



**RAYSTAR**

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## RC1602B-TIW-CSV

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### SPECIFICATION

CUSTOMER:

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

FOR CUSTOMER USE ONLY

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

ISSUED DATE:

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## 1. Revision History

| DATE       | VERSION | REVISED PAGE NO. | Note        |
|------------|---------|------------------|-------------|
| 2012/05/28 | 1       |                  | First issue |

RAYSTAR OPTRONICS

## 2. General Specification

The Features is described as follow:

- Module dimension: 80.0 x 36.0 x 13.5 (max.) mm<sup>3</sup>
- View area: 66.0 x 16.0 mm<sup>2</sup>
- Active area: 56.20x 11.5 mm<sup>2</sup>
- Number of Characters: 16 characters x 2 Lines
- Dot size: 0.55x 0.65 mm<sup>2</sup>
- Dot pitch: 0.60 x 0.70 mm<sup>2</sup>
- Character size: 2.95 x 5.55 mm<sup>2</sup>
- Character pitch: 3.55 x 5.95 mm<sup>2</sup>
- LCD type: FSTN Negative Transmissive
- Duty: 1/16
- View direction: 6 o'clock
- Backlight Type: LED, White

### 3. Module Coding System

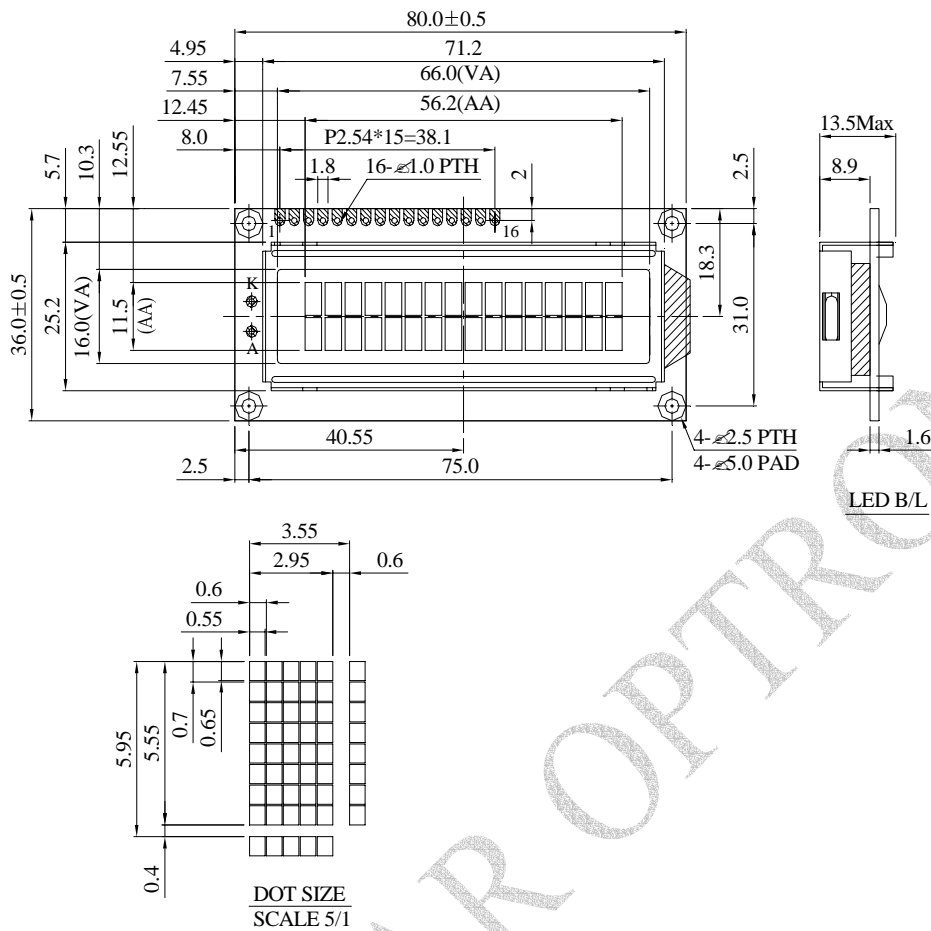
|          |          |             |          |          |          |          |          |          |            |
|----------|----------|-------------|----------|----------|----------|----------|----------|----------|------------|
| <b>R</b> | <b>C</b> | <b>1602</b> | <b>B</b> | <b>-</b> | <b>T</b> | <b>I</b> | <b>W</b> | <b>-</b> | <b>CSV</b> |
| 1        | 2        | 3           | 4        | -        | 5        | 6        | 7        | -        | 8          |

| Item | Description   |  |                                     |
|------|---|--|-------------------------------------|
| 1    | <b>R : Raystar Optronics Inc.</b>                       |  |                                     |
| 2    | Display   | <b>C : Character Type</b>  |                                     |
|      |   | G : Graphic Type   |                                     |
| 3    | Number of dots : Character 16 words, 2 Lines            |  |                                     |
| 4    | Serials code  |  |                                     |
| 5    | LCD   | P : TN Positive, Gray  |                                     |
|      |   | N : TN Negative,   |                                     |
|      |   | G : STN Positive, Gray   |                                     |
|      |   | Y : STN Positive, Yellow Green   |                                     |
|      |   | B : STN Negative, Blue   |                                     |
|      |   | F : FSTN Positive  |                                     |
|      |   | <b>T : FSTN Negative</b>   |                                     |
| 6    | Polarizer Type,<br>Temperature range,<br>View direction | A : Reflective, N.T, 6:00  | K : Transflective, W.T,12:00        |
|      |   | D : Reflective, N.T, 12:00   | 1 : Transflective, U.T,6:00         |
|      |   | G : Reflective, W. T, 6:00   | 4 : Transflective, U.T.12:00        |
|      |   | J : Reflective, W. T, 12:00  | C : Transmissive, N.T,6:00          |
|      |   | 0 : Reflective, U. T, 6:00   | F : Transmissive, N.T,12:00         |
|      |   | 3 : Reflective, U. T, 12:00  | <b>I : Transmissive, W. T, 6:00</b> |
|      |   | B : Transflective, N.T,6:00  | L : Transmissive, W.T,12:00         |
|      |   | E : Transflective, N.T.12:00   | 2 : Transmissive, U. T, 6:00        |
|      |   | H : Transflective, W.T,6:00  | 5 : Transmissive, U.T,12:00         |
| 7    | Backlight   | N : Without backlight  | Y : LED, Yellow Green               |
|      |   | P : EL, Blue green   | A : LED, Amber                      |
|      |   | T : EL, Green  | <b>W : LED, White</b>               |
|      |   | D : EL, White  | O : LED, Orange                     |
|      |   | F : CCFL, White  | G : LED, Green                      |
| 8    | Special code  | CS: English and Cyrillic standard font<br>V: Build in Negative Voltage |                                     |

