

# LM6059BCW

## LCD Module User Manual

Shenzhen TOPWAY Technology Co., Ltd.

| Rev. | Descriptions                                 | Release Date |
|------|--|--------------|
| 0.1  | Preliminary release                          | 2007-09-20   |
| 0.2  | Update Operating Current                     | 2007-11-15   |
| 0.3  | Typing Correction in "1.4 Terminal Function" | 2007-12-20   |
|      |  |              |
|      |  |              |

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# 1. Basic Specifications

## 1.1 Display Specifications

- 1) LCD Display Mode : FSTN, Positive, Transflective
- 2) Display Color : Display Data = "1" : Dark Gray(\*1)  
: Display Data = "0" : Light Gray (\*2)
- 3) Viewing Angle : 6H
- 4) Driving Method : 1/65 duty, 1/9 bias
- 5) Backlight : White LED backlight

Note:

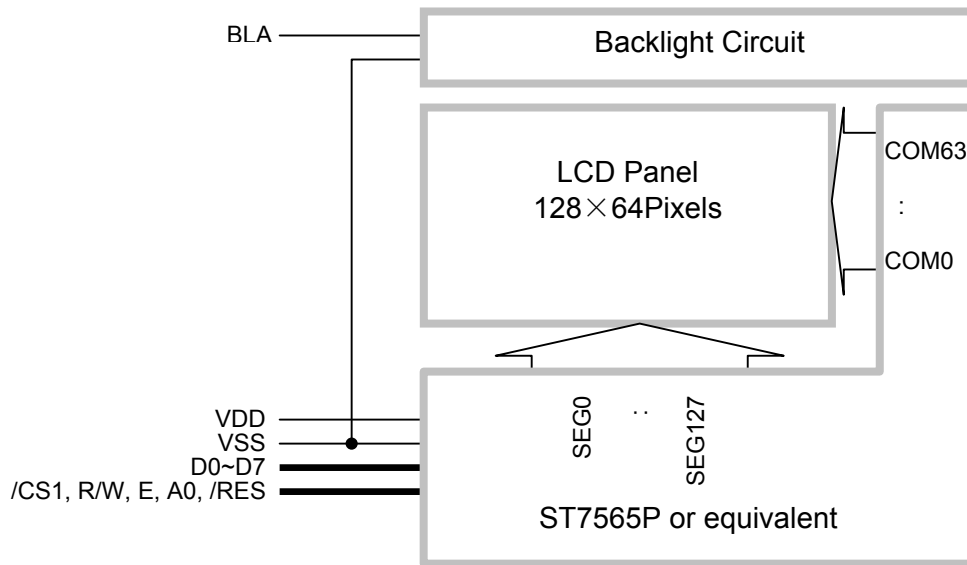
\*1. Color tone may slightly change by Temperature and Driving Condition.

\*2. The Color is defined as the inactive / background color

## 1.2 Mechanical Specifications

- 1) Outline Dimension : 50.9 x 40.9 x 10.0MAX (mm)  
(See attached Outline Drawing for details)

## 1.3 Block Diagram



### 1.4 Terminal Functions

| PIN NO | PIN Name | I/O    | Descriptions   |                                       |
|--------|----------|--------|--|---------------------------------------|
|        |          |        | 6800 mode  | Serial mode                           |
| 1      | /CS1     | Input  | Chip Select<br>/CS1=L, enable access to the LCD module<br>/CS1=H, disable access to the LCD module                         |                                       |
| 2      | /RES     | Input  | Reset signal<br>/RES = L, Initialization is executed<br>/RES = H, Normal running.  |                                       |
| 3      | A0       | Input  | Register Select<br>A0 = H, Transferring the Display Data<br>A0 = L, Transferring the Control Data                          |                                       |
| 4      | R/W      | Input  | R/W=H,E=H;<br>Data or Status read from the LCD module<br>R/W=L,E=H→L;<br>Data or Status latch into the LCD module          | Not used,<br>Leave open or pull<br>Hi |
| 5      | E        | Input  |  |                                       |
| 6      | D0       | I/O    | 8-bit Data bus;<br>Three state I/O terminal for display data or<br>instruction data<br>when /CS=H,<br>D0~D7=High Impedance | Not used,<br>Leave open               |
| :      | :        | I/O    |  |                                       |
| 11     | D5       | I/O    |  |                                       |
| 12     | D6(SCL)  | I/O    |  | Serial clock input                    |
| 13     | D7(SI)   | I/O    |  | Serial data input                     |
| 14     | VDD      | Supply | Positive power supply  |                                       |
| 15     | VSS      | Supply | Negative power supply,0V   |                                       |
| 16     | BLA      | Supply | Positive power for LED backlight   |                                       |
| 17     | NC       | -      | No Connection, leave open  |                                       |
| :      | :        | :      |  |                                       |
| 32     | NC       | -      |  |                                       |

