



# **ORIENT DISPLAY**

Your Total LCD Solution Provider

## Specification for LCD Module

### **AMC1602AR-B-B6WTDW-STY**



Revision A

|      |   |
|------|---|
| AM   | Orient Display  |
| C    | Character Type  |
| 1602 | 16 Characters x 02 Lines                                  |
| A    | Serial A, Module Dimension 80.0 x 36.0 x 14.0 (max)       |
| R    | RoHS Compliant  |
| B    | COB Type  |
| B    | STN Negative Blue<br>(White Character on Blue Background) |
| 6    | 6 o'clock Viewing Direction                               |
| W    | Top: -20~+70°C; Tstr: -30~+80°C                           |
| T    | Transmissive  |
| D    | LED Backlight   |
| W    | White Backlight   |
| /    | Controller ST7066U-0A-BB or equivalent                    |
| /    | Parallel Interface  |



DOCUMENT REVISION HISTORY:

| DATE    | PAGE | DESCRIPTION                   |
|---------|------|-------------------------------|
| 1999.8. | -    | First release                 |
| 2005.3. | -    | Modify the full specification |

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# 1. Module Classification Information

**AMC 1602AR - B - B 6 WTDW - STY**

1 2 3 4 5 6 7 8 9 10 11 12 13

|    |  |  |
|----|--|--|
| 1  | Brand: Orient Display  |  |
| 2  | Display Type: C→ Character Type, G→ Graphic Type,<br>NONE→ Custom-made |  |
| 3  | Display Font: Characters X Lines / Rows X Columns /Others              |  |
| 4  | Model serials no.  |  |
| 5  | RoHS compliant: R→YES NONE→ NO   |  |
| 6  | IC Package Type:   | M→ SMT Type<br>B→ COB Type<br>T→ TAB Type<br>G→ COG Type<br>F→ COF Type<br>S→ Special  |
| 7  | LCD Mode:  | P→TN Positive<br>N→TN Negative<br>Y→ STN Positive, Yellow Green<br>B→ STN Negative, Blue<br>G→ STN Positive, Gray<br>W→ FSTN Positive<br>T→ FSTN Negative<br>F→ FFSTN Negative<br>S→ Special |
| 8  | Viewing direction  | 6→ 6:00,12→12:00, S→Special  |
| 9  | Temperature range  | N → Normal Temperature<br>W→ Wide Temperature<br>S→ Special  |
| 10 | LCD Polarizer Type   | R→ Reflective<br>T→ Transmissive<br>F→ Transflective<br>S→ Special   |
| 11 | Backlight Type   | N→ None<br>D→ LED<br>E→ EL<br>F→ CCFL<br>S→ Special  |
| 12 | Backlight Color  | Y→ Yellow-green<br>B→ Blue<br>A→ Amber<br>W→ White<br>G→ Green<br>R→ Red<br>S→ Special   |
| 13 | IC Brand   | STY:SITRONIX   |

## **2. 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.

## **3. General Specification**

| <b>Item</b>                           | <b>Dimension</b>               | <b>Unit</b> |
|---------------------------------------|--------------------------------|-------------|
| Number of Characters                  | 16 characters x 2 Lines        | —           |
| Module dimension(With LED Backlight ) | 80.0 x 36.0 x 14.0 (MAX)       | mm          |
| View area                             | 64.5 x 15.5                    | mm          |
| Active area                           | 56.20 x 11.50                  | mm          |
| Dot size                              | 0.55x 0.65                     | mm          |
| Dot pitch                             | 0.60 x 0.70                    | mm          |
| Character size                        | 2.95 x 5.55                    | mm          |
| Character pitch                       | 3.55 x 5.95                    | mm          |
| LCD type                              | STN,BLUE,NEGATIVE,TRANSMISSIVE |             |
| Duty                                  | 1/16                           |             |
| View direction                        | 6 o'clock                      |             |
| Backlight Type                        | WHITE LED backlight            |             |

## 4. Absolute Maximum Ratings

| Item                     |                 | Symbol          | Min           | Max          | Unit |
|--------------------------|-----------------|-----------------|---------------|--------------|------|
| Input Voltage            |                 | $V_I$           | -0.3          | $V_{DD}+0.3$ | V    |
| Supply Voltage For Logic |                 | $V_{DD}-V_{SS}$ | -0.3          | 7.0          | V    |
| Supply Voltage For LCD   |                 | $V_{DD}-V_0$    | $V_{dd}-13.5$ | 0            | V    |
| Wide Temperature LCM     | Operating Temp. | $T_{op}$        | -20           | 70           | °C   |
|                          | Storage Temp.   | $T_{str}$       | -30           | 80           | °C   |

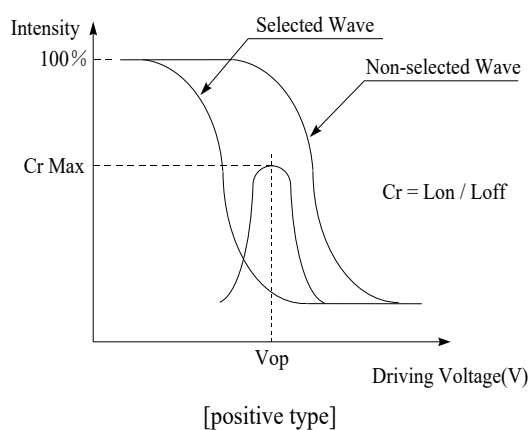
## 5. Electrical Characteristics

| Item                              | Symbol          | Condition  | Min          | Typ | Max          | Unit |
|-----------------------------------|-----------------|--|--------------|-----|--------------|------|
| Supply Voltage For Logic          | $V_{DD}-V_{SS}$ | —  | 4.5          | 5.0 | 5.5          | V    |
| Supply Voltage For LCD            | $V_{DD}-V_0$    | $T_a=25^{\circ}\text{C}$                           | 4.5          | 5.0 | 5.5          | V    |
| Input High Volt.                  | $V_{IH}$        | —  | $0.7 V_{DD}$ | —   | $V_{DD}$     | V    |
| Input Low Volt.                   | $V_{IL}$        | —  | $V_{SS}$     | —   | $0.3 V_{DD}$ | V    |
| Supply Current                    | $I_{DD}$        | $V_{DD}=5\text{V}$                                 | 0.8          | 1.2 | 1.5          | mA   |
| Supply Voltage of White backlight | $V_{LED}$       | Forward current =30 mA<br>Number of LED die 1x2= 2 | 3.8          | 4.1 | 4.3          | V    |