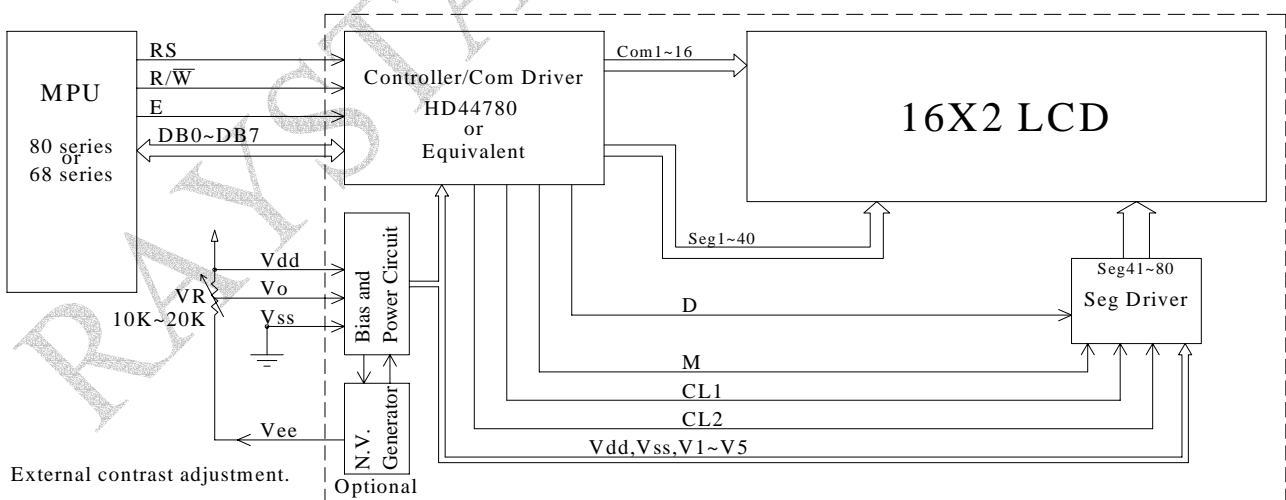
## 4. Interface Pin Function

| Pin # | Symbol          | Level      | Description                              |
|-------|-----------------|------------|--|
| 1     | V <sub>SS</sub> | 0V         | Ground                                   |
| 2     | V <sub>DD</sub> | 3.3V       | Supply Voltage for logic                 |
| 3     | VO              | (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 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    | Vee             | —          | Negative Voltage Output                  |
| 16    | K               | —          | LED-                                     |

## 5. Outline Dimension & Block Diagram



| PIN NO. | SYMBOL |
|---------|--------|
| 1       | Vss    |
| 2       | Vdd    |
| 3       | Vo     |
| 4       | RS     |
| 5       | R/W    |
| 6       | E      |
| 7       | DB0    |
| 8       | DB1    |
| 9       | DB2    |
| 10      | DB3    |
| 11      | DB4    |
| 12      | DB5    |
| 13      | DB6    |
| 14      | DB7    |
| 15      | Vee    |
| 16      | K      |



| Character located | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|-------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| DDRAM address     | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F |
| DDRAM address     | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F |

## 6. 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)

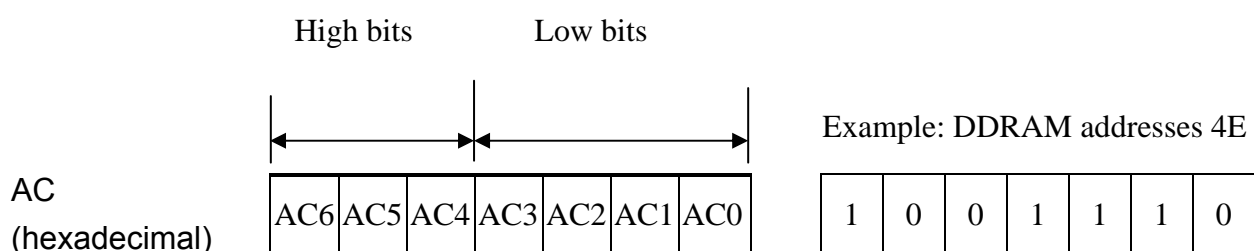
When the busy flag is 1, the controller LSI is in the internal operation mode, and the next instruction will not be accepted. When RS=0 and R/W=1, the busy flag is output to DB7. The next instruction must be written after ensuring that the busy flag is 0.

### 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

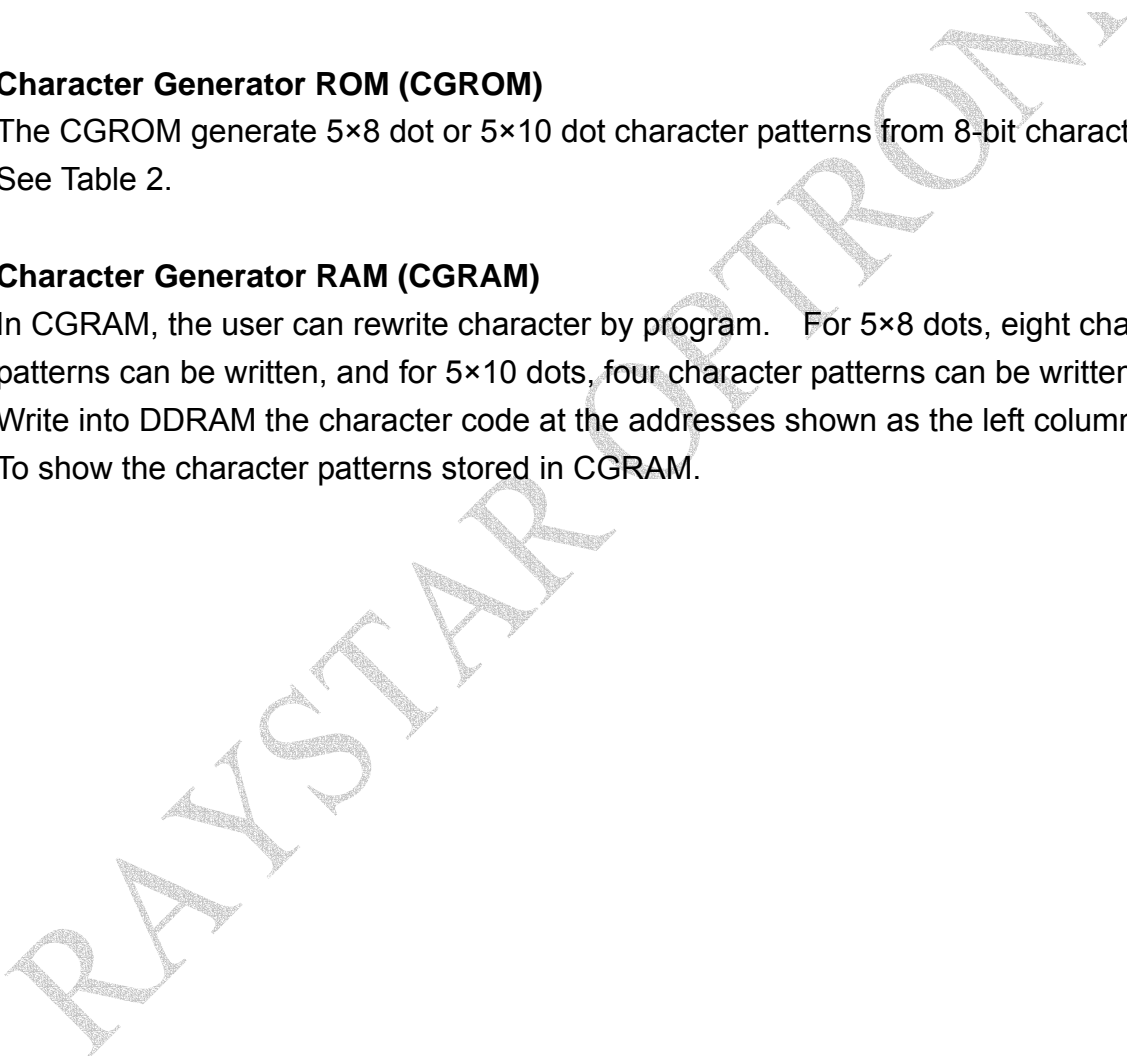
**Character Generator ROM (CGROM)**

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.

