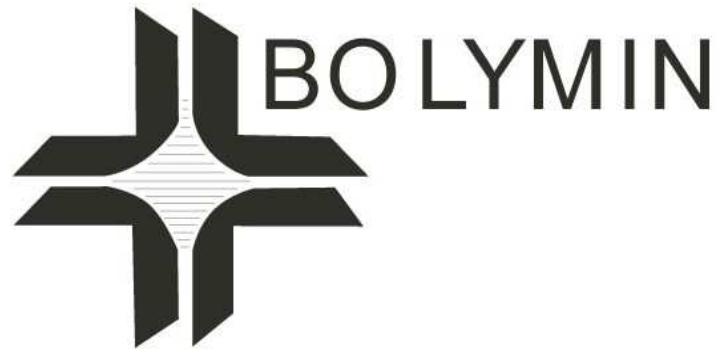




# SPECIFICATIONS FOR LCD MODULE

MODEL NO.  
BG240128A-FNHNHN\$  
VER.02



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                      | 2019/11/13 | SPEC. |
| 02      | Correct module viewing area size | 2020/9/15  | SPEC. |
|         |                                  |            |       |
|         |                                  |            |       |
|         |                                  |            |       |
|         |                                  |            |       |
|         |                                  |            |       |
|         |                                  |            |       |
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## 1. Numbering System

|   |   |        |   |   |   |   |   |   |   |   |    |    |
|---|---|--------|---|---|---|---|---|---|---|---|----|----|
| B | G | 240128 | A | - | F | N | H | N | H | N | \$ | -  |
| 0 | 1 | 2      | 3 |   | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

|   |                      |       |                          |   |                        |
|---|----------------------|-------|--------------------------|---|------------------------|
| 0 | Bolymin              | B     |                          |   |                        |
| 1 | Module Type          | C     | Character type           | P | TAB /TCP type          |
|   |                      | F     | COF type                 | R | Color STN              |
|   |                      | G     | Graphic type             | L | OLED                   |
|   |                      | O     | COG type                 | Z | Customize              |
|   |                      |       |                          |   |                        |
| 2 | Format               | 2004  | 20 character type,4lines |   |                        |
|   |                      | 12232 | 122 × 32 dots            |   |                        |
| 3 | Version No.          | A     |                          |   |                        |
|   |                      |       |                          |   |                        |
| 4 | LCD Color            | B     | STN / Blue, OLED/Blue    | H | HTN                    |
|   |                      | C     | Color                    | T | TN                     |
|   |                      | F     | FSTN                     | Y | STN/Yellow-green       |
|   |                      | G     | STN/Grey                 | D | OLED/Blue+Yellow       |
|   |                      | A     | OLED/Blue+Yellow+Green   | E | OLED/Yellow            |
|   |                      | L     | OLED/Green               | R | OLED/RED               |
|   |                      | W     | OLED/White               | J | ASTN                   |
|   |                      | K     | DFSTN                    | V | VA LCD                 |
|   |                      |       |                          |   |                        |
| 5 | LCD Type             | R     | Positive/reflective      | M | Positive/ transmissive |
|   |                      | P     | Positive/transflective   | N | Negative/ transmissive |
|   |                      | T     | Negative/ transflective  |   |                        |
| 6 | Backlight type/color | L     | (LED)Array/yellow-green  | G | (LED)Edge/yellow-green |
|   |                      | M     | (LED)Array/amber         | H | (LED)Edge/white        |
|   |                      | R     | (LED)Array/red           | D | (LED)Edge/blue         |
|   |                      | U     | (LED)Array/blue          | E | (EL)white              |
|   |                      | W     | (LED)Array/white         | B | (EL)blue               |
|   |                      | C     | (CCFL) white             | F | (LED)Array/RGB         |
|   |                      | Y     | (LED)Array/yellow        | N | No backlight           |
|   |                      | O     | (LED)Array/orange        | K | (LED)Edge/green        |
|   |                      | A     | (LED)Edge/amber          | Q | (LED)Edge/red          |
|   |                      | J     | (LED)Array/green         | I | (LED)Edge/RGB          |
|   |                      | Z     | (LED) arrayred/green     | P | (LED)Edge/orange       |
|   |                      |       |                          |   |                        |

|    |                                         |    |                                                            |     |                                                             |
|----|-----------------------------------------|----|------------------------------------------------------------|-----|-------------------------------------------------------------|
|    |                                         | S  | (LED)edge/RGW                                              | T   | (LED)edge red/green                                         |
|    |                                         | V  | EL blue/green                                              | X   | (LED) Edgewhite /red                                        |
| 7  | CGRAM Font                              | J  | English/Japanese Font                                      | C   | English/Cyrillic Font                                       |
|    |                                         | G  | Chinese(simple)                                            | H   | English/Hebrew Font                                         |
|    |                                         | E  | English/European Font<br>(ST7066U0B-BB)                    | S   | English/European Font<br>(ST7066U-0E-BB)                    |
|    |                                         | F  | Chinese(traditional)                                       | M   | Japanese-Kanji                                              |
|    |                                         | Z  | Z=Chinese(simple)+Chinese<br>(traditional)+Japanese+Korean | K   | Korean<br>(only for BG16032A BG24064C)                      |
|    |                                         | A  | English/Arabic Font                                        | D   | Chinese (simple/traditional)<br>English/Japanese            |
|    |                                         | B  | English/Japanese/European                                  | N   | None                                                        |
| 8  | View Angle<br>/Operation<br>Temperature | B  | Bottom/Normal Temperature 06:00                            | W   | Top/Wide Temperature 12:00                                  |
|    |                                         | H  | Bottom/Wide Temperature 06:00                              | E   | Top/Ultra Temperature 12:00                                 |
|    |                                         | C  | 9H/Normal Temperature 09:00                                | U   | Bottom/Ultra wide Temperature<br>06:00                      |
|    |                                         | T  | Top/Normal Temperature 12:00                               | F   | 9H/Ultra wide Temperature<br>09:00                          |
|    |                                         | G  | 3H/Wide Temperature 3:00                                   | D   | 9H/Wide Temperature 09:00                                   |
|    |                                         | I  | 3H/ Ultra Wide Temperature 3:00                            |     |                                                             |
| 9  | Special Code                            | N  | Negative voltage for LCD                                   | T   | Negative voltage and<br>Temperature compensation<br>for LCD |
|    |                                         | P  | Touch panel                                                | 3/5 | 3/5 voltage logic power<br>supply                           |
| 10 | RoHS                                    | \$ |                                                            |     |                                                             |
| 11 | Customer<br>Code                        |    |                                                            |     |                                                             |

## 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                  | 240 x 128                  | dots |
| Module dimension<br>(L x W x H) | 170.0 x 93.0 x14.0-LED B/L | mm   |
| View area                       | 128.0 x 74.0               | mm   |
| Active area                     | 120.0 x 64.0               | mm   |
| Dot size                        | 0.47 x 0.47                | mm   |
| Dot pitch                       | 0.5 x 0.5                  | mm   |

#### (2) Controller IC: Ultra chip UCI6963

### 4. Absolute Maximum Rating

#### 4.1 Electrical Absolute Maximum Ratings

(Vss=0V, Ta=25°C)

| Item                     | Symbol  | Min  | Typ | Max  | Unit |
|--------------------------|---------|------|-----|------|------|
| Input Voltage            | $V_i$   | Vss  | -   | Vdd  | V    |
| Supply Voltage For Logic | Vdd-Vss | -0.3 | -   | +7   | V    |
| Supply Voltage For LCD   | Vdd-Vo  | -    | -   | 28.0 | V    |
| Negative Voltage Output  | Vee     | -    | -   | -21  | V    |



## 4.2 Environmental Absolute Maximum Ratings

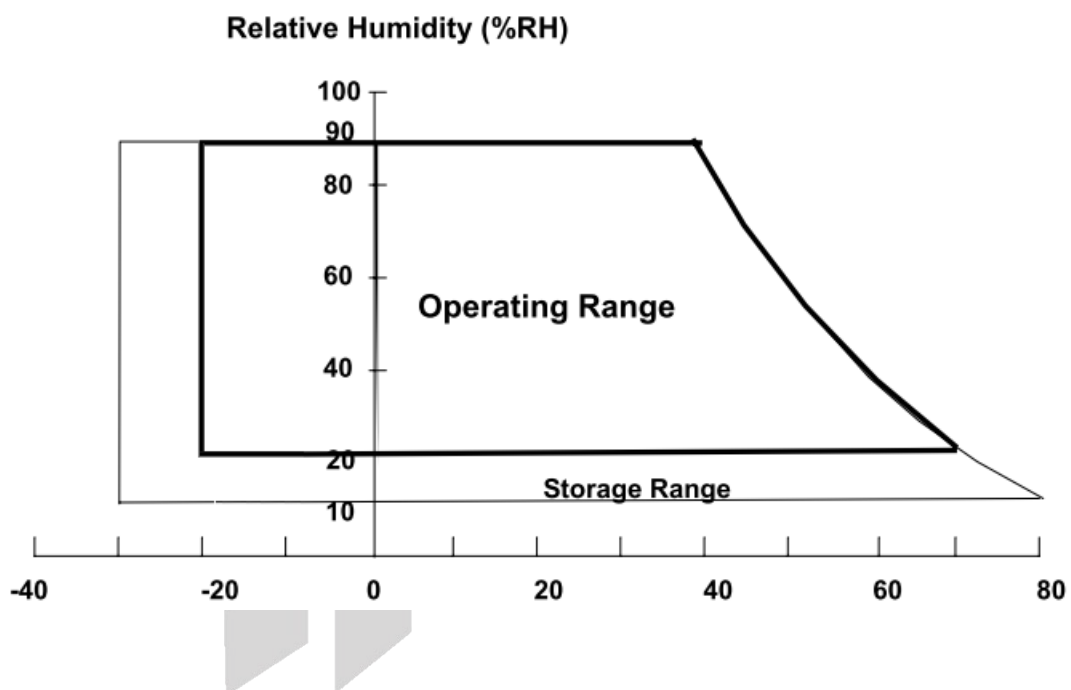
| Item                  | Symbol | Min | Max | Unit | Note |
|-----------------------|--------|-----|-----|------|------|
| Operating Temperature | TOP    | -20 | 70  | °C   | (1)  |
| Storage Temperature   | TST    | -30 | 80  | °C   | (1)  |

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         | —                                         | 4.75 | —    | 5.25 | V                 |
| Supply Voltage For LCD           | Vdd-Vo          | Ta=25°C                                   | 18.5 | 18.8 | 19.1 | V                 |
| Input High Volt.                 | V <sub>IH</sub> | —                                         | 2.2  | —    | Vdd  | V                 |
| Input Low Volt.                  | V <sub>IL</sub> | —                                         | 0    | —    | 0.8  | V                 |
| Output High Volt.                | V <sub>OH</sub> | —                                         | 2.4  | —    | Vdd  | V                 |
| Output Low Volt.                 | V <sub>OL</sub> | —                                         | 0    | —    | 0.4  | V                 |
| Supply Current                   | I <sub>dd</sub> | Vdd=5V                                    | —    | 50   | —    | mA                |
| LCM Surface Luminance<br>Ta=25°C | L               | I <sub>LED</sub> =240mA<br>Display all ON | 100  | 150  | —    | cd/m <sup>2</sup> |