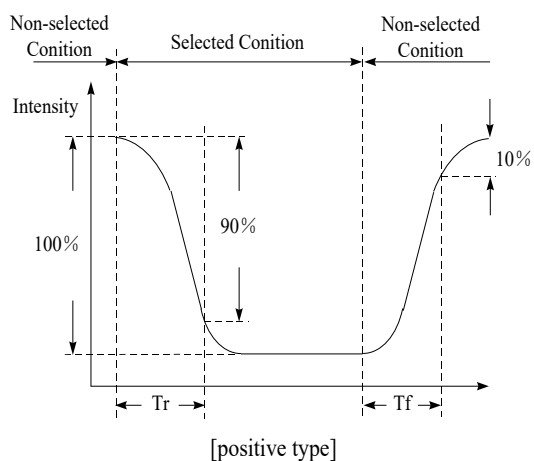
## 6. Optical Characteristics

| Item           | Symbol        | Condition   | Min | Typ | Max | Unit |
|----------------|---------------|-------------|-----|-----|-----|------|
| View Angle     | (V) $\theta$  | $CR \geq 2$ | -20 | —   | 35  | deg  |
|                | (H) $\varphi$ | $CR \geq 2$ | -30 | —   | 30  | deg  |
| Contrast Ratio | CR            | —           | —   | 3   | —   | —    |
| Response Time  | T rise        | —           | —   | —   | 250 | ms   |
|                | T fall        | —           | —   | —   | 250 | ms   |

### Definition of Operation Voltage (Vop)



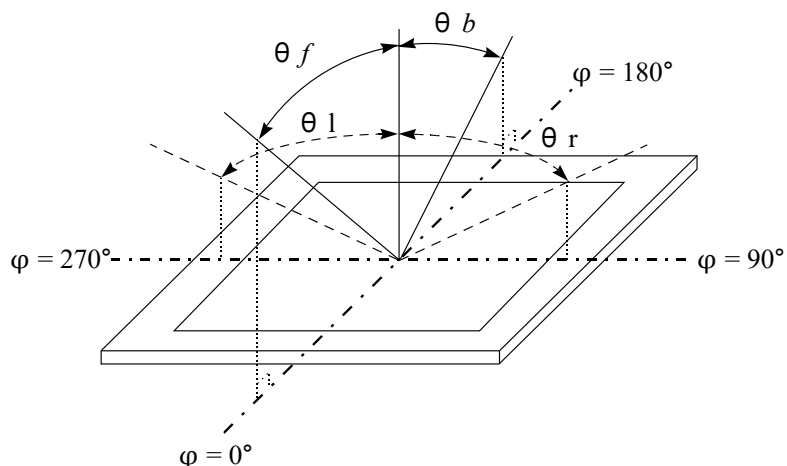
### Definition of Response Time (Tr, Tf)



### Conditions :

Operating Voltage : Vop      Viewing Angle( $\theta$ ,  $\varphi$ ) :  $0^\circ$ ,  $0^\circ$   
 Frame Frequency : 64 HZ      Driving Waveform : 1/N duty , 1/a bias

### Definition of viewing angle( $CR \geq 2$ )



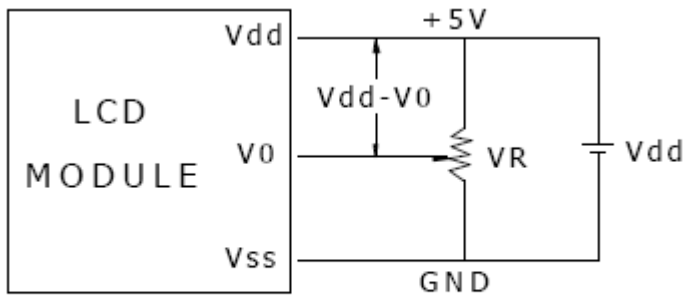
## **7. Interface Pin Function**

| <b>Pin No.</b> | <b>Symbol</b>   | <b>Level</b> | <b>Description</b>                       |
|----------------|-----------------|--------------|--|
| 1              | V <sub>SS</sub> | 0V           | Ground                                   |
| 2              | V <sub>DD</sub> | 5.0V         | Supply Voltage for logic                 |
| 3              | V <sub>0</sub>  | (Variable)   | Operating voltage for LCD                |
| 4              | RS              | H/L          | H: DATA, L: Instruction code             |
| 5              | R/W             | H/L          | H: Read(MPU→Module) L: Write(MPU→Module) |
| 6              | E               | H,H→L        | Chip enable signal                       |
| 7              | DB0             | H/L          | Data bit 0                               |
| 8              | DB1             | H/L          | Data bit 1                               |
| 9              | DB2             | H/L          | Data bit 2                               |
| 10             | DB3             | H/L          | Data bit 3                               |
| 11             | DB4             | H/L          | Data bit 4                               |
| 12             | DB5             | H/L          | Data bit 5                               |
| 13             | DB6             | H/L          | Data bit 6                               |
| 14             | DB7             | H/L          | Data bit 7                               |
| 15             | LED(+)          |              | Anode of LED Backlight                   |
| 16             | LED(-)          |              | Cathode of LED Backlight                 |



