晶采光電科技股份有限公司
AMPIRE CO., LTD.

# SPECIFICATIONS FOR
# LCD MODULE

| | |
|---|---|
| CUSTOMER | |
| CUSTOMER PART NO. | |
| AMPIRE PART NO. | AM-240320MLTNQW-T00H |
| APPROVED BY | |
| DATE | |

☐Approved For Specifications
☐Approved For Specifications & Sample

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|---|---|---|
| | | |

# RECORD OF REVISION

| Revision Date | Page | Contents | Editor |
|---|---|---|---|
| 2017/12/07 | -- | New Release | Lawlite |

# 1 Features

This display module is a color active matrix thin film transistor (TFT) liquid crystal display that uses amorphous silicon TFT as a switching device.
This TFT LCD panel has a 2.8 inch diagonally measured active display area with QVGA resolution (240 horizontal by 320 vertical pixels array).It is suitable for hand-held application. The LCD adopts one backlight with High brightness 4-lamps white LED.

(1) LCD: 1.1 Amorphous-TFT 2.8 inch display, transmissive, normally white type.
1.2 240(RGB) X320 dots Matrix
1.3 LCD Driver IC: ST7789V
1.4 Viewing Direction 12 o'clock(Gray Inversion)
(2) Compatible with ROHS Standard
(3) RGB interface: 18bits, series interface for power setting.
(4) Capacitive Touch Panel.

## 2 Mechanical specifications

| Item | Specifications | unit |
|---|---|---|
| Display resolution(dot) | 240(W) x 320(H) | dots |
| Active area | 43.2 (W) x 57.6(H) | mm |
| Pixel pitch | 0.180 (W) x 0.180 (H) | mm |
| Pixel Arrangement | R.G.B -stripe | - |
| Overall dimension | 53.0(W) x 109.8(H) x 4.2(D) | mm |
| Viewing direction | 12 o'clock (Gray Inversion) | - |
| Response Time | 16 | ms |
| Contrast ratio | 500 | - |
| Display Type | Transmissive | - |
| Display Mode | Normally White | - |

## 3 Absolute max. ratings and environment

### 3.1 Absolute max. ratings

Ta=25°C GND=0V

| Item | Symbol | Min. | Max. | Unit | Remarks |
|---|---|---|---|---|---|
| Power voltage | VDDI – GND | -0.3 | +4.6 | V | - |
| Power voltage | LED A – LED K | -0.5 | +16.0 | V | - |
| Logic Input voltage | VIN | -0.3 | VDDI+0.5 | V | - |

### 3.2 Environment

| Item | Symbol | Min. | Max. | Unit | Note |
|---|---|---|---|---|---|
| Operating Temperature | Top | -20 | 70 | ℃ | - |
| Storage Temperature | Tst | -30 | 80 | ℃ | |

# 4 Electrical specifications

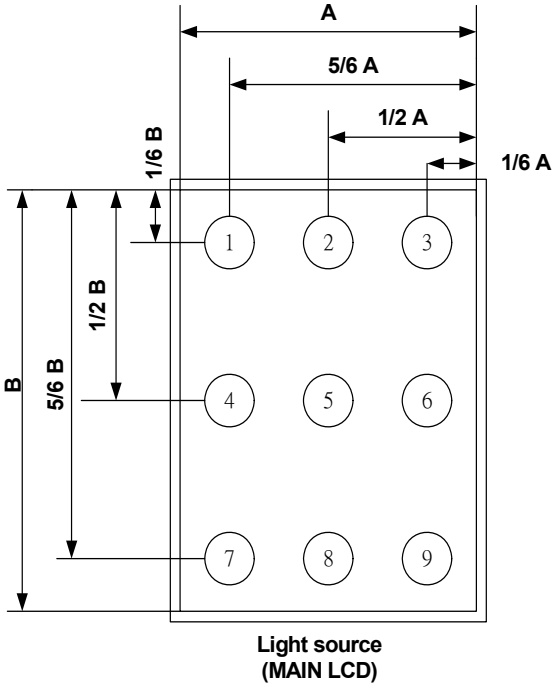
## 4.1 Electrical characteristics of LCM

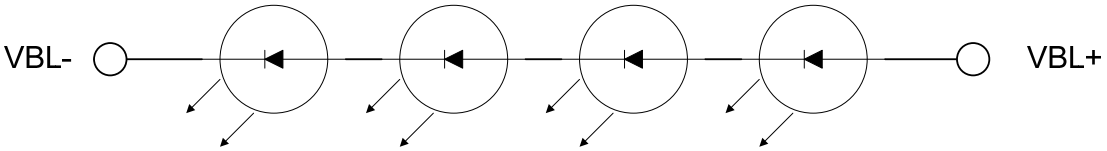
| Item | Symbol | Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Operating voltage | $V_{DDI}$ | - | 3.0 | -- | 3.3 | V |
| High-level input voltage | $V_{IH}$ | - | $0.8V_{DDI}$ | - | $V_{DDI}$ | V |
| Low-level input voltage | $V_{IL}$ | - | 0 | - | $0.2V_{DDI}$ | V |

## 4.2 LED back light specification

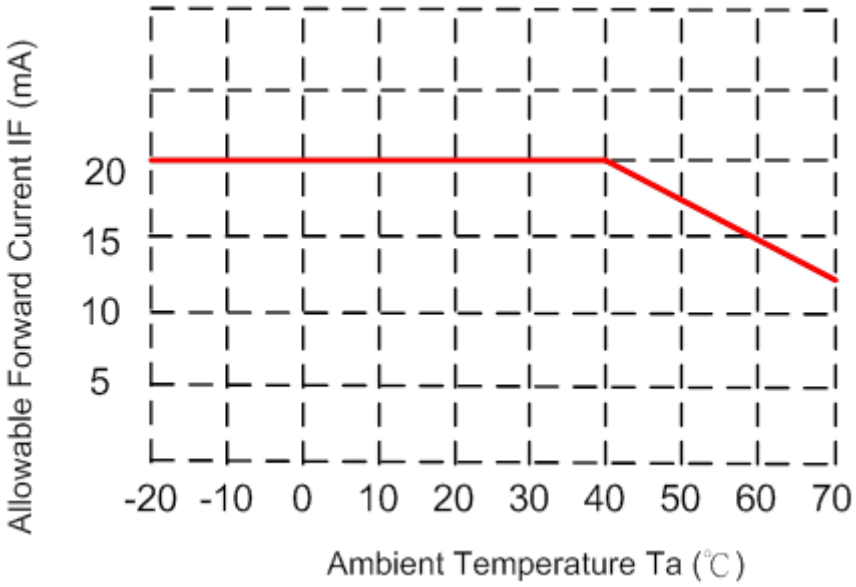
| Item | Symbol | Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Forward voltage | $V_f$ | $I_f$ =20mA | - | 12.4 | 14.4 | V |
| Forward current | $I_f$ | 4-chip Serial | - | 18 | 20 | mA |
| Power Consumption | $P_{BL}$ | $I_f$ =20mA | - | 272 | - | mW |
| Uniformity (with L/G) | - | $I_f$=20mA | 70%*1 | - | - | - |
| Luminous color | White | | | | | |
| Chip connection | 4 chip Serial connection | | | | | |

Bare LED measure position:




*1 Uniformity (LT): $\frac{Min(P1 \sim P9)}{Max(P1 \sim P9)} \times 100 \geq 70\%$