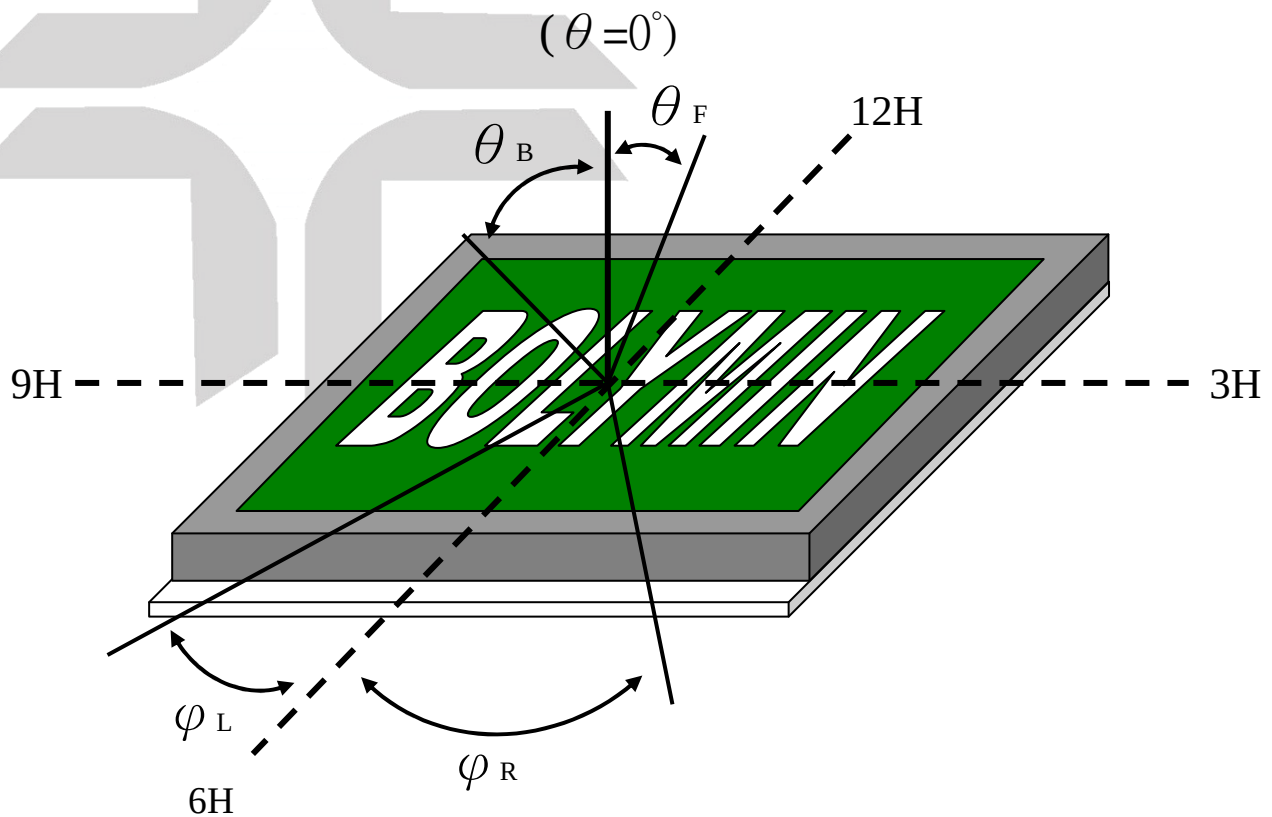
※Optimum LCD driving voltage value, referring to above mentioned range, is changed due to different batch of LCD glass.

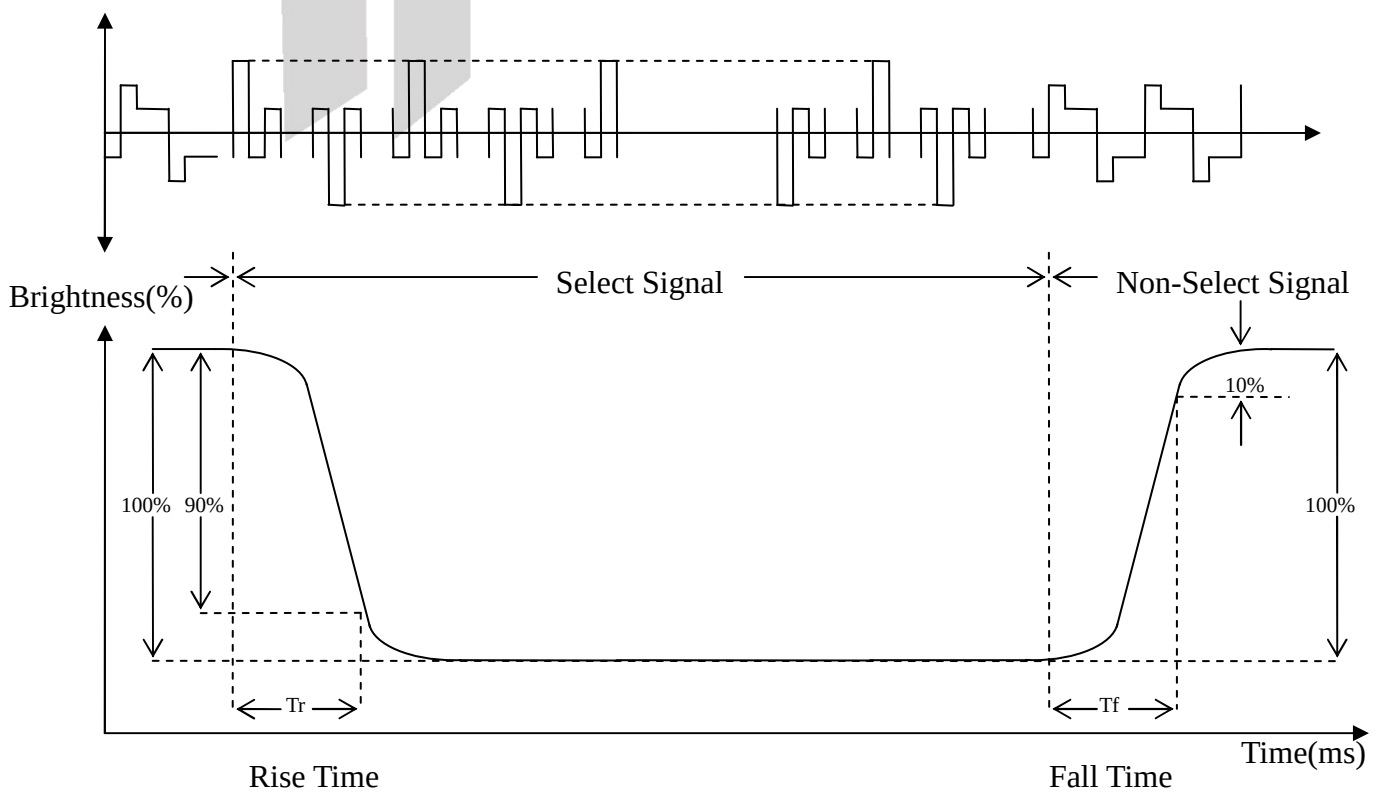
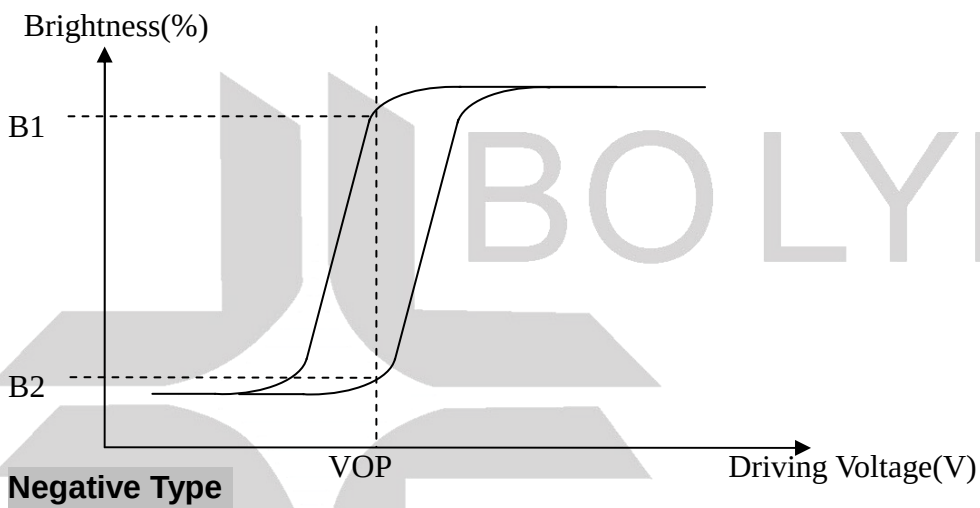
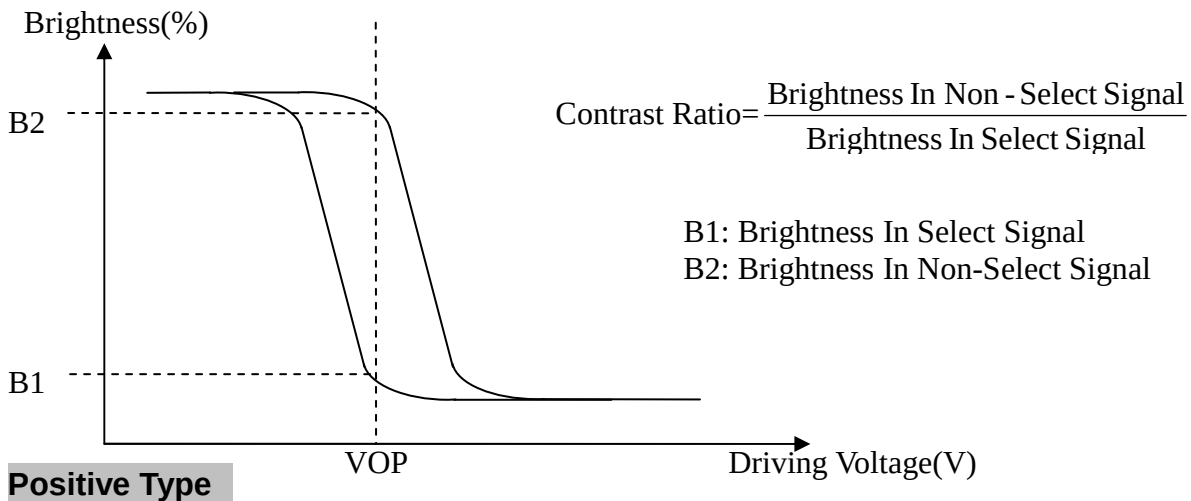
## 6. Optical Characteristics

### a. FSTN

(Ta=25°C)

| Item               | Symbol     | Min. | Typ. | Max. | Unit |
|--------------------|------------|------|------|------|------|
| View Angle (CR>=2) | $\theta_F$ | -    | 36   | -    | deg  |
|                    | $\theta_B$ | -    | 38   | -    | deg  |
|                    | $\phi_L$   | -    | 40   | -    | deg  |
|                    | $\phi_R$   | -    | 45   | -    | deg  |
| Contrast Ratio     | CR         | -    | 5    | -    | -    |
| Response Time 25°C | T rise     | -    | 200  | 400  | ms   |
|                    | T fall     | -    | 250  | 400  | ms   |



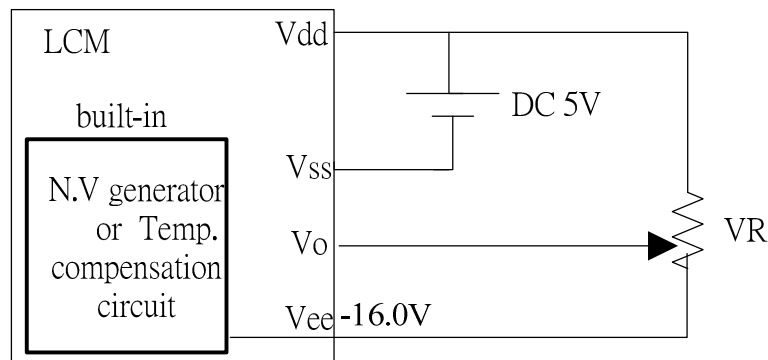


## 7. Interface Pin Function

| Pin No. | Symbol | Level | Description                                                                                       |
|---------|--------|-------|---------------------------------------------------------------------------------------------------|
| 1       | FGND   | -     | Frame GND                                                                                         |
| 2       | Vss    | -     | Power supply ( GND )                                                                              |
| 3       | Vdd    | -     | Power supply ( +5 V )                                                                             |
| 4       | Vo     | -     | Contrast adjustment                                                                               |
| 5       | /WR    | L     | Data write. Write data into UCI6963 when WR = L                                                   |
| 6       | /RD    | L     | Data read. Read data from UCI6963 when RD = L                                                     |
| 7       | /CE    | L     | L : Chip enable                                                                                   |
| 8       | C/D    | H / L | WR=L , C/D=H : Command Write   C/D=L: Data write<br>RD=L , C/D=H : Status Read   C/D=L: Data read |
| 9       | Vee    | -     | Negative voltage output <b>-16.0V</b>                                                             |
| 10      | /RESET | H / L | H : Normal ; L : Initialize UCI6963                                                               |
| 11      | DB0    | H / L | Data bus line                                                                                     |
| 12      | DB1    | H / L | Data bus line                                                                                     |
| 13      | DB2    | H / L | Data bus line                                                                                     |
| 14      | DB3    | H / L | Data bus line                                                                                     |
| 15      | DB4    | H / L | Data bus line                                                                                     |
| 16      | DB5    | H / L | Data bus line                                                                                     |
| 17      | DB6    | H / L | Data bus line                                                                                     |
| 18      | DB7    | H / L | Data bus line                                                                                     |
| 19      | FS     | H / L | Pins for selection of font; H : 6 x 8 , L : 8 x 8                                                 |
| 20      | RV     | H / L | H:Reverse   L:Normal                                                                              |