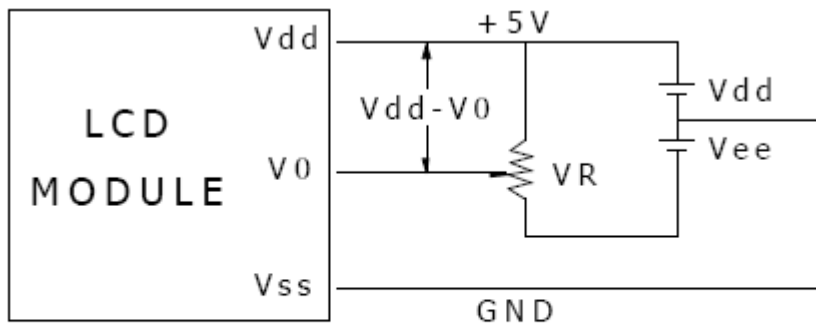
## 8. POWER SUPPLY

### SINGLE SUPPLY VOLTAGE TYPE



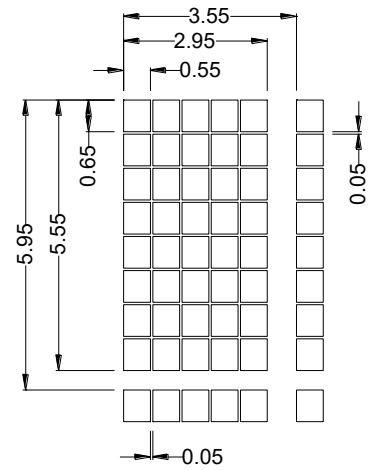
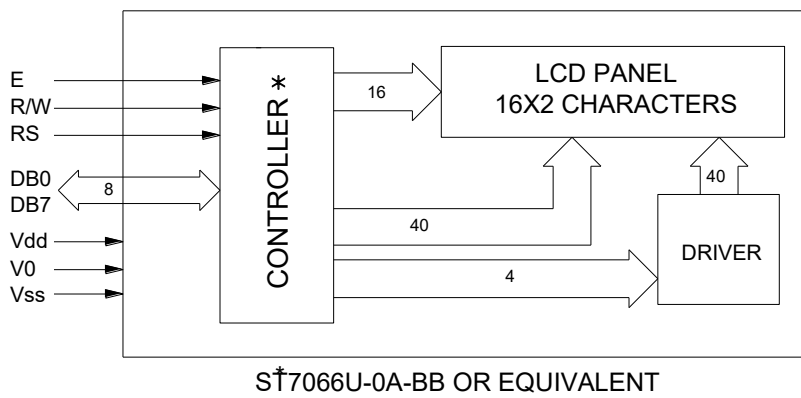
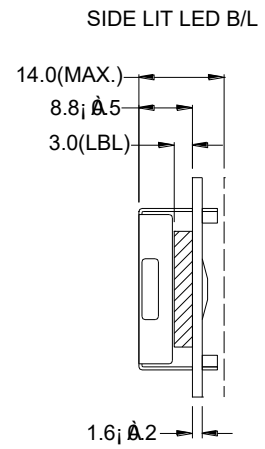
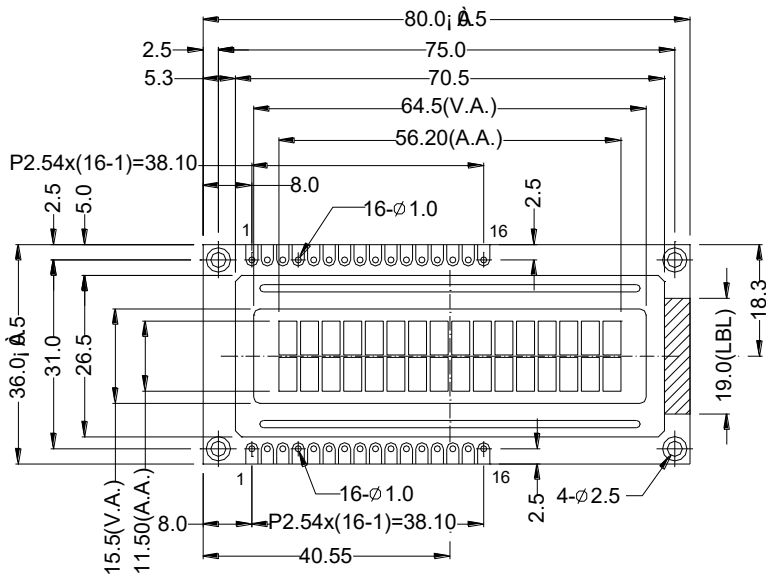
Vdd-V0: LCD Driving Voltage  
VR: 10K - 20K

### DUAL SUPPLY VOLTAGE TYPE



Vdd-V0: LCD Driving Voltage  
VR: 10K - 20K

# 9. Contour Drawing & Block Diagram



# 10. Function Description

The LCD display Module is built in a LSI controller, the controller has two 8-bit registers, an instruction register (IR) and a data register (DR).

The IR stores instruction codes, such as display clear and cursor shift, and address information for display data RAM (DDRAM) and character generator (CGRAM). The IR can only be written from the MPU. The DR temporarily stores data to be written or read from DDRAM or CGRAM. When address information is written into the IR, then data is stored into the DR from DDRAM or CGRAM. By the register selector (RS) signal, these two registers can be selected.

| RS | R/W | Operation   |
|----|-----|---|
| 0  | 0   | IR write as an internal operation (display clear, etc.) |
| 0  | 1   | Read busy flag (DB7) and address counter (DB0 to DB7)   |
| 1  | 0   | Write data to DDRAM or CGRAM (DR to DDRAM or CGRAM)     |
| 1  | 1   | Read data from DDRAM or CGRAM (DDRAM or CGRAM to DR)    |

### Busy Flag (BF)

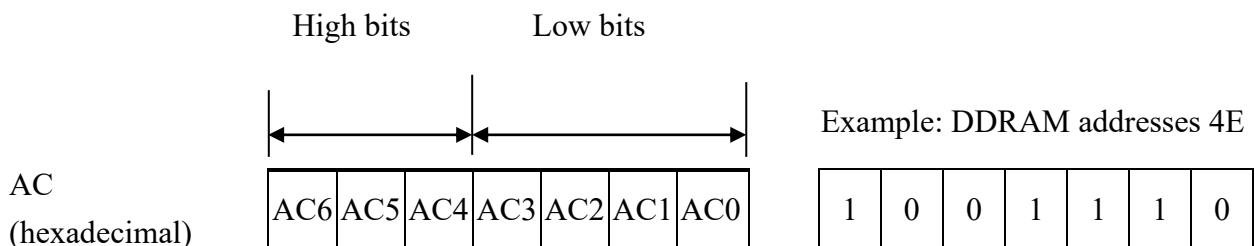
When the busy flag is 1, the controller LSI is in the internal operation mode, and the next instruction will not be accepted. When RS=0 and R/W=1, the busy flag is output to DB7. The next instruction must be written after ensuring that the busy flag is 0.

