

# NHD-2.23-12832UCW3

## Graphic OLED Display Module

|        |                           |
|--------|---------------------------|
| NHD-   | Newhaven Display          |
| 2.23-  | 2.23" Diagonal Size       |
| 12832- | 128 x 32 Pixel Resolution |
| UC-    | Model                     |
| W-     | Emitting Color: White     |
| 3-     | +3V Power Supply          |

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## Document Revision History

| Revision | Date    | Description                                                     | Changed by |
|----------|---------|-----------------------------------------------------------------|------------|
| 0        | 7/27/15 | Initial Product Release                                         | SB         |
| 1        | 6/28/17 | Datasheet Reformat                                              | SB         |
| 2        | 8/3/20  | Included MIN Supply Voltage & Reformatted 2D Mechanical Drawing | AS         |
| 3        | 9/1/20  | Updated 2D Mechanical Drawing                                   | AS         |

## Functions and Features

- 128 x 32 pixel resolution
- Built-in SSD1305 controller
- Parallel or serial MPU interface
- Single, low voltage power supply
- RoHS compliant

**Mechanical Drawing**

SYMBOL      REVISION      DATE

1 2 3 4 5 6 7 8

A

B

C

D

E

F

60

57.02 (V/A)

55.02 (A/A)

10.40

7

18.10

15.10 (V/A)

13.10 (A/A)

26.60

2.50

1

20

P2.54\*19=48.26

7.47

2.50

5.50

1

56.20

21.60

20

8.50

43.10

3.50

3

P0.5\*23=11.50

0.30

22.80

63.20

1

24

P0.43x128-0.02=55.02 (A/A)

P0.41x32-0.02=13.1 (A/A)

"A"

(4,0)

(0,0)

Segment 127  
(Column 1)

Common 32  
(Row 31)

Common 47  
(Row 1)

Segment 0  
(Column 128)

Common 0  
(Row 32)

Common 15  
(Row 2)

(131,31)

0.43

0.41

0.41

0.39

Detail "A"

Notes:

1. Display Color: White
2. Supply Voltage: 3.3V
3. Driver IC: SSD1305
4. Interface: Parallel (6800 or 8080), SPI or I2C Interface
5. Brightness: 120 cd/m<sup>2</sup>

|                                                                                                                                                                                                                             |                                                                                       |                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|--------------------------|
| STANDARD TOLERANCE:<br>(UNLESS OTHERWISE SPECIFIED)                                                                                                                                                                         |  |                          |
| LINEAR: ±0.3mm                                                                                                                                                                                                              | DRAWING/PART NUMBER:<br><b>NHD-2.23-12832UCW3</b>                                     | REVISION:<br><b>1.0</b>  |
| UNLESS OTHERWISE SPECIFIED:<br>- DIMENSIONS ARE IN MILLIMETERS<br>- THIRD ANGLE PROJECTION                                             | DRAWN BY:<br>A. Shah                                                                  | APPROVED BY:<br>A. Shah  |
|                                                                                                                                                                                                                             | DRAWN DATE:<br>9/1/20                                                                 | APPROVED DATE:<br>9/1/20 |
| DO NOT SCALE DRAWING                                                                                                                                                                                                        |                                                                                       | SHEET 1 OF 1             |
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# Interface Description

## Parallel Interface:

| Pin No. | Symbol          | External Connection | Function Description                                                                                                                 |
|---------|-----------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| 1       | V <sub>SS</sub> | Power Supply        | Ground                                                                                                                               |
| 2       | V <sub>DD</sub> | Power Supply        | Supply Voltage for OLED and logic.                                                                                                   |
| 3       | NC              | -                   | No Connect                                                                                                                           |
| 4       | D/C             | MPU                 | Register select signal. D/C=0: Command, D/C=1: Data                                                                                  |
| 5       | R/W or /WR      | MPU                 | <b>6800-interface:</b><br>Read/Write select signal, R/W=1: Read R/W: =0: Write<br><b>8080-interface:</b><br>Active LOW Write signal. |
| 6       | E or /RD        | MPU                 | <b>6800-interface:</b><br>Operation enable signal. Falling edge triggered.<br><b>8080-interface:</b><br>Active LOW Read signal.      |
| 7-14    | DB0 – DB7       | MPU                 | 8-bit Bi-directional data bus lines.                                                                                                 |
| 15      | NC              | -                   | No Connect                                                                                                                           |
| 16      | /RES            | MPU                 | Active LOW Reset signal.                                                                                                             |
| 17      | /CS             | MPU                 | Active LOW Chip Select signal.                                                                                                       |
| 18      | NC              | -                   | No Connect                                                                                                                           |
| 19      | BS2             | MPU                 | MPU Interface Select signal.                                                                                                         |
| 20      | BS1             | MPU                 | MPU Interface Select signal.                                                                                                         |

## Serial Interface:

| Pin No. | Symbol          | External Connection | Function Description                                |
|---------|-----------------|---------------------|-----------------------------------------------------|
| 1       | V <sub>SS</sub> | Power Supply        | Ground                                              |
| 2       | V <sub>DD</sub> | Power Supply        | Supply Voltage for OLED and logic.                  |
| 3       | NC              | -                   | No Connect                                          |
| 4       | D/C             | MPU                 | Register select signal. D/C=0: Command, D/C=1: Data |
| 5-6     | V <sub>SS</sub> | Power Supply        | Ground                                              |
| 7       | SCLK            | MPU                 | Serial Clock signal.                                |
| 8       | SDIN            | MPU                 | Serial Data Input signal.                           |
| 9       | NC              | -                   | No Connect                                          |
| 10-14   | VSS             | Power Supply        | Ground                                              |
| 15      | NC              | -                   | No Connect                                          |
| 16      | /RES            | MPU                 | Active LOW Reset signal.                            |
| 17      | /CS             | MPU                 | Active LOW Chip Select signal.                      |
| 18      | NC              | -                   | No Connect                                          |
| 19      | BS2             | MPU                 | MPU Interface Select signal.                        |
| 20      | BS1             | MPU                 | MPU Interface Select signal.                        |

