I2C device, host has to tell I2C device the Start Register Address before reading corresponding register value.

| I2C Start | I2C Header (W) | Start Reg. Addr (a) | I2C Stop | I2C Start | I2C Header (R) | Value of Reg(a) | Value of Reg(a+1) | … | Value of Reg(a+n) | I2C Stop |
|---|---|---|---|---|---|---|---|---|---|---|

**Register Read Format**

I2C host interface protocol supports Repeated Register Read. That is, once the Start Register Address has been set by host, consequent I2C Read(R) transactions will directly read register values starting from the Start Register Address without setting address first, as shown in **Repeated Register Read.**

| I2C Start | I2C Header (R) | Value of Reg(a) | Value of Reg(a+1) | … | Value of Reg(a+n) | I2C Stop | I2C Start | I2C Header (R) | Value of Reg(a) | Value of Reg(a+1) | … | Value of Reg(a+n) | I2C Stop |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

**Repeated Register Read**

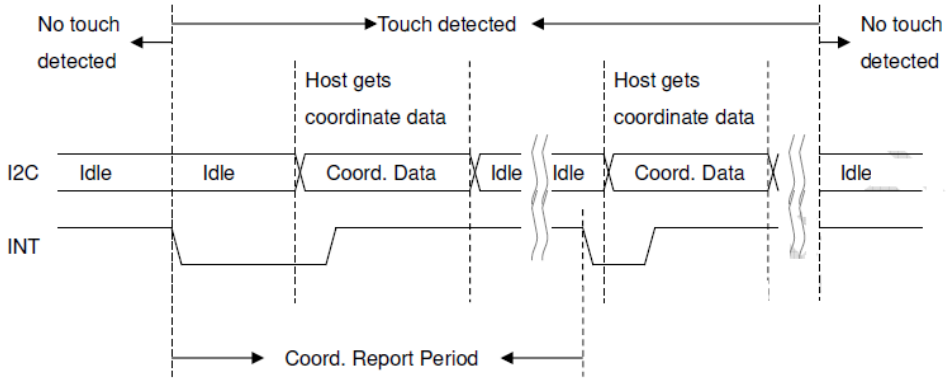
### 6.4 Register Write

For writing register to I2C device, host has to tell I2C device the Start Register Address in each I2C Register Write transaction. Register values to the I2C device will be written to the address starting from the Start Register Address described in Register Write I2C transaction as shown in **Register Write Format**.

| I2C Start | I2C Header(W) | Start Reg. Addr.(a) | Value to Reg(a) | Value to Reg(a+1) | … | Value to Reg(a+n) | I2C Stop |
|---|---|---|---|---|---|---|---|

**Register Write Format**

### 6.5 I2C Electrical Waveform



## 6.6 Report Page Registers

Touch IC provides a register set for host to configure device attributes and retrieve information about fingers and raw data through device host interface. Host interface registers are listed below.

| Reg. Addr. | Name | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|---|
| 0x00 | Firmware Version | Version (RO) | | | | | | | |
| 0x01 | Status Reg. | Error Code (RO) | | | | Device Status (RO) | | | |
| 0x02 | Device Control Reg. | *Reserved* | Multi-Touch Disable (RW) | Proximity Enable (RW) | *Reserved* | *Reserved* | Deep Power Down (RW) | Power Down (RW) | Reset (RW) |
| 0x03 | Timeout to Idle Reg. | Timeout to Idle (sec.) (RW) | | | | | | | |
| 0x04 | XY Resolution (High Byte) | *Reserved* | X_Res_H (RO) | | | *Reserved* | Y_Res_H (RO) | | |
| 0x05 | X Resolution (Low Byte) | X_Res_L (RO) | | | | | | | |
| 0x06 | Y Resolution (Low Byte) | Y_Res_L (RO) | | | | | | | |
| 0x07 | Sensing Counter (High Byte) | Sensing_Counter_H (RO) | | | | | | | |
| 0x08 | Sensing Counter (Low Byte) | Sensing_Counter_L (RO) | | | | | | | |
| 0x09 … 0x0B | … | *Reserved* | | | | | | | |
| 0x0C | Firmware Revision 3 | FW_Rev_3 (RO) | | | | | | | |
| 0x0D | Firmware Revision 2 | FW_Rev_2 (RO) | | | | | | | |
| 0x0E | Firmware Revision 1 | FW_Rev_1 (RO) | | | | | | | |
| 0x0F | Firmware Revision 0 | FW_Rev_0 (RO) | | | | | | | |
| 0x10 | Advanced Touch Info. | *Reserved* | Proximity Flag (RO) | Water Flag (RO) | *Reserved* | Gesture Type(RO) | | | |
| 0x11 | Keys Reg. | Keys (RO) | | | | | | | |
| 0x12 | XY0 Coord. (High Byte) | Valid 0 (RO) | X0_H (RO) | | | *Reserved* | Y0_H (RO) | | |
| 0x13 | X0 Coord. (Low Byte) | X0_L (RO) | | | | | | | |
| 0x14 | Y0 Coord. (Low Byte) | Y0_L (RO) | | | | | | | |
| 0x15 | … | *Reserved.* | | | | | | | |

