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# NHD-2.7-12864WDW3

## Graphic OLED Display Module

|        |                           |
|--------|---------------------------|
| NHD-   | Newhaven Display          |
| 2.7-   | 2.7" Diagonal Size        |
| 12864- | 128 x 64 Pixel Resolution |
| WD-    | Model                     |
| W-     | Emitting Color: White     |
| 3-     | +3.3V Power Supply        |

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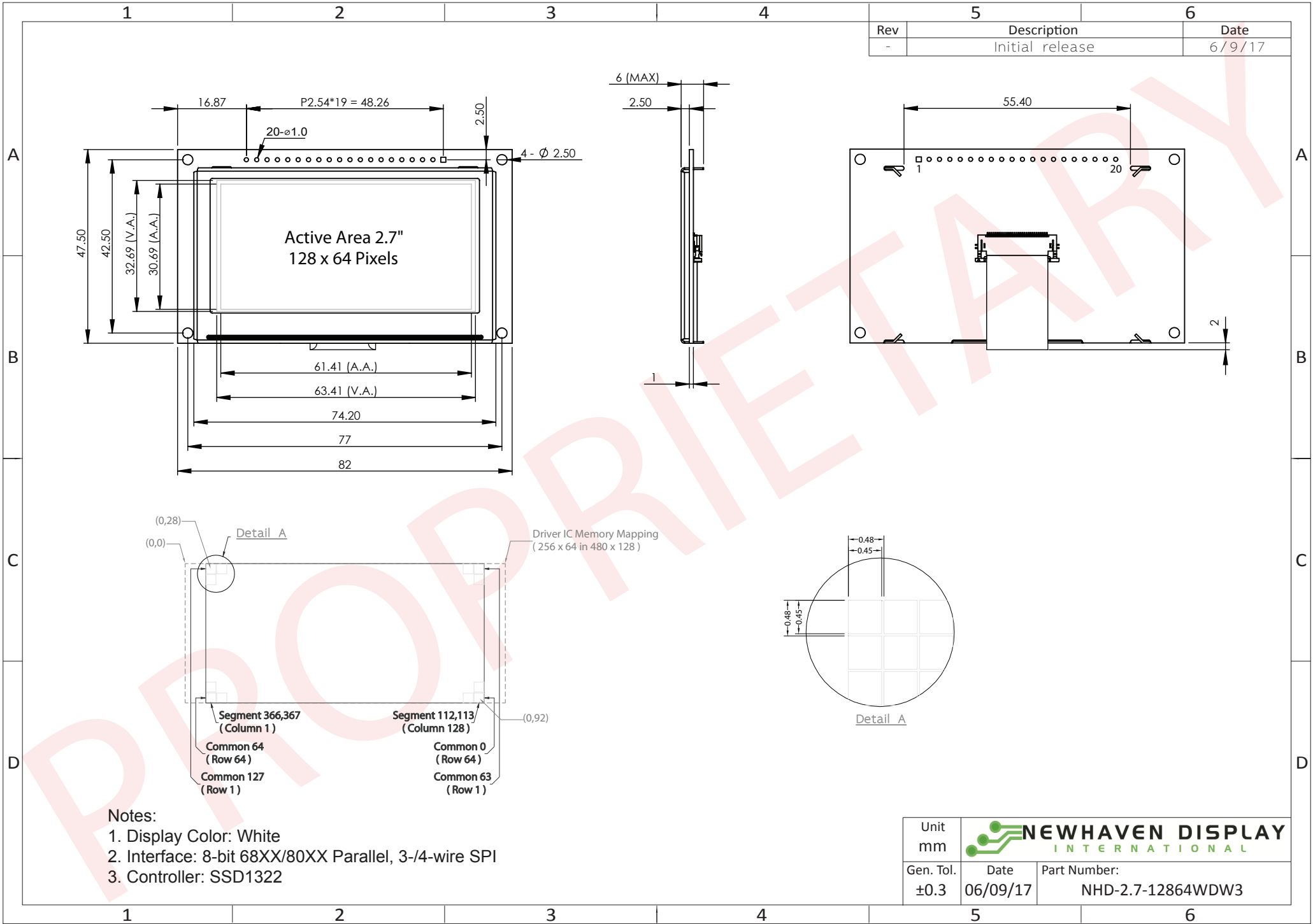
## Document Revision History

| Revision | Date      | Description                      | Changed by |
|----------|-----------|----------------------------------|------------|
| -        | 6/9/2017  | Initial Release                  | ML         |
| 1        | 7/25/2017 | Update Storage Temperature range | ML         |

