

## User's Guide

# **NHD-240128WG-BYGH-VZ#000C**

# **LCM**

(Liquid Crystal Display Graphic Module)

**RoHS Compliant**

|                |                                                         |
|----------------|---------------------------------------------------------|
| <b>NHD-</b>    | Newhaven Display                                        |
| <b>240128-</b> | 240 x 128 pixels                                        |
| <b>WG-</b>     | W= Factory Line    G= Display Type: Graphic             |
| <b>B-</b>      | Model / Serial number                                   |
| <b>Y-</b>      | Yellow/Green LED B/L                                    |
| <b>G-</b>      | STN- Gray                                               |
| <b>H-</b>      | Transflective, 6:00 View, Wide Temperature (-20 ~ +70c) |
| <b>VZ#-</b>    | Built-in Negative voltage; RoHS                         |
| <b>000C-</b>   | With Angled Pin Header                                  |

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# 1. Module Classification Information

NHD    240128    W G ☐ B Y G H - VZ#000C  
 ①                      ②                      ③    ④                      ⑤ ⑥ ⑦ ⑧                      9

① Brand ☐ Newhaven Display

② Display Font ☐ 240 x 128 Dots

③ Factory Line: W

④ Display Type ☐ H ☐ Character Type, **G** ☐ Graphic Type, C ☐ Color

⑤ Model / Serial number = **B**

⑥ Backlight Type ☐    N ☐ Without backlight

B ☐ EL, Blue green

A ☐ LED, Amber

D ☐ EL, Green

R ☐ LED, Red

W ☐ EL, White

O ☐ LED, Orange

F ☐ CCFL, White

G ☐ LED, Green

**Y** ☐ LED, Yellow Green

T ☐ LED, White

⑦ LCD Mode ☐

B ☐ TN Positive, Gray

T ☐ FSTN Negative

N ☐ TN Negative,

C ☐ STN Color

**G** ☐ STN Positive, Gray

F ☐ FSTN Positive

Y ☐ STN Positive, Yellow Green

M ☐ STN Negative, Blue

⑧ LCD Polarize Type/  
Temperature range/  
View direction

A ☐ Reflective, N.T, 6:00

**H** ☐ Transflective, W.T, 6:00

D ☐ Reflective, N.T, 12:00

K ☐ Transflective, W.T, 12:00

G ☐ Reflective, W. T, 6:00

C ☐ Transmissive, N.T, 6:00

J ☐ Reflective, W. T, 12:00

F ☐ Transmissive, N.T, 12:00

B ☐ Transflective, N.T, 6:00

I ☐ Transmissive, W. T, 6:00

E ☐ Transflective, N.T, 12:00

L ☐ Transmissive, W.T, 12:00

9 Special Code

**VZ** : Built-in Negative voltage

**000C** : With Angled Pin Header

## 2. Precautions in use of LCD Modules

- (1) Avoid applying excessive shock 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 store in anti-static electricity container and clean environment.

## 3. General Specification

NHD-240128WG-BYGH-VZ#000C

| ITEM              | STANDARD VALUE                        | UNIT |
|-------------------|---------------------------------------|------|
| Number of Dots:   | 240 ×128                              |      |
| Module dimension: | 144.0×104.0×14.3(MAX)mm               | mm   |
| View area:        | 114.0×64.0mm                          | mm   |
| Active area:      | 107.98×57.58mm                        | mm   |
| Character size:   | (L)0.43×(W)0.43 mm                    | mm   |
| Character pitch:  | (L)0.45×(W)0.45mm                     | mm   |
| LCD type:         | STN-GRAY , Positive , Transflective , |      |
| Duty:             | 1/128                                 |      |
| View direction:   | 6 o'clock                             |      |
| Backlight:        | LED , Yellow/Green                    |      |

## 4. Absolute Maximum Ratings

| ITEM                     | SYMBOL           | MIN.     | TYP. | MAX.     | UNIT |
|--------------------------|------------------|----------|------|----------|------|
| Operating Temperature    | $T_{OP}$         | -20      | □    | +70      | □    |
| Storage Temperature      | $T_{ST}$         | -30      | □    | +80      | □    |
| 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        | □    | 21       | V    |
| LED forward current      | I <sub>LED</sub> | □        | □    | 150      | mA   |

## 5. Electrical Characteristics

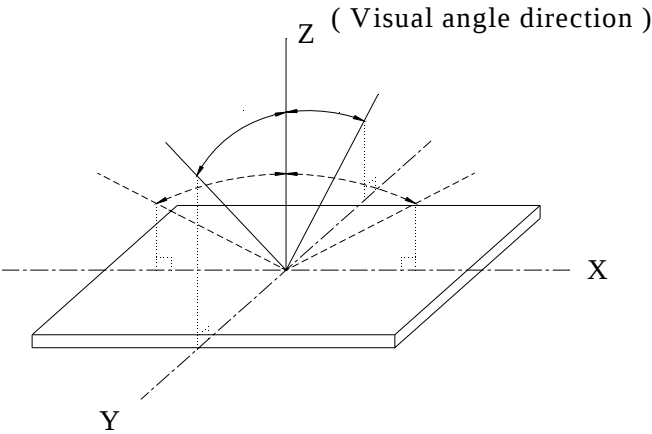
| ITEM                     | SYMBOL          | CONDITION               | MIN.         | TYP. | MAX.     | UNIT |
|--------------------------|-----------------|-------------------------|--------------|------|----------|------|
| Supply Voltage For Logic | $V_{DD}-V_{SS}$ | □                       | 4.75         | 5.0  | 5.25     | V    |
| Supply Voltage For LCD   | $V_{DD}-V_0$    | $T_a=-20^\circ\text{C}$ | □            | □    | 21.7     | V    |
|                          |                 | $T_a=25^\circ\text{C}$  | □            | 19.5 | □        | V    |
|                          |                 | $T_a=+70^\circ\text{C}$ | 17.8         | □    | □        | V    |
| Input High Vol           | $V_{IH}$        | □                       | $V_{DD}-2.2$ | □    | $V_{DD}$ | V    |
| Input Low Vol            | $V_{IL}$        | □                       | 0            | □    | 0.8      | V    |
| Output High Vol          | $V_{OH}$        | □                       | $V_{DD}-0.3$ | □    | $V_{DD}$ | V    |
| Output Low Vol.          | $V_{OL}$        | □                       | 0            | □    | 0.3      | V    |
| Supply Current           | I <sub>DD</sub> | $V_{DD}=5V$             | 45           | 55   | 60       | mA   |

# 6.Optical Characteristics

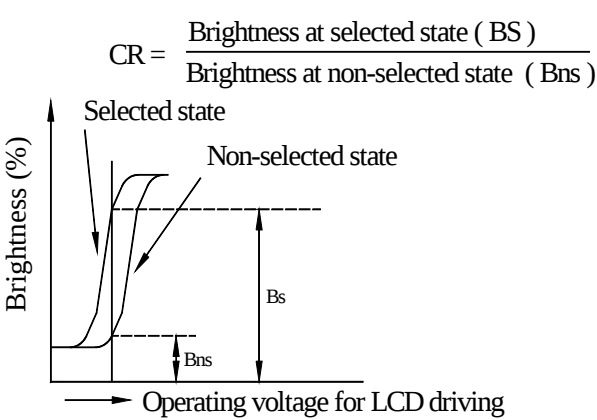
| ITEM           | SYMBAL | CONDITION | MIN. | TYP. | MAX. | UNIT |
|----------------|--------|-----------|------|------|------|------|
| View Angle     | (V)□   | CR□2      | 30   |      | 60   | deg  |
|                | (H)□   | CR□2      | -45  |      | 45   | deg  |
| Contrast Ratio | CR     | □         |      | 5    |      | □    |
| Response Time  | T rise | □         |      | 150  | 200  | ms   |
|                | T fall | □         |      | 150  | 200  | ms   |

