

**BOLYMIN**

**SPECIFICATIONS FOR  
LCD MODULE**

MODEL NO.  
BO128128BFPHH\$  
VER.03

**ROHS**  
COMPLIANT

FOR MESSRS:

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ON DATE OF:

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APPROVED BY:

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**BOLYMIN, INC.**

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### History of Version

| Version | Contents  | Date       | Note  |
|---------|---|------------|---|
| 01      | NEW VERSION   | 2009/04/01 | SPEC.   |
| 02      | <p style="text-align: center;"><b>Add Handling Instruction</b><br/> <b>Update Quality Assurance and Reliability</b><br/> <b>Modify Drawing</b></p>                                    | 2013/02/05 | <p style="text-align: right;">Page<br/>5・14・16<br/>17</p> |
| 03      | <p><b>Modify Handling Precaution ・ Absolute Maximum Rating</b><br/> <b>・ Electrical Characteristics ・ Optical Characteristics ・</b><br/> <b>Quality Assurance and Reliability</b></p> | 2016/05/20 | <p style="text-align: right;">Page<br/>5~10<br/>15~17</p> |
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## 1. Numbering System

|          |          |               |          |          |          |          |          |          |           |
|----------|----------|---------------|----------|----------|----------|----------|----------|----------|-----------|
| <u>B</u> | <u>O</u> | <u>128128</u> | <u>B</u> | <u>F</u> | <u>P</u> | <u>H</u> | <u>:</u> | <u>H</u> | <u>\$</u> |
| 0        | 1        | 2             | 3        | 4        | 5        | 6        | 7        | 8        | 9         |

|          |  |  |   |
|----------|--|--|---|
| <b>0</b> | Brand  | Bolymin  |   |
| <b>1</b> | Module Type                                    | C= character type<br>G= graphic type<br>P= TAB/TCP type  | O= COG type<br>F= COF type<br>L=PLED/OLED   |
| <b>2</b> | Format   | 2002=20 characters, 2 lines<br>12232= 122 x 32 dots  |   |
| <b>3</b> | Version No.                                    | A type   |   |
| <b>4</b> | LCD Color                                      | G=STN/gray<br>Y=STN/yellow-green<br>PLED/yellow-green<br>C=color STN,OLED/RGB  | B=STN/blue,OLED/blue<br>F=FSTN<br>T=TN  |
| <b>5</b> | LCD Type                                       | R=positive/reflective<br>P=positive/transflective  | M=positive/transmissive<br>N=negative/transmissive  |
| <b>6</b> | Backlight type/color                           | L=LED array/ yellow-green<br>H=LED edge/white<br>R=LED array/red<br>G=LED edge/yellow-green<br>F=RGB array<br>I=RGB edge<br>Q=LED edge/red<br>N=No backlight | D=LED edge/blue<br>E=EL/white<br>B=EL/blue<br>C=CCFL/white<br>Y=LED Bottom/yellow<br>O=LED array/orange<br>K=LED edge/green<br>A=LED edge/amber |
| <b>7</b> | CGRAM Font<br>(applied only on character type) | J=English/Japanese Font<br>E=English/European Font<br>G=Chinese(simple)<br>F=Chinese(traditional)  | C=English/Cyrillic Font<br>H=English/Hebrew Font<br>A=English/Arabic Font   |
| <b>8</b> | View Angle/ Operating Temperature              | B=Bottom/Normal Temperature<br>H=Bottom/Wide Temperature<br>U=Bottom/Ultra wide Temperature  | T=Top/Normal Temperature<br>W=Top/Wide Temperature<br>C=9H/Normal Temperature<br>E=Top/ultra wide temperature                                   |
| <b>9</b> | Special Code                                   | 3=3.3 volt logic power supply<br>n=negative voltage for LCD<br>c=cable/connector<br>xxx=to be assigned on datasheet  | t=temperature compensation for LCD<br>p=touch panel<br>\$=RoHS  |

## 2. Handling Precaution

### 2.1 Precaution in use of LCD Module

- 2.1.1. LCD panel is made of glass. Avoid excessive mechanical shock or applying strong pressure and/or sharp tools on the surface of display area.
- 2.1.2. The polarizer placed on the display surface is easily scratched and damaged. Extreme care should be taken when handling it. To clean dust or dirt off the display surface, wipe gently with cotton, or other soft material soaked with isopropyl alcohol, ethyl alcohol, do not use water, ketone or aromatics to clear display surface, and never scrub it hard.
- 2.1.3. Keep LCD panels away from direct sunlight. The storage environment should be dust-free, clean, dry, temperature is  $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$  and the humidity is below 55% RH.
- 2.1.4. Do not input any signal before power is turned on.
- 2.1.5. Avoid pressing on the metal bezel, otherwise the elastomer connector could be deformed and lose contact, resulting in missing pixels and also cause rainbow on the display.
- 2.1.6. It's important to control soldering temperature and time. RoHS compliant materials might need higher temperature and time, but try to keep temperature under  $350^{\circ}\text{C}$  and time in 3-5 sec.
- 2.1.7. EL is manufactured from the organic film, and is easily affected by temperature, humidity and other environmental impact. Long time storage might cause low quality of the case. Therefore, please start production in 3 months after reception of the LCM. If in any case, long time storage over 3 months is necessary, please keep EL in vacuum package or at least in humidity  $< 35\%$  RH, and temperature  $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$ .  
Note: 2.1.7. is applied to EL backlight only.

### 2.2 Static Electricity Precautions:

- 2.2.1. The LCD module contains a C-MOS LSI. People who operate the LCM should wear ESD protection equipment to prevent ESD hurt on products.
- 2.2.2. Do not touch any of the conductive parts such as the LSI pads; the copper leads on the PCB and the interface terminals with any parts of the human body.
- 2.2.3. Do not touch the connection terminals of the display with bare hand; it will cause disconnection or defective insulation of terminals.
- 2.2.4. The modules should be kept in anti-static bags or trays for storage.
- 2.2.5. Only properly grounded soldering irons should be used.
- 2.2.6. If an electric screwdriver is used, it should be grounded and shielded to prevent sparks.
- 2.2.7. The normal static prevention measures should be observed for work clothes and working benches.
- 2.2.8. Since dry air(almost low RH) is inductive to static, a humidity of 50-60% RH is recommended in assembly line.

### 2.3 Operation Precautions:

- 2.3.1. DC voltage applied on LCM causes electrochemical reactions, which will deteriorate the display over time. The applied pulse waveform should be a symmetric waveform such that no DC component remains. Be sure to use the specified operating voltage.
- 2.3.2. LCD driving voltage should be kept within specified range; excess voltage will shorten display life, while less voltage may not turn on LCM.
- 2.3.3. LCM response time will be extremely delayed in low operating temperature(such as  $-20^{\circ}\text{C}$ ) than in room operating temperature. Therefore, higher LCD driving voltage is required in low operating temperature; On the other hand, in high operating temperature (such as  $+70^{\circ}\text{C}$ ) LCD shows dark background color, therefore lower LCD driving voltage is required. Be sure to use the specified LCD driving voltage in different operating temperature.

## 2.4 Safety:

- 2.4.1 If the LCD panel breaks, be careful not to get the liquid crystal to touch your skin.  
If the liquid crystal touches your skin or clothes, please wash it off immediately by using soap and water.

## 2.5 WARRANTY POLICY

**Bolymin .Will provide one-year warranty for the products only if under specification operating conditions.**

**If there are functional defects found during the period of warranty, the defective products would be replaced on a one-to-one basis.**

**Bolymin would not be responsible for any direct/indirect liabilities consequential to any parties.**

## 2.6 MTBF

- 2.6.1 .By specific test condition, MTBF based on 30°C normal operation temperature is 50,000hours.

### 2.6.2 Test Condition:

2.6.2.1 Supply Voltage for LCM: Typical Vdd

2.6.2.2 CC (Constant Current) mode and typical current is applied for LED.

2.6.2.3 Run-Patterns: by Bolymin's test program that has defined patterns and cyclic period.

2.6.2.4 Humidity: 60%RH

### 2.6.3 Test Criteria:

Attenuation of average brightness:  $\leq 50\%$

Increasing of current consumption for LCM/Backlight:  $\leq 20\%$

Display function at room temperature: Normal

Appearance: Normal

### 3. General Specification

#### (1) Mechanical Dimension

| Item                            | Dimension        | Unit |
|---------------------------------|------------------|------|
| Number of Dots                  | 128 x 128        | dots |
| Module dimension<br>(L x W x H) | 72.4x115.8 x 6.0 | mm   |
| View area                       | 50 x 50          | mm   |
| Active area                     | 44.77 x 44.77    | mm   |
| Dot size                        | 0.32x 0.32       | mm   |
| Dot pitch                       | 0.35 x 0.35      | mm   |

#### (2) Controller IC: ST7541i controller

### 4. Absolute Maximum Ratings

#### 4.1 Electrical Absolute Maximum Ratings

(V<sub>SS</sub>=0V, T<sub>a</sub>=25°C)

