



**RAYSTAR**

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**RG160128A-FHW-V**

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## **SPECIFICATION**

**CUSTOMER:**

|             |  |
|-------------|--|
| APPROVED BY |  |
| PCB VERSION |  |
| DATE        |  |

FOR CUSTOMER USE ONLY

| SALES BY | APPROVED BY | CHECKED BY | PREPARED BY |
|----------|-------------|------------|-------------|
|          |             |            |             |

ISSUED DATE:

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## 1. Revision History

| DATE       | VERSION | REVISED PAGE NO. | Note        |
|------------|---------|------------------|-------------|
| 2012/08/23 | 1       |                  | First issue |

RAYSTAR OptoELECTRONICS

## 2. General Specification

The Features is described as follow:

- Module dimension: 129.0×102.0×16.5 (max.) mm<sup>3</sup>
- View area: 101.0×82.0 mm<sup>2</sup>
- Active area: 95.96×76.76 mm<sup>2</sup>
- Number of dots: 160 ×128
- Dot size: 0.56×0.56 mm<sup>2</sup>
- Dot pitch: 0.60×0.60 mm<sup>2</sup>
- LCD type: FSTN Positive Transflective
- Duty: 1/128
- View direction: 6 o'clock
- Backlight Type: LED , White

### 3. Module Coding System

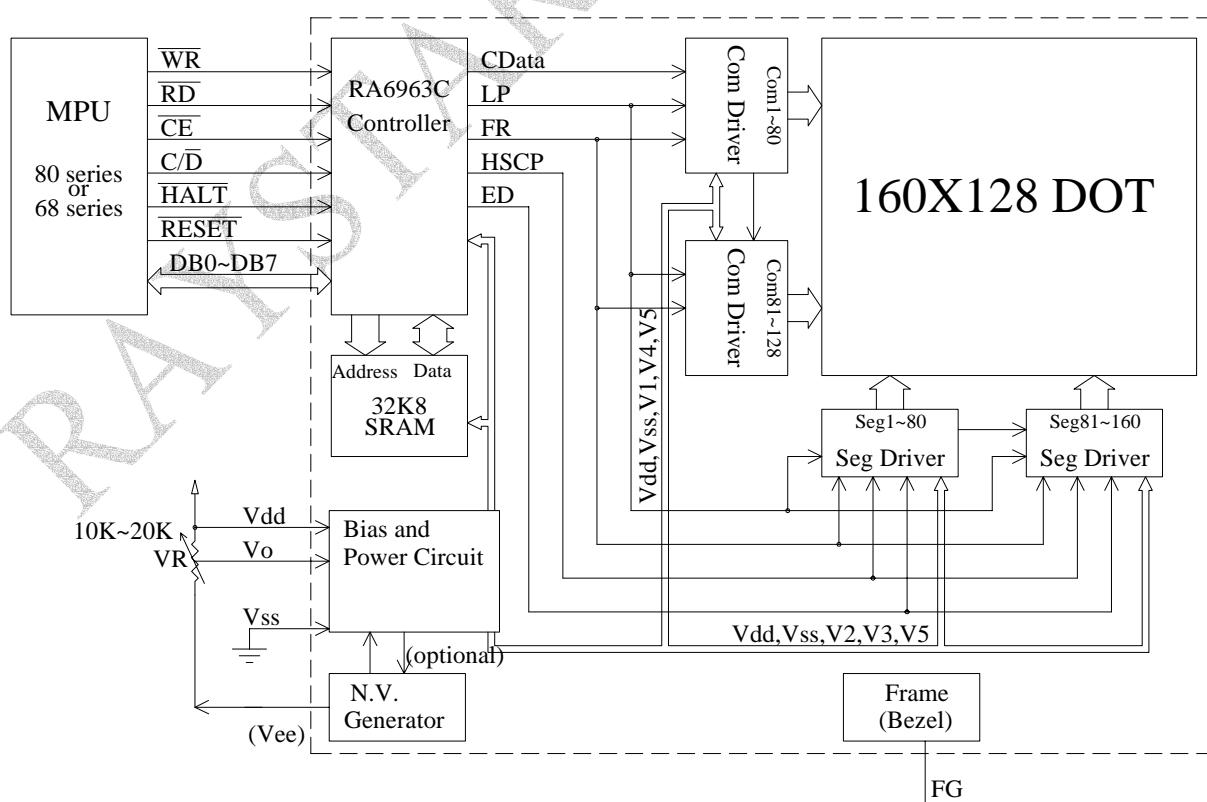
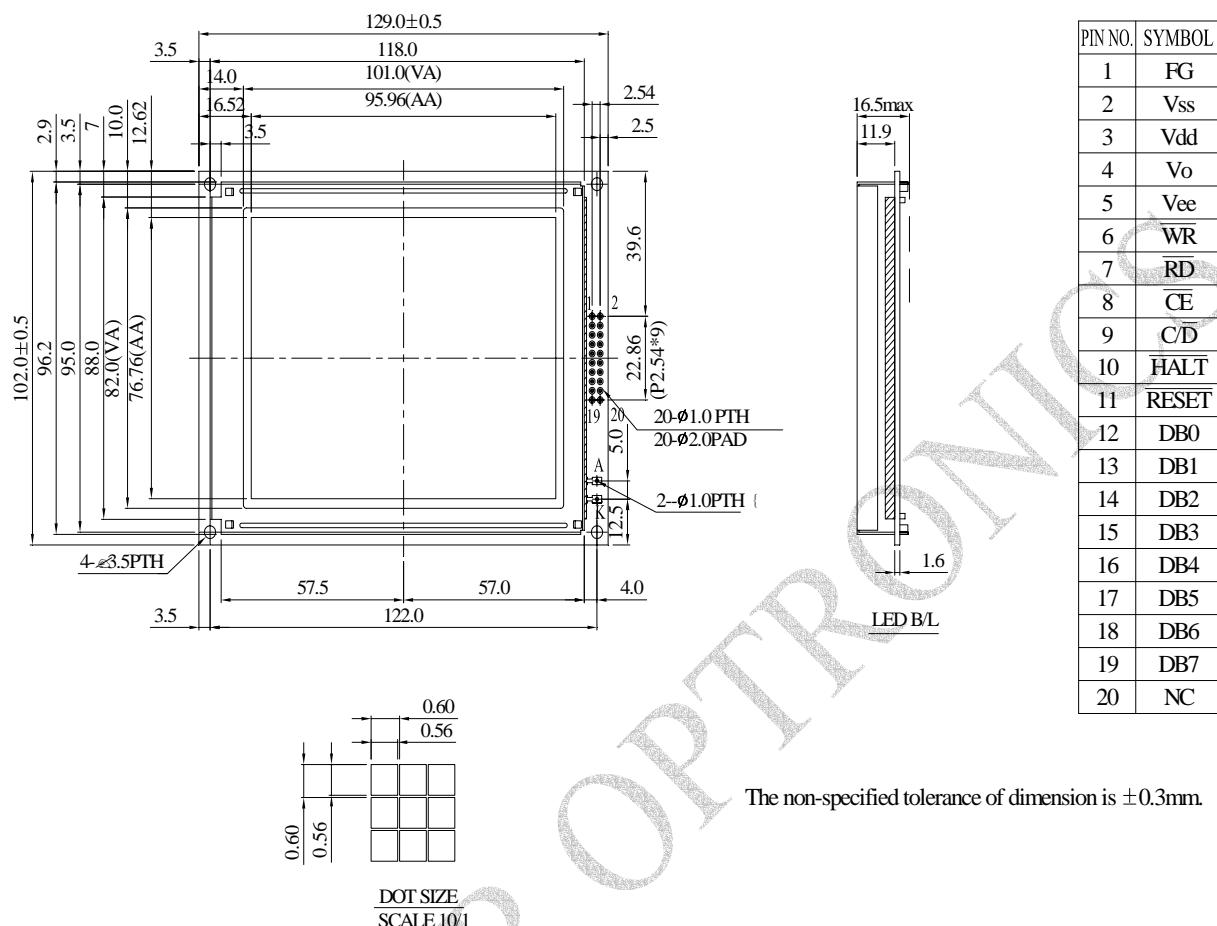
| R | G | 160128 | A | - | F | H | W | - | V |
|---|---|--------|---|---|---|---|---|---|---|
| 1 | 2 | 3      | 4 | - | 5 | 6 | 7 | - | 8 |

| Item | Description   |  |  |
|------|---|--|--|
| 1    | <b>R : Raystar Optronics Inc.</b>   |  |  |
| 2    | Display<br><b>G : Graphic Type</b>  |  |  |
| 3    | Number of dots : <b>160 x128 Dots</b>   |  |  |
| 4    | Serials code  |  |  |
| 5    | LCD<br><br>P : TN Positive, Gray<br>N : TN Negative,<br>G : STN Positive, Gray<br>Y : STN Positive, Yellow Green<br>B : STN Negative, Blue<br><b>F : FSTN Positive</b><br>T : FSTN Negative   |  |  |
| 6    | Polarizer Type,<br>Temperature range,<br>View direction<br><br>A : Reflective, N.T, 6:00      K : Transflective, W.T,12:00<br>D : Reflective, N.T, 12:00      1 : Transflective, U.T,6:00<br>G : Reflective, W. T, 6:00      4 : Transflective, U.T,12:00<br>J : Reflective, W. T, 12:00      C : Transmissive, N.T,6:00<br>O : Reflective, U. T, 6:00      F : Transmissive, N.T,12:00<br>3 : Reflective, U. T, 12:00      I : Transmissive, W. T, 6:00<br>B : Transflective, N.T,6:00      L : Transmissive, W.T,12:00<br>E : Transflective, N.T,12:00      2 : Transmissive, U. T, 6:00<br><b>H: Transflective, W.T,6:00</b> 5 : Transmissive, U.T,12:00 |  |  |
| 7    | Backlight<br><br>N : Without backlight<br>P : EL, Blue green<br>T : EL, Green<br>D : EL, White<br>F : CCFL, White   |  |  |
| 8    | Special code<br>V: Build-in Negative Voltage  |  |  |