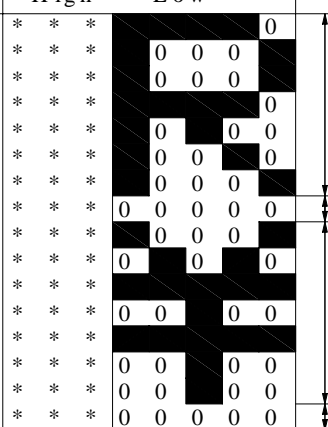
Write into DDRAM the character code at the addresses shown as the left column of table 1. To show the character patterns stored in CGRAM.



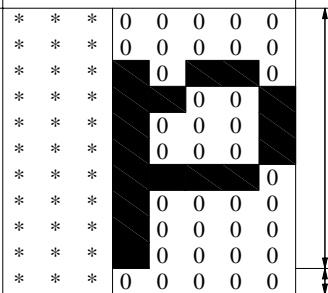
**Relationship between CGRAM Addresses, Character Codes (DDRAM) and Character patterns.**

**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   |       | 7 6 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 | * * * 0 0 0 0                     |  <p>Character pattern( 1 )</p> <p>Cursor pattern</p> <p>Character pattern( 2 )</p> <p>Cursor pattern</p> |
| 0 0 0 0 * 0 0 1                |     | 0 0 1         | 0 0 0 | * * * 0 0 0 0                     |   |
|                                |     |               | 0 0 0 | * * * 0 0 0 0                     |   |
|                                |     |               | 0 0 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 * 1 1 1                |     | 1 1 1         | 1 0 0 | * * *                             |   |
|                                |     |               | 1 0 1 |                                   |   |
|                                |     |               | 1 1 0 |                                   |   |
|                                |     |               | 1 1 1 |                                   |   |

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   |         | 7 6 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 | * * * 0 0 0 0 0                   |  <p>Character pattern</p> <p>Cursor pattern</p> |
|                                |     |               | 0 0 0 1 | * * * 0 0 0 0 0                   |   |
|                                |     |               | 0 0 1 0 | * * * 0 0 0 0 0                   |   |
|                                |     |               | 0 0 1 1 | * * * 0 0 0 0 0                   |   |
|                                |     |               | 0 1 0 0 | * * * 0 0 0 0 0                   |   |
|                                |     |               | 0 1 0 1 | * * * 0 0 0 0 0                   |   |
|                                |     |               | 0 1 1 0 | * * * 0 0 0 0 0                   |   |
|                                |     |               | 0 1 1 1 | * * * 0 0 0 0 0                   |   |
|                                |     |               | 1 0 0 0 | * * * 0 0 0 0 0                   |   |
|                                |     |               | 1 0 0 1 | * * * 0 0 0 0 0                   |   |
|                                |     |               | 1 0 1 0 | * * * 0 0 0 0 0                   |   |
|                                |     |               | 1 1 1 1 | * * * * * *                       |   |

■ : " High "

# 7. Character Generator ROM Pattern

Table.2

| Upper<br>4 bit<br>Lower<br>4 bit | LLLL       | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|----------------------------------|------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL                             | CG RAM (1) |      |      | 0    | 1    | 2    | 3    | 4    |      |      | E    | F    | G    | H    | I    | J    |
| LLLH                             | CG RAM (2) |      | !    | l    | o    | a    | n    |      |      | r    | s    | u    | v    | w    | x    | y    |
| LLHL                             | CG RAM (3) |      | "    | z    | B    | b    | r    |      |      | e    | e    | e    | u    | u    | u    | u    |
| LLHH                             | CG RAM (4) |      | #    | c    | s    | s    | s    |      |      | h    | b    | w    | u    | z    | z    | z    |
| LHLL                             | CG RAM (5) |      | \$   | 4    | 0    | t    | t    |      |      | 3    | r    | e    | t    | a    | a    | a    |
| LHLH                             | CG RAM (6) |      | %    | 5    | e    | u    | u    |      |      | k    | e    | e    | e    | u    | u    | u    |
| LHHL                             | CG RAM (7) |      | &    | 6    | f    | u    | u    |      |      | 6    | w    | w    | t    | u    | u    | u    |
| LHHH                             | CG RAM (8) |      | '    | 7    | g    | u    | u    |      |      | J    | a    | a    | t    | '    | '    | '    |
| HLLL                             | CG RAM (1) |      | (    | 8    | H    | X    | X    |      |      | n    | w    | e    | u    | '    | '    | '    |
| HLLH                             | CG RAM (2) |      | )    | 9    | I    | y    | y    |      |      | Y    | o    | a    | t    | '    | '    | '    |
| HLHL                             | CG RAM (3) |      | *    | 0    | J    | Z    | Z    |      |      | 0    | k    | e    | u    | e    | e    | e    |
| HLHH                             | CG RAM (4) |      | +    | 1    | K    | X    | X    |      |      | 4    | a    | t    | w    | e    | e    | e    |
| HHLL                             | CG RAM (5) |      | ,    | 2    | L    | X    | X    |      |      | u    | w    | n    | w    | u    | u    | u    |
| HHLH                             | CG RAM (6) |      | -    | 3    | M    | w    | w    |      |      | L    | w    | e    | w    | w    | w    | w    |
| HHHL                             | CG RAM (7) |      | .    | 4    | N    | w    | w    |      |      | u    | n    | e    | t    | e    | e    | e    |
| HHHH                             | CG RAM (8) |      | /    | 5    | O    | w    | w    |      |      | 0    | t    | e    | '    | '    | '    | '    |