### 1.5 Jumper Functions

Interface selection is available by the jumper on the back side of the LCD module

| JP1   | JP2   | Interface Mode      |
|-------|-------|---------------------|
| CLOSE | OPEN  | 6800 Mode (default) |
| OPEN  | CLOSE | Serial Mode         |

## 2. Absolute Maximum Ratings

| Items                 | Symbol   | Min. | Max.         | Unit | Condition       |
|-----------------------|----------|------|--------------|------|-----------------|
| Supply Voltage        | $V_{DD}$ | -0.3 | +3.3         | V    | $V_{SS} = 0V$   |
| Input Voltage         | $V_{IN}$ | -0.3 | $V_{DD}+0.3$ | V    | $V_{SS} = 0V$   |
| Operating Temperature | $T_{OP}$ | -20  | +70          | °C   | No Condensation |
| Storage Temperature   | $T_{ST}$ | -30  | +80          | °C   | No Condensation |

Cautions:

Any Stresses exceeding the Absolute Maximum Ratings may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

## 3. Electrical Characteristics

### 3.1 DC Characteristics

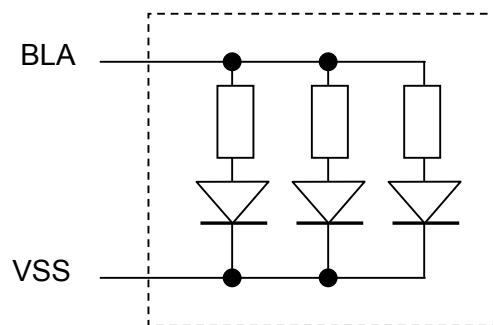
$V_{SS}=0V, V_{DD}=3.0V, T_{OP}=25^{\circ}C$

| Items               | Symbol   | MIN.                 | TYP. | MAX.                 | Unit | Condition / Application Pin |
|---------------------|----------|----------------------|------|----------------------|------|-----------------------------|
| Operating Voltage   | $V_{DD}$ | 2.8                  | -    | 3.3                  | V    | VDD                         |
| Input High Voltage  | $V_{IH}$ | $0.8 \times V_{DD}$  | -    | $V_{DD}$             | V    | /RES, /CS1, A0,             |
| Input Low Voltage   | $V_{IL}$ | $V_{SS}$             | -    | $0.2 \times V_{DD}$  | V    | /WR, /RD, D0~D7             |
| Output High Voltage | $V_{OH}$ | $0.75 \times V_{DD}$ | -    | $V_{DD}$             | V    | D0~D7                       |
| Output Low Voltage  | $V_{OL}$ | $V_{SS}$             | -    | $0.25 \times V_{DD}$ | V    | D0~D7                       |
| Operating Current   | $I_{DD}$ | -                    | 0.4  | 1.5                  | mA   | VDD                         |