# 5 Optical characteristics

Optical characteristics

| Item | | Symbol | Conditions | Min | Typ | Max | Unit | Note |
|---|---|---|---|---|---|---|---|---|
| Contrast Ratio | | CR | Viewing normal angle $\Theta_x = \Theta_y = 0$ | - | 500 | - | - | |
| Response Time | | $T_R+T_F$ | | - | 16 | - | ms | (4) |
| Viewing Angle | Top | $\Theta_T$ | CR≧10 | - | 70 | - | deg | (2) |
| | Bottom | $\Theta_B$ | | - | 50 | - | | |
| | Left | $\Theta_L$ | | - | 70 | - | | |
| | Right | $\Theta_R$ | | - | 70 | - | | |
| Module Chromaticity | Red | $X_R$ | Viewing normal angle $\Theta_x = \Theta_y = 0$ | 0.576 | 0.626 | 0.676 | - | - |
| | | $Y_R$ | | 0.286 | 0.336 | 0.386 | | |
| | Green | $X_G$ | | 0.226 | 0.276 | 0.326 | | |
| | | $Y_G$ | | 0.500 | 0.550 | 0.600 | | |
| | Blue | $X_B$ | | 0.094 | 0.144 | 0.194 | | |
| | | $Y_B$ | | 0.080 | 0.130 | 0.180 | | |
| | White | $X_W$ | | 0.257 | 0.307 | 0.357 | | |
| | | $Y_W$ | | 0.279 | 0.329 | 0.379 | | |
| Brightness | | - | LCD center | 170 | 212 | - | Cd/㎡ | (1) |

Note (1) Measurement Setup:

The LCD module should be stabilized at given temperature(25°C) for 15 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting backlight for 15 minutes in a windless room.

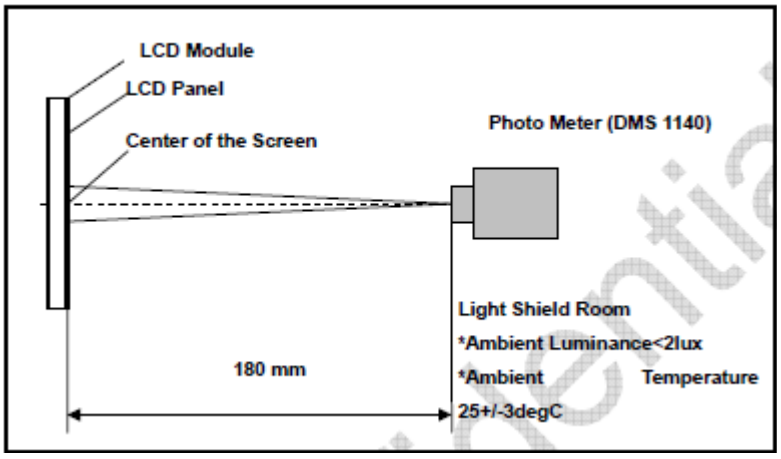



Figure 2 Measurement Setup

Note (2) Definition of Viewing Angle

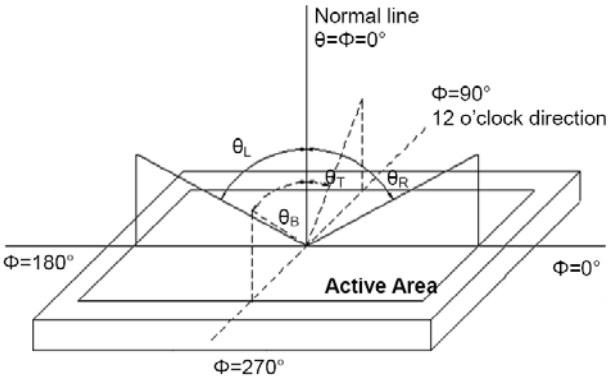



Figure 3 Definition of Viewing Angle

Note (3) Definition Of Contrast Ratio (CR)