## Functions and Features

- 128 x 64 pixel resolution
- Built-in SSD1322 controller
- Parallel or Serial MPU interface
- Single, low voltage power supply
- Power options via on-board jumpers
- RoHS compliant

Mechanical Drawing



# Interface Description

## Parallel Interface:

| Pin No. | Symbol        | External Connection | Function Description                                                                                                                                                 |
|---------|---------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | VSS           | Power Supply        | Ground                                                                                                                                                               |
| 2       | VDD           | Power Supply        | Supply Voltage for OLED module                                                                                                                                       |
| 3       | N.C. (BC_VDD) | -                   | No Connect by default. Can be configured to provide independent supply voltage (2.8V – 12V DC) for boost converter. (refer to On-Board Jumper Options section below) |
| 4       | D/C           | MPU                 | Data/Command 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                                                                                                                                        |
| 15      | N.C. (VCC)    | -                   | No Connect by default. Can be configured for external VCC (+15V). (refer to On-Board Jumper Options table below)                                                     |
| 16      | /RES          | MPU                 | Active LOW Reset signal                                                                                                                                              |
| 17      | /CS           | MPU                 | Active LOW Chip Select signal                                                                                                                                        |
| 18      | /SHDN (N.C.)  | MPU                 | Active LOW Shutdown control pin for boost converter (pulled HIGH via on-board 15kΩ resistor)<br>Can be made a No Connect by removing resistor R1.                    |
| 19      | BS1           | MPU                 | MPU Interface select signal                                                                                                                                          |
| 20      | BS0           | MPU                 | MPU Interface select signal                                                                                                                                          |

## Serial Interface:

| Pin No. | Symbol        | External Connection | Function Description                                                                                                                                               |
|---------|---------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | VSS           | Power Supply        | Ground                                                                                                                                                             |
| 2       | VDD           | Power Supply        | Supply Voltage for OLED module                                                                                                                                     |
| 3       | N.C. (BC_VDD) | -                   | No Connect by default. Can be configured to provide independent supply voltage (2.8V – 12V DC) for boost converter. (refer to On-Board Jumper Options table below) |
| 4       | D/C           | MPU                 | Data/Command select signal, D/C=0: Command, D/C=1: Data (tie LOW for 3-wire Serial Interface)                                                                      |
| 5-6     | VSS           | Power Supply        | Ground                                                                                                                                                             |
| 7       | SCLK          | MPU                 | Serial Clock signal                                                                                                                                                |
| 8       | SDIN          | MPU                 | Serial Data Input signal                                                                                                                                           |
| 9       | N.C.          | -                   | No Connect                                                                                                                                                         |
| 10-14   | VSS           | Power Supply        | Ground                                                                                                                                                             |
| 15      | N.C. (VCC)    | -                   | No Connect by default. Can be configured for external VCC (+15V). (refer to On-Board Jumper Options section below)                                                 |
| 16      | /RES          | MPU                 | Active LOW Reset signal                                                                                                                                            |
| 17      | /CS           | MPU                 | Active LOW Chip Select signal                                                                                                                                      |
| 18      | /SHDN (N.C.)  | MPU                 | Active LOW Shutdown control pin for boost converter (pulled HIGH via on-board 15kΩ resistor)<br>Can be made a No Connect by removing resistor R1.                  |
| 19      | BS1           | MPU                 | MPU Interface select signal                                                                                                                                        |
| 20      | BS0           | MPU                 | MPU Interface select signal                                                                                                                                        |

