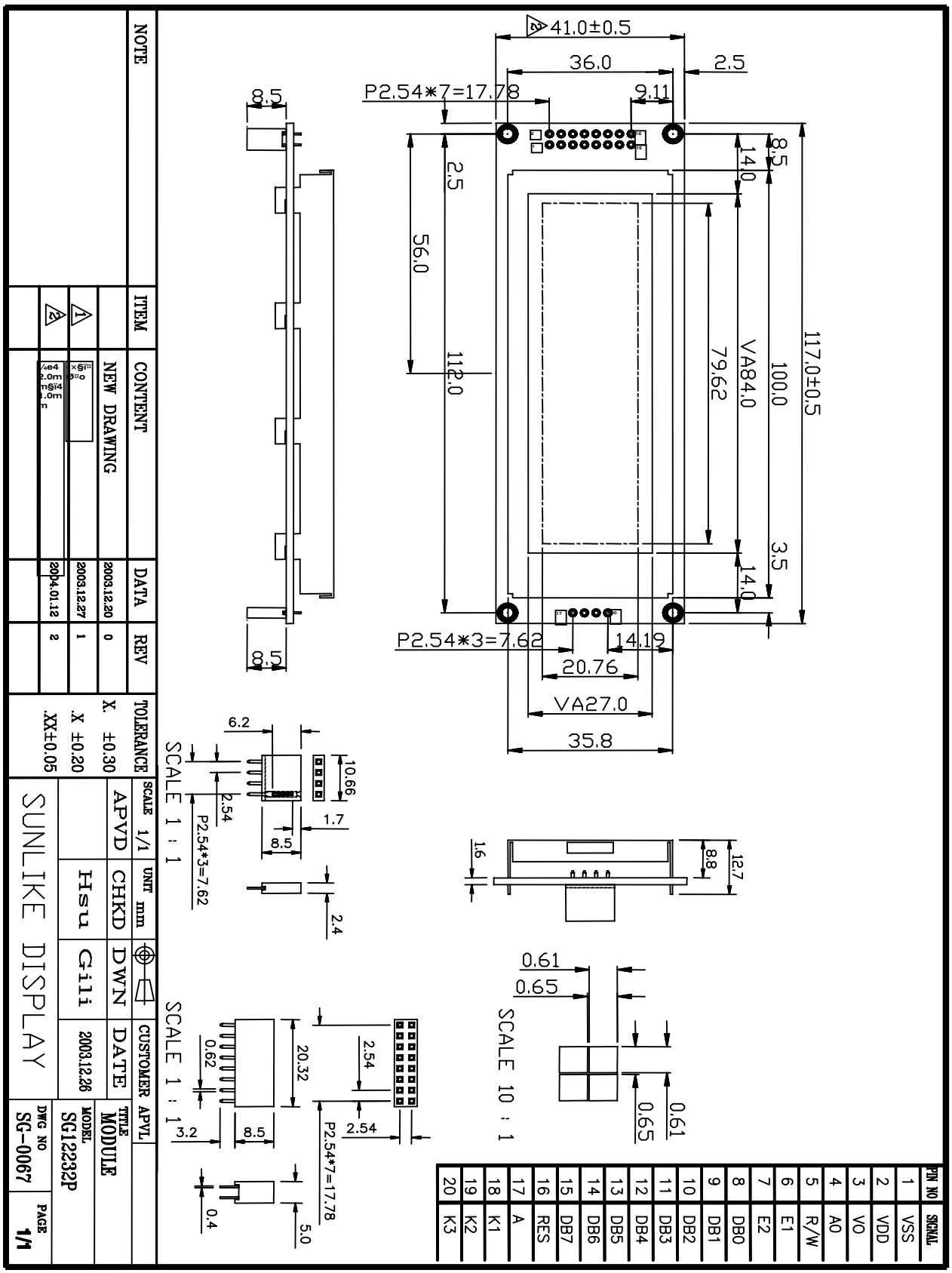
# SUNLIKE DISPLAY Model No: SG12232P

## GENERAL SPECIFICATION

| ITEM | DESCRIPTION | | | | |
|---|---|---|---|---|---|
| Product No | SG12232PFAB-HB-R | | | | |
| LCD Type | ☐ STN Gray Positive | ☐ STN Yellow Green Positive | ☐ STN Blue Negative | | |
| | ☐ FSTN Negative White & Black | ■ FSTN Positive Black & White | | | |
| Rear Polarizer | ☐ Reflective | ■ Transflective | ☐ Transmissive | | |
| Backlight Type | ☐ NO B/L | ■ LED | ☐ CCFL | ☐ EL | |
| Backlight Color | ■ All Color RGB | ☐ Yellow Green | ☐ Amber | ☐ White | ☐ Blue Green |
| View Direction | ■ 6 O'clock | ☐ 12 O'clock | | | |
| Temperature Range | ☐ Normal | ■ Wide | | | |
| Frame | ■ Black | ☐ Silver | | | |

## TO BE VERY CAREFUL !

The LCD driver ICs are made by CMOS process, which are very easy to be damaged by static charge, make sure the user is grounded when handling the LCM.




