



RAYSTAR



SPECIFICATION



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SPECIFICATION

REC001602AYPP5N00001

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 |
|------------|---------|------------------|-------------|
| 2010/08/13 | 1 | | First issue |

2. General Specification

The Features is described as follow:

- Module dimension: 80.0 ×36.0 × 10.0 (max.) mm³
- View area: 66.0 × 16.0 mm²
- Active area: 56.95 × 11.85 mm²
- Number of dots: 16 x 2
- Pixel size: 0.55 x 0.65 mm²
- Pixel pitch: 0.60 x0.70 mm²
- Character size: 2.95x5.55 mm²
- Character pitch:3.6 x6.3 mm²
- Module type: Character Passive Matrix
- Duty: 1/16
- Emitting Color: Yellow

3. Module Coding System

| | | | | | | | | | | |
|----------|----------|----------|---------------|----------|----------|----------|----------|----------|----------|--------------|
| R | E | C | 001602 | A | Y | P | P | 5 | N | 00001 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

| Item | Description | |
|------|--|--|
| 1 | R : Raystar Optronics Inc. | |
| 2 | E : OLED | |
| 3 | Display Type : C → Character Type , G→Graphic Type | |
| 4 | Number of dots : 16 characters, 2Lines. | |
| 5 | Serials code | |
| 6 | Emitting Color | A : Amber R : RED |
| | | B : Blue Y : Yellow |
| | | G : Green W : White |
| 7 | Polarizer | P : With Polarizer ; N: Without Polarizer |
| 8 | Display Mode | P : Passive Matrix ; A: Active Matrix |
| 9 | Driver Voltage | 3: 3.0 V; 5: 5.0V |
| 10 | Touch Panel | N : Without touch panel ; T: With touch panel |
| 11 | Serial No. | 0001: Sales code |

4. Interface Pin Function

| No. | Symbol | I/O | Function |
|-----|--------|-------|--|
| 1 | VSS | 0V | Ground |
| 2 | VDD | 5.0V | Supply Voltage for logic |
| 3 | NC | — | |
| 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 | NC | — | |
| 16 | NC | — | |

✳️ Brightness Control

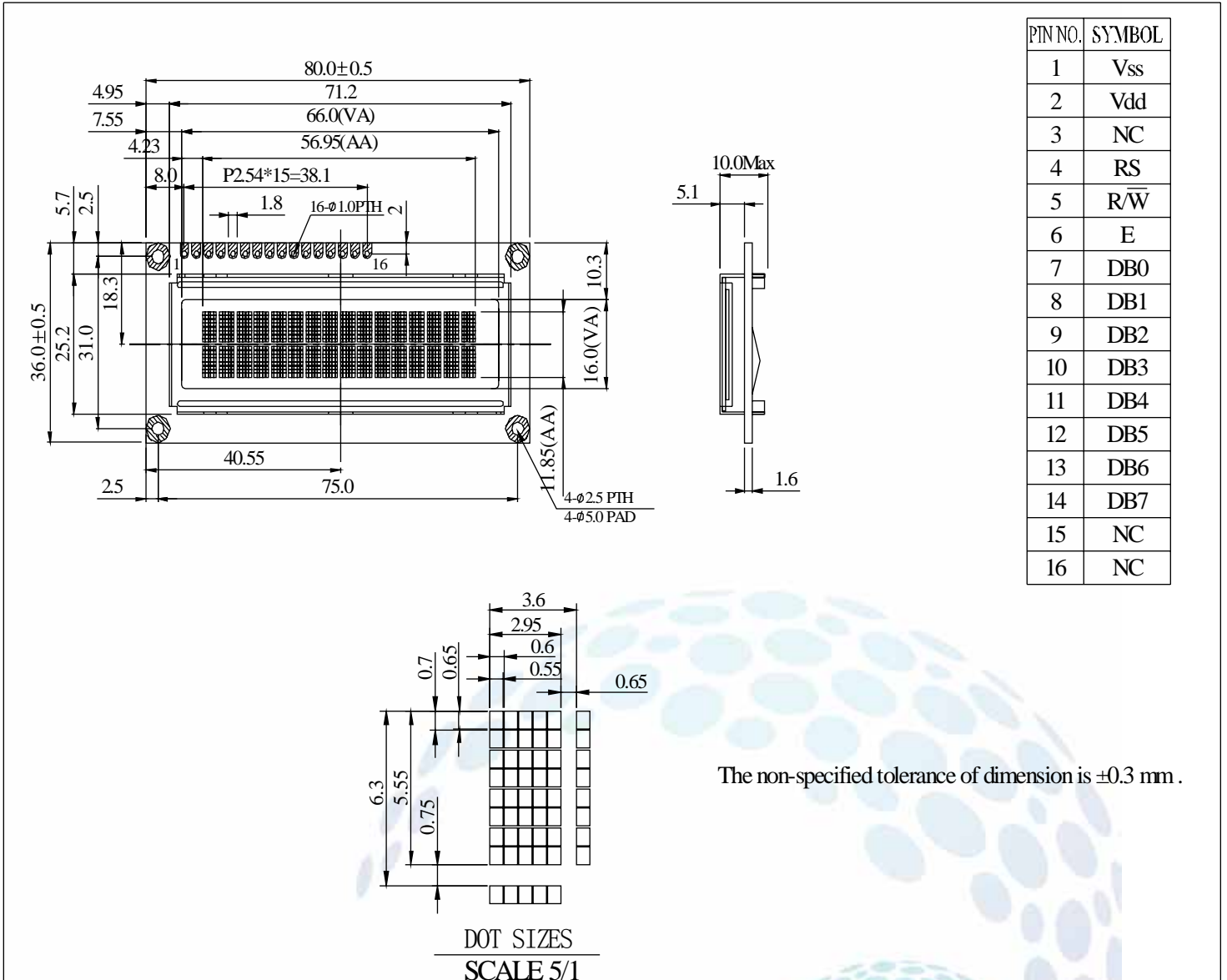
| Brightness(nits) | Power consumption(measured with random texts) |
|------------------|---|
| 125(typical) | 150mW(5V*30mA) |

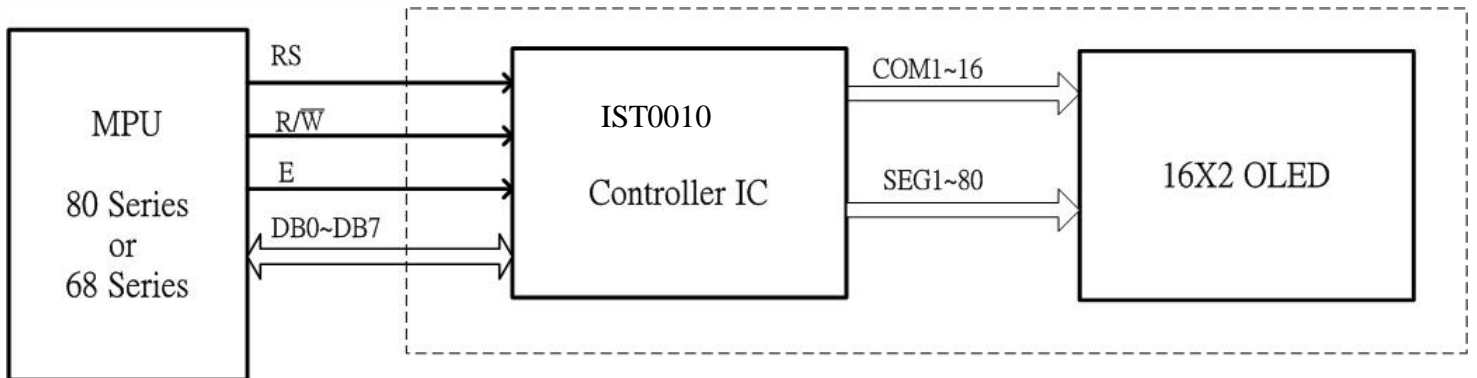
Notes: 1. When random texts pattern is running, averagely, at any instance, about 1/2 of pixels will be

on.

2. You can use the display off mode to make long life.

5. Outline Dimension





| Address Format | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|------------------------|-----|------|------|------|------|------|------|------|
| CA (Character Address) | 1 | ADD6 | ADD5 | ADD4 | ADD3 | ADD2 | ADD1 | ADD0 |

| 1 | 2 | 3 | 4 | ..... | ..... | 13 | 14 | 15 | 16 |
|------------|------------|------------|------------|-------|-------|------------|------------|------------|------------|
| CA10000000 | CA10000001 | CA10000010 | CA10000011 | ..... | ..... | CA10001100 | CA10001101 | CA10001110 | CA10001111 |
| CA11000000 | CA11000001 | CA11000010 | CA11000011 | ..... | ..... | CA11001100 | CA11001101 | CA11001110 | CA11001111 |

6. Optics & Electrical Characteristics

REGISTERS

IC provides two types of 8-bit registers, namely: Instruction Register (IR) and Data Register (DR). The register is selected using the RS Pin. When the RS pin is set to "0", the Instruction Register Type is selected. When RS pin is set to "1", the Data Register Type is selected. Please refer to the table below.

| RS | R/WB | Operation |
|----|------|---|
| 0 | 0 | Instruction register write as an internal operation. |
| 0 | 1 | Read busy flag (DB7) and address counter (DB0 to DB6) |
| 1 | 0 | Data register write as an internal operation (DR to DDRAM or CGRAM) |
| 1 | 1 | Data register read as an internal operation (DDRAM or CGRAM to DR) |

INSTRUCTION REGISTER (IR)

The Instruction Register is used to store the instruction code (i.e. Display Clear, Cursor Home and others), Display Data RAM (DDRAM) Address, and the Character Generator RAM (CGRAM) Address. Instruction register can only be written from the MPU.

DATA REGISTER (DR)

The Data Register is used as a temporary storage for data that are going to be written into the DDRAM or CGRAM as well as those data that are going to be read from the DDRAM or CGRAM.

BUSY FLAG (BF)

The Busy Flag is used to determine whether IC is idle or internally operating. When IC is performing some internal operations, the Busy Flag is set to "1". Under this condition, the no other instruction will not be accepted. When RS Pin is set to "0" and R/WB Pin is set to "1", the Busy Flag will be outputted to the DB7 pin.

When IC is idle or has completed its previous internal operation, the Busy Flag is set to "0". The next instruction can now be processed or executed.

ADDRESS COUNTER (AC)

The address counter is used to assign the Display Data RAM (DDRAM) Address and the Character Generator RAM (CGRAM) Address. When Address information is written into the Instruction Register (IR), this Address information is sent from the Instruction Register to the Address Counter. At the same time, the nature of the Address (either CGRAM or DDRAM) is determined by the instruction. After writing into or reading from the DDRAM or CGRAM, the Address Counter is automatically increased or decreased by 1 (for Write or Read Function). It must be noted that when the RS pin is set to "0" and R/WB is set to "1", the contents of the Address Counter are outputted to the pins -- DB0 to

DISPLAY DATA RAM (DDRAM)

The Display Data RAM (DDRAM) is used to store the Display Data which is represented as 8-bit character code. The Display Data RAM supports an extended capacity of 128 x 8-bits or 128 characters.

The Display Data RAM Address (ADD) is set in the Address Counter as a hexadecimal.

| | High Order Bits | | | Low Order Bits | | | |
|-----------------------|-----------------|-----|-----|----------------|-----|-----|-----|
| Address Counter (hex) | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |

An example of a DDRAM Address=39 is given below.

| DDRAM Address: 39 | | | | | | |
|-------------------|-----|-----|-----|-----|-----|-----|
| AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 |

1-LINE DISPLAY (N=0)

When the number of characters displayed is less than 128, the first character is displayed at the head position. The relationship between the DDRAM Address and position on the OLED Panel is shown below.

| Display Position (digit) | 1 | 2 | 3 | 4 | ..... | 126 | 127 | 128 |
|-----------------------------|----|----|----|----|-------|-----|-----|-----|
| DDRAM address (hexadecimal) | 00 | 01 | 02 | 03 | ..... | 7D | 7E | 7F |

For example, when only 8 characters are displayed in one Display Line, the relationship between the DDRAM Address and position on the OLED Panel is shown below.

| Display Position | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|------------------|----|----|----|----|----|----|----|----|
| DDRAM address | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 |
| Shift left | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 |
| Shift right | 7F | 00 | 01 | 02 | 03 | 04 | 05 | 06 |

2-LINE DISPLAY (N=1)

Case 1: The Number of Characters displayed is less than 64 x 2 lines

When the number of characters displayed is less than 64 x 2 lines, then the first character of the first and second lines are displayed starting from the head. It is important to note that every line reserve 64 x8bits DDRAM space. 1st line is 00 to 3F,second line is 40 to 7F.Please refer the figure below.

| Display Position | 1 | 2 | 3 | 4 | ..... | 61 | 62 | 63 | 64 |
|--------------------------------|----|----|----|----|-------|----|----|----|----|
| DDRAM Address (hexadecimal) | 00 | 01 | 02 | 03 | ..... | 3C | 3D | 3E | 3F |
| | 40 | 41 | 42 | 43 | ..... | 7C | 7D | 7E | 7F |

To illustrate, for 2-line x 20 characters display, the relationship between the DDRAM address and position of the OLED panel is shown below.

| Display Position | 1 | 2 | 3 | 4 | ..... | 18 | 19 | 20 |
|--------------------------------|----|----|----|----|-------|----|----|----|
| DDRAM address (hexadecimal) | 00 | 01 | 02 | 03 | ..... | 11 | 12 | 13 |
| | 40 | 41 | 42 | 43 | ..... | 51 | 52 | 53 |
| Shift left | 01 | 02 | 03 | 04 | ..... | 19 | 20 | 21 |
| | 41 | 42 | 43 | 44 | ..... | 52 | 53 | 54 |
| Shift right | 3F | 00 | 01 | 02 | ..... | 10 | 11 | 12 |
| | 7F | 40 | 41 | 42 | ..... | 50 | 51 | 52 |

Case 2: 40-Character x 2 Lines Display

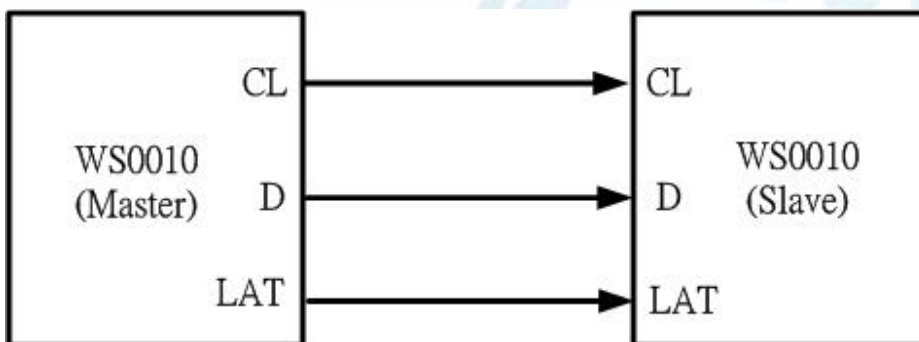
IC(Master) can be extended to display 40 characters x 2 lines by cascade the other IC(Slave). When there is a Display Shift operation, the DDRAM Address is also shifted. Please refer to the example below.

