

# SPECIFICATION

## FOR LCD MODULE

|                              |                      |
|------------------------------|----------------------|
| <b>MODEL NO:</b>             | <b>TM402CBCWVBYA</b> |
| <b>CUSTOMER:</b>             |                      |
| <b>CUSTOMER P/N.</b>         |                      |
| <b>VERSION</b>               | <b>V1.0</b>          |
| <b>CUSTOMER<br/>APPROVED</b> |                      |

☐ Preliminary specification

☒ Final specification

|             |            |                         |             |
|-------------|------------|-------------------------|-------------|
| PREPARED BY | CHECKED BY | VERIFIED BY<br>QA DEPT. | APPROVED BY |
|             |            |                         |             |

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RoHS

## REVISION RECORD

| Version | Page | Revision Items           | Name     | Date      |
|---------|------|--------------------------|----------|-----------|
| 1.0     |      | First release for new IC | Chenrong | 2008.1.15 |
|         |      |                          |          |           |

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## 1 Description

The TM402CBCWVBYA, Character LCM unit consists of 40-character×2-line dot-matrix(5×8 dot) LCD panel, LCD driver, controller LSI on a single PCB. Incorporating mask ROM-based character generator and display data RAM in the controller LSI, the unit can efficiently display the desired character under microprocessor control.

- ◆ Wide viewing direction.
- ◆ Wide Operating temperature.
- ◆ Requirements on environmental protection: RoHS.

## 2 Features

| Item                  | Contents                  |
|-----------------------|---------------------------|
| LCD type              | STN                       |
|                       | Positive                  |
| LCD Duty              | 1/16                      |
| LCD Bias              | 1/5                       |
| Polarizer             | Transflective             |
| LCD background color  | Yellow-Green              |
| Segment color         | Blue-Black                |
| Backlighting          | LED                       |
| Backlighting type     | Edge                      |
| Backlighting color    | Yellow-Green              |
| Backlighting drive    | 250mA                     |
| View direction        | 6:00(Wide view direction) |
| Operating temperature | -20℃~+70℃                 |
| Storage temperature   | -30℃~+80℃                 |
| Controller            | ST7066U                   |
| Frame                 | SPCC(Black)               |
| Technology            | COB                       |
| Power supply          | VDD=5.0V                  |
| Data Transfer         | 8-Bit Parallel            |

Notes:

- Color tone can slightly change with temperature and driving voltage.
- Color tone will be changed by backlight.

### +3 Absolute maximum ratings

(Without LED backlighting ,Ta=25℃)

| Parameter                    | Symbol | Min      | Max     | Unit | Remark          |
|------------------------------|--------|----------|---------|------|-----------------|
| Logic circuit supply voltage | VCC    | -0.3     | +7.0    | V    |                 |
| LCD driving voltage          | VLCD   | VCC-10.0 | VCC+0.3 | V    |                 |
| Operating temperature range  | Top    | -20      | +70     | ℃    | No Condensation |
| Storage temperature range    | Tst    | -30      | +80     | ℃    |                 |

Note :

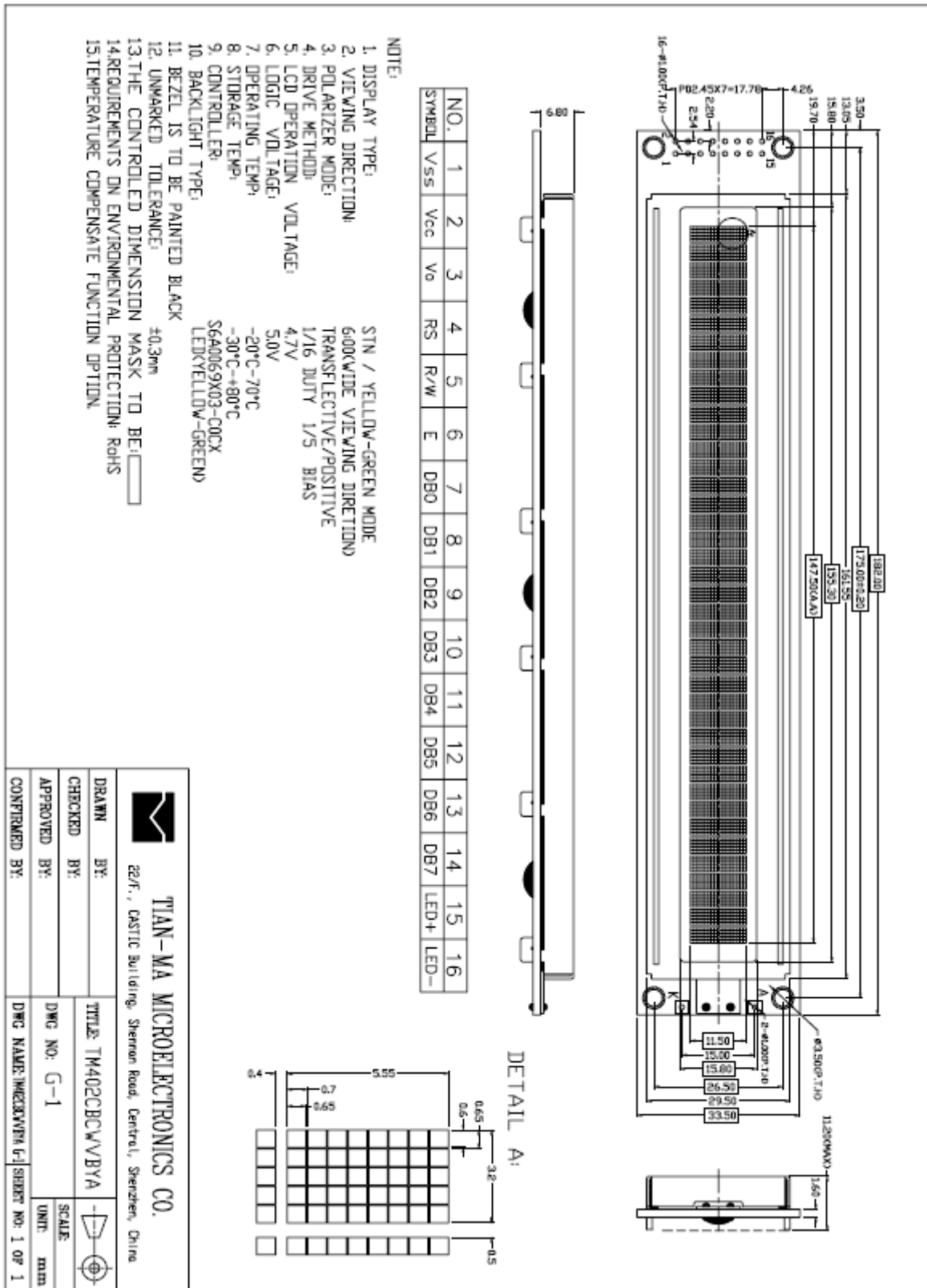
- LCD operating voltage  $V_{LCD}=V_{CC}-V_{ee}$
- If the module is above these absolute maximum ratings. It may become permanently damaged.
- $V_{CC}>V_{SS}$  must be maintained.