## 4. Interface Pin Function

| Pin # | Symbol | Level | Description   |
|-------|--------|-------|---|
| 1     | FG     |       | Frame ground  |
| 2     | Vss    | 0V    | Ground  |
| 3     | Vdd    |       | Power supply for logic  |
| 4     | Vo     |       | Power supply for LCD contrast adjustment  |
| 5     | Vee    |       | -16v Output   |
| 6     | /WR    | L     | Data write. Write data into RA6963 when /WR = L   |
| 7     | /RD    | L     | Data read. Read data from RA6963 when RD = L  |
| 8     | /CE    | L     | Chip enable the controller RA6963   |
| 9     | 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 |
| 10    | /HALT  | L     | Clock operating stop signal   |
| 11    | /RESET | L     | Reset signal  |
| 12    | DB0    | H / L | Data bus line   |
| 13    | DB1    | H / L | Data bus line   |
| 14    | DB2    | H / L | Data bus line   |
| 15    | DB3    | H / L | Data bus line   |
| 16    | DB4    | H / L | Data bus line   |
| 17    | DB5    | H / L | Data bus line   |
| 18    | DB6    | H / L | Data bus line   |
| 19    | DB7    | H / L | Data bus line   |
| 20    | NC     |       | NC  |

## 5. Outline Dimension & Block Diagram



## 6. Display Control Instruction

### 6.1 Communications with MPU

- **Status Read**

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

#### **Status Check**

The Status of RA6963 can be read from the data lines.

| <b>RD</b> | <b>WR</b> | <b>CS</b> | <b>C/D</b> | <b>SD[7:0]</b> |
|-----------|-----------|-----------|------------|----------------|
| L         | H         | L         | H          | Status Word    |

The RA6963 status word format is as follows:

| MSB | SD7  | SD6  | SD5  | SD4  | SD3  | SD2  | SD1  | SD0  | LSB |
|-----|------|------|------|------|------|------|------|------|-----|
|     | STA7 | STA6 | STA5 | STA4 | STA3 | STA2 | STA1 | STA0 |     |

|      |  |                                     |
|------|--|-------------------------------------|
| 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 copy commands. | 0: No error<br>1: Error             |
| STA7 | Check the blink condition                  | 0: Display off<br>1: Normal display |

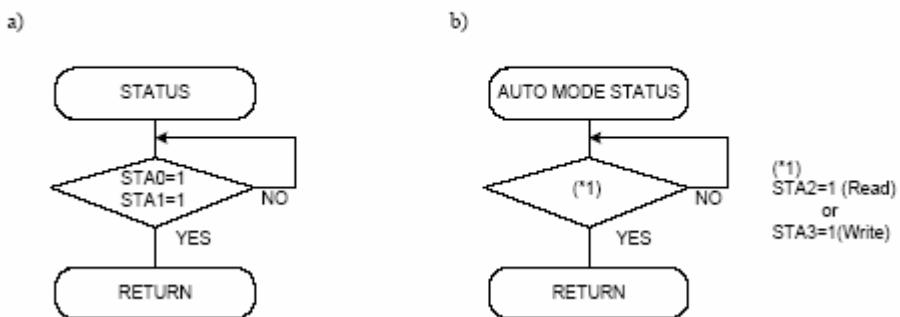
Note 1: It is necessary to check STA0 and STA1 at the same time.

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



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

If a status check is not carried out, the RA6963 cannot operate normally, even after a delay time.

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

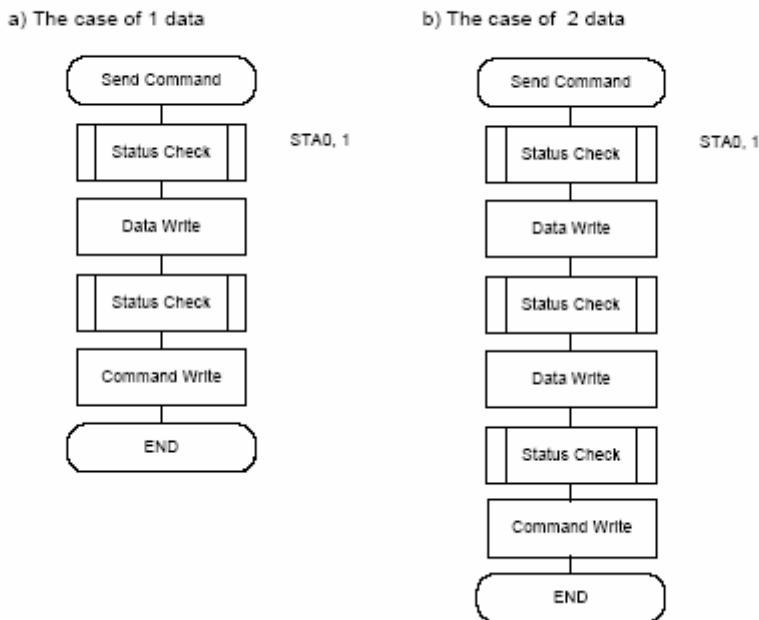
If a MSB=0 command is sent to the RA6963 during this period, the RA6963 enters Wait status.

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

### • Setting Data

When using the RA6963, first set the data, then set the command.

#### Procedure for Sending a Command



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

- **Command Definitions**

| Command                      | Code     | D1          | D2           | Function                        |
|------------------------------|----------|-------------|--------------|---------------------------------|
| <b>Registers Setting</b>     | 00100001 | X address   | Y address    | Set cursor pointer              |
|                              | 00100010 | Data        | 00h          | Set Offset Register             |
|                              | 00100100 | Low address | High address | Set Address pointer             |
| <b>Set Control Word</b>      | 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                |
| <b>Mode Set</b>              | 1000X000 | --          | --           | OR mode                         |
|                              | 1000X001 | --          | --           | EXOR mode                       |
|                              | 1000X011 | --          | --           | AND mode                        |
|                              | 1000X100 | --          | --           | Text Attribute mode             |
|                              | 10000XXX | --          | --           | Internal CG ROM mode            |
|                              | 10001XXX | --          | --           | External CG RAM mode            |
| <b>Display Mode</b>          | 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             |
| <b>Cursor Pattern Select</b> | 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                   |
| <b>Data Read/Write</b>       | 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 Non-variable ADP |
|                              | 11000101 | --          | --           | Data Read and Non-variable ADP  |
| <b>Data auto Read/Write</b>  | 10110000 | --          | --           | Set Data Auto Write             |
|                              | 10110001 | --          | --           | Set Data Auto Read              |
|                              | 10110010 | --          | --           | Auto Reset                      |
| <b>Screen Peek</b>           | 11100000 | --          | --           | Screen Peek                     |
| <b>Screen Copy</b>           | 11101000 |             |              | Screen Copy                     |
| <b>Bit Set/Reset</b>         | 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)                     |

|                    |          |      |                                |  |
|--------------------|----------|------|--------------------------------|--|
| Screen Reverse     | 11010000 | Data | Data<br>(Don't care)<br>(Note) | Whole screen reverse<br>Data Bit 0<br>0 : Normal<br>1 : Reverse  |
| Blink Time         | 01010000 | Data | Data<br>(Don't care)<br>(Note) | If Frame = 60Hz<br>Data Bit 2:0<br>000 : 0.066s<br>001 : 0.25s<br>010 : 0.5s (Default)<br>011 : 0.75s<br>100 : 1s<br>101 : 1.25s<br>110 : 1.5s<br>111 : 2s |
| Cursor Auto Moving | 01100000 | Data | Data<br>(Don't care)<br>(Note) | Data Bit 0<br>0 : Disable.(Default)<br>1 : Enable.   |
| CGROM Font Select  | 01110000 | Data | Data<br>(Don't care)<br>(Note) | Data Bit 1:0<br>00 : Do not care.(Default)<br>01 : Do not care.<br>10 : CGROM Font-01.<br>11 : CGROM Font-02.  |

Note : In these functions, it must be sent two data before sending the command, but the contents of the second datum (D2) can be any values.

## 6.2 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 |

### • Set Cursor Pointer

The X-Adrs and Y-Adrs specify the position of the cursor. 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)

a) Single-Scan  
X-Adrs 00h to 4Fh

b) Dual-Scan  
X-Adrs 00h to 4Fh

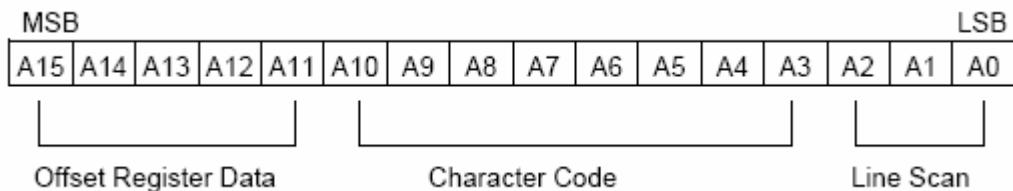
Y-Adrs 00h to 0Fh

Y-Adrs 00h to 0Fh  
Upper Screen

Y-Adrs 10h to 1Fh  
Lower Screen

- **Set Offset Register**

The offset register is used to determine the external character generator RAM area. The RA6963 has a 16-bit address bus as follows:



RA6963 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 mode, 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 RAM 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 07FFh                      |
| 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     | 1Eh    |
| 1401h     | 11h    |
| 1402h     | 11h    |
| 1403h     | 1Eh    |
| 1404h     | 14h    |
| 1405h     | 12h    |
| 1406h     | 11h    |
| 1407h     | 00h    |

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

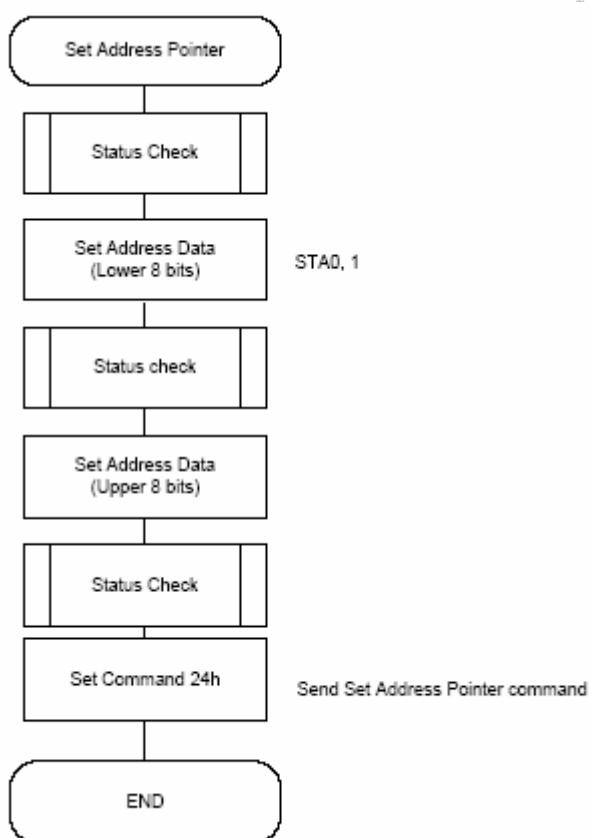
|                   | (RAM Data) | (Character) |
|-------------------|------------|-------------|
| AB γ DE ζ GH      | 21h        | A           |
| :                 | 22h        | B           |
| :                 | 83h        | 11h         |
| :                 | 24h        | D           |
| :                 | 25h        | E           |
| Display Character | 86h        | 14h         |
|                   | 27h        | G           |
|                   | 28h        | H           |

The "γ" and "ζ" are displayed by character generator RAM.