### 3.2 LED Backlight Circuit Characteristics

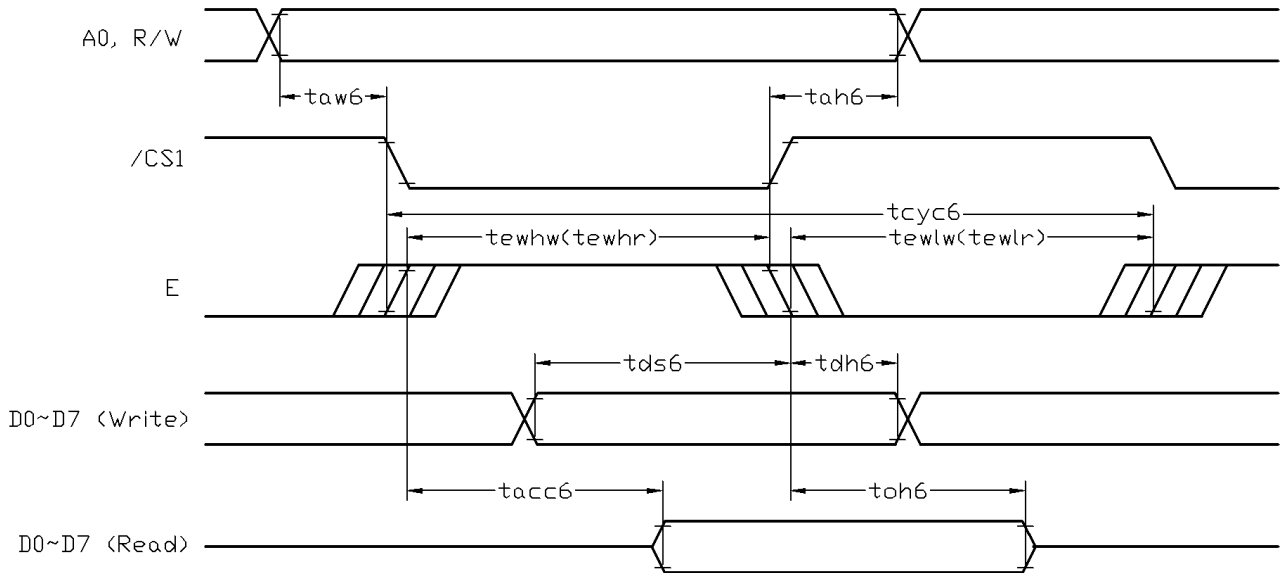
$V_{SS}=0V, I_f=50mA, T_{OP}=25^{\circ}C$

| Items           | Symbol     | MIN | TYP | MAX | Unit | Applicable Pin |
|-----------------|------------|-----|-----|-----|------|----------------|
| Forward Voltage | $V_{fBLA}$ | -   | 3.3 | -   | V    | BLA            |
| Forward Current | $I_{fBLA}$ | -   | -   | 70  | mA   | BLA            |



**3.3 AC Characteristics**

**3.3.1 6800 Mode System Bus Timing**



$V_{SS}=0V, V_{DD}=3.0V, T_{OP}=25^{\circ}C$

| Item                           | Symbol | MIN. | TYP. | MAX. | Unit |
|--------------------------------|--------|------|------|------|------|
| System cycle time              | tcyc6  | 500  | -    | -    | ns   |
| Address setup time (A0)        | taw6   | 10   | -    | -    | ns   |
| Address hold time (A0)         | tah6   | 10   | -    | -    | ns   |
| Control LOW pulse width (/RD)  | tewlr  | 275  | -    | -    | ns   |
| Control LOW pulse width (/WR)  | tewlw  | 275  | -    | -    | ns   |
| Control HIGH pulse width (/RD) | tewhr  | 225  | -    | -    | Ns   |
| Control HIGH pulse width (/WR) | tewhw  | 225  | -    | -    | Ns   |
| Data setup time                | tds6   | 50   | -    | -    | Ns   |
| Data hold time                 | tdh6   | 10   | -    | -    | Ns   |
| /RD access time (*2)           | tacc6  | -    | -    | 175  | Ns   |
| Output disable time (*2)       | tch6   | 13   | -    | 125  | Ns   |