### Address Counter (AC)

The address counter (AC) assigns addresses to both DDRAM and CGRAM

### Display Data RAM (DDRAM)

This DDRAM is used to store the display data represented in 8-bit character codes. Its extended capacity is 80×8 bits or 80 characters. Below figure is the relationships between DDRAM addresses and positions on the liquid crystal display.



Display position DDRAM address

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F |
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F |

2-Line by 16-Character Display

**Character Generator ROM (CGROM)**

The CGROM generate 5×8 dot or 5×10 dot character patterns from 8-bit character codes. See Table 2.

**Character Generator RAM (CGRAM)**

In CGRAM, the user can rewrite character by program. For 5×8 dots, eight character patterns can be written, and for 5×10 dots, four character patterns can be written.

Write into DDRAM the character code at the addresses shown as the left column of table 1. To show the character patterns stored in CGRAM.

# Relationship between CGRAM Addresses, Character Codes (DDRAM) and Character patterns

**Table 1.**

For 5 \* 8 dot character patterns

| Character Codes ( DDRAM data ) |   |   |   |     |   |   |   | CGRAM Address |  |     |  | Character Patterns ( CGRAM data ) |   |   |   |     |  |   |  |                        |       |   |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|--------------------------------|---|---|---|-----|---|---|---|---------------|--|-----|--|-----------------------------------|---|---|---|-----|--|---|--|------------------------|-------|---|--|--|-------|---|---|---|--|--|--|--|----------------|-------|---|--|--|--|--|
| 7                              | 6 | 5 | 4 | 3   | 2 | 1 | 0 | 5             |  | 4   |  | 3                                 |   | 2 |   | 1   |  | 0 |  |                        |       |   |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
| High                           |   |   |   | Low |   |   |   | High          |  | Low |  | High                              |   |   |   | Low |  |   |  |                        |       |   |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
| 0 0 0 0 * 0 0 0                |   |   |   |     |   |   |   | 0 0 0         |  |     |  | 0 0 0                             | * | * | * |     |  |   |  | Character pattern( 1 ) |       |   |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 0 0 1                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 0 1 0                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 0 1 1                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 1 0 0                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 1 0 1                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 1 1 0                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 1 1 1                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 0 0 0                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 0 0 1                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
| 0 0 0 0 * 0 0 1                |   |   |   |     |   |   |   | 0 0 1         |  |     |  | 0 1 0                             | * | * | * |     |  |   |  | Character pattern( 2 ) |       |   |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 0 1 1                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 1 0 0                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 1 0 1                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 1 1 0                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 1 1 1                             | * | * | * |     |  |   |  |                        | 0 0 0 | 0 |  |  |       |   |   |   |  |  |  |  |                |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  | 0 0 0 0 * 1 1 1                   |   |   |   |     |  |   |  |                        | 1 1 1 |   |  |  | 1 0 0 | * | * | * |  |  |  |  | Cursor pattern |       |   |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  |                                   |   |   |   |     |  |   |  |                        |       |   |  |  | 1 0 1 | * | * | * |  |  |  |  |                | 0 0 0 | 0 |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  |                                   |   |   |   |     |  |   |  |                        |       |   |  |  | 1 1 0 | * | * | * |  |  |  |  |                | 0 0 0 | 0 |  |  |  |  |
|                                |   |   |   |     |   |   |   |               |  |     |  |                                   |   |   |   |     |  |   |  |                        |       |   |  |  | 1 1 1 | * | * | * |  |  |  |  |                | 0 0 0 | 0 |  |  |  |  |

For 5 \* 10 dot character patterns

| Character Codes ( DDRAM data ) |   |   |   |   |     |   |   |   |  | CGRAM Address |  |     |   |  | Character Patterns ( CGRAM data ) |   |   |   |   |     |  |  |  |                   |         |   |
|--------------------------------|---|---|---|---|-----|---|---|---|--|---------------|--|-----|---|--|-----------------------------------|---|---|---|---|-----|--|--|--|-------------------|---------|---|
| 7                              | 6 | 5 | 4 | 3 | 2   | 1 | 0 | 5 |  | 4             |  |     | 3 |  | 2                                 |   | 1 |   | 0 |     |  |  |  |                   |         |   |
| High                           |   |   |   |   | Low |   |   |   |  | High          |  | Low |   |  | High                              |   |   |   |   | Low |  |  |  |                   |         |   |
| 0 0 0 0 * 0 0 0                |   |   |   |   |     |   |   |   |  | 0 0           |  |     |   |  | 0 0 0 0                           | * | * | * |   |     |  |  |  | Character pattern |         |   |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 0 0 0 1                           | * | * | * |   |     |  |  |  |                   | 0 0 0 0 | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 0 0 1 0                           | * | * | * |   |     |  |  |  |                   | 0 0 0   | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 0 0 1 1                           | * | * | * |   |     |  |  |  |                   | 0 0 0   | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 0 1 0 0                           | * | * | * |   |     |  |  |  |                   | 0 0 0   | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 0 1 0 1                           | * | * | * |   |     |  |  |  |                   | 0 0 0   | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 0 1 1 0                           | * | * | * |   |     |  |  |  |                   | 0 0 0   | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 0 1 1 1                           | * | * | * |   |     |  |  |  |                   | 0 0 0   | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 1 0 0 0                           | * | * | * |   |     |  |  |  |                   | 0 0 0   | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 1 0 0 1                           | * | * | * |   |     |  |  |  |                   | 0 0 0   | 0 |
| 0 0 0 0 * 1 1 1                |   |   |   |   |     |   |   |   |  | 1 0 1 0       |  |     |   |  | 1 0 1 0                           | * | * | * |   |     |  |  |  | Cursor pattern    |         |   |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 1 0 1 1                           | * | * | * |   |     |  |  |  |                   | 0 0 0 0 | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 1 1 0 0                           | * | * | * |   |     |  |  |  |                   | 0 0 0 0 | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 1 1 0 1                           | * | * | * |   |     |  |  |  |                   | 0 0 0 0 | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 1 1 1 0                           | * | * | * |   |     |  |  |  |                   | 0 0 0 0 | 0 |
|                                |   |   |   |   |     |   |   |   |  |               |  |     |   |  | 1 1 1 1                           | * | * | * |   |     |  |  |  |                   | 0 0 0 0 | 0 |