The contrast ratio can be calculated by the following expression

Contrast Ratio (CR) = L63 / L0

L63: Luminance of gray level 63, L0: Luminance of gray level 0

Note (4) Definition Of Response Time

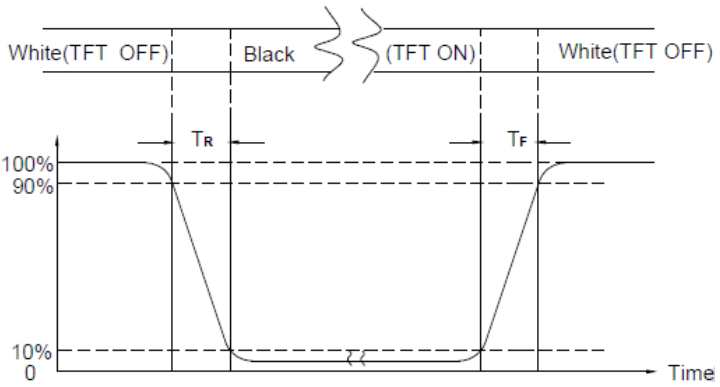



Figure 4 Definition of Response Time

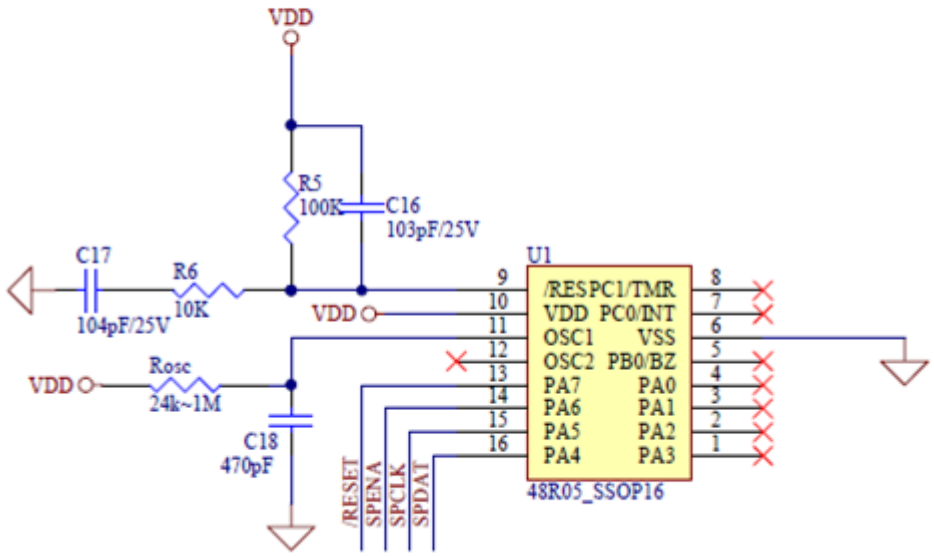
# 6. Electrical Specifications

## 6.1 TFT LCD Panel FPC Descriptions

| No. | Symbol | I/O | Description | Remark |
|---|---|---|---|---|
| 1. | VBL- | I | Backlight LED Cathode. | |
| 2. | VBL- | I | Backlight LED Cathode. | |
| 3. | VBL+ | I | Backlight LED Anode. | |
| 4. | VBL+ | I | Backlight LED Anode. | |
| 5. | NC | - | No connection. | |
| 6. | /RESET | | Hardware Reset | |
| 7. | NC | | Not Use | |
| 8. | Y- | I | Touch Panel--Top electrode | |
| 9. | X+ | I | Touch Panel--Right electrode | |
| 10. | Y+ | I | Touch Panel--Bottom electrode | |
| 11. | X- | I | Touch Panel--Left electrode | |
| 12. | NC | | Not Use | |
| 13. | NC | | Not Use | |
| 14. | B2 | I | Blue Data Bit 2 | |
| 15. | B3 | I | Blue Data Bit 3 | |
| 16. | B4 | I | Blue Data Bit 4 | |
| 17. | B5 | I | Blue Data Bit 5 | |
| 18. | B6 | I | Blue Data Bit 6 | |
| 19. | B7 | I | Blue Data Bit 7 | |
| 20. | NC | | Not Use | |
| 21. | NC | | Not Use | |
| 22. | G2 | I | Green Data Bit 2 | |
| 23. | G3 | I | Green Data Bit 3 | |
| 24. | G4 | I | Green Data Bit 4 | |
| 25. | G5 | I | Green Data Bit 5 | |
| 26. | G6 | I | Green Data Bit 6 | |
| 27. | G7 | I | Green Data Bit 6 | |
| 28. | NC | | Not Use | |
| 29. | NC | | Not Use | |
| 30. | R2 | I | Red Data Bit 2 | |
| 31. | R3 | I | Red Data Bit 3 | |
| 32. | R4 | I | Red Data Bit 4 | |
| 33. | R5 | I | Red Data Bit 5 | |
| 34. | R6 | I | Red Data Bit 6 | |
| 35. | R7 | I | Red Data Bit 7 | |
| 36. | HSYNC | I | Horizontal Sync Input | |
| 37. | VSYNC | I | Vertical Sync Input | |
| 38. | DCLK | I | Dot Data Clock | |

| | | | | |
|---|---|---|---|---|
| 39. | NC | | Not Use | |
| 40. | NC | | Not Use | |
| 41. | VDDI | I | Digital Power | |
| 42. | VDDI | I | Digital Power | |
| 43. | SPENA | I | SPI Interface Data Enable Signal | Note1 |
| 44. | NC | | Not Use | |
| 45. | NC | | Not Use | |
| 46. | NC | | Not Use | |
| 47. | NC | | Not Use | |
| 48. | NC | | Not Use | |
| 49. | SPCLK | I | SPI Interface Data Clock | Note1 |
| 50. | SPDAT | I | SPI Interface Data | Note1 |
| 51. | NC | | Not Use | |
| 52. | DE | I | Data Enable Input | |
| 53. | GND | I | Ground | |
| 54. | GND | I | Ground | |

**Note1: The module is with a MCU 48R05. The MCU will send the initial code to ST7789 when power ON. Please let these pins open.**



### 6.2 System Function Command Table

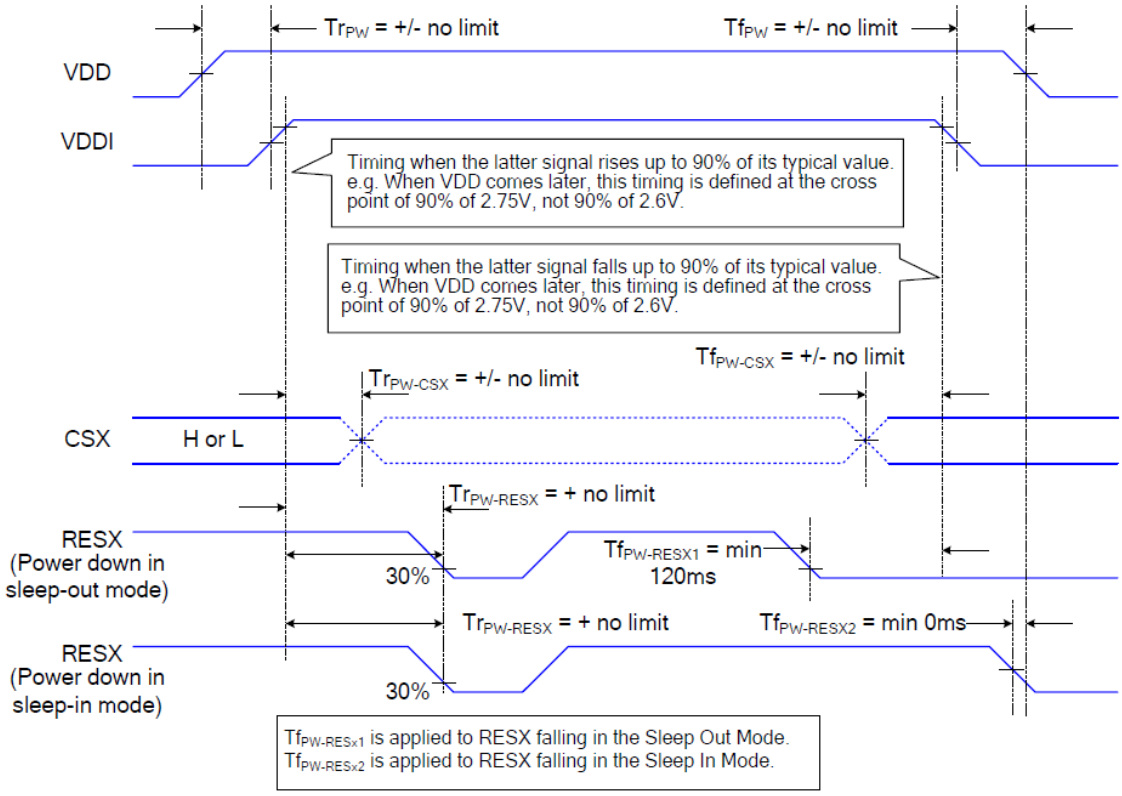
(Please refer to ST7789 data sheet)

# 7 Application

### 7.1 Power ON/OFF Sequence

VDDI can be applied in any order.
VDDI can be power down in any order.
During power off, if LCD is in the Sleep Out mode, VDDI must be powered down minimum 120msec
after RESX has been released.
During power off, if LCD is in the Sleep In mode, VDDI can be powered down minimum 0msec after
RESX has been released.
CSX can be applied at any timing or can be permanently grounded. RESX has priority over CSX.
Note 1: There will be no damage to the display module if the power sequences are not met.
Note 2: There will be no abnormal visible effects on the display panel during the Power On/Off Sequences.
Note 3: There will be no abnormal visible effects on the display between end of Power On Sequence and before receiving Sleep Out
command. Also between receiving Sleep In command and Power Off Sequence.
Note 4: If RESX line is not held stable by host during Power On Sequence as defined in the sequence below, then it will be necessary to
apply a Hardware Reset (RESX) after Host Power On Sequence is complete to ensure correct operation. Otherwise function is not
guaranteed.

The power on/off sequence is illustrated below




### 7.1.1 Uncontrolled Power Off

The uncontrolled power-off means a situation which removed a battery without the controlled power off sequence. It will neither damage the module or the host interface.

If uncontrolled power-off happened, the display will go blank and there will not any visible effect on the display (blank display) and remains blank until “Power On Sequence” powers it up.

**7.2 Power Level Definition**

6 level modes are defined they are in order of Maximum Power consumption to Minimum Power Consumption

1. Normal Mode On (full display), Idle Mode Off, Sleep Out.
   In this mode, the display is able to show maximum 262,144 colors.