## 8. Power supply for LCD Module and LCD operating voltage adjustment

LCM operating on " DC 5V " input with built-in negative voltage



## 9. Backlight information

### 9.1 Specification

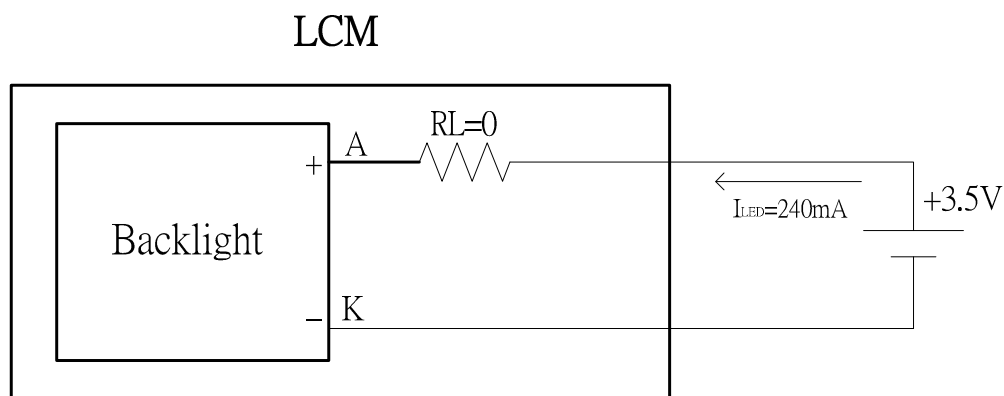
#### (1) LED edge/white

| Parameter                | Symbol           | Min  | Typ | Max  | Unit | Test Condition          |
|--------------------------|------------------|------|-----|------|------|-------------------------|
| Supply Current           | I <sub>LED</sub> | —    | 240 | —    | mA   | V=3.5V                  |
| Supply Voltage           | V                | 3.2  | 3.5 | 3.8  | V    | I <sub>LED</sub> =240mA |
| Reverse Voltage          | V <sub>R</sub>   | —    | —   | 5    | V    | —                       |
| CIE Chromaticity Diagram | X                | 0.30 | —   | 0.34 | nm   | I <sub>LED</sub> =240mA |
|                          | Y                | 0.28 | —   | 0.34 |      |                         |
| Color                    | White            |      |     |      |      |                         |

### 9.2 Backlight driving methods

#### a. LED B/L driven from A.K pin directly

##### a.1 edge/white



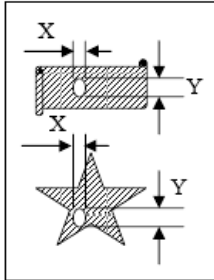
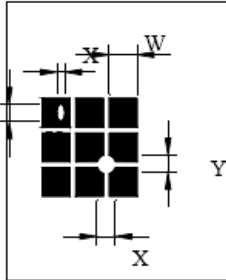
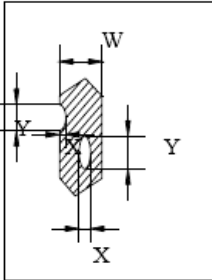
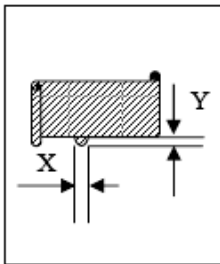
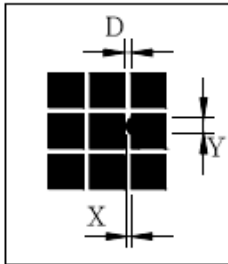
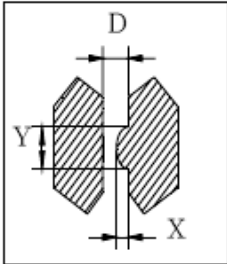
## 10. Quality Assurance

### 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) | <table><tr><th colspan="2">Zone<br/>Dimension \</th><th>Acceptable Number</th><th>Class Of Defects</th><th>Acceptable Level</th></tr><tr><td colspan="2">D ≤ 0.10</td><td>Disregard</td><td rowspan="4">Minor</td><td rowspan="4">2.5</td></tr><tr><td colspan="2">0.10 &lt; D ≤ 0.2</td><td>4</td></tr><tr><td colspan="2">0.2 &lt; D ≤ 0.3</td><td>2</td></tr><tr><td colspan="2">0.3 &lt; D</td><td>0</td></tr></table>                                            |          |                   |                  | Zone<br>Dimension \ |  | Acceptable Number | Class Of Defects | Acceptable Level | D ≤ 0.10 |       | Disregard | Minor    | 2.5       | 0.10 < D ≤ 0.2 |     | 4       | 0.2 < D ≤ 0.3 |   | 2       | 0.3 < D |   | 0 |         |   |
|                                                                                 |                                 | Zone<br>Dimension \                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          | Acceptable Number | Class Of Defects | Acceptable Level    |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
|                                                                                 |                                 | D ≤ 0.10                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          | Disregard         | Minor            | 2.5                 |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
|                                                                                 |                                 | 0.10 < D ≤ 0.2                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          | 4                 |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
|                                                                                 |                                 | 0.2 < D ≤ 0.3                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          | 2                 |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
|                                                                                 |                                 | 0.3 < D                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          | 0                 |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
| D=(Long + Short)/2                                                              |                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |                   |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
| Total defects should not exceed 5/module                                        |                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |                   |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
| Defect that is located at outside of AA and doesn't affect function is ignored. |                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |                   |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
| 2                                                                               | Scratch, Substances             | <table><tr><th colspan="2">Zone</th><th rowspan="2">Acceptable Number</th><th rowspan="2">Class Of Defects</th><th rowspan="2">Acceptable Level</th></tr><tr><th>X(mm)</th><th>Y(mm)</th></tr><tr><td>—</td><td>0.05 ≥ W</td><td>Disregard</td><td rowspan="4">Minor</td><td rowspan="4">2.5</td></tr><tr><td>4.0 ≥ L</td><td>0.05 ≥ W</td><td>4</td></tr><tr><td>3.0 ≥ L</td><td>0.1 ≥ W</td><td>2</td></tr><tr><td>—</td><td>0.1 &lt; W</td><td>0</td></tr></table> |          |                   |                  | Zone                |  | Acceptable Number | Class Of Defects | Acceptable Level | X(mm)    | Y(mm) | —         | 0.05 ≥ W | Disregard | Minor          | 2.5 | 4.0 ≥ L | 0.05 ≥ W      | 4 | 3.0 ≥ L | 0.1 ≥ W | 2 | — | 0.1 < W | 0 |
|                                                                                 |                                 | Zone                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          | Acceptable Number | Class Of Defects | Acceptable Level    |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
|                                                                                 |                                 | X(mm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Y(mm)    |                   |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
|                                                                                 |                                 | —                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0.05 ≥ W | Disregard         | Minor            | 2.5                 |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
|                                                                                 |                                 | 4.0 ≥ L                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0.05 ≥ W | 4                 |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
|                                                                                 |                                 | 3.0 ≥ L                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0.1 ≥ W  | 2                 |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
| —                                                                               | 0.1 < W                         | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |          |                   |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
| X: Length    Y: Width                                                           |                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |                   |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
| Total defects should not exceed 5/module                                        |                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |          |                   |                  |                     |  |                   |                  |                  |          |       |           |          |           |                |     |         |               |   |         |         |   |   |         |   |
| 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><tr><th>Zone<br/>Dimension</th><th>Acceptable<br/>Number</th><th>Class Of<br/>Defects</th><th>Acceptable<br/>Level</th></tr><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></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                             | <p>1. Incomplete or broken line is not allowed.<br/>2. Pinholes</p> <table><tr><th>Dimension <math>\Phi</math>(mm)</th><th>Criteria</th><th>Class Of<br/>Defects</th><th>Acceptable<br/>Level</th></tr><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></table> <div></div> <p><math>\varnothing = (X+Y)/2</math></p> <p>3. Deformation</p> <table><tr><th>Dimension <math>\Phi</math>(mm)</th><th>Criteria</th><th>Class Of<br/>Defects</th><th>Acceptable<br/>Level</th></tr><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></table> <div></div> <p>D : 間距</p> <p><math>\varnothing = (X+Y)/2</math></p> | 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

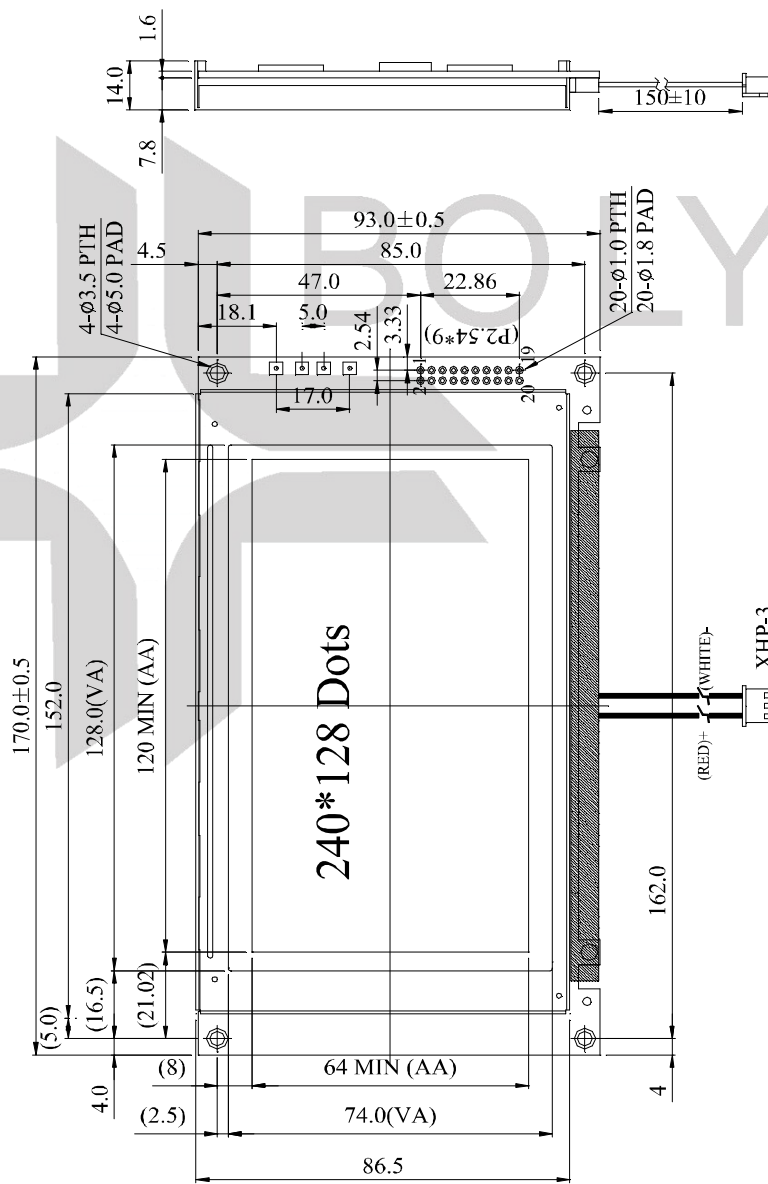
| Environmental Test |                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                 |                     |
|--------------------|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 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℃<br>96 hrs                                                                                                                                   | —                   |
| 2                  | Low Temperature storage           | Endurance test applying the high storage temperature for a long time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | -30℃<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℃<br>96 hrs                                                                                                                                   | —                   |
| 4                  | Low Temperature Operation         | Endurance test applying the electric stress under low temperature for a long time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | -20℃<br>96 hrs                                                                                                                                  | —                   |
| 5                  | Humidity Test                     | Endurance test applying the high humidity storage for a long time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 40℃, 90%RH<br>96hrs                                                                                                                             | —                   |
| 6                  | Temperature cycle (Non-operation) | <p>Endurance test applying the low and high temperature cycle.</p> <p>-30℃ <span style="display: inline-block; width: 150px; border-bottom: 1px solid black; position: relative; top: -10px;"> <span style="position: absolute; left: -5px; top: -5px;">←</span> <span style="position: absolute; right: -5px; top: -5px;">→</span> </span> 80℃</p> <p>30min <span style="display: inline-block; width: 100px; border-bottom: 1px solid black; position: relative; top: -10px;"> <span style="position: absolute; left: -5px; top: -5px;">←</span> <span style="position: absolute; right: -5px; top: -5px;">→</span> </span> 30min</p> <p style="text-align: center;">1 cycle</p> | -30℃/80℃<br>10 cycles                                                                                                                           | —                   |
| 7                  | Vibration test                    | Endurance test applying the vibration during transportation and using.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <p>Total Fixed Amplitude: 1.5mm</p> <p>Vibration Frequency : 10~55Hz</p> <p>One cycle 60 seconds to 3 direction of X,Y,Z for each 15minutes</p> | —                   |