### I2C Interface:

| Pin No. | Symbol             | External Connection | Function Description                                          |
|---------|--------------------|---------------------|---------------------------------------------------------------|
| 1       | V <sub>SS</sub>    | Power Supply        | Ground                                                        |
| 2       | V <sub>DD</sub>    | Power Supply        | Supply Voltage for OLED and logic.                            |
| 3       | NC                 | -                   | No Connect                                                    |
| 4       | SA0                | MPU                 | Slave Address Selection signal.                               |
| 5-6     | V <sub>SS</sub>    | Power Supply        | Ground                                                        |
| 7       | SCL                | MPU                 | Serial Clock signal.                                          |
| 8       | SDA <sub>IN</sub>  | MPU                 | Serial Data input signal (pins 8 and 9 can be tied together). |
| 9       | SDA <sub>OUT</sub> | MPU                 | Serial Data output signal (pin9 can be no connect).           |
| 10-14   | V <sub>SS</sub>    | Power Supply        | Ground                                                        |
| 15      | NC                 | -                   | No Connect                                                    |
| 16      | /RES               | MPU                 | Active LOW Reset signal.                                      |
| 17      | V <sub>SS</sub>    | Power Supply        | Ground                                                        |
| 18      | NC                 | -                   | No Connect                                                    |
| 19      | BS2                | MPU                 | MPU Interface Select signal.                                  |
| 20      | BS1                | MPU                 | MPU Interface Select signal.                                  |

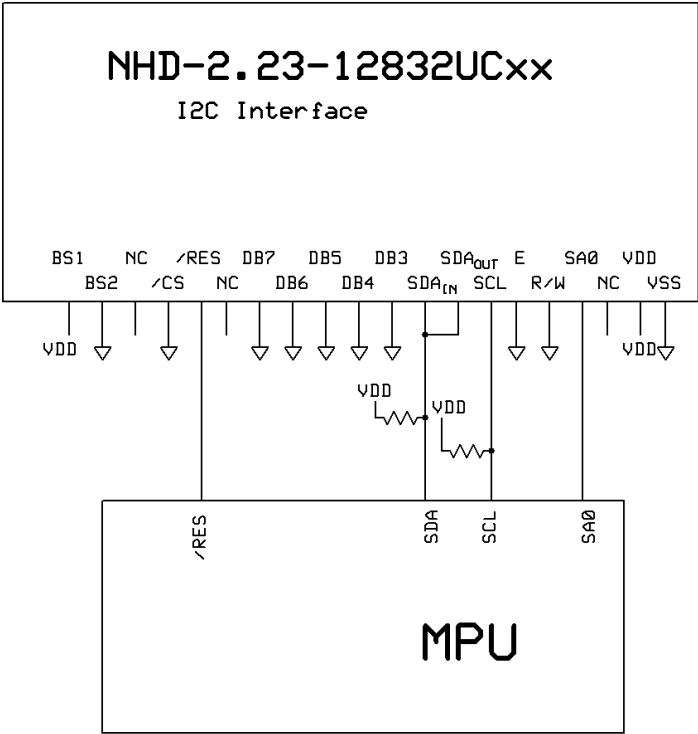
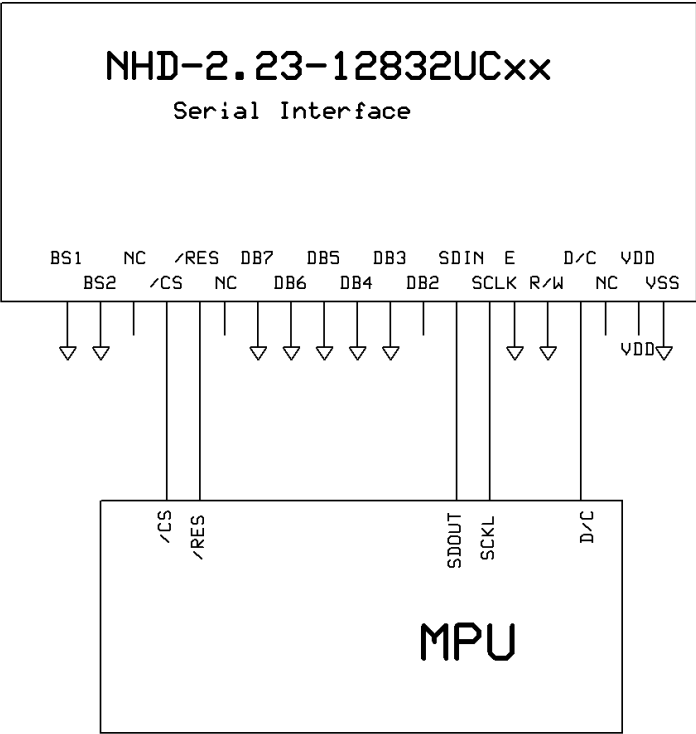
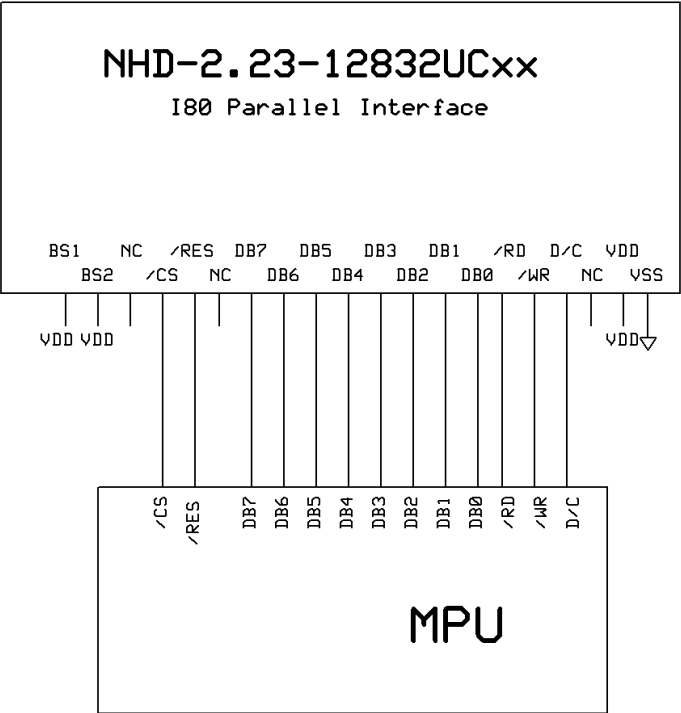
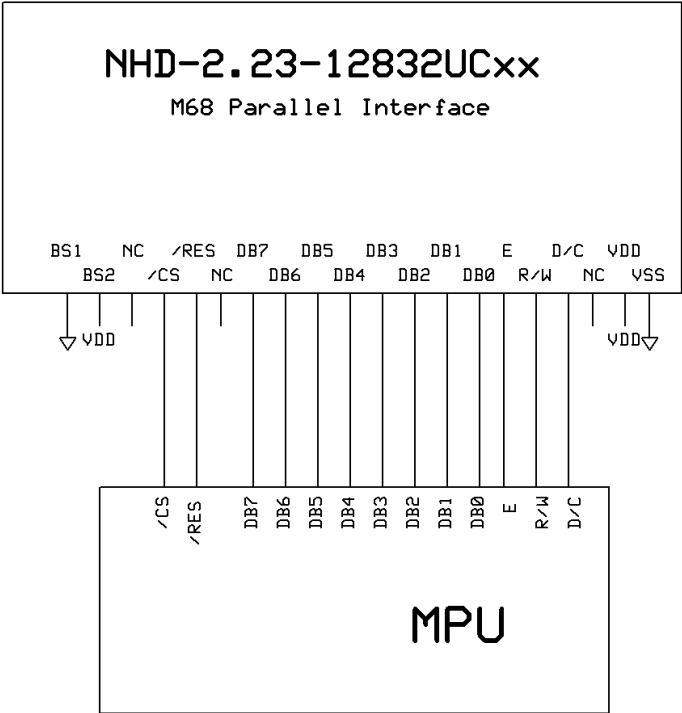
### MPU Interface Pin Selections

