



深圳市拓普微科技开发有限公司

SHENZHEN TOPWAY TECHNOLOGY CO., LTD.

# LM13232AFW

## LCD Module User Manual

|                          |             |              |
|--------------------------|-------------|--------------|
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| Date: 2010-03-09         | Date:       | Date:        |

| Rev. | Descriptions                             | Release Date |
|------|------------------------------------------|--------------|
| 0.1  | Preliminary release                      | 2008-06-03   |
| 0.2  | Add serial pin-out descriptions          | 2009-05-31   |
| 0.3  | Revise Basic Specifications descriptions | 2010-03-09   |
|      |                                          |              |
|      |                                          |              |

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## 1. Basic Specifications

### 1.1 Display Specifications

- |                     |                                        |
|---------------------|----------------------------------------|
| 1) LCD Display Mode | : STN-Blue, Negative, Transmissive     |
| 2) Display Color    | : Display Data = "1" : Light Gray (*1) |
|                     | : Display Data = "0" : Dark Blue (*2)  |
| 3) Viewing Angle    | : 6H                                   |
| 4) Driving Method   | : 1/33 duty, 1/6 bias                  |
| 5) Backlight        | : White LED backlight                  |

Note:

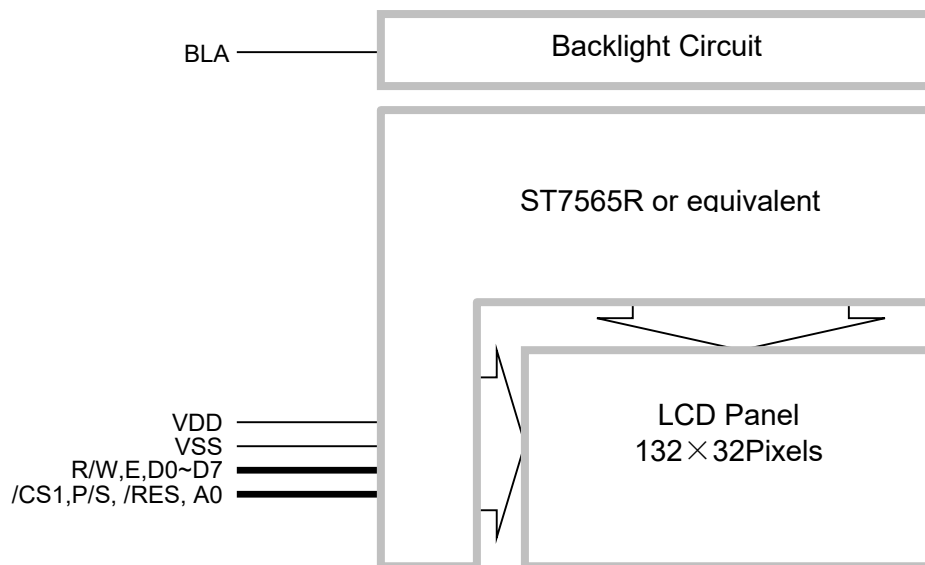
\*1. Color tone may slightly change by Temperature and Driving Condition.

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

### 1.2 Mechanical Specifications

- |                      |                              |
|----------------------|------------------------------|
| 1) Outline Dimension | : 80.0 x 35.0 x 11.5MAX (mm) |
|----------------------|------------------------------|
- (See attached Outline Drawing for details)

