

**BOLYMIN**

**SPECIFICATIONS FOR  
LCD MODULE**

**MODEL NO.**  
**BC2004AI series**  
**VER.04**

**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

| <b>Version</b> | <b>Contents</b>   | <b>Date</b>       | <b>Note</b>             |
|----------------|---|-------------------|-------------------------|
| <b>01</b>      | <b>NEW VERSION</b>  | <b>2012/12/12</b> | <b>SPEC</b>             |
| <b>02</b>      | <b>Modify Handling Instruction</b>                        | <b>2013/01/31</b> | <b>Page<br/>6</b>       |
| <b>03</b>      | <b>Modify Quality Assurance and Reliability</b>           | <b>2013/06/27</b> | <b>Page<br/>13 、 15</b> |
| <b>04</b>      | <b>Modify Handling Instruction 、 Mechanical Dimension</b> | <b>2014/03/11</b> | <b>Page<br/>6 、 7</b>   |
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## 1. Numbering System

| <u>B</u> | <u>C</u>                                       | <u>2004</u> | <u>AI</u>  | - | - | - | -   | - | <u>XXX</u> |
|----------|--|-------------|--|---|---|---|---|---|------------|
| 0        | 1  | 2           | 3  | 4 | 5 | 6 | 7   | 8 | 9          |
| 0        | Brand  |             | Bolymin  |   |   |   |   |   |            |
| 1        | 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   |   |            |
| 2        | Format   |             | 2002=20 characters, 2 lines<br>12232= 122 x 32 dots  |   |   |   |   |   |            |
| 3        | Version No.                                    |             | A type   |   |   |   |   |   |            |
| 4        | LCD Color                                      |             | G=STN/gray<br>Y=STN/yellow-green<br>C=color STN  |   |   |   | B=STN/blue<br>F=FSTN<br>T=TN  |   |            |
| 5        | LCD Type                                       |             | R=positive/reflective<br>P=positive/transflective  |   |   |   | M=positive/transmissive<br>N=negative/transmissive  |   |            |
| 6        | 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<br>Q=LED edge/red<br>A=LED edge/amber<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 |   |            |
| 7        | 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   |   |            |
| 8        | 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                                   |   |            |
| 9        | 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>20i=SPI interface  |   |            |

## 2. Handling Instruction

### 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 on the surface of display area.
- 2.1.2. The polarizer used on the display surface is easily scratched and damaged. Extreme care should be taken when handling. 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 and never scrub hard.
- 2.1.3. Store the panel or module in a dark place where the temperature is  $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$  and the humidity is below 60% RH.
- 2.1.4. Keep LCD panels away from direct sunlight, also avoid them in high-temperature & high humidity environment for a long period.
- 2.1.5. Do not input any signal before power is turned on.
- 2.1.6. 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.
- 2.1.7. To control temperature and time of soldering is  $320 \pm 10^{\circ}\text{C}$  and 3-5 sec.
- 2.1.8. EL manufactured from the organic film, and easily affected by temperature, humidity and other environmental impact. Long-term placement in a place will cause low quality of the case. Therefore, unpack the cartons and start the production with the LCM within three months after the reception of them.

### 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 is inductive to static, a relative humidity of 50-60% is recommended.

### 2.3 Operation Precautions:

- 2.3.1. Since applied DC voltage causes electro-chemical reactions, which deteriorate the display, 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. Driving voltage should be kept within specified range; excess voltage will shorten display life.
- 2.3.3. An electrochemical reaction due to direct current causes LCD deterioration, Avoid the use of -Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD's show dark color in them.

## 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.Features

- (1) COB with metal frame.
- (2) 5x7 dots with cursor.
- (3) +5.0V single power supply.
- (4) Support 3-types of serial mode input interface.
- (5) I2C & SPI serial modes while data transmitting rate up to 100 KHz-clock rate.
- (6) Support RS232 (5.0V TTL signal).
- (7) Auto demo mode.
- (8) Software functionally adjusts LCD contrast & backlight luminance .
- (9) Changeable I2C slave address for multi-module control.
- (10) USB optional (\*).

(\*)This module provides a stand-alone USB to RS232(TTL) serial converter, which enables USB connectivity in applications that have a RS232(TTL) interface.

### 4.General Specification

#### (1) Mechanical Dimension

| Item                              | Dimension  | Unit |
|-----------------------------------|--|------|
| Number of Characters              | 20 characters×4 Lines                            | —    |
| Module dimension<br>( L x W x H ) | 98 x 60x 13.4 – LED B/L<br>98 x 60x 9.1 – No B/L | mm   |
| View area                         | 77x 25.2   | mm   |
| Active area                       | 70.4 x 20.8                                      | mm   |
| Dot size                          | 0.55 x 0.55                                      | mm   |
| Dot pitch                         | 0.6 x 0.6  | mm   |
| Character size ( L x W )          | 2.95 x4.75                                       | mm   |
| Character pitch ( L x W )         | 3.55 x 5.35                                      | mm   |

#### (2) Controller IC: **ST7066U (or Equivalent) controller**

#### (3)Backlight: LED Series

#### (4) Temperature Range

|           | Normal     | Wide       |
|-----------|------------|------------|
| Operating | 0 ~+50°C   | -20 ~+70°C |
| Storage   | -10 ~+60°C | -30 ~+80°C |

## 5. Absolute Maximum Rating

### 5.1 Electrical Absolute Maximum Ratings

(V<sub>ss</sub>=0V, Ta=25°C)

| Item                        | Symbol                           | Min  | Max                  | Unit |
|-----------------------------|----------------------------------|------|----------------------|------|
| Supply Voltage (Logic)      | V <sub>dd</sub> -V <sub>ss</sub> | -0.3 | 7                    | V    |
| Supply Voltage (LCD Driver) | V <sub>dd</sub> -V <sub>o</sub>  | -0.3 | V <sub>dd</sub> +0.3 | V    |
| Wide Temperature Type       | Top                              | -20  | +70                  | °C   |
|                             | T <sub>stg</sub>                 | -30  | +80                  | °C   |
| Normal Temperature Type     | Top                              | 0    | +50                  | °C   |
|                             | T <sub>stg</sub>                 | -10  | +60                  | °C   |

## 6. Electrical Characteristics

(V<sub>ss</sub>=0V, Ta=25°C)

| Item                     | Symbol                           | Condition           | Min                 | Typ | Max             | Unit |
|--------------------------|----------------------------------|---------------------|---------------------|-----|-----------------|------|
| Supply Voltage For Logic | V <sub>dd</sub> -V <sub>ss</sub> | -                   | -                   | 5.0 | -               | V    |
| Input High Volt.         | V <sub>IH</sub>                  | -                   | 0.7*V <sub>dd</sub> | -   | V <sub>dd</sub> | V    |
| Input Low Volt.          | V <sub>IL</sub>                  | -                   | -0.3                | -   | 0.6             | V    |
| Supply Current           | I <sub>dd</sub>                  | V <sub>dd</sub> =5V | -                   | -   | 285(*)          | mA   |