## Interface Selection

### MPU Interface Pin Selections

| Pin Name | 6800 Parallel 8-bit interface | 8080 Parallel 8-bit interface | 3-wire Serial Interface | 4-wire Serial Interface |
|----------|-------------------------------|-------------------------------|-------------------------|-------------------------|
| BS1      | 1                             | 1                             | 0                       | 0                       |
| BS0      | 1                             | 0                             | 1                       | 0                       |

### MPU Interface Pin Assignment Summary

| 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 |
| 3-wire SPI    | Tie LOW                |    |    |    | NC | SDIN | SCLK |    | Tie LOW         |     | /CS | Tie LOW | /RES |
| 4-wire SPI    | Tie LOW                |    |    |    | NC | SDIN | SCLK |    | Tie LOW         |     | /CS | D/C     | /RES |

## On-Board Jumper Options

### Default Jumper Setting

| R4    | R5   | R7   | Description                                                                                                                                                                |
|-------|------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Close | Open | Open | <b>(default)</b> OLED controller and boost converter + OLED panel are powered from VDD (pin #2). This allows the full module to be powered by a single low-voltage supply. |

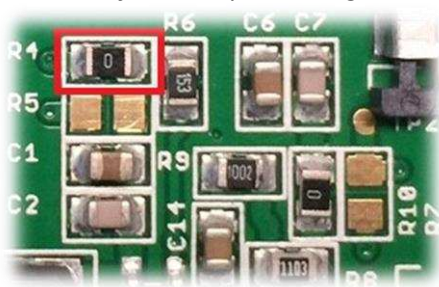
### Jumper Option #1 - Independent Supply Voltage for Boost Converter (BC\_VDD)

| R4   | R5    | R7   | Description                                                                                                                                                                                                                                                 |
|------|-------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Open | Close | Open | Boost converter + OLED panel are powered from BC_VDD (pin #3). OLED controller is still powered from VDD (pin #2). This allows for increased efficiency through the boost converter, by allowing a supply voltage up to +12V at its input, BC_VDD (pin #3). |

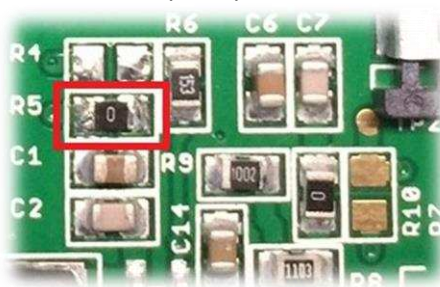
### Jumper Option #2 – External Supply Voltage for OLED Panel (VCC)

| R4   | R5   | R7    | Description                                                                                                                                                                                                               |
|------|------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Open | Open | Close | OLED panel is powered from VCC (pin #15) – boost converter is not used. OLED controller is still powered from VDD (pin #2). This allows for maximum module efficiency, and drastically reduced total current consumption. |

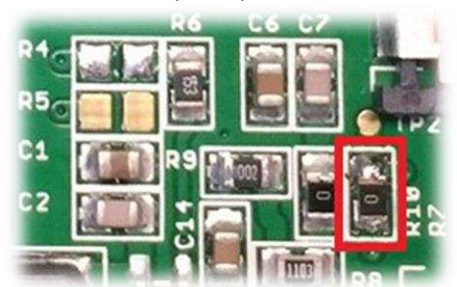
Default Jumper Setting



Jumper Option #1



Jumper Option #2



For detailed electrical information on each jumper option, please see the Electrical Characteristics table below.