■ : " High "

# 11. Character Generator ROM Pattern

Table.2

| Lower 4 Bits \ Upper 4 Bits | 0000       | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|-----------------------------|------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| xxxx0000                    | CG RAM (1) |      | 0    | @    | P    | `    | P    |      |      |      |      | -    | 9    | ≡    | α    | ρ    |
| xxxx0001                    | (2)        | !    | 1    | A    | Q    | a    | q    |      |      |      | 。    | ア    | チ    | △    | ä    | g    |
| xxxx0010                    | (3)        | "    | 2    | B    | R    | b    | r    |      |      |      | 「    | イ    | ツ    | ×    | β    | θ    |
| xxxx0011                    | (4)        | #    | 3    | C    | S    | c    | s    |      |      |      | 」    | ウ    | テ    | ε    | ε    | ∞    |
| xxxx0100                    | (5)        | \$   | 4    | D    | T    | d    | t    |      |      |      | 、    | エ    | ト    | †    | μ    | Ω    |
| xxxx0101                    | (6)        | %    | 5    | E    | U    | e    | u    |      |      |      | ・    | オ    | ナ    | 1    | ε    | Ü    |
| xxxx0110                    | (7)        | &    | 6    | F    | V    | f    | v    |      |      |      | ヲ    | カ    | ニ    | ヨ    | ρ    | Σ    |
| xxxx0111                    | (8)        | '    | 7    | G    | W    | g    | w    |      |      |      | ア    | キ    | ヌ    | ラ    | g    | π    |
| xxxx1000                    | (1)        | (    | 8    | H    | X    | h    | x    |      |      |      | イ    | ク    | ネ    | リ    | √    | ×    |
| xxxx1001                    | (2)        | )    | 9    | I    | Y    | i    | y    |      |      |      | ウ    | ケ    | ル    |      | '    | γ    |
| xxxx1010                    | (3)        | *    | :    | J    | Z    | j    | z    |      |      |      | エ    | コ    | ハ    | レ    | j    | ≠    |
| xxxx1011                    | (4)        | +    | ;    | K    | [    | k    | {    |      |      |      | オ    | サ    | ヒ    | ロ    | *    | ≠    |
| xxxx1100                    | (5)        | ,    | <    | L    | ¥    | l    | l    |      |      |      | カ    | シ    | フ    | ワ    | φ    | ⊙    |
| xxxx1101                    | (6)        | -    | =    | M    | ]    | m    | }    |      |      |      | ユ    | ヌ    | ハ    | ン    | ≠    | ÷    |
| xxxx1110                    | (7)        | .    | >    | N    | ^    | n    | →    |      |      |      | ヨ    | セ    | ホ    | ”    | ≠    |      |
| xxxx1111                    | (8)        | /    | ?    | O    | _    | o    | €    |      |      |      | ッ    | リ    | マ    | °    | ö    | ■    |