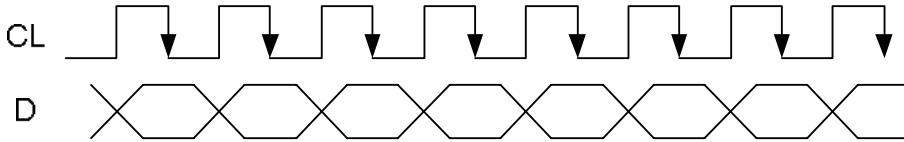
| Display Position | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | ... | 37 | 38 | 39 | 40 |
|------------------|---------------------|----|----|----|----|----|----|----|-----------------------------------|----|----|-----|----|----|----|----|
| DDRAM address | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | ... | 24 | 25 | 26 | 27 |
| | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | ... | 64 | 65 | 66 | 67 |
| | IC display (Master) | | | | | | | | Cascade 2 nd IC(Slave) | | | | | | | |
| Shift left | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | ... | 25 | 26 | 27 | 28 |
| | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | ... | 65 | 66 | 67 | 68 |
| Shift right | 3F | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | ... | 23 | 24 | 25 | 26 |
| | 7F | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | ... | 63 | 64 | 65 | 66 |

SLAVE MODE DATA INPUT

When IC is under slave mode, display data is send from the other IC(master).The input data "D" is shifted at the falling edge of CL

| M/S | Mode | D | CL | LAT |
|-----|--------|--------|--------|--------|
| H | Master | Output | Output | Output |
| L | Slave | Input | Input | Input |

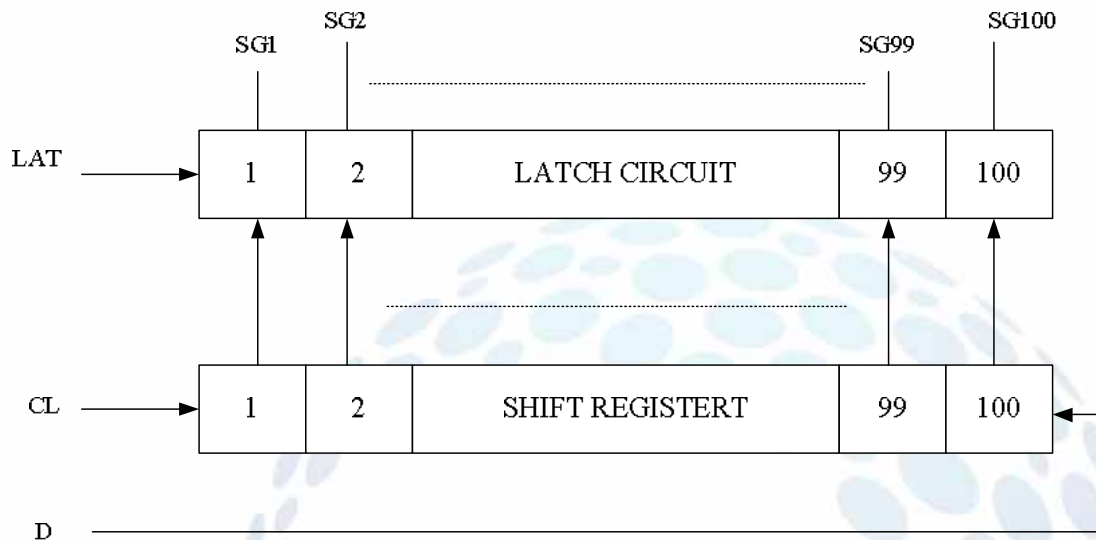




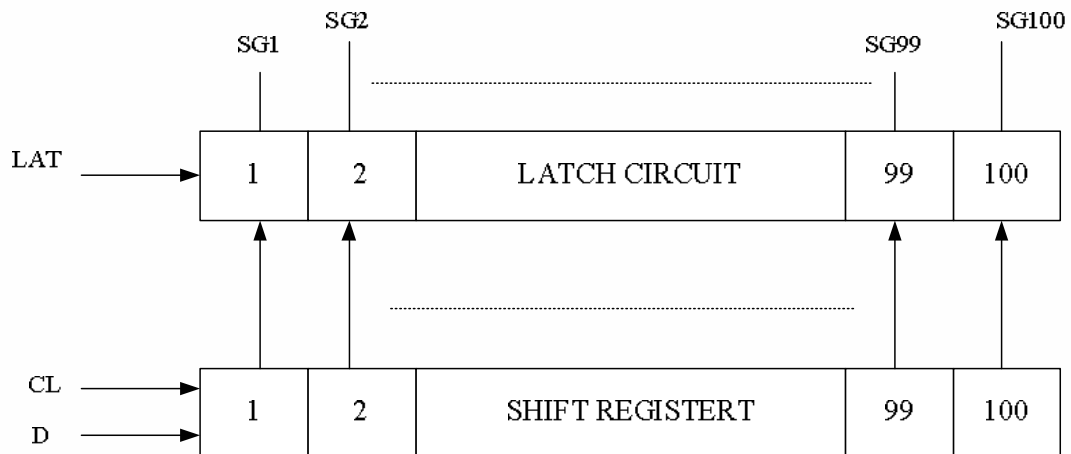
BIDIRECTIONAL SHIFT REGISTER BLOCK

This block shifts the serial data at the falling edge of CL. When SHL is set "H", the data input from D is shifted from bit100 to bit1 (When IC is "master" mode, D is output; When IC is "slave" mode, D is input). When SHL is set "L", the data input is shifted from bit1 to bit100.

Condition 1 : SHL="H"



Condition 2 : SHL="L



CHARACTER GENERATOR ROM (CGROM)

The Character Generator ROM (CGROM) is used to generate either 5 x 8 dots or 5 x 10 dots character patterns from 8-bit character codes. IC build in three set of font tables as "Western European", "English Japanese" and "English Russian". User can use software to select suitable font table (**Default "English Japanese"**).

CHARACTER GENERATOR RAM (CGRAM)

The Character Generator RAM (CGRAM) is used to generate either 5 x 8 dot or 5 x 10 dot character patterns. It can generate eight 5 x 8 dot character patterns or four 5 x 10 dot character patterns. The character patterns generated by the CGRAM can be rewritten. User-defined character patterns for the CGRAM are supported.

RELATIONSHIP BETWEEN CGRAM ADDRESS, DDRAM CHARACTER CODE AND CGRAM CHARACTER PATTERNS (FOR 5 X 8 DOT CHARACTER PATTERN)

| 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 | * | * | * | 1 | 1 | 1 | 1 | 0 | Character pattern 1 |
| | | | | | | | | | | | 0 | 0 | 1 | * | * | * | 1 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | 0 | 1 | 0 | * | * | * | 1 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | 0 | 1 | 1 | * | * | * | 1 | 1 | 1 | 1 | 0 | |
| | | | | | | | | | | | 1 | 0 | 0 | * | * | * | 1 | 0 | 1 | 0 | 0 | |
| | | | | | | | | | | | 1 | 0 | 1 | * | * | * | 1 | 0 | 0 | 1 | 0 | |
| | | | | | | | | | | | 1 | 1 | 0 | * | * | * | 1 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | 1 | 1 | 1 | * | * | * | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | 0 | | | | 0 | | | | Cursor Position | | | |
| 0 | 0 | 0 | 0 | * | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | * | * | * | 1 | 0 | 0 | 0 | 1 | Character pattern 2 |
| | | | | | | | | | | | 0 | 0 | 1 | * | * | * | 0 | 1 | 0 | 1 | 0 | |
| | | | | | | | | | | | 0 | 1 | 0 | * | * | * | 1 | 1 | 1 | 1 | 1 | |
| | | | | | | | | | | | 0 | 1 | 1 | * | * | * | 0 | 0 | 1 | 0 | 0 | |
| | | | | | | | | | | | 1 | 0 | 0 | * | * | * | 1 | 1 | 1 | 1 | 1 | |
| | | | | | | | | | | | 1 | 0 | 1 | * | * | * | 0 | 0 | 1 | 0 | 0 | |
| | | | | | | | | | | | 1 | 1 | 0 | * | * | * | 0 | 0 | 1 | 0 | 0 | |
| | | | | | | | | | | | 1 | 1 | 1 | * | * | * | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | 0 | | | | 0 | | | | Cursor position | | | |
| 0 | 0 | 0 | 0 | * | . | . | . | . | . | . | . | . | . | * | * | * | . | . | . | . | . | Character pattern 3~7 |
| | | | | | | | | | | | . | . | . | * | * | * | . | . | . | . | . | |
| | | | | | | | | | | | . | . | . | * | * | * | . | . | . | . | . | |
| | | | | | | | | | | | . | . | . | * | * | * | . | . | . | . | . | |
| | | | | | | | | | | | . | . | . | * | * | * | . | . | . | . | . | |
| 0 | 0 | 0 | 0 | * | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | * | * | * | 0 | 0 | 0 | 0 | 0 | Character pattern 8 |
| | | | | | | | | | | | 0 | 0 | 1 | * | * | * | 0 | 1 | 0 | 1 | 0 | |
| | | | | | | | | | | | 0 | 1 | 0 | * | * | * | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | 0 | 1 | 1 | * | * | * | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | 1 | 0 | 0 | * | * | * | 1 | 0 | 0 | 0 | 1 | |
| | | | | | | | | | | | 1 | 0 | 1 | * | * | * | 0 | 1 | 1 | 1 | 0 | |
| | | | | | | | | | | | 1 | 1 | 0 | * | * | * | 0 | 0 | 1 | 0 | 0 | |
| | | | | | | | | | | | 1 | 1 | 1 | * | * | * | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | 0 | | | | 0 | | | | Cursor position | | | |

Notes:

1. * = Not Relevant

2. The character pattern row positions correspond to the CGRAM data bits -- 0 to 4, where bit 4 is in the left position.

3. Character Code Bits 0 to 2 correspond to the CGRAM Address Bits 3 to 5 (3 bits: 8 types)

4. If the CGRAM Data is set to "1", then the selection is displayed. If the CGRAM is set to "0", there no selection is made.

5. The CGRAM Address Bits 0 to 2 are used to define the character pattern line position. The 8th line is the cursor position and its display is formed by the logical OR with the cursor. The 8th line CGRAM data bits 0 to 4 must be set to "0". If any of the 8th line CGRAM data bits 0 to 4 is set to "1", the corresponding display location will light up regardless of the cursor position.

6. When the Character Code Bits 4 to 7 are set to "0", then the CGRAM Character Pattern is selected. It must be noted that Character Code Bit 3 is not relevant and will not have any effect on the character display. Because of this, the first Character Pattern shown above (R) can be displayed when the Character Code is 00H or 08H.



RELATIONSHIP BETWEEN CGRAM ADDRESS, DDRAM CHARACTER CODE AND CGRAM CHARACTER PATTERNS (FOR 5 X10 DOT CHARACTER PATTERN)

| 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 1 0 0 | Character pattern 1 | | | | | | | |
| | | | | | | | | | | 0 | 0 | 0 | 1 | * * * 0 1 1 1 0 | | | | | | | | |
| | | | | | | | | | | 0 | 0 | 1 | 0 | * * * 1 0 1 0 1 | | | | | | | | |
| | | | | | | | | | | 0 | 0 | 1 | 1 | * * * 1 0 1 0 0 | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 0 | 0 | * * * 0 1 1 0 0 | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 0 | 1 | * * * 0 0 1 1 0 | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 1 | 0 | * * * 0 0 1 0 1 | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 1 | 1 | * * * 1 0 1 0 1 | | | | | | | | |
| | | | | | | | | | | 1 | 0 | 0 | 0 | * * * 0 1 1 1 0 | | | | | | | | |
| | | | | | | | | | | 1 | 0 | 0 | 1 | * * * 0 0 1 0 0 | | | | | | | | |
| | | | | | | | | | | 1 | 0 | 1 | 0 | * * * * * * * * | | Cursor Position | | | | | | |
| | | | | | | | | | | 1 | 0 | 1 | 1 | * * * * * * * * | | | | | | | | |
| 1 | 1 | 0 | 0 | * * * * * * * * | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 0 | 1 | * * * * * * * * | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 1 | 0 | * * * * * * * * | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 1 | 1 | * * * * * * * * | | | | | | | | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | * | . | . | * | . | . | 0 | 0 | 0 | 0 | * * * | Character pattern 2~3 | | | | | | | |
| | | | | | | | | | | 0 | 0 | 0 | 1 | * * * | | | | | | | | |
| | | | | | | | | | | 0 | 0 | 1 | 0 | * * * | | | | | | | | |
| | | | | | | | | | | 0 | 0 | 1 | 1 | * * * | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 0 | 0 | * * * | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 0 | 1 | * * * | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 1 | 0 | * * * | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 1 | 1 | * * * | | | | | | | | |
| | | | | | | | | | | 1 | 0 | 0 | 0 | * * * | | | | | | | | |
| | | | | | | | | | | 1 | 0 | 0 | 1 | * * * | | | | | | | | |
| | | | | | | | | | | 1 | 0 | 1 | 0 | * * * | | | | | | | | |
| | | | | | | | | | | 1 | 0 | 1 | 1 | * * * | | | | | | | | |
| 0 | 0 | 0 | 0 | * | 1 | 1 | * | 1 | 1 | 0 | 0 | 0 | 0 | * * * 1 0 1 0 1 | Character pattern 4 | | | | | | | |
| | | | | | | | | | | 0 | 0 | 0 | 1 | * * * 1 1 1 1 1 | | | | | | | | |
| | | | | | | | | | | 0 | 0 | 1 | 0 | * * * 1 1 1 1 1 | | | | | | | | |
| | | | | | | | | | | 0 | 0 | 1 | 1 | * * * 1 1 1 1 1 | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 0 | 0 | * * * 0 1 1 1 0 | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 0 | 1 | * * * 0 0 1 0 0 | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 1 | 0 | * * * 0 0 1 0 0 | | | | | | | | |
| | | | | | | | | | | 0 | 1 | 1 | 1 | * * * 1 0 1 0 1 | | | | | | | | |
| | | | | | | | | | | 1 | 0 | 0 | 0 | * * * 0 1 1 1 0 | | | | | | | | |
| | | | | | | | | | | 1 | 0 | 0 | 1 | * * * 0 0 1 0 0 | | | | | | | | |
| | | | | | | | | | | 1 | 0 | 1 | 0 | * * * * * * * * | | Cursor Position | | | | | | |
| | | | | | | | | | | 1 | 0 | 1 | 1 | * * * * * * * * | | | | | | | | |
| 1 | 1 | 0 | 0 | * * * * * * * * | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 0 | 1 | * * * * * * * * | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 1 | 0 | * * * * * * * * | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 1 | 1 | * * * * * * * * | | | | | | | | | | | | | | | | | | |