| Pin Name | 6800 Parallel 8-bit interface | 8080 Parallel 8-bit interface | Serial Interface | I2C Interface |
|----------|-------------------------------|-------------------------------|------------------|---------------|
| BS2      | 1                             | 1                             | 0                | 0             |
| BS1      | 0                             | 1                             | 0                | 1             |

### MPU Interface Pin Assignment Summery

| Bus Interface | Data/Command Interface |    |    |    |                   |    |                    |      | Control Signals |     |     |     |      |
|---------------|------------------------|----|----|----|-------------------|----|--------------------|------|-----------------|-----|-----|-----|------|
|               | D7                     | D6 | D5 | D4 | D3                | D2 | D1                 | D0   | E               | R/W | /CS | D/C | /RES |
| 8-bit 6800    | D[7:0]                 |    |    |    |                   |    |                    |      | E               | R/W | /CS | D/C | /RES |
| 8-bit 8080    | D[7:0]                 |    |    |    |                   |    |                    |      | /RD             | /WR | /CS | D/C | /RES |
| SPI           | Tie LOW                |    |    |    | NC                |    | SDIN               | SCLK | Tie LOW         |     | /CS | D/C | /RES |
| I2C           | Tie LOW                |    |    |    | SDA <sub>IN</sub> |    | SDA <sub>OUT</sub> | SCL  | Tie LOW         |     | SA0 |     | /RES |

Wiring Diagrams



## Electrical Characteristics

| Item                        | Symbol                                | Condition                                    | Min.                  | Typ. | Max.                  | Unit |
|-----------------------------|---------------------------------------|----------------------------------------------|-----------------------|------|-----------------------|------|
| Operating Temperature Range | T <sub>OP</sub>                       | Absolute Max                                 | -40                   | -    | +85                   | °C   |
| Storage Temperature Range   | T <sub>ST</sub>                       | Absolute Max                                 | -40                   | -    | +90                   | °C   |
|                             |                                       |                                              |                       |      |                       |      |
| Supply Voltage              | V <sub>DD</sub>                       |                                              | 3.0                   | 3.3  | 3.5                   | V    |
| Supply Current (logic)      | I <sub>DD</sub>                       | T <sub>OP</sub> =25°C, V <sub>DD</sub> =3.3V | -                     | 180  | 300                   | μA   |
| Supply Current (display)    | I <sub>CC</sub>                       | 50% ON, V <sub>DD</sub> =3.3V                | -                     | 62   | 70                    | mA   |
|                             |                                       | 100% ON, V <sub>DD</sub> =3.3V               | -                     | 113  | 120                   | mA   |
| Sleep Mode Current          | I <sub>DD</sub> +I <sub>CCSLEEP</sub> | -                                            | -                     | 3    | 15                    | μA   |
| "H" Level input             | V <sub>IH</sub>                       | -                                            | 0.8 * V <sub>DD</sub> | -    | V <sub>DD</sub>       | V    |
| "L" Level input             | V <sub>IL</sub>                       | -                                            | V <sub>SS</sub>       | -    | 0.2 * V <sub>DD</sub> | V    |
| "H" Level output            | V <sub>OH</sub>                       | -                                            | 0.9 * V <sub>DD</sub> | -    | V <sub>DD</sub>       | V    |
| "L" Level output            | V <sub>OL</sub>                       | -                                            | V <sub>SS</sub>       | -    | 0.1 * V <sub>DD</sub> | V    |