### 1.3 Block Diagram



## 1.4 Terminal Functions

| Pin No. | PIN Name  | I/O         | Descriptions                                                                                       |                                            |
|---------|-----------|-------------|----------------------------------------------------------------------------------------------------|--------------------------------------------|
|         |           |             | Parallel mode (Default)                                                                            | Serial mode                                |
| 1       | VSS       | Power       | Negative power supply, 0V                                                                          |                                            |
| 2       | VDD       | Power       | Positive power supply                                                                              |                                            |
| 3       | NC        | -           | No Connection, leave open                                                                          |                                            |
| 4       | A0        | Input       | Register Select<br>A0 = H, Transferring the Display Data<br>A0 = L, Transferring the Control Data  |                                            |
| 5       | R/W       | Input       | Read write control<br>R/W=H; data or status read<br>R/W=L; data or command write                   | Not used, pull high or low                 |
| 6       | E         | Input       | Enable trigger                                                                                     | Not used, pull high or low                 |
| 7       | D0        | I/O         | Bi-directional data bus                                                                            | Not used, leave open or pull high          |
| :       | :         |             |                                                                                                    |                                            |
| 12      | D5        |             |                                                                                                    |                                            |
| 13      | D6 (SCLK) | I/O (Input) |                                                                                                    | Serial Clock Input                         |
| 14      | D7 (SID)  | I/O (Input) |                                                                                                    | Serial Data Input                          |
| 15      | BLA       | Power       | Positive power for LED backlight                                                                   |                                            |
| 16      | /CS1      | Input       | Chip Select<br>/CS1=L, enable access to the LCD module<br>/CS1=H, disable access to the LCD module |                                            |
| 17      | P/S       | Input       | Interface selection:<br>P/S=H; 8 bit parallel bus mode                                             | Interface selection:<br>P/S=L; serial mode |
| 18      | /RES      | Input       | Reset signal<br>/RES = L, Initialization is executed<br>/RES = H, Normal running                   |                                            |

Note:

It is write only, in serial mode

## 2. Absolute Maximum Ratings

| Items                 | Symbol   | Min. | Max.         | Unit | Condition       |
|-----------------------|----------|------|--------------|------|-----------------|
| Supply Voltage        | $V_{DD}$ | -0.3 | +3.4         | 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

$V_{SS}=0V$ ,  $V_{DD}=3.3V$ ,  $T_{OP}=25^{\circ}C$

| Items              | Symbol   | MIN.                | TYP. | MAX.                | Unit | Condition / Application Pin |
|--------------------|----------|---------------------|------|---------------------|------|-----------------------------|
| Operating Voltage  | $V_{DD}$ | 2.9                 | 3.3  | 3.4                 | V    | VDD                         |
| Input High Voltage | $V_{IH}$ | $0.8 \times V_{DD}$ | -    | $V_{DD}$            | V    | R/W, E,/RES, /CS1, A0, P/S  |
| Input Low Voltage  | $V_{IL}$ | $V_{SS}$            | -    | $0.2 \times V_{DD}$ | V    |                             |
| Operating Current  | $I_{DD}$ | -                   | 0.15 | 0.6                 | mA   | VDD                         |

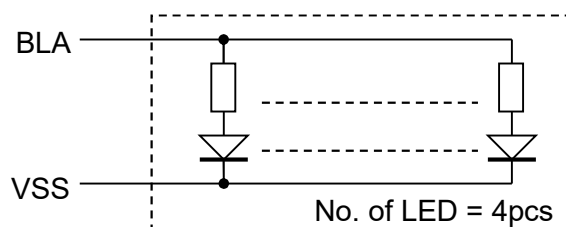
### 3.2 LED Backlight Circuit Characteristics

$V_{SS}=0V$ ,  $I_{f_{BLA}}=52mA$ ,  $T_{OP}=25^{\circ}C$

| Items           | Symbol        | MIN. | TYP. | MAX. | Unit | Applicable Pin |
|-----------------|---------------|------|------|------|------|----------------|
| Forward Voltage | $V_{f_{BLA}}$ | -    | 3.3  | -    | V    | BLA            |
| Forward Current | $I_{f_{BLA}}$ | -    | 52   | 85   | mA   | BLA            |