### • 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



### 6.3 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.

#### • 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 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      |
| MD2=H, MD3=H                 | : 32 Columns |
| DUAL =H, MDS=L, MD0=L, MD1=H | : 4 Lines    |

|       |       |       |       |       |
|-------|-------|-------|-------|-------|
| 0000h | 0001h | ..... | 001Eh | 001Fh |
| 0020h | 0021h | ..... | 003Eh | 002Fh |
| 0040h | 0041h | ..... | 005Eh | 005Fh |
| 0060h | 0061h | ..... | 007Eh | 007Fh |

- **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 + CL            |
| 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      |
| MD2=H, MD3=H                 | : 32 columns |
| DUAL =H, MDS=L, MD0=H, MD1=H | : 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 | 015Fh |
| 0160h | 0161h | ..... | 017Eh | 017Fh |
| 0180h | 0181h | ..... | 019Eh | 019Fh |
| 01A0h | 01A1h | ..... | 01BEh | 01BFh |
| 01C0h | 01C1h | ..... | 01DEh | 01DFh |
| 01E0h | 01E1h | ..... | 01FEh | 01FFh |

### • Set Text Area

The display columns are defined by the hardware setting. This command can be used to adjust the columns of the display.

(Example)

|                                       |                       |
|---------------------------------------|-----------------------|
| LCD Size                              | : 20 columns, 4 lines |
| Text Home Address                     | : 0000h               |
| Text Area                             | : 0014h               |
| MD2=H, MD3=H                          | : 32 columns          |
| <u>DUAL</u> =H, MDS =L, MD0= L, MD1=H | : 4 lines             |

|      |      |       |      |      |       |      |
|------|------|-------|------|------|-------|------|
| 0000 | 0001 | ..... | 0013 | 0014 | ..... | 001F |
| 0014 | 0015 | ..... | 0027 | 0028 | ..... | 0033 |
| 0028 | 0029 | ..... | 003B | 003C | ..... | 0047 |
| 003C | 003D | ..... | 004F | 0050 | ..... | 005B |



### • Set Graphic Area

The display columns are defined by the hardware setting. This command can be used to adjust the columns of the graphic display.

(Example)

|                                    |                       |
|------------------------------------|-----------------------|
| LCD Size                           | : 20 columns, 2 lines |
| Graphic Home Address               | : 0000h               |
| Graphic Area                       | : 0014h               |
| MD2=H, MD3=H                       | : 32 columns          |
| <u>DUAL</u> =H, MDS=L MD0=H, MD1=H | : 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 | 013C | ..... | 0147 |
| 013C | 013D | ..... | 014F | 0150 | ..... | 015B |

→ LCD ←

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.

## 6.4 Mode Set

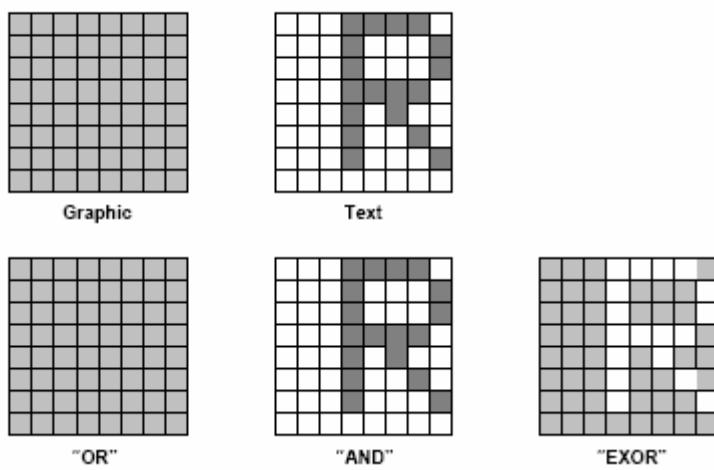
| Code     | Function                          | Operand |
|----------|-----------------------------------|---------|
| 1000X000 | OR Mode                           | —       |
| 1000X001 | EXOR Mode                         | —       |
| 1000X011 | AND Mode                          | —       |
| 1000X100 | Text Attribute Mode               | —       |
| 10000XXX | Internal Character Generator Mode | —       |
| 10001XXX | 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)



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, bold 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 that in order to for the Attribute function 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 |
|---|---|---|---|----|----|----|----|

X: Invalid

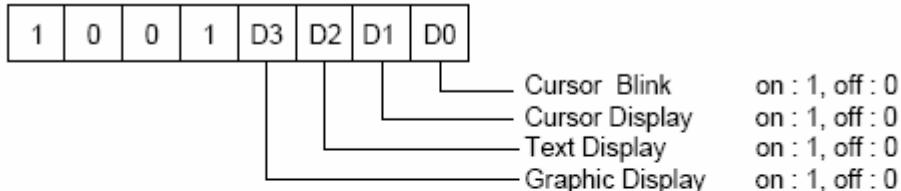
**< Table 6-15 >**

| 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 |
| 0  | 1  | 1  | 1  | Bold Display             |
| 1  | 1  | 1  | 1  | Blink of Bold Display    |

## 6.5 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



Note: It is necessary to turn on "Text Display" and "Graphic Display" in the following cases.

- Combination of text /graphic display
- Attribute function

## 6.6 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.

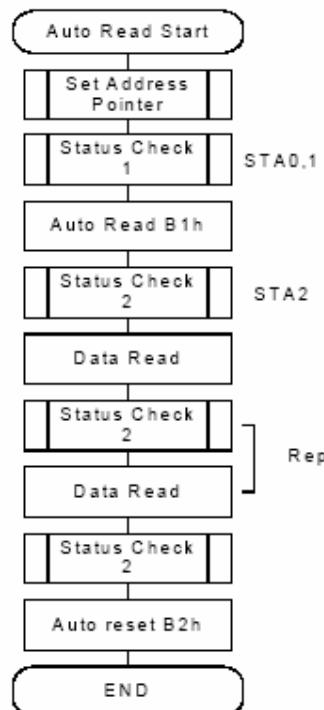
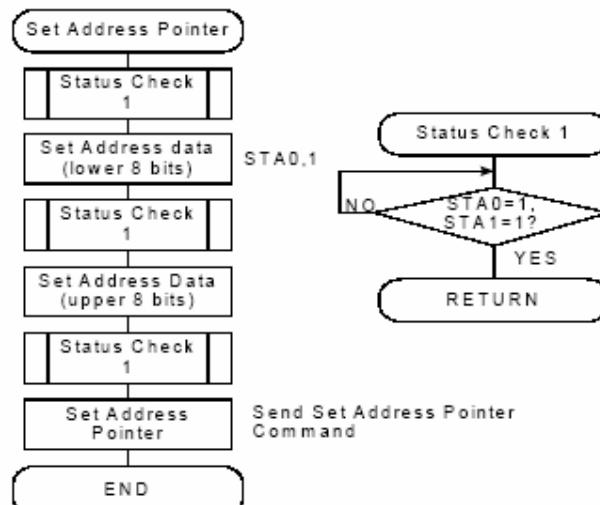
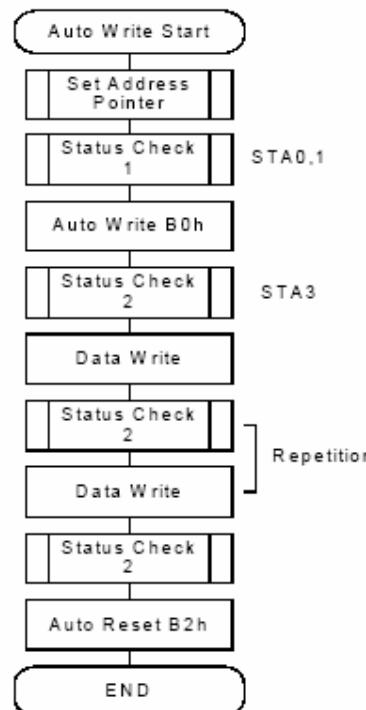
## 6.7 Data Auto Read/Write

| Code     | Hex. | Function            | Operand |
|----------|------|---------------------|---------|
| 10110000 | B0h  | Set Data Auto Write | —       |
| 10110001 | B1h  | Set Data Auto Read  | —       |
| 10110010 | B2h  | Auto Reset          | —       |

This 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 does not need 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 RA6963 cannot accept any other commands.

The Auto Reset command must be sent to the RA6963 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**


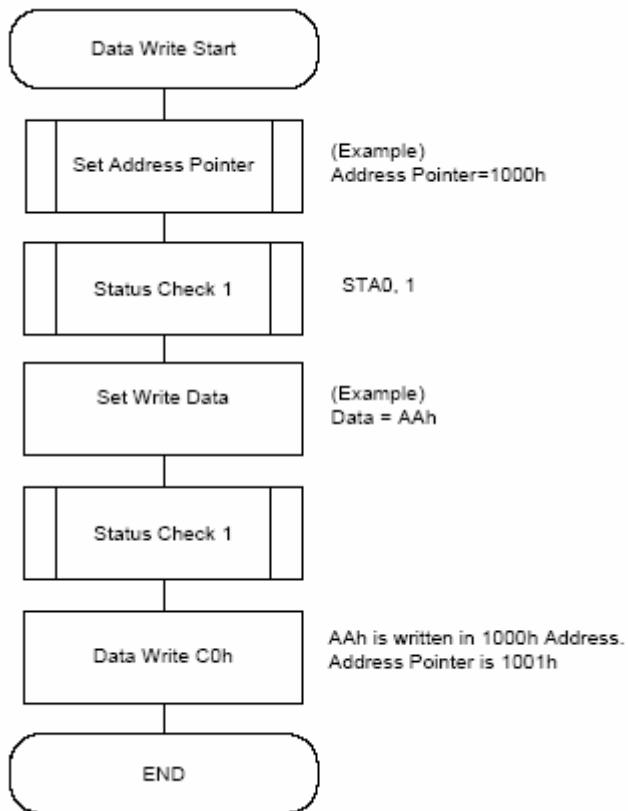
## 6.8 Data Read/Write

| 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 Write and Decrement ADP    | —       |
| 11000100 | C4h  | Data Write and Non-variable ADP | Data    |
| 11000101 | C5h  | Data Read and Non-variable ADP  | —       |

This command is used for writing data from the MPU to external display RAM, and reading data from external display RAM. 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.