## Optical Characteristics

| Item                   |        | Symbol         | Condition                                                  | Min.     | Typ. | Max. | Unit              |
|------------------------|--------|----------------|------------------------------------------------------------|----------|------|------|-------------------|
| Optimal Viewing Angles | Top    | φY+            | CR≥10,000                                                  | 80       | -    | -    | °                 |
|                        | Bottom | φY-            |                                                            | 80       | -    | -    | °                 |
|                        | Left   | θX-            |                                                            | 80       | -    | -    | °                 |
|                        | Right  | θX+            |                                                            | 80       | -    | -    | °                 |
| Contrast Ratio         |        | Cr             | -                                                          | 10,000:1 | -    | -    | -                 |
| Response Time          | Rise   | T <sub>R</sub> | -                                                          | -        | 10   | -    | μs                |
|                        | Fall   | T <sub>F</sub> | -                                                          | -        | 10   | -    | μs                |
| Brightness             |        | L <sub>V</sub> | 50% Checkerboard                                           | 100      | 120  | -    | cd/m <sup>2</sup> |
| Lifetime               |        | -              | L <sub>V</sub> = 120 cd/m <sup>2</sup><br>50% Checkerboard | 10,000   | -    | -    | Hrs.              |

**Note:** Lifetime at typical temperature is based on accelerated high-temperature operation. Lifetime is tested at average 50% pixels on and is rated as Hours until **Half-Brightness**. The Display OFF command can be used to extend the lifetime of the display.

Luminance of active pixels will degrade faster than inactive pixels. Residual (burn-in) images may occur. To avoid this, every pixel should be illuminated uniformly.

## Built-in SSD1305 controller.

### Instruction Table

| Instruction                                | Code |                                            |                           |                           |                           |                           |                           |                           |                           |                           | Description                                                                                                                                                                                                                                                                                                                                                                               | RESET value                  |
|--------------------------------------------|------|--------------------------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
|                                            | D/C  | HEX                                        | DB7                       | DB6                       | DB5                       | DB4                       | DB3                       | DB2                       | DB1                       | DB0                       |                                                                                                                                                                                                                                                                                                                                                                                           |                              |
| Set Lower Column Start Address             | 0    | 00~0F                                      | 0                         | 0                         | 0                         | 0                         | X3                        | X2                        | X1                        | X0                        | Set the lower nibble of the column start address register for Page Addressing Mode.                                                                                                                                                                                                                                                                                                       | 0                            |
| Set Higher Column Start Address            | 0    | 10~1F                                      | 0                         | 0                         | 0                         | 1                         | X3                        | X2                        | X1                        | X0                        | Set the higher nibble of the column start address register for Page Addressing Mode.                                                                                                                                                                                                                                                                                                      | 0                            |
| Set Memory Addressing Mode                 | 0    | 20<br>A[1:0]                               | 0<br>*                    | 0<br>*                    | 1<br>*                    | 0<br>*                    | 0<br>*                    | 0<br>*                    | 0<br>A1                   | 0<br>A0                   | A[1:0] = 00b, Horizontal Addressing Mode<br>A[1:0] = 01b, Vertical Addressing Mode<br>A[1:0] = 10b, Page Addressing Mode<br>A[1:0] = 11b, Invalid                                                                                                                                                                                                                                         | 10b                          |
| Set Column Address                         | 0    | 21<br>A[7:0]<br>B[7:0]                     | 0<br>A7<br>B7             | 0<br>A6<br>B6             | 1<br>A5<br>B5             | 0<br>A4<br>B4             | 0<br>A3<br>B3             | 0<br>A2<br>B2             | 0<br>A1<br>B1             | 1<br>A0<br>B0             | Setup column start and end address<br>A[7:0]: Column start address. Range: 0-131d<br>B[7:0]: Column end address. Range: 0-131d                                                                                                                                                                                                                                                            | 0<br>131d                    |
| Set Page Address                           | 0    | 22<br>A[2:0]<br>B[2:0]                     | 0<br>*<br>*               | 0<br>*<br>*               | 1<br>*<br>*               | 0<br>*<br>*               | 0<br>*<br>*               | 0<br>A2<br>B2             | 1<br>A1<br>B1             | 0<br>A0<br>B0             | Setup page start and end address<br>A[2:0]: Page start address. Range: 0-7d<br>B[2:0]: Page end address. Range: 0-7d                                                                                                                                                                                                                                                                      | 0<br>7d                      |
| Set Display Start Line                     | 0    | 40~7F                                      | 0                         | 1                         | X5                        | X4                        | X3                        | X2                        | X1                        | X0                        | Set display RAM display start line register from 0-63d.                                                                                                                                                                                                                                                                                                                                   | 0                            |
| Set Contrast Control                       | 0    | 81<br>A[7:0]                               | 1<br>A7                   | 0<br>A6                   | 0<br>A5                   | 0<br>A4                   | 0<br>A3                   | 0<br>A2                   | 0<br>A1                   | 1<br>A0                   | Double byte command to select 1 out of 256 contrast steps. Contrast increases as the value increases.                                                                                                                                                                                                                                                                                     | 0x80                         |
| Set Brightness                             | 0    | 82<br>A[7:0]                               | 1<br>A7                   | 0<br>A6                   | 0<br>A5                   | 0<br>A4                   | 0<br>A3                   | 0<br>A2                   | 1<br>A1                   | 0<br>A0                   | Double byte command to select 1 out of 256 brightness steps. Brightness increases as the value increases.                                                                                                                                                                                                                                                                                 | 0x80                         |
| Set Look-Up Table                          | 0    | 91<br>X[5:0]<br>A[5:0]<br>B[5:0]<br>C[5:0] | 1<br>*<br>*<br>*<br>*     | 0<br>*<br>*<br>*<br>*     | 0<br>X5<br>A5<br>B5<br>C5 | 1<br>X4<br>A4<br>B4<br>C4 | 0<br>X3<br>A3<br>B3<br>C3 | 0<br>X2<br>A2<br>B2<br>C2 | 0<br>X1<br>A1<br>B1<br>C1 | 1<br>X0<br>A0<br>B0<br>C0 | Set current drive pulse width of Bank 0, Color A, B and C.<br>Bank 0: X[5:0] = 31 to 63. Pulse width set to 32 to 64 clocks.<br>Color A: X[5:0] = 31 to 63. Pulse width set to 32 to 64 clocks.<br>Color B: X[5:0] = 31 to 63. Pulse width set to 32 to 64 clocks.<br>Color C: X[5:0] = 31 to 63. Pulse width set to 32 to 64 clocks.<br>Note: Color D pulse width is fixed at 64 clocks. | 0x31<br>0x3F<br>0x3F<br>0x3F |
| Set Bank Color of Bank1 to Bank16 (Page 0) | 0    | 92<br>A[7:0]<br>B[7:0]<br>C[7:0]<br>D[7:0] | 1<br>A7<br>B7<br>C7<br>D7 | 0<br>A6<br>B6<br>C6<br>D6 | 0<br>A5<br>B5<br>C5<br>D5 | 1<br>A4<br>B4<br>C4<br>D4 | 0<br>A3<br>B3<br>C3<br>D3 | 0<br>A2<br>B2<br>C2<br>D2 | 1<br>A1<br>B1<br>C1<br>D1 | 0<br>A0<br>B0<br>C0<br>D0 | Sets the bank color of Bank1~Bank16 to any one of the 4 colors A,B,C, and D.<br>A[1:0] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK1.<br>A[3:2] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK2.<br>.<br>.<br>.<br>D[5:4] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK15.<br>D[7:6] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK16.     |                              |
| Set Bank Color of                          | 0    | 93                                         | 1                         | 0                         | 0                         | 1                         | 0                         | 0                         | 1                         | 1                         | Sets the bank color of Bank17~Bank32 to any one of the 4 colors                                                                                                                                                                                                                                                                                                                           |                              |