## 6.1 Definitions

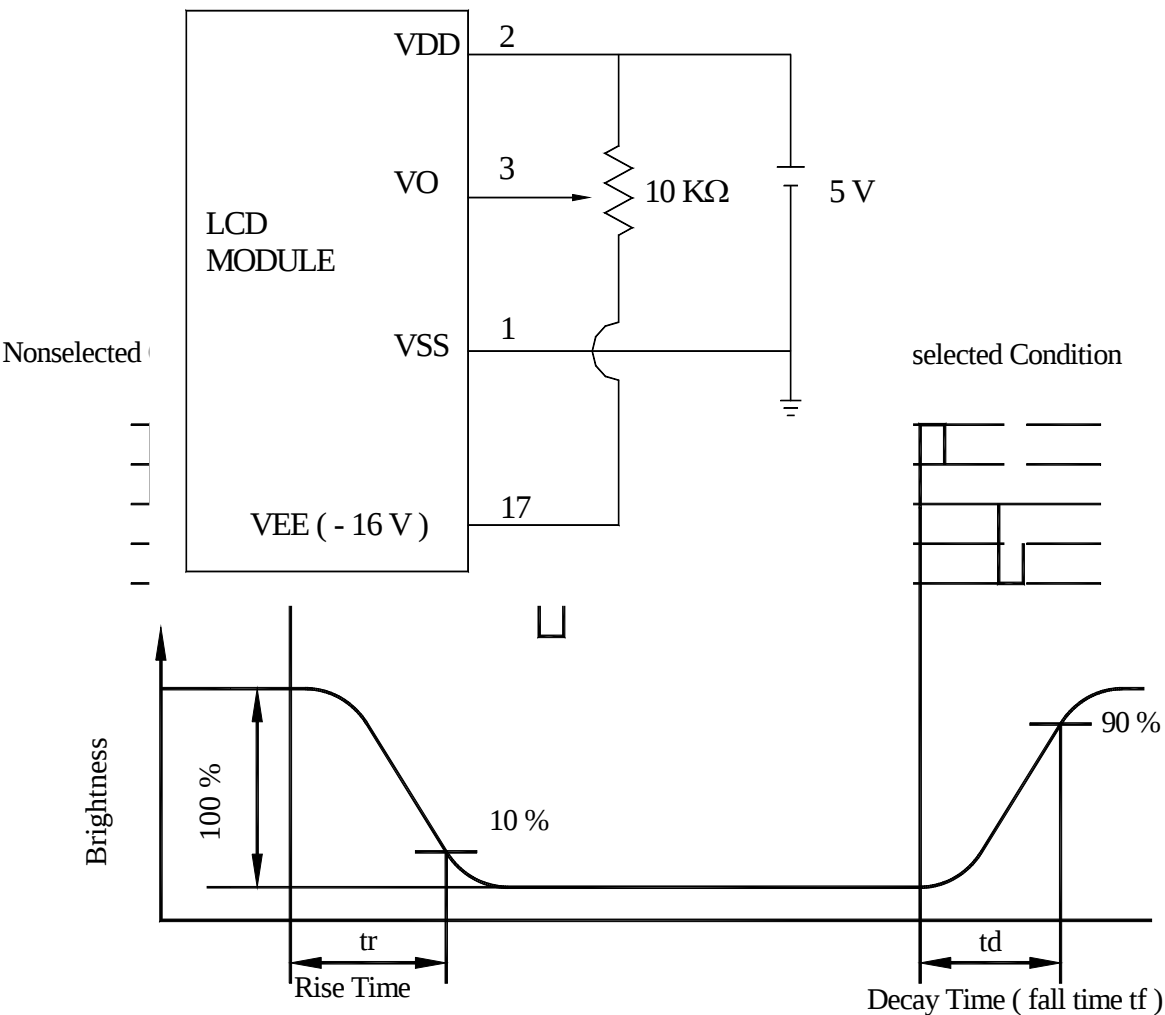
### ■View Angles



### ■Contrast Ratio

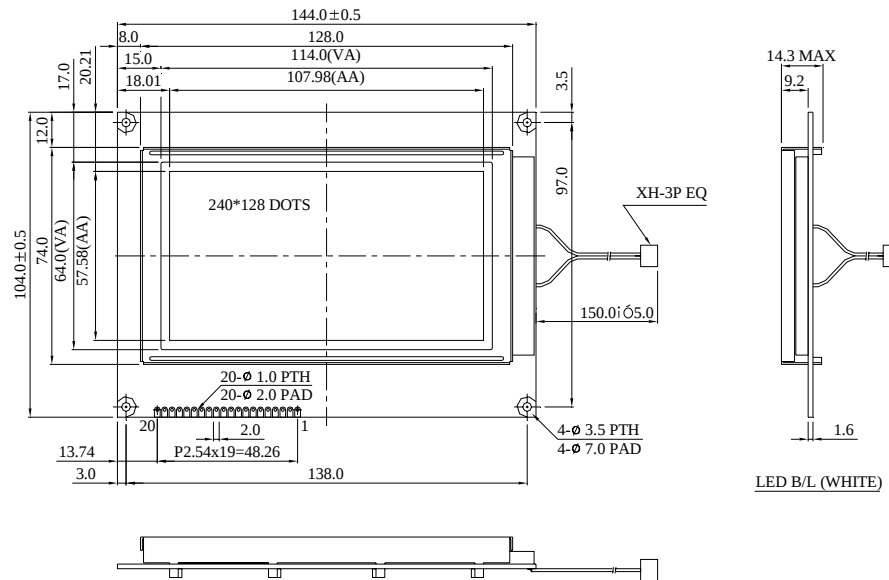


7.Power Supply for LCD Module and Contrast Adjust

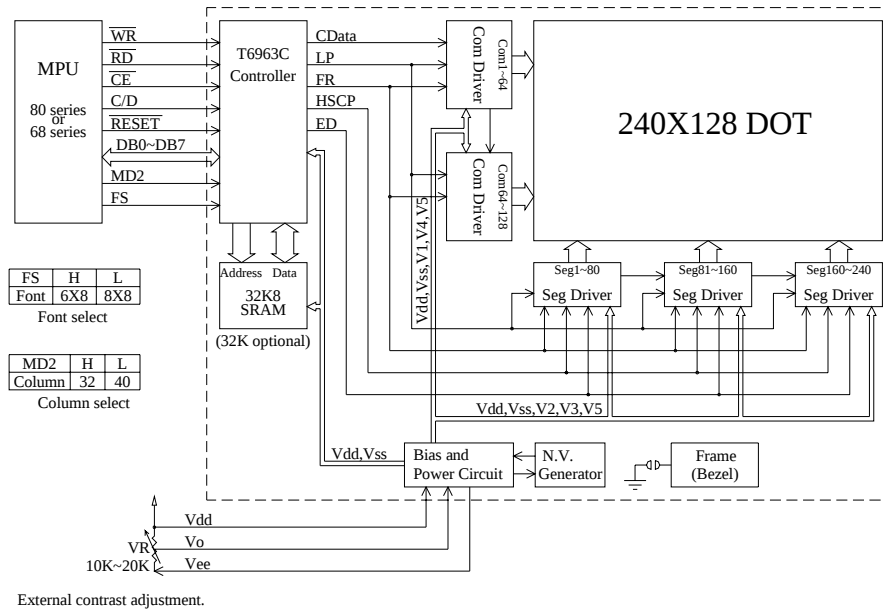
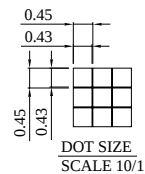


VDD-V0: LCD Operating Voltage (at 25 )

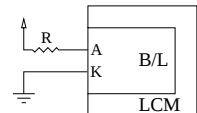
## 8. Contour Drawing & Block Diagram



| PIN NO. | SYMBOL                    |
|---------|---------------------------|
| 1       | V <sub>ss</sub>           |
| 2       | V <sub>dd</sub>           |
| 3       | V <sub>o</sub>            |
| 4       | C/D                       |
| 5       | $\overline{\text{RD}}$    |
| 6       | $\overline{\text{WR}}$    |
| 7       | DB0                       |
| 8       | DB1                       |
| 9       | DB2                       |
| 10      | DB3                       |
| 11      | DB4                       |
| 12      | DB5                       |
| 13      | DB6                       |
| 14      | DB7                       |
| 15      | $\overline{\text{CE}}$    |
| 16      | $\overline{\text{RESET}}$ |
| 17      | V <sub>ee</sub>           |
| 18      | MD2                       |
| 19      | FS1                       |
| 20      | NC                        |



LED B/L drive directly  
from A,K .