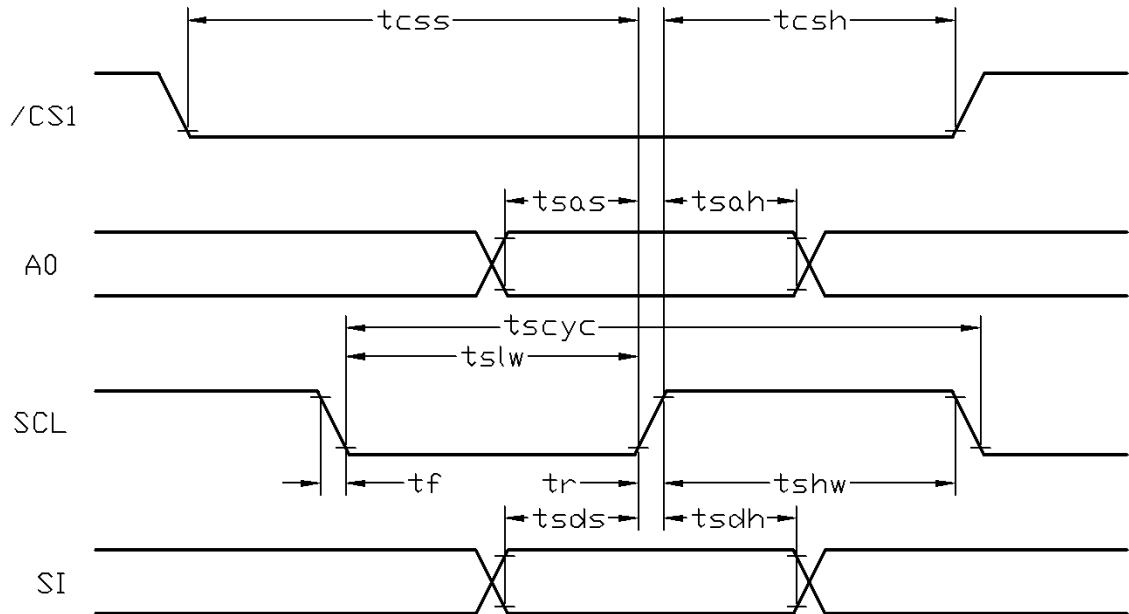
Note:

\*1. Input signal rise/fall time should be less than 15ns .

\*2. CL=100pF

\*3.All timing is using 20% and 80% of VDD as the reference.

**3.3.2 Serial Mode Interface**



$V_{SS}=0V, V_{DD}=3.0V, T_{OP}=25^{\circ}C$

| Item                    | Symbol | MIN. | TYP. | MAX. | Unit |
|-------------------------|--------|------|------|------|------|
| Serial Clock Period     | tscyc  | 125  | -    | -    | Ns   |
| Address setup time (A0) | tsas   | 38   | -    | -    | Ns   |
| Address hold time (A0)  | tsah   | 25   | -    | -    | Ns   |
| SCL "H" pulse width     | tshw   | 63   | -    | -    | Ns   |
| SCL "L" pulse width     | tslw   | 63   | -    | -    | ns   |
| Data setup time         | tsds   | 38   | -    | -    | ns   |
| Data hold time          | tsdh   | 25   | -    | -    | ns   |
| CS-SCL time             | tcss   | 38   | -    | -    | ns   |
| CS-SCL time             | tcsh   | 75   | -    | -    | ns   |

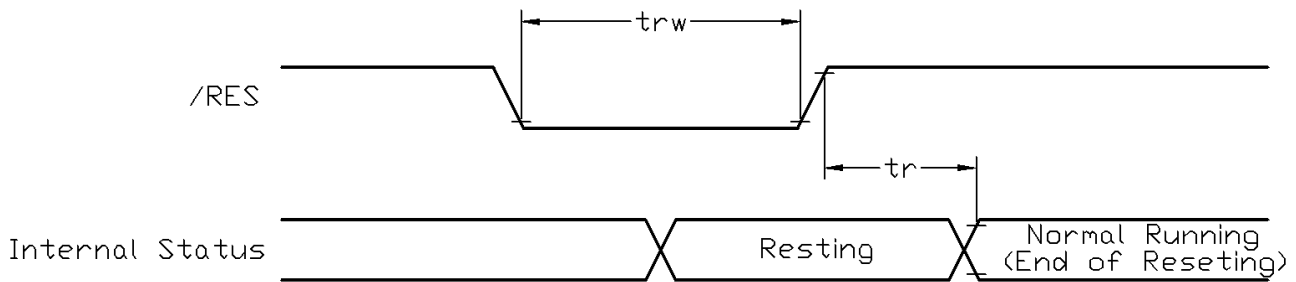
Note:

\*1. Input signal rise/fall time should be less than 15ns .

\*2. CL=100pF

\*3.All timing is using 20% and 80% of VDD as the reference.