## 4 Mechanical Characteristics

### 4.1 Mechanical features

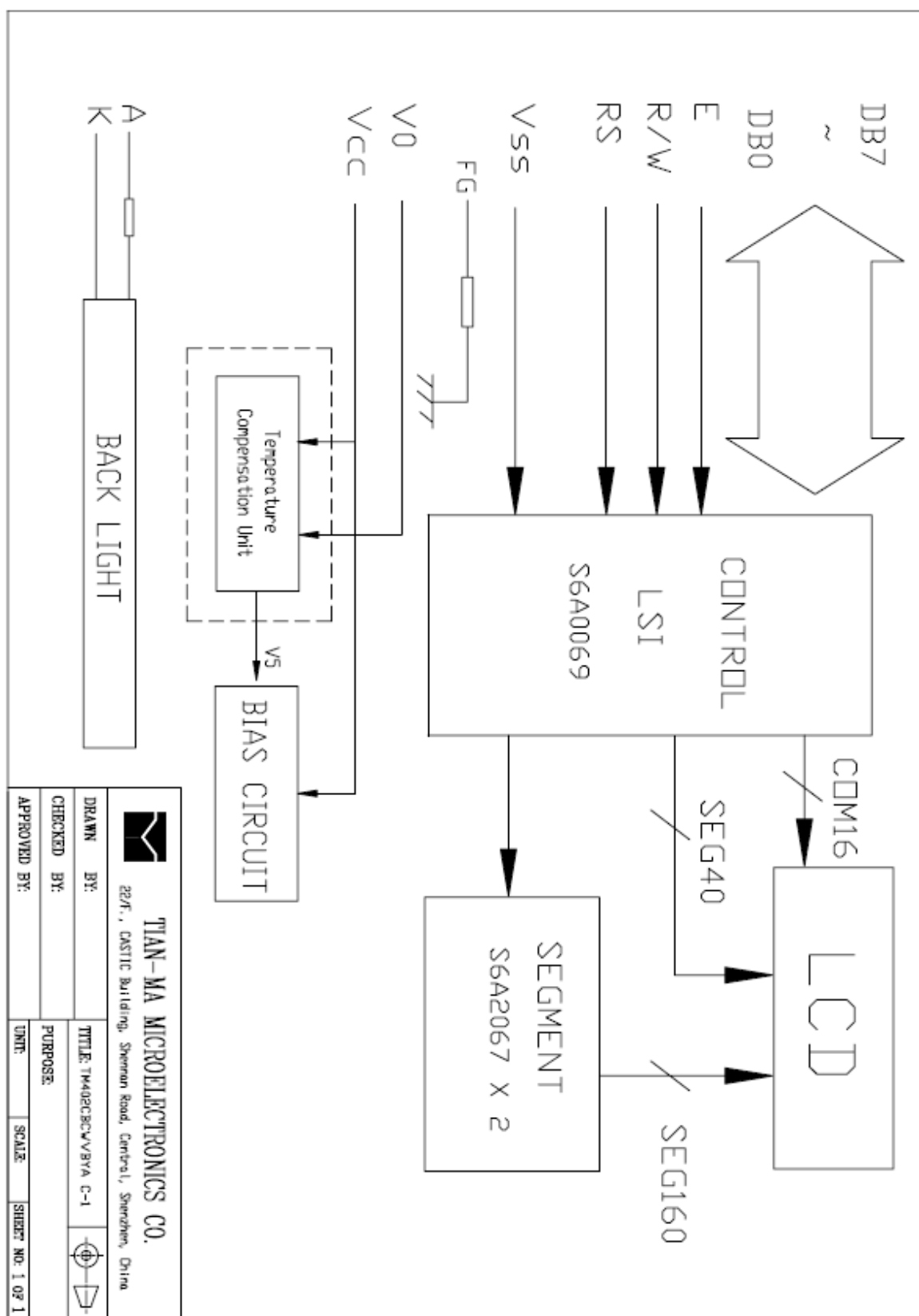
| Parameter                       | Standard Value                    | Unit |
|---------------------------------|-----------------------------------|------|
| Display type                    | Character Module                  | --   |
| Character size(W×H)             | 3.20 × 5.55                       | mm   |
| Number of dots/characters (W×H) | 40 × 2 (5×8)                      | --   |
| View area (W×H)                 | 155.30 × 15.80                    | mm   |
| Active Area (W×H)               | 147.50 × 11.50                    | mm   |
| Dot Size (W×H)                  | 0.60 × 0.65                       | mm   |
| Dot Pitch (W×H)                 | 0.65 × 0.70                       | mm   |
| Module size(W×H×D)              | 182.00 × 33.50 × 11.20(MAX)       | mm   |
| Module total weight (approx)    | 83.5                              | g    |
| Module outline dimensions       | Refer to page 5-“Outline drawing” | --   |

## 4.2 Mechanical drawing.



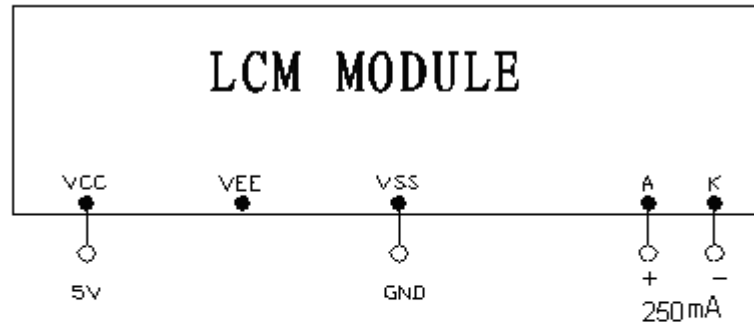
## 5 Circuit

### 5.1 Block Diagram

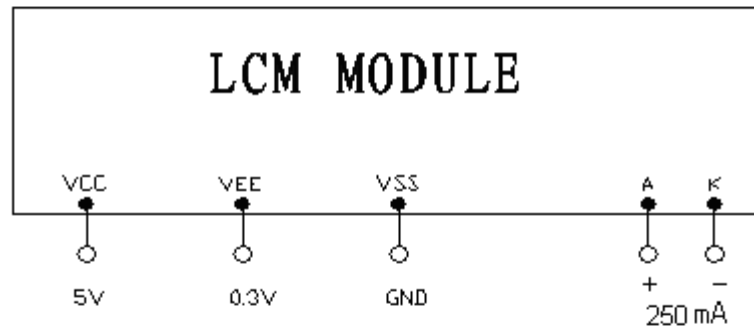


## 5.2 Recommend power supply circuit

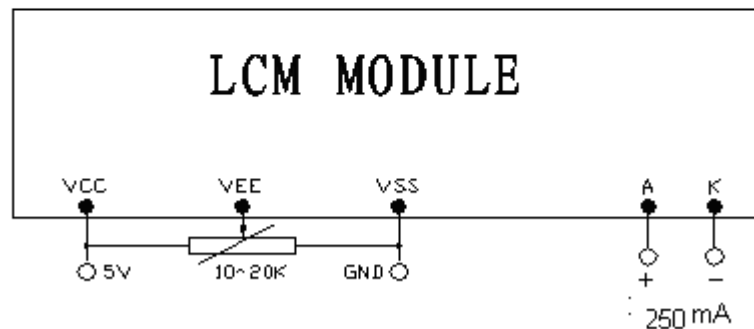
The first driving method



The second driving method



The third driving method



Note:

- You can control the contrast of module outside by add a VR (the third driving method, please remove R11 on PCB)
- You can use fixed current or 4.2VDC to drive the backlight



## 6 Interface description .

| Pin No. | Symbol | I/O   | Description                                |
|---------|--------|-------|--|
| 1       | VSS    | 0V    | Ground                                     |
| 2       | VCC    | 5.0V  | Power supply voltage for logic and LCD(+)  |
| 3       | VEE    | 0.3V  | Power supply voltage for LCD(-)            |
| 4       | RS     | I/O   | Selects registers (H: Data L: Instruction) |
| 5       | R/W    | I/O   | Selects read or write                      |
| 6       | E      | I/O   | Data read/write enable signal              |
| 7       | DB0    | I/O   | Data bit0                                  |
| 8       | DB1    | I/O   | Data bit1                                  |
| 9       | DB2    | I/O   | Data bit2                                  |
| 10      | DB3    | I/O   | Data bit3                                  |
| 11      | DB4    | I/O   | Data bit4                                  |
| 12      | DB5    | I/O   | Data bit5                                  |
| 13      | DB6    | I/O   | Data bit6                                  |
| 14      | DB7    | I/O   | Data bit7                                  |
| 15      | A      | 250mA | Power supply voltage for LED(+)            |
| 16      | K      |       | Power supply voltage for LED(-)            |

## 7 Instruction Code & Timing characteristics

### 7.1 COMMAND

The module TM402CBCWVBYA include the controller-ST7066U. The table below lists the types of commands, including the code of each command. more details refer to ST7066U data sheet please.

| Command                    | Command Code |     |     |      |      |      |      |      |      |      | Command Description   | Execution time (fsoc= 270kHz) |
|----------------------------|--------------|-----|-----|------|------|------|------|------|------|------|---|-------------------------------|
|                            | RS           | R/W | DB7 | DB6  | DB5  | DB4  | DB3  | DB2  | DB1  | DB0  |   |                               |
| Clear Display              | 0            | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 0    | 1    | Write "20H" to DDRAM. and set DDRAM address to "00H" from AC.   | 1.52ms                        |
| Return Home                | 0            | 0   | 0   | 0    | 0    | 0    | 0    | 0    | 1    | X    | Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.          | 1.52ms                        |
| Entry Mode Set             | 0            | 0   | 0   | 0    | 0    | 0    | 0    | 1    | I/D  | S    | Sets cursor move direction and specifies display shift. These operations are performed during data write and read.                        | 37us                          |
| Display ON/OFF Control     | 0            | 0   | 0   | 0    | 0    | 0    | 1    | D    | C    | B    | D=1:entire display on<br>C=1:cursor on<br>B=1:cursor position on  | 37us                          |
| Cursor or Display Shift    | 0            | 0   | 0   | 0    | 0    | 1    | S/C  | R/L  | X    | X    | Set cursor moving and display shift control bit, and the direction, without changing DDRAM data.  | 37us                          |
| Function Set               | 0            | 0   | 0   | 0    | 1    | DL   | N    | F    | X    | X    | Set interface data length (DL : 4-bit/8-bit), numbers of display line (N : 1-line/2-line), display font type(F : 5 X 8 dots/ 5 X 11 dots) | 37us                          |
| Set CGRAM Address          | 0            | 0   | 0   | 1    | AC 5 | AC 4 | AC 3 | AC 2 | AC 1 | AC 0 | Set CGRAM address in address counter.   | 37us                          |
| Set DDRAM Address          | 0            | 0   | 1   | AC 6 | AC 5 | AC 4 | AC 3 | AC 2 | AC 1 | AC 0 | Set DDRAM address in address counter.   | 37us                          |
| Read Busy Flag and Address | 0            | 1   | BF  | AC 6 | AC 5 | AC 4 | AC 3 | AC 2 | AC 1 | AC 0 | Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.                    | 0us                           |
| Write Data to RAM          | 1            | 0   | D7  | D6   | D5   | D4   | D3   | D2   | D1   | D0   | Write data into internal RAM (DDRAM/CGRAM).   | 37 us                         |
| Read Data from RAM         | 1            | 1   | D7  | D6   | D5   | D4   | D3   | D2   | D1   | D0   | Read data from internal RAM (DDRAM/CGRAM).  | 37 us                         |

Be sure the ST7066U is not in the busy state(BF=0) before sending an instruction from the MPU to the

ST7066U.If an instruction is sent without checking the busy flag, the time between the first instruction and next instruction will take much longer than the instruction time itself. Refer to instruction Table for the list of each instruction execution time.