Notes:

1. * = Not Relevant
2. The character pattern row positions correspond to the CGRAM data bits -- 0 to 4, where bit 4 is in the left position.
3. Character Code Bits 1 and 2 correspond to the CGRAM Address Bits -- 4 and 5 respectively (2 bits : 4 types)
4. If the CGRAM Data is set to "1", then the selection is displayed. If the CGRAM is set to "0", there no selection is made.
5. The CGRAM Address Bits 0 to 3 are used to define the character pattern line position. The 11th line is the cursor position and its display is formed by the logical OR with the cursor. The 11th line CGRAM data bits 0 to 4 must be set to "0". If any of the 11th line CGRAM data bits 0 to 4 is set to "1", the corresponding display location will light up regardless of the cursor position.
6. When the Character Code Bits 4 to 7 are set to "0", then the CGRAM Character Pattern is selected. It must be noted that Character Code Bit -- 0 and 3 are not relevant and will not have any effect on the character display. Because of this, the Character Pattern shown above (\$) can be displayed when the Character Code is 00H, 01H, 08H or 09H.

TIMING GENERATION CIRCUIT

The timing signals for the internal circuit operations (i.e. DDRAM, CGRAM, and CGROM) are generated by the Timing Generation Circuit. The timing signals for the MPU internal operation and the RAM Read for Display are generated separately in order to prevent one from interfering with the other. This means that, for example, when the data is being written into the DDRAM, there will be no unwanted interference such as flickering in areas other than the display area.

OLED DRIVER CIRCUIT

IC provides 16 Common Drivers and 100 Segment Driver Outputs. When a character font and the number of lines to be displayed have been selected, the corresponding Common Drivers output the waveform automatically. A non-selection waveform will be outputted by the rest of the Common outputs.

CURSOR/BLINK CONTROL CIRCUIT

The cursor or character blinking is generated by the Cursor / Blink Control Circuit. The cursor or the blinking will appear with the digit located at the Display Data RAM (DDRAM) Address Set in the Address Counter (AC).

| | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |
|-----------------|-----|-----|-----|-----|-----|-----|-----|
| Address counter | 0 | 0 | 0 | 0 | 1 | 1 | 1 |

CASE 1: FOR 1-LINE DISPLAY

Example: When the Address Counter (AC) is set to 0EH, the cursor position is displayed at DDRAM Address 0EH.

| | | | | | | | | | | | |
|-----------------------------|----|----|----|----|----|-------|----|-----------|-------|----|----|
| Display position | 1 | 2 | 3 | 4 | 5 | ..... | 14 | 15 | ..... | 19 | 20 |
| DDRAM address (hexadecimal) | 00 | 01 | 02 | 03 | 04 | ..... | 0D | 0E | ..... | 12 | 13 |

|
Cursor Position

Notes:

The cursor or blinking appears when the Address Counter (AC) selects the Character Generator RAM (CGRAM). When the AC selects CGRAM Address, then the cursor or the blinking is displayed in a irrelevant and meaningless position.

CASE 2: FOR 2-LINE DISPLAY

Example: When the Address Counter (AC) is set to 46H, the cursor position is displayed at DDRAM Address 46H.

| | | | | | | | | | | | |
|-----------------------------|----|----|----|----|----|----|----|----|-------|----|----|
| Display position | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | ..... | 19 | 20 |
| DDRAM address (hexadecimal) | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | ..... | 09 | 13 |
| | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | ..... | 49 | 53 |

Cursor Position

Notes:

The cursor or blinking appears when the Address Counter (AC) selects the Character Generator RAM (CGRAM). When the AC selects CGRAM Address, then the cursor or the blinking is displayed in an irrelevant and meaningless position.

CHARACTER MODE ADDRESSING

IC provides two kind of character mode. User can fill in 128 characters data (N=0, one line) or 64 characters data per line (N=1, two line) in embedded RAM to display graphic. Character mode address can be controlled by DDRAM address instruction.

| | | | | | | | | |
|------------------------|-----|------|------|------|------|------|------|------|
| Address Format | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
| CA (Character Address) | 1 | ADD6 | ADD5 | ADD4 | ADD3 | ADD2 | ADD1 | ADD0 |

(1) 1-Line condition (N=0)

| 1 | 2 | 3 | 4 | ..... | ..... | 125 | 126 | 127 | 128 |
|-------------|-------------|-------------|-------------|-------|-------|-------------|-------------|-------------|-------------|
| CA=10000000 | CA=10000001 | CA=10000010 | CA=10000011 | | | CA=11111100 | CA=11111101 | CA=11111110 | CA=11111111 |

(2) 2-Line condition (N=1)

| 1 | 2 | 3 | 4 | ..... | ..... | 61 | 62 | 63 | 64 |
|-------------|-------------|-------------|-------------|-------|-------|-------------|-------------|-------------|-------------|
| CA=10000000 | CA=10000001 | CA=10000010 | CA=10000011 | | | CA=10111100 | CA=10111101 | CA=10111110 | CA=10111111 |
| CA=11000000 | CA=11000001 | CA=11000010 | CA=11000011 | | | CA=11111100 | CA=11111101 | CA=11111110 | CA=11111111 |

GRAPHIC MODE ADDRESSING

IC provides not only character mode but also graphic mode. User can fill in 100x16 data in embedded RAM to display graphic. Graphic mode addressing is different from character mode.

Use DDRAM address instruction to set X-axis address of Graphic mode and CGRAM address instruction to set Y-axis of Graphic mode.

| Address Format | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|------------------------------|-----|------|------|------|------|------|------|------|
| GXA (Graphic X-axis Address) | 1 | ADD6 | ADD5 | ADD4 | ADD3 | ADD2 | ADD1 | ADD0 |
| GYA (Graphic Y-axis Address) | 0 | 1 | 0 | 0 | 0 | 0 | 0 | CGA0 |

| | 1 | 2 | 3 | 4 | | | 97 | 98 | 99 | 100 | |
|--------|------------------------------|------------------------------|------------------------------|------------------------------|-------|-------|----|------------------------------|------------------------------|------------------------------|------------------------------|
| CGA0=0 | GXA=10000000 GYA=01000000 | GXA=10000001 GYA=01000000 | GXA=10000010 GYA=01000000 | GXA=10000011 GYA=01000000 | D0 | | | GXA=11100000 GYA=01000000 | GXA=11100001 GYA=01000000 | GXA=11100010 GYA=01000000 | GXA=11100011 GYA=01000000 |
| | | | | | D1 | | | | | | |
| | | | | | D2 | | | | | | |
| | | | | | D3 | | | | | | |
| | | | | | D4 | | | | | | |
| | | | | | D5 | | | | | | |
| | | | | | D6 | | | | | | |
| | | | | | D7 | | | | | | |
| C | | X | X | X | | | X | X | X | X | |



7. Absolute Maximum Ratings

CHARACTER GENERATOR ROM (CGROM)

IC provides three set of character font. Character font can be selected by programming FT.

ENGLISH_JAPANESE CHARACTER FONT TABLE(default FT[1:0]= 00)

| Upper 4bit Lower 4bit | LLLL | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|--------------------------|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL | CG RAM (1) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| LLLL | CG RAM (2) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| LLHL | CG RAM (3) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| LLHH | CG RAM (4) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| LHLL | CG RAM (5) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| LHLH | CG RAM (6) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| LHHL | CG RAM (7) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| LHHH | CG RAM (8) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| HLLL | CG RAM (9) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| HLLH | CG RAM (10) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| HLHL | CG RAM (11) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| HLHH | CG RAM (12) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| HHLL | CG RAM (13) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| HHLH | CG RAM (14) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| HHHL | CG RAM (15) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |
| HHHH | CG RAM (16) | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ | ☒ |

WESTERN EUROPEAN CHARACTER FONT TABLE I (FT[1:0]=01)

| Upper 4bit Lower 4bit | LLLL | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|--------------------------|-------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL | CG RAM (1) | | | ø | á | â | ã | ä | å | æ | ç | è | é | ê | ë | ï |
| LLLL | CG RAM (2) | | ! | 1 | A | Q | 3 | 4 | 0 | E | Y | ± | L | 7 | 9 | 9 |
| LLHL | CG RAM (3) | | " | 2 | B | R | b | r | 0 | E | 1 | U | B | 7 | 9 | 9 |
| LLHH | CG RAM (4) | | # | 3 | O | S | s | o | E | 1 | T | R | 7 | 9 | 9 | 9 |
| LHLL | CG RAM (5) | | * | 4 | D | T | d | t | 0 | E | 1 | ↓ | 9 | 7 | 9 | 9 |
| LHLH | CG RAM (6) | | × | 5 | E | U | e | u | 0 | E | 1 | 9 | 9 | 7 | 9 | 9 |
| LHHL | CG RAM (7) | | 8 | 6 | F | V | f | v | 0 | E | 9 | 9 | 9 | 7 | 9 | 9 |
| LHHH | CG RAM (8) | | 7 | 7 | G | W | g | w | 0 | E | 9 | 9 | 9 | 9 | 9 | 9 |
| HLLL | CG RAM (9) | | C | 8 | H | X | h | x | 0 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| HLLH | CG RAM (10) | | > | 9 | I | Y | i | y | 0 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| HLHL | CG RAM (11) | | * | : | J | Z | j | z | 0 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| HLHH | CG RAM (12) | | + | ; | K | L | k | l | 0 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| HHLL | CG RAM (13) | | , | < | L | Y | l | y | 0 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| HHLH | CG RAM (14) | | - | = | M | I | m | i | 0 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| HHHL | CG RAM (15) | | . | > | N | ^ | n | ^ | 0 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| HHHH | CG RAM (16) | | / | ? | 0 | □ | o | * | 0 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |

ENGLISH_RUSSIAN CHARACTER FONT TABLE(FT[1:0]=10)

| Upper 4bit | LLLL | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LHHH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|---------------|-------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| LLLL | CG RAM (1) | А | В | С | Д | Е | Ж | З | И | Й | К | Л | М | Н | О | П |
| LLLL | CG RAM (2) | а | б | в | г | д | е | ж | з | и | й | к | л | м | н | о |
| LLHL | CG RAM (3) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| LLHH | CG RAM (4) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| LHLL | CG RAM (5) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| LHLH | CG RAM (6) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| LHHL | CG RAM (7) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| LHHH | CG RAM (8) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| HLLL | CG RAM (9) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| HLLH | CG RAM (10) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| HLHL | CG RAM (11) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| HLHH | CG RAM (12) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| HHLL | CG RAM (13) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| HHLH | CG RAM (14) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| HHHL | CG RAM (15) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |
| HHHH | CG RAM (16) | А | Б | В | Г | Д | Е | Ж | З | И | Й | К | Л | М | Н | О |

WESTERN EUROPEAN CHARACTER FONT TABLE II (FT[1:0]=1)

| Upper 4bit Lower 4bit | LLLL | LLLH | LLHL | LLHH | LHLL | LHLH | LHHL | LH HH | HLLL | HLLH | HLHL | HLHH | HHLL | HHLH | HHHL | HHHH |
|--------------------------|-------------|------|------|------|------|------|------|-------|------|------|------|------|------|------|------|------|
| LLLL | CG RAM (1) | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| LLLL | CG RAM (2) | ≡ | ! | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| LLHL | CG RAM (3) | 7 | " | 2 | B | R | B | r | ± | ± | ± | ± | ± | ± | ± | ± |
| LLHH | CG RAM (4) | ± | # | 3 | C | S | C | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| LHLL | CG RAM (5) | ± | 4 | D | T | d | t | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| LHLH | CG RAM (6) | ± | 5 | E | U | e | u | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| LHHL | CG RAM (7) | ± | 6 | F | U | f | u | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| LH HH | CG RAM (8) | ± | 7 | G | W | g | w | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| HLLL | CG RAM (9) | ± | 8 | H | X | h | x | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| HLLH | CG RAM (10) | ± | 9 | I | Y | i | y | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| HLHL | CG RAM (11) | ± | ± | J | Z | j | z | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| HLHH | CG RAM (12) | ± | ± | K | L | k | l | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| HHLL | CG RAM (13) | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| HHLH | CG RAM (14) | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| HHHL | CG RAM (15) | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± |
| HHHH | CG RAM (16) | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± | ± |