**3.3.3 Reset Timing**



$V_{SS}=0V, V_{DD}=3.0V, T_{OP}=25^{\circ}C$

| Item                  | Symbol | MIN. | TYP. | MAX. | Unit    |
|-----------------------|--------|------|------|------|---------|
| Reset time            | tr     | -    | -    | 2.5  | $\mu s$ |
| Reset LOW pulse width | trw    | 2.5  | -    | -    | $\mu s$ |

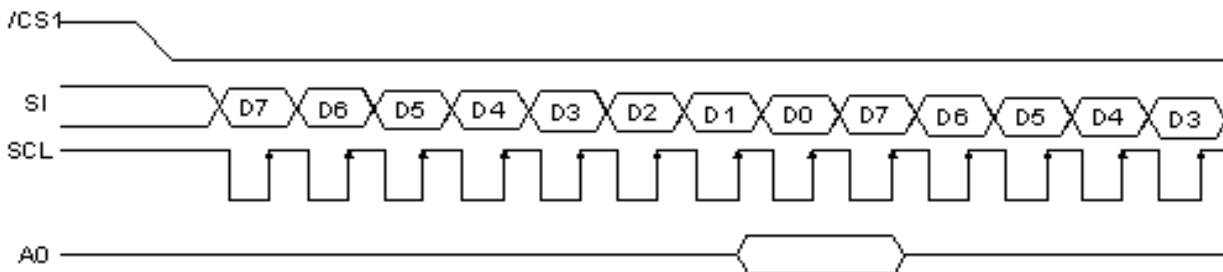
Note:

\*1.All timing is using 20% and 80% of VDD as the reference.

**4. Function specifications**

**4.1 The Serial Interface**

When the serial interface has been selected then when the chip is in active state the serial data input(SI) and the serial clock(SCL) can be received. The serial data is read from the serial data input pin in the rising edge of the serial clock . When “A0”=“H”, the data is display data, and when “A0”=“L”, the data is command.



**4.2 Basic Setting**

To drive the LCD module correctly and provide normally display, please use the following setting

- ADC = 0 (normal)
- SHL select = 1 (reverse)
- LCD Bias Select = 1/9
- Initial Display Line = 0
- Entire Display ON/OFF = OFF (normal)
- Reverse Display ON/OFF = OFF (normal)
- Set Power Control Set:  
voltage follower = ON, voltage converter = ON, voltage regulator = ON
- Display ON/OFF = ON

Note:

\*1. These setting/commands should issue the LCD module while start up.

\*2. See the Display Commands section for details.



**4.3 Resetting the LCD module**

The LCD module should be initialized by using /RES terminal.  
 While turning on the VDD and VSS power supply, maintain /RES terminal at LOW level. After the power supply stabilized, release the reset terminal (/RES=HIGH)

**4.4 Display Memory Map**

| Page address   | data          | LCD Display (front view) |       |
|----------------|---------------|--------------------------|-------|
| 0              | D0<br>:<br>D7 |                          |       |
| 1              | D0<br>:<br>D7 |                          |       |
| 2              | D0<br>:<br>D7 |                          |       |
| 3              | D0<br>:<br>D7 |                          |       |
| 4              | D0<br>:<br>D7 |                          |       |
| 5              | D0<br>:<br>D7 |                          |       |
| 6              | D0<br>:<br>D7 |                          |       |
| 7              | D0<br>:<br>D7 |                          |       |
| Column Address |               | 00h                      | → 7Fh |

- Note:
- \*1. ADC = 0 (normal)
  - \*2. SHL Selection = 1 (reverse)
  - \*3. Initial Display Line = 0