## 7.2 Interface Timing characteristics

Note: Please refer to IC: ST7066U data sheet for more details.

(VCC = 5V, TA =25℃)

| Mode                                 | Characteristics         | Symbol     | Min  | Typ | Max | Unit |
|--------------------------------------|-------------------------|------------|------|-----|-----|------|
| Write Mode<br>(refer to<br>Figure-1) | Enable Cycle Time       | $T_C$      | 1200 | -   | -   | ns   |
|                                      | Enable Rise / Fall Time | $T_R, T_F$ | -    | -   | 25  |      |
|                                      | Enable Pulse Width      | $T_{PW}$   | 140  | -   | -   |      |
|                                      | Address Setup Time      | $T_{AS}$   | 0    | -   | -   |      |
|                                      | Address Hold Time       | $T_{AH}$   | 10   | -   | -   |      |
|                                      | Data Setup Time         | $T_{DSW}$  | 40   | -   | -   |      |
|                                      | Data Hold Time          | $T_H$      | 10   | -   | -   |      |

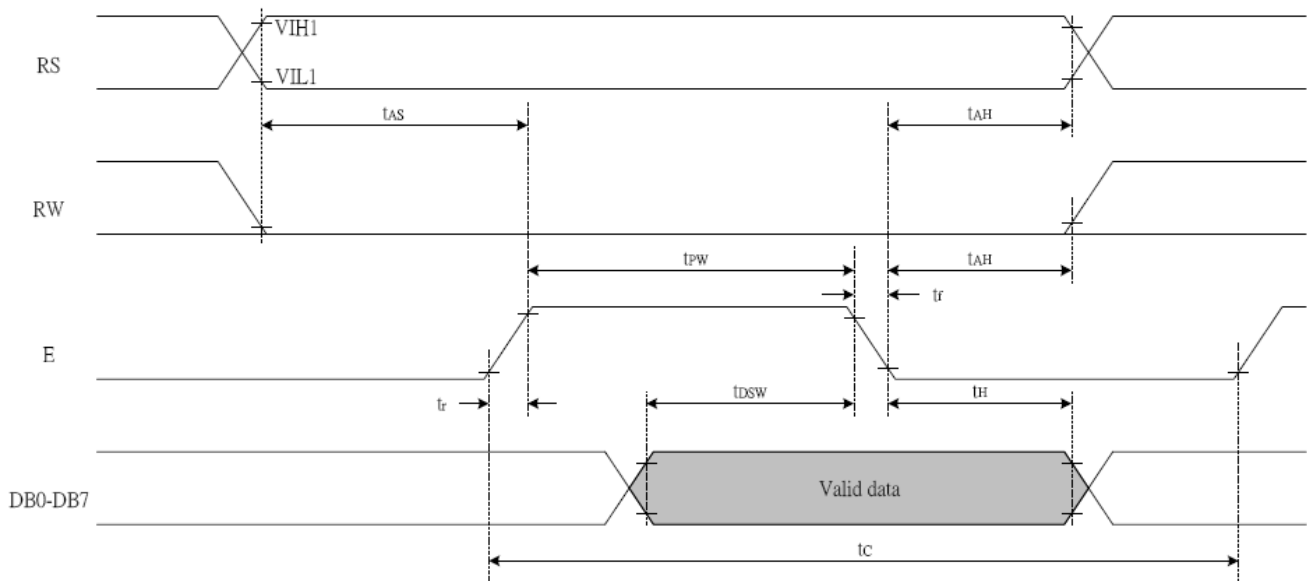


Figure 1. Write Mode Timing Diagram

(VCC = 5V, Ta = 25°C)

| Mode                                | Characteristics         | Symbol       | Min  | Typ | Max | Unit |
|-------------------------------------|-------------------------|--------------|------|-----|-----|------|
| Read Mode<br>(refer to<br>Figure-2) | Enable Cycle Time       | $T_C$        | 1200 | -   | -   | ns   |
|                                     | Enable Rise / Fall Time | $T_{R, T_F}$ | -    | -   | 25  |      |
|                                     | Enable Pulse Width      | $T_{PW}$     | 140  | -   | -   |      |
|                                     | Address Setup Time      | $T_{AS}$     | 0    | -   | -   |      |
|                                     | Address Hold Time       | $T_{AH}$     | 10   | -   | -   |      |
|                                     | Data Setup Time         | $T_{DDR}$    | -    | -   | 100 |      |
|                                     | Data Hold Time          | $T_H$        | 10   | -   | -   |      |