2. Partial Mode On, Idle Mode Off, Sleep Out.
   In this mode part of the display is used with maximum 262,144 colors.

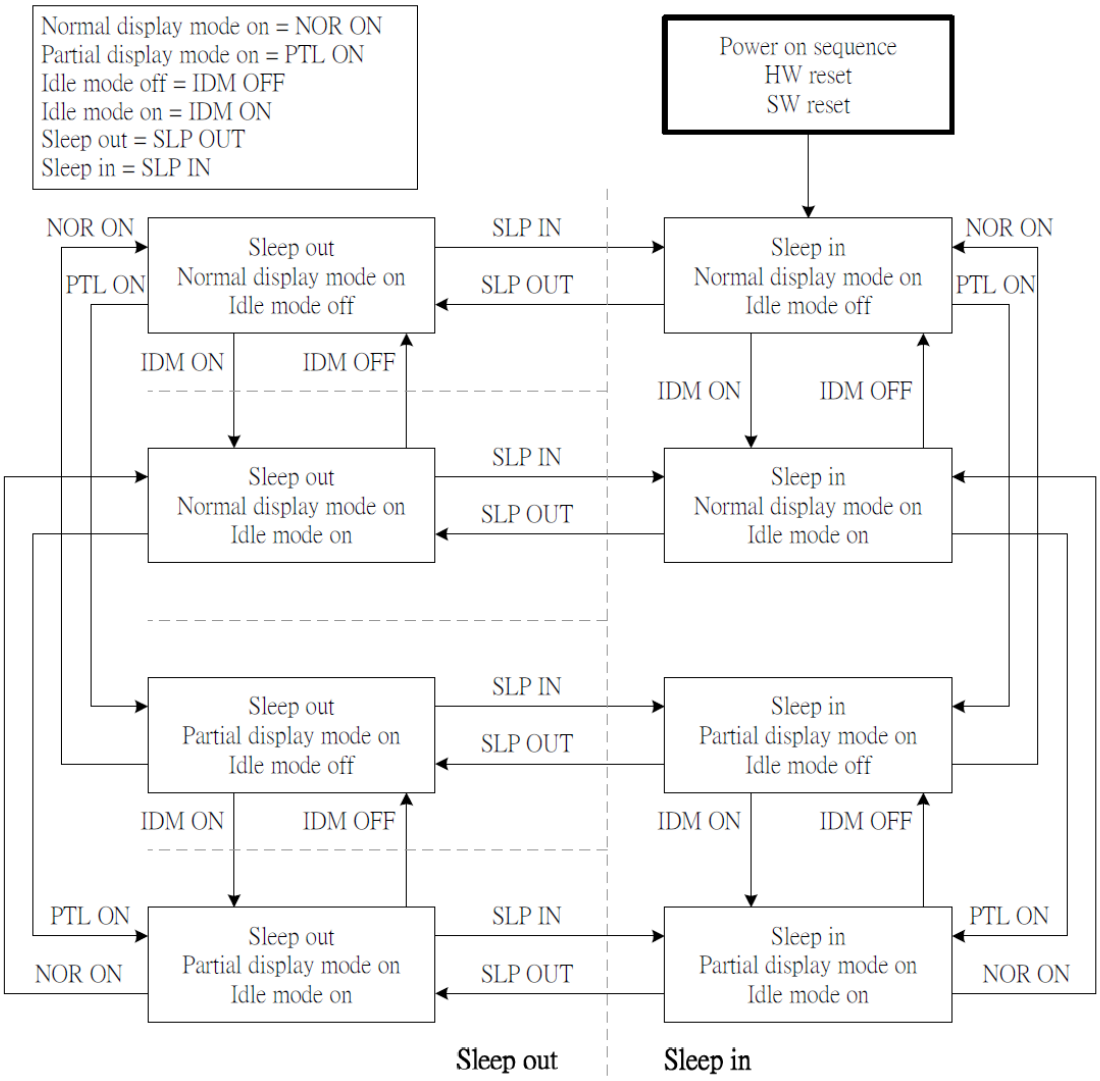
3. Normal Mode On (full display), Idle Mode On, Sleep Out.
   In this mode, the full display area is used but with 8 colors.

4. Partial Mode On, Idle Mode On, Sleep Out.
   In this mode, part of the display is used but with 8 colors.

5. Sleep In Mode
   In this mode, the DC: DC converter, internal oscillator and panel driver circuit are stopped. Only the MCU interface and memory works with VDDI power supply. Contents of the memory are safe.

Note: Transition between modes 1-5 is controllable by MCU commands. Mode 6 is entered only when both Power supplies are removed.

### 7.3 Power Flow Chart



# 8 Electrical Characteristics

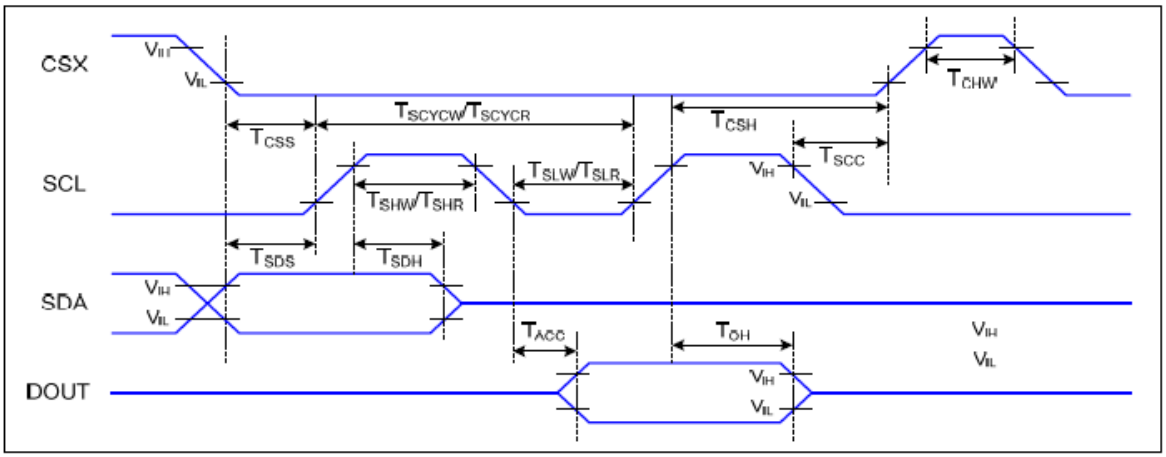
## 8.1 AC Characteristics (SPI Interface Timing Characteristics)

*VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=-30 to 70 ℃*

| Signal | Symbol | Parameter | Min | Max | Unit | Description |
|---|---|---|---|---|---|---|
| CSX | $T_{CSS}$ | Chip select setup time (write) | 15 | | ns | |
| | $T_{CSH}$ | Chip select hold time (write) | 15 | | ns | |
| | $T_{CSS}$ | Chip select setup time (read) | 60 | | ns | |
| | $T_{SCC}$ | Chip select hold time (read) | 65 | | ns | |
| | $T_{CHW}$ | Chip select "H" pulse width | 40 | | ns | |
| SCL | $T_{SCYCW}$ | Serial clock cycle (Write) | 66 | | ns | |
| | $T_{SHW}$ | SCL "H" pulse width (Write) | 15 | | ns | |
| | $T_{SLW}$ | SCL "L" pulse width (Write) | 15 | | ns | |
| | $T_{SCYCR}$ | Serial clock cycle (Read) | 150 | | ns | |
| | $T_{SHR}$ | SCL "H" pulse width (Read) | 60 | | ns | |
| | $T_{SLR}$ | SCL "L" pulse width (Read) | 60 | | ns | |
| SDA (DIN) | $T_{SDS}$ | Data setup time | 10 | | ns | |
| | $T_{SDH}$ | Data hold time | 10 | | ns | |
| DOUT | $T_{ACC}$ | Access time | 10 | 50 | ns | For maximum CL=30pF |
| | $T_{OH}$ | Output disable time | 15 | 50 | ns | For minimum CL=8pF |

**3-line serial Interface Characteristics**

*Note : The rising time and falling time (Tr, Tf) of input signal are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.*