## Electrical Characteristics

Values for Current shown below are based on the recommended initialization provided on page 12.

| 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     | -    | +85     | °C   |
| Default Jumper Setting             |                      |                       |         |      |         |      |
| Supply Voltage for Module          | VDD                  | -                     | 2.8     | 3.3  | 3.5     | V    |
| Supply Current for Module          | IDD                  | VDD=3.3V, 50% ON      | -       | 215  | 235     | mA   |
|                                    |                      | VDD=3.3V, 100% ON     | -       | 345  | 375     | mA   |
| Jumper Option #1                   |                      |                       |         |      |         |      |
| Supply Voltage for Module          | VDD                  | -                     | 2.8     | 3.3  | 3.5     | V    |
| Supply Voltage for Boost Converter | BC_VDD               | -                     | 2.8     | -    | 12      | V    |
| Supply Current for Module          | IDD                  | VDD=3.3V              | -       | 190  | 305     | μA   |
| Supply Current for Boost Converter | IDD <sub>BC</sub>    | BC_VDD=5.0V, 50% ON   | -       | 135  | 150     | mA   |
|                                    |                      | BC_VDD=5.0V, 100% ON  | -       | 200  | 215     | mA   |
|                                    |                      | BC_VDD=12.0V, 50% ON  | -       | 60   | 70      | mA   |
|                                    |                      | BC_VDD=12.0V, 100% ON | -       | 80   | 90      | mA   |
| Jumper Option #2                   |                      |                       |         |      |         |      |
| Supply Voltage for Module          | VDD                  | -                     | 2.8     | 3.3  | 3.5     | V    |
| Supply Voltage for OLED Panel      | VCC                  | -                     | 14.5    | 15   | 15.5    | V    |
| Supply Current for Module          | IDD                  | VDD=3.3V              | -       | 180  | 300     | μA   |
| Supply Current for OLED Panel      | ICC                  | VCC=15V, 50% ON       | -       | 45   | 50      | mA   |
|                                    |                      | VCC=15V, 100% ON      | -       | 60   | 70      | mA   |
|                                    |                      |                       |         |      |         |      |
| Sleep Mode Current                 | IDD <sub>SLEEP</sub> | -                     | -       | 25   | 120     | μA   |
| “H” Level input                    | V <sub>ih</sub>      | -                     | 0.8*VDD | -    | VDD     | V    |
| “L” Level input                    | V <sub>il</sub>      | -                     | VSS     | -    | 0.2*VDD | V    |
| “H” Level output                   | V <sub>oh</sub>      | -                     | 0.9*VDD | -    | VDD     | V    |
| “L” Level output                   | V <sub>ol</sub>      | -                     | VSS     | -    | 0.1*VDD | V    |

**Note:** The electrical characteristics shown above for Jumper Option #1 and Jumper Option #2 apply only when the on-board jumpers are configured accordingly. By default, only Default Jumper Setting supply voltage and current (in bold) need to be considered. For details, see On-Board Jumper Options section on previous page.

## Optical Characteristics

Values for Brightness shown below are based on the recommended initialization provided on page 12.

| Item                   | Symbol          | Condition                                                  | Min.      | Typ. | Max. | Unit              |
|------------------------|-----------------|------------------------------------------------------------|-----------|------|------|-------------------|
| Optimal Viewing Angles | Top             | -                                                          | -         | 85   | -    | °                 |
|                        | Bottom          |                                                            | -         | 85   | -    | °                 |
|                        | Left            |                                                            | -         | 85   | -    | °                 |
|                        | Right           |                                                            | -         | 85   | -    | °                 |
| Contrast Ratio         | C <sub>r</sub>  | -                                                          | >10,000:1 | -    | -    | -                 |
| Response Time          | Rise            | T <sub>r</sub>                                             | -         | 15   | -    | ns                |
|                        | Fall            | T <sub>f</sub>                                             | -         | 15   | -    | ns                |
| Brightness             | L <sub>br</sub> | 50% ON (checkerboard)                                      | 60        | 80   | 130  | cd/m <sup>2</sup> |
| Lifetime               | -               | T <sub>a</sub> =25°C, L <sub>br</sub> =80cd/m <sup>2</sup> | 30,000    | -    | -    | hrs               |
|                        | -               | T <sub>a</sub> =25°C, L <sub>br</sub> =60cd/m <sup>2</sup> | 50,000    | -    | -    | 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**. To extend the life of the display, lower values may be used for the contrast setting registers – see below table of commands for details.