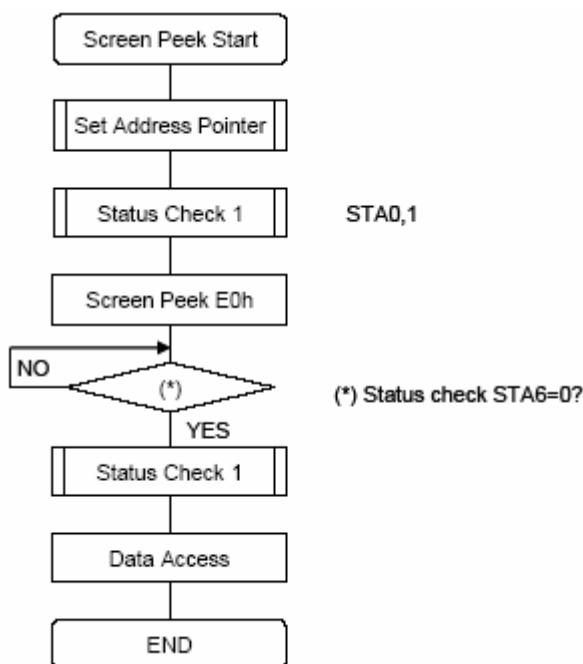
## 6.9 Screen Peek

| Code     | Hex. | Function    | Operand |
|----------|------|-------------|---------|
| 11100000 | E0h  | Screen Peek | —       |

This command is used to transfer 1 byte of displayed data to the data stack; this byte can 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.



Note: This command is available when hardware column number and software column number are the same. Hardware column number is related to MD2 and MD3 setting. Software column number is related to Set Text Area and Set Graphic Area command.

## 6-10 Screen Copy

| Code     | Hex. | Function    | Operand |
|----------|------|-------------|---------|
| 11101000 | E8h  | Screen Copy | —       |

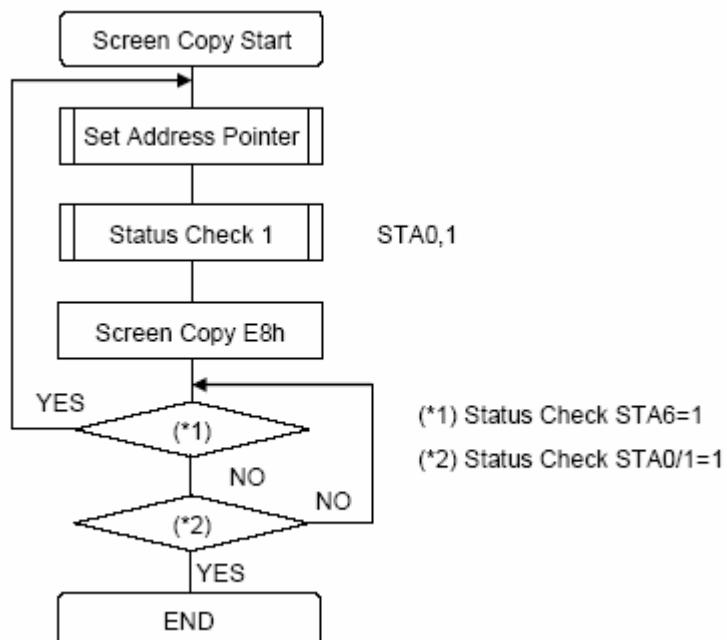
This command copies a single raster line of data to the graphic area.

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.)

Note 2: With Dual-Scan, this command cannot be used (because the RA6963 cannot separate the upper screen data and lower screen data).

Refer to the following flowchart.



Note: This command is available when hardware column number is the same. Hardware column number is related to MD2 and MD3 setting. Software column number is related to Set Text Area and Set Graphic Area command.

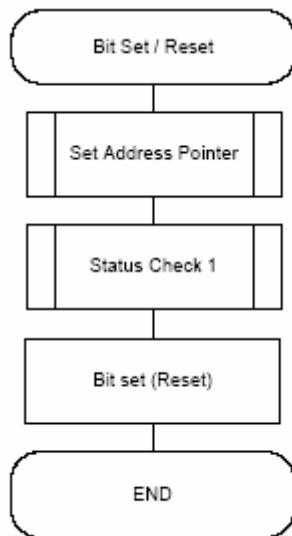
## 6-11 Bit Set/Reset

| 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 used to set or reset a bit of the byte specified by the address pointer. Only one bit can be set / reset at time.

Refer to following flowchart.



## 6-12 Screen Reverse

| Code     | Hex. | Function                                  | D1   | D2 |
|----------|------|---|------|----|
| 11010000 | D0h  | Enable/Disable the whole screen reversing | Data | -  |

Screen Reverse Selection (D1)

| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------|------|------|------|------|------|------|------|
| x    | x    | x    | x    | x    | x    | x    | 0/1  |

Bit0 = 0 : Normally display.

Bit0 = 1 : Reverse the whole screen.

This command (D0h) is used to reverse the displayed data of the whole screen. When this function is enabled, the displayed data on the LCD are reversed to show reversing pattern.

## 6-13 Blink Time

| Code     | Hex. | Function  | D1               | D2                 |
|----------|------|---|------------------|--------------------|
| 01010000 | 50h  | Adjust the blink time for the blink functions of the RA6963 | Data (Bit2~Bit0) | Do not care (Note) |

Note : In this function, it must be sent two data before sending the command, but the contents of the second datum (D2) can be any values.

Blink Time Selection (D1)

| Bit 2 | Bit 1 | Bit 0 | Blink Time (If $f_R=60Hz$ ) |
|-------|-------|-------|-----------------------------|
| 0     | 0     | 0     | 0.066 sec.                  |
| 0     | 0     | 1     | 0.25 sec.                   |
| 0     | 1     | 0     | 0.5 sec.                    |
| 0     | 1     | 1     | 0.75 sec.                   |
| 1     | 0     | 0     | 1 sec.                      |
| 1     | 0     | 1     | 1.25 sec.                   |
| 1     | 1     | 0     | 1.5 sec.                    |
| 1     | 1     | 1     | 2 sec.                      |

The blink time of the blink functions are adjusted by this command (50h). For example, if the frequency of the frame equals 60Hz, the blink time can be adjusted from 0.066 second to 2 second by using software selections. The selections are listed in the Table 6-26.

## 6-14 Cursor Auto Moving

| Code     | Hex. | Function                                     | D1          | D2                 |
|----------|------|--|-------------|--------------------|
| 01100000 | 60h  | Enable/Disable the automatic cursor movement | Data (Bit0) | Do not care (Note) |

Note : In this function, it must be sent two data before sending the command, but the contents of the second datum (D2) can be any values.

Cursor Auto Moving Selection (D1)

| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------|------|------|------|------|------|------|------|
| x    | x    | x    | x    | x    | x    | x    | 0/1  |

Bit0 = 0 : Disable.

Bit0 = 1 : Enable.

The RA6963 provides a unique function for the automatic cursor movement. After writing (reading) each displayed datum, the cursor pointer is automatically increased/decreased by one in the Cursor Auto-Moving mode.

## 6-15 CGROM Font Select

| Code     | Hex. | Function                      | D1               | D2                 |
|----------|------|-------------------------------|------------------|--------------------|
| 01110000 | 70h  | Change the Character Font Map | Data (Bit1~Bit0) | Do not care (Note) |

Note : In this function, it must be sent two data before sending the command, but the contents of the second datum (D2) can be any values.

CGROM Font Selection (D1)

| Bit 1 | Bit 0 | CGROM Font           |
|-------|-------|----------------------|
| 0     | 0     | Do not care(Default) |
| 0     | 1     | Do not care          |
| 1     | 0     | CGROM Font-01.       |
| 1     | 1     | CGROM Font-02.       |

This command (70h) is a convenient function for selecting the Character Font Map. The user can get more built-in characters from CGROM Font-01 or CGROM Font-02, which is determined by software selections. The selections are listed in the Table 6-30.

## 6-16 Character Font Map

CGROM Font - 01

| LSB<br>MSB | 0 | 1 | 2 | 3  | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|------------|---|---|---|----|---|---|---|---|---|---|---|---|---|---|---|---|
| 0          | ! | " | # | \$ | % | 8 | ' | ( | ) | * | + | , | - | . | / |   |
| 1          | 0 | 1 | 2 | 3  | 4 | 5 | 6 | 7 | 8 | 9 | : | : | < | = | > |   |
| 2          | ä | À | Á | Ë  | É | Ç | Ð | Ñ | Ã | Í | Ј | Ќ | Љ | Њ | Ѡ |   |
| 3          | Р | ҆ | ҇ | ҈  | ҉ | Ҋ | ҋ | Ҍ | ҍ | Ҏ | ҏ | Ґ | ґ | Ғ | ғ |   |
| 4          | ~ | ä | à | á  | ë | é | ç | ð | ñ | ã | í | ј | ќ | љ | ѡ |   |
| 5          | ҆ | ҇ | ҈ | ҉  | Ҋ | ҋ | Ҍ | ҍ | Ҏ | ҏ | Ґ | ґ | Ғ | ғ | Ҕ |   |
| 6          | ҆ | ҇ | ҈ | ҉  | Ҋ | ҋ | Ҍ | ҍ | Ҏ | ҏ | Ґ | ґ | Ғ | ғ | Ҕ |   |
| 7          | ҆ | ҇ | ҈ | ҉  | Ҋ | ҋ | Ҍ | ҍ | Ҏ | ҏ | Ґ | ґ | Ғ | ғ | Ҕ |   |