## 9. Interface Pin Function

| Pin No. | Symbol | Level | Description                                                                                         |
|---------|--------|-------|-----------------------------------------------------------------------------------------------------|
| 1       | Vss    |       | GND                                                                                                 |
| 2       | Vdd    |       | Power supply ( +5 V )                                                                               |
| 3       | Vo     |       | Power supply for LCD driver                                                                         |
| 4       | 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 |
| 5       | RD     | L     | Data read. Read data from T6963C when RD = L                                                        |
| 6       | WR     | L     | Data write. Write data into T6963C when WR = L                                                      |
| 7       | DB0    | H / L | Data bus line                                                                                       |
| 8       | DB1    | H / L | Data bus line                                                                                       |
| 9       | DB2    | H / L | Data bus line                                                                                       |
| 10      | DB3    | H / L | Data bus line                                                                                       |
| 11      | DB4    | H / L | Data bus line                                                                                       |
| 12      | DB5    | H / L | Data bus line                                                                                       |
| 13      | DB6    | H / L | Data bus line                                                                                       |
| 14      | DB7    | H / L | Data bus line                                                                                       |
| 15      | CE     | L     | L : Chip enable                                                                                     |
| 16      | RESET  | H / L | H : Normal ; L : Initialize T6963C                                                                  |
| 17      | Vee    |       | Negative Voltage Output (-16V)                                                                      |
| 18      | MD2    | H / L | H: 32 columns ; L: 40 columns                                                                       |
| 19      | FS     | H / L | Pins for selection of font ; H : 6 * 8 , L : 8 * 8                                                  |

|    |     |  |               |
|----|-----|--|---------------|
| 20 | N.C |  | No connection |
|----|-----|--|---------------|

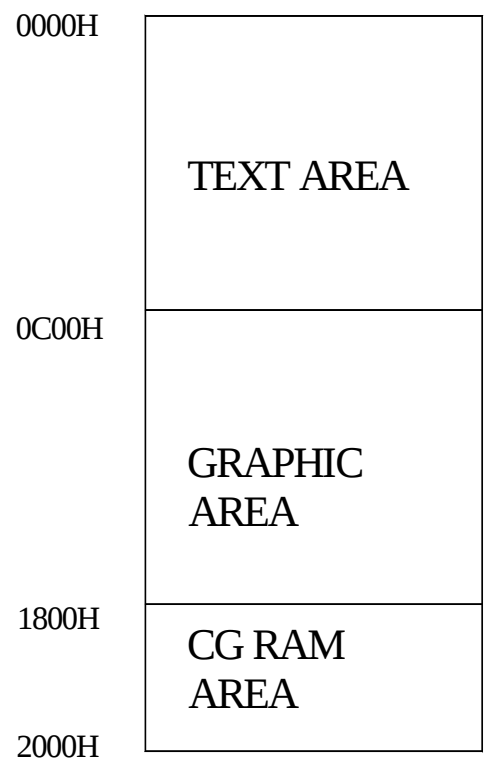
# 10. Display control instruction

The LCD Module has built in a T6963C 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 T6963C 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 T6963C 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.

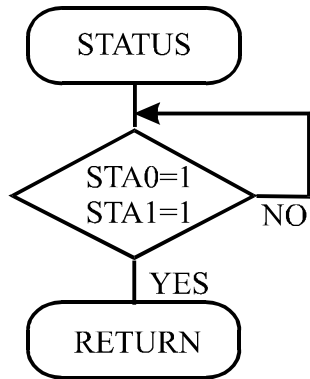
There is a possibility of erroneous operation due to a hardware interrupt.

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

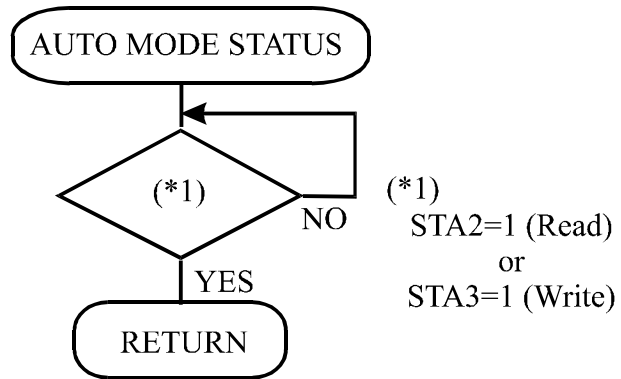
(Note 3) STA2 and STA3 are valid in Auto mode; STA0 and STA1 are invalid.

## 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 T6963C 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 T6963C during this period, the T6963C enters Wait status.

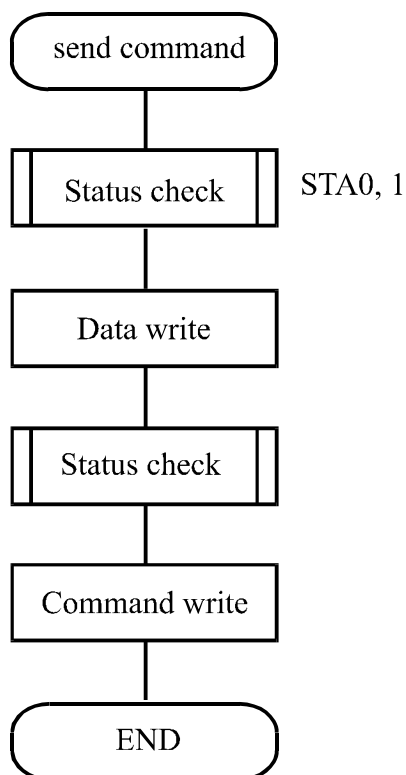
If a status check is not carried out in this state before the next command is sent, there is the possibility that the command or data data will not be received.

## (2)Setting date

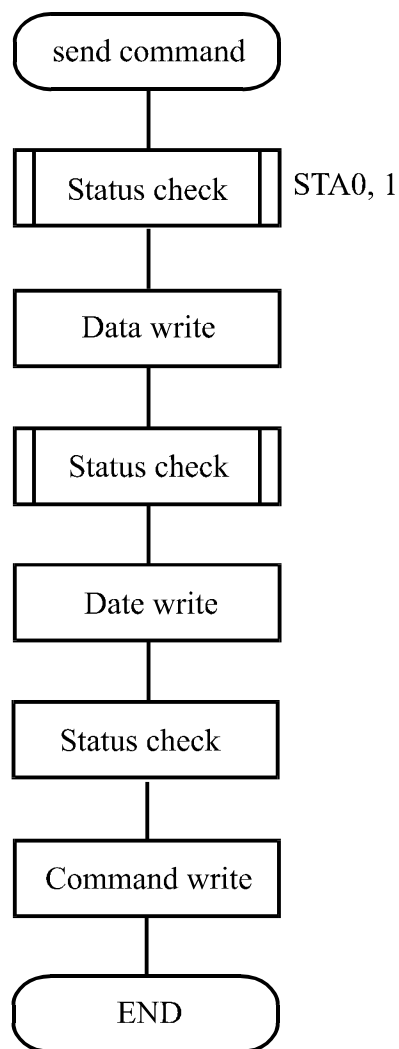
When using the T6963C, first set the data, then set the command.

### 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.

## □ 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              | 1000×000  | <input type="checkbox"/> | <input type="checkbox"/> | OR mode                         |
|                       | 1000×001  | <input type="checkbox"/> | <input type="checkbox"/> | EXOR mode                       |
|                       | 1000×011  | <input type="checkbox"/> | <input type="checkbox"/> | AND mode                        |
|                       | 1000×100  | <input type="checkbox"/> | <input type="checkbox"/> | Text Attribute mode             |
|                       | 10000×××  | <input type="checkbox"/> | <input type="checkbox"/> | Internal CG ROM mode            |
|                       | 10001×××  | <input type="checkbox"/> | <input type="checkbox"/> | External CG RAM mode            |
| DISPLAY MODE          | 10010000  | <input type="checkbox"/> | <input type="checkbox"/> | Display off                     |
|                       | 1001××10  | <input type="checkbox"/> | <input type="checkbox"/> | Cursor on, blink off            |
|                       | 10001××11 | <input type="checkbox"/> | <input type="checkbox"/> | Cursor on, blink on             |
|                       | 100101××  | <input type="checkbox"/> | <input type="checkbox"/> | Text on, graphic off            |
|                       | 100110××  | <input type="checkbox"/> | <input type="checkbox"/> | Text off, graphic on            |
|                       | 100111××  | <input type="checkbox"/> | <input type="checkbox"/> | Text on, graphic on             |
| CURSOR PATTERN SELECT | 10100000  | <input type="checkbox"/> | <input type="checkbox"/> | 1-line cursor                   |
|                       | 10100001  | <input type="checkbox"/> | <input type="checkbox"/> | 2-line cursor                   |
|                       | 10100010  | <input type="checkbox"/> | <input type="checkbox"/> | 3-line cursor                   |
|                       | 10100011  | <input type="checkbox"/> | <input type="checkbox"/> | 4-line cursor                   |
|                       | 10100100  | <input type="checkbox"/> | <input type="checkbox"/> | 5-line cursor                   |
|                       | 10100101  | <input type="checkbox"/> | <input type="checkbox"/> | 6-line cursor                   |
|                       | 10100110  | <input type="checkbox"/> | <input type="checkbox"/> | 7-line cursor                   |
|                       | 10100111  | <input type="checkbox"/> | <input type="checkbox"/> | 8-line cursor                   |
| DATA AUTO READ/WRITE  | 10110000  | <input type="checkbox"/> | <input type="checkbox"/> | Set Data Auto Write             |
|                       | 10110001  | <input type="checkbox"/> | <input type="checkbox"/> | Set Data Auto Read              |
|                       | 10110010  | <input type="checkbox"/> | <input type="checkbox"/> | Auto Reset                      |
| DATA READ/WRITE       | 11000000  | Data                     | <input type="checkbox"/> | Data Write and Increment ADP    |
|                       | 11000001  | <input type="checkbox"/> | <input type="checkbox"/> | Data Read and Increment ADP     |
|                       | 11000010  | Data                     | <input type="checkbox"/> | Data Write and Decrement ADP    |
|                       | 11000011  | <input type="checkbox"/> | <input type="checkbox"/> | Data Read and Decrement ADP     |
|                       | 11000100  | Data                     | <input type="checkbox"/> | Data Write and Non-variable ADP |
|                       | 11000101  | <input type="checkbox"/> | <input type="checkbox"/> | Data Read and Non-variable ADP  |
| SCREEN PEEK           | 11100000  | <input type="checkbox"/> | <input type="checkbox"/> | Screen Peek                     |
| SCREEN COPY           | 11101000  |                          |                          | Screen Copy                     |
| BIT SET/RESET         | 11110×××  | <input type="checkbox"/> | <input type="checkbox"/> | Bit Reset                       |
|                       | 11111×××  | <input type="checkbox"/> | <input type="checkbox"/> | Bit Set                         |
|                       | 1111×000  | <input type="checkbox"/> | <input type="checkbox"/> | Bit 0 (LSB)                     |
|                       | 11111×001 | <input type="checkbox"/> | <input type="checkbox"/> | Bit 1                           |
|                       | 11111×010 | <input type="checkbox"/> | <input type="checkbox"/> | Bit 2                           |
|                       | 11111×011 | <input type="checkbox"/> | <input type="checkbox"/> | Bit 3                           |
|                       | 11111×100 | <input type="checkbox"/> | <input type="checkbox"/> | Bit 4                           |
|                       | 11111×101 | <input type="checkbox"/> | <input type="checkbox"/> | Bit 5                           |