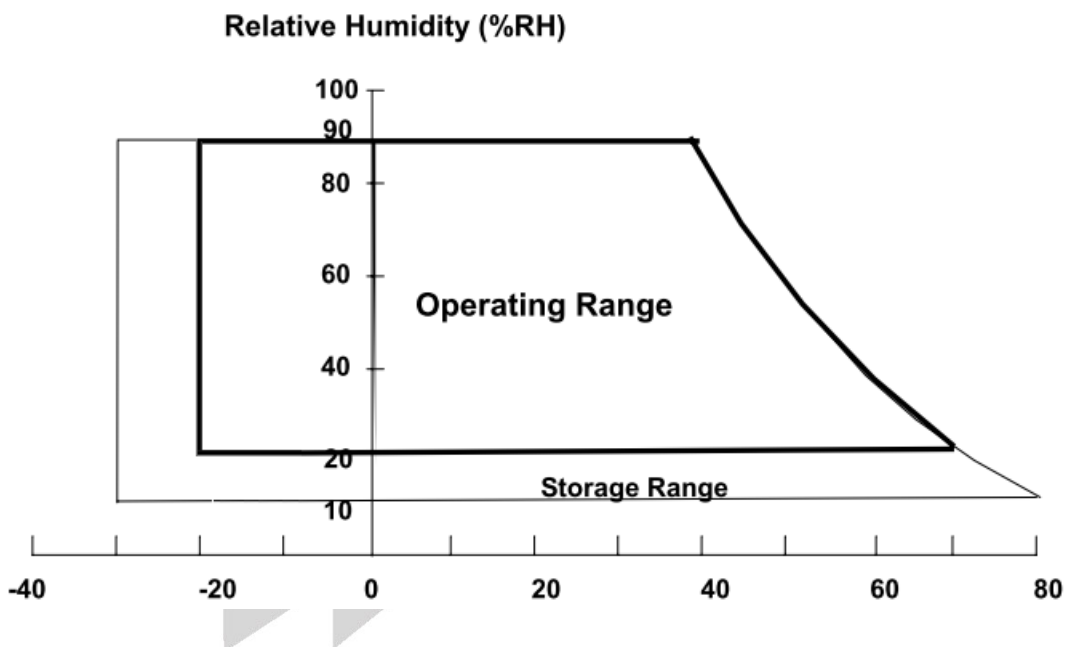
| Item                     | Symbol                           | Min | Typ | Max | Unit |
|--------------------------|----------------------------------|-----|-----|-----|------|
| Supply Voltage For Logic | V <sub>DD</sub> -V <sub>SS</sub> | 1.8 | -   | 3.3 | V    |
| Supply Voltage For LCD   | V <sub>O</sub> -V <sub>SS</sub>  | 3.5 | -   | 15  | V    |

## 4.2 Environmental Absolute Maximum Ratings

| Item                  | Symbol | Min | Max | Unit | Note |
|-----------------------|--------|-----|-----|------|------|
| Operating Temperature | TOP    | -20 | 70  | °C   | (1)  |
| Storage Temperature   | TST    | -30 | 80  | °C   | (1)  |

Note (1)

- (a) 90 %RH Max. ( $T_a \leq 40$  °C).
- (b) Wet-bulb temperature should be 39 °C Max. ( $T_a > 40$  °C).
- (c) No condensation.

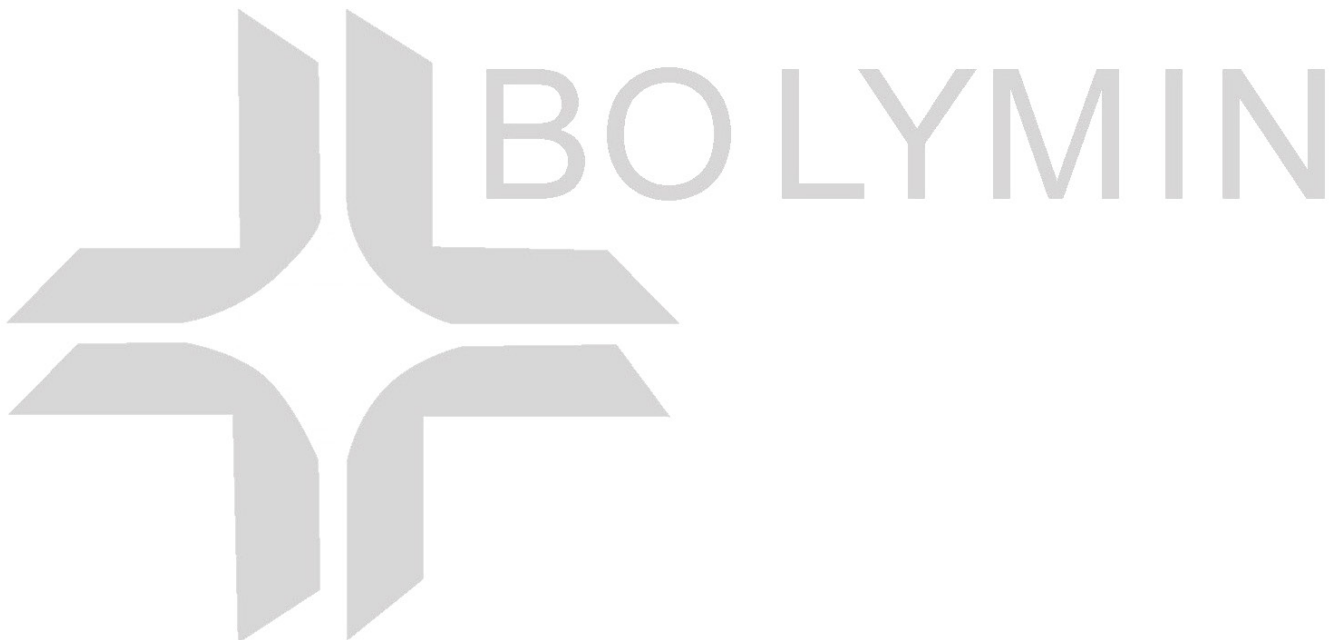




## 5. Electrical Characteristics

| Item                                  | Symbol          | Condition                                 | Min     | Typ  | Max     | Unit              |
|---------------------------------------|-----------------|---|---------|------|---------|-------------------|
| Supply Voltage For Logic              | Vdd-Vss         | —   | 1.8     | 3.0  | 3.3     | V                 |
| Supply Voltage For LCD                | Vo-Vss          | Ta=25°C                                   | 13.7    | 14.0 | 14.3    | V                 |
| Input High Volt.                      | V <sub>IH</sub> | —   | 0.7*Vdd | —    | Vdd     | V                 |
| Input Low Volt.                       | V <sub>IL</sub> | —   | Vss     | —    | 0.3*Vdd | V                 |
| Output High Volt.                     | V <sub>OH</sub> | —   | 0.7*Vdd | —    | Vdd     | V                 |
| Output Low Volt.                      | V <sub>OL</sub> | —   | Vss     | —    | 0.3*Vdd | V                 |
| Supply Current(with positive voltage) | I <sub>dd</sub> | Vdd=3.0V                                  | —       | 5    | —       | mA                |
| LCM Surface Luminance<br>Ta=25°C      | L               | I <sub>LED</sub> =60mA<br>Display all OFF | 62      | 93   | —       | cd/m <sup>2</sup> |

※Optimum LCD driving voltage value, referring to above mentioned range, is changed due to different batch of LCD glass.