|                                                          |   |                                                                  |                                                  |                                                  |                                                  |                                                  |                                                  |                                                  |                                                  |                                                  |                                                                                                                                                                                                                                                                                                                          |                |
|----------------------------------------------------------|---|------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| Bank17 to Bank32<br>(Page 1)                             |   | <b>A[7:0]</b><br><b>B[7:0]</b><br><b>C[7:0]</b><br><b>D[7:0]</b> | <b>A7</b><br><b>B7</b><br><b>C7</b><br><b>D7</b> | <b>A6</b><br><b>B6</b><br><b>C6</b><br><b>D6</b> | <b>A5</b><br><b>B5</b><br><b>C5</b><br><b>D5</b> | <b>A4</b><br><b>B4</b><br><b>C4</b><br><b>D4</b> | <b>A3</b><br><b>B3</b><br><b>C3</b><br><b>D3</b> | <b>A2</b><br><b>B2</b><br><b>C2</b><br><b>D2</b> | <b>A1</b><br><b>B1</b><br><b>C1</b><br><b>D1</b> | <b>A0</b><br><b>B0</b><br><b>C0</b><br><b>D0</b> | A,B,C, and D.<br>A[1:0] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK17.<br>A[3:2] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK18.<br>.<br>.<br>.<br>D[5:4] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK31.<br>D[7:6] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK32. |                |
| Set Segment Remap                                        | 0 | <b>A0/A1</b>                                                     | <b>1</b>                                         | <b>0</b>                                         | <b>1</b>                                         | <b>0</b>                                         | <b>0</b>                                         | <b>0</b>                                         | <b>0</b>                                         | <b>X0</b>                                        | X[0] = 0; Column address 0 is mapped to SEG0<br>X[0] = 1; Column address 131 is mapped to SEG0                                                                                                                                                                                                                           | 0              |
| Entire Display ON                                        | 0 | <b>A4/A5</b>                                                     | <b>1</b>                                         | <b>0</b>                                         | <b>1</b>                                         | <b>0</b>                                         | <b>0</b>                                         | <b>1</b>                                         | <b>0</b>                                         | <b>X0</b>                                        | X[0] = 0; Resume RAM content display. Output follows RAM content.<br>X[0] = 1; Entire display ON. Output ignores RAM content.                                                                                                                                                                                            | 0              |
| Set Normal/<br>Inverse Display                           | 0 | <b>A6/A7</b>                                                     | <b>1</b>                                         | <b>0</b>                                         | <b>1</b>                                         | <b>0</b>                                         | <b>0</b>                                         | <b>1</b>                                         | <b>1</b>                                         | <b>X0</b>                                        | X[0] = 0; Normal display.<br>X[0] = 1; Inverse display.                                                                                                                                                                                                                                                                  | 0              |
| Set Multiplex Ratio                                      | 0 | <b>A8</b><br><b>A[5:0]</b>                                       | <b>1</b><br>*                                    | <b>0</b><br>*                                    | <b>1</b><br><b>A5</b>                            | <b>0</b><br><b>A4</b>                            | <b>1</b><br><b>A3</b>                            | <b>0</b><br><b>A2</b>                            | <b>0</b><br><b>A1</b>                            | <b>0</b><br><b>A0</b>                            | Set MUX ratio to N+1 MUX<br>N=A[5:0]; from 16MUX to 64MUX (0 to 14 are invalid)                                                                                                                                                                                                                                          | 64             |
| Dim mode setting                                         | 0 | <b>AB</b><br><b>A[3:0]</b><br><b>B[7:0]</b><br><b>C[7:0]</b>     | <b>1</b><br>*<br><b>B7</b><br><b>C7</b>          | <b>0</b><br>*<br><b>B6</b><br><b>C6</b>          | <b>1</b><br>*<br><b>B5</b><br><b>C5</b>          | <b>0</b><br>*<br><b>B4</b><br><b>C4</b>          | <b>1</b><br><b>A3</b><br><b>B3</b><br><b>C3</b>  | <b>0</b><br><b>A2</b><br><b>B2</b><br><b>C2</b>  | <b>1</b><br><b>A1</b><br><b>B1</b><br><b>C1</b>  | <b>1</b><br><b>A0</b><br><b>B0</b><br><b>C0</b>  | A[3:0] = reserved. Set as 0000b<br>B[7:0] = Set contrast for BANK0. Range 0-255d. Refer to command 81h.<br>C[7:0] = Set brightness for color bank. Range 0-255d. Refer to command 82h.                                                                                                                                   |                |
| Master configuration                                     | 0 | <b>AD</b><br><b>AE</b>                                           | <b>1</b><br><b>1</b>                             | <b>0</b><br><b>0</b>                             | <b>1</b><br><b>0</b>                             | <b>0</b><br><b>0</b>                             | <b>1</b><br><b>1</b>                             | <b>1</b><br><b>1</b>                             | <b>0</b><br><b>1</b>                             | <b>1</b><br><b>0</b>                             | Selects external VCC supply                                                                                                                                                                                                                                                                                              | AEh            |
| Set Display ON/<br>OFF                                   | 0 | <b>AC/</b><br><b>AE/</b><br><b>AF</b>                            | <b>1</b>                                         | <b>0</b>                                         | <b>1</b>                                         | <b>0</b>                                         | <b>1</b>                                         | <b>1</b>                                         | <b>A1</b>                                        | <b>A0</b>                                        | ACh = Display ON in dim mode<br>AEh = Display OFF (sleep mode)<br>AFh = Display ON in normal mode                                                                                                                                                                                                                        | AEh            |
| Set Page Start Address                                   | 0 | <b>B0~B7</b>                                                     | <b>1</b>                                         | <b>0</b>                                         | <b>1</b>                                         | <b>1</b>                                         | <b>0</b>                                         | <b>X2</b>                                        | <b>X1</b>                                        | <b>X0</b>                                        | Set GDRAM Page Start Address for Page Addressing Mode using X[2:0].<br>PAGE0~PAGE7                                                                                                                                                                                                                                       |                |
| Set COM Output Scan Direction                            | 0 | <b>C0/C8</b>                                                     | <b>1</b>                                         | <b>1</b>                                         | <b>0</b>                                         | <b>0</b>                                         | <b>X3</b>                                        | <b>0</b>                                         | <b>0</b>                                         | <b>0</b>                                         | X[3] = 0; Normal mode. Scan from COM0 to COM[N-1]<br>X[3] = 1; Remapped mode. Scan from COM[N-1] to COM0                                                                                                                                                                                                                 | 0              |
| Set Display Offset                                       | 0 | <b>D3</b><br><b>A[5:0]</b>                                       | <b>1</b><br>*                                    | <b>1</b><br>*                                    | <b>0</b><br><b>A5</b>                            | <b>1</b><br><b>A4</b>                            | <b>0</b><br><b>A3</b>                            | <b>0</b><br><b>A2</b>                            | <b>1</b><br><b>A1</b>                            | <b>1</b><br><b>A0</b>                            | Set vertical shift by COM from 0~63.                                                                                                                                                                                                                                                                                     | 0              |
| Set Display Clock Divide Ratio /<br>Oscillator Frequency | 0 | <b>D5</b><br><b>A[7:0]</b>                                       | <b>1</b><br><b>A7</b>                            | <b>1</b><br><b>A6</b>                            | <b>0</b><br><b>A5</b>                            | <b>1</b><br><b>A4</b>                            | <b>0</b><br><b>A3</b>                            | <b>1</b><br><b>A2</b>                            | <b>0</b><br><b>A1</b>                            | <b>1</b><br><b>A0</b>                            | A[3:0] = Define the divide ratio of the display clocks.<br>Divide ratio = A[3:0] +1<br>A[7:4] = Set the Oscillator Frequency. Frequency increases with the value of A[7:4]. Range 0000b~1111b.                                                                                                                           | 0000b<br>0111b |
| Set Area Color Mode ON/OFF &<br>Low Power Display Mode   | 0 | <b>D8</b><br><b>X[5:0]</b>                                       | <b>1</b><br><b>0</b>                             | <b>1</b><br><b>0</b>                             | <b>0</b><br><b>X5</b>                            | <b>1</b><br><b>X4</b>                            | <b>1</b><br><b>0</b>                             | <b>0</b><br><b>X2</b>                            | <b>0</b><br><b>0</b>                             | <b>0</b><br><b>X0</b>                            | X[5:4] = 00b; Monochrome mode<br>X[5:4] = 11b; Area Color mode<br>X[2] = 0 and X[0] = 0; Normal power mode<br>X[2] = 1 and X[0] = 1; Set low power display mode                                                                                                                                                          | 00<br>00       |
| Set Pre-charge                                           | 0 | <b>D9</b>                                                        | <b>1</b>                                         | <b>1</b>                                         | <b>0</b>                                         | <b>1</b>                                         | <b>1</b>                                         | <b>0</b>                                         | <b>0</b>                                         | <b>1</b>                                         | A[3:0] = Phase 1 period of up to 15 DCLK clocks. 0 is invalid.<br>A[7:4] = Phase 2 period of up to 15 DCLK clocks. 0 is invalid.                                                                                                                                                                                         | 2h<br>2h       |