|  |           |                          |                          |             |
|--|-----------|--------------------------|--------------------------|-------------|
|  | 11111×110 | <input type="checkbox"/> | <input type="checkbox"/> | Bit 6       |
|  | 11111×111 | <input type="checkbox"/> | <input type="checkbox"/> | Bit 7 (MSB) |

X: invalid

#### ☐ Setting registers

| CODE     | HEX. | FUNCTION            | D1       | D2        |
|----------|------|---------------------|----------|-----------|
| 00100001 | 21H  | SET CURSOR POINTER  | X ADRS   | Y ADRS    |
| 00100010 | 23H  | 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

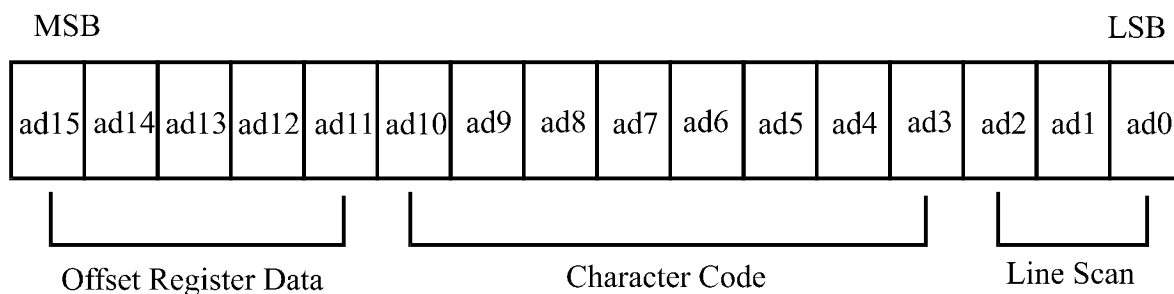
X ADRS 00 to 4FH

Y ADRS 00H to 0FH

#### (2) Set Offset Register

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

The T6963C has a 16-bit address bus as follows.



T6963C 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”

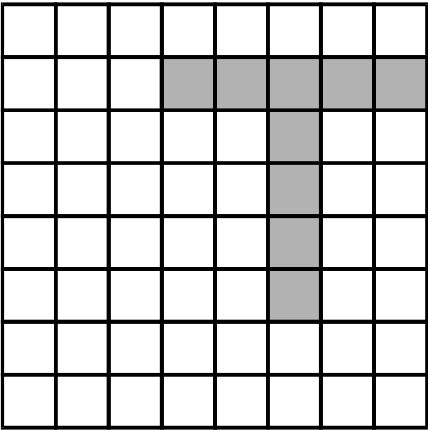
characters. In external CG ROM mode, all 256 codes from 00H to FFH can be used to represent the user’s own characters. The three least significant bits indicate one of the eight rows of eight dots that define the character’s shape.

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

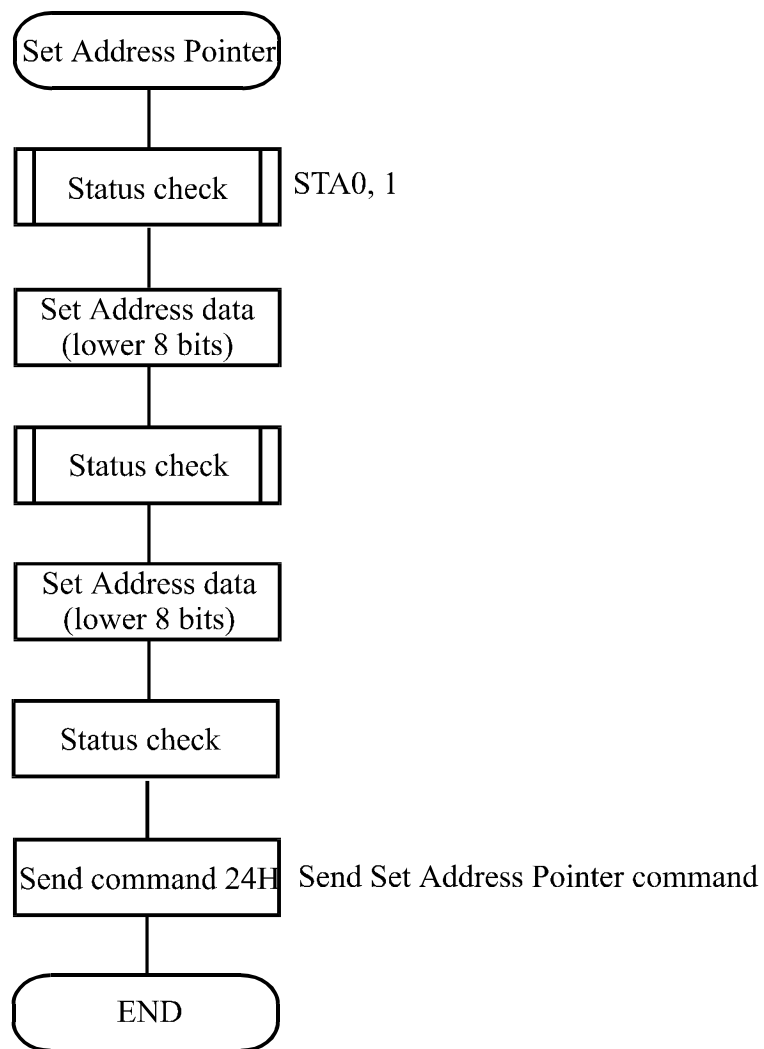
|                   | (RAM DATA) | (Character) |
|-------------------|------------|-------------|
| AB γ DE ζ GHIJKLM | 21H        | A           |
| .                 | 22H        | B           |
| .                 | 83H        | γ           |
| .                 | 24H        | D           |
| .                 | 25H        | E           |
| .                 | 86H        | ζ           |
| Display character |            |             |

□ and □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 | <input type="checkbox"/> 0000H      |
| Graphic area         | <input type="checkbox"/> 0020H      |
|                      | <input type="checkbox"/> 32 Columns |
|                      | <input type="checkbox"/> 2 Lines    |





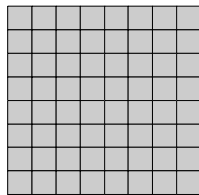
If the graphic area setting is set to match the desired number of columns on the LCD, the addressing scheme will be automatically modified so the start address of each line equals the end address of the previous line +1. ☐ Mode set

| CODE     | FUNCTION                          | OPERAND                  |
|----------|-----------------------------------|--------------------------|
| 1000×000 | OR Mode                           | <input type="checkbox"/> |
| 1000×001 | EXOR Mode                         | <input type="checkbox"/> |
| 1000×011 | AND Mode                          | <input type="checkbox"/> |
| 1000×100 | TEXT ATTRIBUTE Mode               | <input type="checkbox"/> |
| 10000××× | Internal Character Generator Mode | <input type="checkbox"/> |
| 10001××× | External Character Generator Mode | <input type="checkbox"/> |

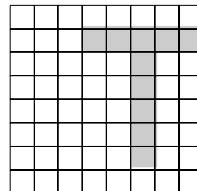
X: invalid

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.