CGROM Font - 02

| LSB<br>MSB | 0 | 1 | 2 | 3  | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|------------|---|---|---|----|---|---|---|---|---|---|---|---|---|---|---|---|
| 0          | ! | " | # | \$ | % | 8 | ' | ( | ) | * | + | , | - | . | / |   |
| 1          | 0 | 1 | 2 | 3  | 4 | 5 | 6 | 7 | 8 | 9 | : | : | < | = | > |   |
| 2          | ä | À | Á | Ë  | É | Ç | Ð | Ñ | Ã | Í | Ј | Ќ | Љ | Њ | Ѡ |   |
| 3          | Р | ҆ | ҇ | ҈  | ҉ | Ҋ | Ҍ | ҍ | Ҏ | ҏ | Ґ | ґ | Ғ | ғ | Ҕ |   |
| 4          | ~ | ä | à | á  | ë | é | ç | ð | ñ | ã | í | ј | ќ | љ | ѡ |   |
| 5          | ҆ | ҇ | ҈ | ҉  | Ҋ | ҋ | Ҍ | ҍ | Ҏ | ҏ | Ґ | ґ | Ғ | ғ | Ҕ |   |
| 6          | ҆ | ҇ | ҈ | ҉  | Ҋ | ҋ | Ҍ | ҍ | Ҏ | ҏ | Ґ | ґ | Ғ | ғ | Ҕ |   |
| 7          | ҆ | ҇ | ҈ | ҉  | Ҋ | ҋ | Ҍ | ҍ | Ҏ | ҏ | Ґ | ґ | Ғ | ғ | Ҕ |   |

The RA6963 has two part number - RA6963L2NA and RA6963L2NB. The RA6963L2NA is compatible to T6963C(code 0101) and the default font is Figure 6-13 as above. The RA6963L2NB is compatible to T6963C(code 0201) and the default font is Figure 6-14 as above.

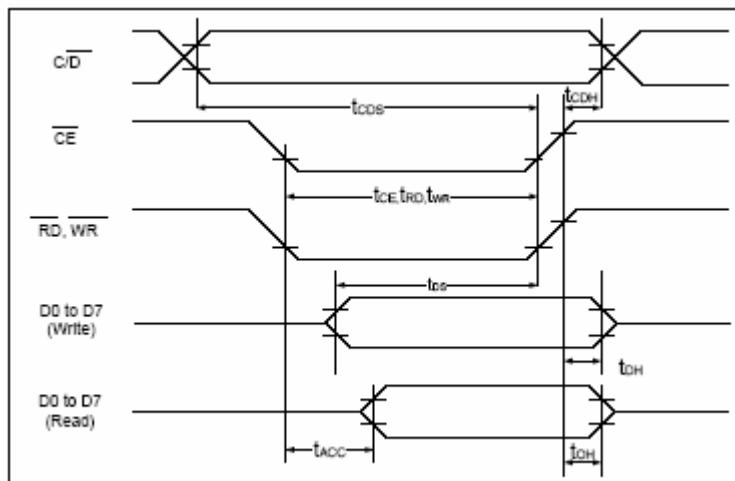
Although RA6963 provide a extra internal command for MCU to select both font of above, but you do not need to change the software to select the font that if you chose the right part number.

## 6-17 RA6963 vs. T6963C

| Item | Description          | RAiO<br>RA6963 | Toshiba<br>T6963C | Note   |
|------|----------------------|----------------|-------------------|--|
| 1    | CGROM Font Select    | Yes            | --                | RA6963 provides two CGROMs – Font-01 and Font-02 |
| 2    | Blink Time Selection | Yes            | --                | RA6963 provides eight selections for blinking.   |
| 3    | Cursor Auto Move     | Yes            | --                |  |
| 4    | Whole Screen Reverse | Yes            | --                |  |
| 5    | Bold Text and Blink  | Yes            | --                | RA6963 provides Bold Text feature.               |
| 6    | Package              | LQFP-<br>67Pin | LQFP-<br>67Pin    |  |

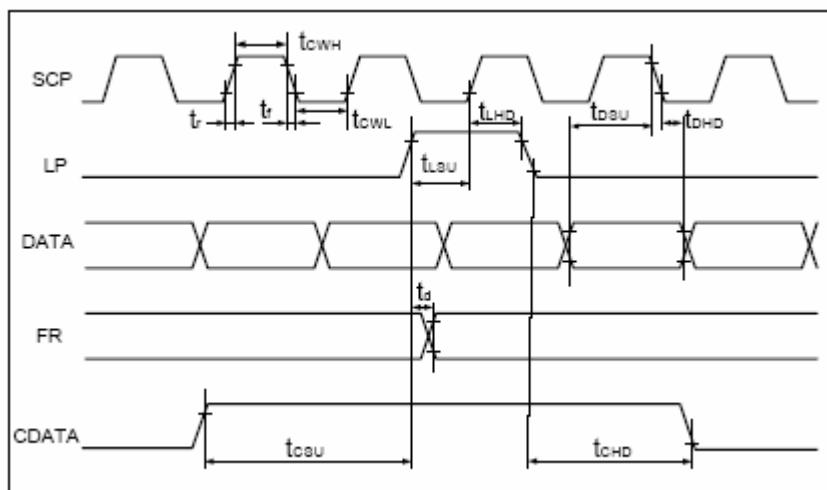
## 7. Timing Characteristics

### MPU Interface Timing



( VDD=+5V±5%, GND=0V, Ta= -20 to +70°C )

| Item                   | Symbol                   | Test Conditions | Min. | Max. | Unit |
|------------------------|--------------------------|-----------------|------|------|------|
| C/D Set Up Time        | $t_{CDH}$                | --              | 100  | --   | ns   |
| C/D Hold Time          | $t_{DS}$                 | --              | 10   | --   | ns   |
| CE, RD, WR Pulse Width | $t_{CE}, t_{RD}, t_{WR}$ | --              | 80   | --   | ns   |
| Data Set Up Time       | $t_{ACC}$                | --              | 80   | --   | ns   |
| Data Hold Time         | $t_{DH}$                 | --              | 40   | --   | ns   |
| Access Time            | $t_{OH}$                 | --              | --   | 150  | ns   |
| Output Hold Time       | $t_{OH}$                 | --              | 10   | 50   | ns   |

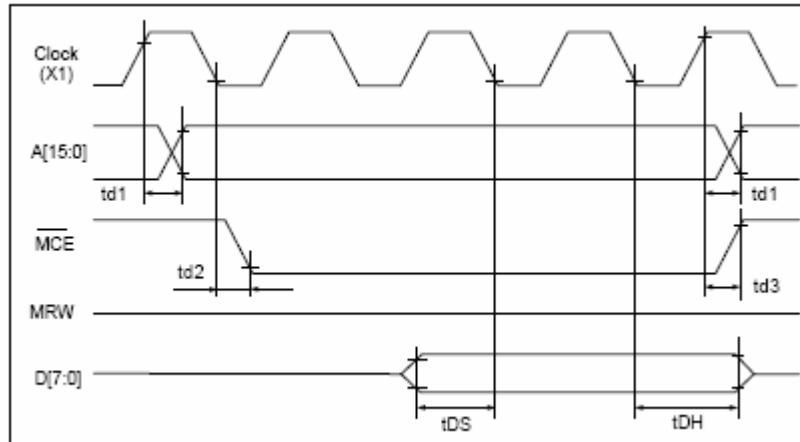
**Driver Interface Timing**


( VDD=+5V±5%, GND=0V, Ta= -20 to +70°C )

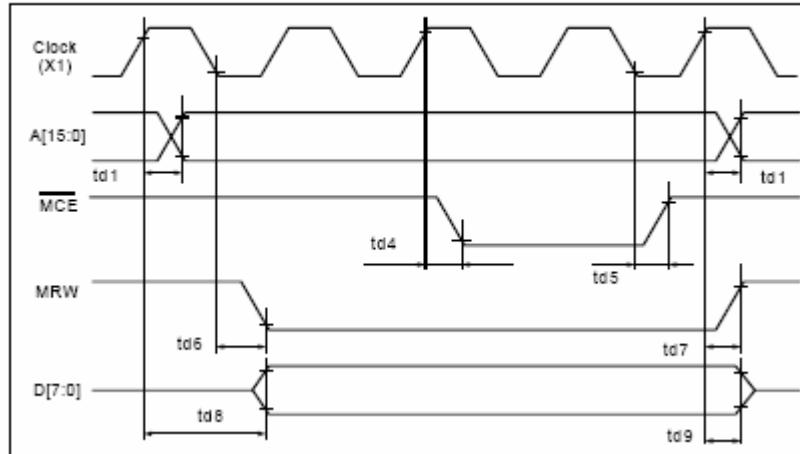
| Item                | Symbol             | Test Conditions           | Min. | Max. | Unit |
|---------------------|--------------------|---------------------------|------|------|------|
| Operating Frequency | $f_{SCP}$          | $Ta = -20\sim70^{\circ}C$ | --   | 9    | MHz  |
| SCP Pulse Width     | $t_{CWH}, t_{CWL}$ | --                        | 150  | --   | ns   |
| SCP Rise/Fall Time  | $t_r, t_f$         | --                        | --   | 30   | ns   |
| LP Setup Time       | $t_{LSU}$          | --                        | 150  | 290  | ns   |
| LP Hold Time        | $t_{LHD}$          | --                        | 5    | 40   | ns   |
| Data Setup Time     | $t_{DSU}$          | --                        | 170  | --   | ns   |
| Data Hold Time      | $t_{DHD}$          | --                        | 80   | --   | ns   |
| FR Delay Time       | $t_d$              | --                        | 0    | 90   | ns   |
| CDATA Setup Time    | $t_{CSU}$          | --                        | 450  | 850  | ns   |
| CDATA Hold Time     | $t_{CHD}$          | --                        | 450  | 950  | ns   |

## External Memory Interface

### External RAM Read



### External RAM Write



( VDD=+5V±5%, GND=0V, Ta=-20 to +70°C )