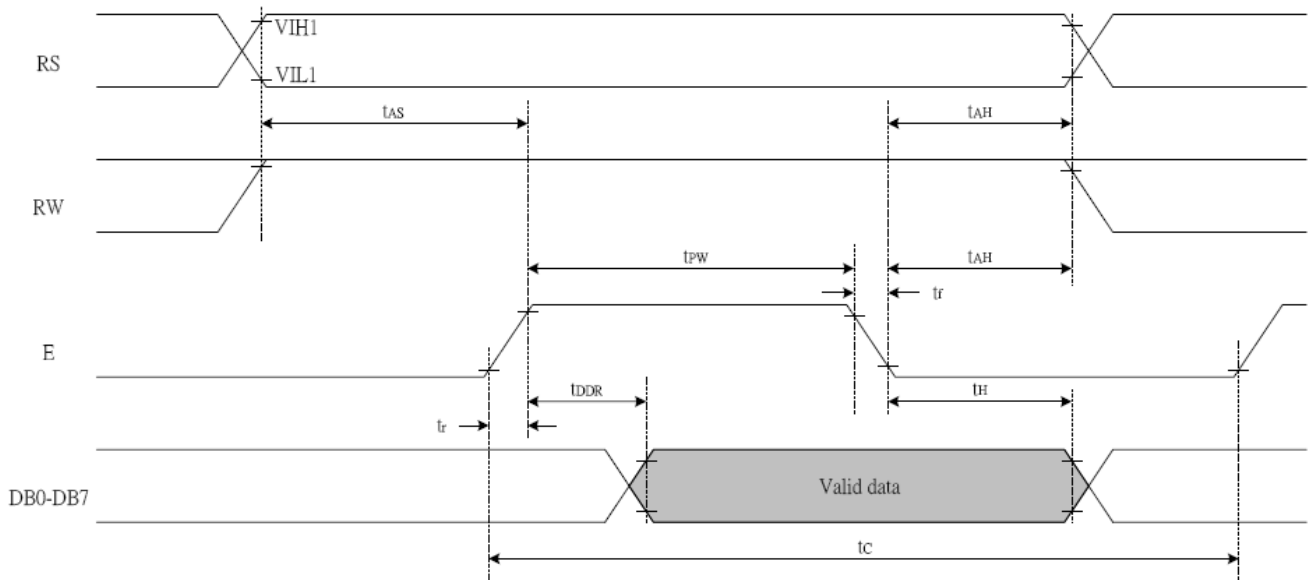


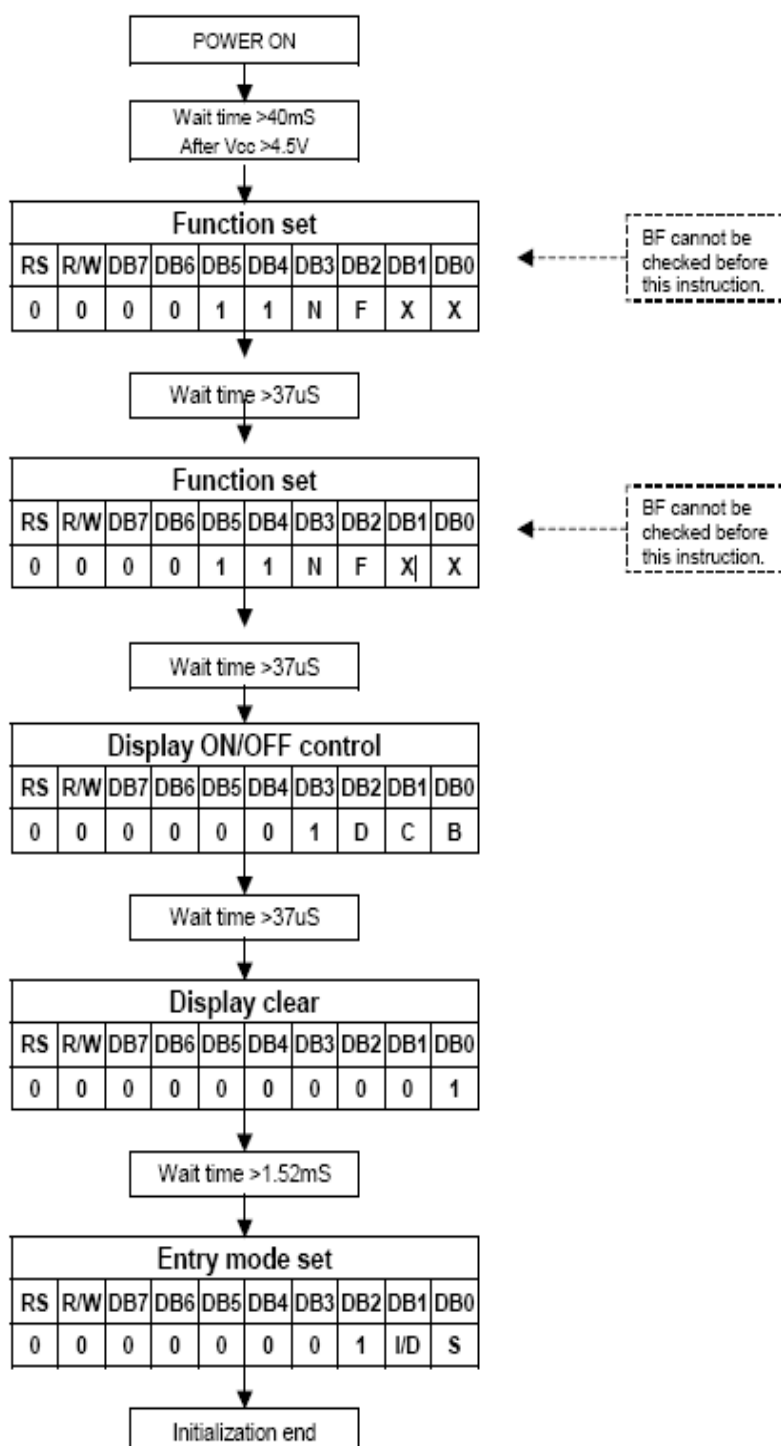
Figure2. Read Mode Timing Diagram

### 7.3 character generator code map(Please refer to ST7066U datasheet for other character code map)

| b7-b4<br>b3-b0 | 0000             | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|----------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0000           | CG<br>RAM<br>(1) |      |      | 0    | 1    | P    | \    | P    |      |      |      | -    | 9    | 3    | 0    | p    |
| 0001           | (2)              |      | !    | 1    | A    | Q    | a    | 9    |      |      | .    | 7    | 7    | 4    | a    | q    |
| 0010           | (3)              |      | "    | 2    | B    | R    | b    | r    |      |      | "    | イ    | ウ    | ×    | β    | θ    |
| 0011           | (4)              |      | #    | 3    | C    | S    | c    | s    |      |      | 」    | ウ    | テ    | エ    | ε    | ※    |
| 0100           | (5)              |      | \$   | 4    | D    | T    | d    | t    |      |      | 、    | エ    | ト    | ト    | μ    | Ω    |
| 0101           | (6)              |      | %    | 5    | E    | U    | e    | u    |      |      | ・    | オ    | オ    | 1    | 0    | 0    |
| 0110           | (7)              |      | &    | 6    | F    | V    | f    | v    |      |      | ヲ    | カ    | ニ    | ヨ    | ρ    | Σ    |
| 0111           | (8)              |      | '    | 7    | G    | W    | g    | w    |      |      | ア    | キ    | マ    | リ    | g    | π    |
| 1000           | (1)              |      | (    | 8    | H    | X    | h    | x    |      |      | イ    | ウ    | ホ    | リ    | フ    | Σ    |
| 1001           | (2)              |      | )    | 9    | I    | Y    | i    | y    |      |      | オ    | ア    | ル    | ル    | リ    | y    |
| 1010           | (3)              |      | *    | :    | J    | Z    | j    | z    |      |      | エ    | コ    | ノ    | ノ    | j    | フ    |
| 1011           | (4)              |      | +    | :    | K    | L    | k    | l    |      |      | オ    | ア    | ヒ    | ロ    | ※    | ※    |
| 1100           | (5)              |      | ,    | <    | L    | ¥    | 1    | 1    |      |      | ト    | ヨ    | フ    | フ    | φ    | π    |
| 1101           | (6)              |      | -    | =    | M    | I    | m    | /    |      |      | ユ    | ズ    | ノ    | ノ    | ト    | ÷    |
| 1110           | (7)              |      | .    | >    | N    | ^    | n    | +    |      |      | ヨ    | エ    | ホ    | ノ    | ノ    |      |
| 1111           | (8)              |      | /    | ?    | O    | _    | o    | *    |      |      | ウ    | ウ    | マ    | ノ    | ノ    |      |

## 7.4 Initialization flow map

(For 8-Bit Interface  $F_{osc}=270KHz$ )

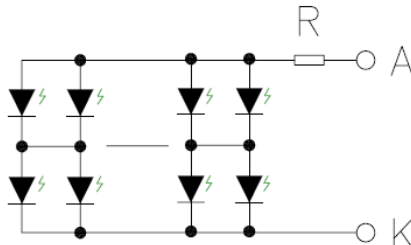


## 8 Electrical characteristics

 $V_{CC}=5.0V$ ,  $V_{SS}=0V$ ,  $T_a=25^{\circ}C$ 

| Parameter  | Symbol              | Condition                         | MIN         | TYP | MAX      | UNIT |
|--|---------------------|-----------------------------------|-------------|-----|----------|------|
| Logic circuit supply voltage                         | $V_{CC}$            | --                                | 4.8         | 5.0 | 5.2      | V    |
| Power supply LCD                                     | $V_{LCD}$           | --                                | 4.4         | 4.7 | 5.0      |      |
| Input voltage for logic circuit                      | "H"level            | $V_{CC}=5.0V$                     | $0.7V_{CC}$ | --  | $V_{CC}$ |      |
|  | "L"level            |                                   | -0.3        | --  | 0.6      |      |
| Output voltage for logic circuit                     | "H"level            |                                   | 3.9         | --  | $V_{CC}$ |      |
|  | "L"level            |                                   | --          | --  | 0.4      |      |
| Logic power supply current<br>(Without backlighting) | $I_{CC}$            | $F_{osc}=270KHz$<br>$V_{CC}=5.0V$ | --          | --  | 3.0      | mA   |
| Used driver IC                                       | ST7066U OF SITRONIX |                                   |             |     |          |      |

## 9 LED backlight characteristics

 $T_a=25^{\circ}C$ 


Circuit diagram (LED 2x25=50 dies)

| Item                 | Symbol       | Condition   | MIN. | TYP. | MAX. | Unit              |
|----------------------|--------------|-------------|------|------|------|-------------------|
| Forward voltage      | $V_f$        | $I_f=250mA$ | 4.0  | 4.2  | 4.4  | V                 |
| Luminous intensity*  | $B_p$        | $I_f=250mA$ | 75   | 100  | --   | cd/m <sup>2</sup> |
| Luminous Uniformity* | $\Delta B_p$ |             | 70   | --   | --   | %                 |
| Peak Wave length     | $\lambda_p$  |             | 569  | 572  | 575  | nm                |

### Note:

- Measured at the bare LED backlight unit.
- If the backlight is above these maximum ratings for long time, the service life of the LED backlight will reduce or it will cause poor reliability.

## 10 Optical Characteristics

### 10.1 Optical Characteristics

Ta=25℃

| Parameter            |            | Symbol   | Ratings |        |      | Unit | Measuring Temp. | Reference    |
|----------------------|------------|--|---------|--------|------|------|-----------------|--------------|
|                      |            |  | Min     | Type   | Max. |      |                 |              |
| Operating voltage    |            | $V_o$  | 4.5     | 4.7    | 4.9  | V    | 25℃             | (Note10-1)   |
| Frame frequency      |            | f  |         | 70     | --   | Hz   | --              | (Note10-2)   |
| Contrast ratio       |            | $Cr(\theta=20^\circ, \Phi=90^\circ \text{ or } 270^\circ)$ | --      | 10     | --   | --   | 25℃             | (Note10-3)   |
| Response time        | Turn on    | $t_{on}$   | --      | --     | 250  | ms   | 25℃             | (Note10-4)   |
|                      |            |  | --      | --     |      |      | 0℃              |              |
|                      | Turn off   | $t_{off}$  | --      | --     | 200  | ms   | 25℃             |              |
|                      |            |  | --      | --     | --   |      | 0℃              |              |
| Viewing angle (Cr≥2) | Up-down    | $\theta_1$<br>( $\Phi=90^\circ \text{ or } 270^\circ$ )    | --      | -45~60 | --   | deg  | 25℃             | [ Note10-5 ] |
|                      | Left-right | $\theta_2$<br>( $\Phi=0^\circ \text{ or } 180^\circ$ )     | --      | -35~40 | --   | deg  | 25℃             |              |

(Note10-1) The maximum and minimum ratings don't mean the LCD works well in the whole range of  $V_o$ .  $V_o$  must be adjusted to optimize the viewing angle and contrast. Refer to definition of drive voltage, refer to 10.2.