| NOTE | ITEM | CONTENT | DATA | REV |
|---|---|---|---|---|
| | | NEW DRAWING | 2003.12.20 | 0 |
| | 1 | | 2003.12.27 | 1 |
| | 2 | | 2004.01.12 | 2 |

| TOLERANCE | SCALE | UNIT | CUSTOMER APVL |
|---|---|---|---|
| X. ±0.30 | 1/1 | mm | |
| .X ±0.20 | APVD | CHKD | DWN | DATE |
| .XX±0.05 | | Hsu | Gili | 2003.12.26 |

SUNLIKE DISPLAY

| TITLE | MODEL | DWG NO | PAGE |
|---|---|---|---|
| MODULE | SG12232P | SG-0067 | 1/1 |

| PIN NO | SIGNAL |
|---|---|
| 1 | VSS |
| 2 | VDD |
| 3 | V0 |
| 4 | A0 |
| 5 | R/W |
| 6 | E1 |
| 7 | E2 |
| 8 | DB0 |
| 9 | DB1 |
| 10 | DB2 |
| 11 | DB3 |
| 12 | DB4 |
| 13 | DB5 |
| 14 | DB6 |
| 15 | DB7 |
| 16 | RES |
| 17 | A |
| 18 | K1 |
| 19 | K2 |
| 20 | K3 |

## ABSOLUTE MAXIMUM RATING

(1) Electrical Absolute Ratings

| Item | Symbol | Min. | Max. | Unit | Note |
|---|---|---|---|---|---|
| Power Supply for Logic | $V_{DD}$-$V_{SS}$ | -0.3 | 8.0 | Volt | |
| Power Supply for LCD | $V_{DD}$-$V_O$ | -0.3 | 12.0 | Volt | |
| Input Voltage | $V_I$ | -0.3 | $V_{DD}$ | Volt | |
| LED Power Dissipation | $P_{AD}$ | - | 232 | mW | |
| LED Forward current | $I_{AF}$ | - | 120 | mA | |
| LED Reverse Voltage | $V_R$ | - | 5 | V | |

(2) Environmental Absolute Maximum Ratings

| Item | Normal Temperature | | | | Wide Temperature | | | |
|---|---|---|---|---|---|---|---|---|
| | Operating | | Storage | | Operating | | Storage | |
| | Min, | Max. | Min, | Max. | Min, | Max. | Min, | Max. |
| Ambient Temperature | 0℃ | +50℃ | -20℃ | +70℃ | -20℃ | +70℃ | -30℃ | +80℃ |
| Humidity(without condensation) | Note 2,4 | | Note 3,5 | | Note 4,5 | | Note 4,6 | |

Note 2 Ta≦50℃: 80% RH max
Ta>50℃: Absolute humidity must be lower than the humidity of 85%RH at 50℃

Note 3 Ta at -20℃ will be<48hrs at 70℃will be <120hrs when humidity is higher than 70%.

Note 4 Background color changes slightly depending on ambient temperature. This phenomenon is reversible.

Note 5 Ta≦70℃: 75RH max
Ta>70℃: absolute humidity must be lower than the humidity of 75%RH at 70℃

Note 6 Ta at -30℃ will be <48hrs, at 80 ℃ will be <120hrs when humidity is higher than 70%.

## ELECTRICAL CHARACTERISTICS

| Item | Symbol | Condition | Min. | Typ | Max. | Unit | note |
|---|---|---|---|---|---|---|---|
| Power Supply for Logic | $V_{DD}$-$V_{SS}$ | - | 4.5 | 5.0 | 5.5 | Volt | |
| Input Voltage | $V_{IL}$ | L level | - | - | 0.6 | Volt | |
| | $V_{IH}$ | H level | 2.2 | - | $V_{DD}$ | Volt | |
| LCM Recommend LCD Module Driving Voltage | $V_{DD}$ –$V_O$ | Ta＝0℃ | - | - | - | Volt | |
| | | Ta＝25℃ | 4.8 | 4.9 | 5.0 | | |
| | | Ta＝50℃ | - | - | - | | |
| Power Supply Current for LCM | $I_{DD}$ | $V_{DD}$ =5.0V | - | 0.5 | 1.0 | mA | |
| LED Forward Voltage | $V_F$ | If＝90 mA | - | 5.0 | - | Volt | |
| LED Forward Current | $I_F$ | - | - | 90 | - | mA | |
| LED Reverse Current | $I_R$ | VR=5V | - | - | 0.2 | mA | |