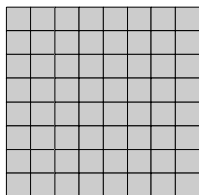
(Example)



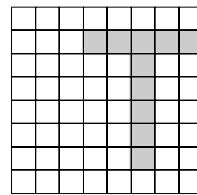
GRAPHIC



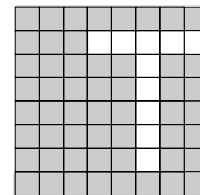
TEXT



“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

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.

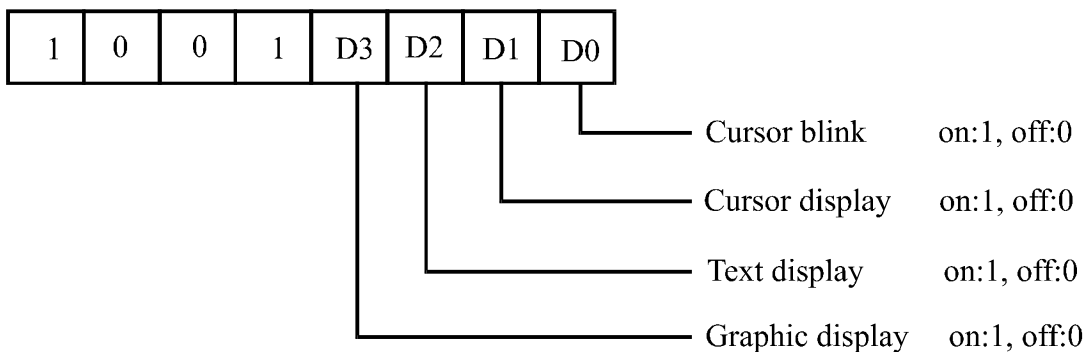
|   |   |   |   |    |    |    |    |
|---|---|---|---|----|----|----|----|
| x | x | x | x | d3 | d2 | d1 | d0 |
|---|---|---|---|----|----|----|----|

| 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

| CODE     | FUNCTION             | OPERAND                  |
|----------|----------------------|--------------------------|
| 10010000 | Display off          | <input type="checkbox"/> |
| 1001××10 | Cursor on, blink off | <input type="checkbox"/> |
| 1001××11 | Cursor on, blink on  | <input type="checkbox"/> |
| 100101×× | Text on, graphic off | <input type="checkbox"/> |
| 100110×× | Text off, graphic on | <input type="checkbox"/> |
| 100111×× | Text on, graphic on  | <input type="checkbox"/> |

X: invalid



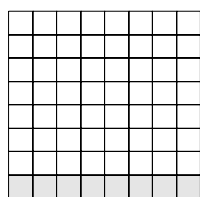
- a) Combination of text/graphic display
- b) Attribute function

☐ Cursor pattern select

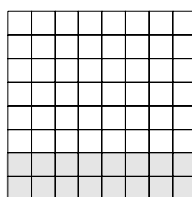
| CODE     | FUNCTION      | OPERAND                  |
|----------|---------------|--------------------------|
| 10100000 | 1-line cursor | <input type="checkbox"/> |
| 10100001 | 2-line cursor | <input type="checkbox"/> |
| 10100010 | 3-line cursor | <input type="checkbox"/> |
| 10100011 | 4-line cursor | <input type="checkbox"/> |
| 10100100 | 5-line cursor | <input type="checkbox"/> |
| 10100101 | 6-line cursor | <input type="checkbox"/> |
| 10100110 | 7-line cursor | <input type="checkbox"/> |
| 10100111 | 8-line cursor | <input type="checkbox"/> |

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

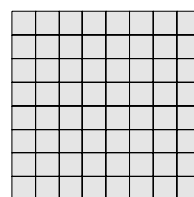
The cursor address is defined by the Cursor Pointer Set command.



1-line cursor



2-line cursor



8-line cursor

☐ Data Auto Read/Write

| CODE     | HEX. | FUNCTION            | OPERAND                  |
|----------|------|---------------------|--------------------------|
| 10110000 | B0H  | Set Data Auto Write | <input type="checkbox"/> |
| 10110001 | B1H  | Set Data Auto Read  | <input type="checkbox"/> |
| 10110010 | B2H  | Auto Reset          | <input type="checkbox"/> |

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 need not be sent between each datum. A Data Auto Write (or Read) command must be sent after a Set Address Pointer

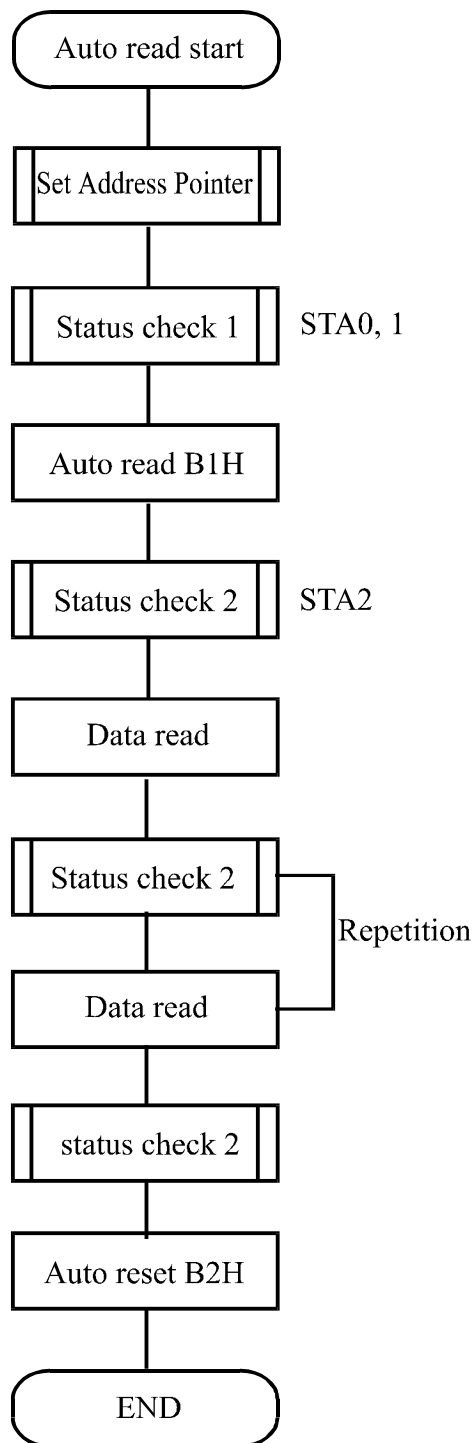
cannot accept any other commands.

The Auto Reset command must be sent to the T69963C after all data has been sent, to clear Auto mode.