\*: Backlight 100% turn on.(Array LED)

## 7. Optical Characteristics

### a. STN

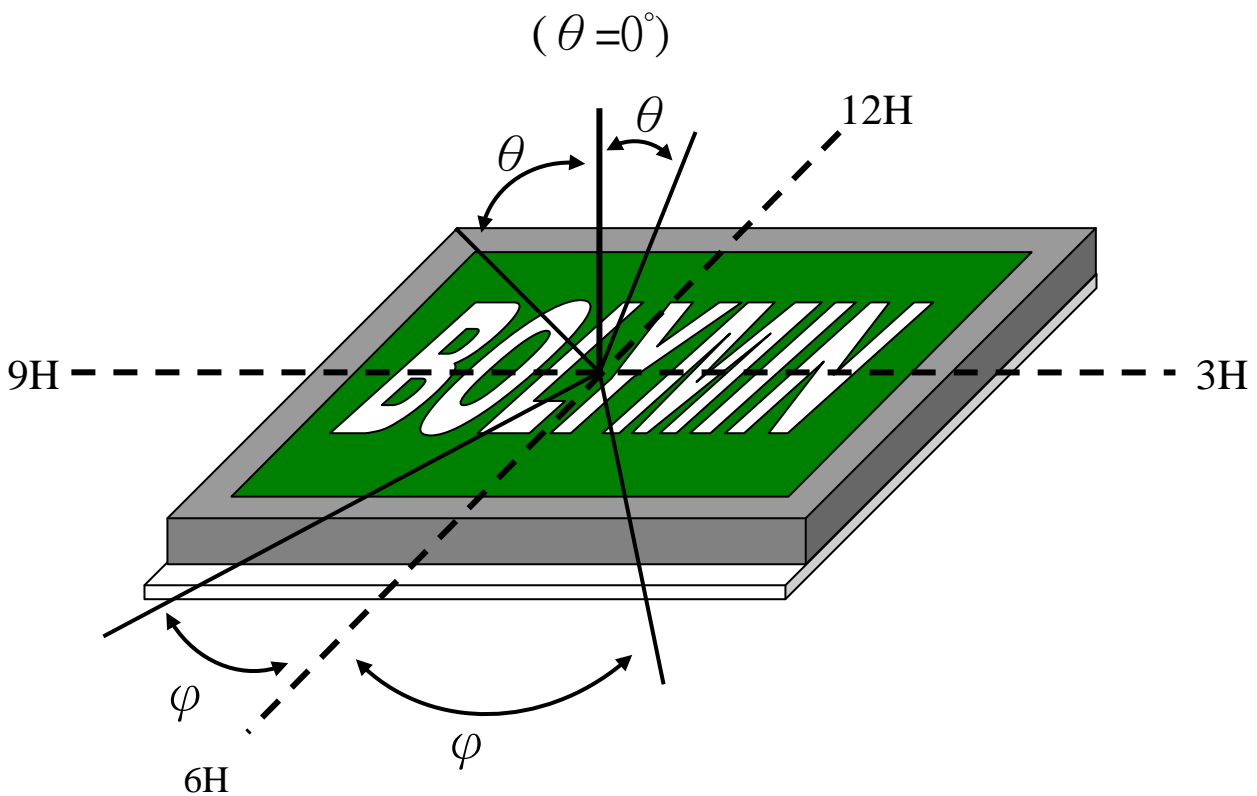
(V<sub>ss</sub>=0V, Ta=25°C)