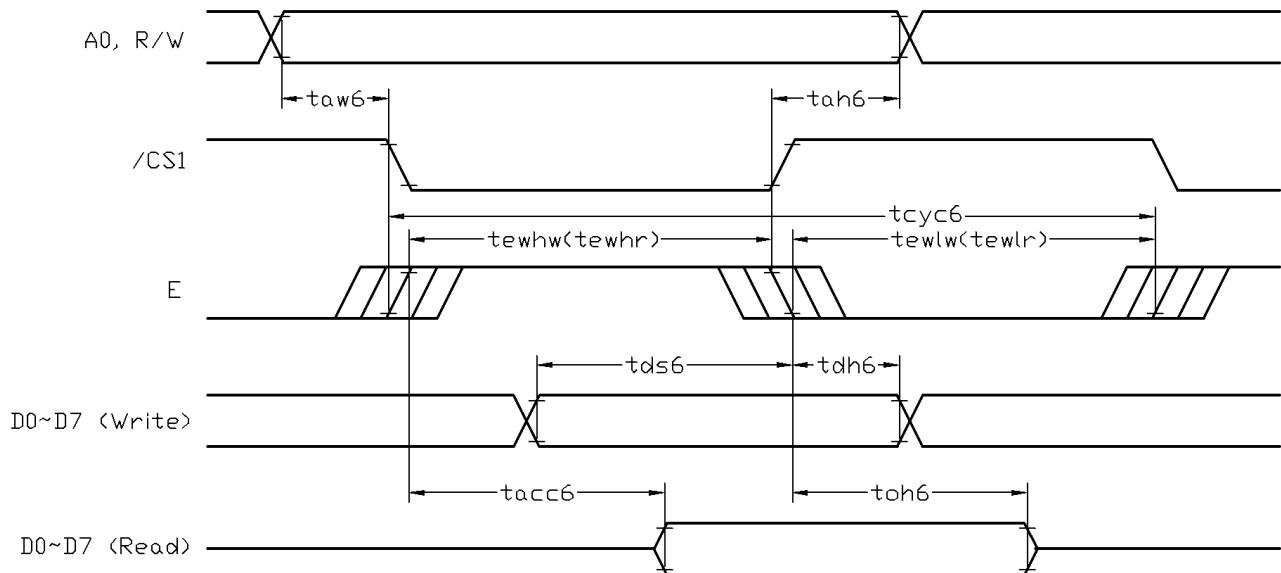
Cautions:

Exceeding the recommended driving current could cause substantial damage to the backlight and shorten its lifetime.



### 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   |
| Enable LOW pulse width (Read)   | tewlr  | 275  | -    | -    | ns   |
| Enable LOW pulse width (Write)  | tewlw  | 275  | -    | -    | ns   |
| Enable HIGH pulse width (Read)  | tewhr  | 225  | -    | -    | ns   |
| Enable HIGH pulse width (Write) | tewhw  | 225  | -    | -    | ns   |
| Data setup time                 | tds6   | 50   | -    | -    | ns   |
| Data hold time                  | tdh6   | 10   | -    | -    | ns   |
| Read access time (*2)           | tacc6  | -    | -    | 175  | ns   |
| Output disable time (*2)        | tch6   | 13   | -    | 125  | ns   |

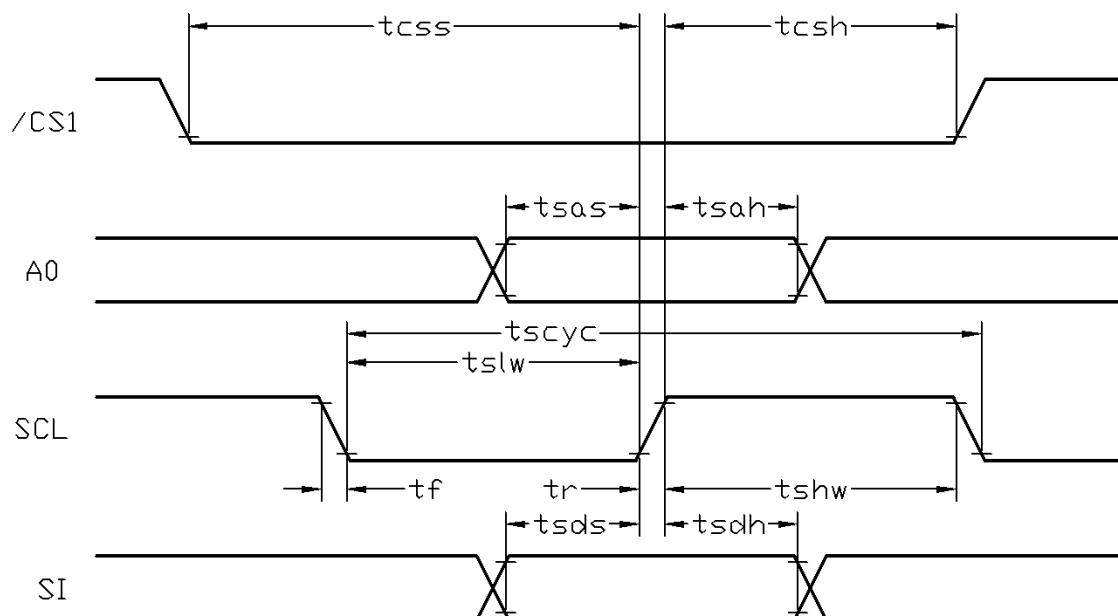
Note:

\*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   |

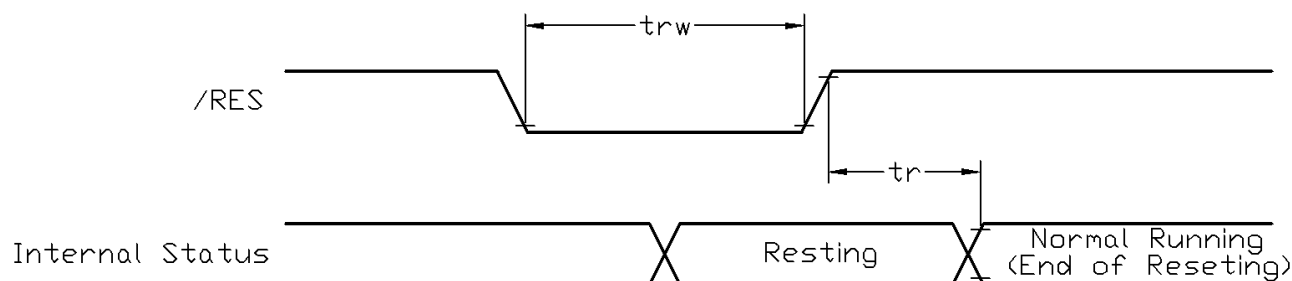
Note:

\*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 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 = 1/6
- 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.

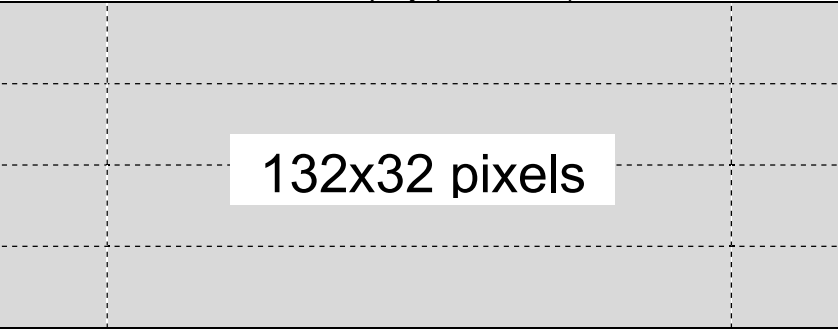
\*2. See the Display Commands section for details.

### 4.2 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)

### 4.3 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 |                                                                                     |       |
| Column Address |               | 00h                                                                                 | → 83h |

Note:

\*1. ADC = 0 (normal)

\*2. SHL Selection = 1 (reverse)

\*3. Initial Display Line = 0



#### 4.4 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 form 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, 1/6 BIAS<br>BIAS=1, 1/5 BIAS                                                                                              |
| 12  | Set Read-Modify-Write             | 0    | 1   | 0   | 1          | 1  | 1                     | 0  | 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)                                                                                                                               |

#### 4.5 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  | Sleep Mode Set                 | 0    | 1   | 0   | 1  | 0  | 1                        | 0  | 1  | 1  | 0     | S                                                       | Sleep Mode (2 byte command)         |
|     |                                | 0    | 1   | 0   | 0  | 0  | 0                        | 0  | 0  | 0  | 0     | 0                                                       | S=0, sleep mode<br>S=1, normal mode |
| 20  | Booster Ratio Set              | 0    | 1   | 0   | 1  | 1  | 1                        | 1  | 1  | 0  | 0     | 0                                                       | Booster Ratio (2 byte command)      |
|     |                                | 0    | 1   | 0   | 0  | 0  | 0                        | 0  | 0  | 0  | Ratio | Ratio=00, 2x, 3x, 4x<br>Ratio=01, 5x<br>Ratio=11, 6x    |                                     |
| 21  | 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 ST7565R data sheet.

##### 4.5.1 Power off the LCD Module

It recommends that enter Sleep Mode before power off the LCD module.

##### 4.5.2 Refreshing The LCD Module

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

## **5. Design and Handling Precaution**

Please refer to "LCD-Module-Design-Handling-Precaution.pdf".