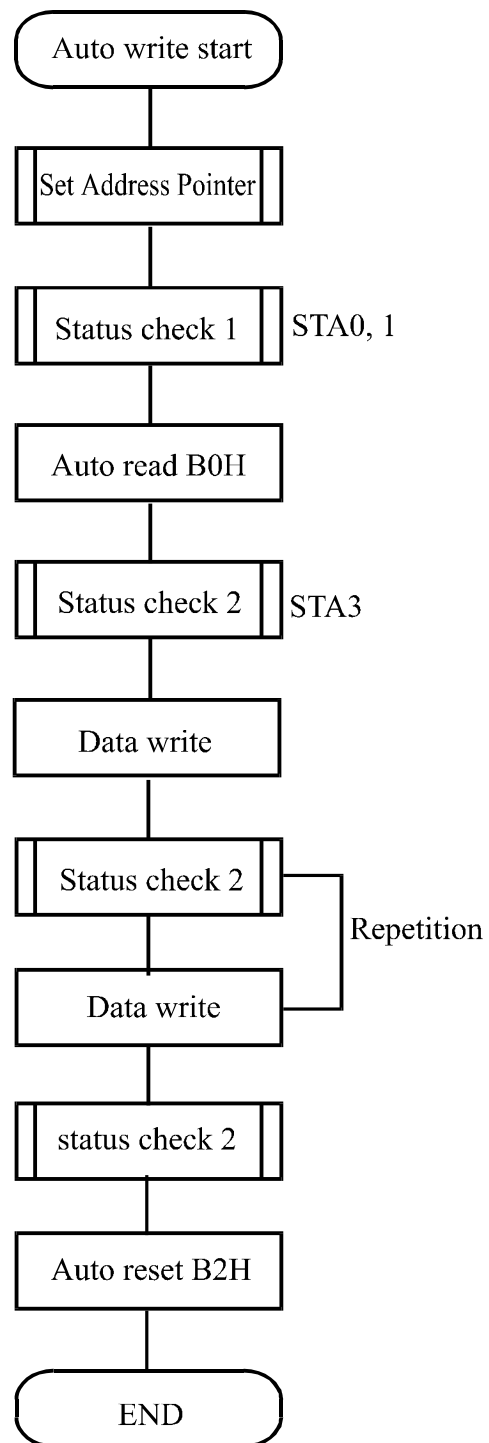
(Note) A Status check for Auto mode

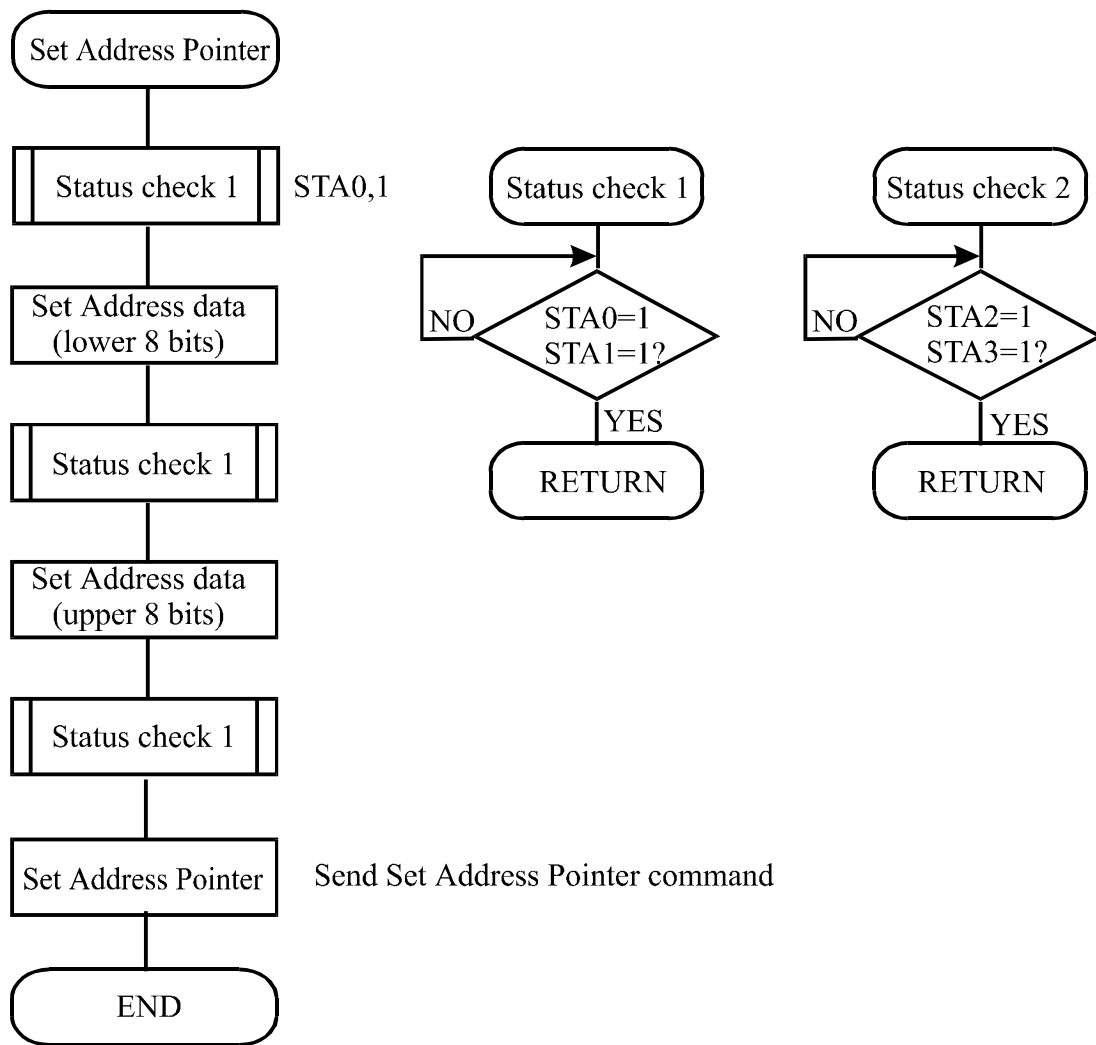
(STA2, STA3 should be checked between sending of each datum. Auto Reset should be performed after checking STA3=1 (STA2=1.) Refer to the following flowchart.

a) Auto Read mode



b) Auto Write mode





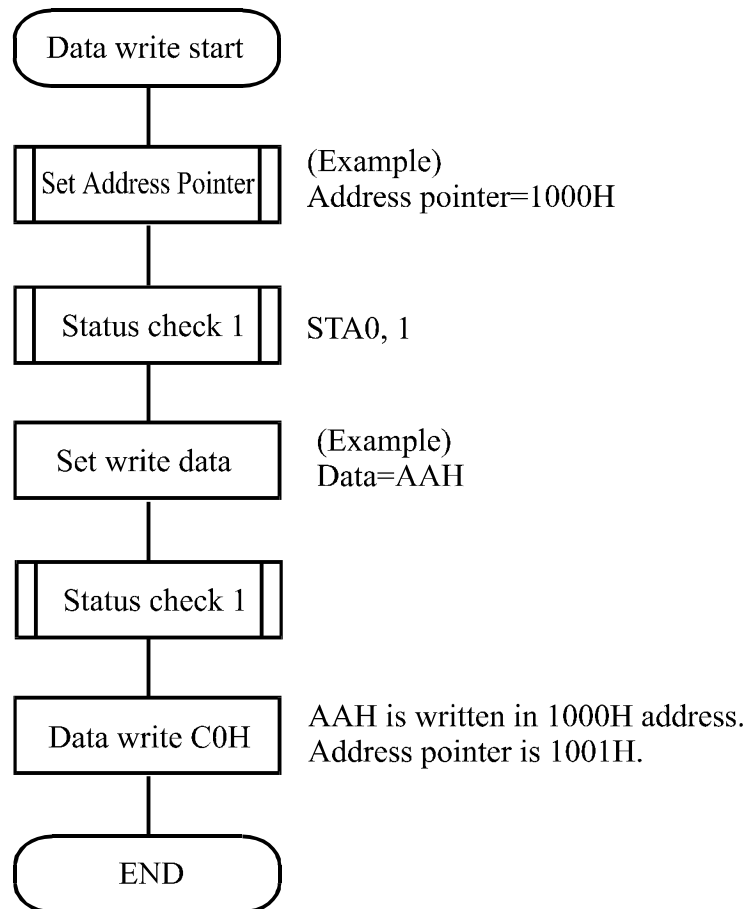
□Data Read/Write

| 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 Read 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 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.