## 8.2 3-Line Serial Interface

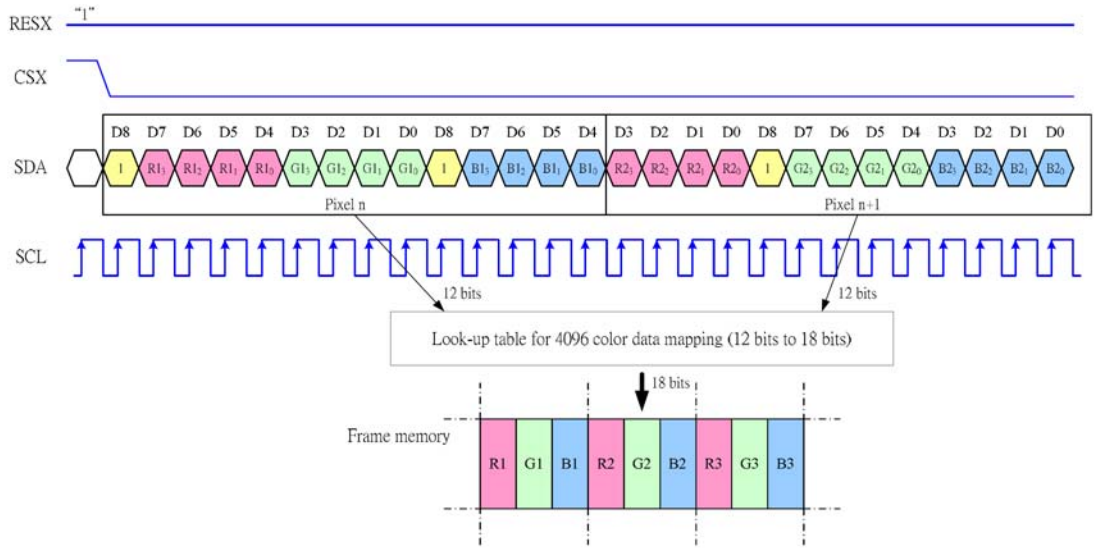
Different display data formats are available for three colors depth supported by the LCM listed below.