8. Block Diagram

| Instruction | Code | | | | | | | | | | Description | Max. Execution Time when fsp or fosc = 250KHz |
|------------------------------------|------|------|------------|-----|-----|-----|-----|-----|-----|-------------------------------------|---|---|
| | RS | R/WB | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 | | |
| Clear Display | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Clears entire display. Sets DDRAM Address 0 into the Address Counter | 6.2ms |
| Return Home | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | Sets DDRAM Address 0 into the Address Counter. Returns shifted display to original position. DDRAM contents remain unchanged. (DB0 is test pin. User should set DB0=0 all the time) | 0 |
| Entry Mode Set | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | S | Sets cursor move direction and specifies display shift. (These operations are performed during data write and read.) | 0 |
| Display ON/OFF Control | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B | Sets entire Display (D) ON/OFF. Sets Cursor (C) ON/OFF. Sets Blinking (B) of Cursor Position Character. | 0 |
| Cursor/ Display Shift/ Mode/ Pwr | 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | 0 | 0 | Moves cursor & shifts display without changing DDRAM contents. | 0 |
| | | | | | | | G/C | PWR | 1 | 1 | Sets Graphic/Character Mode Sets internal power on/off | |
| Function Set | 0 | 0 | 0 | 0 | 1 | DL | N | F | FT1 | FT0 | Sets interface data length (DL). Sets number of display lines (N). Sets Character Font (F). Sets Font Table (FT) | 0 |
| Set CGRAM Address | 0 | 0 | 0 | 1 | ACG | ACG | ACG | ACG | ACG | ACG | Sets CGRAM Address. CGRAM data is sent and received after this setting. | 0 |
| Set DDRAM Address | 0 | 0 | 1 | ADD | ADD | ADD | ADD | ADD | ADD | ADD | Sets DDRAM Address. The DDRAM data is sent and received after this setting. | 0 |
| Read Busy Flag & Address | 0 | 1 | BF | AC | AC | AC | AC | AC | AC | AC | Reads Busy Flag (BF) indicating that internal operation is being performed. Reads Address Counter contents. | 0 |
| Write data into the CGRAM or DDRAM | 1 | 0 | Write Data | | | | | | | Writes data into the CGRAM or DDRAM | | 0 |
| Read Data from the CGRAM or DDRAM | 1 | 1 | Read Data | | | | | | | Read data from the CGRAM or DDRAM | | 0 |

9. Timing Characteristics

AC CHARACTERISTICS

Read / Write Characteristics (8080-series MPU)

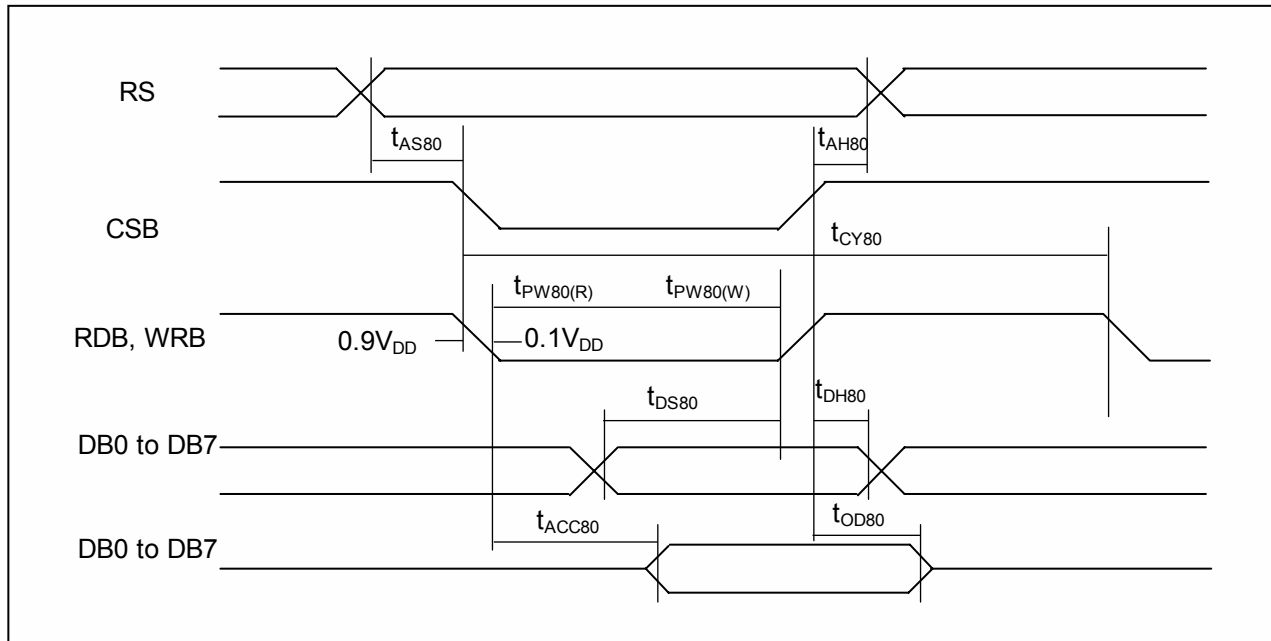


Figure 1. Read / Write Characteristics (8080-series MPU)

VDD = 4.7 to 5.3V, Ta = 25°C)

| Item | Signal | Symbol | Min. | Typ. | Max. | Unit | Remark |
|---------------------|------------------|----------|------|------|------|------|------------|
| Address setup time | RS | tAS80 | 20 | - | - | ns | |
| Address hold time | | tAH80 | 0 | - | - | ns | |
| System cycle time | | tCY80 | 500 | - | - | ns | |
| Pulse width (WRB) | RW_WRB | tPW80(W) | 250 | - | - | ns | |
| Pulse width (RDB) | E_RDB | tPW80(R) | 250 | - | - | ns | |
| Data setup time | DB7 to DB0 | tDS80 | 40 | - | - | ns | |
| Data hold time | | tDH80 | 20 | - | - | ns | |
| Read access time | DB0 | tACC80 | - | - | 180 | ns | CL = 100pF |
| Output disable time | | tOD80 | 10 | - | - | ns | |

Read / Write Characteristics (6800-series Microprocessor)

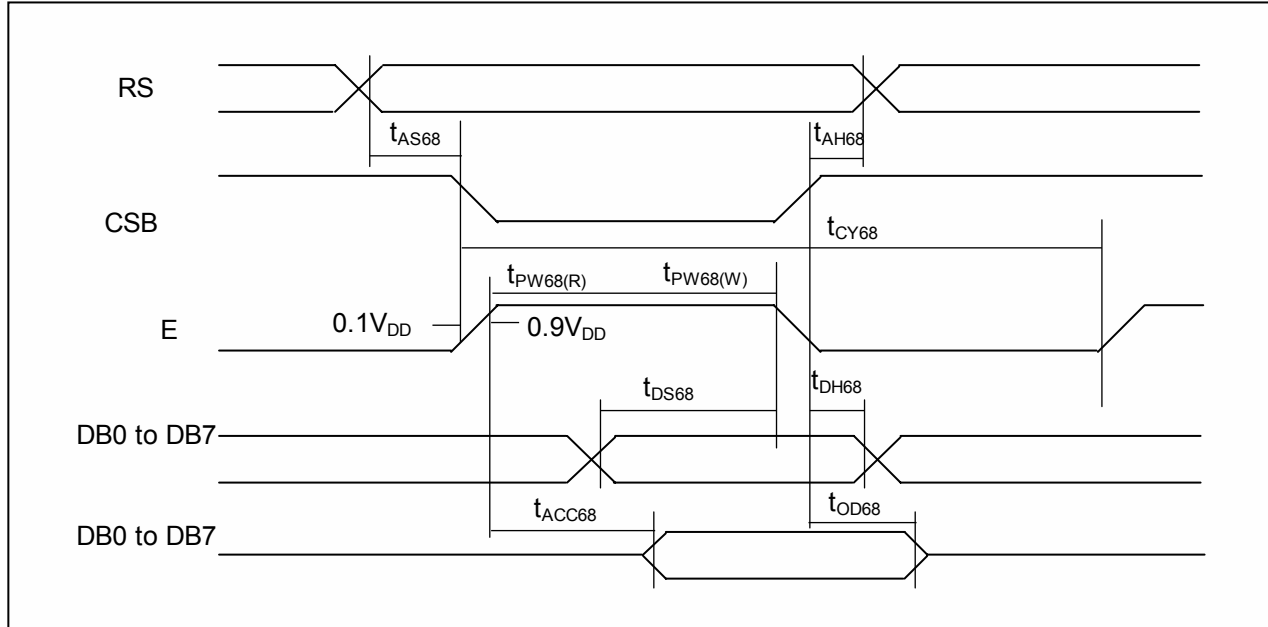


Figure 2. Read / Write Characteristics (6800-series MPU)

(VDD = 4.7 to 5.3V, Ta = 25°C)

| Item | Signal | Symbol | Min. | Typ. | Max. | Unit | Remark |
|---------------------|------------|----------|------|------|------|------|------------|
| Address setup time | RS | tAS68 | 20 | - | - | ns | |
| Address hold time | RS | tAH68 | 0 | - | - | ns | |
| System cycle time | | tCY68 | 500 | - | - | ns | |
| Pulse width (E) | E_RDB | tPW68(W) | 250 | - | - | ns | |
| Pulse width (E) | E_RDB | tPW68(R) | 250 | - | - | ns | |
| Data setup time | DB7 | tDS68 | 40 | - | - | ns | |
| Data hold time | DB7 to DB0 | tDH68 | 20 | - | - | ns | |
| Read access time | DB0 | tACC68 | - | - | 180 | ns | CL = 100pF |
| Output disable time | DB0 | tOD68 | 10 | - | - | ns | |

Serial Interface Characteristics

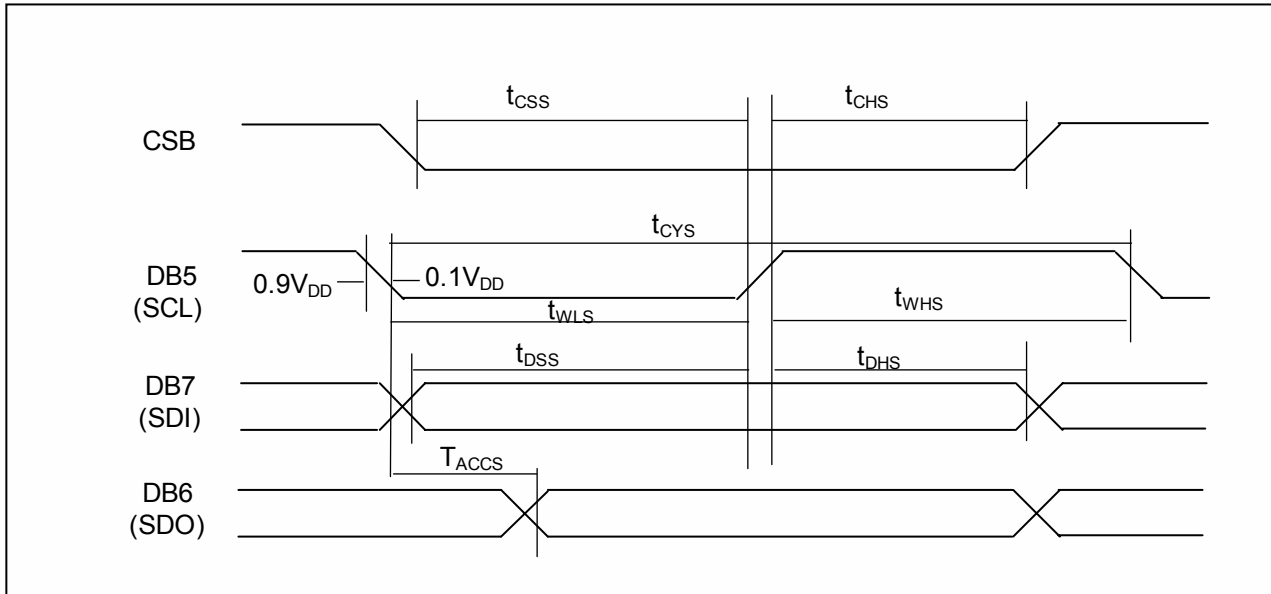


Figure 3. Serial Interface Characteristics

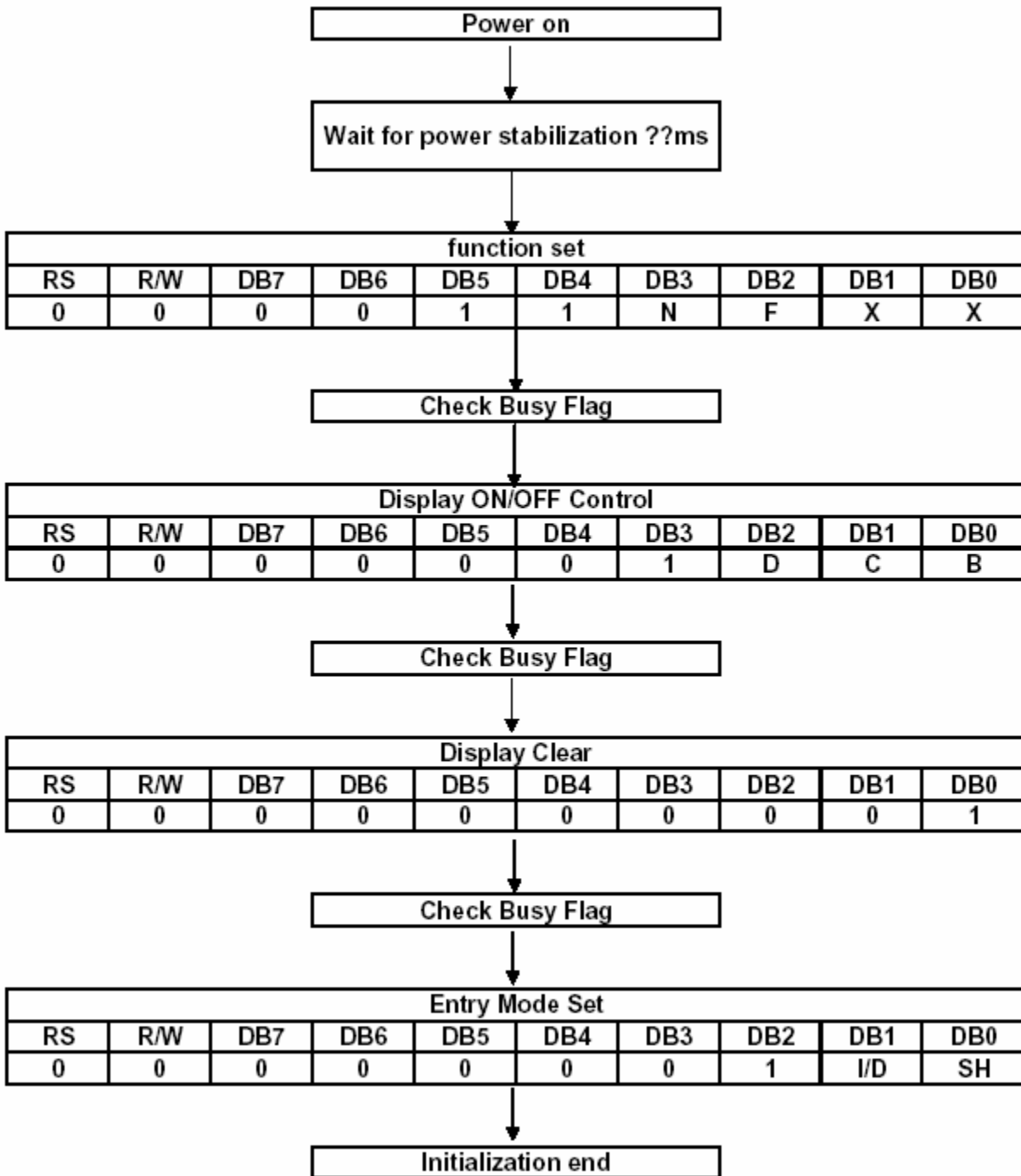
(VDD = 4.7 to 5.3V, Ta = 25°C)

| Item | Signal | Symbol | Min. | Typ. | Max. | Unit | Remark |
|----------------------|-----------|--------|------|------|------|------|--------|
| Serial clock cycle | DB5 (SCL) | tCYS | 300 | - | - | ns | |
| SCL high pulse width | DB5 (SCL) | tWHS | 100 | - | - | ns | |
| SCL low pulse width | DB5 (SCL) | tWLS | 100 | - | - | ns | |
| CSB setup time | CSB | tCSS | 150 | - | - | ns | |
| CSB hold time | CSB | tCHS | 150 | - | - | ns | |
| Data setup time | DB7 (SDI) | tDSS | 100 | - | - | ns | |
| Data hold time | DB7 (SDI) | tDHS | 100 | - | - | ns | |
| Read access time | DB6 (SDO) | tACCS | - | - | 80 | ns | |