## Controller Information

Built-in SSD1322 controller.

For details, view full datasheet at [http://www.newhavendisplay.com/app\\_notes/SSD1322.pdf](http://www.newhavendisplay.com/app_notes/SSD1322.pdf)

## Table of Commands

| Instruction            | Code |        |     |     |     |     |     |     |     |     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | RESET value                |
|------------------------|------|--------|-----|-----|-----|-----|-----|-----|-----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
|                        | D/C  | HEX    | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| Enable Grayscale Table | 0    | 00     | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | Enable the Grayscale table settings. (see command 0xB8)                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                            |
| Set Column Address     | 0    | 15     | 0   | 0   | 0   | 1   | 0   | 1   | 0   | 1   | Set column start and end address<br>A[6:0]: Column start address. Range: 0-119d<br>B[6:0]: Column end address. Range: 0-119d                                                                                                                                                                                                                                                                                                                                                                                   | 0<br>119d                  |
|                        | 1    | A[6:0] | *   | A6  | A5  | A4  | A3  | A2  | A1  | A0  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
|                        | 1    | B[6:0] | *   | B6  | B5  | B4  | B3  | B2  | B1  | B0  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| Write RAM Command      | 0    | 5C     | 0   | 1   | 0   | 1   | 1   | 1   | 0   | 0   | Enable MCU to write Data into RAM                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                            |
| Read RAM Command       | 0    | 5D     | 0   | 1   | 0   | 1   | 1   | 1   | 0   | 1   | Enable MCU to read Data from RAM                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                            |
| Set Row Address        | 0    | 75     | 0   | 1   | 1   | 1   | 0   | 1   | 0   | 1   | Set row start and end address<br>A[6:0]: Row start address. Range: 0-127d<br>B[6:0]: Row end address. Range: 0-127d                                                                                                                                                                                                                                                                                                                                                                                            | 0<br>127d                  |
|                        | 1    | A[6:0] | *   | A6  | A5  | A4  | A3  | A2  | A1  | A0  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
|                        | 1    | B[6:0] | *   | B6  | B5  | B4  | B3  | B2  | B1  | B0  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| Set Re-map             | 0    | A0     | 1   | 0   | 1   | 0   | 0   | 0   | 0   | 0   | A[0] = 0; Horizontal Address Increment<br>A[0] = 1; Vertical Address Increment<br>A[1] = 0; Disable Column Address remap<br>A[1] = 1; Enable Column Address remap<br>A[2] = 0; Disable Nibble remap<br>A[2] = 1; Enable Nibble remap<br>A[4] = 0; Scan from COM0 to COM[N-1]<br>A[4] = 1; Scan from COM[N-1] to COM0<br>A[5] = 0; Disable COM split Odd/Even<br>A[5] = 1; Enable COM split Odd/Even<br>B[4] = 0; Disable Dual COM mode<br>B[4] = 1; Enable Dual COM mode<br>Note: A[5] must be 0 if B[4] is 1. | 0<br>0<br>0<br>0<br>0<br>0 |
|                        | 1    | A[5:0] | 0   | 0   | A5  | A4  | 0   | A2  | A1  | A0  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
|                        | 1    | B[4]   | *   | *   | 0   | B4  | 0   | 0   | 0   | 1   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| Set Display Start Line | 0    | A1     | 1   | 0   | 1   | 0   | 0   | 0   | 0   | 1   | Set display RAM display start line register from 0-127.                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0                          |
|                        | 1    | A[6:0] | *   | A6  | A5  | A4  | A3  | A2  | A1  | A0  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| Set Display Offset     | 0    | A2     | 1   | 0   | 1   | 0   | 0   | 0   | 1   | 0   | Set vertical shift by COM from 0~127.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0                          |
|                        | 1    | A[6:0] | *   | A6  | A5  | A4  | A3  | A2  | A1  | A0  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| Display Mode           | 0    | A4~A7  | 1   | 0   | 1   | 0   | 0   | X2  | X1  | X0  | 0xA4 = Entire display OFF<br>0xA5 = Entire display ON, all pixels Grayscale level 15<br>0xA6 = Normal display<br>0xA7 = Inverse display                                                                                                                                                                                                                                                                                                                                                                        | 0xA6                       |
| Enable Partial Display | 0    | A8     | 1   | 0   | 1   | 0   | 1   | 0   | 0   | 0   | Turns ON partial mode.<br>A[6:0] = Address of start row<br>B[6:0] = Address of end row (B[6:0] > A[6:0])                                                                                                                                                                                                                                                                                                                                                                                                       |                            |
|                        | 1    | A[6:0] | 0   | A6  | A5  | A4  | A3  | A2  | A1  | A0  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
|                        | 1    | B[6:0] | 0   | B6  | B5  | B4  | B3  | B2  | B1  | B0  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |
| Exit Partial Display   | 0    | A9     | 1   | 0   | 1   | 0   | 1   | 0   | 0   | 1   | Exit Partial Display mode                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                            |
| Function Selection     | 0    | AB     | 1   | 0   | 1   | 0   | 1   | 0   | 1   | 1   | A[0] = 0; External VDD<br>A[0] = 1; Internal VDD regulator                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1                          |
|                        | 1    | A[0]   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | A0  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                            |