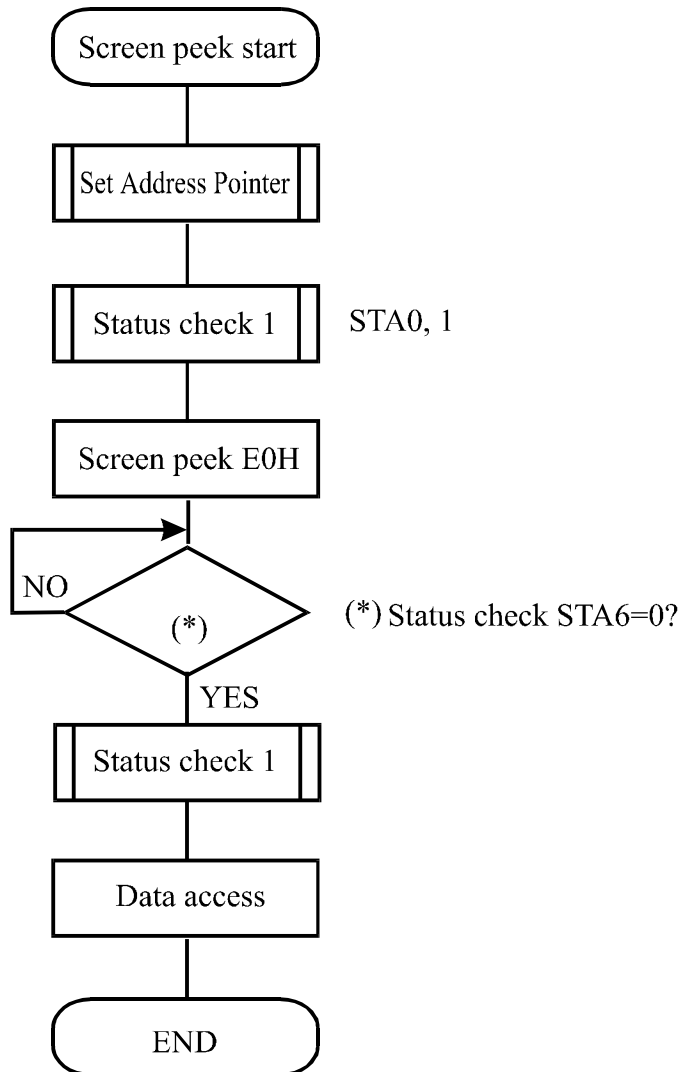
## □ Screen Peek

| 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 | □       |

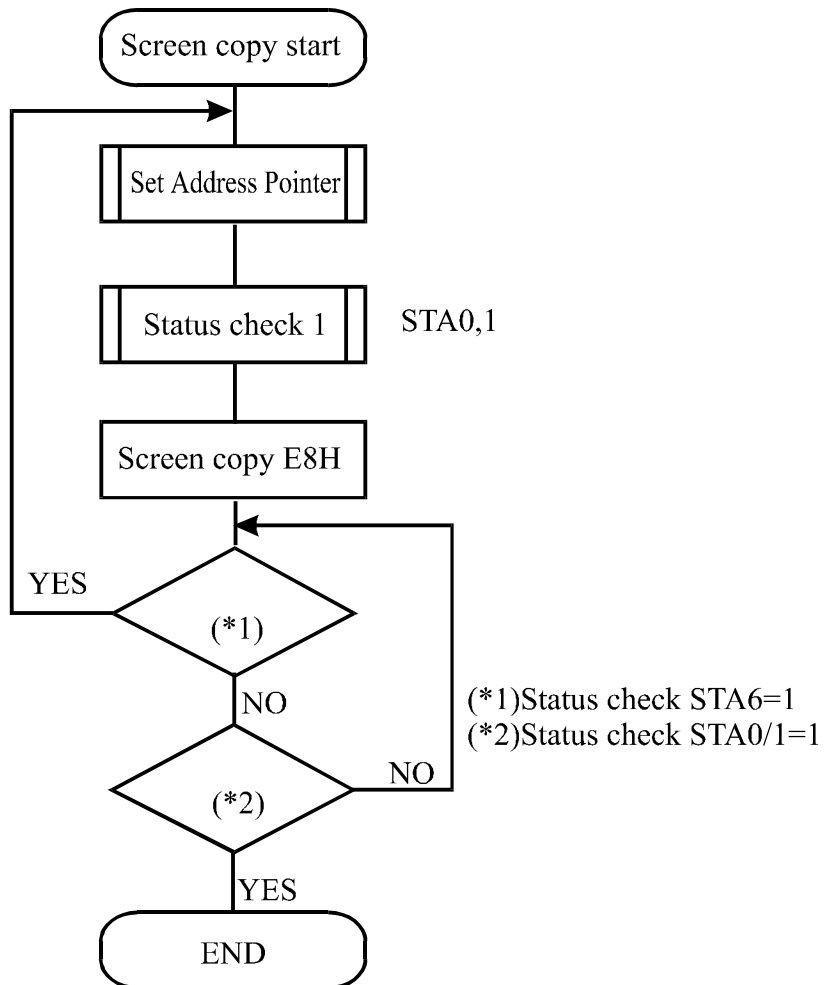
This command copies a single raster line of data to the graphic area.

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 |
|------|----------|---------|
|------|----------|---------|

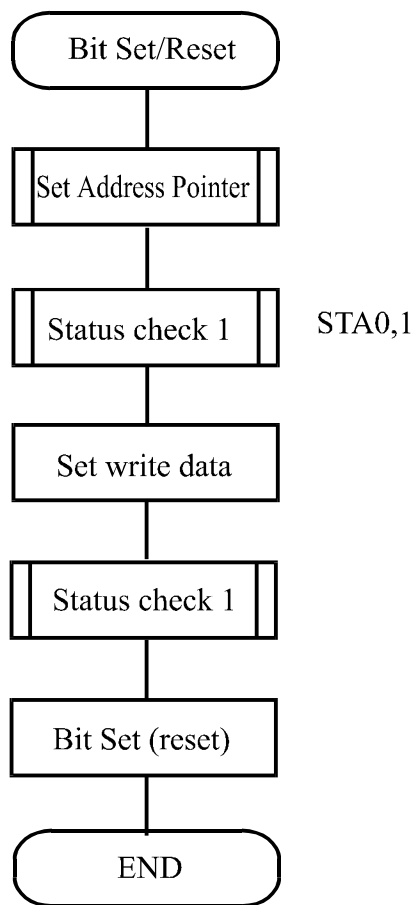
|          |             |                          |
|----------|-------------|--------------------------|
| 11110××× | Bit Reset   | <input type="checkbox"/> |
| 11111××× | Bit Set     | <input type="checkbox"/> |
| 1111×000 | Bit 0 (LSB) | <input type="checkbox"/> |
| 1111×001 | Bit 1       | <input type="checkbox"/> |
| 1111×010 | Bit 2       | <input type="checkbox"/> |
| 1111×011 | Bit 3       | <input type="checkbox"/> |
| 1111×100 | Bit 4       | <input type="checkbox"/> |
|          |             |                          |
| 1111×101 | Bit 5       | <input type="checkbox"/> |
| 1111×110 | Bit 6       | <input type="checkbox"/> |
| 1111×111 | Bit 7 (MSB) | <input type="checkbox"/> |

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.



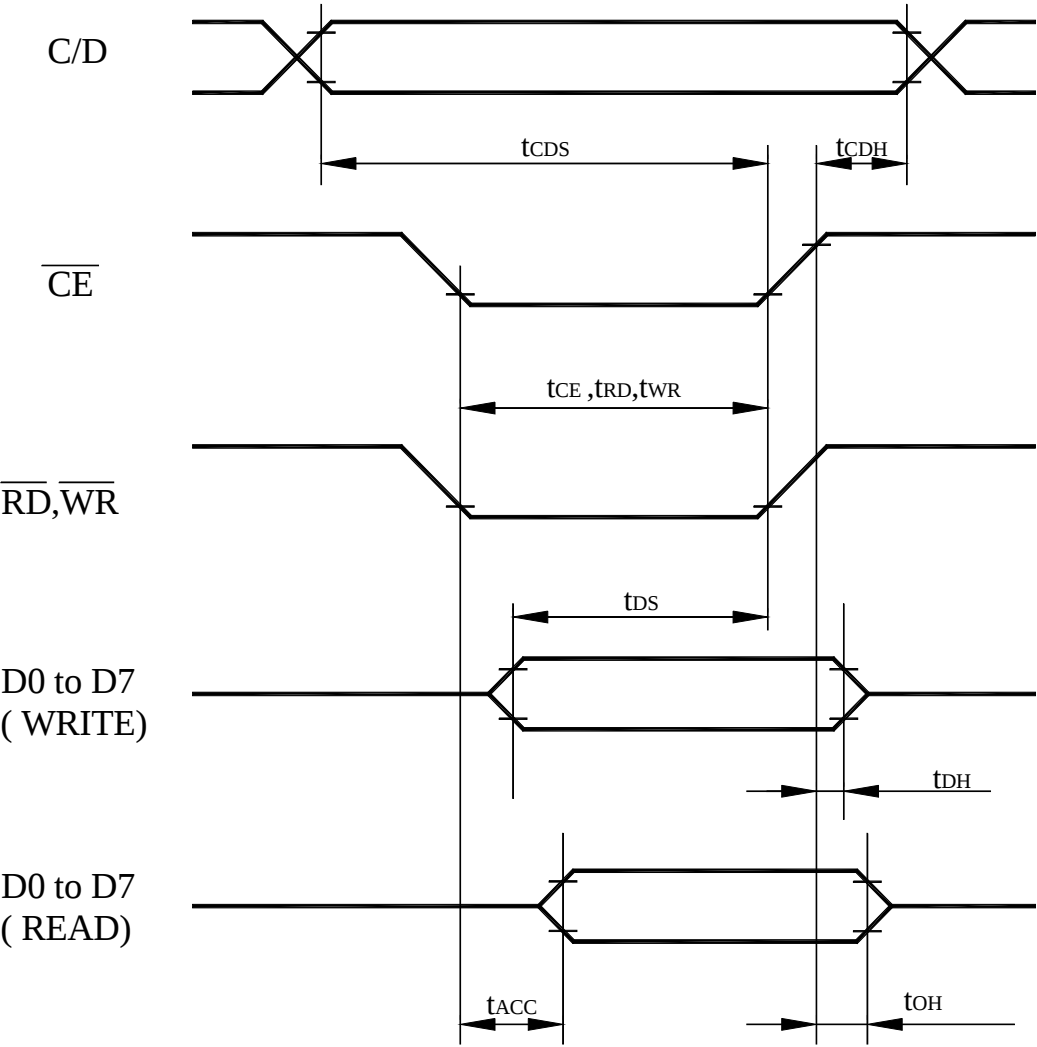
# CHARACTER CODE MAP

| 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    |
| LHHL                             | e    | f    | g    | h    | i    | j    | k    | l    |
| LHHH                             | m    | n    | o    | p    | q    | r    | s    | t    |
| HLLL                             | u    | v    | w    | x    | y    | z    | {    | }    |
| HLLH                             | ~    |      |      |      |      |      |      |      |
| HLHL                             |      |      |      |      |      |      |      |      |
| HLHH                             |      |      |      |      |      |      |      |      |
| HHLL                             |      |      |      |      |      |      |      |      |
| HHLH                             |      |      |      |      |      |      |      |      |
| HHHL                             |      |      |      |      |      |      |      |      |
| HHHH                             |      |      |      |      |      |      |      |      |