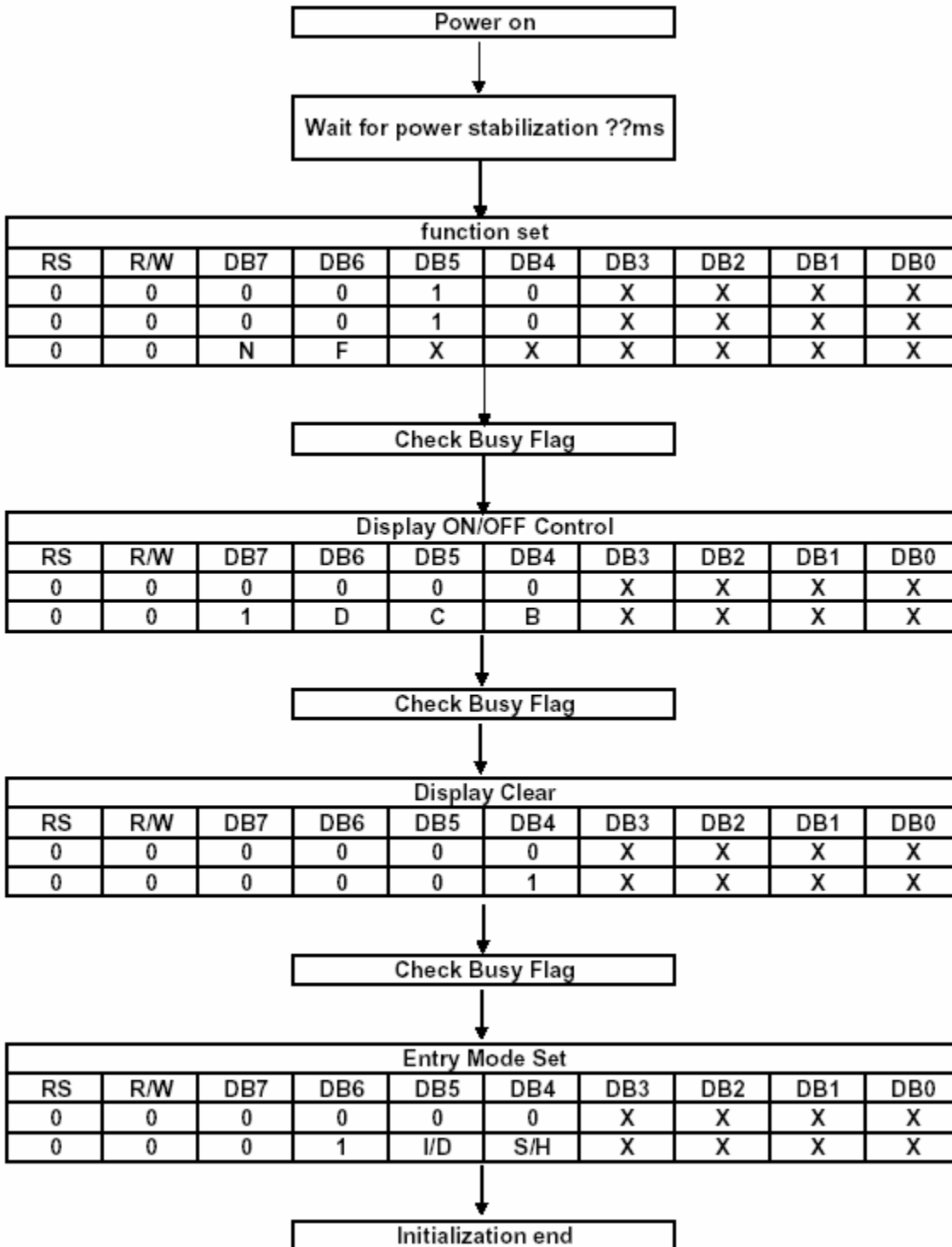
Serial Interface Characteristics

10. Initializing of OLED Module

(1)8-bit mode



(2)4-bit mode



INSTRUCTIONS

IC Instruction Register (IR) and Data Register (DR) are the only registers that can be controlled by the MPU. Prior to the commencement of its internal operation, IC temporarily stores the control information to its Instruction Register (IR) and Data Register (DR) in order to easily facilitate interface with various types of MPU. The internal operations of the IC are determined by the signals (RS, R/WB, DB0 to DB7) that are sent from the MPU. These signals are categorized into 4 instructions types, namely:

- 1, Function Setting Instructions (i.e. Display, Format, Data Length etc.)
2. Internal RAM Address Setting Instructions
3. Data Transfer with Internal RAM Instructions
4. Miscellaneous Function Instructions

The generally used instructions are those that execute data transfers with the internal RAM. However, when the internal RAM addresses are auto incremented/decremented by 1 after each Data Write, the program load of the MPU is lightened. The Display Shift Instruction can be executed at the same time as the Display Data Write, thereby minimizing system development time with maximum programming efficiency.

When an instruction is being executed for an internal operation, only the Busy Flag/Address Read

Instruction can be performed. The other instructions are not valid. It should be noted that during the execution of an instruction, the Busy Flag is set to "1". The Busy Flag is set to "0" when the instructions

are can be accepted and executed. Therefore, the Busy Flag should be checked to make certain that

BF = "0" before sending another instruction from the MPU. If not, the time between the first instruction and the next instruction is longer than the time it takes to execute the instruction itself.

| Instruction | Code | | | | | | | | | | Description | Max. Execution Time when fsp or fosc = 250KHz |
|------------------------------------|------|------|------------|-----|-----|-----|-----|-----|-----|-------------------------------------|--|---|
| | RS | R/WB | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 | | |
| Clear Display | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Clears entire display. Sets DDRAM Address 0 into the Address Counter | 6.2ms |
| Return Home | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | Sets DDRAM Address 0 into the Address Counter. Returns shifted display to original position. DDRAM contents remain unchanged. (DB0 is test pin. User should set DB0=0 all the time) | 0 |
| Entry Mode Set | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | S | Sets cursor move direction and specifies display shift. (These operations are performed during data write and read.) | 0 |
| Display ON/OFF Control | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B | Sets entire Display (D) ON/OFF. Sets Cursor (C) ON/OFF. Sets Blinking (B) of Cursor Position Character. | 0 |
| Cursor/ Display Shift/ Mode/ Pwr | 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | 0 | 0 | Moves cursor & shifts display without changing DDRAM contents. | 0 |
| | | | | | | | G/C | PWR | 1 | 1 | Sets Graphic/Character Mode Sets internal power on/off | |
| Function Set | 0 | 0 | 0 | 0 | 1 | DL | N | F | FT1 | FT0 | Sets interface data length (DL). Sets number of display lines (N). Sets Character Font (F). Sets Font Table (FT) | 0 |
| Set CGRAM Address | 0 | 0 | 0 | 1 | ACG | ACG | ACG | ACG | ACG | ACG | Sets CGRAM Address. CGRAM data is sent and received after this setting. | 0 |
| Set DDRAM Address | 0 | 0 | 1 | ADD | ADD | ADD | ADD | ADD | ADD | ADD | Sets DDRAM Address. The DDRAM data is sent and received after this setting. | 0 |
| Read Busy Flag & Address | 0 | 1 | BF | AC | AC | AC | AC | AC | AC | AC | Reads Busy Flag (BF) indicating that internal operation is being performed. Reads Address Counter contents. | 0 |
| Write data into the CGRAM or DDRAM | 1 | 0 | Write Data | | | | | | | Writes data into the CGRAM or DDRAM | | 0 |
| Read Data from the CGRAM or DDRAM | 1 | 1 | Read Data | | | | | | | Read data from the CGRAM or DDRAM | | 0 |

Notes:

1. After the CGRAM/DDRAM Read or Write Instruction has been executed, the RAM Address Counter is incremented or decremented by 1. After the Busy Flag is turned OFF, the RAM Address is updated.
2. I/D=Increment/Decrement Bit
 - I/D="1": Increment
 - I/D="0": Decrement
3. S=Shift Entire Display Control Bit. When S="0", shift function disable.
4. BF=Busy Flag
 - BF="1": Internal Operating in Progress
 - BF="0": No Internal Operation is being executed, next instruction can be accepted.
5. R/L=Shift Right/Left
 - R/L="1": Shift to the Right
 - R/L="0": Shift to the Left
6. S/C=Display Shift/Cursor Move
 - S/C="1": Display Shift
 - S/C="0": Cursor Move
7. G/C=Graphic/Character mode selection. G/C="0", Character mode is selected. G/C="1", Graphic mode is selected.
8. PWR=Internal DCDC on/of control. PWR="1", DCDC on. PWR="0", DCDC off.
9. DDRAM=Display Data RAM
10. CGRAM=Character Generator RAM
11. ACG=CGRAM Address
12. ADD=Address Counter Address (corresponds to cursor address)
13. AC=Address Counter (used for DDRAM and CGRAM Addresses)
14. F=Character Pattern Mode
 - F="1": 5 x 10 dots
 - F="0": 5 x 8 dots
15. N=Number of Lines Displayed
 - N="1": 2-Line Display
 - N="0": 1-Line Display

INSTRUCTION DESCRIPTION

CLEAR DISPLAY INSTRUCTION

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

This instruction is used to clear the Display Write Space 20H in all DDRAM Addresses. That is, the character pattern for the Character Code 20H must be a BLANK pattern. It then sets the DDRAM Address 0 into the Address Counter and reverts the display to its original state (if the display has been shifted). The display will be cleared and the cursor or blinking will go to the left edge of the display. If there are 2 lines displayed, the cursor or blinking will go to the first line's left edge of the display.

Under the Entry Mode, this instruction also sets the I/D to 1 (Increment Mode). The S Bit of the Entry Mode does not change.

RETURN HOME INSTRUCTION

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

Note: * = Not Relevant

This instruction is used to set the DDRAM Address 0 into the Address Counter and revert the display to its original status (if the display has been shifted). The DDRAM contents do not change. The cursor or blinking will go to the left edge of the display. If there are 2 lines displayed, the cursor or blinking will go to the first line's left edge of the display.

ENTRY MODE SET INSTRUCTION

The Entry Mode Set Instruction has two controlling bits: I/D and S. Please refer to the table below.

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

I/D IS THE INCREMENT/DECREMENT BIT.

When I/D is set to "1", the DDRAM Address is incremented by "1" when a character code is written into

or read from the DDRAM. An increment of 1 will move the cursor or blinking one step to the right. When I/D is set to "0", the DDRAM is decremented by 1 when a character code is written into or read from the DDRAM. A decrement of 1 will move the cursor or blinking one step to the left.

S: SHIFT ENTIRE DISPLAY CONTROL BIT

This bit is used to shift the entire display. When S is set to "1", the entire display is shifted to the right

(when I/D ="0") or left (when I/D ="1"). When S is set to "0", the display is not shifted.

Ex1 : I/D=1, S=1

| | | | | | | | | |
|---|---|---|---|---|---|---|--|--------------------------------|
| | | 1 | 2 | 3 | 4 | _ | | Initial display |
| | 1 | 2 | 3 | 4 | A | _ | | Input new character "A" |
| 1 | 2 | 3 | 4 | A | B | _ | | Input new character "B" |
| 2 | 3 | 4 | A | B | C | _ | | Input new character "C" |
| 3 | 4 | A | B | C | D | _ | | Input new character "D" |

Ex2 : I/D=0, S=1

| | | | | | | | | |
|---|---|---|---|---|---|---|--|--------------------------------|
| 1 | 2 | 3 | 4 | _ | | | | Initial display |
| | 1 | 2 | 3 | 4 | A | | | Input new character "A" |
| | | 1 | 2 | 3 | B | A | | Input new character "B" |
| | | | 1 | 2 | C | B | | Input new character "C" |
| | | | | 1 | D | C | | Input new character "D" |

DISPLAY ON/OFF CONTROL INSTRUCTION

The Display On / OFF Instruction is used to turn the display ON or OFF. The controlling bits are D, C and B.

| RS | R/WB | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|------|-----|-----|-----|-----|-----|-----|-----|-----|
|----|------|-----|-----|-----|-----|-----|-----|-----|-----|

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B |
|---|---|---|---|---|---|---|---|---|---|

CURSOR/DISPLAY SHIFT INSTRUCTION

This instruction is used to shift the cursor or display position to the left or right without writing or reading

the Display Data. This function is used to correct or search the display. Please refer to the table below.

| RS | R/WB | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|------|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | G/C | PW | 1 | 1 |

| S/C | R/L | Shift Function |
|-----|-----|---|
| 0 | 0 | Shifts the cursor position to the left. (AC is decremented by 1). |
| 0 | 1 | Shifts cursor position to the right. (AC incremented by 1). |
| 1 | 0 | Shifts entire display to the left. The cursor follows the display shift. |
| 1 | 1 | Shifts the entire display to the right. The cursor follows the display shift. |

In a 2-line Display, the cursor moves to the second line when it passes the 40th digit of the first line.