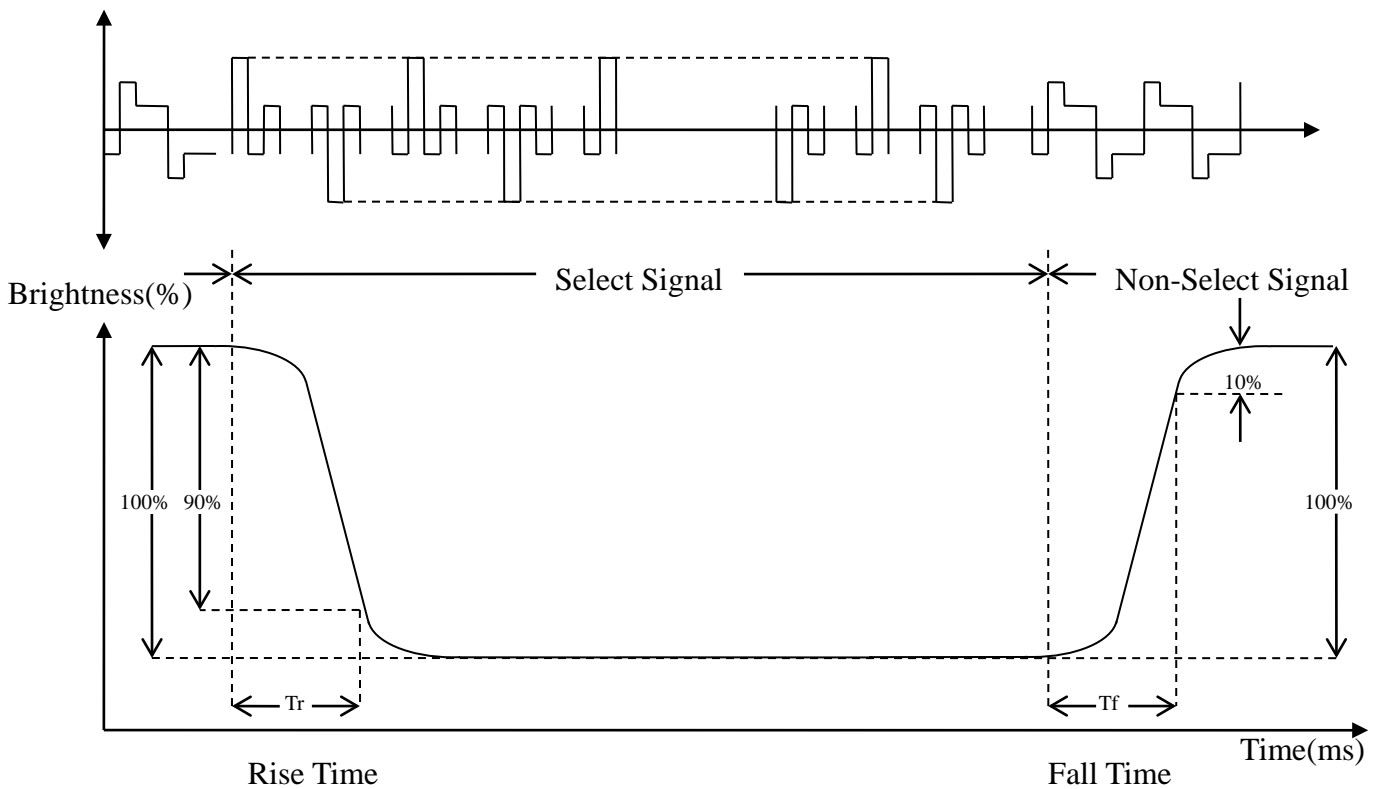
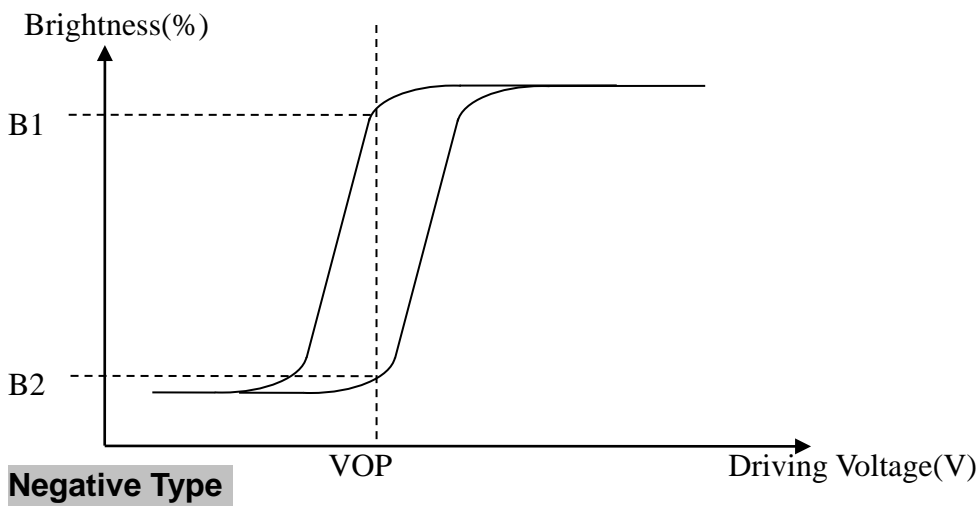
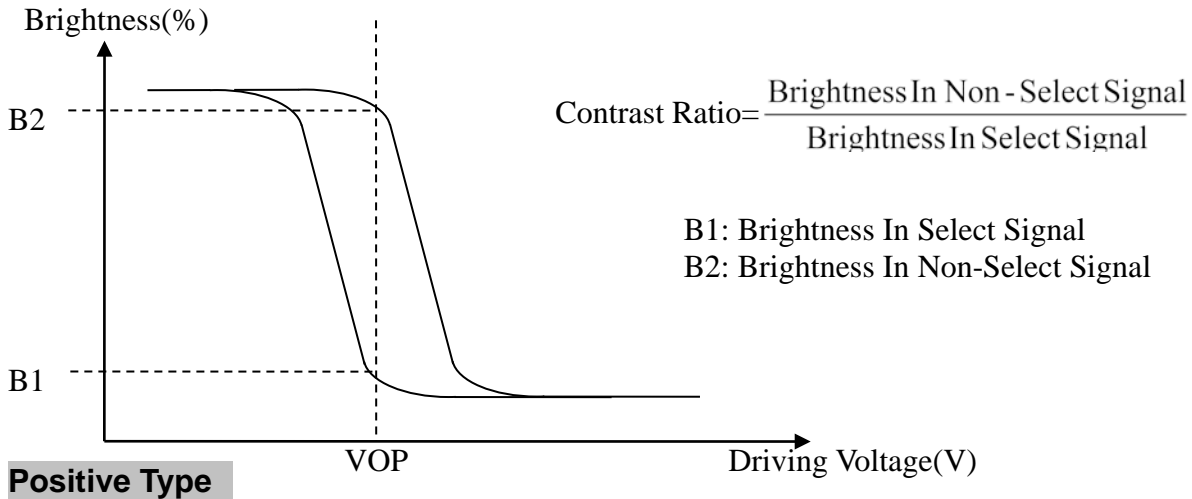
| Item               | Symbol        | Condition   | Min. | Typ. | Max. | Unit |
|--------------------|---------------|-------------|------|------|------|------|
| View Angle         | (V) $\theta$  | CR $\geq$ 2 | 10   | -    | 45   | deg  |
|                    | (H) $\varphi$ | CR $\geq$ 2 | -30  | -    | 30   | deg  |
| Contrast Ratio     | CR            | -           | -    | 3    | -    | -    |
| Response Time 25°C | T rise        | -           | -    | 200  | 350  | ms   |
|                    | T fall        | -           | -    | 250  | 400  | ms   |



**b. FSTN**

| Item               | Symbol        | Condition   | Min. | Typ. | Max. | Unit |
|--------------------|---------------|-------------|------|------|------|------|
| View Angle         | (V) $\theta$  | $CR \geq 3$ | 10   |      | 60   | deg  |
|                    | (H) $\varphi$ | $CR \geq 3$ | -45  |      | 45   | deg  |
| Contrast Ratio     | CR            | —           |      | 5    |      | —    |
| Response Time 25°C | T rise        | —           |      | 200  | 400  | ms   |
|                    | T fall        | —           |      | 250  | 400  | ms   |





## 8.Interface Pin Function

### 8.1 Pin Description

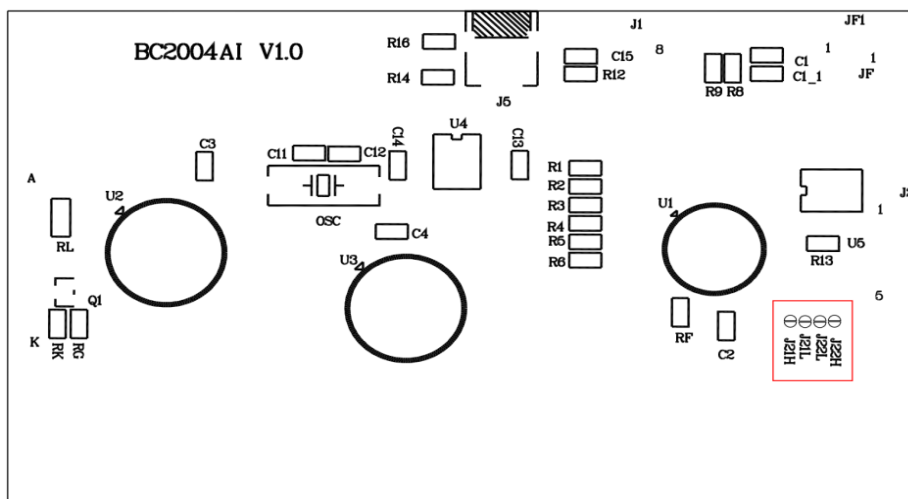
| Pin No. | Symbol | Level | Description  |
|---------|--------|-------|--|
| 1       | TX     | -     | RS-232 level output port.                                    |
| 2       | RX     | -     | RS-232 level input port                                      |
| 3       | VSS    | 0V    | Ground.  |
| 4       | VDD    | 5V    | System power supply input.                                   |
| 5       | SDA    | H/L   | I2C:Data Input/output for the I2C<br>SPI:Serial data Input . |
| 6       | SCL    | H/L   | I2C:Clock Input for I2C<br>SPI:Serial Clock Input .          |
| 7       | SDO    | H/L   | SPI:Serial data output                                       |
| 8       | /CS    | H/L   | SPI:Chip select  |