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

## 12. Appendix (Drawing , UCi6963 controller data)

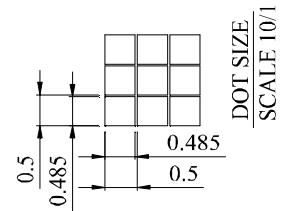
### 12.1 Drawing

| PIN NO. | SYMBOL          |
|---------|-----------------|
| 1       | FGND            |
| 2       | V <sub>ss</sub> |
| 3       | V <sub>dd</sub> |
| 4       | V <sub>o</sub>  |
| 5       | WR              |
| 6       | RD              |
| 7       | CE              |
| 8       | C/D             |
| 9       | V <sub>ee</sub> |
| 10      | RESET           |
| 11      | DB0             |
| 12      | DB1             |
| 13      | DB2             |
| 14      | DB3             |
| 15      | DB4             |
| 16      | DB5             |
| 17      | DB6             |
| 18      | DB7             |
| 19      | FS              |
| 20      | RV              |



1. The non-specified tolerance of dimension is  $\pm 0.3$  mm .

|            |           |                            |
|------------|-----------|----------------------------|
| SCALE: 1/1 | REV: 0    | 寶麗明股份有限公司<br>BOLYMIN, INC. |
| UNIT: mm   | PAGE: 1/1 | MODEL<br>BG240128A         |
| APPROVE    |           | TITLE<br>LCM DRAWING       |
| CHECK      |           | DWG NO.                    |
| DRAW       |           |                            |



## 12.2 UCi6963 controller data

### 12.2.1 Display control instruction

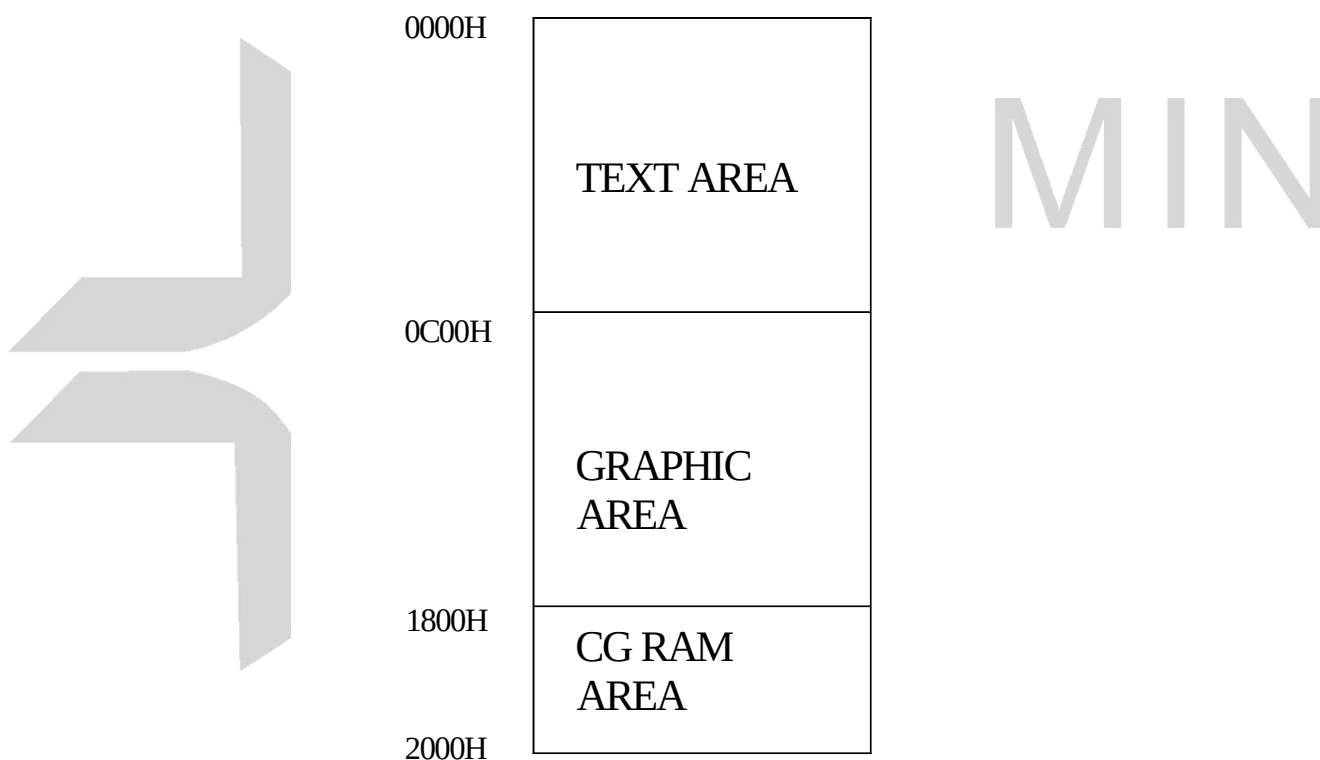
The LCD Module has built in a UCi6963 LSI controller, It has an 8-bit parallel data bus and control lines for writing or reading through an MPU interface, it has a 128-word character generator ROM ( refer to Table 1. ), which can control an external display RAM of up to 8K bytes. Allocation of text, graphics and external character generator RAM can be made easily and the display window can be moved freely within the allocated memory range.

#### •RAM Interface

The external RAM is used to store display data( text, graphic and external CG data ). It can be freely allocated to the memory area( 8 Kbyte max ).

Recommend

- Flowchart of communications with MPU



#### (1)Status Read

A status check must be performed before data is read or written.

#### Status check

The Status of UCI6963 can be read from the data lines.

|                        |   |
|------------------------|---|
| $\overline{\text{RD}}$ | L |
| $\overline{\text{WR}}$ | H |
| $\overline{\text{CE}}$ | L |
| C/D                    | H |
| Do to D7               | H |

The UCI6963 status word format is as follows:

| MSB  |      |      |      | LSB  |      |      |      |
|------|------|------|------|------|------|------|------|
| STA7 | STA6 | STA5 | STA4 | STA3 | STA2 | STA1 | STA0 |
| D7   | D6   | D5   | D4   | D3   | D2   | D1   | D0   |

|      |                                                            |                                   |
|------|------------------------------------------------------------|-----------------------------------|
| STA0 | Check command execution capability                         | 0:Disable<br>1:Enable             |
| STA1 | Check data read/write Capability                           | 0:Disable<br>1:Enable             |
| STA2 | Check Auto mode data read capability                       | 0:Disable<br>1:Enable             |
| STA3 | Check Auto mode data write capability                      | 0:Disable<br>1:Enable             |
| STA4 | Not used                                                   |                                   |
| STA5 | Check controller operation capability                      | 0:Disable<br>1:Enable             |
| STA6 | Error flag. Used for Screen Peek and Screen copy commands. | 0:No error<br>1>Error             |
| STA7 | Check the blink condition                                  | 0:Disable off<br>1:Normal display |

(Note 1) It is necessary to check STA0 and STA1 at the same time.

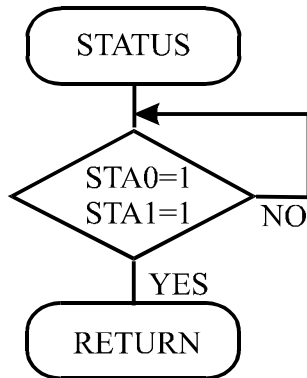
There is a possibility of erroneous operation due to a hardware interrupt.

(Note 2) For most modes STA0/STA1 are used as a status check.

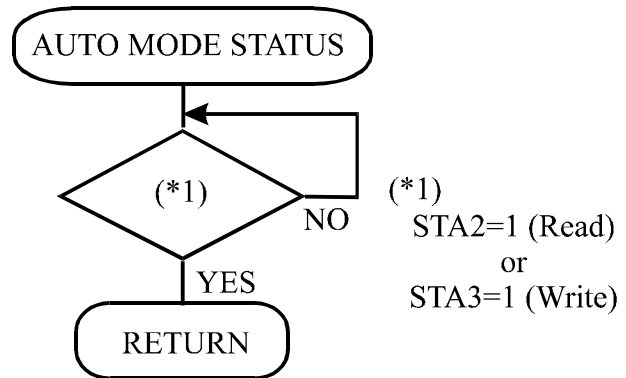
(Note 3) STA2 and STA3 are valid in Auto mode; STA0 and STA1 are invalid.

Status Checking flow

(a)



(b)



(Note 4) When using the MSB=0 command, a Status Read must be performed.

If a status check is not carried out, the UCi6963 cannot operate normally, even after a delay time.

The hardware interrupt occurs during the address calculation period (at the end of each line).

If a MSB=0 command is sent to the UCi6963 during this period, the UCi6963 enters Wait status.

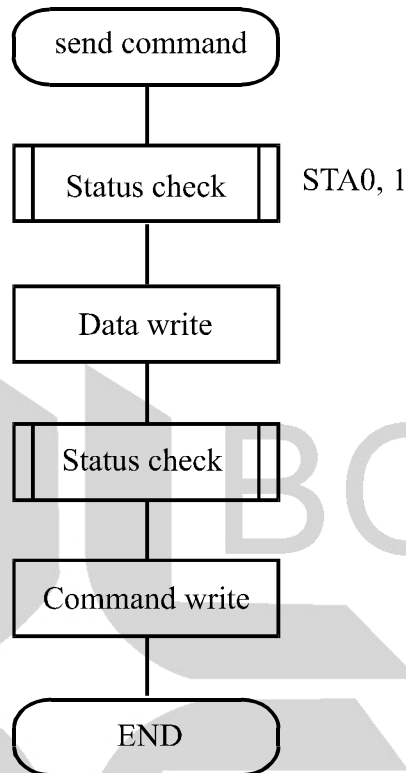
If a status check is not carried out in this state before the next command is sent, there is the possibility that the command or data data will not be received.