(Note10-2) The frequency shouldn't be too low to avoid flicker. Refer to definition of drive voltage, refer to 10.2.

(Note10-3) Refer to 10.2/10.3/10.4/10.5.

(Note10-4) The selected state is dark and non-selected state is white( or bright) with positive type, reversely the selected state is white (or bright) and non-selected state is dark with negative type. Refer to 10.6 definition of response time.

(Note10-5) Generally the viewing direction is 6:00 or 12:00, sometimes 3:00 or 9:00. The range of left to right and up to down based on Cr=2 show the viewing angle. Viewing angle range isn't the range of defects inspection. Refer to 10.4.



## 10.2 Definition of drive voltage

### (1) Definition of drive voltage and waveform

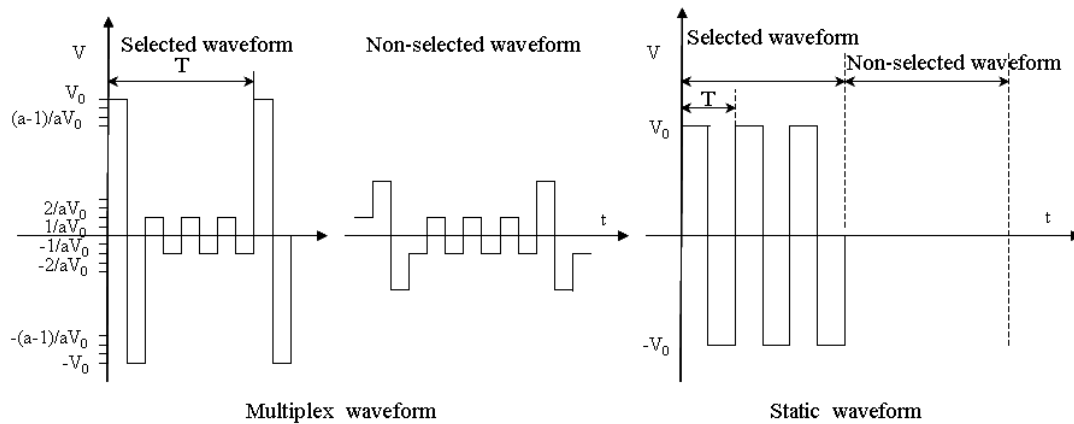


Fig.1 Definition of drive voltage and waveform

Operating voltage:  $V_0$

Frame frequency:  $f=1/T$

Duty:  $1/N$

Bias:  $1/a$

### (2) Operating voltage: $V_0$

TIANMA can evaluate whether the LCD can be redesigned to obtain customer preferable performance if customer's LCD drive voltage isn't adjustable.

## 10.3 Optical characteristics measurement equipment and method

The setup and test method are showed in fig.2. Test methods are different according to different illumination mode.

Transmissive mode: light resource is placed at the back of LCD.

Reflective mode and transfective mode: light resource is placed at the front side of LCD.

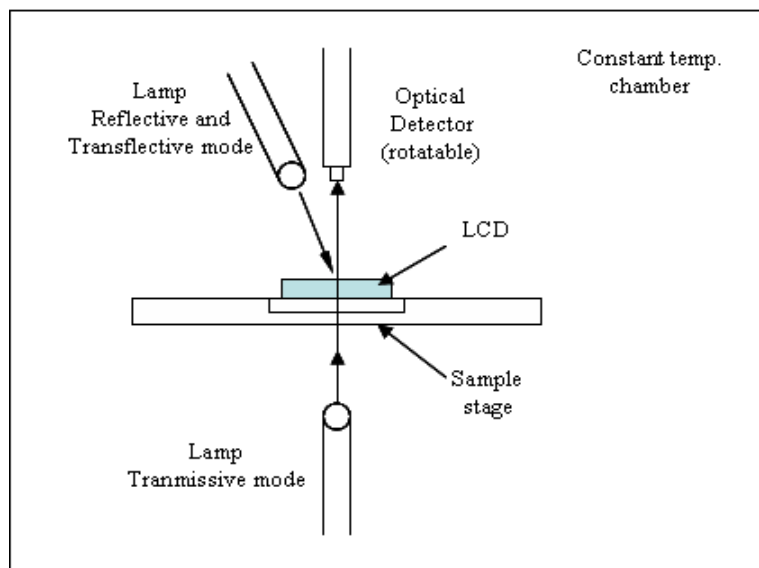


Fig.2 Optical characteristics measurement equipment

The chamber temperature, light resource and driving signal should be stable before testing. If test the characteristics under high or low temperature, the test system should be stable for more than 10 minutes before testing.

## 10.4 Definition of viewing direction

Refer to the graph below marked by  $\theta$  and  $\phi$

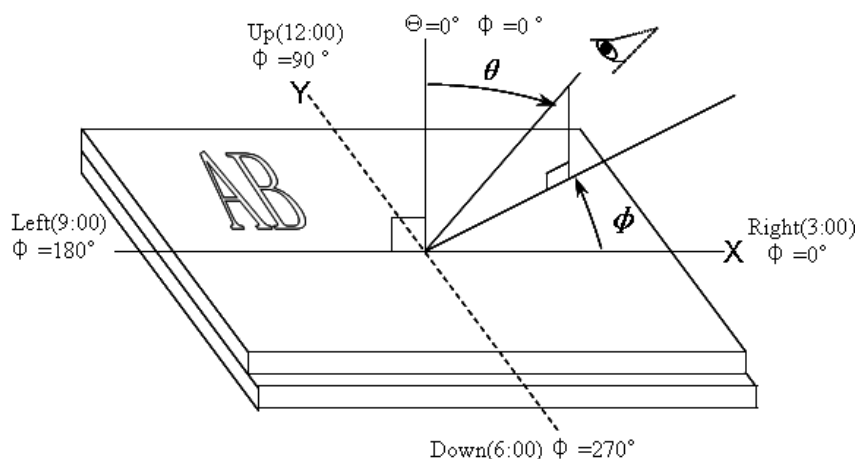


Fig.3 Definition of viewing direction

## 10.5 Definition of contrast ratio

Contrast ratio can be calculated by the formula (10-1) below for positive type. If the LCD is negative type,  $Cr(\theta, \phi)$  is equal to luminance ( $\theta, \phi$ , non-selected state) divided by luminance ( $\theta, \phi$ , selected state). Note3-4 shows the relationship between selected state, non-selected state and bright state, dark state.

$$Cr(\theta, \phi) = \frac{L_2}{L_1} = \frac{\text{Luminance}(\theta, \phi) \text{ (Bright state)}}{\text{Luminance}(\theta, \phi) \text{ (Dark state)}} \quad (10-1)$$

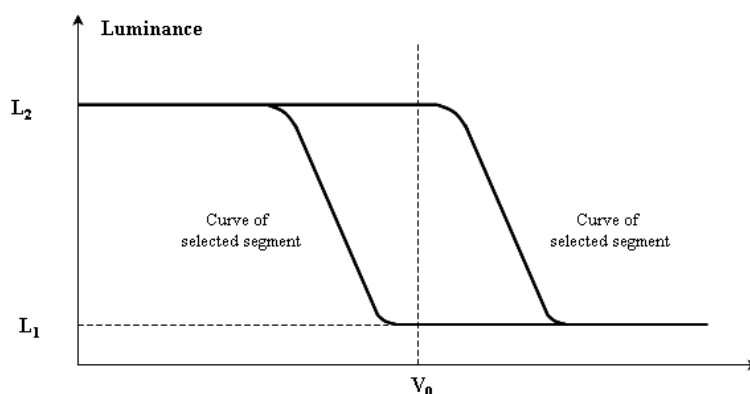


Fig.4 Electro-optical characteristic (EOC) graph (positive type)

## 10.6 Definition of response time

Turn on time (rise time):  $t_{on} = t_d + t_r$  (from non-selected state to selected state)

Turn off time (fall time):  $t_{off} = t_D + t_R$  (from selected state to non-selected state)