| Reg. Addr. | Name | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|---|
| 0x16 | XY1 Coord. (High Byte) | Valid 1 (RO) | X1_H (RO) | | | *Reserved* | Y1_H (RO) | | |
| 0x17 | X1 Coord. (Low Byte) | X1_L (RO) | | | | | | | |
| 0x18 | Y1 Coord. (Low Byte) | Y1_L (RO) | | | | | | | |
| 0x19 | … | *Reserved.* | | | | | | | |
| 0x1A … 0x35 | … | … | | | | | | | |
| 0x36 | XY9 Coord. (High Byte) | Valid 9 (RO) | X9_H (RO) | | | *Reserved* | Y9_H (RO) | | |
| 0x37 | X9 Coord. (Low Byte) | X9_L (RO) | | | | | | | |
| 0x38 | Y9 Coord. (Low Byte) | Y9_L (RO) | | | | | | | |
| 0x39 | Reserved | *Reserved.* | | | | | | | |
| 0x3A … 0x3E | … | *Reserved* | | | | | | | |
| 0x3F | Contact Count Max. | Max Number of Contacts Support (RO) | | | | | | | |
| 0x40 … 0xCA | … | *Reserved* | | | | | | | |
| 0xCB | PWM0 Duty | *Reserved* | PWM0 Duty (RW) | | | | | | |
| 0xCC | PWM1 Duty | *Reserved* | PWM1 Duty (RW) | | | | | | |
| 0xCD | PWM2 Duty | *Reserved* | PWM2 Duty (RW) | | | | | | |
| 0xCE | PWM3 Duty | *Reserved* | PWM3 Duty (RW) | | | | | | |
| 0xCF | PWM Control | PWM Trigger (RW) | PWM Clock (RW) | | | PWM3 Enable (RW) | PWM2 Enable (RW) | PWM1 Enable (RW) | PWM0 Enable (RW) |
| 0xD0 … 0xEF | … | *Reserved* | | | | | | | |
| 0xF0 | Misc. Info. | Smart Wake Up Flag (RO) | *Reserved* | | | | | | |
| 0xF1 | Misc. Control | Enable Smart Wake Up (RW) | *Reserved* | | | | | | |
| 0xF2 | Smart Wake Up ID | Smart Wake Up ID (RW) | | | | | | | |
| 0xF3 … 0xFE | … | *Reserved* | | | | | | | |
| 0xFF | Page Reg. | Page Number (RW) | | | | | | | |

Note:
Please refer to ST1633i IC datasheet and Sitronix Touch IC Protocol for detail.