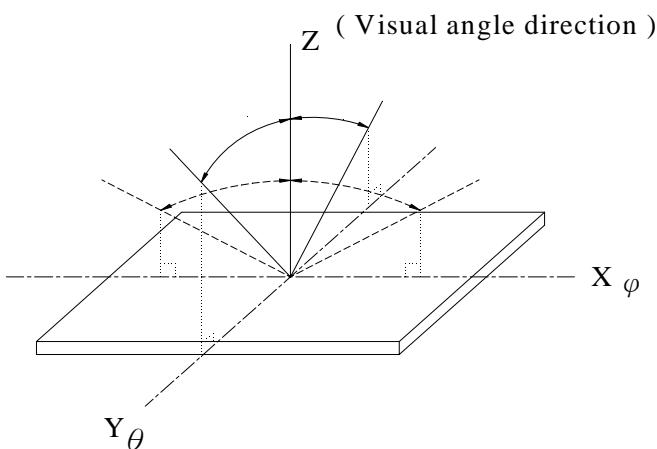
| Item                       | Symbol   | Test Conditions | Min. | Max. | Unit |
|----------------------------|----------|-----------------|------|------|------|
| Address Delay Time         | $t_{d1}$ | --              | --   | 250  | ns   |
| MCE Fall Delay Time(Read)  | $t_{d2}$ | --              | --   | 180  | ns   |
| MCE Rise Delay Time(Read)  | $t_{d3}$ | --              | --   | 180  | ns   |
| Data Setup Time            | $t_{DS}$ | --              | --   | --   | ns   |
| Data Hold Time             | $t_{DH}$ | --              | --   | --   | ns   |
| MCE Fall Delay Time(Write) | $t_{d4}$ | --              | --   | 200  | ns   |
| MCE Rise Delay Time(Write) | $t_{d5}$ | --              | --   | 200  | ns   |
| MRW Fall Delay Time        | $t_{d6}$ | --              | --   | 180  | ns   |
| MRW Rise Delay Time        | $t_{d7}$ | --              | --   | 180  | ns   |
| Data Stable Time           | $t_{d8}$ | --              | --   | 450  | ns   |
| Data Hold Time             | $t_{d9}$ | --              | --   | 200  | ns   |

## 8. Optical Characteristics

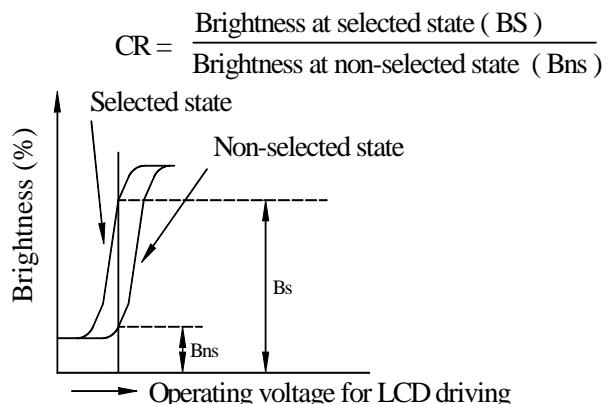
| Item           | Symbol        | Condition   | Min | Typ | Max | Unit |
|----------------|---------------|-------------|-----|-----|-----|------|
| View Angle     | (V) $\theta$  | CR $\geq 3$ | 30  | —   | 60  | deg  |
|                | (H) $\varphi$ | CR $\geq 3$ | -45 | —   | 45  | deg  |
| Contrast Ratio | CR            | —           | —   | 5   | —   | —    |
| Response Time  | T rise        | —           | —   | 200 | 300 | ms   |
|                | T fall        | —           | —   | 200 | 300 | ms   |

### Definitions

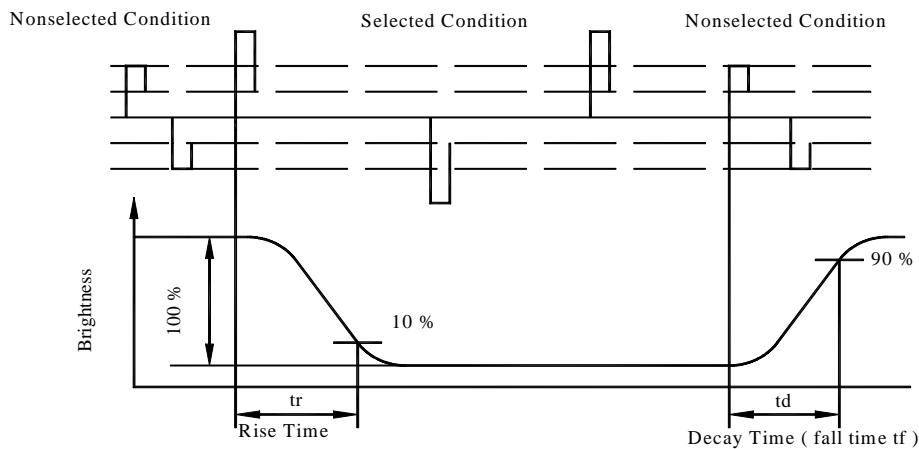
#### ■ View Angles



#### ■ Contrast Ratio



#### ■ Response Time



## 9. Absolute Maximum Ratings

| ITEM                     | SYMBOL          | MIN.     | TYP. | MAX.     | UNIT |
|--------------------------|-----------------|----------|------|----------|------|
| Operating Temperature    | $T_{OP}$        | -20      | —    | +70      | °C   |
| Storage Temperature      | $T_{ST}$        | -30      | —    | +80      | °C   |
| Input Voltage            | $V_I$           | $V_{SS}$ | —    | $V_{DD}$ | V    |
| Supply Voltage For Logic | $V_{DD}-V_{SS}$ | -0.3     | —    | +7       | V    |
| Supply Voltage For LCD   | $V_{DD}-V_0$    | 0        | —    | 28       | V    |

## 10. Electrical Characteristics

| ITEM                     | SYMBOL          | CONDITION | MIN.         | TYP. | MAX.     | UNIT |
|--------------------------|-----------------|-----------|--------------|------|----------|------|
| Supply Voltage For Logic | $V_{DD}-V_{SS}$ | —         | 3.0          | —    | 5.5      | V    |
| Supply Voltage For LCD   | $V_{DD}-V_0$    | Ta=-20°C  | —            | —    | 21.1     | V    |
|                          |                 | Ta=25°C   | 18.6         | 19.2 | 19.8     | V    |
|                          |                 | Ta=70°C   | 16.8         | —    | —        | V    |
| Input High Volt.         | $V_{IH}$        | —         | $0.8V_{DD}$  | —    | $V_{DD}$ | V    |
| Input Low Volt.          | $V_{IL}$        | —         | 0            | —    | 0.2      | V    |
| Output High Volt.        | $V_{OH}$        | —         | $V_{DD}-0.3$ | —    | $V_{DD}$ | V    |
| Output Low Volt.         | $V_{OL}$        | —         | 0            | —    | 0.3      | V    |
| Supply Current           | $I_{DD}$        | —         | —            | 42   | 50       | mA   |

## 11. Backlight Information

### Specification

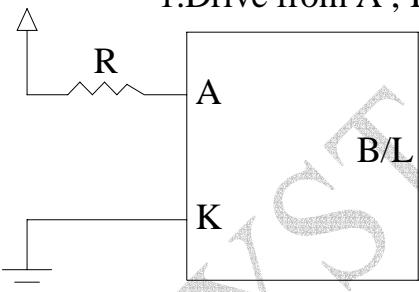
| PARAMETER          | SYMBOL    | MIN   | TYP | MAX | UNIT     | TEST CONDITION  |
|--------------------|-----------|-------|-----|-----|----------|-----------------|
| Supply Current     | $I_{LED}$ | 115.2 | 128 | 200 | mA       | $V=3.5V$        |
| Supply Voltage     | $V$       | 3.4   | 3.5 | 3.6 | V        | —               |
| Reverse Voltage    | $VR$      | —     | —   | 5   | V        | —               |
| Luminous Intensity | $IV$      | 240   | 300 | —   | $cd/m^2$ | $I_{LED}=128mA$ |
| Life Time          | —         | —     | 50K | —   | Hr.      | $I_{LED}=128mA$ |
| Color              | White     |       |     |     |          |                 |

Note:

The LED of B/L is drive by current only; drive voltage is for reference only. Drive voltage has to make driving current under safety area (current between minimum and maximum).

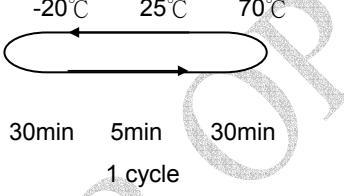
#### LED B\L Drive Method

##### 1. Drive from A , K



## 12. Reliability

### Content of Reliability Test (wide temperature, -20°C~70°C)

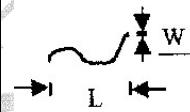
| Environmental Test                      |  |   |      |  |
|---|--|---|------|--|
| Test Item                               | Content of Test  | Condition   | Note |  |
| High Temperature storage                | Endurance test applying the high storage temperature for a long time.  | 80°C<br>200hrs  | 2    |  |
| Low Temperature storage                 | Endurance test applying the high storage temperature for a long time.  | -30°C<br>200hrs   | 1,2  |  |
| High Temperature Operation              | Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.   | 70°C<br>200hrs  | -    |  |
| Low Temperature Operation               | Endurance test applying the electric stress under low temperature for a long time.   | -20°C<br>200hrs   | 1    |  |
| High Temperature/<br>Humidity Operation | The module should be allowed to stand at 60°C,90%RH max For 96hrs under no-load condition excluding the polarizer, Then taking it out and drying it at normal temperature. | 60°C,90%RH<br>96hrs   | 1,2  |  |
| Thermal shock resistance                | The sample should be allowed stand the following 10 cycles of operation<br><br>         | -20°C/70°C<br>10 cycles   | -    |  |
| Vibration test                          | Endurance test applying the vibration during transportation and using.   | fixed<br>amplitude:<br>15mm<br>Vibration.<br>Frequency:<br>10~55Hz.<br>One cycle 60<br>seconds to 3<br>directions of<br>X,Y,Z for<br>Each 15<br>minutes | 3    |  |
| Static electricity test                 | Endurance test applying the electric stress to the terminal.   | VS=800V,RS=<br>1.5kΩ<br>CS=100pF<br>1 time  |      |  |

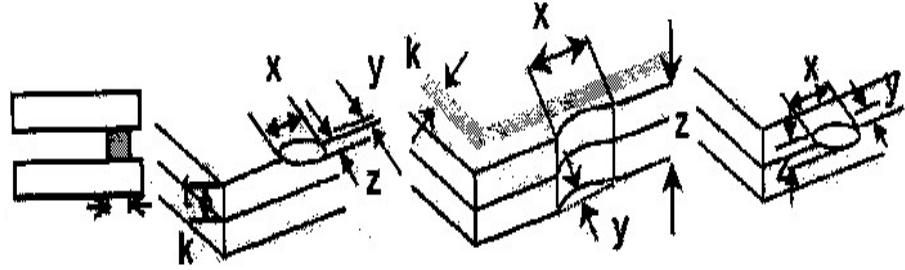
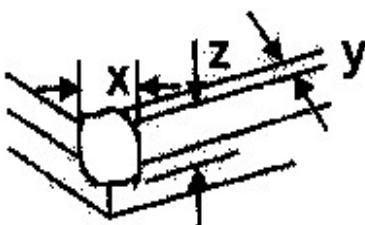
**Note1: No dew condensation to be observed.**