4k colors, RGB 4-4-4-bit input

65k colors, RGB 5-6-5-bit input

262k colors, RGB 6-6-6-bit input

**Write data for 12-bit/pixel (RGB-4-4-4 bit input), 4K-Colors, 3Ah="03h"**

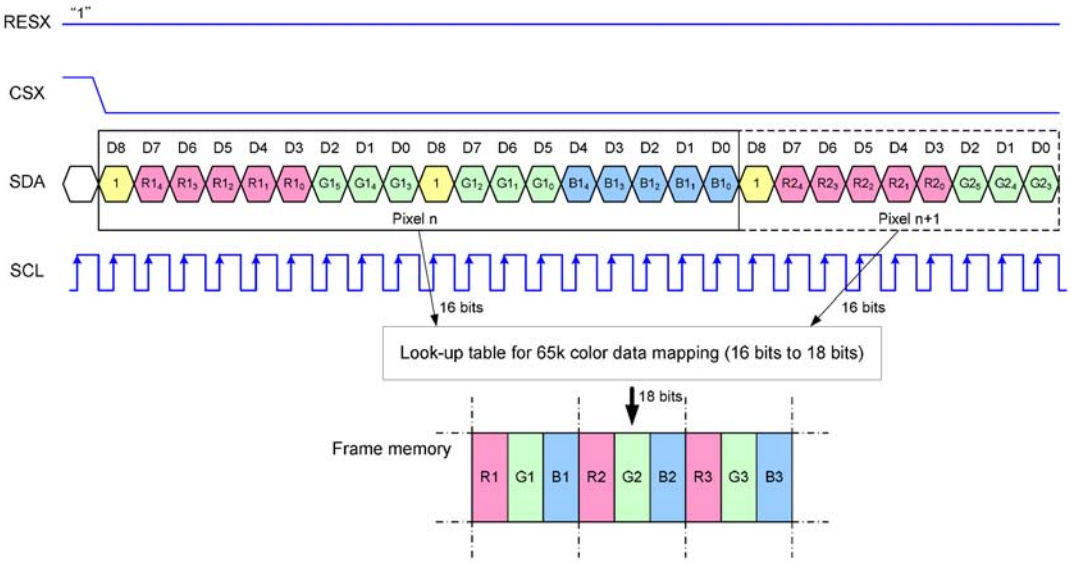



*Note 1: Pixel data with the 16-bit color depth information*

*Note 2: The most significant bits are: Rx4, Gx5 and Bx4*

*Note 3: The least significant bits are: Rx0, Gx0 and Bx0*

**Write data for 16-bit/pixel (RGB 5-6-5-bit input), 65K-Colors, 3Ah="05h"**

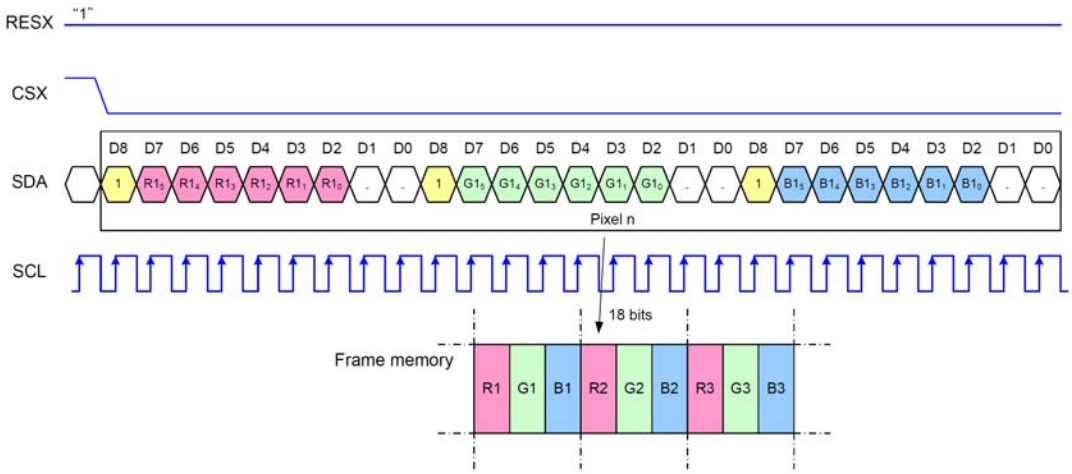



*Note 1: Pixel data with the 16-bit color depth information*

*Note 2: The most significant bits are: Rx4, Gx5 and Bx4*

*Note 3: The least significant bits are: Rx0, Gx0 and Bx0*

**Write data for 18-bit/pixel (RGB-6-6-6-bit input), 262K-Colors, 3Ah=”06h”**




*Note 1: Pixel data with the 18-bit color depth information*

*Note 2: The most significant bits are: Rx5, Gx5 and Bx5*

*Note 3: The least significant bits are: Rx0, Gx0 and Bx0*

## 8.3 RGB Interface

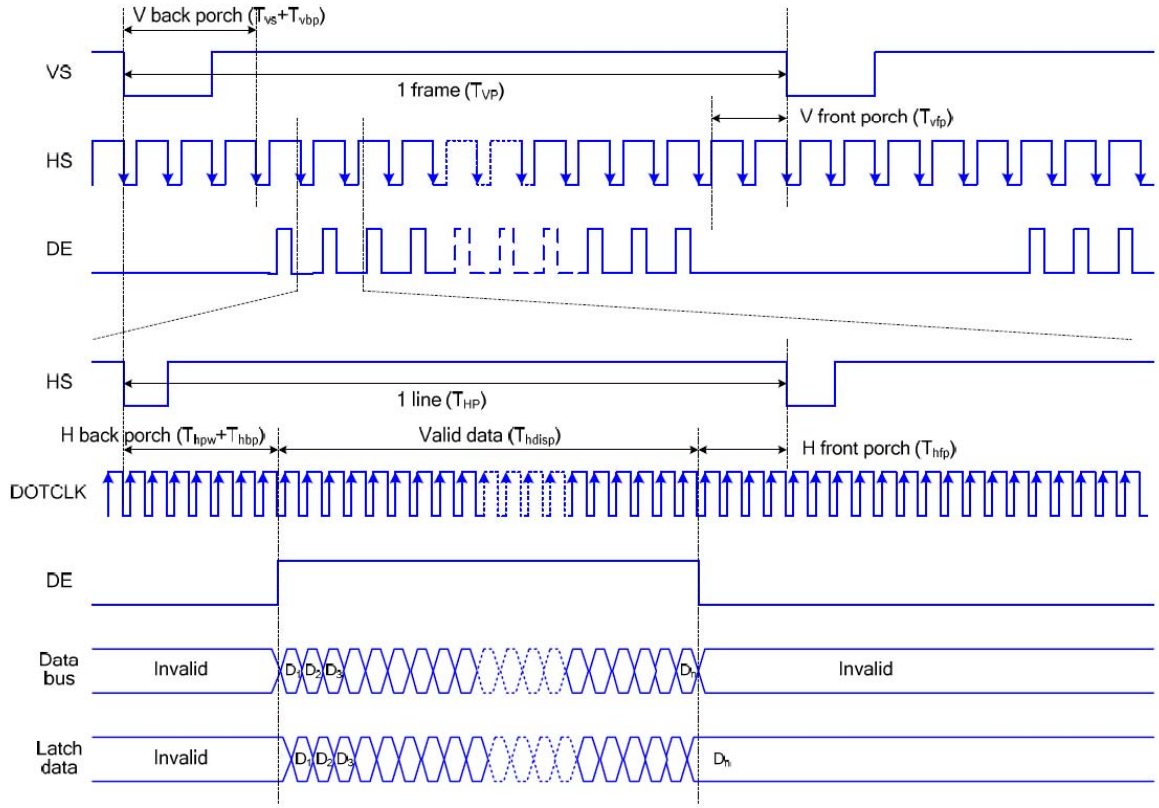
### 8.3.1 RGB Interface Mode Selection

ST7789V supports two kinds of RGB interface, DE mode and HV mode. Each mode also can select with ram and without ram. The table shown below uses command B1h to select RGB interface mode.

| RCM[1:0] | WO | RGB Mode | Data Path |
|---|---|---|---|
| 10 | 0 | DE mode | Ram |
| | 1 | | Shift register (without Ram) |
| 11 | 0 | HV mode | Ram |
| | 1 | | Shift register (without Ram) |

### 8.3.2 RGB Interface Timing

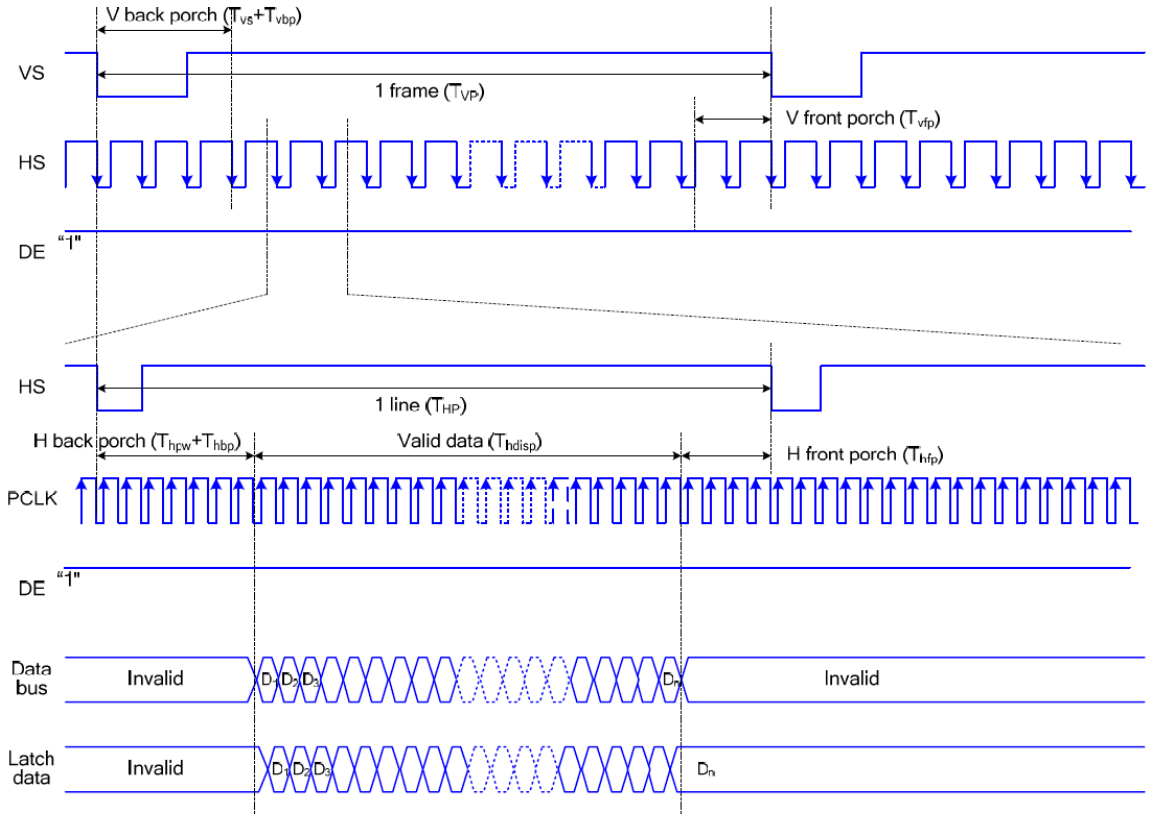
The timing chart of RGB interface DE mode is shown as follows.




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

**Timing Chart of Signals in RGB Interface DE Mode**

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




**Timing chart of RGB interface HV mod**

# 9 TP controller

ST1624 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). ST1624 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.