| Period                                    |   | A[7:0]       | A7     | A6     | A5      | A4      | A3      | A2      | A1     | A0     |                                                                                                                                                                              |            |
|-------------------------------------------|---|--------------|--------|--------|---------|---------|---------|---------|--------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Set COM pins<br>Hardware<br>configuration | 0 | DA<br>X[5:4] | 1<br>0 | 1<br>0 | 0<br>X5 | 1<br>X4 | 1<br>0  | 0<br>0  | 1<br>1 | 0<br>0 | X[4] = 0; Sequential COM pin configuration<br>X[4] = 1; Alternative COM pin configuration<br>X[5] = 0; Disable COM Left/Right remap<br>X[5] = 1; Enable COM Left/Right remap | 1<br><br>1 |
| Set VCOMH<br>Deselect Level               | 0 | DB<br>A[5:2] | 1<br>0 | 1<br>0 | 0<br>A5 | 1<br>A4 | 1<br>A3 | 0<br>A2 | 1<br>0 | 1<br>0 | A[5:2] = 0000b; VCOMH = ~0.43*VCC<br>A[5:2] = 1101b; VCOMH = ~0.77*VCC<br>A[5:2] = 1111b; VCOMH = ~0.83*VCC                                                                  | 1101       |
| Enter Read<br>Modify Write<br>mode        | 0 | E0           | 1      | 1      | 1       | 0       | 0       | 0       | 0      | 0      | Enter the Read/Modify/Write mode.                                                                                                                                            |            |
| NOP                                       | 0 | E3           | 1      | 1      | 1       | 0       | 0       | 0       | 1      | 1      | Command for No Operation                                                                                                                                                     |            |
| Exit Read Modify<br>Write mode            | 0 | EE           | 1      | 1      | 1       | 0       | 1       | 1       | 1      | 0      | Exit the Read/Modify/Write mode.                                                                                                                                             |            |