The first and second line displays will shift at the same time.

When the displayed data is shifted repeatedly, each line moves only horizontally. The second line display does not shift into the first line position.

The Address Counter (AC) contents will not change if the only action performed is a Display Shift.

G/C: GRAPHIC MODE / CHARACTER MODE SELECTION

This bit is used to select the display mode for further process.

When *G/C* = 1, the *GRAPHIC MODE* will be selected.

When *G/C* = 0, the *CHARACTER MODE* will be selected.

PWR: ENABLE/DISABLE INTERNAL POWER

This bit is used to turn ON or turn OFF the internal power.

When *PWR* = 1, the internal power is turned ON.

When *PWR* = 0, the internal power is turned OFF.

FUNCTION SET INSTRUCTION

The Function Set Instruction has three controlling 3 bits, namely: DL, N and F. Please refer to the table below.

| RS | R/WB | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|------|-----|-----|-----|-----|-----|-----|-----|-----|
|----|------|-----|-----|-----|-----|-----|-----|-----|-----|

| | | | | | | | | | |
|---|---|---|---|---|----|---|---|-----|-----|
| 0 | 0 | 0 | 0 | 1 | DL | N | F | FT1 | FT0 |
|---|---|---|---|---|----|---|---|-----|-----|

DL: INTERFACE DATA LENGTH CONTROL BIT

This is used to set the interface data length. When DL is set to "1", the data is sent or received in 8-bit length via the DB0 to DB7 (for an 8-Bit Data Transfer). When DL is set to "0", the data is sent or received in 4-bit length via DB4 to DB7 (for a 4-Bit Data Transfer). When the 4-bit data length is selected, the data must be sent or received twice.

N: NUMBER OF DISPLAY LINE

This is used to set the number of display lines. When N="1", the 2-line display is selected. When N is set to "0", the 1-line display is selected.

F: CHARACTER FONT SET

This is used to set the character font set. When F is set to "0", the 5 x 8 dot character font is selected. When F is set to "1", the 5 x 10 dot character font is selected. It must be noted that the character font setting must be performed at the head of the program before executing any instructions other than the Busy Flag and Address Instruction. Otherwise, the Function Set Instruction cannot be executed unless the interface data length is changed.

FT1, FT0: FONT TABLE SELECTION

These two bits are used to select one font table out of the three for further process.

When (FT1, FT0) = (0, 0), the *ENGLISH_JAPANESE CHARACTER FONT TABLE* will be selected.

(FT1, FT0) = (0, 1), the *WESTERN EUROPEAN CHARACTER FONT TABLE* will be selected.

(FT1, FT0) = (1, 0), the *ENGLISH_RUSSIAN CHARACTER FONT TABLE* will be selected.

(FT1, FT0) = (1, 1), N/A

Note: The default setting for FT1 and FT0 is 0 and 0 respectively which means the default Font Table

is *ENGLISH_JAPANESE CHARACTER FONT TABLE*.

SET CGRAM ADDRESS INSTRUCTION

This instruction is used to set the CGRAM Address binary AAAAAA into the Address Counter. Data is then written to or read from the MPU for CGRAM.

| RS | R/WB | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|------|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 0 | 0 | 0 | ACG | ACG | ACG | ACG | ACG | ACG |

Note: ACG is the CGRAM Address

SET DDRAM ADDRESS INSTRUCTION

This instruction is used to set the DDRAM Address binary AAAAAAA into the Address Counter.

The data is written to or read from the MPU for the DDRAM. If 1-line display is selected (N="0"), then

AAAAAAA can be 00H to 4FH. When the 2-line display is selected, then AAAAAAA can be 00H to 27H

for the first line and 40H to 67H for the second line.

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

Note: ADD = DDRAM Address

READ BUSY FLAG AND ADDRESS INSTRUCTION

This instruction is used to read the Busy Flag (BF) to indicate if IC is internally operating on a previously received instruction. If BF is set to "1", then the internal operation is in progress and the next instruction will not be accepted. If the BF is set to "0", then the previously received instruction has been executed and the next instruction can be accepted and processed. It is important to check the BF

status before proceeding to the next write operation. The value of the Address Counter in binary AAAAAAA is simultaneously read out. This Address Counter is used by both the CGRAM and the DDRAM and its value is determined by the previous instruction. The contents of the address are the same as for the instructions -- Set CGRAM Address and Set DDRAM Address.

| RS | R/WB | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|------|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 1 | BF | AC | AC | AC | AC | AC | AC | AC |

Notes:

1. BF=Busy Flag
2. AC=Address Counter

WRITE DATA TO CGRAM / DDRAM INSTRUCTION

This instruction writes 8-bit binary data -- DDDDDDDD to the CGRAM or the DDRAM. The previous CGRAM or DDRAM Address setting determines whether a data is to be written into the CGRAM or the DDRAM. After the write process is completed, the address is automatically incremented or

decremented by 1 in accordance with the Entry Mode instruction. It must be noted that the Entry Mode instruction also determines the Display Shift.

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

READ DATA FROM THE CGRAM OR DDRAM INSTRUCTION

This instruction reads the 8-bit binary data -- DDDDDDDD from the CGRAM or the DDRAM. The Set CGRAM Address or Set DDRAM Address Set Instruction must be executed before this instruction can be performed, otherwise, the first Read Data will not be valid.

| RS | R/WB | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|------|-----|-----|-----|-----|-----|-----|-----|-----|
| 1 | 1 | D | D | D | D | D | D | D | D |

MPU INTERFACE

IC provides High-speed 8-bit parallel bi-directional interface with 6800-series or 8080-series and serial interface. User can choice by signal "PS" and "C68".

68 – series interface

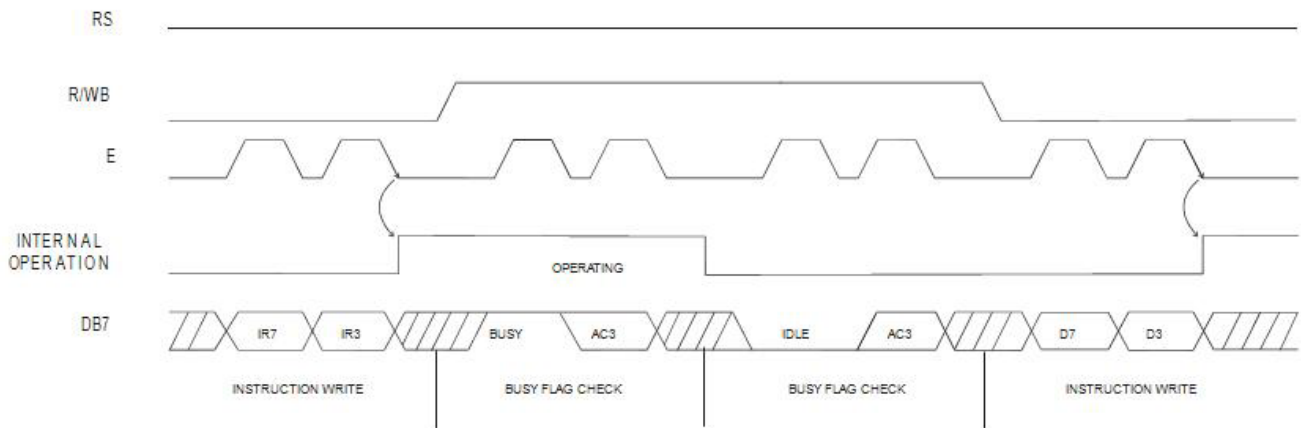
(a) 8-BIT mode **(Not available for serial mode)**

When IC interfaces with an 8-bit MPU, DB0 to DB7 are used. The 8-bit data transfer starts from the four high order bits --DB4 to DB7 followed by the four low order bits -- DB0 to DB3. An example of a Busy Flag Check Timing in an 8-Bit MPU Interface is given in the diagra

(b) 4-BIT mode **(Not available for serial mode)**

IC can be configured to interface with a 4-bit MPU and is selected via a program. If the I/O port of the 4-Bit MPU from which IC is connected to, is capable of transferring 8 bits, then an 8-bit data transfer operation is executed. Otherwise, two 4-bit data transfer operations are needed to

satisfy one complete data transfer. Under the 4-bit data transfer, DB4 to DB7 are used as bus lines. DB0 to DB3 are disabled. The data transfer between IC and MPU is completed after two 4-bit data have been transferred. The Busy Flag must be checked (one instruction) after completion of the data transfer (that is, 4-bit data has been transferred twice.). The Busy Flag must be checked after two 4-bits data transfer has been completed. Please refer to the diagram below for a 4-bit data transfer timing sequence.



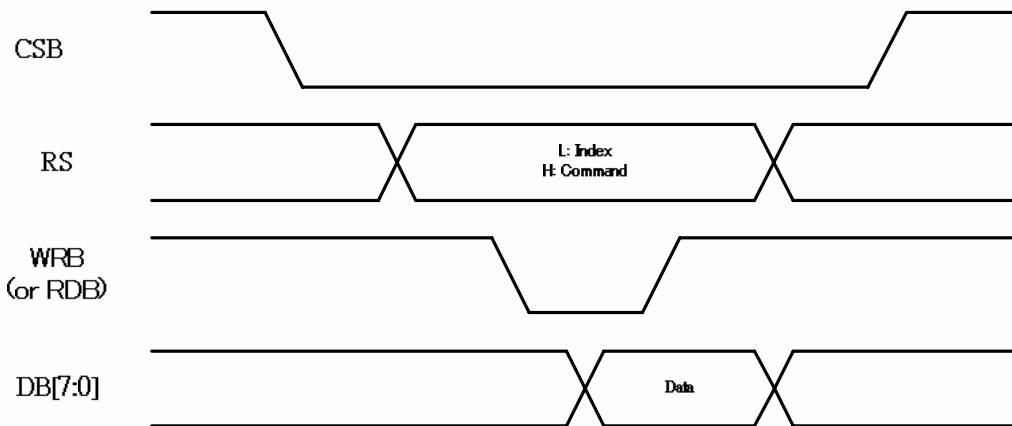
where:

1. IR7=Instruction Bit 7
2. IR3=Instruction Bit 3
3. AC3=Address Counter 3

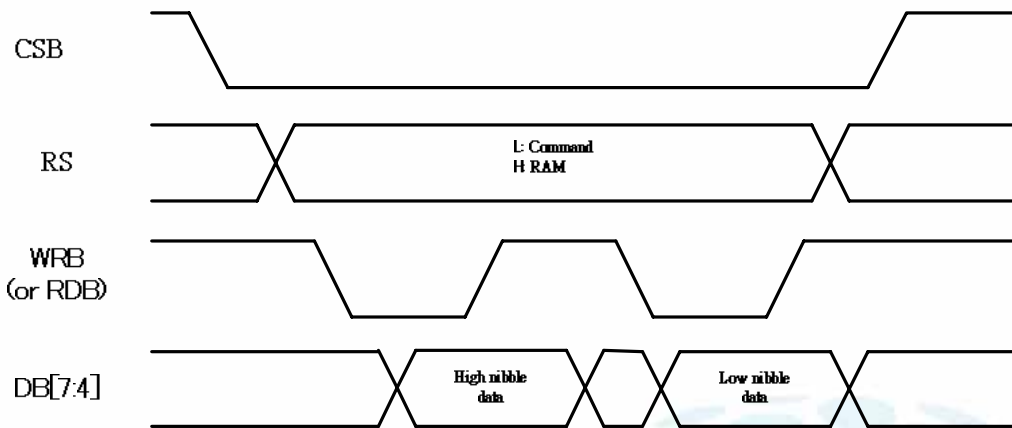
From the above timing diagram, it is important to note that the Busy Flag Check and the data transfer are both executed twice.