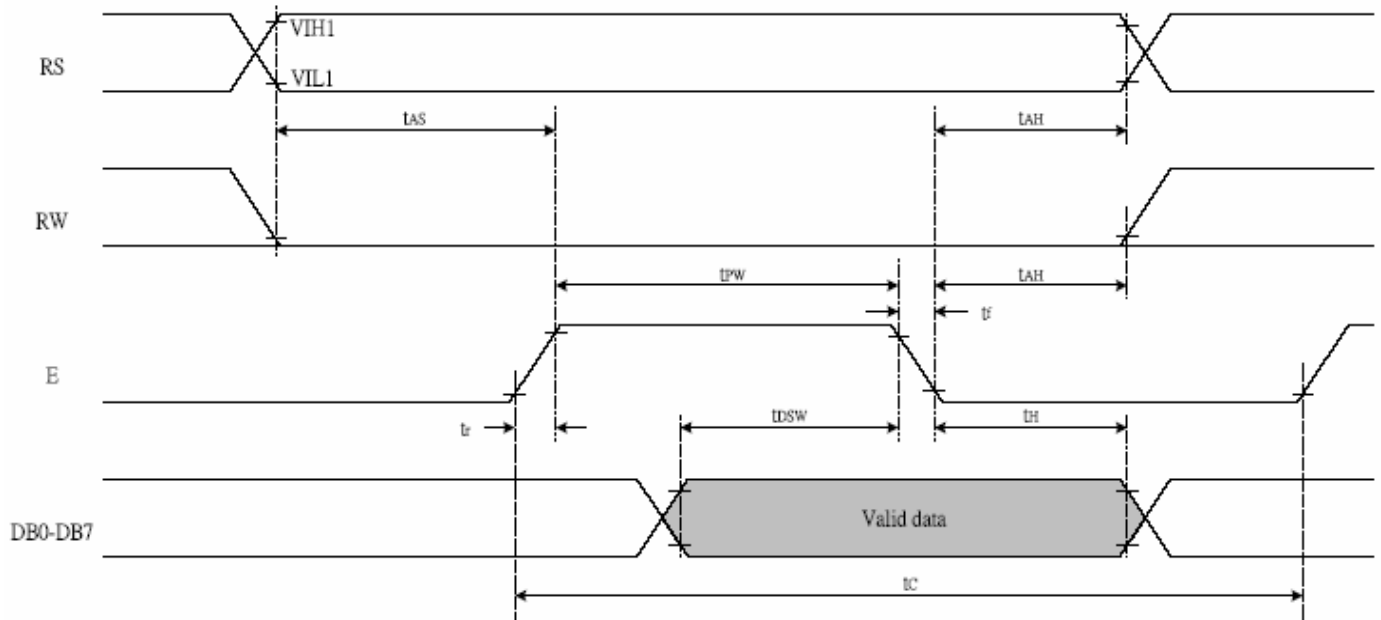
## 8. Instruction Table

| 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   | 0   | 1           | Write "20H" to DDRAM. and set DDRAM address to "00H" from AC   | 1.52ms |
| Return Home                | 0                | 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. | 1.52ms |
| Entry Mode Set             | 0                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | I/D | SH          | Sets cursor move direction and specifies display shift. These operations are performed during data write and read.               | 37μs   |
| Display ON/OFF Control     | 0                | 0   | 0   | 0   | 0   | 0   | 0   | 1   | D   | C   | B           | D=1:entire display on<br>C=1:cursor on<br>B=1:cursor position on   | 37μs   |
| Cursor or Display Shift    | 0                | 0   | 0   | 0   | 0   | 0   | 1   | S/C | R/L | —   | —           | Set cursor moving and display shift control bit, and the direction, without changing DDRAM data.                                 | 37μs   |
| Function Set               | 0                | 0   | 0   | 0   | 0   | 1   | DL  | N   | F   | —   | —           | DL:interface data is 8/4 bits<br>N:number of line is 2/1<br>F:font size is 5x11/5x8  | 37μs   |
| Set CGRAM Address          | 0                | 0   | 0   | 1   | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |             | Set CGRAM address in address counter   | 37μs   |
| Set DDRAM Address          | 0                | 0   | 1   | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |             | Set DDRAM address in address counter   | 37μs   |
| 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)   | 37μs   |
| Read Data from RAM         | 1                | 1   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  |             | Read data from internal RAM (DDRAM/CGRAM)  | 37μs   |

\* "—" : don't care

## 9. Timing Characteristics

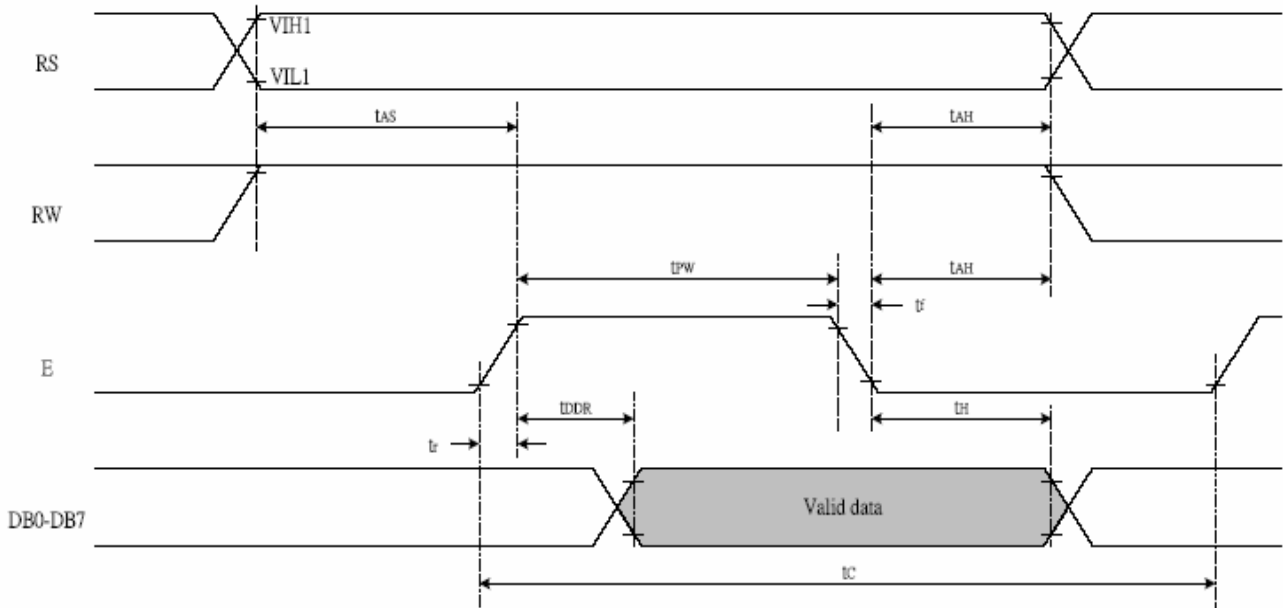
### 9.1 Writing data from MPU to ST7066U



$T_a = -30 \sim +85^\circ\text{C}$ ,  $V_{DD} = 3.3 \pm 0.5\text{V}$

|       |                       |                 |      |   |    |    |
|-------|-----------------------|-----------------|------|---|----|----|
| TC    | Enable Cycle Time     | Pin E           | 1200 | - | -  | ns |
| TPW   | Enable Pulse Width    | Pin E           | 460  | - | -  | ns |
| TR,TF | Enable Rise/Fall Time | Pin E           | -    | - | 25 | ns |
| TAS   | Address Setup Time    | Pins: RS,RW,E   | 0    | - | -  | ns |
| TAH   | Address Hold Time     | Pins: RS,RW,E   | 10   | - | -  | ns |
| TDSW  | Data Setup Time       | Pins: DB0 - DB7 | 80   | - | -  | ns |
| TH    | Data Hold Time        | Pins: DB0 - DB7 | 10   | - | -  | ns |