For detailed instruction information, see datasheet: [http://www.newhavendisplay.com/app\\_notes/SSD1305.pdf](http://www.newhavendisplay.com/app_notes/SSD1305.pdf)

## MPU Interface

For detailed timing information, see datasheet: [http://www.newhavendisplay.com/app\\_notes/SSD1305.pdf](http://www.newhavendisplay.com/app_notes/SSD1305.pdf)

### 6800-MPU Parallel Interface

The parallel interface consists of 8 bi-directional data pins, R/W, D/C, E, and /CS.

A LOW on R/W indicates write operation, and HIGH on R/W indicates read operation.

A LOW on D/C indicates “Command” read or write, and HIGH on D/C indicates “Data” read or write.

The E input serves as data latch signal, while /CS is LOW. Data is latched at the falling edge of E signal.

| Function      | E | R/W | /CS | D/C |
|---------------|---|-----|-----|-----|
| Write Command | ↓ | 0   | 0   | 0   |
| Read Status   | ↓ | 1   | 0   | 0   |
| Write Data    | ↓ | 0   | 0   | 1   |
| Read Data     | ↓ | 1   | 0   | 1   |

### 8080-MPU Parallel Interface

The parallel interface consists of 8 bi-directional data pins, /RD, /WR, D/C, and /CS.

A LOW on D/C indicates “Command” read or write, and HIGH on D/C indicates “Data” read or write.

A rising edge of /RS input serves as a data read latch signal while /CS is LOW.

A rising edge of /WR input serves as a data/command write latch signal while /CS is LOW.

| Function      | /RD | /WR | /CS | D/C |
|---------------|-----|-----|-----|-----|
| Write Command | 1   | ↑   | 0   | 0   |
| Read Status   | ↑   | 1   | 0   | 0   |
| Write Data    | 1   | ↑   | 0   | 1   |
| Read Data     | ↑   | 1   | 0   | 1   |

Alternatively, /RD and /WR can be kept stable while /CS serves as the data/command latch signal.

| Function      | /RD | /WR | /CS | D/C |
|---------------|-----|-----|-----|-----|
| Write Command | 1   | 0   | ↑   | 0   |
| Read Status   | 0   | 1   | ↑   | 0   |
| Write Data    | 1   | 0   | ↑   | 1   |
| Read Data     | 0   | 1   | ↑   | 1   |

## **Serial Interface**

The serial interface consists of serial clock SCLK, serial data SDIN, D/C, and /CS.

D0 acts as SCLK and D1 acts as SDIN. D2 should be left open. D3~D7, E, and R/W should be connected to GND.

| Function      | /RD | /WR | /CS | D/C | D0 |
|---------------|-----|-----|-----|-----|----|
| Write Command | 0   | 0   | 0   | 0   | ↑  |
| Write Data    | 0   | 0   | 0   | 1   | ↑  |

SDIN is shifted into an 8-bit shift register on every rising edge of SCLK in the order of D7, D6,...D0.