80 – series interface

(a) 8-BIT mode

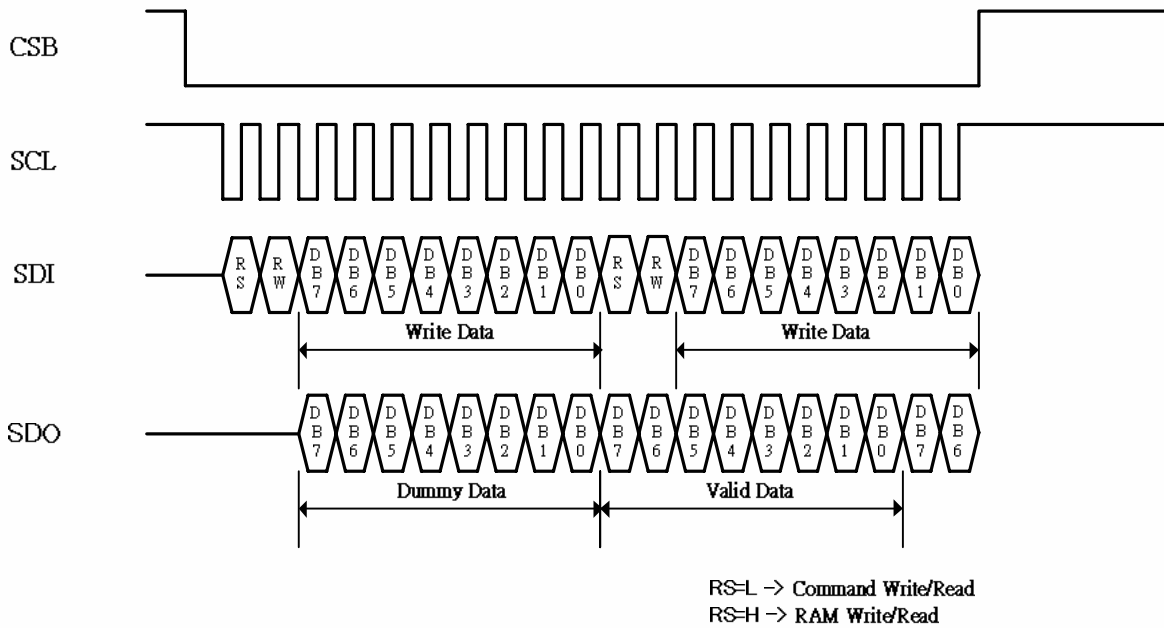


(b) 4-BIT mode



Serial interface

3-Line series Write/Read



AC CHARACTERISTICS

Read / Write Characteristics (8080-series MPU)

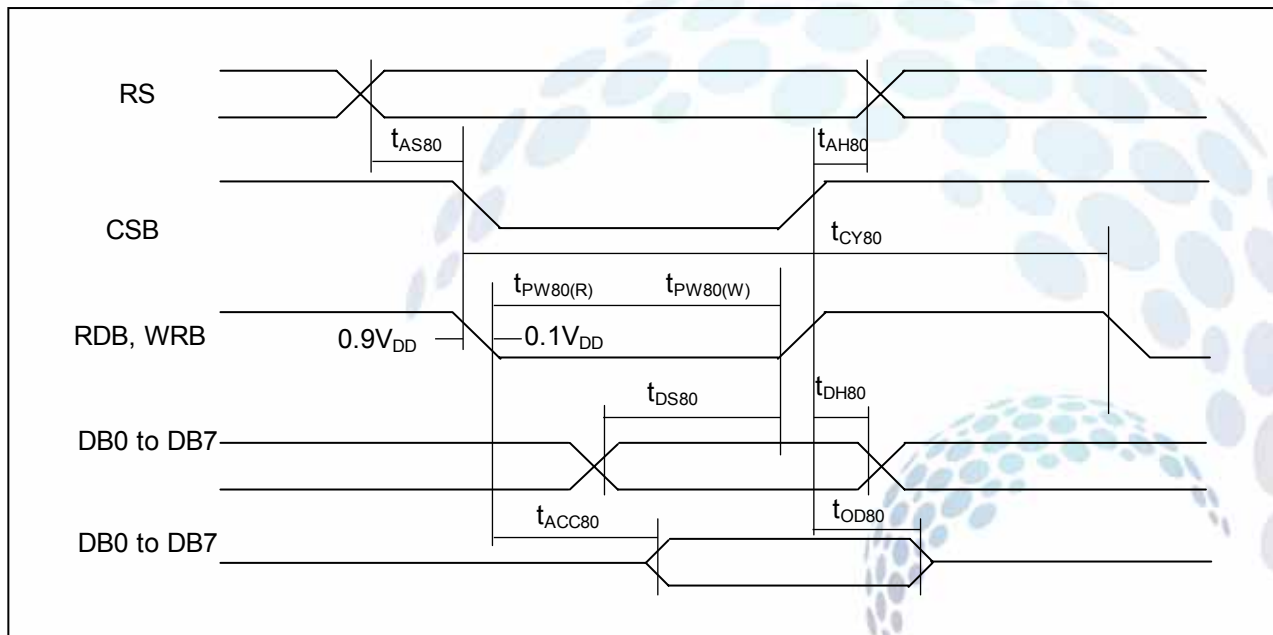


Figure 1. Read / Write Characteristics (8080-series MPU)

VDD = 4.7 to 5.3V, Ta = -40 to +85°C)

| Item | Signal | Symbol | Min. | Typ. | Max. | Unit | Remark |
|---------------------|------------------|----------|------|------|------|------|---------------|
| Address setup time | RS | tAS80 | 0 | - | - | ns | |
| Address hold time | | tAH80 | 0 | - | - | ns | |
| System cycle time | | tCY80 | 300 | - | - | ns | |
| Pulse width (WRB) | RW_WRB | tPW80(W) | 80 | - | - | ns | |
| Pulse width (RDB) | E_RDB | tPW80(R) | 80 | - | - | ns | |
| Data setup time | DB7 to DB0 | tDS80 | 40 | - | - | ns | |
| Data hold time | | tDH80 | 15 | - | - | ns | |
| Read access time | DB0 | tACC80 | - | - | 140 | ns | CL = 100pF |
| Output disable time | | tOD80 | 10 | - | 100 | ns | |

Read / Write Characteristics (6800-series Microprocessor)

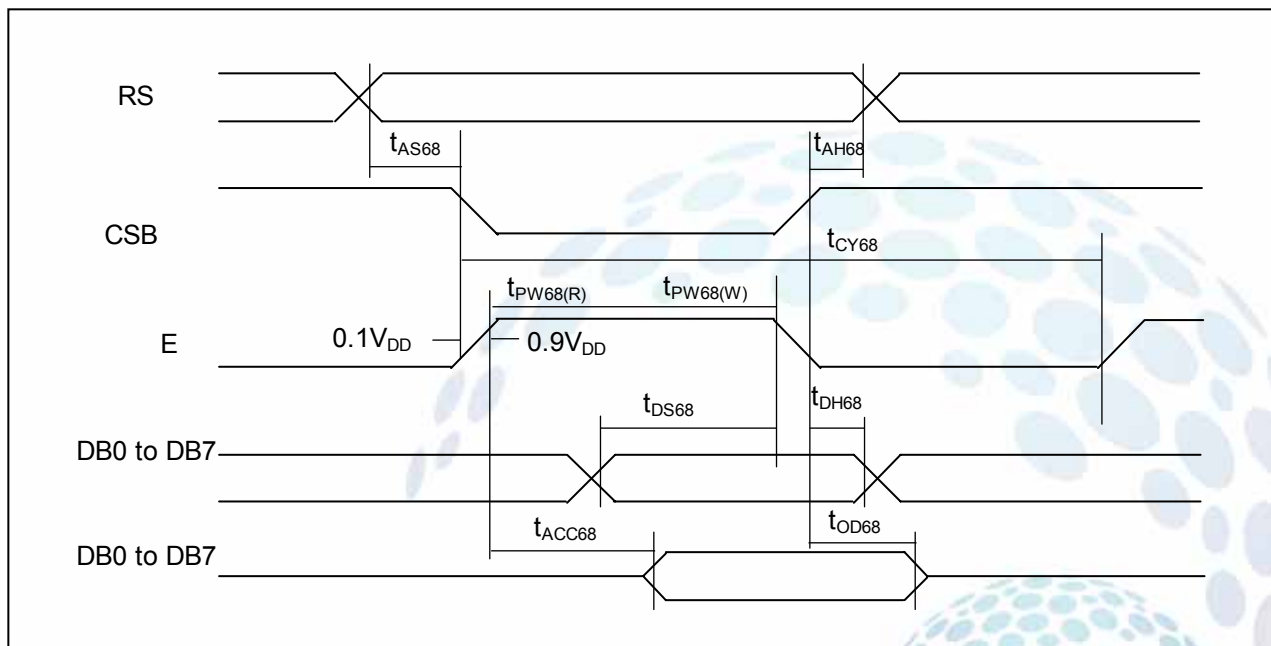


Figure 2. Read / Write Characteristics (6800-series MPU)

(VDD = 4.7 to 5.3V, Ta = -40 to +85°C)

| Item | Signal | Symbol | Min. | Typ. | Max. | Unit | Remark |
|---------------------|------------------|----------|------|------|------|------|---------------|
| Address setup time | RS | tAS68 | 0 | - | - | ns | |
| Address hold time | | tAH68 | 0 | - | - | ns | |
| System cycle time | | tCY68 | 300 | - | - | ns | |
| Pulse width (E) | E_RDB | tPW68(W) | 80 | - | - | ns | |
| Pulse width (E) | E_RDB | tPW68(R) | 80 | - | - | ns | |
| Data setup time | DB7 to DB0 | tDS68 | 40 | - | - | ns | |
| Data hold time | | tDH68 | 0 | - | - | ns | |
| Read access time | DB0 | tACC68 | - | - | 70 | ns | CL = 100pF |
| Output disable time | | tOD68 | 5 | - | 50 | ns | |

Serial Interface Characteristics

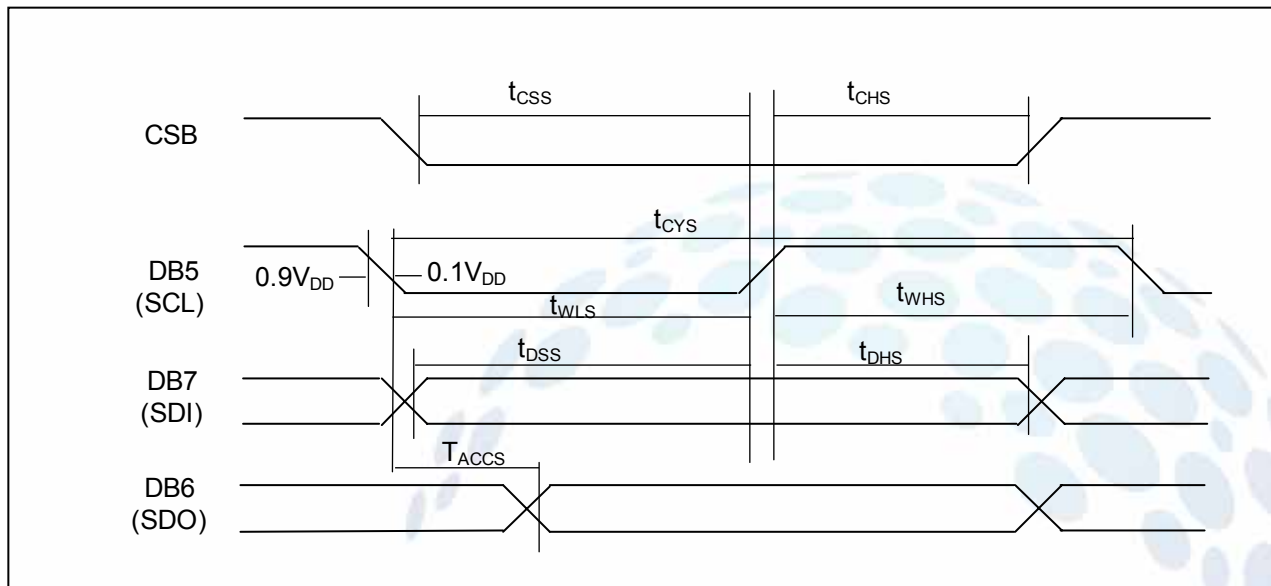


Figure 3. Serial Interface Characteristics

(VDD = 4.7 to 5.3V, Ta = -40 to +85°C)

| Item | Signal | Symbol | Min. | Typ. | Max. | Unit | Remark |
|------|--------|--------|------|------|------|------|--------|
|------|--------|--------|------|------|------|------|--------|

| | | | | | | | |
|----------------------|--------------|--------------|-----|---|----|----|--|
| Serial clock cycle | DB5 (SCL) | tCYS | 250 | - | - | ns | |
| SCL high pulse width | | twHS | 100 | - | - | | |
| SCL low pulse width | | twLS | 100 | - | - | | |
| CS1B setup time | CSB | tCSS | 150 | - | - | ns | |
| CS1B hold time | | tCHS | 150 | - | - | | |
| Data setup time | DB7 (SDI) | tDSS | 100 | - | - | ns | |
| Data hold time | | tDHS | 100 | - | - | | |
| Read access time | DB6 (SDO) | tACCs | - | - | 50 | ns | |



11.OLED Lifetime

| ITEM | Conditions | Value | Remark |
|-----------|---|------------|--------|
| Life Time | Ta=25°C /Initial 50% check board brightness 125nits | 50,000 Hrs | Note |

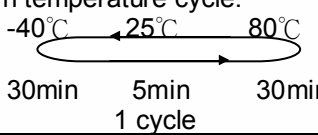
Notes:

1. Simulation pattern for operation test: interchanging with 50% checkboard
The brightness decay does not exceed 50%.
2. You can use the display off mode to make long life.
3. The average operating lifetime at room temperature is estimated by the accelerated operation at high temperature conditions.



12. 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 240hrs | — |
| High Temperature Operation | Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time. | 80°C 240hrs | — |
| Low Temperature Operation | Endurance test applying the electric stress under low temperature for a long time. | -40°C 240hrs | — |
| High Temperature/ Humidity Storage | Endurance test applying the high temperature and high humidity storage for a long time. | 60°C, 90%RH 240hrs | — |
| Temperature Cycle | Endurance test applying the low and high temperature cycle.  | -40°C/80°C 100 cycles | — |
| Mechanical Test | | | |
| Vibration test | Endurance test applying the vibration during transportation and using. | 10~22Hz→1.5mmp-p 22~500Hz→1.5G Total 0.5hrs | — |
| Shock test | Constructional and mechanical endurance test applying the shock during transportation. | 50G Half sign wave 11 msdc 3 times of each direction | — |
| Atmospheric pressure test | Endurance test applying the atmospheric pressure during transportation by air. | 115mbar 40hrs | — |
| Others | | | |
| Static electricity test | Endurance test applying the electric stress to the terminal. | VS=800V,RS=1.5kΩ CS=100pF 1 time | — |

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

Test and measurement conditions

1. All measurements shall not be started until the specimens attain to temperature stability. After the completion of the described reliability test, the samples were left at room temperature for 2 hrs prior to conducting the failure test at $23\pm 5^{\circ}\text{C}$; $55\pm 15\%$ RH.
2. All-pixels-on is used as operation test pattern.
3. The degradation of Polarizer are ignored for High Temperature storage, High Temperature/ Humidity Storage, Temperature Cycle

Evaluation criteria

1. The function test is OK.
2. No observable defects.
3. Luminance: $> 50\%$ of initial value.
4. Current consumption: within $\pm 50\%$ of initial value.

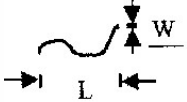
APPENDIX:

RESIDUE IMAGE

Because the pixels are lighted in different time, the luminance of active pixels may reduce or differ from inactive pixels. Therefore, the residue image will occur. To avoid the residue image, every pixel needs to be lighted up uniformly.