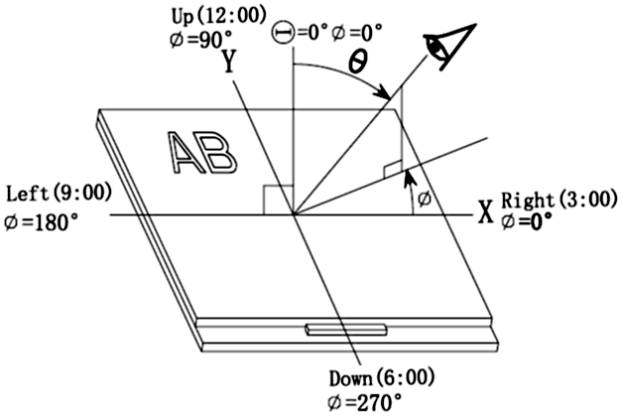
## 7. Optical Characteristics

| Item | | Symbol | Condition | Min | Typ | Max | Unit | Remark |
|---|---|---|---|---|---|---|---|---|
| View Angles | | θT | CR≧10 | 60 | 70 | -- | Degree | Note 2 |
| | | θB | | 40 | 50 | -- | | |
| | | θL | | 60 | 70 | -- | | |
| | | θR | | 60 | 70 | -- | | |
| Contrast Ratio | | CR | θ=0° | 400 | 500 | -- | | Note1、Note3 |
| Response Time | | $T_{ON}$ | 25℃ | -- | 20 | 30 | ms | Note1 Note4 |
| | | $T_{OFF}$ | | | | | | |
| Chromaticity | White | x | Backlight is on | 0.265 | 0.315 | 0.365 | | Note5 Note1 |
| | | y | | 0.285 | 0.335 | 0.385 | | |
| | Red | x | | 0.531 | 0.581 | 0.631 | | |
| | | y | | 0.295 | 0.345 | 0.395 | | |
| | Green | x | | 0.298 | 0.348 | 0.395 | | |
| | | y | | 0.531 | 0.581 | 0.631 | | |
| | Blue | x | | 0.103 | 0.153 | 0.203 | | |
| | | y | | 0.045 | 0.095 | 0.145 | | |
| Uniformity | | U | | 75 | 80 | -- | % | Note1、Note6 |
| NTSC | | | | -- | 50 | -- | % | Note 5 |
| Luminance | | L | | 250 | 300 | -- | $cd/m^2$ | Note1、Note7 |

Note：
The parameter is slightly changed by temperature, driving voltage and materiel
Please see the Notes for testing conditions

Note 1:
The data are measured after LEDs are turned on for 5 minutes. LCM displays full white. The brightness is the average value of 9 measured spots. Measurement equipment SR-3A (1°)
Measuring condition:
- Measuring surroundings: Dark room
- Measuring temperature: Ta=25℃.
- Adjust operating voltage to get optimum contrast at the center of the display.

Note 2:
The definition of viewing angle:
Refer to the graph below marked by $\theta$ and $\Phi$

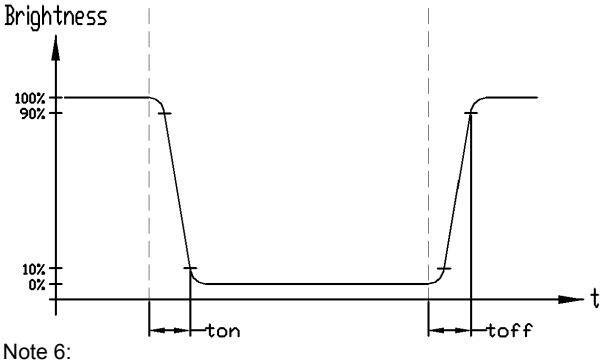



Note 3:
The definition of contrast ratio (Test LCM using SR-3A (1°)):

$$\text{Contrast Ratio(CR)} = \frac{\text{Luminance When LCD is at "White" state}}{\text{Luminance When LCD is at "Black" state}}$$

(Contrast Ratio is measured in optimum common electrode voltage)

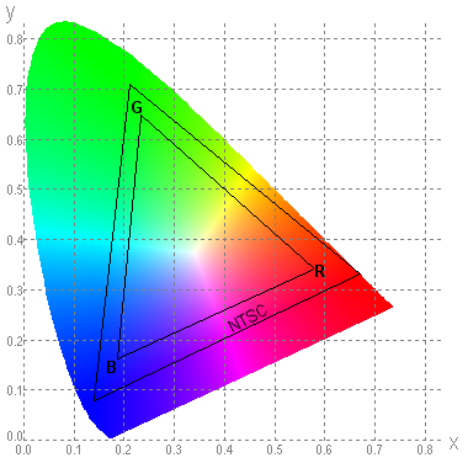
Note 4:
Definition of Response time. (Test LCD using BM-7A(2°)):
The output signals of photo detector are measured when the input signals are changed from "black" to "white"(falling time) and from "white" to "black"(rising time), respectively. The response time is defined as the time interval between the 10% and 90% of amplitudes.Refer to figure as below.