### 8.2 Jumper selection for communication

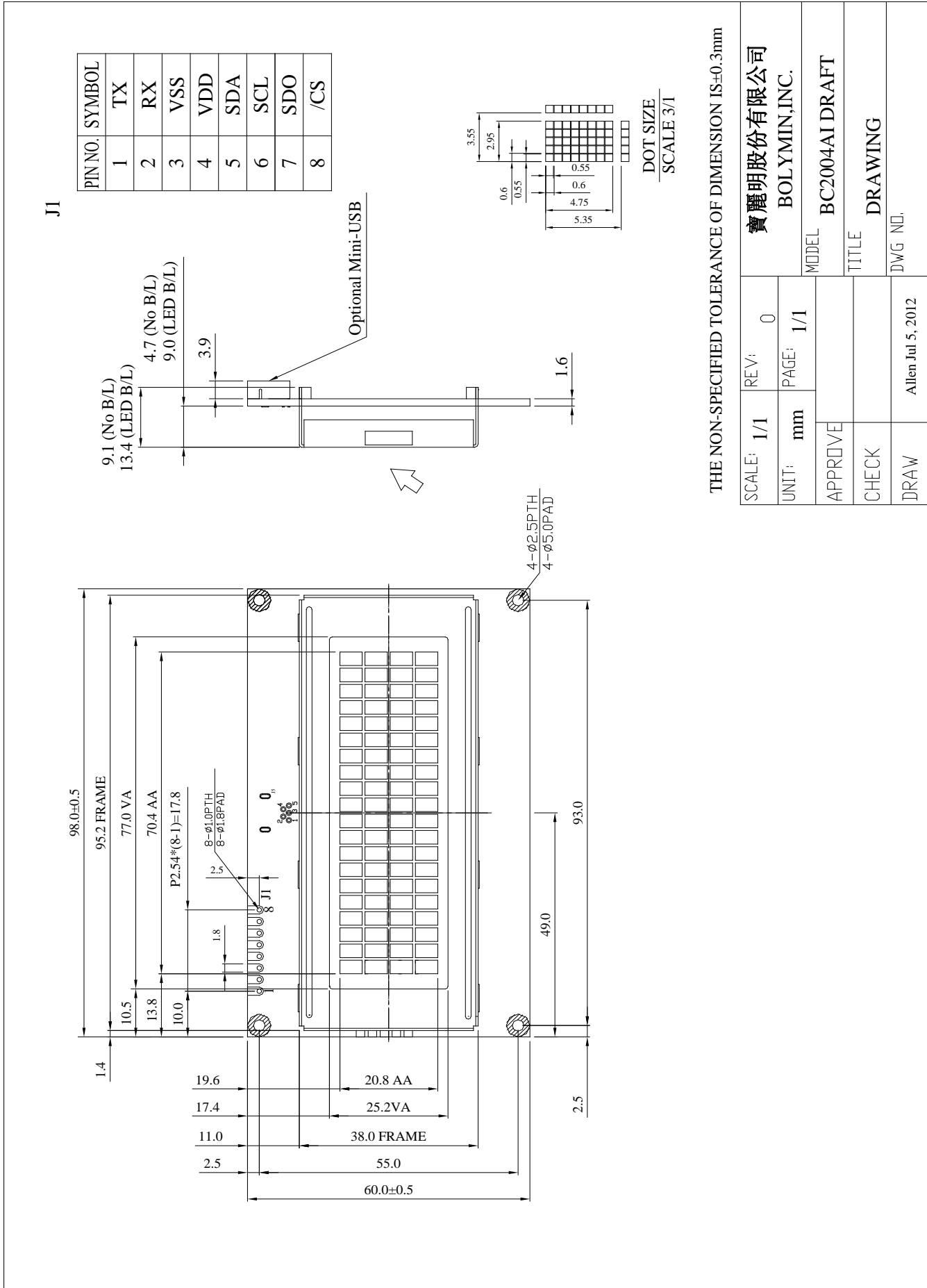
| Protocol | J21H  | J21L  | J22H  | J22L  | Description             |
|----------|-------|-------|-------|-------|-------------------------|
| I2C      | short | *     | *     | short | <b>100KHz max clock</b> |
| SPI      | *     | short | *     | short | <b>100KHz max clock</b> |
| RS232    | *     | short | short | *     | <b>5V, TTL signal</b>   |
| DEMO     | short | *     | short | *     | <b>Self-test</b>        |

\* : Open

### 8.3 Jumper location



## 9. Drawing



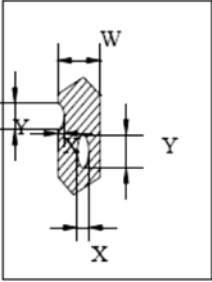
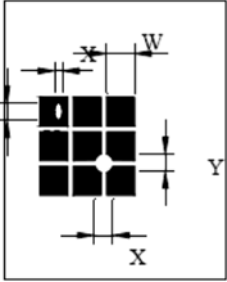
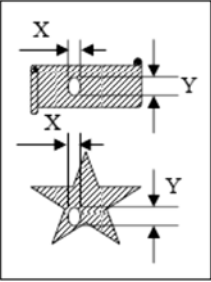
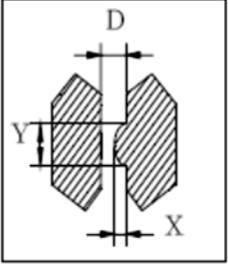
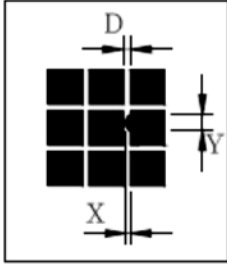
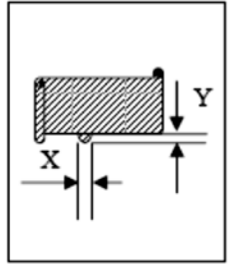
## 10. Quality Assurance