9.2 Reading data from ST7066U to MPU

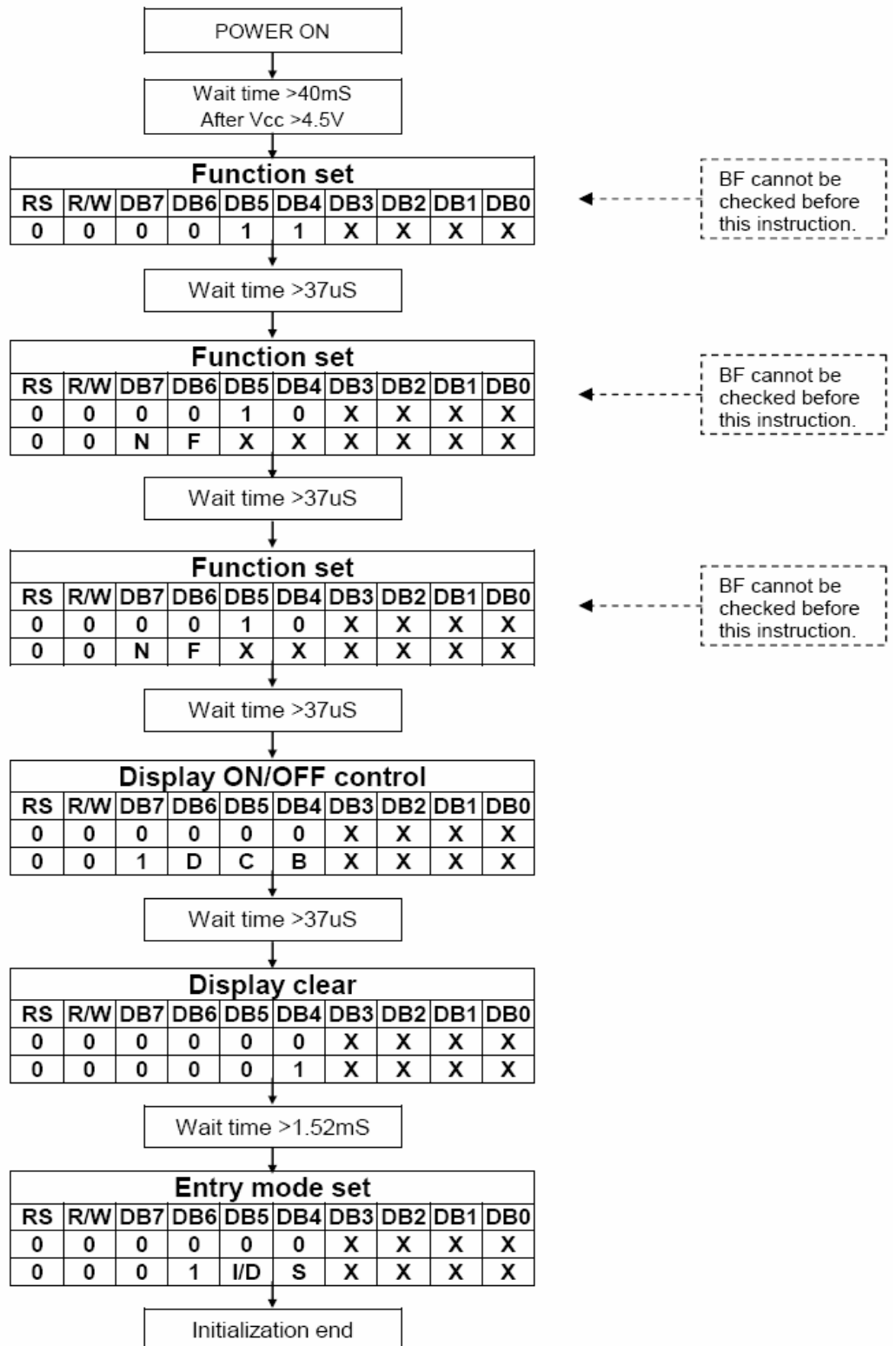


Ta=-30~+85°C, VDD=3.3± 0.5V

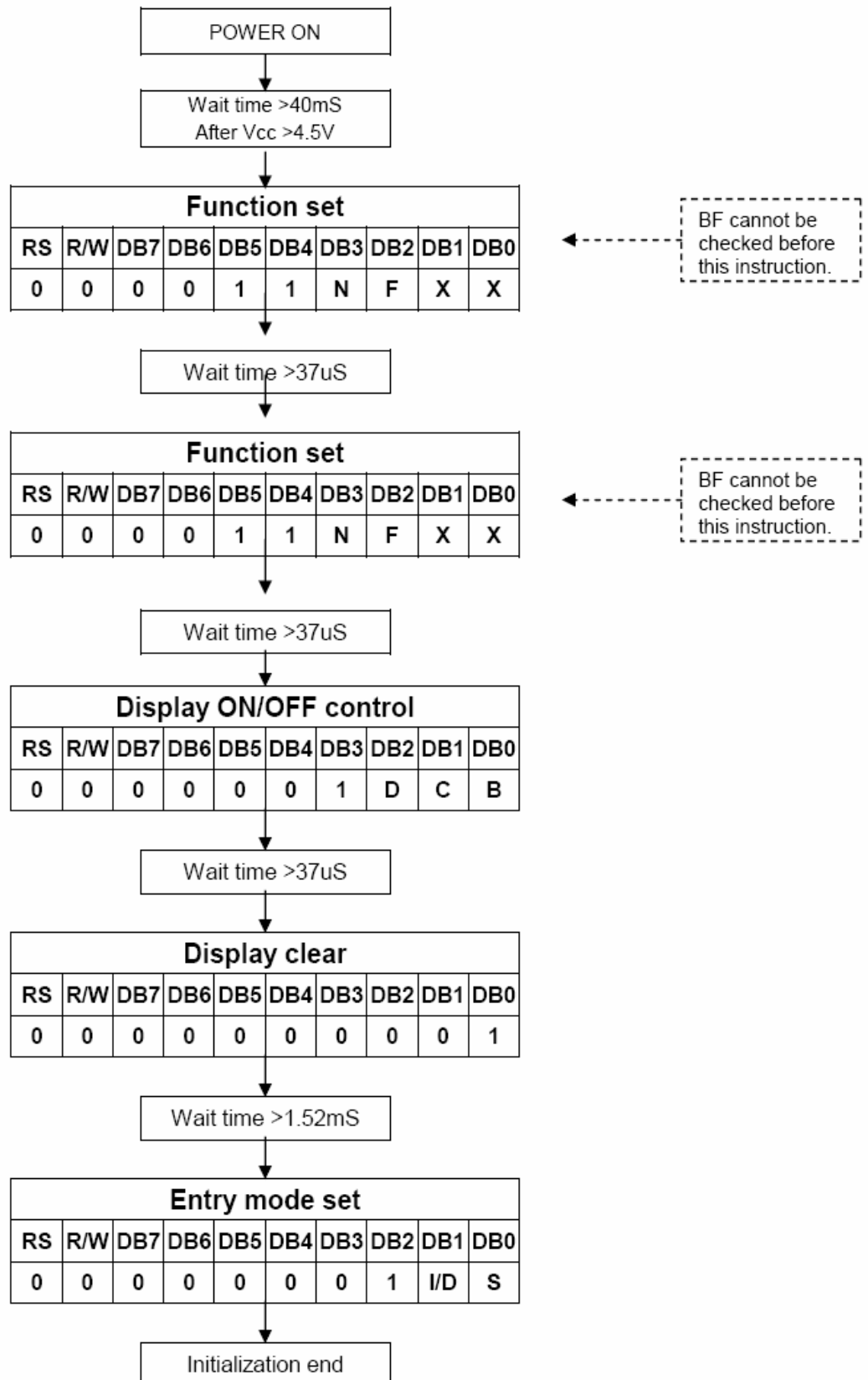
| Read Mode |                       | (Reading Data from ST7066U to MPU) |      |   |     |    |
|-----------|-----------------------|------------------------------------|------|---|-----|----|
| TC        | Enable Cycle Time     | Pin E                              | 1200 | - | -   | ns |
| TPW       | Enable Pulse Width    | Pin E                              | 480  | - | -   | ns |
| TR,TF     | Enable Rise/Fall Time | Pin E                              | -    | - | 25  | ns |
| TAS       | Address Setup Time    | Pins: RS,RW,E                      | 0    | - | -   | ns |
| TAH       | Address Hold Time     | Pins: RS,RW,E                      | 10   | - | -   | ns |
| TDDR      | Data Setup Time       | Pins: DB0 - DB7                    | -    | - | 320 | ns |
| TH        | Data Hold Time        | Pins: DB0 - DB7                    | 10   | - | -   | ns |

# 10. Initializing of LCM

- 4-bit Interface (fosc=270KHz)



- 8-bit Interface ( $f_{osc}=270\text{KHz}$ )