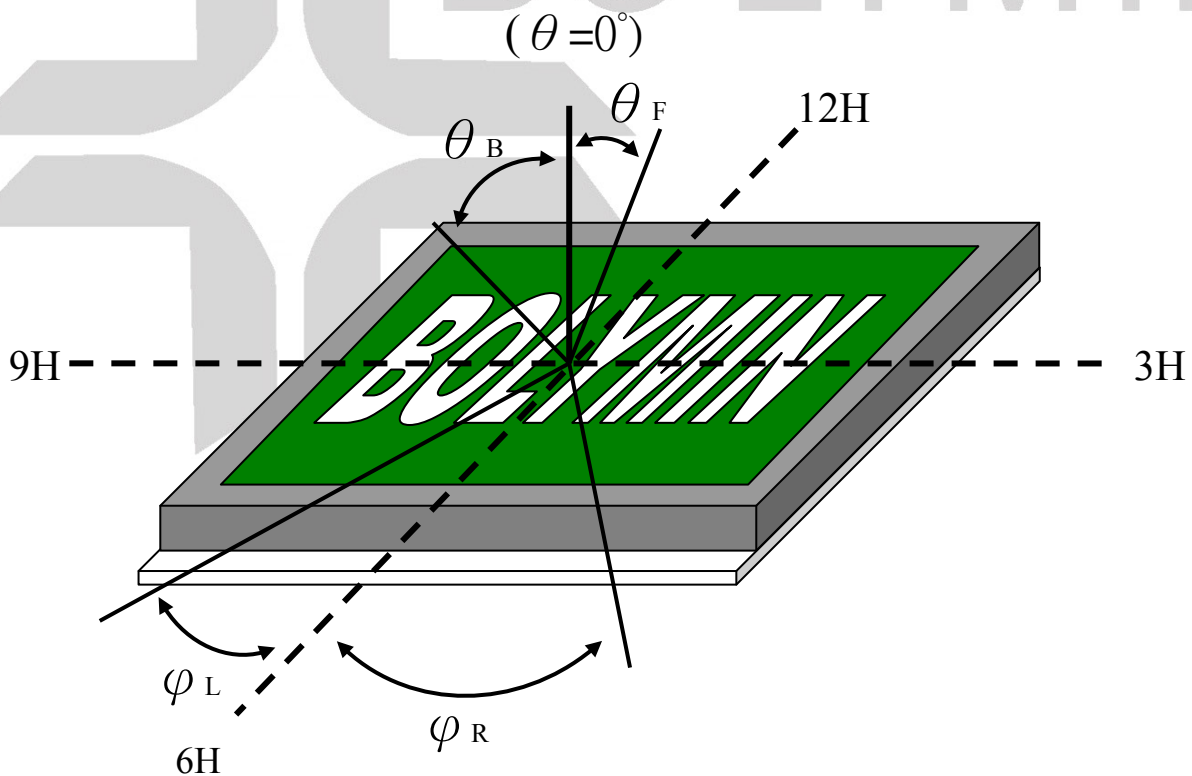


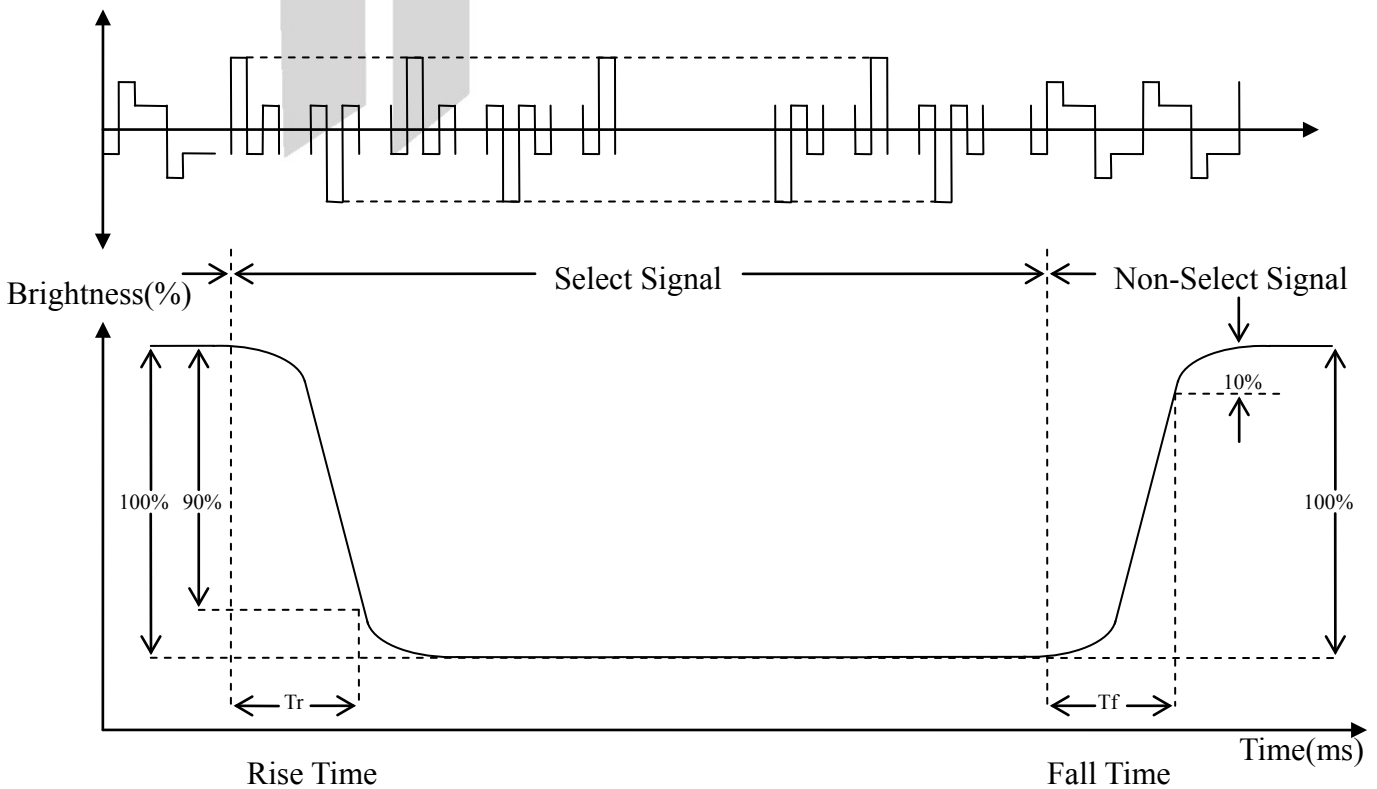
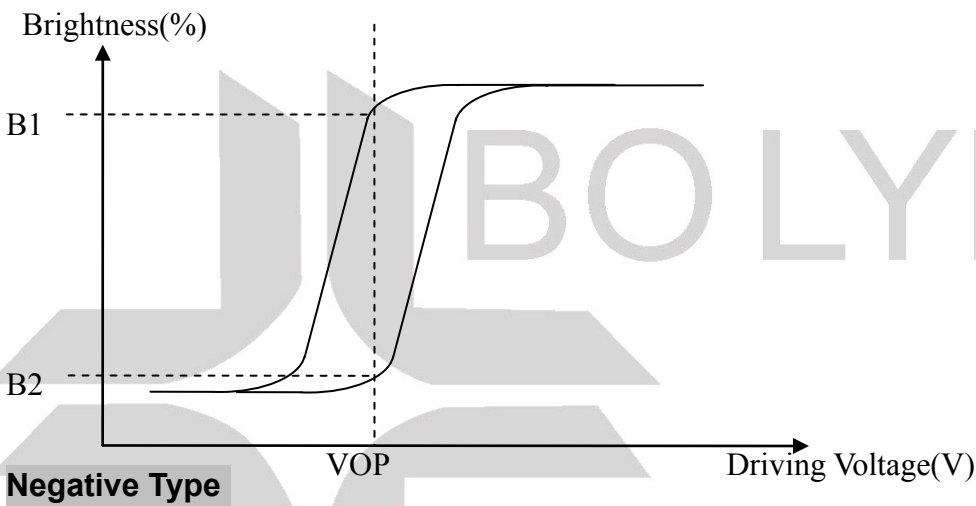
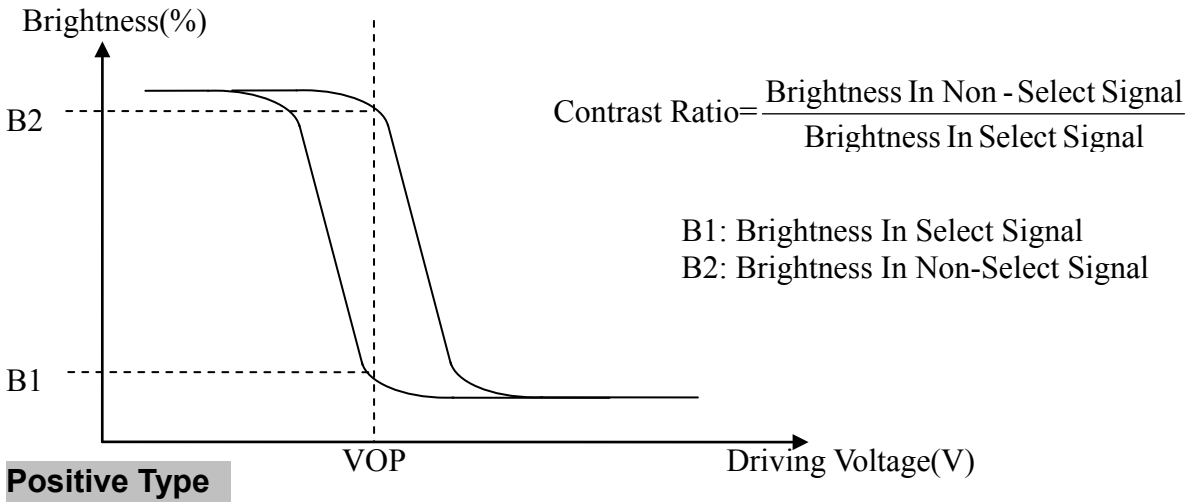
## 6. Optical Characteristics

a. FSTN

( $T_a=25^{\circ}\text{C}$ )

| Item                                | Symbol      | Min. | Typ. | Max. | Unit |
|-------------------------------------|-------------|------|------|------|------|
| View Angle (CR $\geq$ 2)            | $\theta_F$  | -    | 36   | -    | deg  |
|                                     | $\theta_B$  | -    | 38   | -    | deg  |
|                                     | $\varphi_L$ | -    | 45   | -    | deg  |
|                                     | $\varphi_R$ | -    | 40   | -    | deg  |
| Contrast Ratio                      | CR          | -    | 5    | -    | -    |
| Response Time 25 $^{\circ}\text{C}$ | T rise      | -    | 200  | 400  | ms   |
|                                     | T fall      | -    | 250  | 400  | ms   |