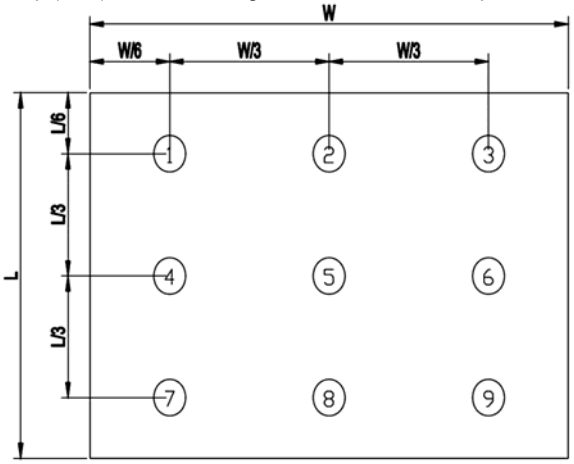

Note 5:
Definition of Color of CIE1931 Coordinate and NTSC Ratio.

Color gamut:

$$S = \frac{\text{Area of RGB triangle}}{\text{Area of NTSC triangle}} \times 100\%$$




Note 6:
The luminance uniformity is calculated by using following formula.
△Bp = Bp (Min.) / Bp (Max.)×100 (%)
Bp (Max.) = Maximum brightness in 9 measured spots
Bp (Min.) = Minimum brightness in 9 measured spots.