### 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.

### 10.2 Inspection Parameters

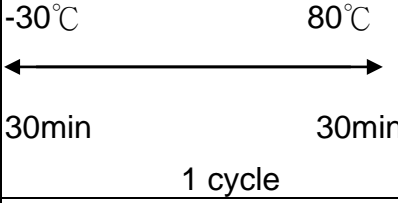
| NO.   | Parameter            | Criteria            |               |                   |                  |                  |
|---|----------------------|---------------------|---------------|-------------------|------------------|------------------|
| 1   | Black or White spots | Zone                |               | 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<br>glass &<br>polarizer) | <table border="1" data-bbox="416 226 1174 517"> <thead> <tr> <th>Zone<br/>Dimension</th> <th>Acceptable<br/>Number</th> <th>Class Of<br/>Defects</th> <th>Acceptable<br/>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> <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/>Bobbie is sawn only under reflection light is disregarded.</p>  | Zone<br>Dimension     | Acceptable<br>Number | Class Of<br>Defects | Acceptable<br>Level | $D \leq 0.2$ | Disregard | Minor | 2.5 | $0.2 < D \leq 0.5$    | 3 | $0.5 < D$              | 0 |               |   |                       |          |                     |                     |               |           |       |     |                                    |   |                              |   |
|------------------------------------|---|--|-----------------------|----------------------|---------------------|---------------------|--------------|-----------|-------|-----|-----------------------|---|------------------------|---|---------------|---|-----------------------|----------|---------------------|---------------------|---------------|-----------|-------|-----|------------------------------------|---|------------------------------|---|
| Zone<br>Dimension                  | Acceptable<br>Number                              | Class Of<br>Defects  | Acceptable<br>Level   |                      |                     |                     |              |           |       |     |                       |   |                        |   |               |   |                       |          |                     |                     |               |           |       |     |                                    |   |                              |   |
| $D \leq 0.2$                       | Disregard   | Minor  | 2.5                   |                      |                     |                     |              |           |       |     |                       |   |                        |   |               |   |                       |          |                     |                     |               |           |       |     |                                    |   |                              |   |
| $0.2 < D \leq 0.5$                 | 3   |  |                       |                      |                     |                     |              |           |       |     |                       |   |                        |   |               |   |                       |          |                     |                     |               |           |       |     |                                    |   |                              |   |
| $0.5 < D$                          | 0   |  |                       |                      |                     |                     |              |           |       |     |                       |   |                        |   |               |   |                       |          |                     |                     |               |           |       |     |                                    |   |                              |   |
| 4                                  | Displaying<br>Pattern                             | <ol style="list-style-type: none"> <li>Incomplete or broken line is not allowed.</li> <li>Pinholes           <table border="1" data-bbox="459 779 1281 1025"> <thead> <tr> <th>Dimension <math>\Phi</math>(mm)</th> <th>Criteria</th> <th>Class Of<br/>Defects</th> <th>Acceptable<br/>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> <div style="display: flex; justify-content: space-around; align-items: center;">    </div> <p style="text-align: center;"><math>\phi = (X+Y)/2</math></p> </li> <li>Deformation           <table border="1" data-bbox="459 1420 1342 1626"> <thead> <tr> <th>Dimension <math>\Phi</math>(mm)</th> <th>Criteria</th> <th>Class Of<br/>Defects</th> <th>Acceptable<br/>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> <div style="display: flex; justify-content: space-around; align-items: center;">    </div> <p style="text-align: center;"><math>D</math> : 間距      <math>\phi = (X+Y)/2</math></p> </li> </ol> | Dimension $\Phi$ (mm) | Criteria             | Class Of<br>Defects | Acceptable<br>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<br>Defects | Acceptable<br>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<br>Defects  | Acceptable<br>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<br>Defects  | Acceptable<br>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>168 hrs  | —                   |
| 2                  | Low Temperature storage           | Endurance test applying the high storage temperature for a long time.  | -30°C<br>168 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>168 hrs  | —                   |
| 4                  | Low Temperature Operation         | Endurance test applying the electric stress under low temperature for a long time.   | -20°C<br>168 hrs   | —                   |
| 5                  | Humidity Test                     | Endurance test applying the high humidity storage for a long time.   | 40°C, 90%RH<br>96 hrs  | —                   |
| 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 (Communication Information)

### 12-1 Communication Information

This module uses PIC16F690 micro controller for serial communication.

#### 12.1.1 I2C protocol

The I2C interface is able to receive data up to 100KHz-clock rate.

Default slave address of this module is 0xA0. The address could be changed to any 8-bit value by instruction function, but the LSB (least significant bit) must always be '0'. Once the slave address has been changed, the value will be stored in system memory. The slave address that has been changed will be restored to default value when input mode changes to other modes.

#### 12.1.2 SPI protocol

The SPI interface is able to receive data at up to 100KHz-clock rate.

SPI mode has a normally high level idle clock. When /CS is LOW, data input is sampled on the rising edge of the Serial clock line (SCL).

#### 12.1.3 RS232 protocol

The RS232 signal must be 5V TTL compatible. Communication format is 8-bit data, 1 Stop bit, no parity, no handshaking. Default BAUD rate is 9600, and is changeable with a command function. Once the BAUD rate has been changed, the value will be stored in system memory. The BAUD rate that has been changed will be restored to default value when input mode changes to other modes.

### Jumper selection for communication:

| Protocol | J21H         | J21L         | J22H         | J22L         | Description             |
|----------|--------------|--------------|--------------|--------------|-------------------------|
| I2C      | <b>short</b> | *            | *            | <b>short</b> | <b>100KHz max clock</b> |
| SPI      | *            | <b>short</b> | *            | <b>short</b> | <b>100KHz max clock</b> |
| RS232    | *            | <b>short</b> | <b>short</b> | *            | <b>5V, TTL signal</b>   |
| DEMO     | <b>short</b> | *            | <b>short</b> | *            | <b>Self -test</b>       |

\* : Open



## 12.4 Instruction table

| <b>Prefix</b> | <b>CMD</b> | <b>Parameter</b> | <b>Description</b>                      |
|---------------|------------|------------------|---|
| 0xFE          | 0x41       | None             | Display on.                             |
| 0xFE          | 0x42       | None             | Display off.                            |
| 0xFE          | 0x45       | 1 byte           | Set cursor.                             |
| 0xFE          | 0x46       | None             | Cursor home.                            |
| 0xFE          | 0x47       | None             | Cursor on.                              |
| 0xFE          | 0x48       | None             | Cursor off.                             |
| 0xFE          | 0x49       | None             | Cursor shift to the left one position.  |
| 0xFE          | 0x4A       | None             | Cursor shift to the right one position. |
| 0xFE          | 0x4B       | None             | Cursor Blink ON.                        |
| 0xFE          | 0x4C       | None             | Cursor Blink OFF.                       |
| 0xFE          | 0x4E       | None             | Backspace.                              |
| 0xFE          | 0x51       | None             | Clear display.                          |
| 0xFE          | 0x52       | 1 byte           | Contrast setting.                       |
| 0xFE          | 0x53       | 1 byte           | Backlight brightness setting.           |
| 0xFE          | 0x54       | 9 bytes          | Custom character generate.              |
| 0xFE          | 0x55       | None             | Shift Display to the Left               |
| 0xFE          | 0x56       | None             | Shift Display to the Right.             |
| 0xFE          | 0x61       | 1 byte           | Change RS232 BAUD rate.                 |
| 0xFE          | 0x62       | 1 byte           | Change I2C slave address.               |
| 0xFE          | 0x70       | None             | Display firmware version number.        |
| 0xFE          | 0x71       | None             | Display RS232 BAUD rate.                |
| 0xFE          | 0x72       | None             | Display I2C address.                    |
| 0xFE          | 0x73       | Dummy byte       | Read Data.                              |