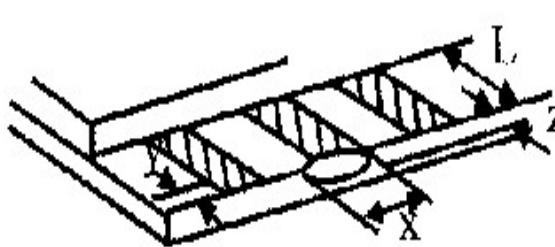
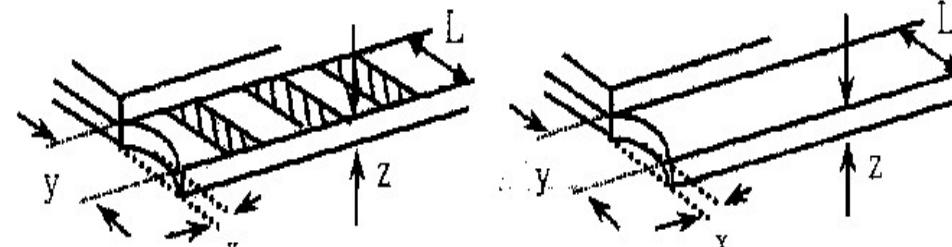
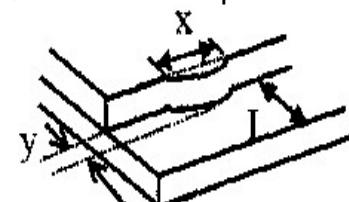
**Note2: The function test shall be conducted after 4 hours storage at the normal temperature and humidity after remove from the test chamber.**

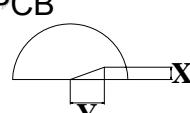
**Note3: Vibration test will be conducted to the product itself without putting it in a container.**

## 13. Inspection specification

| NO                      | Item  | Criterion   | AQL         |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
|-------------------------|---|---|-------------|-----------------|------------------|-----------------|-------------------------|-----------------|-------------------------|----------------------|---------------|--------------|----------------------|-----|------------|---------------|-----|
| 01                      | Electrical Testing  | 1.1 Missing vertical, horizontal segment, segment contrast defect.<br>1.2 Missing character, dot or icon.<br>1.3 Display malfunction.<br>1.4 No function or no display.<br>1.5 Current consumption exceeds product specifications.<br>1.6 LCD viewing angle defect.<br>1.7 Mixed product types.<br>1.8 Contrast defect.   | 0.65        |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| 02                      | Black or white spots on LCD (display only)                | 2.1 White and black spots on display $\leq 0.25\text{mm}$ , no more than three white or black spots present.<br>2.2 Densely spaced: No more than two spots or lines within 3mm  | 2.5         |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| 03                      | LCD black spots, white spots, contamination (non-display) | 3.1 Round type : As following drawing<br>$\Phi = (x + y) / 2$<br>3.2 Line type : (As following drawing)  <table border="1"> <thead> <tr> <th>Length</th> <th>Width</th> <th>Acceptable Q TY</th> </tr> </thead> <tbody> <tr> <td>---</td> <td><math>W \leq 0.02</math></td> <td>Accept no dense</td> </tr> <tr> <td><math>L \leq 3.0</math></td> <td><math>0.02 &lt; W \leq 0.03</math></td> <td rowspan="2">2</td> </tr> <tr> <td><math>L \leq 2.5</math></td> <td><math>0.03 &lt; W \leq 0.05</math></td> </tr> <tr> <td>---</td> <td><math>0.05 &lt; W</math></td> <td>As round type</td> </tr> </tbody> </table> | Length      | Width           | Acceptable Q TY  | ---             | $W \leq 0.02$           | Accept no dense | $L \leq 3.0$            | $0.02 < W \leq 0.03$ | 2             | $L \leq 2.5$ | $0.03 < W \leq 0.05$ | --- | $0.05 < W$ | As round type | 2.5 |
| Length                  | Width   | Acceptable Q TY   |             |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| ---                     | $W \leq 0.02$   | Accept no dense   |             |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| $L \leq 3.0$            | $0.02 < W \leq 0.03$                                      | 2   |             |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| $L \leq 2.5$            | $0.03 < W \leq 0.05$                                      |   |             |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| ---                     | $0.05 < W$  | As round type   |             |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| 04                      | Polarizer bubbles   | If bubbles are visible, judge using black spot specifications, not easy to find, must check in specify direction. <table border="1"> <thead> <tr> <th>Size <math>\Phi</math></th> <th>Acceptable Q TY</th> </tr> </thead> <tbody> <tr> <td><math>\Phi \leq 0.20</math></td> <td>Accept no dense</td> </tr> <tr> <td><math>0.20 &lt; \Phi \leq 0.50</math></td> <td>3</td> </tr> <tr> <td><math>0.50 &lt; \Phi \leq 1.00</math></td> <td>2</td> </tr> <tr> <td><math>1.00 &lt; \Phi</math></td> <td>0</td> </tr> <tr> <td>Total Q TY</td> <td>3</td> </tr> </tbody> </table>   | Size $\Phi$ | Acceptable Q TY | $\Phi \leq 0.20$ | Accept no dense | $0.20 < \Phi \leq 0.50$ | 3               | $0.50 < \Phi \leq 1.00$ | 2                    | $1.00 < \Phi$ | 0            | Total Q TY           | 3   | 2.5        |               |     |
| Size $\Phi$             | Acceptable Q TY   |   |             |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| $\Phi \leq 0.20$        | Accept no dense   |   |             |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| $0.20 < \Phi \leq 0.50$ | 3   |   |             |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| $0.50 < \Phi \leq 1.00$ | 2   |   |             |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| $1.00 < \Phi$           | 0   |   |             |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |
| Total Q TY              | 3   |   |             |                 |                  |                 |                         |                 |                         |                      |               |              |                      |     |            |               |     |

| NO                 | Item                  | Criterion  | AQL               |               |                |               |                       |               |                    |                   |               |                   |               |                |               |                       |               |                    |                   |               |     |
|--------------------|-----------------------|--|-------------------|---------------|----------------|---------------|-----------------------|---------------|--------------------|-------------------|---------------|-------------------|---------------|----------------|---------------|-----------------------|---------------|--------------------|-------------------|---------------|-----|
| 05                 | Scratches             | Follow NO.3 LCD black spots, white spots, contamination  |                   |               |                |               |                       |               |                    |                   |               |                   |               |                |               |                       |               |                    |                   |               |     |
| 06                 | Chipped glass         | <p>Symbols Define:</p> <p>x: Chip length      y: Chip width      z: Chip thickness<br/> k: Seal width      t: Glass thickness      a: LCD side length<br/> L: Electrode pad length:</p> <p>6.1 General glass chip :</p> <p>6.1.1 Chip on panel surface and crack between panels:</p>  <table border="1"> <tr> <td>z: Chip thickness</td> <td>y: Chip width</td> <td>x: Chip length</td> </tr> <tr> <td><math>z \leq 1/2t</math></td> <td>Not over viewing area</td> <td><math>x \leq 1/8a</math></td> </tr> <tr> <td><math>1/2t &lt; z \leq 2t</math></td> <td>Not exceed <math>1/3k</math></td> <td><math>x \leq 1/8a</math></td> </tr> </table> <p>① If there are 2 or more chips, x is total length of each chip.</p> <p>6.1.2 Corner crack:</p>  <table border="1"> <tr> <td>z: Chip thickness</td> <td>y: Chip width</td> <td>x: Chip length</td> </tr> <tr> <td><math>z \leq 1/2t</math></td> <td>Not over viewing area</td> <td><math>x \leq 1/8a</math></td> </tr> <tr> <td><math>1/2t &lt; z \leq 2t</math></td> <td>Not exceed <math>1/3k</math></td> <td><math>x \leq 1/8a</math></td> </tr> </table> <p>① If there are 2 or more chips, x is the total length of each chip.</p> | z: Chip thickness | y: Chip width | x: Chip length | $z \leq 1/2t$ | Not over viewing area | $x \leq 1/8a$ | $1/2t < z \leq 2t$ | Not exceed $1/3k$ | $x \leq 1/8a$ | z: Chip thickness | y: Chip width | x: Chip length | $z \leq 1/2t$ | Not over viewing area | $x \leq 1/8a$ | $1/2t < z \leq 2t$ | Not exceed $1/3k$ | $x \leq 1/8a$ | 2.5 |
| z: Chip thickness  | y: Chip width         | x: Chip length   |                   |               |                |               |                       |               |                    |                   |               |                   |               |                |               |                       |               |                    |                   |               |     |
| $z \leq 1/2t$      | Not over viewing area | $x \leq 1/8a$  |                   |               |                |               |                       |               |                    |                   |               |                   |               |                |               |                       |               |                    |                   |               |     |
| $1/2t < z \leq 2t$ | Not exceed $1/3k$     | $x \leq 1/8a$  |                   |               |                |               |                       |               |                    |                   |               |                   |               |                |               |                       |               |                    |                   |               |     |
| z: Chip thickness  | y: Chip width         | x: Chip length   |                   |               |                |               |                       |               |                    |                   |               |                   |               |                |               |                       |               |                    |                   |               |     |
| $z \leq 1/2t$      | Not over viewing area | $x \leq 1/8a$  |                   |               |                |               |                       |               |                    |                   |               |                   |               |                |               |                       |               |                    |                   |               |     |
| $1/2t < z \leq 2t$ | Not exceed $1/3k$     | $x \leq 1/8a$  |                   |               |                |               |                       |               |                    |                   |               |                   |               |                |               |                       |               |                    |                   |               |     |