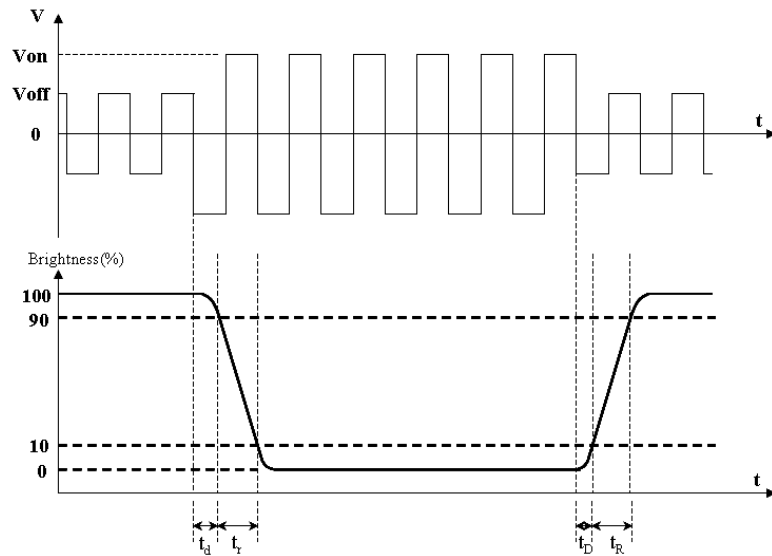


Fig.5 Definition of response time (positive type)

## 10.7 Definition of viewing angle

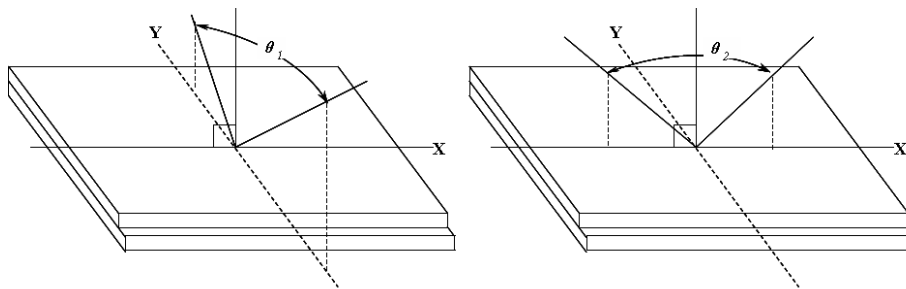


Fig 6 Definition of viewing angle

$\theta_1$  ——range of viewing angle from up to down

$\theta_2$  ——range of viewing angle from left to right.

## 11 Reliability

### 11.1 Content of Reliability Test

Ta=25℃

| No | Test Item                             | Test condition  | Criterion  |
|----|---------------------------------------|---|--|
| 1  | High Temperature Storage              | 80℃±2℃ 240H<br>Restore 2H at 25℃<br>Power off                                     | After testing, cosmetic and electrical defects should not happen.  |
| 2  | Low Temperature Storage               | -30℃±2℃ 240H<br>Restore 2H at 25℃<br>Power off                                    |  |
| 3  | High Temperature Operation            | 70℃±2℃ 240H<br>Restore 2H at 25℃<br>Power on                                      |  |
| 4  | Low Temperature Operation             | -20℃±2℃ 240H<br>Restore 4H at 25℃<br>Power on                                     |  |
| 5  | High Temperature & Humidity Operation | 40℃±2℃ 90%RH 240H<br>Power on   |  |
| 6  | Temperature Cycle                     | -30℃→25℃→80℃<br>30min 5min 30min<br>after 10cycle, Restore 2H at 25℃<br>Power off |  |
| 7  | Vibration Test                        | 10Hz~150Hz, 100m/s <sup>2</sup> , 120min  |  |
| 8  | Shock Test                            | Half-sine wave,300m/s <sup>2</sup> ,11ms  |  |
| 9  | Drop Test(package state)              | 800mm, concrete floor,1corner,<br>3edges, 6 sides each time                       | 1.After testing, cosmetic and electrical defects should not happen.<br>2.the product should remain at initial place<br>3.Product uncovered or package broken is not permitted. |

Notes:

- Each test item applies for a test sample only once, The test sample can not be used again in any other test item.
- The test sample is inspected after 2 hours or more storing at room temperature and room humidity after each test item is finished.
- The criteria refer to 11.2.

**11.2 Inspection of criteria**

| Remark NO. | Content   |
|------------|---|
| 1          | Functional test is OK.<br>Missing Segment, shorts, unclear segment, nondisplay, display abnormally, liquid crystal leak are unallowable.                                      |
| 2          | After testing, cosmetic defects should not happen, no low temperature bubbles, seal loose and fall, frame rainbow, ACF bubble growing are unallowable in the appearance test. |
| 3          | Total current consumption should not be over 10% of initial value.  |
| 4          | After tests being executed, Contrast must be larger than 70% of its initial value prior to the tests.   |
| 5          | No glass crack, chipped glass, end seal loose frame crack and so on.  |
| 6          | No structure loose and fall.  |

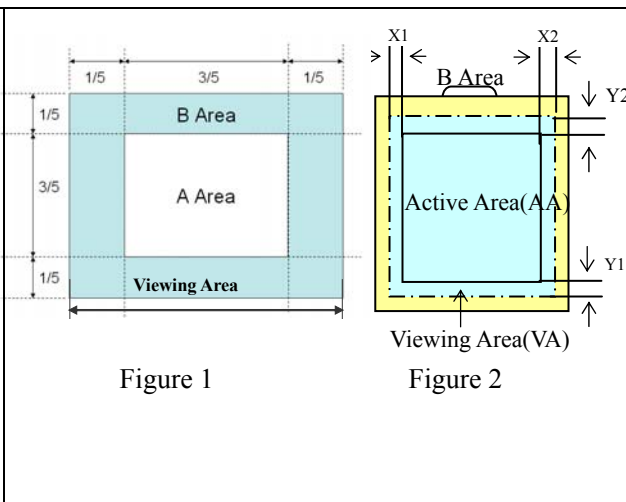
## 12 Quality level

### 12.1 Classification of defects

Major defects (MA): A major defect refers to a defect that may substantially degrade usability for product applications. All functional defects: no display、display abnormally、open or missing segment、short circuit, missing component, outline dimension beyond the drawing, and progressive defects and those affecting reliability.

Minor defects (MI): A minor defect refers to a defect which is not considered to be able substantially degrade the product application or a defect that deviates from existing standards almost unrelated to the effective use of the product or its operation. Black spot, White spot, Bright spot, Pinhole, Black line, White line, Contrast variation, Bubble(Bubble in the cell is not included),Glass defect, and Polarizer defect beyond the standard as follows.

### 12.2 Definition of inspection range

|  |  |
|--|--|
| <p>For dot defect of TFT LCD which is not smaller than 3 inches, dividing three areas to make a judgment (according to figure 1).</p> <p>A zone : center of viewing area<br/>B zone : periphery of viewing area<br/>C zone : Outside viewing area</p> <p>For other defects, dividing two areas to make a judgment (according figure 2).</p> <p>A zone : Inside Viewing area<br/>B zone : Outside Viewing area</p> <p>X1(A.A~V.A): 2mm    X2(A.A~V.A): 2mm<br/>Y1(A.A~V.A): 2mm    Y2(A.A~V.A): 2mm</p> |  <p>Figure 1 shows a square viewing area divided into three horizontal zones: A Area (center), B Area (periphery), and C Area (outside). The dimensions are 1/5 for the top and bottom zones, and 3/5 for the center zone. Figure 2 shows a square viewing area (VA) divided into an Active Area (AA) and a B Area. The dimensions are X1, X2, Y1, and Y2 for the B Area, and the Active Area (AA) is the central square.</p> |
|--|--|

### 12.3 Inspection items and general notes

|                  |   |   |
|------------------|---|---|
| General notes    | <p>①Should any defects which are not specified in this standard happen, additional standard shall be determined by mutual agreement between customer and TIANMA.</p> <p>②Viewing area should be the area which TIANMA guarantees.</p> <p>③Limited sample should be prior to this Inspection standard.</p> <p>④Viewing judgment should be under static pattern.</p> <p>⑤Inspection conditions</p> <p>Inspection distance: 250 mm (from the sample)      Temperature : 25±5 °C</p> <p>Inspection angle : 45 degrees in 12 o'clock direction (all defects in viewing area should be inspected from this direction)</p> |   |
| Inspection items | Pinhole, Bright spot, Black spot, White spot, Black line, White Line, Foreign particle, Bubble  | The color of a small area is different from the remainder. The phenomenon doesn't change with voltage |
|                  | Contrast variation  | The color of a small area is different from the remainder. The phenomenon changes with voltage        |
|                  | Polarizer defect  | Scratch, Dirt, Particle, Bubble on polarizer or between polarizer and glass                           |
|                  | Dot defect (TFT LCD)  | the pixel appears bright or dark abnormally when display.   |
|                  | Functional defect   | no display, display abnormally, open or missing segment, short circuit, False viewing direction       |