**4.5 Display Commands**

| No. | Instructions                      | Code |     |     |            |    |                       |    |                 |               |    |      | Function  |
|-----|-----------------------------------|------|-----|-----|------------|----|-----------------------|----|-----------------|---------------|----|------|---|
|     |                                   | a0   | /RD | /WR | D7         | D6 | D5                    | D4 | D3              | D2            | D1 | D0   |   |
| 1   | Display ON/OFF                    | 0    | 1   | 0   | 1          | 0  | 1                     | 0  | 1               | 1             | 1  | DON  | DON=0, display off<br>DON=1, display on   |
| 2   | Display start line set            | 0    | 1   | 0   | 0          | 1  | Display start address |    |                 |               |    |      | Sets the display RAM display start line address   |
| 3   | Set Page Address                  | 0    | 1   | 0   | 1          | 0  | 1                     | 1  | Page Address    |               |    |      | Set the display RAM page address  |
| 4   | Set Column Address (Upper-4-bits) | 0    | 1   | 0   | 0          | 0  | 0                     | 1  | Col. Add. Upper |               |    |      | Set the upper-4-bit of column address counter   |
|     | Set Column Address (Lower-4-bits) | 0    | 1   | 0   | 0          | 0  | 0                     | 0  | Col. Add. Lower |               |    |      | Set the lower-4-bit of column address counter   |
| 5   | Read Status                       | 0    | 0   | 1   | Status     |    |                       |    | 0               | 0             | 0  | 0    | Read the status data  |
| 6   | Write Display Data                | 1    | 1   | 0   | Write Data |    |                       |    |                 |               |    |      | Write data into the display RAM   |
| 7   | Read Display Data                 | 1    | 0   | 1   | Read Data  |    |                       |    |                 |               |    |      | Read data from the display RAM  |
| 8   | ADC Select                        | 0    | 1   | 0   | 1          | 0  | 1                     | 0  | 0               | 0             | 0  | ADC  | Sets the display RAM address SEG output correspondence<br>ADC= 0,normal . ADC=1, reverse  |
| 9   | Normal/Reverse Display            | 0    | 1   | 0   | 1          | 0  | 1                     | 0  | 0               | 1             | 1  | REV  | REV=0, Normal display<br>REV=1, Reverse display   |
| 10  | Entire Display ON/OFF             | 0    | 1   | 0   | 1          | 0  | 1                     | 0  | 0               | 1             | 0  | EON  | EON=0, Normal display<br>EON=1, Entire display ON   |
| 11  | Set LCD Bias                      | 0    | 1   | 0   | 1          | 0  | 1                     | 0  | 0               | 0             | 1  | BIAS | Set the LCD driving voltage bias<br>BIAS=0, 1/9 BIAS<br>BIAS=1, 1/7 BIAS  |
| 12  | Set Read-Modify-Write             | 0    | 1   | 0   | 1          | 1  | 1                     | 0  | 0               | 0             | 0  |      | Enter the "Read-Modify-Write" mode<br>column address counter will increase in each "Write Display Data",<br>and will not increase in each "Read Display Data command" |
| 13  | Reset Read-Modify-Write           | 0    | 1   | 0   | 1          | 1  | 1                     | 0  | 1               | 1             | 1  | 0    | Clear the "Read-Modify-Write" mode  |
| 14  | Reset                             | 0    | 1   | 0   | 1          | 1  | 1                     | 0  | 0               | 0             | 1  | 0    | Resets the LCD module   |
| 15  | SHL Select                        | 0    | 1   | 0   | 1          | 1  | 0                     | 0  | SHL             | *             | *  | *    | Set the COM scanning direction<br>SHL=0, Normal display<br>SHL=1, Flipped in y direction<br>* = don't care terms  |
| 16  | Power Control Set                 | 0    | 1   | 0   | 0          | 0  | 1                     | 0  | 1               | VC            | VR | VF   | Set the power circuit operation mode<br>VF: LCD Supply Voltage Follower<br>VR: LCD Supply Voltage Regulator<br>VC: LCD Supply Voltage Converter (1=ON, 0=OFF)         |
| 17  | Regulator Resistor Select         | 0    | 1   | 0   | 0          | 0  | 1                     | 0  | 0               | Radio setting |    |      | Set the built-in resistor ratio (Rb/Ra)   |

Note: \*1. Do not use any other command not listed, or the system malfunction may result.  
\*2. For the details of the Display Commands, please refer to ST7565P data sheet.