## OPTICAL CHARACTERISTICS

| Item | Symbol | Condition | Min. | Typ | Max. | Unit | note |
|---|---|---|---|---|---|---|---|
| Viewing angle range | Φf(12 o'clock) | When Cr≧ 1.4 | - | 20 | - | Degree | 9,10 |
| | Φb(6 o'clock) | | - | 40 | - | | |
| | Φl(9 o'clock) | | - | 30 | - | | |
| | Φr(3 o'clock) | | - | 30 | - | | |
| Rise Time | Tr | $V_O$ –Vss =4.8V Ta=25℃ | | 200 | | mS | |
| Fall Time | Tf | | | 250 | | | |
| Frame frequency | Frm | | - | 64 | - | Hz | 8,10 |
| Contrast | Cr | | - | 5.0 | - | | 7 |
| The Brightness Of Backlight | L(Red、Blue) | IF=90 mA | 20 | 45 | | cd/㎡ | |
| | L(Green) | | 40 | 55 | - | cd/㎡ | |
| Peak Emission Wavelength | (Red) λP | | 630 | 635 | 640 | nm | |
| | (Green) λP | | 520 | 525 | 530 | nm | |
| | (Blue) λP | | 465 | 470 | 475 | nm | |

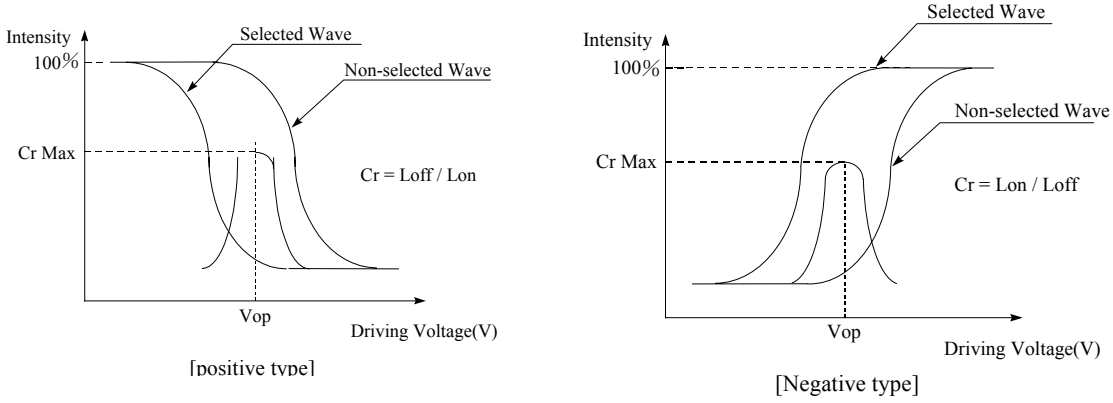
## MECHANICAL SPECIFICATION

| | |
|---|---|
| Product No. | SG12232P |
| Module Size | 117.0(W)×41.0(H)12.7(D) |
| Viewing Area | 84.0(W)mm×27.0(H)mm |
| Resolution | 122(W)×32(H) Dots Matrix |
| Duty Ratio | 1/32 Duty |
| Controller | AX6120D0A |
| DC/DC Converter | Without |

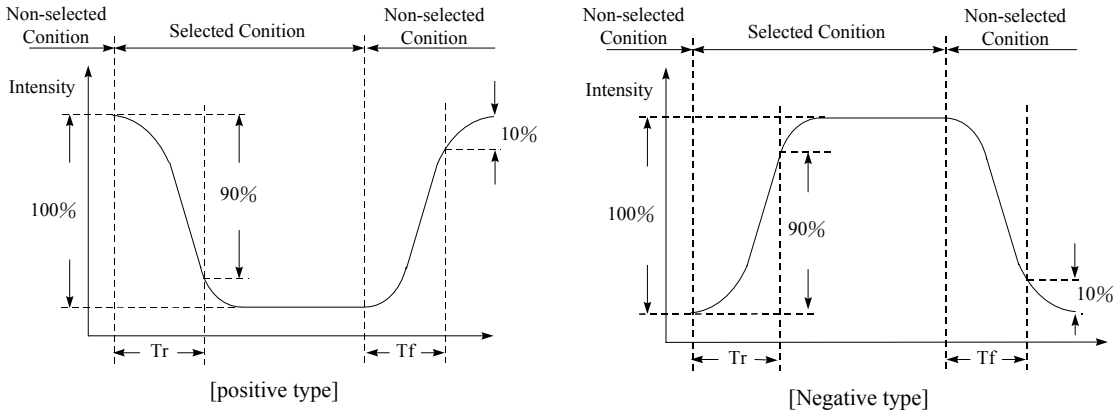
## INTERFACE PIN ASSIGNMENT

| PIN NO | Symbol | Level | Description |
|---|---|---|---|
| 1 | $V_{SS}$ | 0V | GND |
| 2 | $V_{DD}$ | 5V | Logic Supply Voltage |
| 3 | $V_O$ | --- | LCD Driver Supply Voltage |
| 4 | Ao | H/L | Display Data/Display commands switching input .<br>Ao=0:DB0~DB7 are commands input and status output .<br>Ao=1:DB0~DB7 are Display Data input/output |
| 5 | R/W | H/L | Read/Write |
| 6 | E1 | H→ L | Chip Select Signal for IC1 |
| 7 | E2 | H→ L | Chip Select Signal for IC2 |
| 8 | DB0 | H/L | Data Bit 0 |
| 9 | DB1 | H/L | Data Bit 1 |
| 10 | DB2 | H/L | Data Bit 2 |
| 11 | DB3 | H/L | Data Bit 3 |
| 12 | DB4 | H/L | Data Bit 4 |
| 13 | DB5 | H/L | Data Bit 5 |
| 14 | DB6 | H/L | Data Bit 6 |
| 15 | DB7 | H/L | Data Bit 7 |
| 16 | /RES | L | Register Select |
| 17 | A | 5V | Positive Power Supply B/L |
| 18 | K1 | L | Red LED Power Supply |
| 19 | K2 | L | Green LED Power Supply |
| 20 | K3 | L | Blue LED Power Supply |