## (2)Setting date

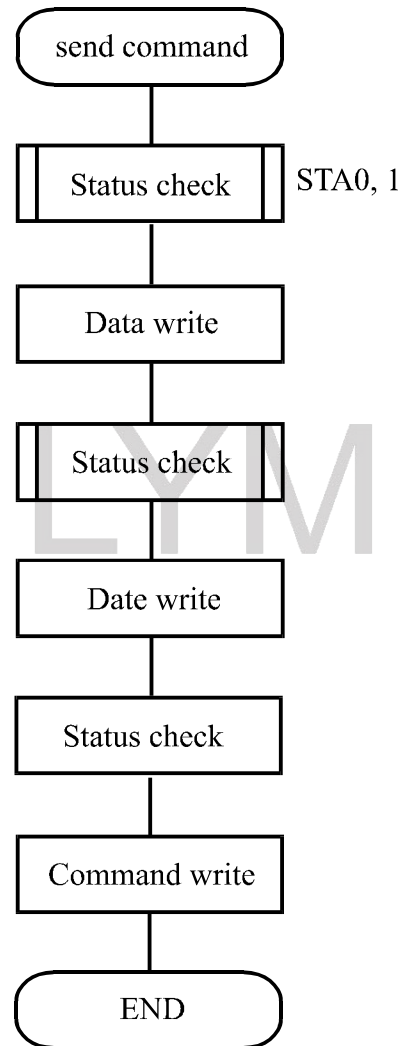
When using the UCI6963, first set the data, then set the command.

### Procedure for sending a command

#### (a)The case of 1 date



#### (b)The case of 2 data



(Note) When sending more than two data, the last datum (or last two data) is valid.

### 12.2.2 Command definitions

| COMMAND                  | CODE      | D1          | D2           | FUNCTION                       |
|--------------------------|-----------|-------------|--------------|--------------------------------|
| REGISTERS SETTING        | 00100001  | X address   | Y address    | Set Cursor Pointer             |
|                          | 00100010  | Date        | 00H          | Set Offset Register            |
|                          | 00100100  | Low address | High address | Set Address Pointer            |
| SET CONTROL WORD         | 01000000  | Low address | High address | Set Text Home Address          |
|                          | 01000001  | Columns     | 00H          | Set Text Area                  |
|                          | 01000010  | Low address | High address | Set Graphic Home Address       |
|                          | 01000011  | Columns     | 00H          | Set Graphic Area               |
| MODE SET                 | 1000x000  | —           | —            | OR mode                        |
|                          | 1000x001  | —           | —            | EXOR mode                      |
|                          | 1000x011  | —           | —            | AND mode                       |
|                          | 1000x100  | —           | —            | Text Attribute mode            |
|                          | 10000xxx  | —           | —            | Internal CG ROM mode           |
|                          | 10001xxx  | —           | —            | External CG RAM mode           |
| DISPLAY MODE             | 10010000  | —           | —            | Display off                    |
|                          | 1001xx10  | —           | —            | Cursor on, blink off           |
|                          | 10001xx11 | —           | —            | Cursor on, blink on            |
|                          | 100101xx  | —           | —            | Text on, graphic off           |
|                          | 100110xx  | —           | —            | Text off, graphic on           |
|                          | 100111xx  | —           | —            | Text on, graphic on            |
| CURSOR PATTERN<br>SELECT | 10100000  | —           | —            | 1-line cursor                  |
|                          | 10100001  | —           | —            | 2-line cursor                  |
|                          | 10100010  | —           | —            | 3-line cursor                  |
|                          | 10100011  | —           | —            | 4-line cursor                  |
|                          | 10100100  | —           | —            | 5-line cursor                  |
|                          | 10100101  | —           | —            | 6-line cursor                  |
|                          | 10100110  | —           | —            | 7-line cursor                  |
|                          | 10100111  | —           | —            | 8-line cursor                  |
| DATA AUTO<br>READ/WRITE  | 10110000  | —           | —            | Set Data Auto Write            |
|                          | 10110001  | —           | —            | Set Data Auto Read             |
|                          | 10110010  | —           | —            | Auto Reset                     |
| DATA READ/WRITE          | 11000000  | Data        | —            | Data Write and Increment ADP   |
|                          | 11000001  | —           | —            | Data Read and Increment ADP    |
|                          | 11000010  | Data        | —            | Data Write and Decrement ADP   |
|                          | 11000011  | —           | —            | Data Read and Decrement ADP    |
|                          | 11000100  | Data        | —            | Data Write and Nonvariable ADP |
|                          | 11000101  | —           | —            | Data Read and Nonvariable ADP  |
| SCREEN PEEK              | 11100000  | —           | —            | Screen Peek                    |

X : invalid

| COMMAND       | CODE      | D1 | D2 | FUNCTION    |
|---------------|-----------|----|----|-------------|
| SCREEN COPY   | 11101000  |    |    | Screen Copy |
| BIT SET/RESET | 11110xxx  | —  | —  | Bit Reset   |
|               | 11111xxx  | —  | —  | Bit Set     |
|               | 1111x000  | —  | —  | Bit 0 (LSB) |
|               | 11111x001 | —  | —  | Bit 1       |
|               | 11111x010 | —  | —  | Bit 2       |
|               | 11111x011 | —  | —  | Bit 3       |
|               | 11111x100 | —  | —  | Bit 4       |
|               | 11111x101 | —  | —  | Bit 5       |
|               | 11111x110 | —  | —  | Bit 6       |
|               | 11111x111 | —  | —  | Bit 7 (MSB) |

X : invalid

• Setting registers

| CODE     | HEX. | FUNCTION            | D1       | D2        |
|----------|------|---------------------|----------|-----------|
| 00100001 | 21H  | SET CURSOR POINTER  | X ADRS   | Y ADRS    |
| 00100010 | 22H  | SET OFFSET REGISTER | DATA     | 00H       |
| 00100100 | 24H  | SET ADDRESS POINTER | LOW ADRS | HIGH ADRS |

(1)Set Cursor Pointer

The position of the cursor is specified by X ADRS and Y ADRS. The cursor position can only be moved by this command. Data read/write from the MPU never changes the cursor pointer. X ADRS and Y ADRS are specified as follows.

X ADRS      00H to 4FH (lower 7 bits are valid)

Y ADRS      00H to 1FH (lower 5 bits are valid)

Single-Scan

X ADRS 00 to 4FH

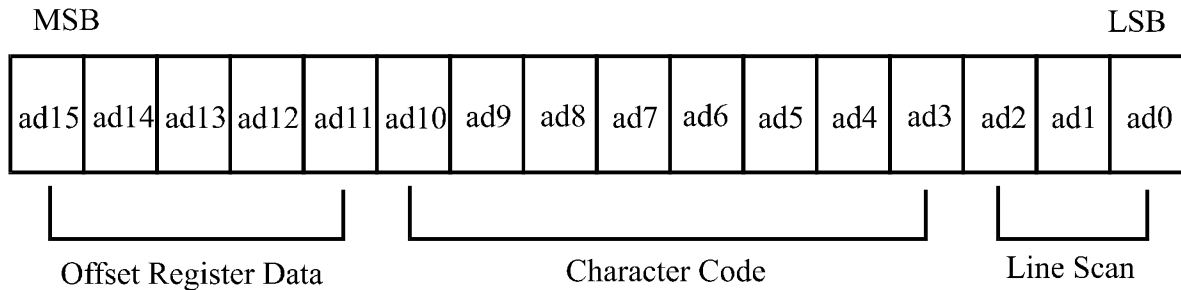
Y ADRS 00H to 0FH



## (2)Set Offset Register

The offset register is used to determine the external character generator RAM area.

The UCi6963 has a 16-bit address bus as follows.



UCi6963 assign External character generator, when character code set 80H TO FFH in using internal character generator. Character code 00H to 80H assign External character generator, when External generator mode.

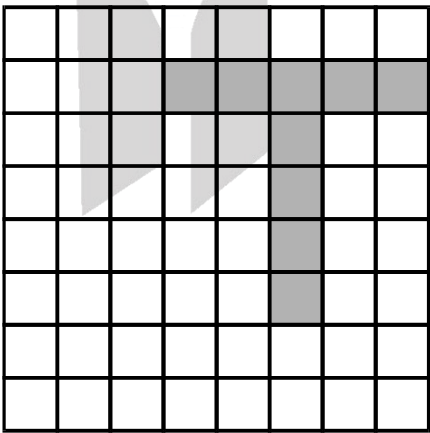
The senior five bits define the start address in external memory of the CG RAM area. The next eight bits represent the character code of the character. In internal CG ROM, character codes 00H to 7FH represent the predefined “internal” CG ROM characters, and codes 80H to FFH represent the user’s own “external” characters. In external CG ROM mode, all 256 codes from 00H to FFH can be used to represent the user’s own characters. The three least significant bits indicate one of the eight rows of eight dots that define the character’s shape.

### The relationship between display RAM address and offset register

| Offset register data | CG RAM hex. address (start to end) |
|----------------------|------------------------------------|
| 00000                | 0000 to 07 FFH                     |
| 00001                | 0800 to 0FFFH                      |
| 00010                | 1000 to 17FFH                      |
| 11100                | E000 to E7FFH                      |
| 11101                | E800 to EFFFH                      |
| 11110                | F000 to F7FFH                      |
| 11111                | F800 to FFFFH                      |

(Example 1)

|                                       |                     |
|---------------------------------------|---------------------|
| Offset register                       | 02H                 |
| Character code                        | 80H                 |
| Character generator RAM start address | 0001 0100 0000 0000 |
|                                       | 1 4 0 0 H           |

|                                                                                     | (address) | (data) |
|-------------------------------------------------------------------------------------|-----------|--------|
|  | 1400H     | 00H    |
|                                                                                     | 1401H     | 1FH    |
|                                                                                     | 1402H     | 04H    |
|                                                                                     | 1403H     | 04H    |
|                                                                                     | 1404H     | 04H    |
|                                                                                     | 1405H     | 04H    |
|                                                                                     | 1406H     | 04H    |
|                                                                                     | 1407H     | 00H    |

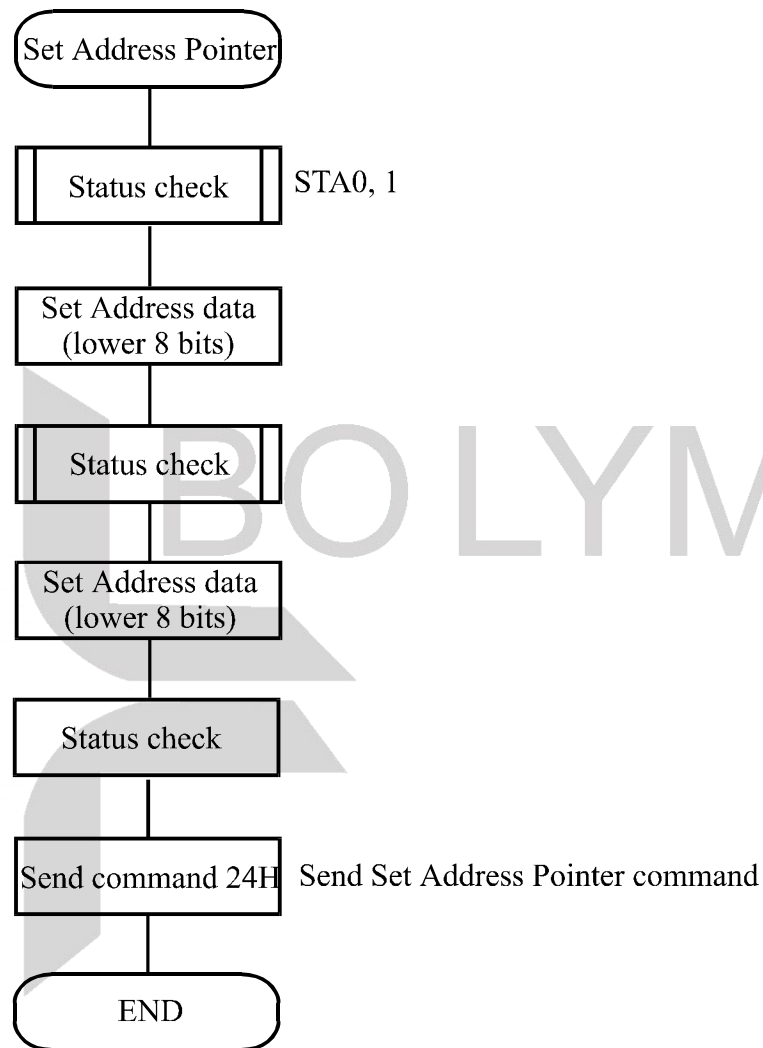
(Example 2) The relationship between display RAM data and display characters

$\gamma$  and  $\zeta$  are displayed by character generator RAM.