## 12.5 Instruction Description

| Display on         |                              |        |             |
|--------------------|------------------------------|--------|-------------|
| <b>Syntax</b>      | hexadecimal                  | 0xFE   | 0x41        |
| <b>Parameter</b>   | Parameter                    | Length | Description |
|                    | None                         | None   | None        |
| <b>Description</b> | Entire display is turned on. |        |             |

| Display off        |   |        |             |
|--------------------|---|--------|-------------|
| <b>Syntax</b>      | hexadecimal   | 0xFE   | 0x42        |
| <b>Parameter</b>   | Parameter   | Length | Description |
|                    | None  | None   | None        |
| <b>Description</b> | Entire display is turned off, but display data is remained in DDRAM |        |             |

| Set Cursor         |   |        |   |       |
|--------------------|---|--------|---|-------|
| <b>Syntax</b>      | hexadecimal   | 0xFE   | 0x45                                      | [pos] |
| <b>Parameter</b>   | Parameter   | Length | Description                               |       |
|                    | [pos]   | 1 byte | Put cursor at location specified by [pos] |       |
| <b>Description</b> | This command uses to set the cursor to specific position where the character will be displayed. The typical cursor position for a 2-line display is show below; a cursor position out of these ranges will not be viewable. |        |   |       |
| <b>Default</b>     | After a reset, the cursor is on position 0x00.  |        |   |       |

|              | Column1 | Column20 |
|--------------|---------|----------|
| <b>Line1</b> | 0x00    | 0x13     |
| <b>Line2</b> | 0x40    | 0x53     |
| <b>Line3</b> | 0x14    | 0x27     |
| <b>Line4</b> | 0x54    | 0x67     |

| Cursor Home        |  |        |             |
|--------------------|--|--------|-------------|
| <b>Syntax</b>      | hexadecimal  | 0xFE   | 0x46        |
| <b>Parameter</b>   | Parameter  | Length | Description |
|                    | None   | None   | None        |
| <b>Description</b> | This command sets the cursor return to line 1, column 1 of the LCD screen. |        |             |

| Cursor on          |                              |        |             |
|--------------------|------------------------------|--------|-------------|
| <b>Syntax</b>      | hexadecimal                  | 0xFE   | 0x47        |
| <b>Parameter</b>   | Parameter                    | Length | Description |
|                    | None                         | None   | None        |
| <b>Description</b> | Cursor is turned on          |        |             |
| <b>Default</b>     | The underline cursor is off. |        |             |

| Cursor off         |   |        |             |
|--------------------|---|--------|-------------|
| <b>Syntax</b>      | hexadecimal   | 0xFE   | 0x48        |
| <b>Parameter</b>   | Parameter   | Length | Description |
|                    | None  | None   | None        |
| <b>Description</b> | Cursor is disappeared in current display, but I/D register remains its data |        |             |
| <b>Default</b>     | The underline cursor is off.  |        |             |

| Cursor shift to the left one position. |  |        |             |
|--|--|--------|-------------|
| <b>Syntax</b>                          | hexadecimal                            | 0xFE   | 0x49        |
| <b>Parameter</b>                       | Parameter                              | Length | Description |
|  | None                                   | None   | None        |
| <b>Description</b>                     | Cursor shift to the left one position. |        |             |
| <b>Default</b>                         | None                                   |        |             |

| Cursor shift to the right one position. |   |        |             |
|---|---|--------|-------------|
| <b>Syntax</b>                           | hexadecimal                             | 0xFE   | 0x4A        |
| <b>Parameter</b>                        | Parameter                               | Length | Description |
|   | None                                    | None   | None        |
| <b>Description</b>                      | Cursor shift to the right one position. |        |             |
| <b>Default</b>                          | None                                    |        |             |

| Cursor Blink ON    |   |        |             |
|--------------------|---|--------|-------------|
| <b>Syntax</b>      | hexadecimal   | 0xFE   | 0x4B        |
| <b>Parameter</b>   | Parameter   | Length | Description |
|                    | None  | None   | None        |
| <b>Description</b> | Cursor blink is on, the character is also blink on this position. |        |             |
| <b>Default</b>     | Cursor blink is on.   |        |             |

| Cursor Blink OFF   |                      |        |             |
|--------------------|----------------------|--------|-------------|
| <b>Syntax</b>      | hexadecimal          | 0xFE   | 0x4C        |
| <b>Parameter</b>   | Parameter            | Length | Description |
|                    | None                 | None   | None        |
| <b>Description</b> | Cursor blink is off. |        |             |

| Back Space         |   |        |             |
|--------------------|---|--------|-------------|
| <b>Syntax</b>      | hexadecimal   | 0xFE   | 0x4E        |
| <b>Parameter</b>   | Parameter   | Length | Description |
|                    | None  | None   | None        |
| <b>Description</b> | This command is destructive backspace, the cursor is moved back one space and the character on the cursor is deleted. |        |             |
| <b>Default</b>     | None.   |        |             |

| Clear display      |   |        |             |
|--------------------|---|--------|-------------|
| <b>Syntax</b>      | hexadecimal   | 0xFE   | 0x51        |
| <b>Parameter</b>   | Parameter   | Length | Description |
|                    | None  | None   | None        |
| <b>Description</b> | This command clears the entire display and place the cursor at line 1 column 1. |        |             |
| <b>Default</b>     | None.   |        |             |

| Contrast setting   |  |        |   |            |
|--------------------|--|--------|---|------------|
| <b>Syntax</b>      | hexadecimal  | 0xFE   | 0x52  | [contrast] |
| <b>Parameter</b>   | Parameter  | Length | Description                                     |            |
|                    | [contrast]   | 1 byte | Set the display contrast, value between 1 to 50 |            |
| <b>Description</b> | This command sets the LCD character display contrast, the contrast setting is between 1 to 50, where 50 is the highest contrast. |        |   |            |
| <b>Default</b>     | Default contrast value is 44.  |        |   |            |

| Backlight Brightness setting |   |        |  |              |
|------------------------------|---|--------|--|--------------|
| <b>Syntax</b>                | hexadecimal   | 0xFE   | 0x53   | [brightness] |
| <b>Parameter</b>             | Parameter   | Length | Description  |              |
|                              | [brightness]  | 1 byte | Set the LCD backlight brightness level, value between 1 to 8 |              |
| <b>Description</b>           | This command set the LCD display backlight brightness level, the value is between 1 to 8. |        |  |              |
| <b>Default</b>               | Default brightness value is 8.  |        |  |              |

| Custom character generate |   |         |                                  |                   |
|---------------------------|---|---------|----------------------------------|-------------------|
| <b>Syntax</b>             | hexadecimal   | 0xFE    | 0x54                             | [addr] [d0 ...d7] |
| <b>Parameter</b>          | Parameter   | Length  | Description                      |                   |
|                           | [addr]  | 1 byte  | Custom character address, 0 – 7  |                   |
|                           | [d0 ...d7]  | 8 bytes | Custom character pattern bit map |                   |
| <b>Description</b>        | This command used to generate custom character. The custom character pattern is bit mapped into 8 bytes, the bit map for Spanish character ‘¿’ is shown in table below, to display the custom character, user simply enter the address of the character (0 to 8). |         |                                  |                   |
| <b>Default</b>            | None.   |         |                                  |                   |

| Addr | Bit  | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Hex  |
|------|------|---|---|---|---|---|---|---|---|------|
| 0x00 | Byte | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0x04 |
| 0x01 | Byte | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0x00 |
| 0x02 | Byte | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0x04 |
| 0x03 | Byte | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0x08 |
| 0x04 | Byte | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0x10 |
| 0x05 | Byte | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0x11 |
| 0x06 | Byte | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0x0E |
| 0x07 | Byte | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0x00 |