**[Note 7] Definition of Operation Voltage (Vop)**




**[Note 8] Definition of Response Time (Tr, Tf)**

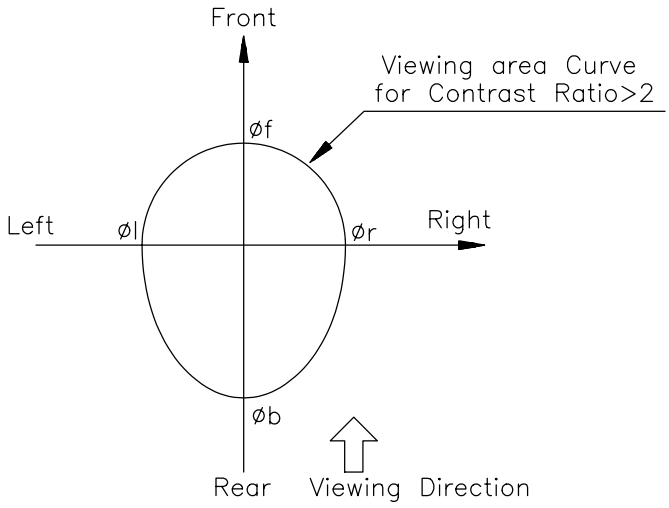



**Conditions:**

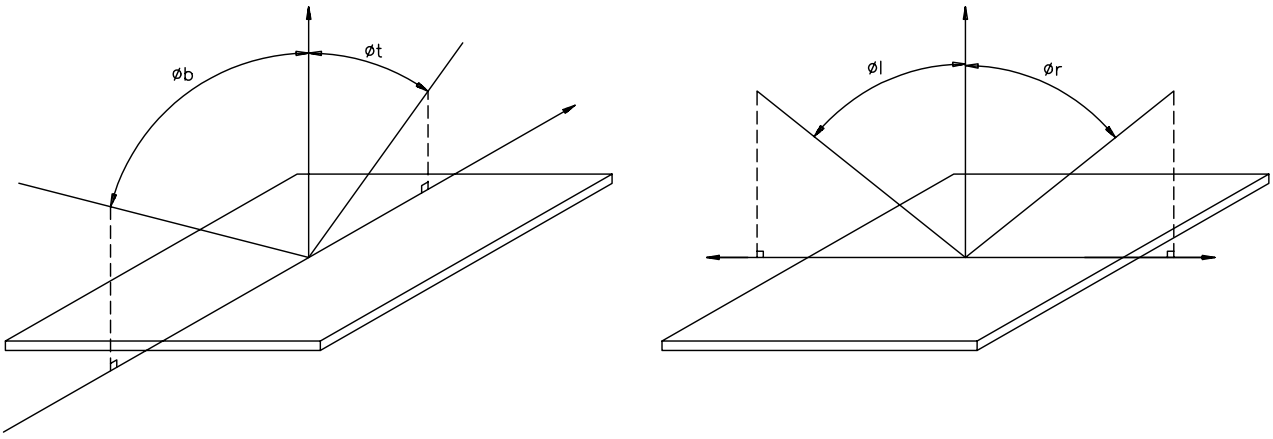
**Operating Voltage : Vop** **Viewing Angle( $\theta$ , $\varphi$ ): 0° , 0°**

**Frame Frequency : 64 Hz** **Driving Wave form : 1/N duty, 1/a bias**

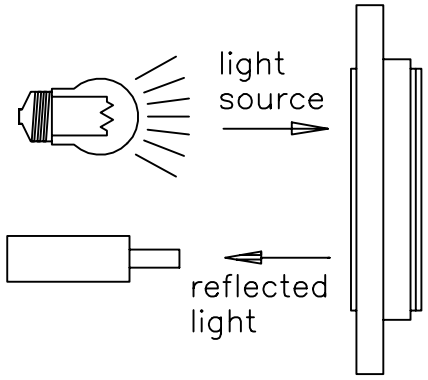
**[Note 9] Definition of Viewing Direction**