### (3)Set Address Pointer

The Set Address Pointer command is used to indicate the start address for writing to (or reading from) external RAM.

#### The Flowchart for Set Address Pointer command



• Set Control Word

| CODE     | HEX. | FUNCTION                 | D1          | D2           |
|----------|------|--------------------------|-------------|--------------|
| 01000000 | 40H  | Set Text Home Address    | Low address | High address |
| 01000001 | 41H  | Set Text Area            | Columns     | 00H          |
| 01000010 | 42H  | Set Graphic Home Address | Low address | High address |
| 01000011 | 43H  | Set Graphic Area         | Columns     | 00H          |

The home address and column size are defined by this command.

(1)Set Text Home Address

The starting address in the external display RAM for text display is defined by this command.

The text home address indicates the leftmost and uppermost position.

The relationship between external display RAM address and display position

|             |  |               |
|-------------|--|---------------|
| TH          |  | TH+CL         |
| TH+TA       |  | TH+TA+CL      |
| (TH+TA)+TA  |  | TH+2TA+CL     |
| (TH+2TA)+TA |  | TH+3TA+CL     |
|             |  |               |
| TH+(n-1)TA  |  | TH+(n-1)TA+CL |

TH:Text home address

TA:Text area number (columns)

CL:Columns are fixed by hardware (pin-programmable).

(Example)

Text home address : 0000H  
 Text area : 0020H  
 : 32 Columns  
 : 4 Lines

|       |       |  |       |       |
|-------|-------|--|-------|-------|
| 0000H | 0001H |  | 001EH | 001FH |
| 0020H | 0021H |  | 003EH | 002FH |
| 0040H | 0041H |  | 005EH | 005FH |
| 0060H | 0061H |  | 007EH | 007FH |

## (2)Set Graphic Home Address

The starting address of the external display RAM used for graphic display is defined by this command. The graphic home address indicates the leftmost and uppermost position.

The relationship between external display RAM address and display position

|             |  |               |
|-------------|--|---------------|
| GH          |  | GH+GL         |
| GH+GA       |  | GH+GA+CL      |
| (GH+GA)+GA  |  | GH+2GA+CL     |
| (GH+2GA)+GA |  | GH+3GA+CL     |
|             |  |               |
| GH+(n-1)GA  |  | GH+(n-1)GA+CL |

GH:Graphic home address

GA:Graphic area number (columns)

CL:Columns are fixed by hardware (pin-programmable).

(Example)

Graphic home address : 0000H  
 Graphic area : 0020H  
 : 32 Columns  
 : 2 Lines

|       |       |  |       |       |
|-------|-------|--|-------|-------|
| 0000H | 0001H |  | 001EH | 001FH |
| 0020H | 0021H |  | 003EH | 003FH |
| 0040H | 0041H |  | 005EH | 005FH |
| 0060H | 0061H |  | 007EH | 007FH |
| 0080H | 0081H |  | 009EH | 009FH |
| 00A0H | 00A1H |  | 00BEH | 00BFH |
| 00C0H | 00C1H |  | 00DEH | 00DFH |
| 00E0H | 00E1H |  | 00FEH | 00FFH |
| 0100H | 0101H |  | 011EH | 011FH |
| 0120H | 0121H |  | 013EH | 013FH |
| 0140H | 0141H |  | 015EH | 014FH |
| 0160H | 0161H |  | 017EH | 017FH |
| 0180H | 0181H |  | 109EH | 019FH |
| 01A0H | 01A1H |  | 01BEH | 01BFH |
| 01C0H | 01C1H |  | 01DEH | 01DFH |
| 01E0H | 01E1H |  | 01FEH | 01FFH |



(Example)

LCD size 20 columns, 2lines

Graphic home address : 0000H

Graphic are : 0014H

Set 32 columns, 2 Lines

|      |      |       |      |       |       |       |
|------|------|-------|------|-------|-------|-------|
| 0000 | 0001 | ..... | 0013 | 0014  | ..... | 001F  |
| 0014 | 0015 | ..... | 0027 | 0028  | ..... | 0033  |
| 0028 | 0029 | ..... | 003B | 003C  | ..... | 0047  |
| 003C | 003D | ..... | 004F | 0050  | ..... | 005B  |
| 0050 | 0051 | ..... | 0063 | 0064  | ..... | 006F  |
| 0064 | 0065 | ..... | 0077 | 0078  | ..... | 0083  |
| 0078 | 0079 | ..... | 008B | 008C  | ..... | 0097  |
| 008C | 008D | ..... | 009F | 00A0  | ..... | 00AB  |
| 00A0 | 00A1 | ..... | 00B3 | 00B4  | ..... | 00BF  |
| 00B4 | 00B5 | ..... | 00C7 | 00C8  | ..... | 00D3  |
| 00C8 | 00C9 | ..... | 00DB | 00DC  | ..... | 00E7  |
| 00DC | 00DD | ..... | 00EF | 00F0  | ..... | 00FD  |
| 00F0 | 00F1 | ..... | 0103 | 0104  | ..... | 011F  |
| 0104 | 0105 | ..... | 0127 | 0128  | ..... | 0123  |
| 0128 | 0129 | ..... | 013B | 0013C | ..... | 00147 |
| 013C | 013D | ..... | 014F | 0150  | ..... | 015B  |



If the graphic area setting is set to match the desired number of columns on the LCD, the addressing scheme will be automatically modified so that the start address of each line equals the end address of the previous line +1.



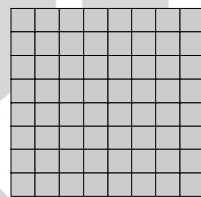
• Mode set

| CODE     | FUNCTION                          | OPERAND |
|----------|-----------------------------------|---------|
| 1000×000 | OR Mode                           | —       |
| 1000×001 | EXOR Mode                         | —       |
| 1000×011 | AND Mode                          | —       |
| 1000×100 | TEXT ATTRIBUTE Mode               | —       |
| 10000×xx | Internal Character Generator Mode | —       |
| 10001×xx | External Character Generator Mode | —       |

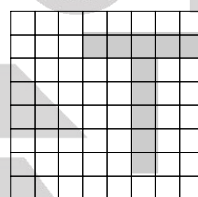
X:invalid

The display mode is defined by this command. The display mode does not change until the next command is sent. The logical OR, EXOR, AND of text or graphic display can be displayed. In Internal Character Generator mode, character codes 00H to 7FH are assigned to the built-in character generator ROM. The character codes 80H to FFH are automatically assigned to the external character generator RAM.

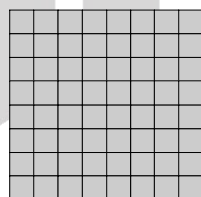
(Example)



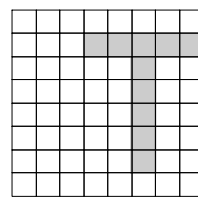
GRAPHIC



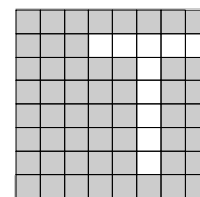
TEXT



“OR”



“AND”



“TXOR”

(Note) Attribute functions can only be applied to text display, since the attribute data is placed in the graphic RAM area.

## Attribute function

The attribute operations are Reverse display, Character blink and Inhibit. The attribute data is written into the graphic area which was defined by the Set Control Word command. Only text display is possible in Attribute Function mode; graphic display is automatically disabled. However, the Display Mode command must be used to turn both Text and Graphic on in order for the Attribute function to be available.

The attribute data for each character in the text area is written to the same address in the graphic area. The Attribute function is defined as follows.

Attribute RAM 1byte

|   |   |   |   |    |    |    |    |
|---|---|---|---|----|----|----|----|
| x | x | x | x | d3 | d2 | d1 | d0 |
|---|---|---|---|----|----|----|----|

| d3 | d2 | d1 | d0 | FUNCTION                 |
|----|----|----|----|--------------------------|
| 0  | 0  | 0  | 0  | Normal display           |
| 0  | 1  | 0  | 1  | Reverse display          |
| 0  | 0  | 1  | 1  | Inhibit display          |
| 1  | 0  | 0  | 0  | Blink of normal display  |
| 1  | 1  | 0  | 1  | Blink of reverse display |
| 1  | 0  | 1  | 1  | Blink of inhibit display |

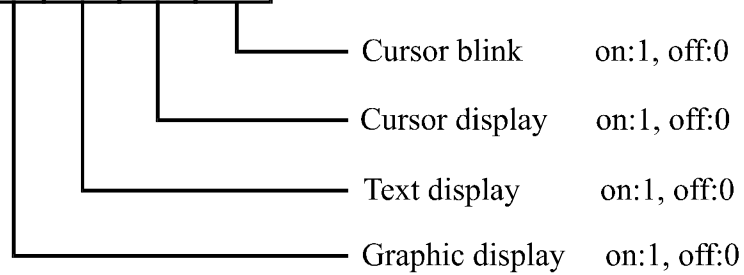
X:invalid

### • Display mode

| CODE     | FUNCTION             | OPERAND |
|----------|----------------------|---------|
| 10010000 | Display off          | —       |
| 1001xx10 | Cursor on, blink off | —       |
| 1001xx11 | Cursor on, blink on  | —       |
| 100101xx | Text on, graphic off | —       |
| 100110xx | Text off, graphic on | —       |
| 100111xx | Text on, graphic on  | —       |

X:invalid

|   |   |   |   |    |    |    |    |
|---|---|---|---|----|----|----|----|
| 1 | 0 | 0 | 1 | D3 | D2 | D1 | D0 |
|---|---|---|---|----|----|----|----|



(Note) It is necessary to turn on “Text display” and “Graphic display” in the following cases.

a) Combination of text/graphic display

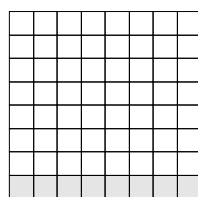
b) Attribute function

• Cursor pattern select

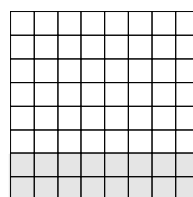
| CODE     | FUNCTION      | OPERAND |
|----------|---------------|---------|
| 10100000 | 1-line cursor | —       |
| 10100001 | 2-line cursor | —       |
| 10100010 | 3-line cursor | —       |
| 10100011 | 4-line cursor | —       |
| 10100100 | 5-line cursor | —       |
| 10100101 | 6-line cursor | —       |
| 10100110 | 7-line cursor | —       |
| 10100111 | 8-line cursor | —       |

When cursor display is ON, this command selects the cursor pattern in the range 1 line to 8 lines.

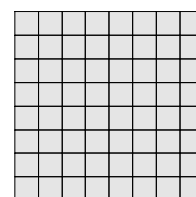
The cursor address is defined by the Cursor Pointer Set command.