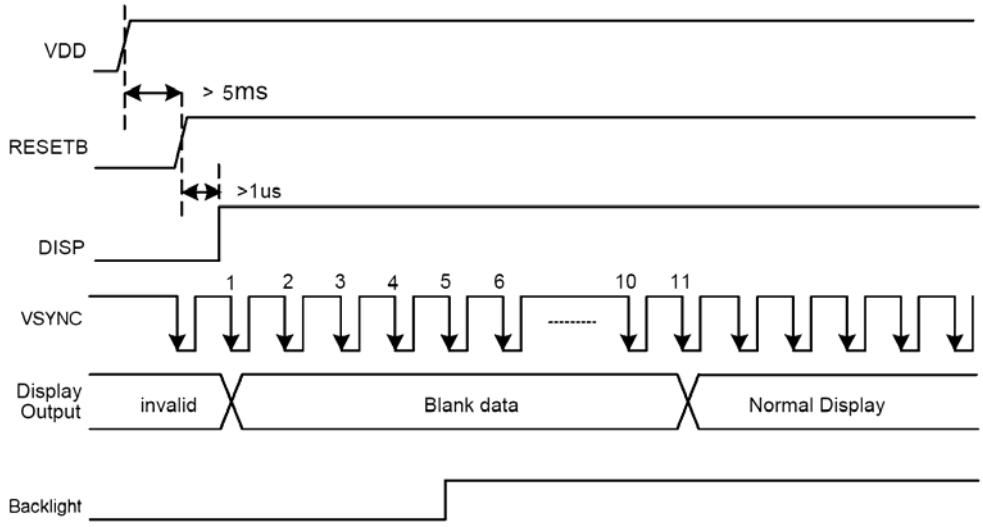



Note 7:
Measured the luminance of white state at center point

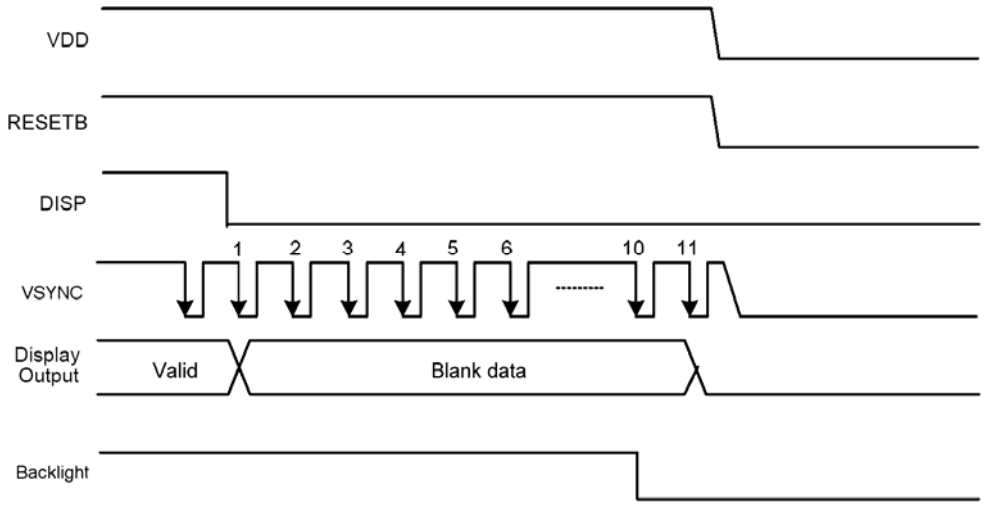
# 8. Function Specifications

## 8.1 Power On/Off Sequence

Power On Timing Sequence




Power Off Timing Sequence




To prevent abnormal display that might show on screen,
it is suggest to use to following standby sequence.
Power on, turn on the backlight AFTER power supply stable and display ready.
Power off, turn off the backlight BEFORE power down.

# 9. CTP Application Precautions

## 1. CTP Mounting Precaution

**1.1** Bezel Mounting (Figure 1)

- The bezel window should be bigger than the CTP active area. It should be≥0.5mm each side.
- Gasket should be installed between the bezel and the CTP surface. The final gap should be about 0.5~1.0mm.
- It is recommended to provide an additional support bracket for backside support when necessary (e.g. slim type TFT module without mounding structure). They should only provide appropriate support and keep the module in place.
- The mounting structure should be strong enough to prevent external uneven force or twist act onto the module.

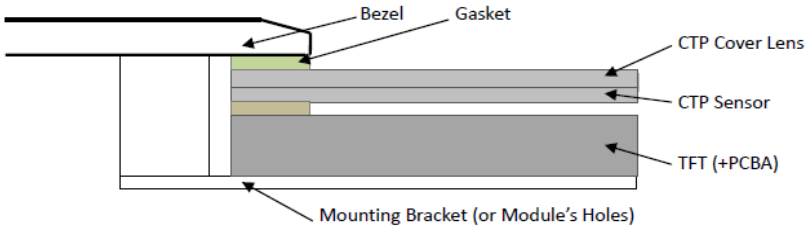



Figure 1

**1.2** Surface Mounting (Figure 2)

- As the CTP assembling on the countersink area with double side adhesive. The countersink area should be flat and clean to ensure the double side adhesive installation result.
- The Bezel is recommend to keep a gap (≥0.3mm each side) around the cover lens for tolerance.
- It is recommended to provide an additional support bracket with gasket for backside support when necessary (e.g. TFT module without mounding structure). They should only provide appropriate support and keep the module in place.
- The mounting structure should be strong enough to prevent external uneven force or twist act onto the module.

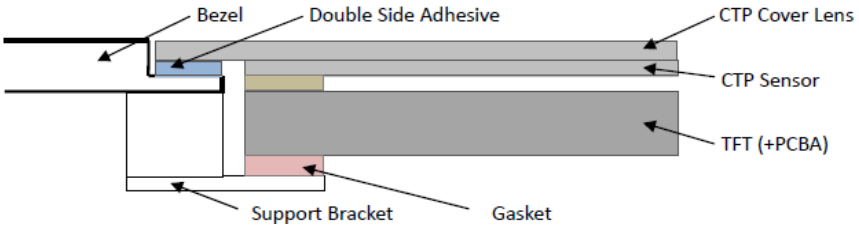



Figure 2

**1.3** Additional Cover Lens Mounting (Figure 3)

- For the case of additional cover Lens mounting, it is necessary to recheck with the CTP specification about the material and thickness to ensure the functionality.
- It should keep a 0.2~0.3mm gap between the cover lens and the CTP surface..
- The cover lens window should be bigger than the active area of the CTP. It should be≥0.5mm each side.
- It is recommended to provide an additional support bracket for backside support when necessary (e.g. slim type TFT module without mounding structure). They should only provide appropriate support and keep the module in place.
- The mounting structure should be strong enough to prevent external uneven force or twist act onto the module.