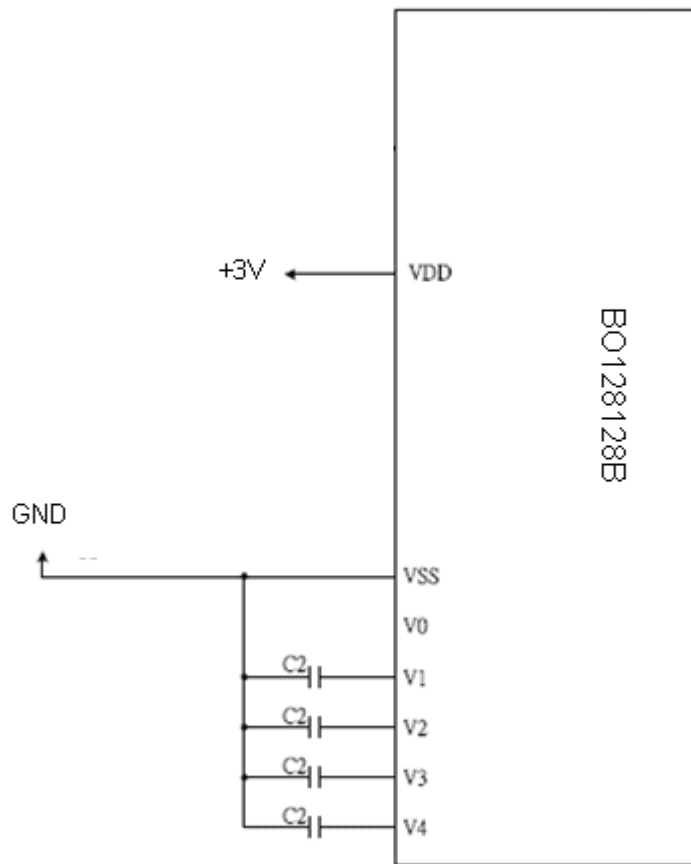




## 7.Interface Pin Function

| Pin No. | Symbol | Level | Description                |
|---------|--------|-------|----------------------------|
| 1       | VO     | -     | LCD driver voltage         |
| 2       | V1     | -     |                            |
| 3       | V2     | -     |                            |
| 4       | V3     | -     |                            |
| 5       | V4     | -     |                            |
| 6       | NC     | -     | No connector               |
| 7       | VSS    | -     | Ground                     |
| 8       | VDD    | -     | Power supply               |
| 9       | SCL    | H/L   | I2C serial clock input     |
| 10      | SDA    | H/L   | I2C serial Data input      |
| 11      | /RES   | H/L   | Reset H: Disable L: Enable |
| 12      | NC     | -     | No connector               |

## 8. Power supply for LCD Module



YMIN

$C2 = 0.1\mu F \sim 1\mu F$  (suggestion value:  $C2=0.1\mu F$ )

## 9. Backlight information

### 9.1 Specification

#### (1) LED edge/white

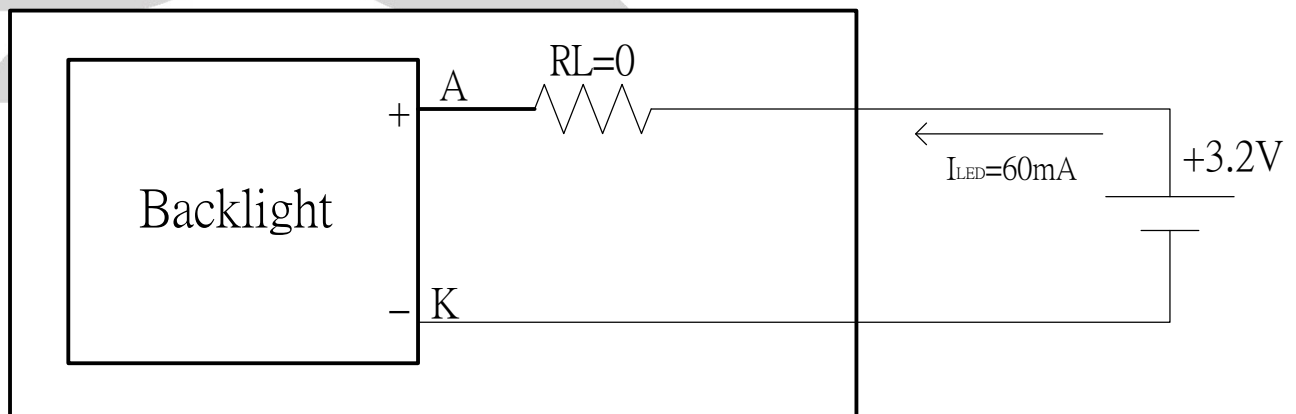
| Parameter       | Symbol           | Min  | Typ | Max  | Unit | Test Condition         |
|-----------------|------------------|------|-----|------|------|------------------------|
| Supply Current  | I <sub>LED</sub> | —    | 60  | —    | mA   | V=3.2V                 |
| Supply Voltage  | V                | 2.9  | 3.2 | 3.4  | V    | I <sub>LED</sub> =60mA |
| Reverse Voltage | V <sub>R</sub>   | —    | —   | 5    | V    |                        |
| CIE             | X                | 0.25 | —   | 0.31 |      | I <sub>LED</sub> =60mA |
|                 | Y                | 0.25 | —   | 0.31 |      |                        |
| Color           | White            |      |     |      |      |                        |

### 9.2 Backlight driving methods

#### a. LED B/L drive from A,K direct

##### a.1 edge / white

LCM



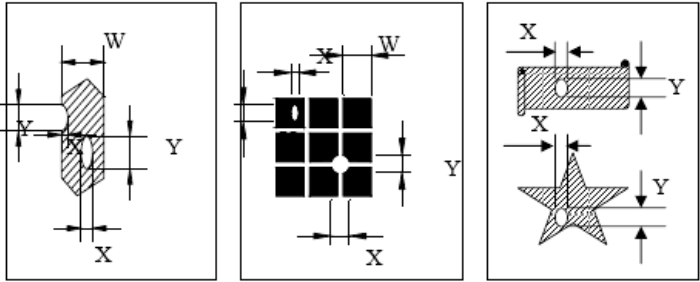
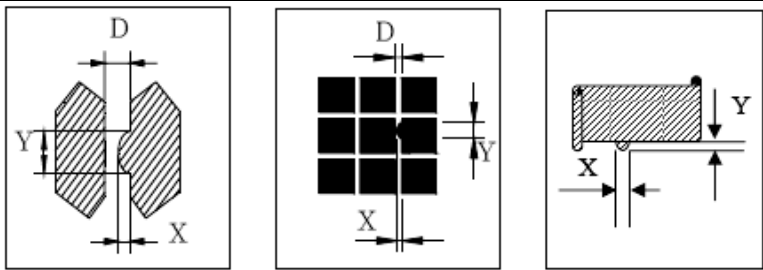
## 10. Quality Assurance

### 10.1 Inspection conditions

1. The LCD shall be inspected under 20~40W white fluorescent light.
2. Checking Direction shall be in the 40 degree from perpendicular line of specimen surface.
3. Checker shall see over 30 cm.
4. Inspect about 5 seconds for each side.
5. Defect that is located at outside of VA and doesn't affect function is ignored.

### 10.2 Inspection Parameters

| NO.   | Parameter                       | Criteria            |               |                   |                  |                  |
|---|---------------------------------|---------------------|---------------|-------------------|------------------|------------------|
| 1   | Black or White spots (Particle) | Zone                |               | Acceptable Number | Class Of Defects | Acceptable Level |
|   |                                 | Dimension           |               |                   |                  |                  |
|   |                                 | $D \leq 0.10$       |               | Disregard         | Minor            | 2.5              |
|   |                                 | $0.10 < D \leq 0.2$ |               | 4                 |                  |                  |
|   |                                 | $0.2 < D \leq 0.3$  |               | 2                 |                  |                  |
| $0.3 < D$   |                                 | 0                   |               |                   |                  |                  |
| $D = (\text{Long} + \text{Short}) / 2$<br>Total defects should not exceed 5/module<br>Defect that is located at outside of AA and doesn't affect function is ignored. |                                 |                     |               |                   |                  |                  |
| 2   | Scratch, Substances             | Zone                |               | Acceptable Number | Class Of Defects | Acceptable Level |
|   |                                 | X(mm)               | Y(mm)         |                   |                  |                  |
|   |                                 | —                   | $0.05 \geq W$ | Disregard         | Minor            | 2.5              |
|   |                                 | $4.0 \geq L$        | $0.05 \geq W$ | 4                 |                  |                  |
|   |                                 | $3.0 \geq L$        | $0.1 \geq W$  | 2                 |                  |                  |
| —   | $0.1 < W$                       | 0                   |               |                   |                  |                  |
| X: Length    Y: Width<br>Total defects should not exceed 5/module<br>Defect that is located at outside of AA and doesn't affect function is ignored.                  |                                 |                     |               |                   |                  |                  |