1-line cursor



2-line cursor



8-line cursor

• Data Auto Read/Write

| CODE     | HEX. | FUNCTION            | OPERAND |
|----------|------|---------------------|---------|
| 10110000 | B0H  | Set Data Auto Write | —       |
| 10110001 | B1H  | Set Data Auto Read  | —       |
| 10110010 | B2H  | Auto Reset          | —       |

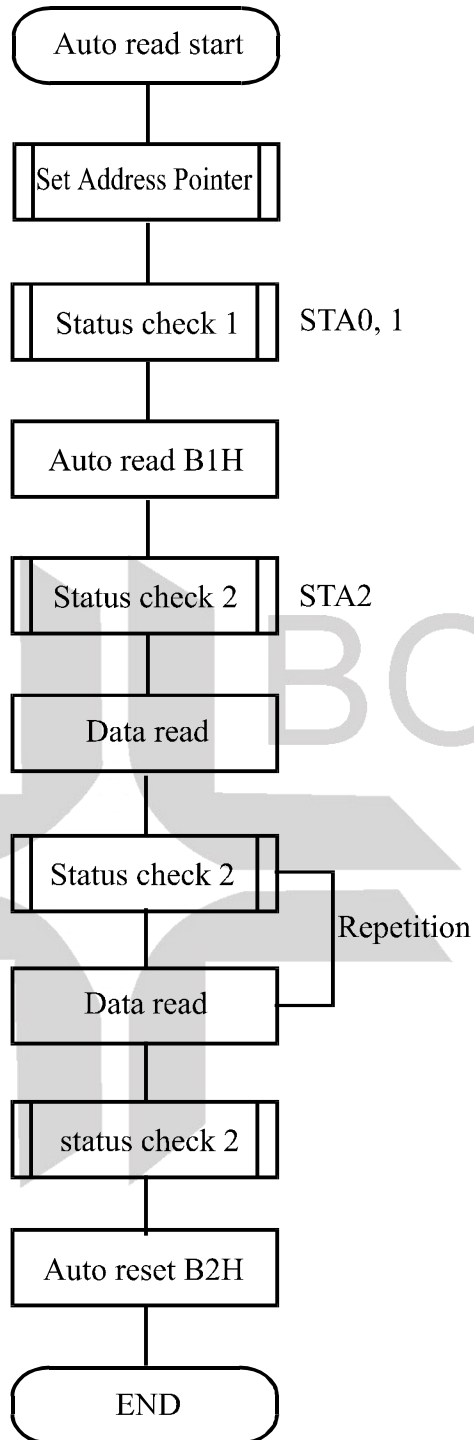
The command is convenient for sending a full screen of data from the external display RAM. After setting Auto mode, a Data Write (or Read) command is need not be sent between each datum. A Data Auto Write (or Read) command must be sent after a Set Address Pointer command. After this command, the address pointer is automatically incremented by 1 after each datum. In Auto mode, the UCi6963 cannot accept any other commands.

The Auto Reset command must be sent to the UCi6963 after all data has been sent, to clear Auto mode.

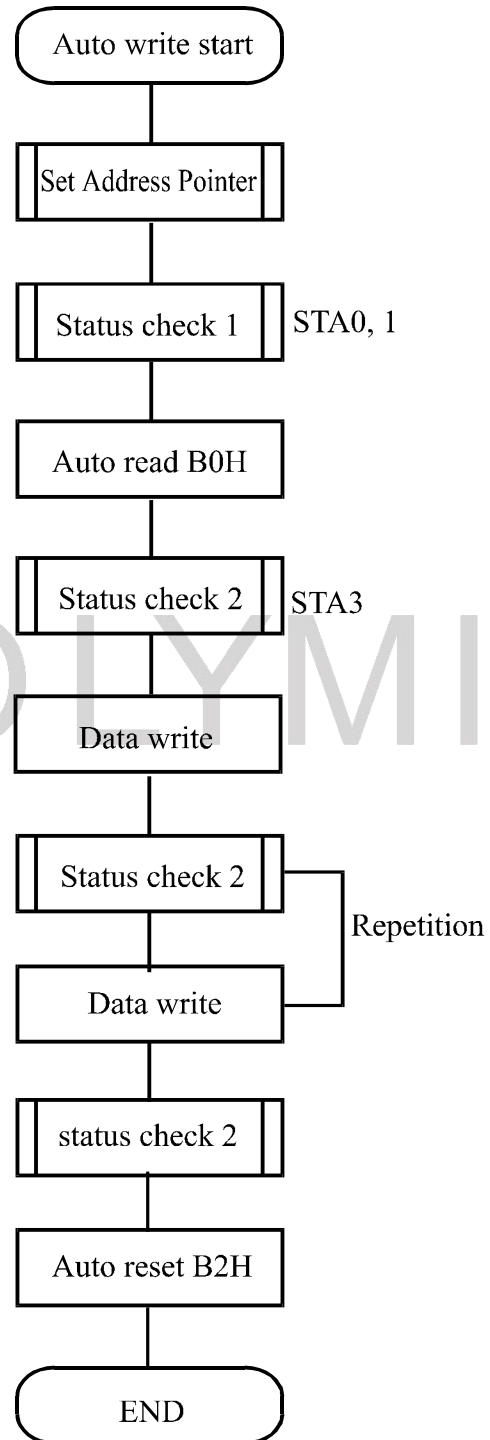
(Note) A Status check for Auto mode

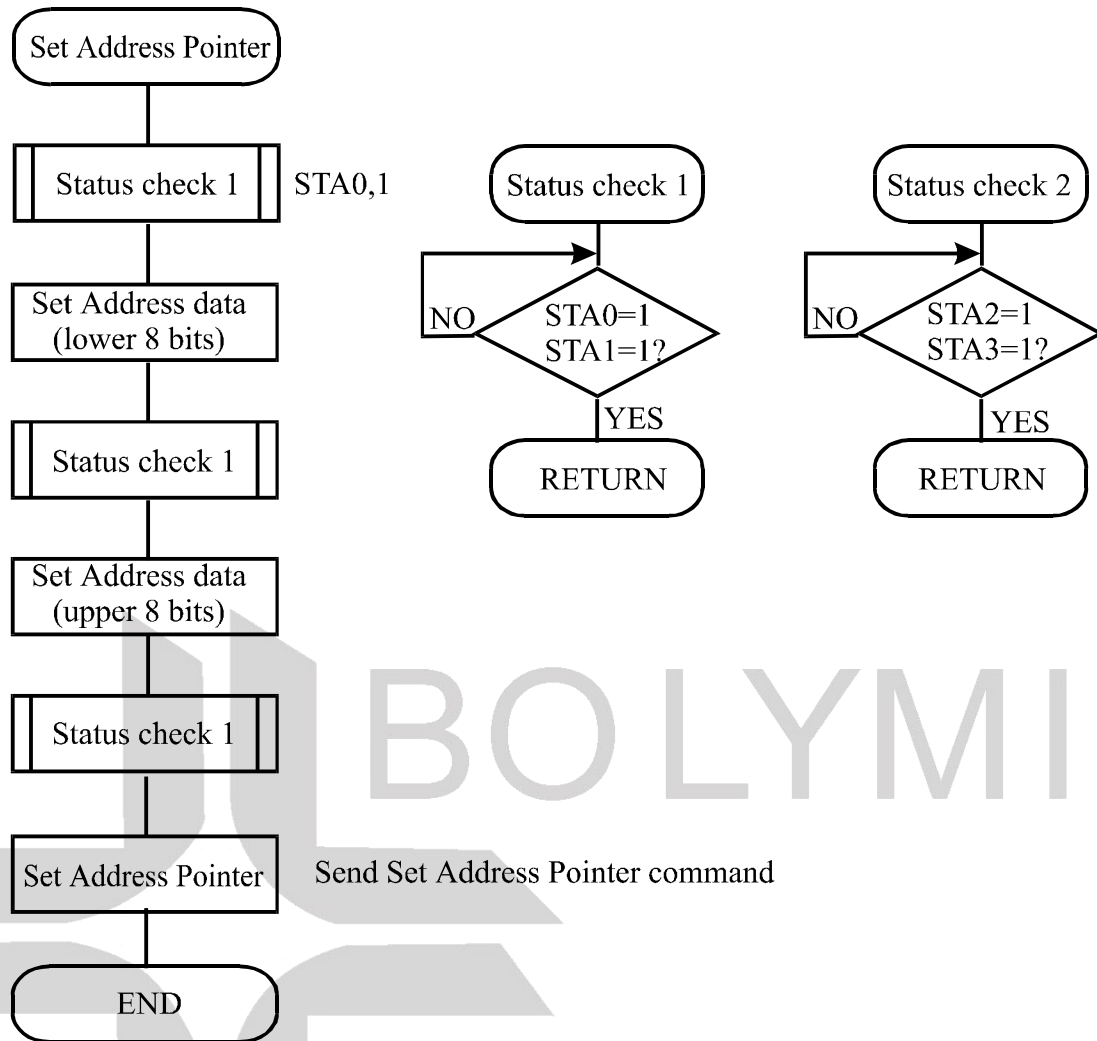
(STA2, STA3 should be checked between sending of each datum. Auto Reset should be performed after checking STA3=1 (STA2=1.) Refer to the following flowchart.

a)Auto Read mode



b)Auto Write mode





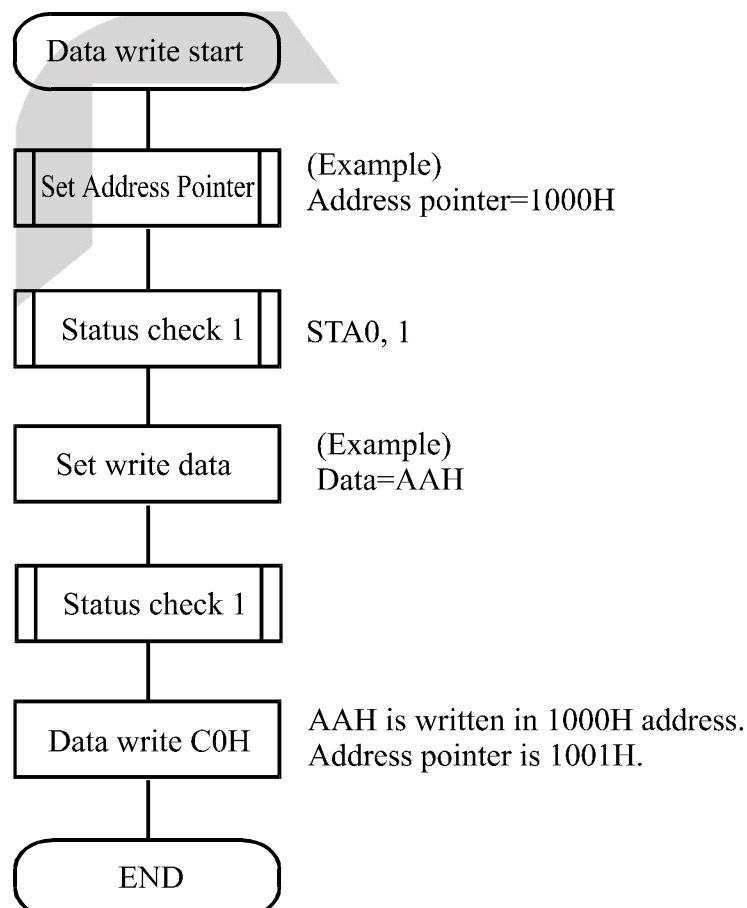
• Date Read/Write

| CODE     | HEX. | FUNCTION                       | OPERAND |
|----------|------|--------------------------------|---------|
| 11000000 | C0H  | Data Write and Increment ADP   | Data    |
| 11000001 | C1H  | Data Read and Increment ADP    | —       |
| 11000010 | C2H  | Data Write and Decrement ADP   | Data    |
| 11000011 | C3H  | Data Read and Decrement ADP    | —       |
| 11000100 | C4H  | Data Write and Nonvariable ADP | Data    |
| 11000101 | C5H  | Data Read and Nonvariable ADP  | —       |

This command is used for writing data from the MPU to external display RAM, and reading data from external display RAM to the MPU. Data Write/Data Read should be executed after setting address using Set Address Pointer command. The address pointer can be automatically incremented or decremented using this command.

(Note) This command is necessary for each 1-byte datum.

Refer to the following flowchart.