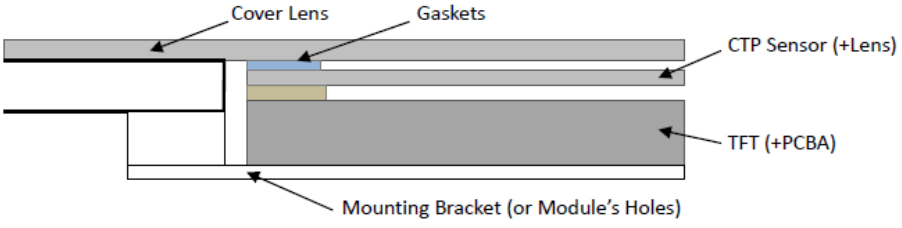


Figure 3

## 2. Handling Precautions

**2.1** The product made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.

**2.2** Do not apply excessive or uneven force to the product since this may damage to the performance.

**2.3** 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 Isopropyl alcohol or Ethyl alcohol solvents. Solvents other than those mentioned above may damage the product. Especially, do not use Water, Ketone, Aromatic solvents.

**2.4** Do not attempt to disassemble the CTP Module.

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

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

a. Be sure to ground the body when handling the CTP Modules.

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

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

d. The CTP 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.

## 3. Storage and Transportation Precautions

**3.1** When storing the CTP modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.

**3.2** The CTP modules should be stored the required temperature range. If the CTP modules will be stored for a long time, the recommend condition is the temperature of 0~40 ℃ and relative humidity of ≤80%.

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

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

# 10. Precautions of using LCD Modules

**Mounting**

- Mounting must use holes arranged in four corners or four sides.
- The mounting structure so provide even force on to LCD module. Uneven force (ex. Twisted stress) should not applied to the module. And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
- It is suggested to attach a transparent protective plate to the surface in order to protect the polarizer. It should have sufficient strength in order to the resist external force.
- The housing should adopt radiation structure to satisfy the temperature specification.
- Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
- Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. Never rub with dust clothes with chemical treatment. Do not touch the surface of polarizer for bare hand or greasy cloth.(Some cosmetics deteriorate the polarizer.)
- When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzine. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
- Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer

**Operating**

- The spike noise causes the mis-operation of circuits. It should be within the ±200mV level (Over and under shoot voltage)
- Response time depends on the temperature.(In lower temperature, it becomes longer.)
- Brightness depends on the temperature. (In lower temperature, it becomes lower.) And in lower temperature, response time(required time that brightness is stable after turned on) becomes longer.
- Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
- When fixed patterns are displayed for a long time, remnant image is likely to occur.
- Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference

**Electrostatic Discharge Control**

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

**Strong Light Exposure**

Strong light exposure causes degradation of polarizer and color filter.

**Storage**

When storing modules as spares for a long time, the following precautions are necessary.

- Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
- The polarizer surface should not come in contact with any other object. It is recommended that they be stored in the container in which they were shipped.

**Protection Film**

- When the protection film is peeled off, static electricity is generated between the film and polarizer. This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
- The protection film is attached to the polarizer with a small amount of glue. If some stress is applied to rub the protection film against the polarizer during the time you peel off the film, the glue is apt tore main on the polarizer. Please carefully peel off the protection film without rubbing it against the polarizer.
- When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the polarizer after the protection film is peeled off.
- You can remove the glue easily. When the glue remains on the polarizer surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.

**Transportation**

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

# 11. Appendix A <Inspection items and criteria for appearance defect>

| Items | Criteria | | | |
|---|---|---|---|---|
| Open Segment or Common | Not permitted | | | |
| Short | Not permitted | | | |
| Wrong Viewing Angle | Not permitted | | | |
| Decliners | Not permitted | | | |
| Contrast Ration Uneven | According to the limit specimen | | | |
| Crosstalk | According to the limit specimen | | | |
| White spots | X>1 pixel | A-area | Not permitted | Max 6 spots allowed |
| | | B-area | Max. 1 allowed | |
| | 1/2 pixel<X≤1 pixel | A-area | Not permitted | |
| | | B-area | Max. 2 allowed | |
| | X≤1/2 pixel | A-area | Max. 1 allowed | |
| | | B-area | Max. 4 allowed | |
| Black Sport | X>1 pixel | A-area | Not permitted | |
| | | B-area | Max. 2 allowed | |
| | X≤1/2 pixel | A-area | Max. 1 allowed | |
| | | B-area | Max. 4 allowed | |
| Line Defect | Apparent vertical horizontal line defects are not permitted | | | |

Note:

1. On Pixel include 3 dots (RedDot + GreenDot + BlueDot)
2. Definition of Panel “A-area” and “B-area”