| 3  | Air Bubbles<br>( between glass & polarizer) | <table border="1"> <thead> <tr> <th>Zone<br/>Dimension</th> <th>Acceptable Number</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> </thead> <tbody> <tr> <td><math>D \leq 0.2</math></td> <td>Disregard</td> <td rowspan="3">Minor</td> <td rowspan="3">2.5</td> </tr> <tr> <td><math>0.2 &lt; D \leq 0.5</math></td> <td>3</td> </tr> <tr> <td><math>0.5 &lt; D</math></td> <td>0</td> </tr> </tbody> </table>  | Zone<br>Dimension     | Acceptable Number | Class Of Defects | Acceptable Level | $D \leq 0.2$ | Disregard | Minor | 2.5 | $0.2 < D \leq 0.5$    | 3 | $0.5 < D$              | 0 |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
|--|---|--|-----------------------|-------------------|------------------|------------------|--------------|-----------|-------|-----|-----------------------|---|------------------------|---|---------------|---|-----------------------|----------|------------------|------------------|---------------|-----------|-------|-----|------------------------------------|---|------------------------------|---|
| Zone<br>Dimension  | Acceptable Number                           | Class Of Defects   | Acceptable Level      |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| $D \leq 0.2$   | Disregard                                   | Minor  | 2.5                   |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| $0.2 < D \leq 0.5$   | 3   |  |                       |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| $0.5 < D$  | 0   |  |                       |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| <p>Total defects shall not excess 3/module.<br/>Defect that is located at outside of AA and doesn't affect function is ignored.<br/>Bobble is sawn only under reflection light is disregarded.</p> |   |  |                       |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| 4  | Displaying Pattern                          | <p>1. Incomplete or broken line is not allowed.<br/>2. Pinholes</p> <table border="1"> <thead> <tr> <th>Dimension <math>\Phi</math>(mm)</th> <th>Criteria</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> </thead> <tbody> <tr> <td><math>\Phi &lt; 0.1</math></td> <td>Disregard</td> <td rowspan="4">Minor</td> <td rowspan="4">2.5</td> </tr> <tr> <td><math>0.1 &lt; \Phi \leq 0.2</math></td> <td>2</td> </tr> <tr> <td><math>0.2 &lt; \Phi \leq 0.25</math></td> <td>1</td> </tr> <tr> <td><math>0.25 &lt; \Phi</math></td> <td>0</td> </tr> </tbody> </table>  <p style="text-align: center;"><math>\phi = (X+Y)/2</math></p> <p>3. Deformation</p> <table border="1"> <thead> <tr> <th>Dimension <math>\Phi</math>(mm)</th> <th>Criteria</th> <th>Class Of Defects</th> <th>Acceptable Level</th> </tr> </thead> <tbody> <tr> <td><math>\Phi &lt; 0.15</math></td> <td>Disregard</td> <td rowspan="3">Minor</td> <td rowspan="3">2.5</td> </tr> <tr> <td><math>\Phi \leq 0.25</math> and <math>X \leq 1/2D</math></td> <td>3</td> </tr> <tr> <td><math>\Phi &gt; 0.25</math> and <math>X &gt; 1/2D</math></td> <td>0</td> </tr> </tbody> </table>  <p style="text-align: center;"><math>D</math> : 間距<br/><math>\phi = (X+Y)/2</math></p> | Dimension $\Phi$ (mm) | Criteria          | Class Of Defects | Acceptable Level | $\Phi < 0.1$ | Disregard | Minor | 2.5 | $0.1 < \Phi \leq 0.2$ | 2 | $0.2 < \Phi \leq 0.25$ | 1 | $0.25 < \Phi$ | 0 | Dimension $\Phi$ (mm) | Criteria | Class Of Defects | Acceptable Level | $\Phi < 0.15$ | Disregard | Minor | 2.5 | $\Phi \leq 0.25$ and $X \leq 1/2D$ | 3 | $\Phi > 0.25$ and $X > 1/2D$ | 0 |
| Dimension $\Phi$ (mm)  | Criteria                                    | Class Of Defects   | Acceptable Level      |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| $\Phi < 0.1$   | Disregard                                   | Minor  | 2.5                   |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| $0.1 < \Phi \leq 0.2$  | 2   |  |                       |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| $0.2 < \Phi \leq 0.25$   | 1   |  |                       |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| $0.25 < \Phi$  | 0   |  |                       |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| Dimension $\Phi$ (mm)  | Criteria                                    | Class Of Defects   | Acceptable Level      |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| $\Phi < 0.15$  | Disregard                                   | Minor  | 2.5                   |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| $\Phi \leq 0.25$ and $X \leq 1/2D$   | 3   |  |                       |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |
| $\Phi > 0.25$ and $X > 1/2D$   | 0   |  |                       |                   |                  |                  |              |           |       |     |                       |   |                        |   |               |   |                       |          |                  |                  |               |           |       |     |                                    |   |                              |   |

Other Inspection standard reference Bolymin standard.



## 11. Reliability

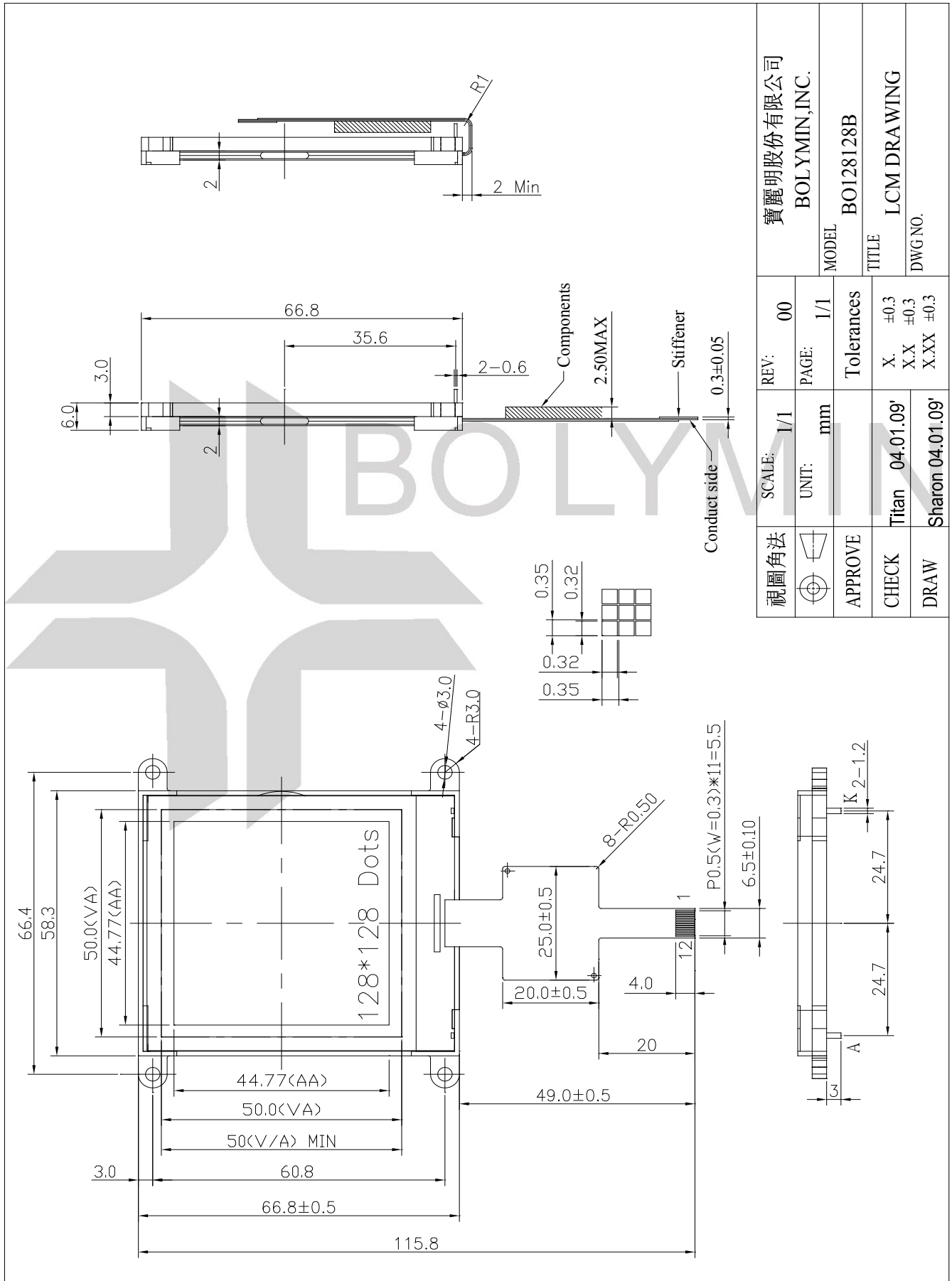
### ■ Content of Reliability Test

| Environmental Test |                                   |  |  |                     |
|--------------------|-----------------------------------|--|--|---------------------|
| No                 | Test Item                         | Content of Test  | Test Condition   | Applicable Standard |
| 1                  | High Temperature storage          | Endurance test applying the high storage temperature for a long time.  | 80°C<br>96 hrs   | —                   |
| 2                  | Low Temperature storage           | Endurance test applying the high storage temperature for a long time.  | -30°C<br>96 hrs  | —                   |
| 3                  | High Temperature Operation        | Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.                             | 70°C<br>96 hrs   | —                   |
| 4                  | Low Temperature Operation         | Endurance test applying the electric stress under low temperature for a long time.   | -20°C<br>96 hrs  | —                   |
| 5                  | Humidity Test                     | Endurance test applying the high humidity storage for a long time.   | 40°C, 90%RH<br>96hrs   | —                   |
| 6                  | Temperature cycle (Non-operation) | Endurance test applying the low and high temperature cycle.<br> | -30°C/80°C<br>10 cycles  | —                   |
| 7                  | Vibration test                    | Endurance test applying the vibration during transportation and using.   | Total Fixed Amplitude: 1.5mm<br>Vibration Frequency : 10~55Hz<br>One cycle 60 seconds to 3 direction of X,Y,Z for each 15minutes | —                   |