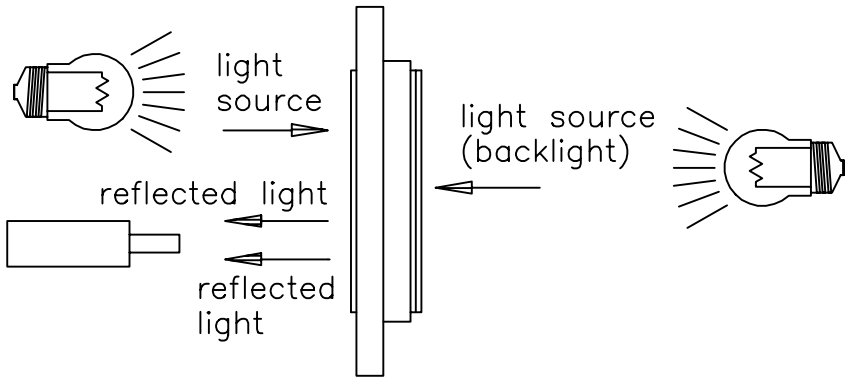
**[Note 10] Definition of viewing angle**




**[Note 11] Description of Measuring Equipment**

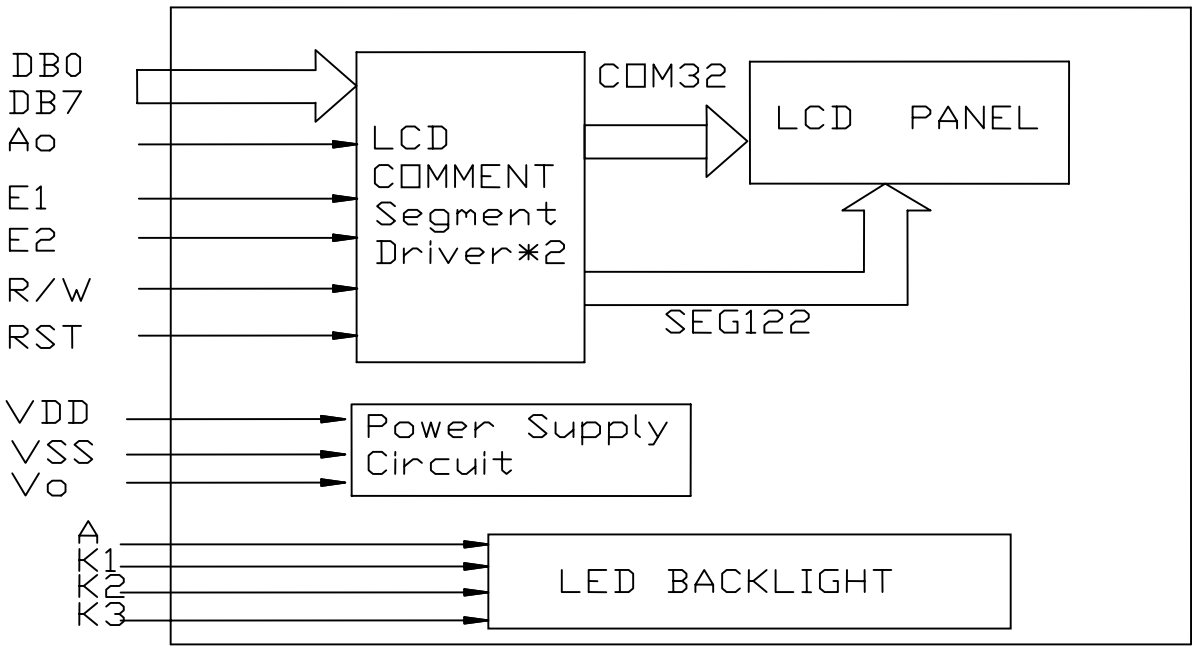



Reflective type

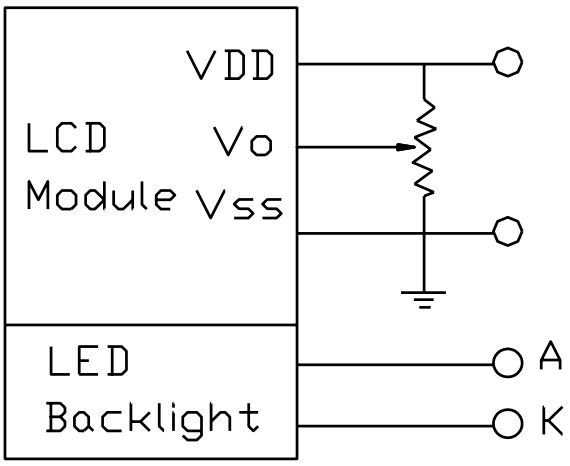



Transflective type

## BLOCK DIAGRAM

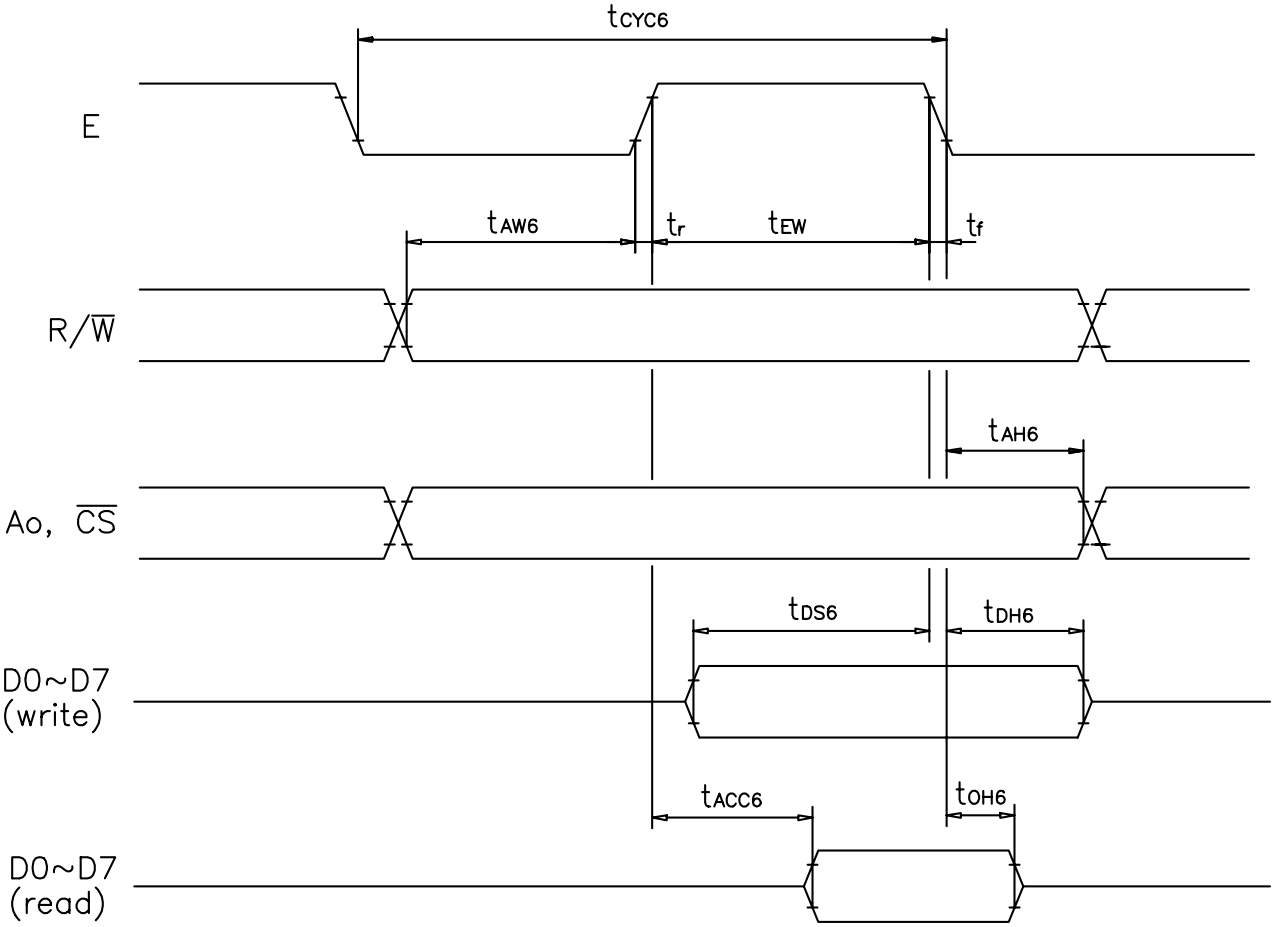



## POWER SUPPLY



## TIMING CHARACTERISTICS

AC Characteristic—68-series MPU Bus Read/Write



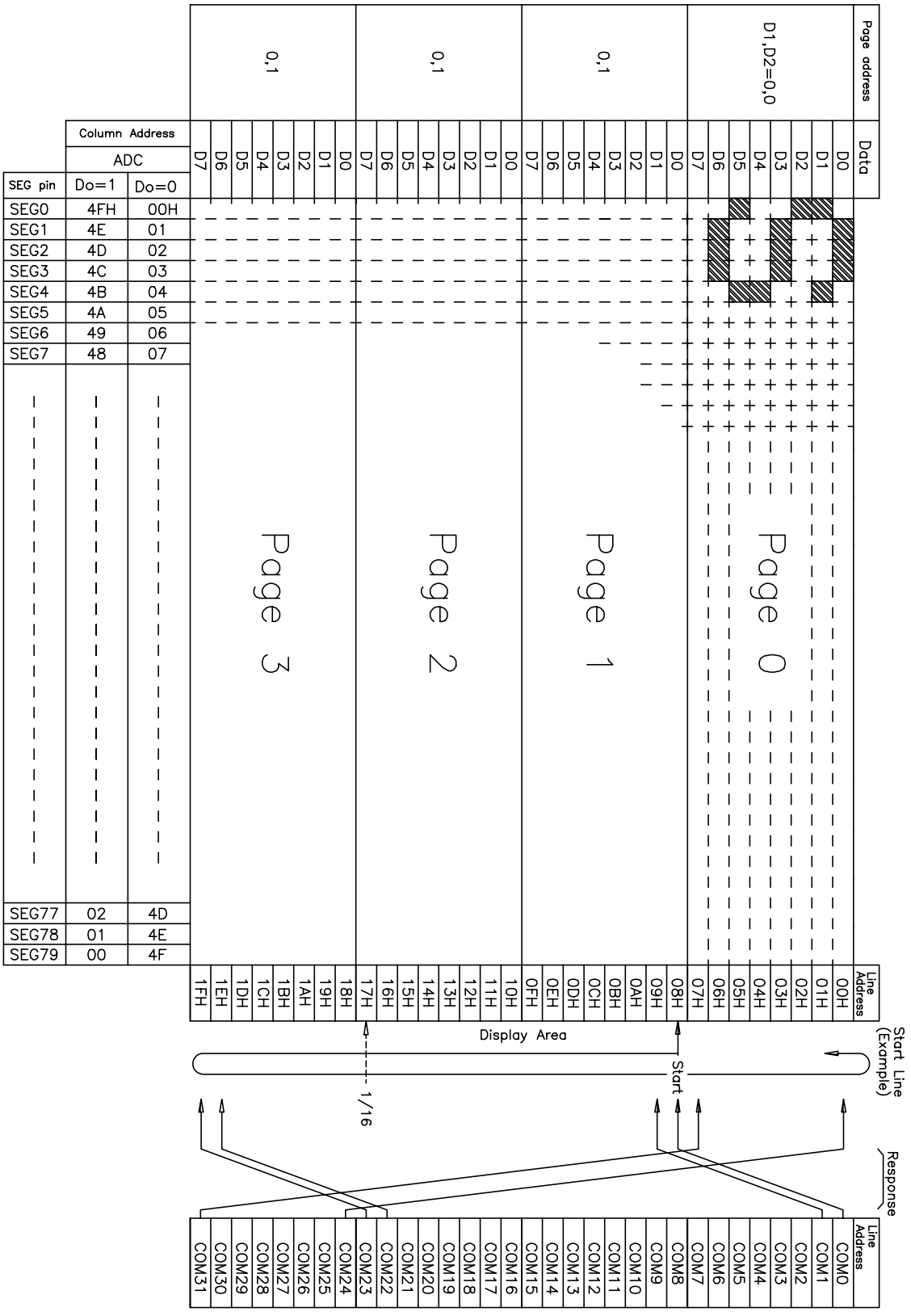
Ta=0~50℃, $V_{DD}$=5.0V±10%, unless state otherwise

| Parameter | | Symbol | Condition | Rating | | Unit | Signal |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Max. | | |
| System cycle time | | $t_{CYC6}$ | | 1000 | - | ns | Ao, CS, R/W |
| Address setup time | | $t_{AW6}$ | | 20 | - | ns | |
| Address hold time | | $t_{AH6}$ | | 10 | - | ns | |
| Data setup time | | $t_{DS6}$ | | 80 | - | ns | D0 to D7 |
| Data hold time | | $t_{DH6}$ | | 10 | - | ns | |
| Output disable time | | $t_{OH6}$ | $C_L$=100pF | 10 | 60 | ns | |
| Access time | | $t_{ACC6}$ | | - | 90 | ns | |
| Enable pulse-width | Read | $t_{EW}$ | | 100 | - | ns | E |
| | Write | | | 80 | - | ns | |
| Rise and fall time | | $t_r$, $t_f$ | - | - | 15 | Ns | - |

Ta=0~50℃, $V_{DD}$=2.7 to 4.5V,