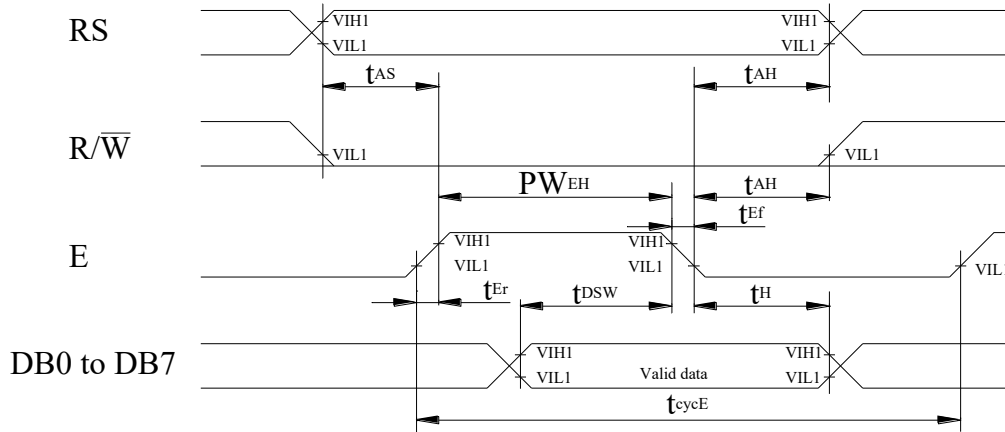
# 12. Instruction Table

| Instruction                | Instruction Code |     |     |     |     |     |     |     |     |     | Description  | Execution time<br>(fosc=270Khz) |
|----------------------------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|---------------------------------|
|                            | RS               | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |  |                                 |
| Clear Display              | 0                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | Write "00H" to DDRAM and set DDRAM address to "00H" from AC  | 1.53ms                          |
| Return Home                | 0                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | —   | Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.   | 1.53ms                          |
| Entry Mode Set             | 0                | 0   | 0   | 0   | 0   | 0   | 0   | 1   | I/D | SH  | Assign cursor moving direction and enable the shift of entire display.   | 39μs                            |
| Display ON/OFF Control     | 0                | 0   | 0   | 0   | 0   | 0   | 1   | D   | C   | B   | Set display (D), cursor (C), and blinking of cursor (B) on/off control bit.  | 39μs                            |
| Cursor or Display Shift    | 0                | 0   | 0   | 0   | 0   | 1   | S/C | R/L | —   | —   | Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data.                                | 39μs                            |
| Function Set               | 0                | 0   | 0   | 0   | 1   | DL  | N   | F   | —   | —   | Set interface data length (DL:8-bit/4-bit), numbers of display line (N:2-line/1-line)and, display font type (F:5×11 dots/5×8 dots) | 39μs                            |
| Set CGRAM Address          | 0                | 0   | 0   | 1   | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set CGRAM address in address counter.  | 39μs                            |
| Set DDRAM Address          | 0                | 0   | 1   | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set DDRAM address in address counter.  | 39μs                            |
| Read Busy Flag and Address | 0                | 1   | BF  | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.             | 0μs                             |
| Write Data to RAM          | 1                | 0   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  | Write data into internal RAM (DDRAM/CGRAM).  | 43μs                            |
| Read Data from RAM         | 1                | 1   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  | Read data from internal RAM (DDRAM/CGRAM).   | 43μs                            |

\* "—": don't care

# 13. Timing Characteristics

## 13.1 Write Operation

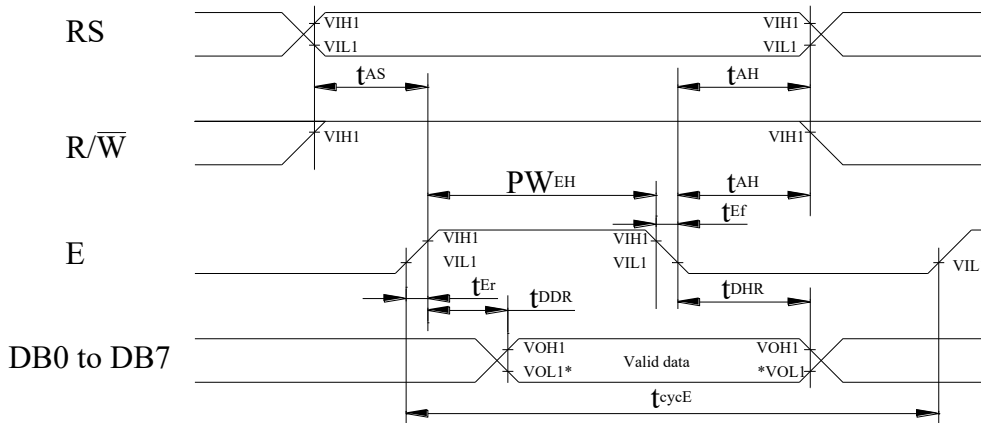


$T_a=25^{\circ}\text{C}$ ,  $V_{DD}=5.0\pm 0.5\text{V}$

| Item                               | Symbol           | Min  | Typ | Max | Unit |
|------------------------------------|------------------|------|-----|-----|------|
| Enable cycle time                  | $t_{cycE}$       | 1200 | —   | —   | ns   |
| Enable pulse width (high level)    | $PW_{EH}$        | 140  | —   | —   | ns   |
| Enable rise/fall time              | $t_{Er}, t_{Ef}$ | —    | —   | 25  | ns   |
| Address set-up time (RS, R/W to E) | $t_{AS}$         | 0    | —   | —   | ns   |
| Address hold time                  | $t_{AH}$         | 10   | —   | —   | ns   |
| Data set-up time                   | $t_{DSW}$        | 40   | —   | —   | ns   |
| Data hold time                     | $t_H$            | 10   | —   | —   | ns   |



## 13.2 Read Operation



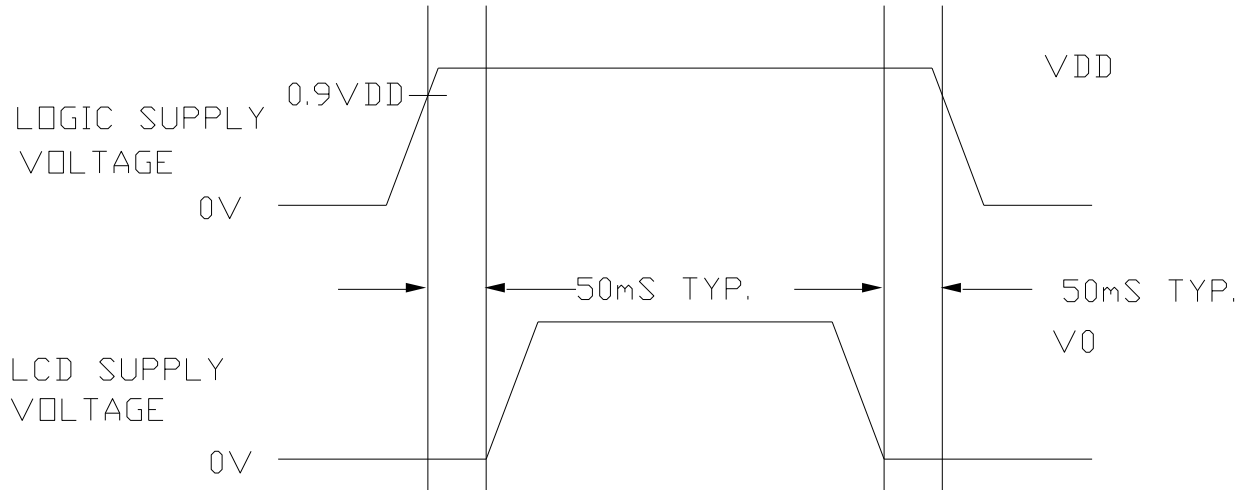
NOTE: \*VOL1 is assumed to be 0.8V at 2 MHz operation.