| NO                    | Item           | Criterion   | AQL           |                |                   |                       |               |                |               |                |                   |            |               |                |          |           |               |            |     |
|-----------------------|----------------|---|---------------|----------------|-------------------|-----------------------|---------------|----------------|---------------|----------------|-------------------|------------|---------------|----------------|----------|-----------|---------------|------------|-----|
| 06                    | Glass crack    | <p>Symbols :</p> <p>x: Chip length      y: Chip width      z: Chip thickness<br/> k: Seal width      t: Glass thickness      a: LCD side length<br/> L: Electrode pad length</p> <p>6.2 Protrusion over terminal :</p> <p>6.2.1 Chip on electrode pad :</p>  <table border="1"> <tr> <td>y: Chip width</td> <td>x: Chip length</td> <td>z: Chip thickness</td> </tr> <tr> <td><math>y \leq 0.5\text{mm}</math></td> <td><math>x \leq 1/8a</math></td> <td><math>0 &lt; z \leq t</math></td> </tr> </table> <p>6.2.2 Non-conductive portion:</p>  <table border="1"> <tr> <td>y: Chip width</td> <td>x: Chip length</td> <td>z: Chip thickness</td> </tr> <tr> <td><math>y \leq L</math></td> <td><math>x \leq 1/8a</math></td> <td><math>0 &lt; z \leq t</math></td> </tr> </table> <p> <ul style="list-style-type: none"> <li>◎ If the chipped area touches the ITO terminal, over 2/3 of the ITO must remain and be inspected according to electrode terminal specifications.</li> <li>◎ If the product will be heat sealed by the customer, the alignment mark not be damaged.</li> </ul> </p> <p>6.2.3 Substrate protuberance and internal crack.</p>  <table border="1"> <tr> <td>y: width</td> <td>x: length</td> </tr> <tr> <td><math>y \leq 1/3L</math></td> <td><math>x \leq a</math></td> </tr> </table> | y: Chip width | x: Chip length | z: Chip thickness | $y \leq 0.5\text{mm}$ | $x \leq 1/8a$ | $0 < z \leq t$ | y: Chip width | x: Chip length | z: Chip thickness | $y \leq L$ | $x \leq 1/8a$ | $0 < z \leq t$ | y: width | x: length | $y \leq 1/3L$ | $x \leq a$ | 2.5 |
| y: Chip width         | x: Chip length | z: Chip thickness   |               |                |                   |                       |               |                |               |                |                   |            |               |                |          |           |               |            |     |
| $y \leq 0.5\text{mm}$ | $x \leq 1/8a$  | $0 < z \leq t$  |               |                |                   |                       |               |                |               |                |                   |            |               |                |          |           |               |            |     |
| y: Chip width         | x: Chip length | z: Chip thickness   |               |                |                   |                       |               |                |               |                |                   |            |               |                |          |           |               |            |     |
| $y \leq L$            | $x \leq 1/8a$  | $0 < z \leq t$  |               |                |                   |                       |               |                |               |                |                   |            |               |                |          |           |               |            |     |
| y: width              | x: length      |   |               |                |                   |                       |               |                |               |                |                   |            |               |                |          |           |               |            |     |
| $y \leq 1/3L$         | $x \leq a$     |   |               |                |                   |                       |               |                |               |                |                   |            |               |                |          |           |               |            |     |

| NO | Item               | Criterion   | AQL   |
|----|--------------------|---|---|
| 07 | Cracked glass      | The LCD with extensive crack is not acceptable.   | 2.5   |
| 08 | Backlight elements | 8.1 Illumination source flickers when lit.<br>8.2 Spots or scratched that appear when lit must be judged. Using LCD spot, lines and contamination standards.<br>8.3 Backlight doesn't light or color wrong.   | 0.65<br>2.5<br>0.65   |
| 09 | Bezel              | 9.1 Bezel may not have rust, be deformed or have fingerprints, stains or other contamination.<br>9.2 Bezel must comply with job specifications.   | 2.5<br>0.65   |
| 10 | PCB 、 COB          | 10.1 COB seal may not have pinholes larger than 0.2mm or contamination.<br>10.2 COB seal surface may not have pinholes through to the IC.<br>10.3 The height of the COB should not exceed the height indicated in the assembly diagram.<br>10.4 There may not be more than 2mm of sealant outside the seal area on the PCB. And there should be no more than three places.<br>10.5 No oxidation or contamination PCB terminals.<br>10.6 Parts on PCB must be the same as on the production characteristic chart. There should be no wrong parts, missing parts or excess parts.<br>10.7 The jumper on the PCB should conform to the product characteristic chart.<br>10.8 If solder gets on bezel tab pads, LED pad, zebra pad or screw hold pad, make sure it is smoothed down.<br>10.9 The Scraping testing standard for Copper Coating of PCB<br><br>$X * Y \leq 2 \text{mm}^2$ | 2.5<br>2.5<br>0.65<br>2.5<br>2.5<br>0.65<br>0.65<br>2.5<br>2.5<br>2.5 |
| 11 | Soldering          | 11.1 No un-melted solder paste may be present on the PCB.<br>11.2 No cold solder joints, missing solder connections, oxidation or icicle.<br>11.3 No residue or solder balls on PCB.<br>11.4 No short circuits in components on PCB.  | 2.5<br>2.5<br>2.5<br>0.65   |

| NO | Item               | Criterion   | AQL  |
|----|--------------------|---|--|
| 12 | General appearance | 12.1 No oxidation, contamination, curves or, bends on interface Pin (OLB) of TCP.<br>12.2 No cracks on interface pin (OLB) of TCP.<br>12.3 No contamination, solder residue or solder balls on product.<br>12.4 The IC on the TCP may not be damaged, circuits.<br>12.5 The uppermost edge of the protective strip on the interface pin must be present or look as if it causes the interface pin to sever.<br>12.6 The residual rosin or tin oil of soldering (component or chip component) is not burned into brown or black color.<br>12.7 Sealant on top of the ITO circuit has not hardened.<br>12.8 Pin type must match type in specification sheet.<br>12.9 LCD pin loose or missing pins.<br>12.10 Product packaging must the same as specified on packaging specification sheet.<br>12.11 Product dimension and structure must conform to product specification sheet. | 2.5<br>0.65<br>2.5<br>2.5<br>2.5<br>2.5<br>2.5<br>0.65<br>0.65<br>0.65<br>0.65 |

## 14. Precautions in use of LCD Modules

1. Avoid applying excessive shocks to the module or making any alterations or modifications to it.
2. Don't make extra holes on the printed circuit board, modify its shape or change the components of LCD module.
3. Don't disassemble the LCM.
4. Don't operate it above the absolute maximum rating.
5. Don't drop, bend or twist LCM.
6. Soldering: only to the I/O terminals.
7. Storage: please storage in anti-static electricity container and clean environment.
8. Raystar have the right to change the passive components  
(Resistors, capacitors and other passive components will have different appearance and color caused by the different supplier.)
9. Raystar have the right to change the PCB Rev.

## 15. Material List of Components for RoHS

1. RAYSTAR Optronics Co., Ltd. hereby declares that all of or part of products, including, but not limited to, the LCM, accessories or packages, manufactured and/or delivered to your company (including your subsidiaries and affiliated company) directly or indirectly by our company (including our subsidiaries or affiliated companies) do not intentionally contain any of the substances listed in all applicable EU directives and regulations, including the following substances.

Exhibit A : The Harmful Material List

| Material      | (Cd)    | (Pb)     | (Hg)     | (Cr6+)   | PBBs     | PBDEs    |
|---------------|---------|----------|----------|----------|----------|----------|
| Limited Value | 100 ppm | 1000 ppm |

Above limited value is set up according to RoHS.

2. Process for RoHS requirement :

(1) Use the Sn/Ag/Cu soldering surface : the surface of Pb-free solder is rougher than we used before.

(2) Heat-resistance temp. :

Reflow : 250°C, 30 seconds Max. ;

Connector soldering wave or hand soldering : 320°C, 10 seconds max.

(3) Temp. curve of reflow, max. Temp. : 235±5°C ;

Recommended customer's soldering temp. of connector : 280°C, 3 seconds.

## 16. Recommendable storage

1. Place the panel or module in the temperature 25°C±5°C and the humidity below 65% RH

2. Do not place the module near organics solvents or corrosive gases.

3. Do not crush, shake, or jolt the module

**LCM Sample Estimate Feedback Sheet**
**Module Number :** \_\_\_\_\_

**1、Panel Specification :**

|                            |                               |                                     |
|----------------------------|-------------------------------|-------------------------------------|
| 1. Panel Type :            | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 2. View Direction :        | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 3. Numbers of Dots :       | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 4. View Area :             | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5. Active Area :           | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 6. Operating Temperature : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 7. Storage Temperature :   | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 8.Others :                 | _____                         |                                     |

**2、Mechanical Specification :**

|                             |                               |                                     |
|-----------------------------|-------------------------------|-------------------------------------|
| 1. PCB Size :               | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 2. Frame Size :             | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 3. Material of Frame :      | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 4. Connector Position :     | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5. Fix Hole Position :      | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 6. Backlight Position :     | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 7. Thickness of PCB :       | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 8. Height of Frame to PCB : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 9. Height of Module :       | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 10.Others :                 | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |

**3、Relative Hole Size :**

|                            |                               |                                     |
|----------------------------|-------------------------------|-------------------------------------|
| 1.Pitch of Connector :     | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 2.Hole size of Connector : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 3.Mounting Hole size :     | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 4.Mounting Hole Type :     | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5.Others :                 | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |

**4、Backlight Specification :**

|  |                               |                                     |
|--|-------------------------------|-------------------------------------|
| 1.B/L Type :                                     | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 2.B/L Color :                                    | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 3.B/L Driving Voltage (Reference for LED Type) : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 4.B/L Driving Current :                          | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5.Brightness of B/L :                            | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 6.B/L Solder Method :                            | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 7.Others :                                       | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |

&gt;&gt; Go to page 2 &lt;&lt;

**Module Number :** \_\_\_\_\_

**5、Electronic Characteristics of Module :**

|                              |                               |                                     |
|------------------------------|-------------------------------|-------------------------------------|
| 1. Input Voltage :           | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 2. Supply Current :          | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 3. Driving Voltage for LCD : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 4. Contrast for LCD :        | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5. B/L Driving Method :      | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 6. Negative Voltage Output : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 7. Interface Function :      | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 8. LCD Uniformity :          | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 9. ESD test :                | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 10. Others :                 | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |

**6、Summary :**

**Sales signature :** \_\_\_\_\_

**Customer Signature :** \_\_\_\_\_

**Date :** / /