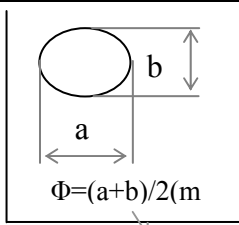
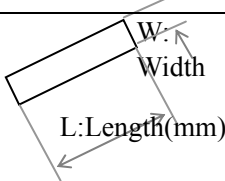
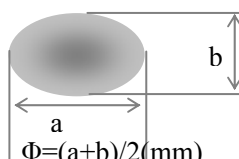
|  |                |   |
|--|----------------|---|
|  | Glass defect   | Glass crack, Shaved corner of glass, Surplus glass        |
|  | Segment defect | Pin holes or cracks in segment, Transformation of segment |
|  | PCB defect     | Components assembly defect                                |


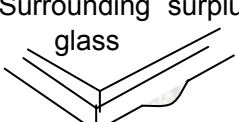
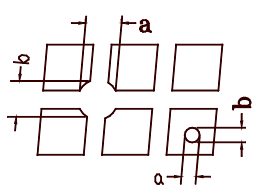
## 12.4 Outgoing Inspection level

| Outgoing Inspection standard | Inspection conditions  | Inspection |      |      |    |      |
|------------------------------|------------------------|------------|------|------|----|------|
|                              |                        | Min.       | Max. | Unit | IL | AQL  |
| Major Defects                | See 13.3 general notes | See        | 13.5 |      | II | 0.65 |
| Minor Defects                | See 13.3 general notes | See        | 13.5 |      | II | 1.5  |

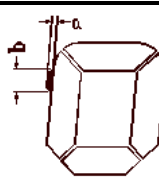
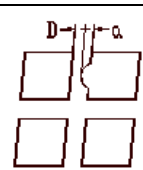
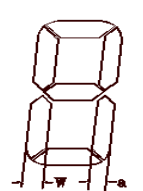
Note: Sampling standard conforms to GB2828

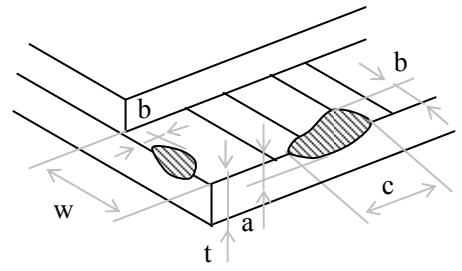
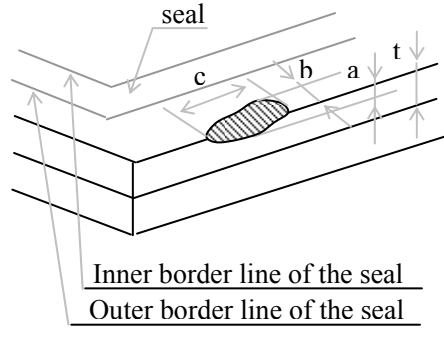
## 12.5 Inspection Items and Criteria

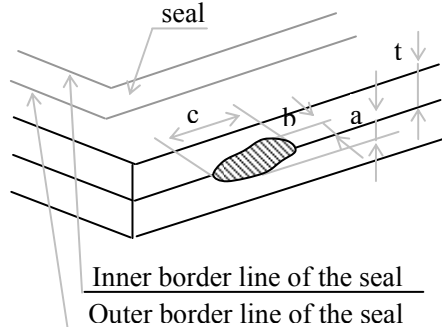
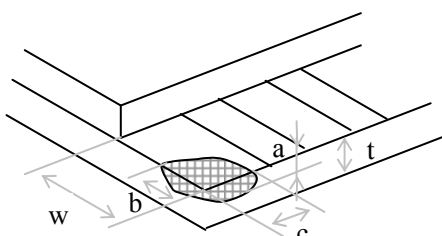
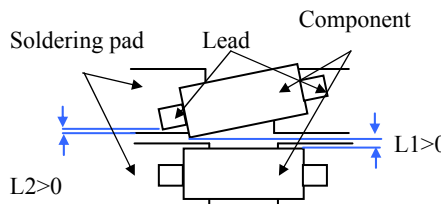
| Inspection items |  |   | Judgment standard          |                                      |                   |        |           |
|------------------|--|---|----------------------------|--------------------------------------|-------------------|--------|-----------|
|                  |  |   | Category                   |                                      | Acceptable number |        |           |
|                  |  |   |                            |                                      | A zone            | B zone |           |
| 1                | Black spot, White spot, Bright Spot, Pinhole, Foreign Particle, Bubble and Particle in or on glass, Scratch on glass |    | A                          | $\Phi \leq 0.10$                     | Neglected         |        | Neglected |
|                  |  |   | B                          | $0.10 < \Phi \leq 0.15$              | 2                 |        |           |
|                  |  |   | C                          | $0.15 < \Phi \leq 0.20$              | 1                 |        |           |
|                  |  |   | D                          | $0.20 < \Phi$                        | 0                 |        |           |
|                  |  |   | Total defective point(B,C) |                                      | 3                 |        |           |
| 2                | Black line, White line, Bubble and Particle Between Polarizer and glass, Scratch on glass                            |   | A                          | $W \leq 0.01$                        | Neglected         |        | Neglected |
|                  |  |   | B                          | $0.01 < W \leq 0.03$<br>$L \leq 3.0$ | 2                 |        |           |
|                  |  |   | C                          | $0.03 < W \leq 0.05$<br>$L \leq 3.0$ | 1                 |        |           |
|                  |  |   | D                          | $0.05 < W$                           | 0                 |        |           |
|                  |  |   | Total defective point(B,C) |                                      | 3                 |        |           |
| 3                | Contrast variation   |  | A                          | $\Phi \leq 0.2$                      | Neglected         |        | Neglected |
|                  |  |   | B                          | $0.2 < \Phi \leq 0.3$                | 2                 |        |           |
|                  |  |   | C                          | $0.3 < \Phi \leq 0.4$                | 1                 |        |           |
|                  |  |   | D                          | $0.4 < \Phi$                         | 0                 |        |           |
|                  |  |   | Total defective point(B,C) |                                      | 3                 |        |           |
| 4                | Dot defect (if TFT LCD is used)  | TFT LCD is smaller than 3 inches  | LCD Class                  | Defect                               | A zone            |        | B zone    |
|                  |  |   | A                          | Bright dot                           | 1                 |        | Neglected |
|                  |  |   |                            | Dark dot                             | 2                 |        |           |
|                  |  |   |                            | Total                                | 2                 |        |           |
|                  |  |   | B                          | Bright dot                           | 2                 |        |           |
|                  |  |   |                            | Dark dot                             | 3                 |        |           |
|                  |  |   |                            | Total                                | 4                 |        |           |
|                  |  | TFT LCD between 3~10.4 inches   | LCD Class                  | Defect                               | A zone            | B zone | C zone    |
|                  |  |   | A                          | Bright dot                           | 1                 | 1      | Neglected |
|                  |  |   |                            | Dark dot                             | 1                 | 2      |           |
|                  |  |   |                            | Total                                | 4                 |        |           |
|                  |  |   | B                          | Bright dot                           | 2                 | 2      |           |
|                  |  |   |                            | Dark dot                             | 2                 | 3      |           |
|                  |  |   |                            | Total                                | 6                 |        |           |

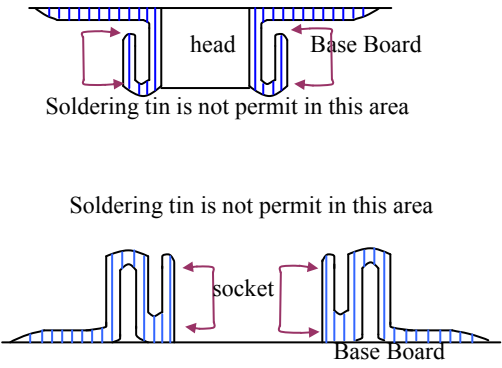
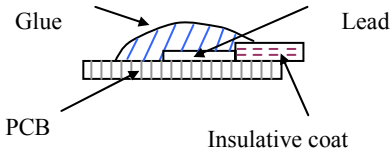
|    |  |   |  |   |           |                    |
|----|--|---|--|---|-----------|--------------------|
|    |  | Notes:<br>Bright dot: in R、G、B or dark display figure, the pixel appears bright.<br>Dark dot: in R、G、B or white display figure, the pixel appears dark.<br>Defect area must be less than an half size of the dot. |  |   |           |                    |
| 5  | Bubble inside cell                         |   | any size   |   | none      | none               |
| 6  | Polarizer defect<br>(if Polarizer is used) | Scratch ,damage on polarizer, Particle on polarizer or between polarizer and glass.   | Refer to item 1 and item 2.                                    |   |           |                    |
|    |  | Bubble, dent and convex   | A  | $\Phi \leq 0.3$                         | Neglected | Neglected          |
|    |  |   | B  | $0.3 < \Phi \leq 0.7$                   | 2         |                    |
|    |  |   | C  | $0.7 < \Phi$                            | 0         |                    |
|    |  |   | Total defective point(B,C)                                     |   | 2         |                    |
| 7  | Surplus glass                              | <div>Stage surplus glass<br/></div>  | $b \leq 0.3\text{mm}$  |   |           |                    |
|    |  | <div>Surrounding surplus glass<br/></div>  | Should not influence outline dimension and assembling.         |   |           |                    |
| 8  | Open segment or open common                |   | Not permitted  |   |           |                    |
| 9  | Short circuit                              |   | Not permitted  |   |           |                    |
| 10 | False viewing direction                    |   | Not permitted  |   |           |                    |
| 11 | Contrast ratio uneven                      |   | According to the limit specimen                                |   |           |                    |
| 12 | Crosstalk                                  |   | According to the limit specimen                                |   |           |                    |
| 13 | Black /White spot(display)                 |   | Refer to item 1  |   |           |                    |
| 14 | Black /White line(display)                 |   | Refer to item 2  |   |           |                    |
| 15 | Pin holes and cracks in segment            | <div></div>  | not counted  | Max.3 dots allowed                      |           | Max.3 dots allowed |
|    |  |   | $x < 0.1\text{mm}$   | $0.1\text{mm} \leq x \leq 0.2\text{mm}$ |           |                    |
|    |  |   | $x = (a+b)/2$  |   |           |                    |
|    |  | not counted   | Max.2 dots allowed   |   |           |                    |
|    |  | $A < 0.1\text{mm}$  | $0.1\text{mm} \leq A \leq 0.2\text{mm}$<br>$D < 0.25\text{mm}$ |   |           |                    |