| Parameter | | Symbol | Condition | Rating | | Unit | Signal |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Max. | | |
| System cycle time | | $t_{CYC6}$ | | 2000 | - | ns | Ao, CS, R/W |
| Address setup time | | $t_{AW6}$ | | 40 | - | ns | |
| Address hold time | | $t_{AH6}$ | | 20 | - | ns | |
| Data setup time | | $t_{DS6}$ | | 160 | - | ns | D0 to D7 |
| Data hold time | | $t_{DH6}$ | | 20 | - | ns | |
| Output disable time | | $t_{OH6}$ | $C_L$=100pF | 20 | 120 | ns | |
| Access time | | $t_{ACC6}$ | | - | 180 | ns | |
| Enable pulse-width | Read | $t_{EW}$ | | 200 | - | ns | E |
| | Write | | | 160 | - | ns | |
| Rise and fall time | | $t_r$, $t_f$ | - | - | 15 | Ns | - |

## DISPLAY DATA RAM ADDRESSING



## DISPLAY COMMANDS

| Instruction | Ao | E | R/W | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Display ON/OFF | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1/0 | To control the display ON or OFF. The internal status and display RAM data are not affected. 0:OFF, 1:ON |
| Display start line | 0 | 1 | 0 | 1 | 1 | 0 | Display start address (0~31) | | | | | Specifies RAM line corresponding to top line of display. |
| Set page address | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | Page (0 to 3) | | To set the display RAM page in page address register. |
| Set column (segment) address | 0 | 1 | 0 | 0 | Column address (0 to 79) | | | | | | | To set display RAM column address in column address register. |
| Status Read | 0 | 0 | 1 | Busy | ADC | ON/ OFF | Reset | 0 | 0 | 0 | 0 | Read the following status:<br>Busy 1: Busy<br>0: Ready<br>ADC 1: CW output<br>0: CCW output<br>ON/OFF 1: Display OFF<br>0: Display ON<br>Reset 1: Being reset<br>0: Normal |
| Write display data | 1 | 1 | 0 | Write Data | | | | | | | | To write data from data bus to display RAM. |
| Read display data | 1 | 0 | 1 | Read Data | | | | | | | | To read data from display RAM to data bus |
| Select ADC | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0/1 | 0: CW output, 1: CCW output |
| Status drive ON/OFF | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0/1 | To select static driving operation 1: Static drive, 0: Normal driving |
| Select Duty | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0/1 | To select duty cycle 1: 1/32 duty, 0: 1/16 duty |
| Read-modity-write | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | Read-modify-write ON |
| End | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | Read-modify-write OFF |
| Reset | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | To reset by software |