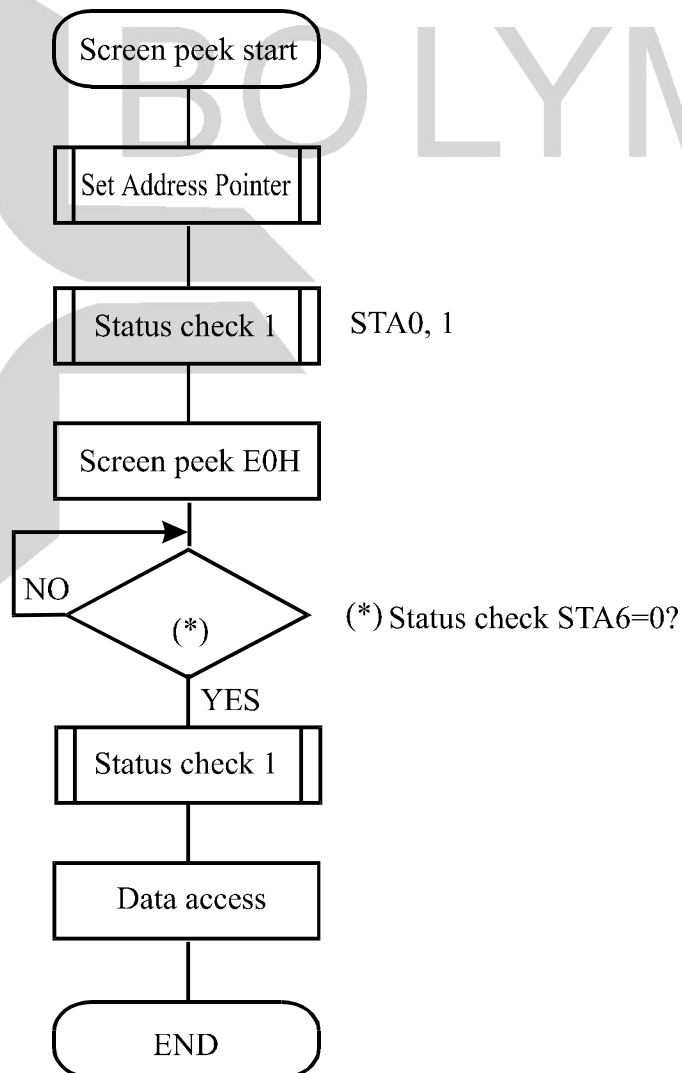
# • Screen Peek

| CODE     | HEX. | FUNCTION    | OPERAND |
|----------|------|-------------|---------|
| 11100000 | E0H  | Screen Peek | —e      |

This command is used to transfer 1 byte of displayed data to the data stack; this byte can then be read from the MPU by data access. The logical combination of text and graphic display data on the LCD screen can be read by this command.

The status (STA6) should be checked just after the Screen Peek command. If the address determined by the Set Address Pointer command is not in the graphic area, this command is ignored and a status flag (STA6) is set.

Refer to the following flowchart.





# • Screen Copy

| CODE     | HEX. | FUNCTION    | OPERAND |
|----------|------|-------------|---------|
| 11101000 | E8H  | Screen Copy | —       |

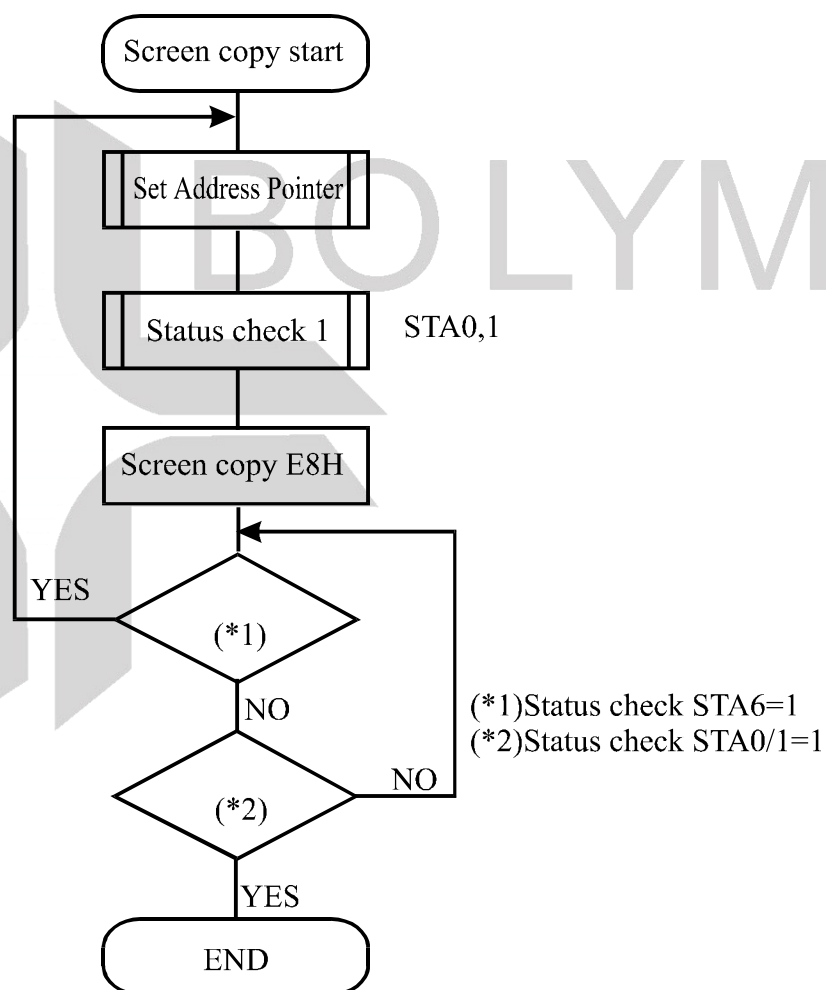
This command copies a single raster line of data to the graphic area.

The start point must be set using the Set Address Pointer command.

(Note 1) If the attribute function is being used, this command is not available.

(With Attribute data is graphic area data.)

Refer to the following flowchart.



• Bit Set/Reset

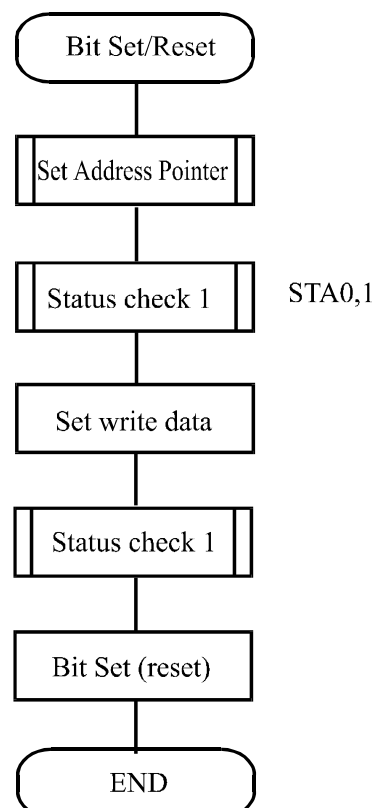
| CODE     | FUNCTION    | OPERAND |
|----------|-------------|---------|
| 11110xxx | Bit Reset   | —       |
| 11111xxx | Bit Set     | —       |
| 1111x000 | Bit 0 (LSB) | —       |
| 1111x001 | Bit 1       | —       |
| 1111x010 | Bit 2       | —       |
| 1111x011 | Bit 3       | —       |
| 1111x100 | Bit 4       | —       |
| 1111x101 | Bit 5       | —       |
| 1111x110 | Bit 6       | —       |
| 1111x111 | Bit 7 (MSB) | —       |

X:invalid

This command use to set or reset a bit of the byte specified by the address pointer.

Only one bit can be set/reset at a time.

Refer to the following flowchart.



### 12.2.3 Character code

| Upper<br>4 bit<br>Lower<br>4 bit | LLLL | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH |
|----------------------------------|------|------|------|------|------|------|------|------|
| LLLL                             |      | 0    | 1    | 2    | 3    | 4    | 5    | 6    |
| LLLH                             | !    | 7    | 8    | 9    | A    | B    | C    | D    |
| LLHL                             | "    | E    | F    | G    | H    | I    | J    | K    |
| LLHH                             | L    | M    | N    | O    | P    | Q    | R    | S    |
| LHLL                             | T    | U    | V    | W    | X    | Y    | Z    | [    |
| LHLH                             | ^    | _    | `    | a    | b    | c    | d    | e    |
| LHHL                             | f    | g    | h    | i    | j    | k    | l    | m    |
| LHHH                             | n    | o    | p    | q    | r    | s    | t    | u    |
| HLLL                             | v    | w    | x    | y    | z    | {    |      | }    |
| HLLH                             | ~    |      |      |      |      |      |      |      |
| HLHL                             |      |      |      |      |      |      |      |      |
| HLHH                             |      |      |      |      |      |      |      |      |
| HHLL                             |      |      |      |      |      |      |      |      |
| HHLH                             |      |      |      |      |      |      |      |      |
| HHHL                             |      |      |      |      |      |      |      |      |
| HHHH                             |      |      |      |      |      |      |      |      |

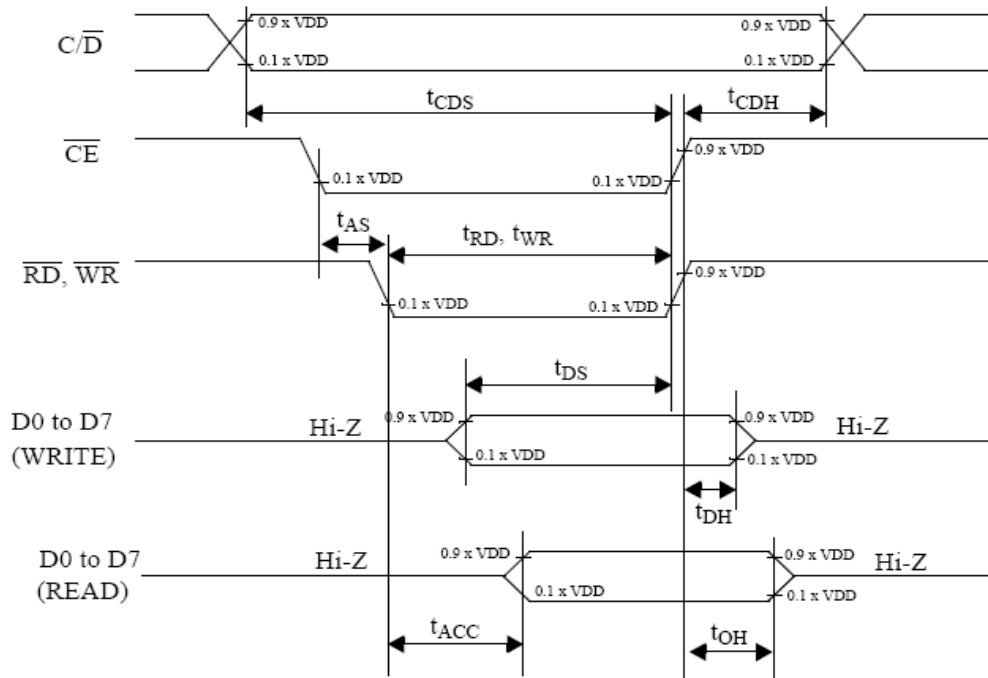


## 12.2.4 Timing characteristics

### Bus Timing

(  $V_{ss} = 0\text{ V}$  ,  $V_{DD} = 5\text{ V}$  )

| symbol           | parameter                                  | MIN. | MAX. | test conditons | Unit |
|------------------|--------------------------------------------|------|------|----------------|------|
| $t_{CDS}$        | $C/\overline{D}$ set-up time               | 100  |      |                | ns   |
| $t_{CDH}$        | $C/\overline{D}$ hold time                 | 10   |      |                | ns   |
| $t_{RD}, t_{WR}$ | $\overline{RD}, \overline{WR}$ pulse width | 80   |      |                | ns   |
| $t_{AS}$         | Address set-up time                        | 0    |      |                | ns   |
| $t_{AH}$         | Address hold time                          | 0    |      |                | ns   |
| $t_{DS}$         | Data set-up time                           | 80   |      |                | ns   |
| $t_{DH}$         | Data hold time                             | 40   |      | Note           | ns   |
| $t_{ACC}$        | Access time                                |      | 150  | Note           | ns   |
| $t_{OH}$         | Output hold time                           | 10   | 50   | Note           | ns   |



Microcontroller bus interface timing