|    |                           |   |  |  |                       |
|----|---------------------------|---|--|--|-----------------------|
| 16 | Transformation of segment |  | not counted  | Max.1 defects allowed each segment             | Max.3 defects allowed |
|    |                           |   | $x<0.1\text{mm}$   | $0.1\text{mm}\leq x\leq 0.2\text{mm}$          |                       |
|    |                           |   | $x=(a+b)/2$  |  |                       |
|    |                           |  | not counted  | Max.1 defects allowed each segment             |                       |
|    |                           |   | $a<0.1\text{mm}$   | $0.1\text{mm}\leq a\leq 0.2\text{mm}$<br>$D>0$ |                       |
|    |                           |  | $0.8W\leq a\leq 1.2W$<br>$a=\text{measured value of width}$<br>$W=\text{nominal value of width}$ |  | Max.2 defects allowed |
|    |                           |   |  |  |                       |

| Inspection items |                    |  | Judgment standard                         |   |
|------------------|--------------------|--|---|---|
|                  |                    |  | Category(application: B zone)             |   |
| 17               | Glass defect crack | ①The front of lead terminals<br>        | A   | If $a \leq t$ and $b \leq 1.0$ , $c$ is not limited                               |
|                  |                    |  | B   | $a \leq t$ , $1 \leq b \leq 2\text{mm}$ , $c \leq 3\text{mm}$                     |
|                  |                    |  | C   | If glass crack cover alignment mark and patterns, $b \leq 0.5\text{mm}$ .         |
|                  |                    |  | D   | Crack at two sides of lead terminals should not cover patterns and alignment mark |
|                  |                    | ②Surrounding crack—non-contact side<br> | $b < \text{Inner borderline of the seal}$ |   |
|                  |                    |  |   |   |

|    |            |   |  |   |
|----|------------|---|--|---|
|    |            | <p>③ Surrounding crack— contact side seal</p>  <p><u>Inner border line of the seal</u><br/><u>Outer border line of the seal</u></p>  | <p><math>b &lt; \text{Outer borderline of the seal}</math></p>                       |   |
|    |            | <p>④ Corner</p>    | A  | <p><math>a \leq t, \quad b \leq 3.0, \quad c \leq 3.0</math></p> <p>*Glass crack should not cover patterns u and alignment mark and patterns.</p> |
| 18 | PCB defect | <p>Component soldering:<br/>No cold soldering、short、open circuit、burr、tin ball<br/>The flat encapsulation component position deviation must be less than 1/3 width of the pin (Pic.1);<br/>the sheet component deviation:<br/>Pin deviates from the pad and contact with the near components is not permitted (Pic.2)</p> |  |   |
|    |            | <p>lead defect:<br/>The lead lack must be less than 1/3 of its width;<br/>The lead burr must be less than 1/3 of the seam;<br/>Impurities connect with the near leads is not permitted</p>  |  |   |

|  |  |  |  |
|--|--|--|--|
|  |  | <p>Connector soldering:</p> <p>Soldering tin is at contact position of the plug and socket is not permitted</p> <p>No foundation is scald</p> <p>Serious cave distortion on plug and socket contact pin is not permitted</p> |  |
|  |  | <p>Glue on root of the speaker receiver and motor lead:</p> <p>The insulative coat of the lead must join into the PCB; the protected glue must envelop to the insulative coat.</p>   |  |

## 13 Precautions for Use of LCD Modules

### 13.1 Handling Precautions

- 13.1.1 The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.
- 13.1.2 Liquid in LCD is hazardous substance, 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, thoroughly and promptly wash it off using soap and water.
- 13.1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.
- 13.1.4 Don't touch, push or rub the exposed polarizer covering the display surface of the LCD module with anything harder than an HB pencil lead, the polarizer is soft and easily scratched, handle it carefully.
- 13.1.5 Don't put or attach anything on the display area to avoid leaving any marks on.
- 13.1.6 If the display surface is contaminated or becomes dusty, breathe on the surface and gently wipe it with a soft dry cloth. do not scrub hard to avoid damage the surface. 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
- 13.1.7 Do not attempt to disassemble the LCD Module.
- 13.1.8 If the logic circuit power is off, do not apply the input signals.
- 13.1.9 Avoid using the same display pattern long time ( continuous ON segment).Software must be prepared so that the pattern will be changed
- 13.1.10 To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.
- a. Be sure to ground the body and electric appliances when handling the LCD Modules. It is preferable to use conductive mat on table and wear cotton clothes or conductive processed fibre. Synthetic fibre is not recommended.
  - 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 LCD Module is coated with a film to protect the display surface. Be careful and slow when peeling off this protective film since static electricity may be generated. It is recommended to use ionic fan or machine when operating. It is recommended to remove the protection foil slowly (> 3 sec.).
  - e. It is preferable to wear gloves etc, to avoid damaging the LCD. Please do not touch electrodes with bare hands or avoid any other contamination.

### 13.2 Storage precautions

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

13.2.2 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 :  $5^{\circ}\text{C} \sim 40^{\circ}\text{C}$

Relatively humidity:  $\leq 80\%$

13.2.3 The LCD modules should be stored in a clean environment or room, free from acid, alkali and harmful gas.

13.2.4 Store the module in anti-static electricity container and without any physical load.

### 13.3 Transportation precautions

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

### 13.4 Soldering

13.4.1 Use the high quality solders, only solder the I/O terminals.

13.4.2 No higher than  $280^{\circ}\text{C}$  and time less than 3-4 second during soldering.

13.4.3 Rewiring: no more than 3 times.

13.4.4 when you remove connector or cable soldered to I/O terminals, please confirm that solder is fully melted. If you remove by force, electrodes at I/O terminals may be damaged (or stripped off). It is recommended to use solder suction machine.

## 14. LCD Module Part Numbering System

|           |            |          |          |          |          |          |          |          |          |
|-----------|------------|----------|----------|----------|----------|----------|----------|----------|----------|
| <b>TM</b> | <b>402</b> | <b>C</b> | <b>B</b> | <b>C</b> | <b>W</b> | <b>V</b> | <b>B</b> | <b>Y</b> | <b>A</b> |
| ①         | ②          | ③        | ④        | ⑤        | ⑥        | ⑦        | ⑧        | ⑨        | ⑩        |

| NO. | Explanation                                   |                                  |
|-----|---|----------------------------------|
| ①   | TIANMA module indicating                      |                                  |
| ②   | Module type: 3 DIGITS, 40-Character × 2-Line, |                                  |
| ③   | TIANMA module series (A,B,C,D...J)            |                                  |
| ④   | <b>LCD type</b>                               |                                  |
|     | B   | Positive, Yellow-Green mode, STN |
| ⑤   | <b>Backlight type</b>                         |                                  |
|     | C   | Transflective, LED               |
| ⑥   | <b>Temperature range</b>                      |                                  |
|     | W   | Wide temperature                 |
| ⑦   | <b>Viewing Angle</b>                          |                                  |
|     | V   | Wide viewing direction           |
| ⑧   | <b>Technology</b>                             |                                  |
|     | B   | COB (including SMT)              |
| ⑨   | <b>The color of backlight</b>                 |                                  |
|     | Y   | Yellow-green                     |
| ⑩   | <b>Function choice</b>                        |                                  |
|     | A   | Basic function                   |
|     |   |                                  |
|     |   |                                  |
|     |   |                                  |