D/C is sampled on every eighth clock and the data byte in the shift register is written to the GDRAM or command register in the same clock.

Note: Read is not available in serial mode.

## **I<sup>2</sup>C Interface**

The I2C interface consists of a slave address bit SA0, I2C-bus data signal SDA, and I2C-bus clock signal SCL.

D1 and D2 can be tied together, and act as SDA. D0 acts as SCL. Both the data and clock signals must be connected to pull-up resistors. /RES is used to initialize the device.

**Note:** SA0 bit allows the device to have a slave address of either “0111100” or “0111101”.

**Note:** Data and acknowledgement are sent through the SDA. The ITO track resistance and the pull-up resistance at SDA becomes a voltage potential divider. As a result, it may not be possible to attain a valid logic “0” level on SDA for the ACK signal. SDA<sub>IN</sub> must be connected, but SDA<sub>OUT</sub> may be disconnected and the ACK signal will be ignored on the I2C bus.

For detailed protocol information, see datasheet: [http://www.newhavendisplay.com/app\\_notes/SSD1305.pdf](http://www.newhavendisplay.com/app_notes/SSD1305.pdf)

## Example Initialization Sequence:

```
Set_Display_On_Off(0x00);    // Display Off (0x00/0x01)
Set_Display_Clock(0x10);    // Set Clock as 160 Frames/Sec
Set_Multiplex_Ratio(0x1F);  // 1/32 Duty (0x0F~0x3F)
Set_Display_Offset(0x00);   // Shift Mapping RAM Counter (0x00~0x3F)
Set_Start_Line(0x00);       // Set Mapping RAM Display Start Line (0x00~0x3F)
Set_Master_Config(0x00);    // Disable Embedded DC/DC Converter (0x00/0x01)
Set_Area_Color(0x05);       // Set Monochrome & Low Power Save Mode
Set_Addressing_Mode(0x02);  // Set Page Addressing Mode (0x00/0x01/0x02)
Set_Segment_Remap(0x01);   // Set SEG/Column Mapping (0x00/0x01)
Set_Common_Remap(0x08);    // Set COM/Row Scan Direction (0x00/0x08)
Set_Common_Config(0x10);   // Set Alternative Configuration (0x00/0x10)
Set_LUT(0x3F,0x3F,0x3F,0x3F); // Define All Banks Pulse Width as 64 Clocks
Set_Contrast_Control(Brightness); // Set SEG Output Current
Set_Area_Brightness(Brightness); // Set Brightness for Area Color Banks
Set_Precharge_Period(0xD2); // Set Pre-Charge as 13 Clocks & Discharge as 2 Clock
Set_VCOMH(0x08);          // Set VCOM Deselect Level
Set_Entire_Display(0x00);  // Disable Entire Display On (0x00/0x01)
Set_Inverse_Display(0x00); // Disable Inverse Display On (0x00/0x01)
Fill_RAM(0x00);           // Clear Screen
Set_Display_On_Off(0x01);  // Display On (0x00/0x01)
```

## Quality Information

| Test Item                             | Content of Test                                                                                                                | Test Condition                                                                     | Note |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------|
| High Temperature storage              | Test the endurance of the display at high storage temperature.                                                                 | +90°C , 240hrs                                                                     | 2    |
| Low Temperature storage               | Test the endurance of the display at low storage temperature.                                                                  | -40°C , 240hrs                                                                     | 1,2  |
| High Temperature Operation            | Test the endurance of the display by applying electric stress (voltage & current) at high temperature.                         | +85°C 240hrs                                                                       | 2    |
| Low Temperature Operation             | Test the endurance of the display by applying electric stress (voltage & current) at low temperature.                          | -40°C , 240hrs                                                                     | 1,2  |
| High Temperature / Humidity Operation | Test the endurance of the display by applying electric stress (voltage & current) at high temperature with high humidity.      | +60°C , 90% RH , 240hrs                                                            | 1,2  |
| Thermal Shock resistance              | Test the endurance of the display by applying electric stress (voltage & current) during a cycle of low and high temperatures. | -40°C,30min -> 25°C,5min -> 85°C,30min = 1 cycle<br>100 cycles                     |      |
| Vibration test                        | Test the endurance of the display by applying vibration to simulate transportation and use.                                    | 10-22Hz , 15mm amplitude.<br>22-500Hz, 1.5G<br>30min in each of 3 directions X,Y,Z | 3    |
| Atmospheric Pressure test             | Test the endurance of the display by applying atmospheric pressure to simulate transportation by air.                          | 115mbar, 40hrs                                                                     | 3    |
| Static electricity test               | Test the endurance of the display by applying electric static discharge.                                                       | VS=800V, RS=1.5kΩ, CS=100pF<br>One time                                            |      |

**Note 1:** No condensation to be observed.

**Note 2:** Conducted after 2 hours of storage at 25°C, 0%RH.

**Note 3:** Test performed on product itself, not inside a container.

### Evaluation Criteria:

- 1: Display is fully functional during operational tests and after all tests, at room temperature.
- 2: No observable defects.
- 3: Luminance >50% of initial value.
- 4: Current consumption within 50% of initial value

## Precautions for using OLEDs/LCDs/LCMs

See Precautions at [www.newhavendisplay.com/specs/precautions.pdf](http://www.newhavendisplay.com/specs/precautions.pdf)

## Warranty Information and Terms & Conditions

[http://www.newhavendisplay.com/index.php?main\\_page=terms](http://www.newhavendisplay.com/index.php?main_page=terms)

Newhaven Display International, Inc. reserves the right to alter this product or specification at any time without notification.