EX: Send 0xFE 0x54 0x00 0x04 0x00 0x04 0x08 0x10 0x11 0x0E 0x00

| Shift Display to the Left |   |        |             |
|---------------------------|---|--------|-------------|
| <b>Syntax</b>             | hexadecimal   | 0xFE   | 0x55        |
| <b>Parameter</b>          | Parameter   | Length | Description |
|                           | None  | None   | None        |
| <b>Description</b>        | This command shifts the display one place to the left, the cursor position also moves with the display. |        |             |

| Shift Display to the Right |  |        |             |
|----------------------------|--|--------|-------------|
| <b>Syntax</b>              | hexadecimal  | 0xFE   | 0x56        |
| <b>Parameter</b>           | Parameter  | Length | Description |
|                            | None   | None   | None        |
| <b>Description</b>         | This command shifts the display one place to the right, the cursor position also moves with the display. |        |             |

| Display position | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Line 1 address   | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F | 10 | 11 | 12 | 13 |
| Line 2 address   | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F | 50 | 51 | 52 | 53 |
| Line 3 address   | 14 | 15 | 16 | 17 | 18 | 19 | 1A | 1B | 1C | 1D | 1E | 1F | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| Line 4 address   | 54 | 55 | 56 | 57 | 58 | 59 | 5A | 5B | 5C | 5D | 5E | 5F | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 |

For shift left

|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F | 10 | 11 | 12 | 13 | 14 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F | 50 | 51 | 52 | 53 | 54 |
| 15 | 16 | 17 | 18 | 19 | 1A | 1B | 1C | 1D | 1E | 1F | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 0  |
| 55 | 56 | 57 | 58 | 59 | 5A | 5B | 5C | 5D | 5E | 5F | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 40 |

For shift right

|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 27 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F | 10 | 11 | 12 |
| 67 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F | 50 | 51 | 52 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 | 1A | 1B | 1C | 1D | 1E | 1F | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 53 | 54 | 55 | 56 | 57 | 58 | 59 | 5A | 5B | 5C | 5D | 5E | 5F | 60 | 61 | 62 | 63 | 64 | 65 | 66 |

| Change RS232 BAUD Rate |   |        |                            |        |
|------------------------|---|--------|----------------------------|--------|
| <b>Syntax</b>          | hexadecimal   | 0xFE   | 0x61                       | [baud] |
| <b>Parameter</b>       | Parameter   | Length | Description                |        |
|                        | [baud]  | 1 byte | New RS232 BAUD Rate, 1 - 8 |        |
| <b>Description</b>     | This command sets the RS232 BAUD rate, the single byte parameter select the desired BAUD rate as in the table below. The new BAUD rate requires 20 ms to take effect, therefore, the subsequent input must have an appropriate delay. The default BAUD rate can be restored if I2C or SPI is selected as the communication mode. Illegal parameter input will be discarded. |        |                            |        |
| <b>Default</b>         | 9600 BAUD   |        |                            |        |

| Parameter | BAUD          |
|-----------|---------------|
| 1         | <b>300</b>    |
| 2         | <b>1200</b>   |
| 3         | <b>2400</b>   |
| 4         | <b>9600</b>   |
| 5         | <b>14400</b>  |
| 6         | <b>19.2K</b>  |
| 7         | <b>57.6K</b>  |
| 8         | <b>115.2K</b> |

| Change I2C Slave Address |  |        |  |       |
|--------------------------|--|--------|--|-------|
| <b>Syntax</b>            | hexadecimal  | 0xFE   | 0x62   | [adr] |
| <b>Parameter</b>         | Parameter  | Length | Description  |       |
|                          | [adr]  | 1 byte | New I2C address, 0x00 – 0xFE<br>The LSB is always '0'. |       |
| <b>Description</b>       | This command sets the I2C address, the address must be an even number, (LSB = 0). The address change requires 20 microseconds to take effect; therefore, the subsequent input must have an appropriate delay. The default I2C address can be restored if SPI or RS232 is selected as the communication mode. |        |  |       |
| <b>Default</b>           | 0x80   |        |  |       |



#### Display Firmware Version Number

|                    |   |        |             |
|--------------------|---|--------|-------------|
| <b>Syntax</b>      | hexadecimal   | 0xFE   | 0x70        |
| <b>Parameter</b>   | Parameter   | Length | Description |
|                    | None  | None   | None        |
| <b>Description</b> | This command displays the micro-controller firmware version number. |        |             |

#### Display RS232 Baud Rate

|                    |  |        |             |
|--------------------|--|--------|-------------|
| <b>Syntax</b>      | hexadecimal  | 0xFE   | 0x71        |
| <b>Parameter</b>   | Parameter  | Length | Description |
|                    | None   | None   | None        |
| <b>Description</b> | This command displays the current RS232 BAUD rate. |        |             |

#### Display I2C Address

|                    |  |        |             |
|--------------------|--|--------|-------------|
| <b>Syntax</b>      | hexadecimal  | 0xFE   | 0x72        |
| <b>Parameter</b>   | Parameter  | Length | Description |
|                    | None   | None   | None        |
| <b>Description</b> | This command displays the current I2C slave address. |        |             |

#### Read Data

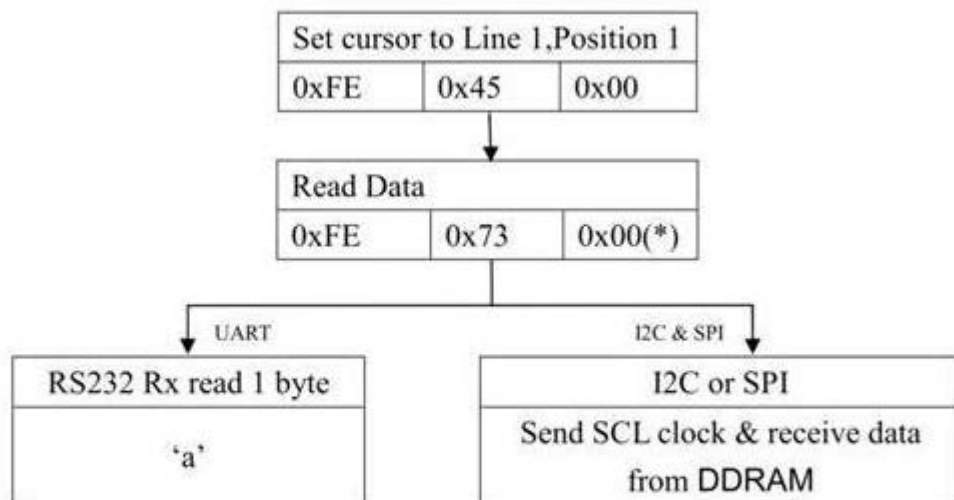
|                    |                             |        |                                |
|--------------------|-----------------------------|--------|--------------------------------|
| <b>Syntax</b>      | hexadecimal                 | 0xFE   | 0x73                           |
| <b>Parameter</b>   | Parameter                   | Length | Description                    |
|                    | dummy                       | 1 byte | Last data byte is a dummy byte |
| <b>Description</b> | This command read LCD data. |        |                                |

## Read Data sequence

Ex:



In order to read the character “a”, displayed on line1, position1  
The read sequence is show below:



(\*) 0x00 is dummy byte; this byte could be any value from 0x00 to 0xFF.