**4.6 Display Commands (continue)**

| No. | Instructions                   | Code |     |     |    |    |                          |    |    |    |    | Function  |  |
|-----|--------------------------------|------|-----|-----|----|----|--------------------------|----|----|----|----|---|--|
|     |                                | A0   | /RD | /WR | D7 | D6 | D5                       | D4 | D3 | D2 | D1 |   | D0   |
| 18  | Electronic volume mode set     | 0    | 1   | 0   | 1  | 0  | 0                        | 0  | 0  | 0  | 0  | 1   | Set reference voltage mode                               |
|     | Electronic volume register set | 0    | 1   | 0   | *  | *  | Electronic Control value |    |    |    |    | Set reference voltage register (Display contrast value) |  |
| 19  | Power Save                     | -    | -   | -   | -  | -  | -                        | -  | -  | -  | -  | -   | Compound Instruction:<br>Display OFF + Entire Display ON |
| 20  | NOP                            | 0    | 1   | 0   | 1  | 1  | 1                        | 0  | 0  | 0  | 1  | 1   | Non-operation command                                    |

Note: \*1. Do not use any other command not listed, or the system malfunction may result.  
 \*2. For the details of the Display Commands, please refer to ST7565P data sheet.

**4.6.1 Power off the LCD Module**

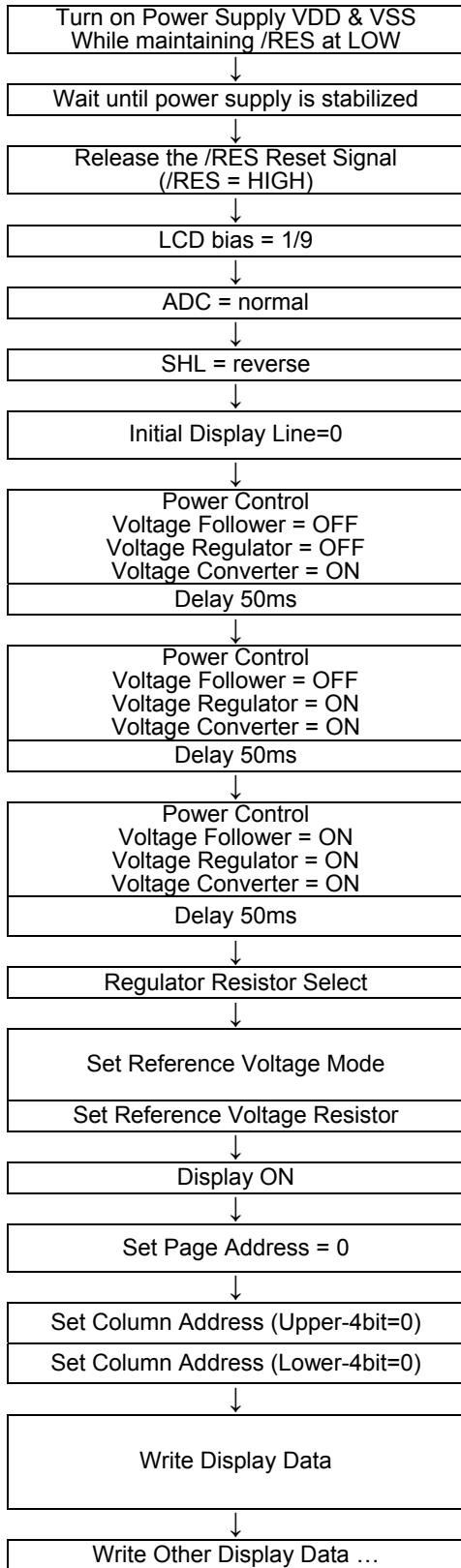
It recommends that enter Power Save mode before power off the LCD module.

**4.6.2 Refreshing The LCD Module**

It recommends that the operating modes and display contents be refreshed periodically to prevent the effect of unexpected noise.