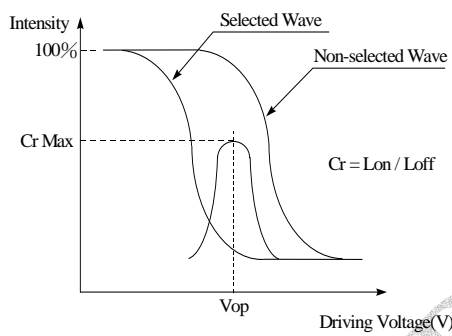




# 11. Optical Characteristics

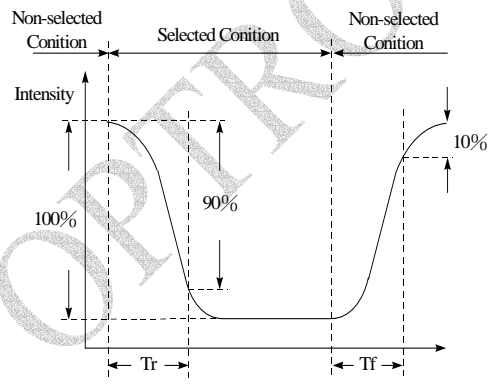
| Item           | Symbol       | Condition   | Min | Typ | Max | Unit |
|----------------|--------------|-------------|-----|-----|-----|------|
| View Angle     | $(V)\theta$  | $CR \geq 2$ | 30  | —   | 60  | deg  |
|                | $(H)\varphi$ | $CR \geq 2$ | -45 | —   | 45  | deg  |
| Contrast Ratio | CR           | —           | —   | 5   | —   | —    |
| Response Time  | T rise       | —           | —   | 150 | 200 | ms   |
|                | T fall       | —           | —   | 150 | 200 | ms   |

Definition of Operation Voltage (Vop)



[positive type]

Definition of Response Time (Tr, Tf)



[positive type]

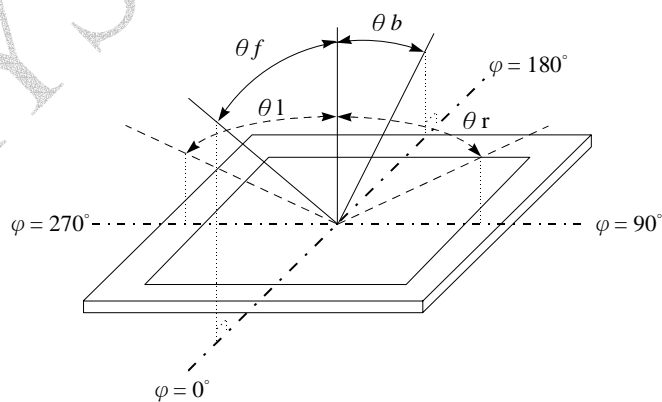
### Conditions :

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( $CR \geq 2$ )



## 12. Absolute Maximum Ratings

| Item                     | Symbol          | Min      | Typ | Max      | Unit |
|--------------------------|-----------------|----------|-----|----------|------|
| Operating Temperature    | $T_{OP}$        | -20      | —   | +70      | °C   |
| Storage Temperature      | $T_{ST}$        | -30      | —   | +80      | °C   |
| Input Voltage            | $V_I$           | $V_{SS}$ | —   | $V_{DD}$ | V    |
| Supply Voltage For Logic | $V_{DD}-V_{SS}$ | -0.3     | —   | 7        | V    |
| Supply Voltage For LCD   | $V_{DD}-V_0$    | -0.3     | —   | 13       | V    |

## 13. Electrical Characteristics

| Item                     | Symbol          | Condition                 | Min          | Typ | Max          | Unit |
|--------------------------|-----------------|---------------------------|--------------|-----|--------------|------|
| Supply Voltage For Logic | $V_{DD}-V_{SS}$ | —                         | 3.0          | 3.3 | 3.6          | V    |
| Supply Voltage For LCD   | $V_{DD}-V_0$    | $T_a=-20^{\circ}\text{C}$ | —            | —   | 5.2          | V    |
|                          |                 | $T_a=25^{\circ}\text{C}$  | —            | 3.7 | —            | V    |
|                          |                 | $T_a=70^{\circ}\text{C}$  | 3.2          | —   | —            | V    |
| Input High Volt.         | $V_{IH}$        | —                         | $0.7 V_{DD}$ | —   | $V_{DD}$     | V    |
| Input Low Volt.          | $V_{IL}$        | —                         | $V_{SS}$     | —   | 0.6          | V    |
| Output High Volt.        | $V_{OH}$        | —                         | $0.7 V_{DD}$ | —   | —            | V    |
| Output Low Volt.         | $V_{OL}$        | —                         | —            | —   | $0.2 V_{DD}$ | V    |
| Supply Current           | $I_{DD}$        | $V_{DD}=3.3\text{V}$      | 1.0          | 1.2 | 1.5          | mA   |

## 14. Backlight Information

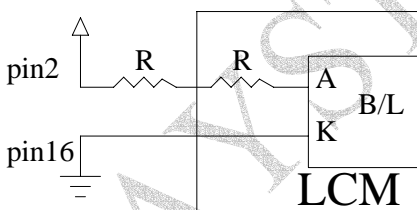
### Specification

| PARAMETER                             | SYMBOL           | MIN | TYP | MAX | UNIT              | TEST CONDITION   |
|---------------------------------------|------------------|-----|-----|-----|-------------------|--|
| Supply Current                        | I <sub>LED</sub> | —   | 32  | 40  | mA                | V=3.5V   |
| Supply Voltage                        | V                | 3.4 | 3.5 | 3.6 | V                 | —  |
| Reverse Voltage                       | V <sub>R</sub>   | —   | —   | 5   | V                 | —  |
| Luminous Intensity                    | I <sub>V</sub>   | 400 | 500 | —   | CD/M <sup>2</sup> | I <sub>LED</sub> =32mA                                 |
| LED Life Time<br>(For Reference only) | —                | —   | 50K | —   | Hr.               | I <sub>LED</sub> ≤ 32mA<br>25°C, 50-60%RH,<br>(Note 1) |
| Color                                 | White            |     |     |     |                   |  |

**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).

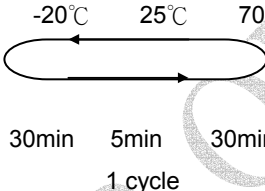
**Note 1:** 50K hours is only an estimate for reference.

2. Drive from pin2, pin16



# 15. Reliability

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

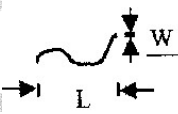
| Environmental Test                      |  |   |      |
|---|--|---|------|
| Test Item                               | Content of Test  | Condition   | Note |
| High Temperature storage                | Endurance test applying the high storage temperature for a long time.  | 80°C<br>200hrs  | 2    |
| Low Temperature storage                 | Endurance test applying the high storage temperature for a long time.  | -30°C<br>200hrs   | 1,2  |
| High Temperature Operation              | Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.   | 70°C<br>200hrs  | -    |
| Low Temperature Operation               | Endurance test applying the electric stress under low temperature for a long time.   | -20°C<br>200hrs   | 1    |
| High Temperature/<br>Humidity Operation | The module should be allowed to stand at 60°C,90%RH max For 96hrs under no-load condition excluding the polarizer, Then taking it out and drying it at normal temperature.   | 60°C,90%RH<br>96hrs   | 1,2  |
| Thermal shock resistance                | <p>The sample should be allowed stand the following 10 cycles of operation</p>  <p style="text-align: center;">-20°C    25°C    70°C</p> <p style="text-align: center;">30min   5min   30min</p> <p style="text-align: center;">1 cycle</p> | -20°C/70°C<br>10 cycles   | -    |
| Vibration test                          | Endurance test applying the vibration during transportation and using.   | fixed amplitude:<br>15mm<br>Vibration.<br>Frequency:<br>10~55Hz.<br>One cycle 60 seconds to 3 directions of X,Y,Z for Each 15 minutes | 3    |
| Static electricity test                 | Endurance test applying the electric stress to the terminal.   | VS=800V,RS=<br>1.5kΩ<br>CS=100pF<br>1 time  | —    |