# 11.Timing Characteristics

Bus Timing  
( V<sub>ss</sub> = 0 V , V<sub>DD</sub> = 5 V )

| Item                 | Symbol       | Min | Typ | Max | Unit |
|----------------------|--------------|-----|-----|-----|------|
| C/D Set-up Time      | tCDS         | 100 | □   | □   | ns   |
| C/D Hold Time        | tCDH         | 10  | □   | □   | ns   |
| CE,RD,WR Pulse Width | tCDS,tRD,tWR | 80  | □   | □   | ns   |
| Data Set-up Time     | tDS          | 80  | □   | □   | ns   |
| Data Hold Time       | tDH          | 40  | □   | □   | ns   |
| Access Time          | tACC         | □   | □   | 150 | ns   |
| Output Hold Time     | tOH          | 10  | □   | 50  | ns   |



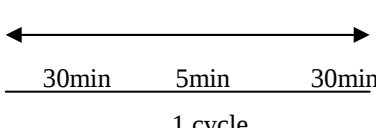
## 12. Quality Assurance

### Screen Cosmetic Criteria

| No.           | Defect                        | Judgement Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Partition  |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
|---------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------------------------|---------|-----------|---------------|---|---------------|---|---------|---|------------|-------------------------------|---------|-----------|---------------|---|---------------|---|---------|---|-------|
| 1             | Spots                         | <p>A) Clear</p> <table><thead><tr><th>Size: d mm</th><th>Acceptable Qty in active area</th></tr></thead><tbody><tr><td>d ≤ 0.1</td><td>Disregard</td></tr><tr><td>0.1 &lt; d ≤ 0.2</td><td>6</td></tr><tr><td>0.2 &lt; d ≤ 0.3</td><td>2</td></tr><tr><td>0.3 &lt; d</td><td>0</td></tr></tbody></table> <p>Note: Including pin holes and defective dots which must be within one pixel size.</p> <p>B) Unclear</p> <table><thead><tr><th>Size: d mm</th><th>Acceptable Qty in active area</th></tr></thead><tbody><tr><td>d ≤ 0.2</td><td>Disregard</td></tr><tr><td>0.2 &lt; d ≤ 0.5</td><td>6</td></tr><tr><td>0.5 &lt; d ≤ 0.7</td><td>2</td></tr><tr><td>0.7 &lt; d</td><td>0</td></tr></tbody></table> | Size: d mm | Acceptable Qty in active area | d ≤ 0.1 | Disregard | 0.1 < d ≤ 0.2 | 6 | 0.2 < d ≤ 0.3 | 2 | 0.3 < d | 0 | Size: d mm | Acceptable Qty in active area | d ≤ 0.2 | Disregard | 0.2 < d ≤ 0.5 | 6 | 0.5 < d ≤ 0.7 | 2 | 0.7 < d | 0 | Minor |
| Size: d mm    | Acceptable Qty in active area |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| d ≤ 0.1       | Disregard                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 0.1 < d ≤ 0.2 | 6                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 0.2 < d ≤ 0.3 | 2                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 0.3 < d       | 0                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| Size: d mm    | Acceptable Qty in active area |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| d ≤ 0.2       | Disregard                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 0.2 < d ≤ 0.5 | 6                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 0.5 < d ≤ 0.7 | 2                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 0.7 < d       | 0                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 2             | Bubbles in Polarizer          | <table><thead><tr><th>Size: d mm</th><th>Acceptable Qty in active area</th></tr></thead><tbody><tr><td>d ≤ 0.3</td><td>Disregard</td></tr><tr><td>0.3 &lt; d ≤ 1.0</td><td>3</td></tr><tr><td>1.0 &lt; d ≤ 1.5</td><td>1</td></tr><tr><td>1.5 &lt; d</td><td>0</td></tr></tbody></table>                                                                                                                                                                                                                                                                                                                                                                                                                     | Size: d mm | Acceptable Qty in active area | d ≤ 0.3 | Disregard | 0.3 < d ≤ 1.0 | 3 | 1.0 < d ≤ 1.5 | 1 | 1.5 < d | 0 | Minor      |                               |         |           |               |   |               |   |         |   |       |
| Size: d mm    | Acceptable Qty in active area |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| d ≤ 0.3       | Disregard                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 0.3 < d ≤ 1.0 | 3                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 1.0 < d ≤ 1.5 | 1                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 1.5 < d       | 0                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 3             | Scratch                       | In accordance with spots cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Minor      |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 4             | Allowable Density             | Above defects should be separated more than 30mm each other.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Minor      |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |
| 5             | Coloration                    | <p>Not to be noticeable coloration in the viewing area of the LCD panels.</p> <p>Back-light type should be judged with back-light on state only.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Minor      |                               |         |           |               |   |               |   |         |   |            |                               |         |           |               |   |               |   |         |   |       |

# 13. 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>200hrs                          | —                   |
| 2                  | Low Temperature storage              | Endurance test applying the high storage temperature for a long time.                                                                                                                                                                                                                                              | -30□<br>200hrs                         | —                   |
| 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>200hrs                          | —                   |
| 4                  | Low Temperature Operation            | Endurance test applying the electric stress under low temperature for a long time.                                                                                                                                                                                                                                 | -20□<br>200hrs                         | —                   |
| 5                  | High Temperature/ Humidity Storage   | Endurance test applying the high temperature and high humidity storage for a long time.                                                                                                                                                                                                                            | 80□,90%RH<br>96hrs                     | —                   |
| 6                  | High Temperature/ Humidity Operation | Endurance test applying the electric stress (Voltage & Current) and temperature / humidity stress to the element for a long time.                                                                                                                                                                                  | 70□,90%RH<br>96hrs                     | —                   |
| 7                  | Temperature Cycle                    | Endurance test applying the low and high temperature cycle.<br><div style="text-align: center;">             -30□      25□      80□<br/> <br/>             30min      5min      30min<br/>             1 cycle           </div> | -30□/80□<br>10 cycles                  | —                   |
| Mechanical Test    |                                      |                                                                                                                                                                                                                                                                                                                    |                                        |                     |
| 8                  | Vibration test                       | Endurance test applying the vibration during transportation and using.                                                                                                                                                                                                                                             | 10~55Hz□1.5mmp-p<br>Total 0.5hrs       | —                   |
| Others             |                                      |                                                                                                                                                                                                                                                                                                                    |                                        |                     |
| 9                  | Static electricity test              | Endurance test applying the electric stress to the terminal.                                                                                                                                                                                                                                                       | VS=800V,RS=1.5k□<br>CS=100pF<br>1 time | —                   |

\*\*\*Supply voltage for logic system=5V. Supply voltage for LCD system = Operating voltage at 25

## 14. Backlight Information

### 14.1 Specification

| PARAMETER          | SYMBOL           | MIN | TYP  | MAX  | UNIT              | TEST CONDITION          |
|--------------------|------------------|-----|------|------|-------------------|-------------------------|
| Supply Current     | I <sub>LED</sub> | 800 | 900  | 1350 | mA                | V=4.2V                  |
| Supply Voltage     | V                | 4.0 | 4.2  | 4.4  | V                 |                         |
| Reverse Voltage    | V <sub>R</sub>   |     |      | 8    | V                 |                         |
| Luminous Intensity | I <sub>V</sub>   | 160 | 200  |      | CD/M <sup>2</sup> | I <sub>LED</sub> =900mA |
| Life Time          |                  |     | 100K |      | Hr.               | I <sub>LED</sub> 900mA  |
| Color              | YELLOW/GREEN     |     |      |      |                   |                         |

**Note: The LED of B/L is drive by current only, drive voltage is for reference only.  
drive voltage can make driving current under safety area (current between  
minimum and maximum).**