※Assess after placing at normal temperature and humidity for 4 hour ◦ No abnormalities in functions and appearance ◦

## 12.Appendix (Drawing , ST7541I controller data)

### 12.1 Drawing



|         |                  |                                  |                            |
|---------|------------------|----------------------------------|----------------------------|
| 視圖角法    | SCALE: 1/1       | REV: 00                          | 寶麗明股份有限公司<br>BOLYMIN, INC. |
| APPROVE | UNIT: mm         | PAGE: 1/1                        | MODEL<br>BO128128B         |
| CHECK   | Titan 04.01.09'  | Tolerances                       | TITLE<br>LCM DRAWING       |
| DRAW    | Sharon 04.01.09' | X. ±0.3<br>X.X ±0.3<br>X.XX ±0.3 | DWG NO.                    |

## 12.2 ST7541i controller data

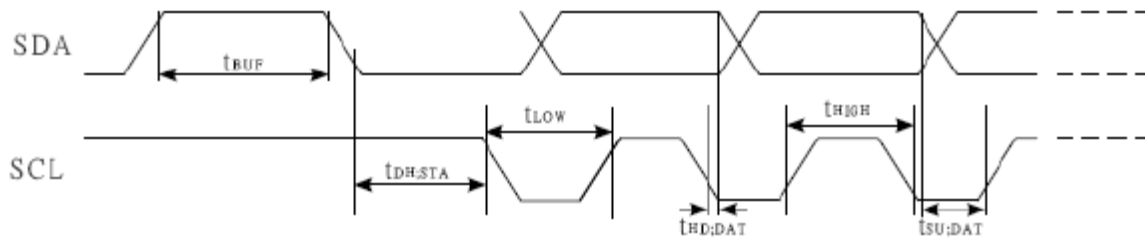
### 12.2.1. Instruction table

| Instruction              | A0 | R/W | DB7        | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0  | Description   |
|--------------------------|----|-----|------------|-----|-----|-----|-----|-----|-----|------|---|
| Mode Set                 | 0  | 0   | 0          | 0   | 1   | 1   | 1   | 0   | 0   | 0    | 2-byte command  |
|                          | 0  | 0   | FR3        | FR2 | FR1 | FR0 | 0   | BE  | x'  | 0    | Set FR (Frame Rate) and BE (Booster Efficiency)                       |
| Read display data        | 1  | 1   | Read data  |     |     |     |     |     |     |      | Read data into DDRAM  |
| Write display data       | 1  | 0   | Write data |     |     |     |     |     |     |      | Write data into DDRAM   |
| Read status              | 0  | 1   | BUSY       | ON  | RES | MF2 | MF1 | MF0 | DS1 | DS0  | Read the internal status  |
| ICON control ON/OFF      | 0  | 0   | 1          | 0   | 1   | 0   | 0   | 0   | 1   | ICON | ICON=0: ICON disable  |
|                          |    |     |            |     |     |     |     |     |     |      | ICON=1: ICON enable & set page address to 16                          |
| Set page address         | 0  | 0   | 1          | 0   | 1   | 1   | P3  | P2  | P1  | P0   | Set page address  |
| Set column address MSB   | 0  | 0   | 0          | 0   | 0   | 1   | 0   | Y7  | Y6  | Y5   | Set column address MSB  |
| Set column address LSB   | 0  | 0   | 0          | 0   | 0   | 0   | Y4  | Y3  | Y2  | Y1   | Set column address LSB  |
| Set Read-modify-Write    | 0  | 0   | 1          | 1   | 1   | 0   | 0   | 0   | 0   | 0    | DDRAM address control:<br>Read: No change<br>Write: column address +1 |
| Reset Read-modify-Write  | 0  | 0   | 1          | 1   | 1   | 0   | 1   | 1   | 1   | 0    | Release read-modify-write   |
| Display ON/OFF           | 0  | 0   | 1          | 0   | 1   | 0   | 1   | 1   | 1   | D    | D=0: Display OFF<br>D=1: Display ON                                   |
| Set Initial Display Line | 0  | 0   | 0          | 1   | 0   | 0   | 0   | 0   | x'  | x'   | 2-byte command  |
|                          | 0  | 0   | x'         | S6  | S5  | S4  | S3  | S2  | S1  | S0   | Specify the initial display line to realize vertical scrolling        |
| Set Initial COM0         | 0  | 0   | 0          | 1   | 0   | 0   | 0   | 1   | x'  | x'   | 2-byte command  |
|                          | 0  | 0   | x'         | C6  | C5  | C4  | C3  | C2  | C1  | C0   | Specify the first COM0 to move display window                         |
| Set Partial Display Duty | 0  | 0   | 0          | 1   | 0   | 0   | 1   | 0   | x'  | x'   | 2-byte command  |
|                          | 0  | 0   | L7         | L6  | L5  | L4  | L3  | L2  | L1  | L0   | Set partial display line number                                       |
| Set N-line Inversion     | 0  | 0   | 0          | 1   | 0   | 0   | 1   | 1   | x'  | x'   | 2-byte command  |
|                          | 0  | 0   | x'         | x'  | x'  | N4  | N3  | N2  | N1  | N0   | Set N-line inversion register   |
| Release N-line Inversion | 0  | 0   | 1          | 1   | 1   | 0   | 0   | 1   | 0   | 0    | Exit N-line inversion mode  |
| Reverse Display ON/OFF   | 0  | 0   | 1          | 0   | 1   | 0   | 0   | 1   | 1   | REV  | REV=0: normal display<br>REV=1: reverse display                       |
| Entire Display ON/OFF    | 0  | 0   | 1          | 0   | 1   | 0   | 0   | 1   | 0   | EON  | EON=0: normal display<br>EON=1: entire display ON                     |

| Instruction                   | A0 | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1  | DB0  | Description   |
|-------------------------------|----|-----|-----|-----|-----|-----|-----|-----|------|------|---|
| Power Control                 | 0  | 0   | 0   | 0   | 1   | 0   | 1   | VC  | VR   | VF   | Set power circuits ON/OFF   |
| Select DC-DC step-up          | 0  | 0   | 0   | 1   | 1   | 0   | 0   | 1   | DC1  | DC0  | Select built-in booster step  |
| Select Regulator Register     | 0  | 0   | 0   | 0   | 1   | 0   | 0   | R2  | R1   | R0   | Select the internal resistance ratio of the regulator resistor                      |
| Select Electronic Volume      | 0  | 0   | 1   | 0   | 0   | 0   | 0   | 0   | 0    | 1    | 2-byte command  |
|                               | 0  | 0   | x'  | x'  | EV5 | EV4 | EV3 | EV2 | EV1  | EV0  | Adjust contrast level   |
| Select LCD bias               | 0  | 0   | 0   | 1   | 0   | 1   | 0   | B2  | B1   | B0   | Select LCD bias   |
| High Power Mode               | 0  | 0   | 1   | 1   | 1   | 1   | 0   | 1   | 1    | 1    | 2-byte command  |
|                               | 0  | 0   | 0   | 0   | 0   | 1   | 1   | 0   | 1    | 0    | Enable High Power Mode  |
| High Power Mode Control       | 0  | 0   | 1   | 1   | 1   | 1   | 0   | 0   | 1    | 1    | 2-byte command  |
|                               | 0  | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 0    | 1    | Controls high driving mode  |
| SHL select                    | 0  | 0   | 1   | 1   | 0   | 0   | SHL | x'  | x'   | x'   | COM bi-directional selection<br>SHL=0: normal direction<br>SHL=1: reverse direction |
| ADC select                    | 0  | 0   | 1   | 0   | 1   | 0   | 0   | 0   | 0    | ADC  | SEG bi-direction selection<br>ADC=0: normal direction<br>ADC=1: reverse direction   |
| Oscillator ON                 | 0  | 0   | 1   | 0   | 1   | 0   | 1   | 0   | 1    | 1    | Start the built-in oscillator   |
| Set power save mode           | 0  | 0   | 1   | 0   | 1   | 0   | 1   | 0   | 0    | P    | P=0: normal mode<br>P=1: sleep mode   |
| Release power save mode       | 0  | 0   | 1   | 1   | 1   | 0   | 0   | 0   | 0    | 1    | Release power save mode   |
| RESET                         | 0  | 0   | 1   | 1   | 1   | 0   | 0   | 0   | 1    | 0    | Software reset<br>Refer to RESET CIRCUIT  |
| Set display data length (DDL) | x' | x'  | 1   | 1   | 1   | 0   | 1   | 0   | 0    | 0    | 2-byte command  |
|                               | x' | x'  | D7  | D6  | D5  | D4  | D3  | D2  | D1   | D0   | Specify the number of data bytes. (3-Line SPI only)                                 |
| Set FRC/PWM mode              | 0  | 0   | 1   | 0   | 0   | 1   | 0   | FRC | PWM1 | PWM0 | FRC: 1=3FRC, 0=4FRC<br>PWM[1:0]:<br>(0,0)=(0,1)=9PWM<br>(1,0)=12PWM<br>(1,1)=15PWM  |
| NOP                           | 0  | 0   | 1   | 1   | 1   | 0   | 0   | 0   | 1    | 1    | No operation  |
| Test Instruction              | 0  | 0   | 1   | 1   | 1   | 1   | x'  | x'  | x'   | x'   | Don't use this instruction  |