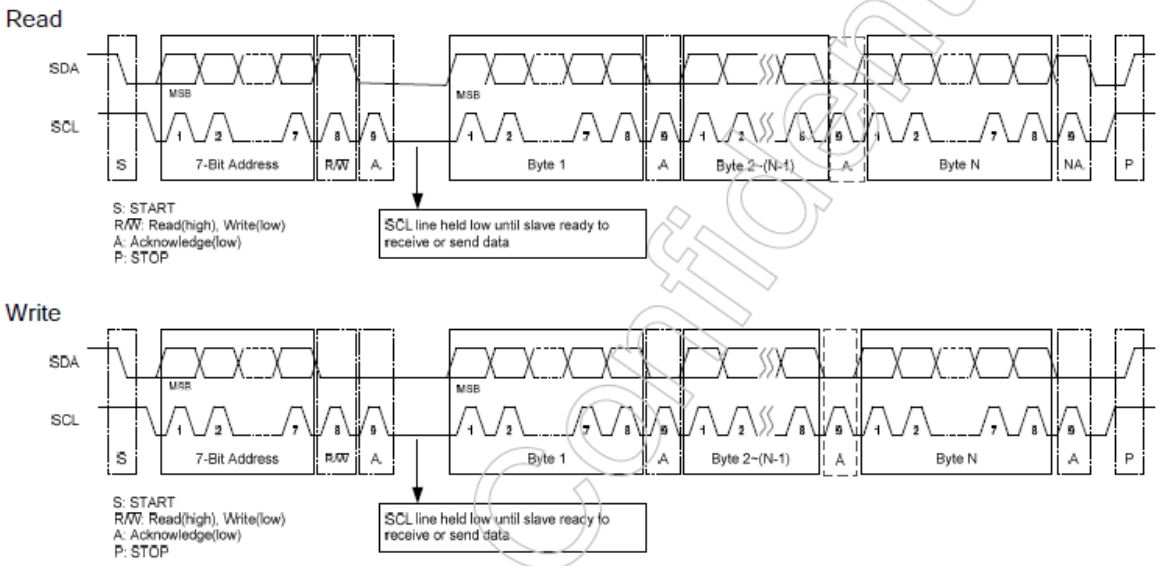



Figure 4-1 I2C Waveform

| Parameter | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| VDD | $V_{VDD}$ | -0.3 | +6 | V |
| IOVDD | $V_{IOVDD}$ | -0.3 | +6 | V |
| Operating Ambient Temperature | $T_A$ | -20 | +80 | ℃ |
| Storage Temperature | $T_S$ | -40 | +125 | ℃ |

Confidential

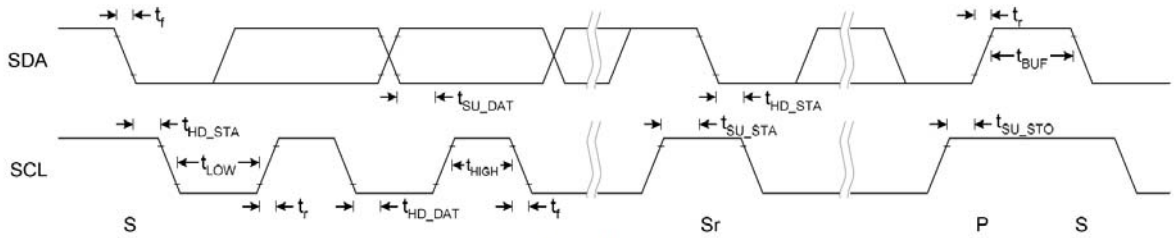



Figure 5-1 I2C Fast Mode Timing

Table 5-3 I2C Fast Mode Timing Characteristic

Conditions: VDD = 3.3V, GND = 0V, $T_A$ = 25°C

| Symbol | Parameter | Rating | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| $f_{SCL}$ | SCL clock frequency | 0 | - | 400 | kHz |
| $t_{LOW}$ | Low period of the SCL clock | 1.3 | - | - | us |
| $t_{HIGH}$ | High period of the SCL clock | 0.6 | - | - | us |
| $t_f$ | Signal falling time | - | - | 300 | ns |
| $t_r$ | Signal rising time | - | - | 300 | ns |
| $t_{SU_STA}$ | Set up time for a repeated START condition | 0.6 | - | - | us |
| $t_{HD_STA}$ | Hold time (repeated) START condition. After this period, the first clock pulse is generated | 0.6 | - | - | us |
| $t_{SU_DAT}$ | Data set up time | 100 | - | - | ns |
| $t_{HD_DAT}$ | Data hold time | 0 | - | 0.9 | us |
| $t_{SU_STO}$ | Set up time for STOP condition | 0.6 | - | - | us |
| $t_{BUF}$ | Bus free time between a STOP and START condition | 1.3 | - | - | us |
| $C_b$ | Capacitive load for each bus line | - | - | 400 | pF |

## TP controller register table

| Reg. Addr. | Name | Bit7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|---|
| 0x10 | Advantaged Touch Info. | Reserved | Proximity Flag (RO) | Reserved | | | | | |
| 0x11 | Keys Reg. | Reserve | | | | | | | |
| 0x12 | XY0 Coord. (High byte) | Valid | X0_H | | | | Y0_H | | |
| 0x13 | X0 Coord. (Low byte) | X0_L | | | | | | | |
| 0x14 | Y0 Coord. (Low byte) | Y0_L | | | | | | | |
| 0x15 | - | Reserve | | | | | | | |
| 0x16 | XY1 Coord. (High byte) | Valid | X1_H | | | | Y1_H | | |
| 0x17 | X1 Coord. (Low byte) | X1_L | | | | | | | |
| 0x18 | Y1 Coord. (Low byte) | Y1_L | | | | | | | |
| 0x19 | - | Reserve | | | | | | | |
| 0x1A~0x21 | …… | …… | | | | | | | |
| 0x22 | XY4 Coord. (High byte) | Valid | X4_H | | | | Y4_H | | |
| 0x23 | X4 Coord. (Low byte) | X4_L | | | | | | | |
| 0x24 | Y4 Coord. (Low byte) | Y4_L | | | | | | | |
| 0x25 | - | Reserve | | | | | | | |

# 10 RELIABILITY

| Test Item | Test Conditions | Note |
|---|---|---|
| High Temperature Operation | 70±3°C , t=240 hrs | |
| Low Temperature Operation | -20±3°C , t=240 hrs | |
| High Temperature Storage | 80±3°C , t=240 hrs | 1,2 |
| Low Temperature Storage | -30±3°C , t=240 hrs | 1,2 |
| Storage at High Temperature and Humidity | 60°C, 90% RH , 240 hrs | 1,2 |
| Thermal Shock Test | -20°C (30min) ~ 70°C (30min)<br>100 cycles | 1,2 |
| Vibration Test (Packing) | Sweep frequency : 10 ~ 55 ~ 10 Hz/1min<br>Amplitude : 0.75mm<br>Test direction : X.Y.Z/3 axis<br>Duration : 30min/each axis | 2 |

Note 1 : Condensation of water is not permitted on the module.

Note 2 : The module should be inspected after 1 hour storage in normal conditions (15-35°C , 45-65%RH).

# 11 USE PRECAUTIONS

## 11.1 Handling precautions

1) The polarizing plate may break easily so be careful when handling it. Do not touch, press or rub it with a hard-material tool like tweezers.
2) Do not touch the polarizing plate surface with bare hands so as not to make it dirty. If the surface or other related part of the polarizing plate is dirty, soak a soft cotton cloth or chamois leather in benzine and wipe off with it. Do not use chemical liquids such as acetone, toluene and isopropyl alcohol. Failure to do so may bring chemical reaction phenomena and deteriorations.
3) Remove any spit or water immediately. If it is left for hours, the suffered part may deform or decolorize.
4) If the LCD element breaks and any LC stuff leaks, do not suck or lick it. Also if LC stuff is stuck on your skin or clothing, wash thoroughly with soap and water immediately.

## 11.2 Installing precautions

1) The PCB has many ICs that may be damaged easily by static electricity. To prevent breaking by static electricity from the human body and clothing, earth the human body properly using the high resistance and discharge static electricity during the operation. In this case, however, the resistance value should be approx. 1MΩ and the resistance should be placed near the human body rather than the ground surface. When the indoor space is dry, static electricity may occur easily so be careful. We recommend the indoor space should be kept with humidity of 60% or more. When a soldering iron or other similar tool is used for assembly, be sure to earth it.
2) When installing the module and ICs, do not bend or twist them. Failure to do so may crack LC element and cause circuit failure.
3) To protect LC element, especially polarizing plate, use a transparent protective plate (e.g., acrylic plate, glass etc) for the product case.
4) Do not use an adhesive like a both-side adhesive tape to make LCD surface (polarizing plate) and product case stick together. Failure to do so may cause the polarizing plate to peel off.