# COMMAND DESCRIPTION

## Display ON/OFF

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | D | AEH, AFH |

This command turns the display ON or OFF.
D=1 : Display ON
D=0 : Display OFF

## Display Start Line

This command specifies the line address shown in page 13 and indicates the display line that corresponding to COM 0. The display area begins at the specified line address and continues in the line address increment direction. This area having the number of line of specified display duty is displayed. If the line address is changed dynamically by this command, the vertical smooth scrolling and paging can be used.

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 1 | 0 | A4 | A3 | A2 | A1 | A0 | C0H to DFH |

This command loads the display start line register.

| A4 | A3 | A2 | A1 | A0 | Line Address |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 |
| | | ⋮ | | | ⋮ |
| 1 | 1 | 1 | 1 | 1 | 31 |

See the figure in page 13.

## Set Page address

This command specifies the page address that corresponds to the low address of the display data RAM when it is accessed by the MPU. Any bit of the display data RAM can be accessed when its page address and column address are specified. The display status is not changed even when the page address is changed.

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | A1 | A0 | B8H to BBH |

This command loads the page address register.

| A1 | A0 | Page |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 2 |
| 1 | 1 | 3 |

See the figure in page 13.

### Set Column Address

This command specifies a column address of the display data RAM. When the display data RAM is accessed by the MPU continuously, the column address in increased by 1 every time. Therefore the MPU can access to data continuously. The column address stops to be incremented at address 80, and the page address is not changed continuously.

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 0 | A6 | A5 | A4 | A3 | A2 | A1 | A0 | 00H to 4FH |

This command loads the column address register.

| A6 | A5 | A4 | A3 | A2 | A1 | A0 | Line Address |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | | | ⋮ | | | | ⋮ |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 79 |

### Read Status

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | BUSY | ADC | ON/OFF | RESET | 0 | 0 | 0 | 0 | 00H to 4FH |

Reading the command I/O register (Ao=0) yields system status information.

- The busy bit indicates whether the driver will accept a command or not.
  Busy=1: The driver is currently executing a command or is resetting. No new command will be accepted.
  Busy=0: The driver will accept a new command.
- The ADC bit indicates the way column addresses are assigned to a segment drivers
  ADC=1: Normal. Column address n → segment address n.
  ADC=1: 0: Inverted. Column address 79-u → segment driver u.
- The ON/OFF bit indicates the current status of the display.
  It is the inverse of the polarity of the display ON/OFF command.
  ON/OFF=1: Display OFF.
  ON/OFF=1: Display ON.
- The RESET bit indicates whether the driver is executing a hardware or a software reset or it is in a normal operating mode.

RESET=1: Currently executing the reset command.
RESET=0: Normal operating.

### Write Display Data

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | Write Data | | | | | | | |

To write an 8-bit data into the display RAM, at a location specified by the contents of the column address and page address register by one.

### Read Display Data

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | Read Data | | | | | | | |

To read an 8-bit data from the data I/O latch, updates the contents of the I/O latch with display data from the display data RAM location specified by the contents of the column address and page address registers and then increments the column address register.
After loading a new address into the column address register one dummy read is required before valid data is obtained.

### Select ADC

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | D | A0H, A1H |

This command selects the relationship between display data RAM column address and segment driver.
D=0: SEG0 ← column address 00H, …(normal)
This command is provided to reduce restrictions on the placement of the driver ICs and routing of tracing during printed circuit board layout. In this LCD module the D should be cleared to 0.

### Static Driver ON/OFF

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | D | A4H, A5H |

To force the display on and all common outputs to be selected.
D=1: Static driver ON.
D=0: Static driver OFF.

### Select Duty

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | D | A8H, A9H |

To set the D-bit to 1 because the LCD module is 1/32 duty.

### End

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | EEH |

This command cancels the **Read-Modify-Write** mode and restores the contents of the column address register to their value prior to the receipt of the **Read-Modify-Write** command.

### Reset

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | E2H |

This command clears:
The display start line register and to set page address register to 3 page.
It does not affect the contents of the display data RAM. When the power supply is turned on, the user must sent a Reset signal into the RES pin. The Reset command cannot be used instead of this Reset signal.

**Read-Modify-Write**

| Ao | E | W/R | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | E0H |

This command defeats column address register auto-increment after reading data. The current contents of the column address register are saved. This mode remains active until an **END** command is received.