## 12.6 Font Table

Code E: English –European Font

| Upper<br>4 bit<br>Lower<br>4 bit | LLLL             | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|----------------------------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL                             | CG<br>RAM<br>(1) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| LLLH                             | CG<br>RAM<br>(2) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| LLHL                             | CG<br>RAM<br>(3) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| LLHH                             | CG<br>RAM<br>(4) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| LHLL                             | CG<br>RAM<br>(5) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| LHLH                             | CG<br>RAM<br>(6) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| LHHL                             | CG<br>RAM<br>(7) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| LHHH                             | CG<br>RAM<br>(8) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| HLLL                             | CG<br>RAM<br>(1) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| HLLH                             | CG<br>RAM<br>(2) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| HLHL                             | CG<br>RAM<br>(3) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| HLHH                             | CG<br>RAM<br>(4) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| HHLL                             | CG<br>RAM<br>(5) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| HHLH                             | CG<br>RAM<br>(6) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| HHHL                             | CG<br>RAM<br>(7) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |
| HHHH                             | CG<br>RAM<br>(8) | !    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 0    | 1    | 2    | 3    | 4    | 5    |

**Code J: English - Japanese Font**

| Upper<br>4 bit<br>Lower<br>4 bit | LLLL             | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|----------------------------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL                             | CG<br>RAM<br>(1) |      |      | o    | p    | f    | f    |      |      |      |      | 一    | o    | e    | o    | o    |
| LLLH                             | (2)              |      | !    | l    | o    | a    | a    |      |      |      |      | フ    | ク    | ク    | ク    | ク    |
| LLHL                             | (3)              |      | "    | z    | r    | r    | r    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| LLHH                             | (4)              |      | *    | o    | s    | s    | s    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| LHLL                             | (5)              |      | *    | o    | t    | t    | t    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| LHLH                             | (6)              |      | *    | e    | e    | e    | e    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| LHHL                             | (7)              |      | *    | e    | f    | f    | f    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| LHHH                             | (8)              |      | *    | e    | w    | w    | w    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| HLLL                             | (1)              |      | *    | e    | x    | x    | x    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| HLLH                             | (2)              |      | *    | e    | y    | y    | y    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| HLHL                             | (3)              |      | *    | e    | z    | z    | z    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| HLHH                             | (4)              |      | *    | e    | k    | k    | k    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| HHLL                             | (5)              |      | *    | e    | l    | l    | l    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| HHLH                             | (6)              |      | *    | e    | m    | m    | m    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| HHHL                             | (7)              |      | *    | e    | n    | n    | n    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |
| HHHH                             | (8)              |      | *    | e    | o    | o    | o    |      |      |      | フ    | ク    | ク    | ク    | ク    | ク    |

**CodeC: English - Cyrillic Font**

| Upper<br>4 bit<br>Lower<br>4 bit | LLLL             | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|----------------------------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL                             | CG<br>RAM<br>(1) |      |      | 0    | 1    | 2    | 3    | 4    |      |      | 5    | 6    | 7    | 8    | 9    | 0    |
| LLLH                             | CG<br>RAM<br>(2) | !    | ;    | 4    | 5    | 6    | 7    | 8    |      |      | 9    | 0    | 1    | 2    | 3    | 4    |
| LLHL                             | CG<br>RAM<br>(3) | "    | 3    | 4    | 5    | 6    | 7    | 8    |      |      | 9    | 0    | 1    | 2    | 3    | 4    |
| LLHH                             | CG<br>RAM<br>(4) | *    | 2    | 3    | 4    | 5    | 6    | 7    |      |      | 8    | 9    | 0    | 1    | 2    | 3    |
| LHLL                             | CG<br>RAM<br>(5) | \$   | 4    | 5    | 6    | 7    | 8    | 9    |      |      | 0    | 1    | 2    | 3    | 4    | 5    |
| LHLH                             | CG<br>RAM<br>(6) | %    | 5    | 6    | 7    | 8    | 9    | 0    |      |      | 1    | 2    | 3    | 4    | 5    | 6    |
| LHHL                             | CG<br>RAM<br>(7) | @    | 6    | 7    | 8    | 9    | 0    | 1    |      |      | 2    | 3    | 4    | 5    | 6    | 7    |
| LHHH                             | CG<br>RAM<br>(8) | #    | 7    | 8    | 9    | 0    | 1    | 2    |      |      | 3    | 4    | 5    | 6    | 7    | 8    |
| HLLL                             | CG<br>RAM<br>(1) | ^    | 8    | 9    | 0    | 1    | 2    | 3    |      |      | 4    | 5    | 6    | 7    | 8    | 9    |
| HLLH                             | CG<br>RAM<br>(2) | >    | 9    | 0    | 1    | 2    | 3    | 4    |      |      | 5    | 6    | 7    | 8    | 9    | 0    |
| HLHL                             | CG<br>RAM<br>(3) | +    | 0    | 1    | 2    | 3    | 4    | 5    |      |      | 6    | 7    | 8    | 9    | 0    | 1    |
| HLHH                             | CG<br>RAM<br>(4) | =    | 1    | 2    | 3    | 4    | 5    | 6    |      |      | 7    | 8    | 9    | 0    | 1    | 2    |
| HHLL                             | CG<br>RAM<br>(5) | ~    | 2    | 3    | 4    | 5    | 6    | 7    |      |      | 8    | 9    | 0    | 1    | 2    | 3    |
| HHLH                             | CG<br>RAM<br>(6) | —    | 3    | 4    | 5    | 6    | 7    | 8    |      |      | 9    | 0    | 1    | 2    | 3    | 4    |
| HHHL                             | CG<br>RAM<br>(7) | ·    | 4    | 5    | 6    | 7    | 8    | 9    |      |      | 0    | 1    | 2    | 3    | 4    | 5    |
| HHHH                             | CG<br>RAM<br>(8) | °    | 5    | 6    | 7    | 8    | 9    | 0    |      |      | 1    | 2    | 3    | 4    | 5    | 6    |