| Instruction   | A0 | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 | Description                            |
|---|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| White palette (1 <sup>st</sup> /2 <sup>nd</sup> frame)<br>set PWM pulse width | 0  | 0   | 1   | 0   | 0   | 0   | 1   | 0   | 0   | 0   | Set white mode palette                 |
|   | 0  | 0   | WB3 | WB2 | WB1 | WB0 | WA3 | WA2 | WA1 | WA0 | 1 <sup>st</sup> /2 <sup>nd</sup> frame |
| White palette (3 <sup>rd</sup> /4 <sup>th</sup> frame)<br>set PWM pulse width | 0  | 0   | 1   | 0   | 0   | 0   | 1   | 0   | 0   | 1   | Set white mode palette                 |
|   | 0  | 0   | WD3 | WD2 | WD1 | WD0 | WC3 | WC2 | WC1 | WC0 | 3 <sup>rd</sup> /4 <sup>th</sup> frame |
| Light palette (1 <sup>st</sup> /2 <sup>nd</sup> frame)<br>set PWM pulse width | 0  | 0   | 1   | 0   | 0   | 0   | 1   | 0   | 1   | 0   | Set light gray mode palette            |
|   | 0  | 0   | LB3 | LB2 | LB1 | LB0 | LA3 | LA2 | LA1 | LA0 | 1 <sup>st</sup> /2 <sup>nd</sup> frame |
| Light palette (3 <sup>rd</sup> /4 <sup>th</sup> frame)<br>set PWM pulse width | 0  | 0   | 1   | 0   | 0   | 0   | 1   | 0   | 1   | 1   | Set light gray mode palette            |
|   | 0  | 0   | LD3 | LD2 | LD1 | LD0 | LC3 | LC2 | LC1 | LC0 | 3 <sup>rd</sup> /4 <sup>th</sup> frame |
| Dark palette (1 <sup>st</sup> /2 <sup>nd</sup> frame)<br>set PWM pulse width  | 0  | 0   | 1   | 0   | 0   | 0   | 1   | 1   | 0   | 0   | Set dark gray mode palette             |
|   | 0  | 0   | DB3 | DB2 | DB1 | DB0 | DA3 | DA2 | DA1 | DA0 | 1 <sup>st</sup> /2 <sup>nd</sup> frame |
| Dark palette (3 <sup>rd</sup> /4 <sup>th</sup> frame)<br>set PWM pulse width  | 0  | 0   | 1   | 0   | 0   | 0   | 1   | 1   | 0   | 1   | Set dark gray mode palette             |
|   | 0  | 0   | DD3 | DD2 | DD1 | DD0 | DC3 | DC2 | DC1 | DC0 | 3 <sup>rd</sup> /4 <sup>th</sup> frame |
| Black palette (1 <sup>st</sup> /2 <sup>nd</sup> frame)<br>set PWM pulse width | 0  | 0   | 1   | 0   | 0   | 0   | 1   | 1   | 1   | 0   | Set black mode palette                 |
|   | 0  | 0   | BB3 | BB2 | BB1 | BB0 | BA3 | BA2 | BA1 | BA0 | 1 <sup>st</sup> /2 <sup>nd</sup> frame |
| Black palette (3 <sup>rd</sup> /4 <sup>th</sup> frame)<br>set PWM pulse width | 0  | 0   | 1   | 0   | 0   | 0   | 1   | 1   | 1   | 1   | Set black mode palette                 |
|   | 0  | 0   | BD3 | BD2 | BD1 | BD0 | BC3 | BC2 | BC1 | BC0 | 3 <sup>rd</sup> /4 <sup>th</sup> frame |

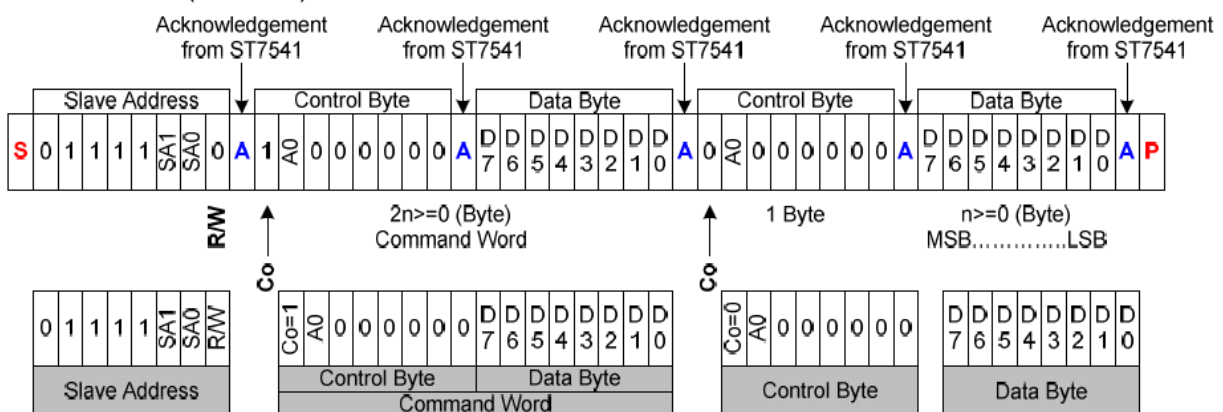
## 12.2.2 . Timing characteristics I2C series



( $V_{DD}=3.3V, T_a=-30\sim 85^{\circ}C$ )

| Item   | Signal | Symbol   | Condition | Rating      |      | Units |
|--|--------|----------|-----------|-------------|------|-------|
|  |        |          |           | Min.        | Max. |       |
| SCL clock frequency                              | SCL    | FSCLK    |           | -           | 400  | KHZ   |
| SCL clock low period                             | SCL    | TLOW     |           | 1.3         | -    | us    |
| SCL clock high period                            | SCL    | THIGH    |           | 0.6         | -    | us    |
| Data set-up time                                 | SI     | TSU;Data |           | 100         | -    | ns    |
| Data hold time                                   | SI     | THD;Data |           | 0           | 0.9  | us    |
| SCL,SDA rise time                                | SCL    | TR       |           | $20+0.1C_b$ | 300  | ns    |
| SCL,SDA fall time                                | SCL    | TF       |           | $20+0.1C_b$ | 300  | ns    |
| Capacitive load represented by each bus line     |        | $C_b$    |           | -           | 400  | pF    |
| Setup time for a repeated START condition        | SI     | TSU;SUA  |           | 0.6         | -    | us    |
| Start condition hold time                        | SI     | THD;STA  |           | 0.6         | -    | us    |
| Setup time for STOP ondition                     |        | TSU;STO  |           | 0.6         | -    | us    |
| Tolerable spike width on bus                     |        | TSW      |           | -           | 50   | ns    |
| BUS free time between a STOP and StART condition | SCL    | TBUF     |           | 1.3         |      | us    |

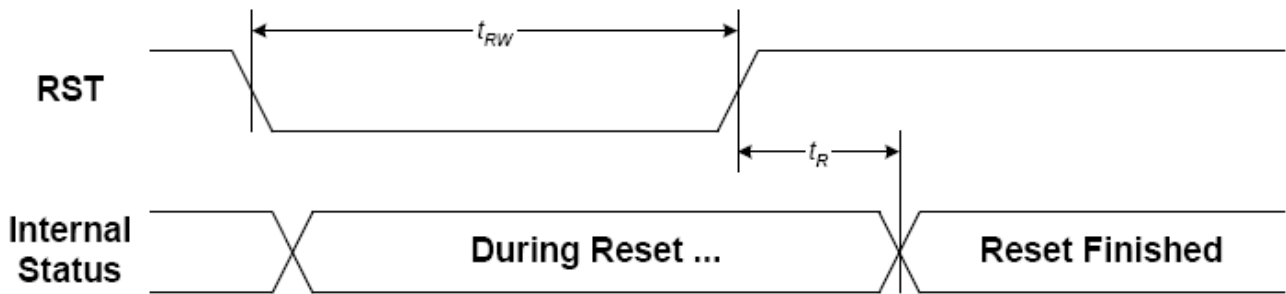
### Write Mode (R/W="0")