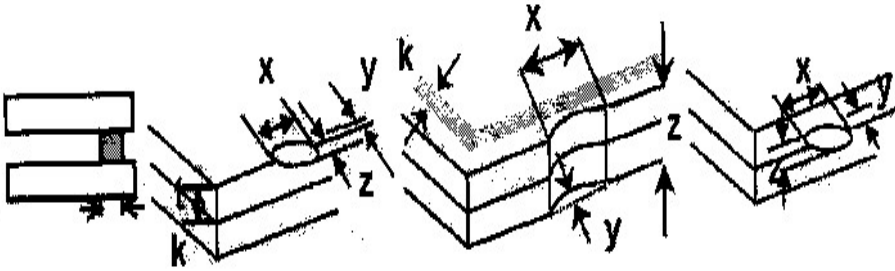
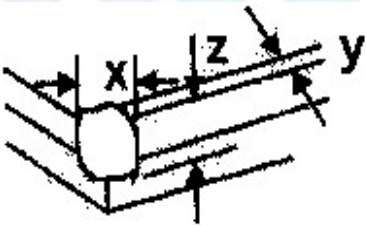


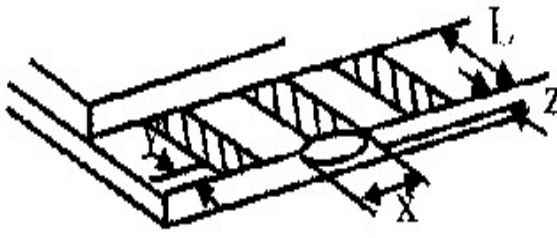
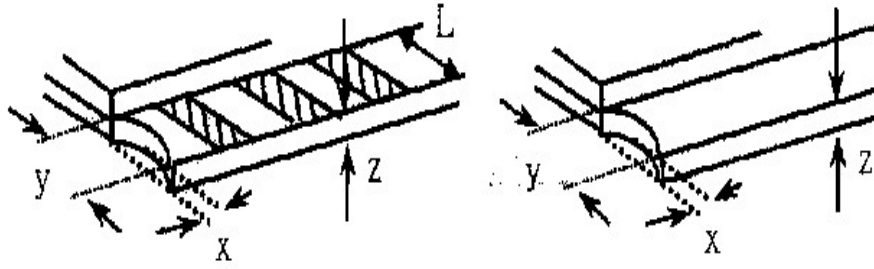
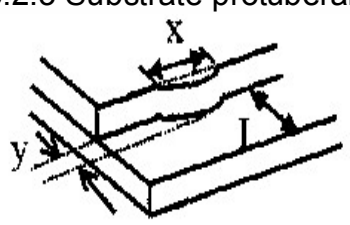
13. Inspection specification

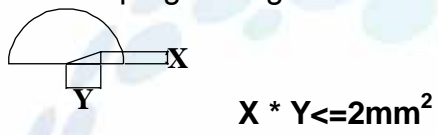
| NO | Item | Criterion | AQL | | | | | | | | | | | | |
|--------------|--|--|----------|-------|----------------|-----|---------------|-----------------|--------------|----------------------|---|--------------|----------------------|-----|------------|
| 01 | Electrical Testing | 1.1 Missing vertical, horizontal segment, segment contrast defect. 1.2 Missing character, dot or icon. 1.3 Display malfunction. 1.4 No function or no display. 1.5 Current consumption exceeds product specifications. 1.6 Viewing angle defect. 1.7 Mixed product types. 1.8 Contrast defect. | 0.65 | | | | | | | | | | | | |
| 02 | Black or bright spots on OLED (display only) | 2.1 Bright and black spots on display $\leq 0.25\text{mm}$, no more than three Bright or black spots present. 2.2 Densely spaced: No more than two spots or lines within 3mm | 2.5 | | | | | | | | | | | | |
| 03 | Black spots, bright spots, contamination (non-display) | 3.1 Round type : As following drawing $\Phi = (x + y) / 2$ | 2.5 | | | | | | | | | | | | |
| | | 3.2 Line type : (As following drawing)  <table border="1"> <thead> <tr> <th>Length h</th> <th>Width</th> <th>Acceptable QTY</th> </tr> </thead> <tbody> <tr> <td>---</td> <td>$W \leq 0.02$</td> <td>Accept no dense</td> </tr> <tr> <td>$L \leq 3.0$</td> <td>$0.02 < W \leq 0.03$</td> <td rowspan="2">2</td> </tr> <tr> <td>$L \leq 2.5$</td> <td>$0.03 < W \leq 0.05$</td> </tr> <tr> <td>---</td> <td>$0.05 < W$</td> <td>As round type</td> </tr> </tbody> </table> | Length h | Width | Acceptable QTY | --- | $W \leq 0.02$ | Accept no dense | $L \leq 3.0$ | $0.02 < W \leq 0.03$ | 2 | $L \leq 2.5$ | $0.03 < W \leq 0.05$ | --- | $0.05 < W$ |
| Length h | 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. | Size Φ | Acceptable Q TY | 2.5 |
| | | | $\Phi \leq 0.2$ | Accept no dense | |
| | | | 0 | 3 | |
| | | | $0.20 < \Phi \leq 0.50$ | 2 | |
| | | | $0.50 < \Phi \leq 1.00$ | 0 | |
| | | | $1.00 < \Phi$ | 0 | |
| | | | Total Q TY | 3 | |



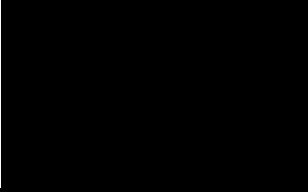
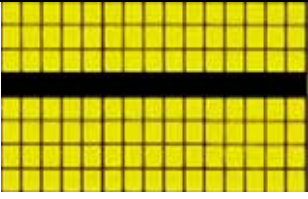
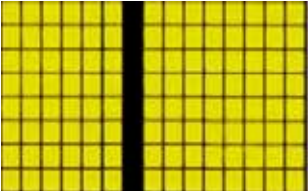
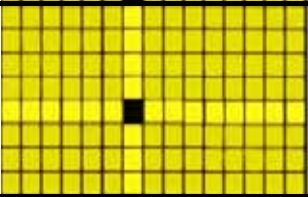
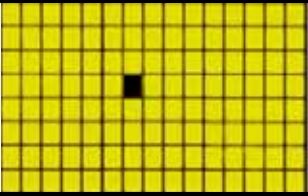
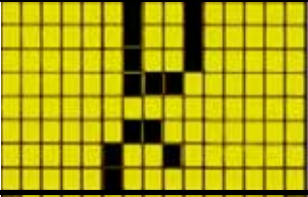
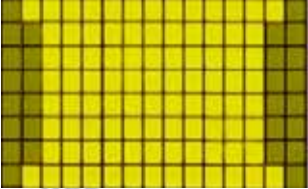
| NO | Item | Criterion | AQL | | | | | | | | | | | | | | | | | | |
|--------------------|-----------------------|--|-------------------|---------------|----------------|---------------|-----------------------|---------------|--------------------|-----------------|---------------|-------------------|---------------|----------------|---------------|-----------------------|---------------|--------------------|-----------------|---------------|-----|
| 05 | Scratches | Follow NO.3 black spots, bright spots, contamination | | | | | | | | | | | | | | | | | | | |
| 06 | Chipped glass | <p>Symbols Define: x: Chip length y: Chip width z: Chip thickness k: Seal width t: Glass thickness a: OLED side length L: Electrode pad length:</p> <p>6.1 General glass chip : 6.1.1 Chip on panel surface and crack between panels:</p>  <table border="1" data-bbox="438 1019 1177 1243"> <tr> <td>z: Chip thickness</td> <td>y: Chip width</td> <td>x: Chip length</td> </tr> <tr> <td>$Z \leq 1/2t$</td> <td>Not over viewing area</td> <td>$x \leq 1/8a$</td> </tr> <tr> <td>$1/2t < z \leq 2t$</td> <td>Not exceed 1/3k</td> <td>$x \leq 1/8a$</td> </tr> </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="438 1579 1177 1803"> <tr> <td>z: Chip thickness</td> <td>y: Chip width</td> <td>x: Chip length</td> </tr> <tr> <td>$Z \leq 1/2t$</td> <td>Not over viewing area</td> <td>$x \leq 1/8a$</td> </tr> <tr> <td>$1/2t < z \leq 2t$</td> <td>Not exceed 1/3k</td> <td>$x \leq 1/8a$</td> </tr> </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</p> <p>k: Seal width t: Glass thickness a: OLED side length</p> <p>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 data-bbox="446 840 670 913">y: Chip width</td> <td data-bbox="670 840 893 913">x: Chip length</td> <td data-bbox="893 840 1117 913">z: Chip thickness</td> </tr> <tr> <td data-bbox="446 913 670 958">$y \leq 0.5\text{mm}$</td> <td data-bbox="670 913 893 958">$x \leq 1/8a$</td> <td data-bbox="893 913 1117 958">$0 < z \leq t$</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 data-bbox="494 1288 718 1361">y: Chip width</td> <td data-bbox="718 1288 941 1361">x: Chip length</td> <td data-bbox="941 1288 1165 1361">z: Chip thickness</td> </tr> <tr> <td data-bbox="494 1361 718 1406">$y \leq L$</td> <td data-bbox="718 1361 941 1406">$x \leq 1/8a$</td> <td data-bbox="941 1361 1165 1406">$0 < z \leq t$</td> </tr> </table> <ul style="list-style-type: none"> ⊙ If the chipped area touches the ITO terminal, over 2/3 of the ITO must remain and be inspected according to electrode terminal specifications. ⊙ If the product will be heat sealed by the customer, the alignment mark not be damaged. | y: Chip width | x: Chip length | z: Chip thickness | $y \leq L$ | $x \leq 1/8a$ | $0 < z \leq t$ | | | |
| y: Chip width | x: Chip length | z: Chip thickness | | | | | | | |
| $y \leq L$ | $x \leq 1/8a$ | $0 < z \leq t$ | | | | | | | |
| <p>6.2.3 Substrate protuberance and internal crack.</p>  <table border="1"> <tr> <td data-bbox="845 1635 1037 1680">y: width</td> <td data-bbox="1037 1635 1228 1680">x: length</td> </tr> <tr> <td data-bbox="845 1680 1037 1724">$y \leq 1/3L$</td> <td data-bbox="1037 1680 1228 1724">$x \leq a$</td> </tr> </table> | y: width | x: length | $y \leq 1/3L$ | $x \leq a$ | | | | | |
| y: width | x: length | | | | | | | | |
| $y \leq 1/3L$ | $x \leq a$ | | | | | | | | |

| NO | Item | Criterion | AQL |
|----|---------------|---|---|
| 07 | Cracked glass | The OLED with extensive crack is not acceptable. | 2.5 |
| 08 | Bezel | 8.1 Bezel may not have rust, be deformed or have fingerprints, stains or other contamination. 8.2 Bezel must comply with job specifications. | 2.5 0.65 |
| 9 | PCB , COB | <p>9.1 COB seal may not have pinholes larger than 0.2mm or contamination.</p> <p>9.2 COB seal surface may not have pinholes through to the IC.</p> <p>9.3 The height of the COB should not exceed the height indicated in the assembly diagram.</p> <p>9.4 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.</p> <p>9.5 No oxidation or contamination PCB terminals.</p> <p>9.6 Parts on PCB must be the same as on the production characteristic chart. There should be no wrong parts, missing parts or excess parts.</p> <p>9.7 The jumper on the PCB should conform to the product characteristic chart.</p> <p>9.8 If solder gets on bezel tab pads, zebra pad or screw hold pad, make sure it is smoothed down.</p> <p>9.9 The Scraping testing standard for Copper Coating of PCB</p>  | <p>2.5</p> <p>2.5 0.65</p> <p>2.5</p> <p>2.5 0.65</p> <p>0.65</p> <p>2.5</p> <p>2.5</p> |
| 10 | Soldering | <p>10.1 No un-melted solder paste may be present on the PCB.</p> <p>10.2 No cold solder joints, missing solder connections, oxidation or icicle.</p> <p>10.3 No residue or solder balls on PCB.</p> <p>10.4 No short circuits in components on PCB.</p> | <p>2.5</p> <p>2.5</p> <p>2.5 0.65</p> |

| NO | Item | Criterion | AQL |
|----|--------------------|--|------|
| 11 | General appearance | 11.1 No oxidation, contamination, curves or, bends on interface Pin (OLB) of TCP. | 2.5 |
| | | 11.2 No cracks on interface pin (OLB) of TCP. | 0.65 |
| | | 11.3 No contamination, solder residue or solder balls on product. | 2.5 |
| | | 11.4 The IC on the TCP may not be damaged, circuits. | 2.5 |
| | | 11.5 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 |
| | | 11.6 The residual rosin or tin oil of soldering (component or chip component) is not burned into brown or black color. | 2.5 |
| | | 11.7 Sealant on top of the ITO circuit has not hardened. | 0.65 |
| | | 11.8 Pin type must match type in specification sheet. | 0.65 |
| | | 11.9 OLED pin loose or missing pins. | 0.65 |
| | | 11.10 Product packaging must the same as specified on packaging specification sheet. | 0.65 |
| | | 11.11 Product dimension and structure must conform to product specification sheet. | 0.65 |



| Check Item | Classification | Criteria |
|--|----------------|---|
| No Display | Major |  |
| Missing Line | Major |   |
| Pixel Short | Major |  |
| Darker Short | Major |  |
| Wrong Display | Major |  |
| Un-uniform $B/A \times 100\% < 70\%$ $A/C \times 100\% < 70\%$ | Major |  |



14. Precautions in use of 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 OLED module.
3. Don't disassemble the OLED module.
4. Don't operate it above the absolute maximum rating.
5. Don't drop, bend or twist OLED module.
6. Soldering: only to the I/O terminals.
7. Storage: please storage in anti-static electricity container and clean environment.
8. Winstar 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. Winstar have the right to change the PCB Rev.

Module Sample Estimate Feedback Sheet

Module Number : _____

1 、 Panel Specification :

| | | |
|----------------------------|-------------------------------|-------------------------------------|
| 1. Panel Type : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 2. Numbers of Pixel : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 3. View Area : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 4. Active Area : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5. Emitting Color : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 6. Uniformity : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 7. Operating Temperature : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 8. Storage Temperature : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 9. 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. Thickness of PCB : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 7. Height of Frame to PCB : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 8. Height of Module : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 9. 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 , _____ |

>> Go to page 2 <<

Module Number : _____

4 · 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 OLED : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 4.Contrast for OLED : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5.Negative Voltage Output : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 6.Interface Function : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 7.ESD test : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 8.Others : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |

5 · Summary :

Sales signature : _____

Customer Signature : _____

Date : / /