## 11.3 Storage precautions

1) Avoid a high temperature and humidity area. Keep the temperature between 0°C and 35°C and also the humidity under 60%.
2) Choose the dark spaces where the product is not exposed to direct sunlight or fluorescent light.
3) Store the products as they are put in the boxes provided from us or in the same conditions as we recommend.

## 11.4 Operating precautions

1) Do not boost the applied drive voltage abnormally. Failure to do so may break ICs. When applying power voltage, check the electrical features beforehand and be careful. Always turn off the power to the LC module controller before removing or inserting the LC module input connector. If the input connector is removed or inserted while the power is turned on, the LC module internal circuit may break.
2) The display response may be late if the operating temperature is under the normal standard, and the display may be out of order if it is above the normal standard. But this is not a failure; this will be restored if it is within the normal standard.
3) The LCD contrast varies depending on the visual angle, ambient temperature, power voltage etc. Obtain the optimum contrast by adjusting the LC dive voltage.
4) When carrying out the test, do not take the module out of the low-temperature space suddenly. Failure to do so will cause the module condensing, leading to malfunctions.
5) Make certain that each signal noise level is within the standard (L level: 0.2VDDI or less and H level: 0.8VDDI or more) even if the module has functioned properly. If it is beyond the standard, the module may often malfunction. In addition, always connect the module when making noise level measurements.
6) The CMOS ICs are incorporated in the module and the pull-up and pull-down function is not adopted for the input so avoid putting the input signal open while the power is ON.

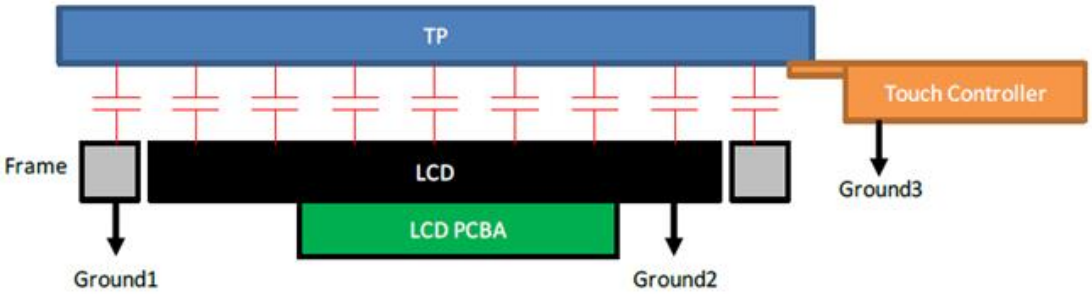
7) The characteristic of the semiconductor element changes when it is exposed to

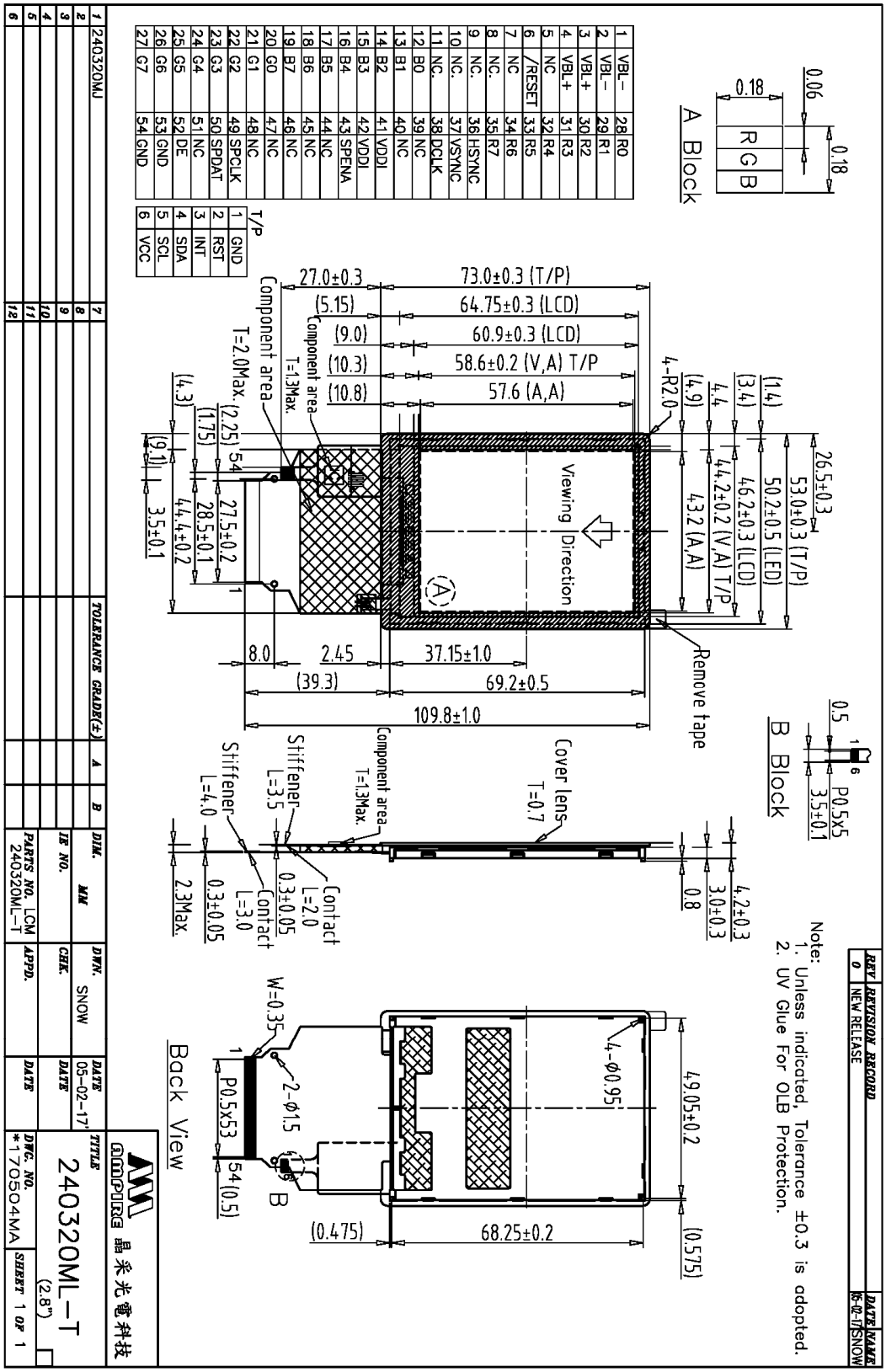
light emissions, therefore ICs on the LCD may malfunction if they receive light emissions. To prevent these malfunctions, design and assemble ICs so that they are shielded from light emissions.

8) Crosstalk occurs because of characteristics of the LCD. In general, crosstalk occurs when the regularized display is maintained. Also, crosstalk is affected by the LC drive voltage. Design the contents of the display, considering crosstalk.

## 11.5 Other

1) Do not disassemble or take the LC module into pieces. The LC modules once disassembled or taken into pieces are not the guarantee articles.
2) Do not keep the LCD at the same display pattern continually. The residual image will happen and it will damage the LCD. Please use screen saver.
3) AMIPRE will provide one year warrantee for all products and three months warrantee for all repairing products.
4) TP needs to work in environment with stable stray capacitance. In order to minimize the variation in stray capacitance, all conductive mechanical parts must not be floating. Intermittent floating any conductive part around the touch sensor may cause significant stray capacitance change and abnormal touch function. It is recommended to keep all conductive parts having same electrical potential as the GND of the touch controller module.




GND1, GND2 and GND3 should be connected together to have the same ground

# 12 MECHANIC DRAWING