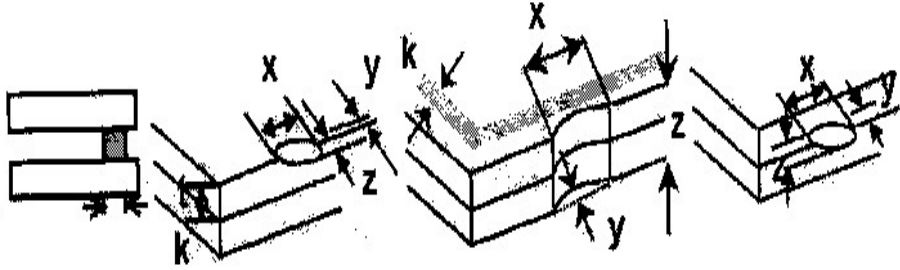
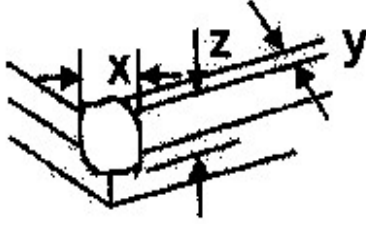
**Note1: No dew condensation to be observed.**

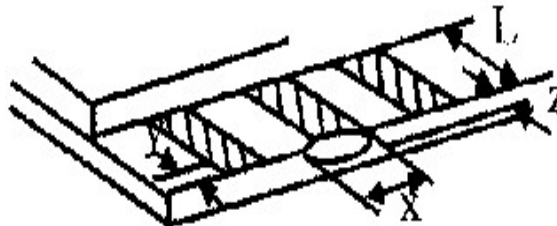
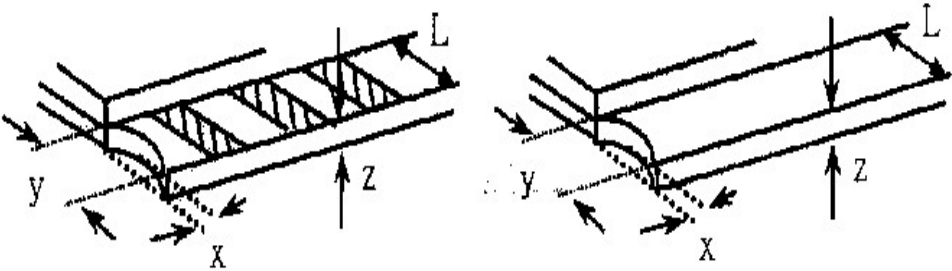
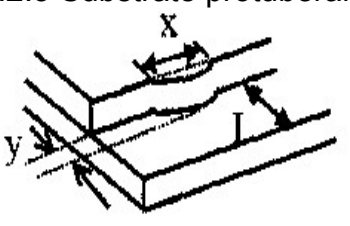
**Note2: The function test shall be conducted after 4 hours storage at the normal temperature and humidity after remove from the test chamber.**

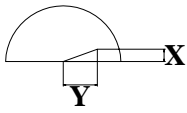
**Note3: Vibration test will be conducted to the product itself without putting it in a container.**

## 16. Inspection specification

| NO                      | Item  | Criterion   | AQL         |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
|-------------------------|---|---|-------------|----------------|------------------|-----------------|-------------------------|---------------|-------------------------|--------------|----------------------|---|--------------|----------------------|-----|
| 01                      | Electrical Testing  | 1.1 Missing vertical, horizontal segment, segment contrast defect.<br>1.2 Missing character, dot or icon.<br>1.3 Display malfunction.<br>1.4 No function or no display.<br>1.5 Current consumption exceeds product specifications.<br>1.6 LCD viewing angle defect.<br>1.7 Mixed product types.<br>1.8 Contrast defect.   | 0.65        |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| 02                      | Black or white spots on LCD (display only)                | 2.1 White and black spots on display $\leq 0.25\text{mm}$ , no more than three white or black spots present.<br>2.2 Densely spaced: No more than two spots or lines within 3mm  | 2.5         |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| 03                      | LCD black spots, white spots, contamination (non-display) | 3.1 Round type : As following drawing<br>$\Phi = (x + y) / 2$   | 2.5         |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
|                         |   | 3.2 Line type : (As following drawing)<br> <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Length</th> <th>Width</th> <th>Acceptable QTY</th> </tr> </thead> <tbody> <tr> <td>---</td> <td><math>W \leq 0.02</math></td> <td>Accept no dense</td> </tr> <tr> <td><math>L \leq 3.0</math></td> <td><math>0.02 &lt; W \leq 0.03</math></td> <td rowspan="2">2</td> </tr> <tr> <td><math>L \leq 2.5</math></td> <td><math>0.03 &lt; W \leq 0.05</math></td> </tr> <tr> <td>---</td> <td><math>0.05 &lt; W</math></td> <td>As round type</td> </tr> </tbody> </table> |             | Length         | Width            | Acceptable QTY  | ---                     | $W \leq 0.02$ | Accept no dense         | $L \leq 3.0$ | $0.02 < W \leq 0.03$ | 2 | $L \leq 2.5$ | $0.03 < W \leq 0.05$ | --- |
| Length                  | Width   | Acceptable QTY  |             |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| ---                     | $W \leq 0.02$   | Accept no dense   |             |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| $L \leq 3.0$            | $0.02 < W \leq 0.03$                                      | 2   |             |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| $L \leq 2.5$            | $0.03 < W \leq 0.05$                                      |   |             |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| ---                     | $0.05 < W$  | As round type   |             |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| 04                      | Polarizer bubbles   | If bubbles are visible, judge using black spot specifications, not easy to find, must check in specify direction. <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Size <math>\Phi</math></th> <th>Acceptable QTY</th> </tr> </thead> <tbody> <tr> <td><math>\Phi \leq 0.20</math></td> <td>Accept no dense</td> </tr> <tr> <td><math>0.20 &lt; \Phi \leq 0.50</math></td> <td>3</td> </tr> <tr> <td><math>0.50 &lt; \Phi \leq 1.00</math></td> <td>2</td> </tr> <tr> <td><math>1.00 &lt; \Phi</math></td> <td>0</td> </tr> <tr> <td>Total QTY</td> <td>3</td> </tr> </tbody> </table>  | Size $\Phi$ | Acceptable QTY | $\Phi \leq 0.20$ | Accept no dense | $0.20 < \Phi \leq 0.50$ | 3             | $0.50 < \Phi \leq 1.00$ | 2            | $1.00 < \Phi$        | 0 | Total QTY    | 3                    | 2.5 |
| Size $\Phi$             | Acceptable QTY  |   |             |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| $\Phi \leq 0.20$        | Accept no dense   |   |             |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| $0.20 < \Phi \leq 0.50$ | 3   |   |             |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| $0.50 < \Phi \leq 1.00$ | 2   |   |             |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| $1.00 < \Phi$           | 0   |   |             |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |
| Total QTY               | 3   |   |             |                |                  |                 |                         |               |                         |              |                      |   |              |                      |     |