**4.7 Basic Operating Sequence (example)**

**4.7.1 Initialization Sequence**



| Code Function |              |    |    |    |    |    |    |    |     | Note  |   |
|---------------|--------------|----|----|----|----|----|----|----|-----|---|---|
| A0            | D7           | D6 | D5 | D4 | D3 | D2 | D1 | D0 | hex |   |   |
| -             | -            | -  | -  | -  | -  | -  | -  | -  | -   | -   | -   |
| -             | -            | -  | -  | -  | -  | -  | -  | -  | -   | -   | -   |
| -             | -            | -  | -  | -  | -  | -  | -  | -  | -   | -   | See AC Characteristics section for timing details |
| 0             | 1            | 0  | 1  | 0  | 0  | 0  | 1  | 0  | A2h | LCD panel Characteristic  |   |
| 0             | 1            | 0  | 1  | 0  | 0  | 0  | 0  | 0  | A0h | No flip on x-direction (SEG)  |   |
| 0             | 1            | 1  | 0  | 0  | 1  | 0  | 0  | 0  | C8h | Flip on y-direction (COM)   |   |
| 0             | 0            | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 40h | i.e. Display RAM "page 0 - D0" Matched to top line of the LCD   |   |
| 0             | 0            | 0  | 1  | 0  | 1  | 1  | 0  | 0  | 2Ch | Turn on the internal Voltage Converter and wait until VOUT stable.  |   |
| -             | -            | -  | -  | -  | -  | -  | -  | -  | -   |   |   |
| 0             | 0            | 0  | 1  | 0  | 1  | 1  | 1  | 0  | 2Eh | Turn on the Internal Voltage Regulator and wait until VOUT stable.  |   |
| -             | -            | -  | -  | -  | -  | -  | -  | -  | -   |   |   |
| 0             | 0            | 0  | 1  | 0  | 1  | 1  | 1  | 1  | 2Fh | Turn on the internal Voltage Follower and wait until VOUT stable  |   |
| -             | -            | -  | -  | -  | -  | -  | -  | -  | -   |   |   |
| 0             | 0            | 0  | 1  | 0  | 0  | 1  | 1  | 0  | 26h | Set the built-in resistor ratio   |   |
| 0             | 1            | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 81h | Set to the middle of the range It may be adjusted for achieving the best display contrast                             |   |
| 0             | 0            | 0  | 0  | 1  | 1  | 0  | 1  | 0  | 1Ah |   |   |
| 0             | 1            | 0  | 1  | 0  | 1  | 1  | 1  | 1  | AFh | Turn on the LCD display   |   |
| 0             | 1            | 0  | 1  | 1  | 0  | 0  | 0  | 0  | B0h | Specify the Display Data RAM page address to 00h  |   |
| 0             | 0            | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 10h | Specify the Display Data RAM column address to 00h  |   |
| 0             | 0            | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 00h |   |   |
| 1             | Display Data |    |    |    |    |    |    |    |     | Write data to Display Data RAM. After write, the internal Column Address Counter will be increased by 1 automatically |   |

## 5. Design and Handling Precaution

1. The LCD panel is made by glass. Any mechanical shock (eg. dropping from high place) will damage the LCD module.
2. Do not add excessive force on the surface of the display, which may cause the Display color change abnormally.
3. The polarizer on the LCD is easily get scratched. If possible, do not remove the LCD protective film until the last step of installation.
4. Never attempt to disassemble or rework the LCD module.
5. Only Clean the LCD with Isopropyl Alcohol or Ethyl Alcohol. Other solvents (eg. water) may damage the LCD.
6. When mounting the LCD module, make sure that it is free from twisting, warping and distortion.
7. Ensure to provide enough space (with cushion) between case and LCD panel to prevent external force adding on it, or it may cause damage to the LCD or degrade the display result.
8. Only hold the LCD module by its side. Never hold LCD module by add force on the heat seal or TAB.
9. Never add force to component of the LCD module. It may cause invisible damage or degrade of the reliability.
10. LCD module could be easily damaged by static electricity. Be careful to maintain an optimum anti-static work environment to protect the LCD module.
11. When peeling off the protective film from LCD, static charge may cause abnormal display pattern. It is normal and will resume to normal in a short while.
12. Take care and prevent get hurt by the LCD panel sharp edge.
13. Never operate the LCD module exceed the absolute maximum ratings.
14. Keep the signal line as short as possible to prevent noisy signal applying to LCD module.
15. Never apply signal to the LCD module without power supply.
16. IC chip (eg. TAB or COG) is sensitive to the light. Strong lighting environment could possibly cause malfunction. Light sealing structure casing is recommend.
17. LCD module reliability may be reduced by temperature shock.
18. When storing the LCD module, avoid exposure to the direct sunlight, high humidity, high temperature or low temperature. They may damage or degrade the LCD module