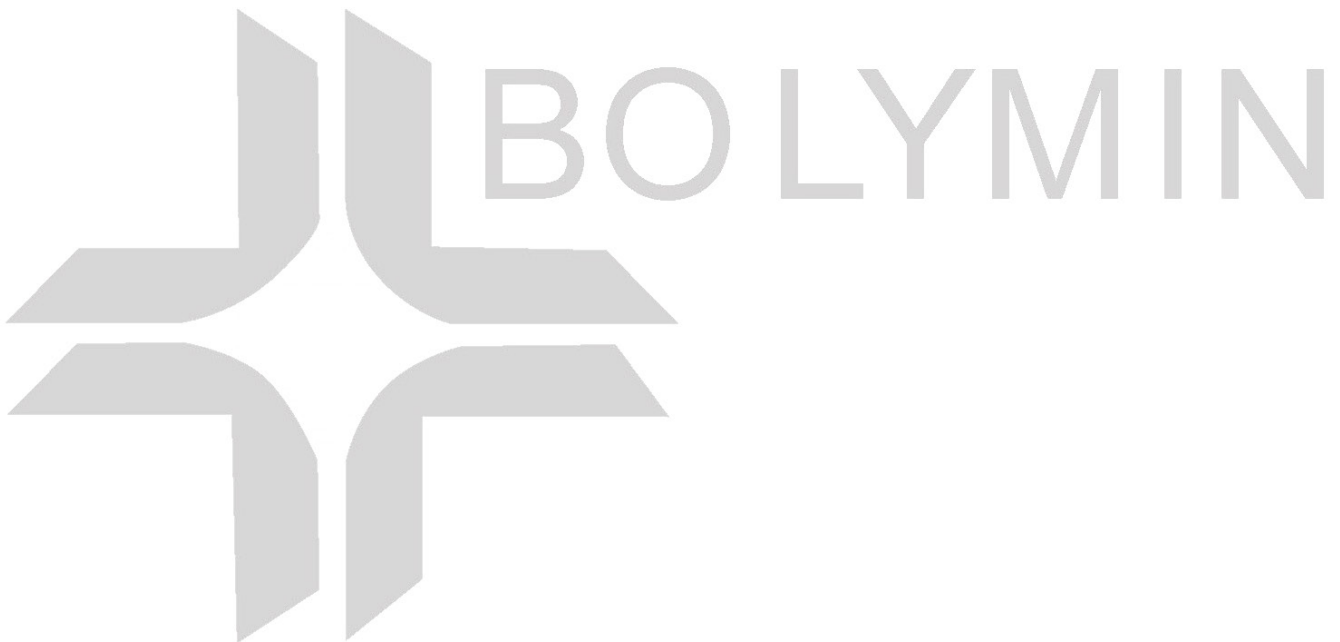
|    |   |  |
|----|---|--|
| Co | 0 | Last control byte. Only a stream of data bytes is allowed to follow. This stream may only be terminated by a STOP or RE-START condition. |
|    | 1 | Another control byte will follow the data byte unless a STOP or RE-START condition is received.  |

**Default SA0=0 SA1=0**

## Reset Timing

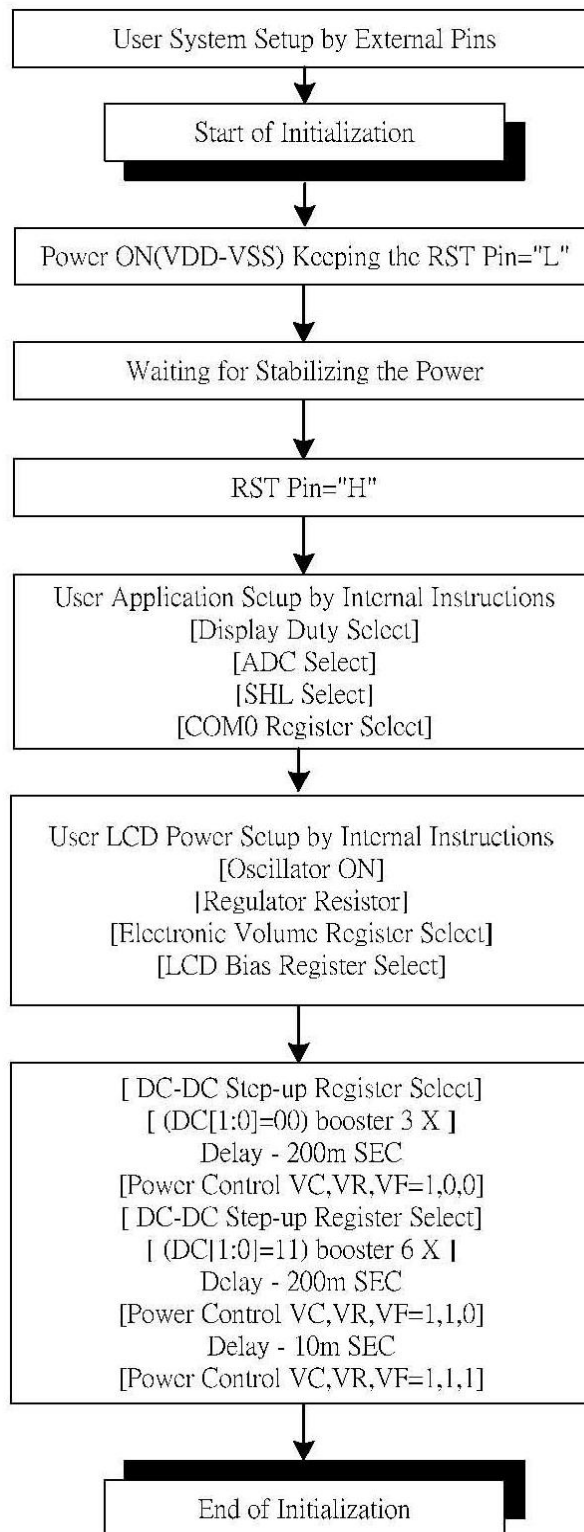


| Item                  | Signal | Symbol | Condition | Rating |      |      | Units |
|-----------------------|--------|--------|-----------|--------|------|------|-------|
|                       |        |        |           | Min.   | Typ. | Max. |       |
| Reset time            |        | tR     |           | —      | —    | 1.5  | us    |
| Reset "L" pulse width | RST    | tRW    |           | 1.5    | —    | —    | us    |



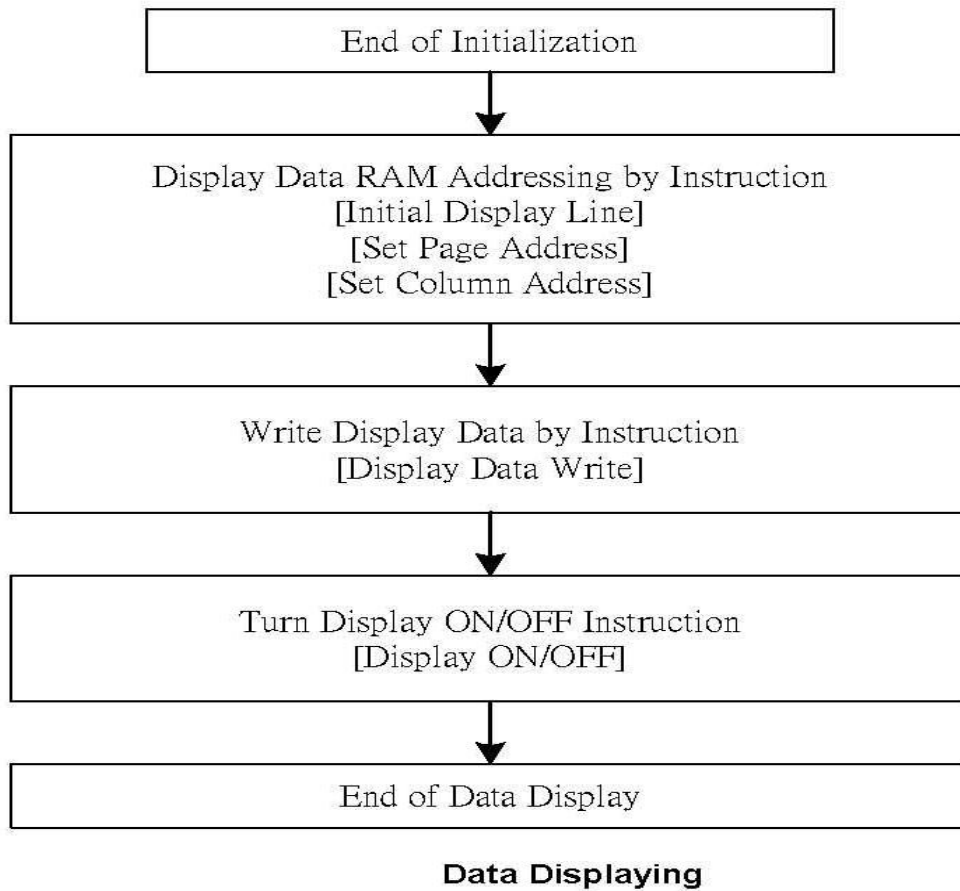
### 12.2.3 . Initializing by Instruction

#### Referential Instruction Setup Flow: Initializing with the built-in Power Supply Circuits



#### Initializing with the Built-in Power Supply Circuits

### Referential Instruction Setup Flow: Data Displaying



### Referential Instruction Setup Flow: Power OFF