$T_a=25^\circ\text{C}$ ,  $V_{DD}=5.0\pm 0.5\text{V}$

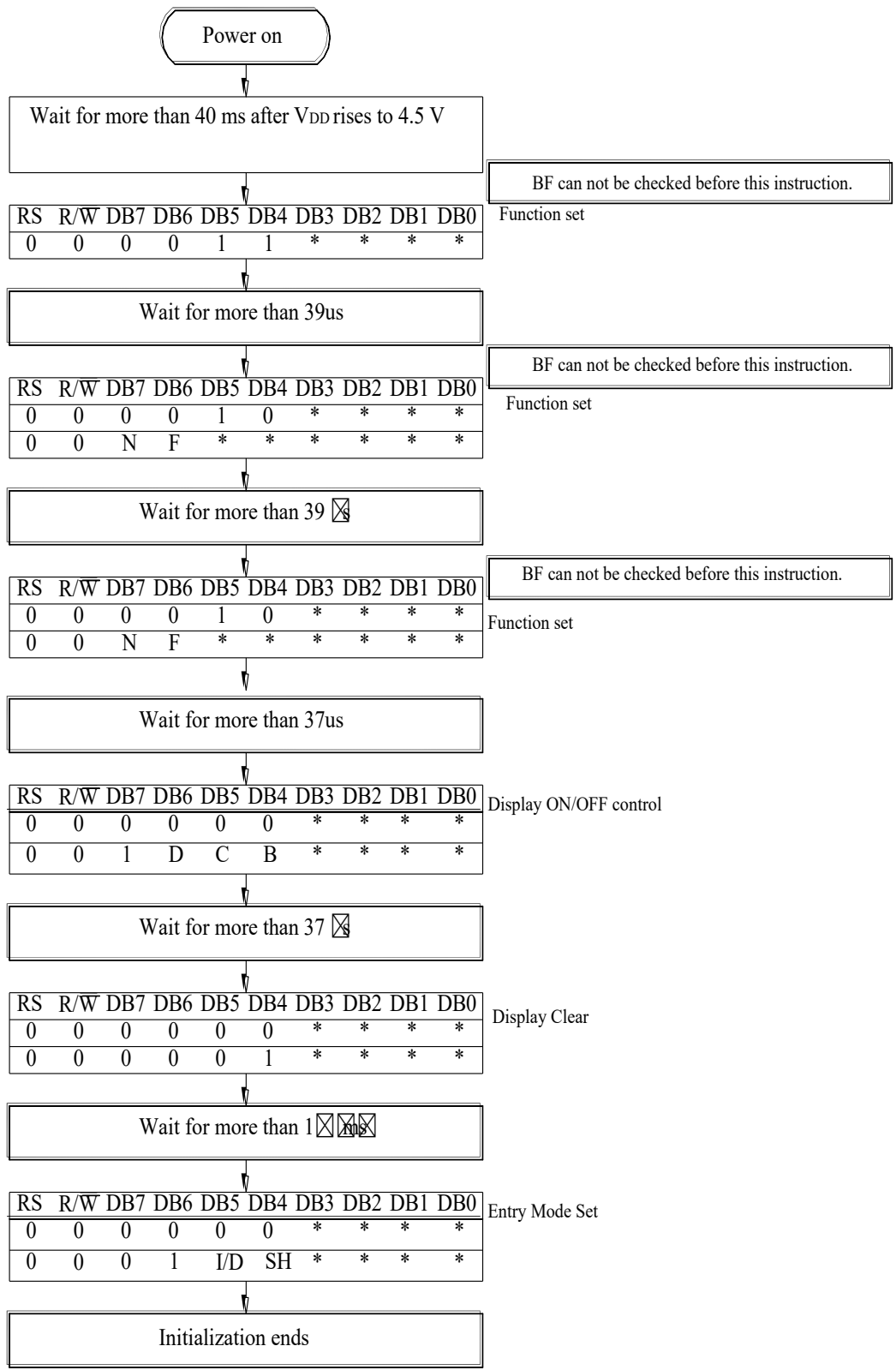
| Item                               | Symbol           | Min  | Typ | Max | Unit |
|------------------------------------|------------------|------|-----|-----|------|
| Enable cycle time                  | $t_{cycE}$       | 1200 | —   | —   | ns   |
| Enable pulse width (high level)    | $PW_{EH}$        | 140  | —   | —   | ns   |
| Enable rise/fall time              | $t_{Er}, t_{Ef}$ | —    | —   | 25  | ns   |
| Address set-up time (RS, R/W to E) | $t_{AS}$         | 0    | —   | —   | ns   |
| Address hold time                  | $t_{AH}$         | 10   | —   | —   | ns   |
| Data delay time                    | $t_{DDR}$        | —    | —   | 100 | ns   |
| Data hold time                     | $t_{DHR}$        | 10   | —   | —   | ns   |

### 13.3 Timing Diagram of VDD Against V0.

Power on sequence shall meet the requirement of Figure 4, the timing diagram of VDD against V0.



# 14. Initializing of LCM



4-Bit Ineterface

Power on

Wait for more than 40 ms after V<sub>DD</sub> rises to 4.5 V

BF can not be checked before this instruction.

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0  | 0   | 0   | 0   | 1   | 1   | N   | F   | *   | *   |

Function set

Wait for more than 39us

BF can not be checked before this instruction.