| NO                 | Item                  | Criterion  | AQL               |               |                |               |                       |               |                    |                 |               |                   |               |                |               |                       |               |                    |                 |               |     |
|--------------------|-----------------------|--|-------------------|---------------|----------------|---------------|-----------------------|---------------|--------------------|-----------------|---------------|-------------------|---------------|----------------|---------------|-----------------------|---------------|--------------------|-----------------|---------------|-----|
| 05                 | Scratches             | Follow NO.3 LCD black spots, white spots, contamination  |                   |               |                |               |                       |               |                    |                 |               |                   |               |                |               |                       |               |                    |                 |               |     |
| 06                 | Chipped glass         | <p>Symbols Define:<br/> x: Chip length      y: Chip width      z: Chip thickness<br/> k: Seal width      t: Glass thickness      a: LCD side length<br/> L: Electrode pad length:</p> <p>6.1 General glass chip :<br/> 6.1.1 Chip on panel surface and crack between panels:</p>  <table border="1" data-bbox="443 1077 1353 1234"> <thead> <tr> <th>z: Chip thickness</th> <th>y: Chip width</th> <th>x: Chip length</th> </tr> </thead> <tbody> <tr> <td><math>Z \leq 1/2t</math></td> <td>Not over viewing area</td> <td><math>x \leq 1/8a</math></td> </tr> <tr> <td><math>1/2t &lt; z \leq 2t</math></td> <td>Not exceed 1/3k</td> <td><math>x \leq 1/8a</math></td> </tr> </tbody> </table> <p>⊙ If there are 2 or more chips, x is total length of each chip.</p> <p>6.1.2 Corner crack:</p>  <table border="1" data-bbox="443 1615 1353 1771"> <thead> <tr> <th>z: Chip thickness</th> <th>y: Chip width</th> <th>x: Chip length</th> </tr> </thead> <tbody> <tr> <td><math>Z \leq 1/2t</math></td> <td>Not over viewing area</td> <td><math>x \leq 1/8a</math></td> </tr> <tr> <td><math>1/2t &lt; z \leq 2t</math></td> <td>Not exceed 1/3k</td> <td><math>x \leq 1/8a</math></td> </tr> </tbody> </table> <p>⊙ If there are 2 or more chips, x is the total length of each chip.</p> | z: Chip thickness | y: Chip width | x: Chip length | $Z \leq 1/2t$ | Not over viewing area | $x \leq 1/8a$ | $1/2t < z \leq 2t$ | Not exceed 1/3k | $x \leq 1/8a$ | z: Chip thickness | y: Chip width | x: Chip length | $Z \leq 1/2t$ | Not over viewing area | $x \leq 1/8a$ | $1/2t < z \leq 2t$ | Not exceed 1/3k | $x \leq 1/8a$ | 2.5 |
| z: Chip thickness  | y: Chip width         | x: Chip length   |                   |               |                |               |                       |               |                    |                 |               |                   |               |                |               |                       |               |                    |                 |               |     |
| $Z \leq 1/2t$      | Not over viewing area | $x \leq 1/8a$  |                   |               |                |               |                       |               |                    |                 |               |                   |               |                |               |                       |               |                    |                 |               |     |
| $1/2t < z \leq 2t$ | Not exceed 1/3k       | $x \leq 1/8a$  |                   |               |                |               |                       |               |                    |                 |               |                   |               |                |               |                       |               |                    |                 |               |     |
| z: Chip thickness  | y: Chip width         | x: Chip length   |                   |               |                |               |                       |               |                    |                 |               |                   |               |                |               |                       |               |                    |                 |               |     |
| $Z \leq 1/2t$      | Not over viewing area | $x \leq 1/8a$  |                   |               |                |               |                       |               |                    |                 |               |                   |               |                |               |                       |               |                    |                 |               |     |
| $1/2t < z \leq 2t$ | Not exceed 1/3k       | $x \leq 1/8a$  |                   |               |                |               |                       |               |                    |                 |               |                   |               |                |               |                       |               |                    |                 |               |     |

| NO   | Item           | Criterion  | AQL               |                |                   |                   |                       |               |                |            |
|--|----------------|--|-------------------|----------------|-------------------|-------------------|-----------------------|---------------|----------------|------------|
| 06   | Glass crack    | <p>Symbols :</p> <p>x: Chip length      y: Chip width      z: Chip thickness<br/>           k: Seal width      t: Glass thickness      a: LCD side length<br/>           L: Electrode pad length</p> <p>6.2 Protrusion over terminal :</p> <p>6.2.1 Chip on electrode pad :</p>  | 2.5               |                |                   |                   |                       |               |                |            |
|  |                | <table border="1"> <tr> <td>y: Chip width</td> <td>x: Chip length</td> <td>z: Chip thickness</td> </tr> <tr> <td><math>y \leq 0.5\text{mm}</math></td> <td><math>x \leq 1/8a</math></td> <td><math>0 &lt; z \leq t</math></td> </tr> </table>  |                   | y: Chip width  | x: Chip length    | z: Chip thickness | $y \leq 0.5\text{mm}$ | $x \leq 1/8a$ | $0 < z \leq t$ |            |
|  |                | y: Chip width  |                   | x: Chip length | z: Chip thickness |                   |                       |               |                |            |
|  |                | $y \leq 0.5\text{mm}$  |                   | $x \leq 1/8a$  | $0 < z \leq t$    |                   |                       |               |                |            |
| <p>6.2.2 Non-conductive portion:</p>   |                |  |                   |                |                   |                   |                       |               |                |            |
| <table border="1"> <tr> <td>y: Chip width</td> <td>x: Chip length</td> <td>z: Chip thickness</td> </tr> <tr> <td><math>y \leq L</math></td> <td><math>x \leq 1/8a</math></td> <td><math>0 &lt; z \leq t</math></td> </tr> </table> <p>⊙ If the chipped area touches the ITO terminal, over 2/3 of the ITO must remain and be inspected according to electrode terminal specifications.</p> <p>⊙ If the product will be heat sealed by the customer, the alignment mark not be damaged.</p> <p>6.2.3 Substrate protuberance and internal crack.</p>  <table border="1"> <tr> <td>y: width</td> <td>x: length</td> </tr> <tr> <td><math>y \leq 1/3L</math></td> <td><math>x \leq a</math></td> </tr> </table> | y: Chip width  | x: Chip length   | z: Chip thickness | $y \leq L$     | $x \leq 1/8a$     | $0 < z \leq t$    | y: width              | x: length     | $y \leq 1/3L$  | $x \leq a$ |
| y: Chip width  | x: Chip length | z: Chip thickness  |                   |                |                   |                   |                       |               |                |            |
| $y \leq L$   | $x \leq 1/8a$  | $0 < z \leq t$   |                   |                |                   |                   |                       |               |                |            |
| y: width   | x: length      |  |                   |                |                   |                   |                       |               |                |            |
| $y \leq 1/3L$  | $x \leq a$     |  |                   |                |                   |                   |                       |               |                |            |

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



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

## 17. Precautions in use of LCD Modules

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

## 18. Material List of Components for RoHs

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

Exhibit A : The Harmful Material List

| Material   | (Cd)    | (Pb)     | (Hg)     | (Cr6+)   | PBBs     | PBDEs    |
|--|---------|----------|----------|----------|----------|----------|
| Limited Value                                    | 100 ppm | 1000 ppm | 1000 ppm | 1000 ppm | 1000 ppm | 1000 ppm |
| Above limited value is set up according to RoHS. |         |          |          |          |          |          |

2. Process for RoHS requirement :

- (1) Use the Sn/Ag/Cu soldering surface ; the surface of Pb-free solder is rougher than we used before.
- (2) Heat-resistance temp. :  
 Reflow : 250°C, 30 seconds Max. ;  
 Connector soldering wave or hand soldering : 320°C, 10 seconds max.
- (3) Temp. curve of reflow, max. Temp. : 235±5°C ;  
 Recommended customer's soldering temp. of connector : 280°C, 3 seconds.

## 19. Recommendable storage

1. Place the panel or module in the temperature 25°C±5°C and the humidity below 65% RH
2. Do not place the module near organics solvents or corrosive gases.
3. Do not crush, shake, or jolt the module

**LCM Sample Estimate Feedback Sheet**

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

**1 、 Panel Specification :**

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

**2 、 Mechanical Specification :**

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

**3 、 Relative Hole Size :**

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

**4 、 Backlight Specification :**

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

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

**5 、 Electronic Characteristics of Module :**

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

**6 、 Summary :**
**Sales signature :** \_\_\_\_\_

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

**Date :**    /    /