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0  | 0   | 0   | 0   | 1   | 1   | N   | F   | *   | *   |

Function set

Wait for more than 37us

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0  | 0   | 0   | 0   | 0   | 0   | 1   | B   | C   | D   |

Display ON/OFF control

Wait for more than 37  $\mu$ s

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   |

Display Clear

Wait for more than 1  $\mu$ s

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0  | 0   | 0   | 0   | 0   | 0   | 0   | 1   | I/D | S   |

Entry Mode Set

Initialization ends

### 8-Bit Ineterface

# 15. Quality Assurance

## Screen Cosmetic Criteria

| Item               | Defect                               | Judgment Criterion   | Partition         |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
|--------------------|--------------------------------------|--|-------------------|--------------------------------------|--------------|-----------|--------------------|---|--------------------|---|-----------|---|-------------------|--------------------------------------|--------------|-----------|--------------------|---|--------------------|---|-----------|---|-------|
| 1                  | Spots                                | <p>A)Clear</p> <table border="0"> <tr> <td><u>Size: d mm</u></td> <td><u>Acceptable Qty in active area</u></td> </tr> <tr> <td><math>d \leq 0.1</math></td> <td>Disregard</td> </tr> <tr> <td><math>0.1 &lt; d \leq 0.2</math></td> <td>6</td> </tr> <tr> <td><math>0.2 &lt; d \leq 0.3</math></td> <td>2</td> </tr> <tr> <td><math>0.3 &lt; d</math></td> <td>0</td> </tr> </table> <p>Note: Including pin holes and defective dots which must be within one pixel size.</p> <p>B)Unclear</p> <table border="0"> <tr> <td><u>Size: d mm</u></td> <td><u>Acceptable Qty in active area</u></td> </tr> <tr> <td><math>d \leq 0.2</math></td> <td>Disregard</td> </tr> <tr> <td><math>0.2 &lt; d \leq 0.5</math></td> <td>6</td> </tr> <tr> <td><math>0.5 &lt; d \leq 0.7</math></td> <td>2</td> </tr> <tr> <td><math>0.7 &lt; d</math></td> <td>0</td> </tr> </table> | <u>Size: d mm</u> | <u>Acceptable Qty in active area</u> | $d \leq 0.1$ | Disregard | $0.1 < d \leq 0.2$ | 6 | $0.2 < d \leq 0.3$ | 2 | $0.3 < d$ | 0 | <u>Size: d mm</u> | <u>Acceptable Qty in active area</u> | $d \leq 0.2$ | Disregard | $0.2 < d \leq 0.5$ | 6 | $0.5 < d \leq 0.7$ | 2 | $0.7 < d$ | 0 | Minor |
| <u>Size: d mm</u>  | <u>Acceptable Qty in active area</u> |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| $d \leq 0.1$       | Disregard                            |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| $0.1 < d \leq 0.2$ | 6                                    |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| $0.2 < d \leq 0.3$ | 2                                    |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| $0.3 < d$          | 0                                    |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| <u>Size: d mm</u>  | <u>Acceptable Qty in active area</u> |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| $d \leq 0.2$       | Disregard                            |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| $0.2 < d \leq 0.5$ | 6                                    |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| $0.5 < d \leq 0.7$ | 2                                    |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| $0.7 < d$          | 0                                    |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| 2                  | Bubbles in Polarizer                 | <table border="0"> <tr> <td><u>Size: d mm</u></td> <td><u>Acceptable Qty in active area</u></td> </tr> <tr> <td><math>d \leq 0.3</math></td> <td>Disregard</td> </tr> <tr> <td><math>0.3 &lt; d \leq 1.0</math></td> <td>3</td> </tr> <tr> <td><math>1.0 &lt; d \leq 1.5</math></td> <td>1</td> </tr> <tr> <td><math>1.5 &lt; d</math></td> <td>0</td> </tr> </table>  | <u>Size: d mm</u> | <u>Acceptable Qty in active area</u> | $d \leq 0.3$ | Disregard | $0.3 < d \leq 1.0$ | 3 | $1.0 < d \leq 1.5$ | 1 | $1.5 < d$ | 0 | Minor             |                                      |              |           |                    |   |                    |   |           |   |       |
| <u>Size: d mm</u>  | <u>Acceptable Qty in active area</u> |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| $d \leq 0.3$       | Disregard                            |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| $0.3 < d \leq 1.0$ | 3                                    |  |                   |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |
| $1.0 < d \leq 1.5$ | 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                           | Not to be noticeable coloration in the viewing area of the LCD panels.<br>Back-light type should be judged with back-light on state only.  | Minor             |                                      |              |           |                    |   |                    |   |           |   |                   |                                      |              |           |                    |   |                    |   |           |   |       |

# 16. Reliability

## Content of Reliability Test

| Environmental Test                   |  |   |                     |
|--------------------------------------|--|---|---------------------|
| Test Item                            | Content of Test  | Test Condition  | Applicable Standard |
| High Temperature storage             | Endurance test applying the high storage temperature for a long time.  | 80°C<br>96hrs   | —                   |
| Low Temperature storage              | Endurance test applying the high storage temperature for a long time.  | -30°C<br>96hrs  | —                   |
| 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>96hrs   | —                   |
| Low Temperature Operation            | Endurance test applying the electric stress under low temperature for a long time.   | -20°C<br>96hrs  | —                   |
| High Temperature/ Humidity Storage   | Endurance test applying the high temperature and high humidity storage for a long time.  | 80°C,90%RH<br>96hrs                                     | —                   |
| High Temperature/ Humidity Operation | Endurance test applying the electric stress (Voltage & Current) and temperature / humidity stress to the element for a long time.  | 70°C,90%RH<br>96hrs                                     | —                   |
| Temperature Cycle                    | Endurance test applying the low and high temperature cycle.<br><div style="text-align: center;"> <p style="margin: 0;">-30°C    25°C    80°C</p> <p style="margin: 0;">30min    5min    30min</p> <p style="margin: 0;">1 cycle</p> </div> | -30°C→80°C<br>10 cycles                                 | —                   |
| Mechanical Test                      |  |   |                     |
| Vibration test                       | Endurance test applying the vibration during transportation and using.   | 10~22Hz→1.5mmp-p<br>22~500Hz→1.5G<br>Total 0.5hrs       | —                   |
| Shock test                           | Constructional and mechanical endurance test applying the shock during transportation.   | 50G Half sign wave 11 msdc<br>3 times of each direction | —                   |

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