|                                        |        |                            |                       |                       |                       |                       |                       |                       |                       |                       |                                                                                                                                                                                                          |      |
|----------------------------------------|--------|----------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Select Default Linear Gray Scale Table | 0      | <b>B9</b>                  | <b>1</b>              | <b>0</b>              | <b>1</b>              | <b>1</b>              | <b>1</b>              | <b>0</b>              | <b>0</b>              | <b>1</b>              | Sets Linear Grayscale table<br>GS0 pulse width = 0<br>GS0 pulse width = 0<br>GS0 pulse width = 8<br>GS0 pulse width = 16<br>.<br>.<br>.<br>GS0 pulse width = 104<br>GS0 pulse width = 112                |      |
| Set Pre-charge Voltage                 | 0<br>1 | <b>BB</b><br><b>A[4:0]</b> | <b>1</b><br>*         | <b>0</b><br>*         | <b>1</b><br>*         | <b>1</b><br><b>A4</b> | <b>1</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 precharge voltage level.<br>A[4:0] = 0x00; 0.20*VCC<br>.<br>.<br>A[4:0] = 0x3E; 0.60*VCC                                                                                                             | 0x17 |
| Set VCOMH Voltage                      | 0<br>1 | <b>BE</b><br><b>A[3:0]</b> | <b>1</b><br>*         | <b>0</b><br>*         | <b>1</b><br>*         | <b>1</b><br>*         | <b>1</b><br><b>A3</b> | <b>1</b><br><b>A2</b> | <b>1</b><br><b>A1</b> | <b>0</b><br><b>A0</b> | Sets the VCOMH voltage level<br>A[3:0] = 0x00; 0.72*VCC<br>.<br>.<br>A[3:0] = 0x04; 0.8*VCC<br>.<br>.<br>A[3:0] = 0x07; 0.86*VCC                                                                         | 0x04 |
| Set Contrast Control                   | 0<br>1 | <b>C1</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>0</b><br><b>A4</b> | <b>0</b><br><b>A3</b> | <b>0</b><br><b>A2</b> | <b>0</b><br><b>A1</b> | <b>1</b><br><b>A0</b> | Double byte command to select 1 out of 256 contrast steps.<br>Contrast increases as the value increases.                                                                                                 | 0x7F |
| Master Contrast Control                | 0<br>1 | <b>C7</b><br><b>A[3:0]</b> | <b>1</b><br>*         | <b>1</b><br>*         | <b>0</b><br>*         | <b>0</b><br>*         | <b>0</b><br><b>A3</b> | <b>1</b><br><b>A2</b> | <b>1</b><br><b>A1</b> | <b>1</b><br><b>A0</b> | A[3:0] = 0x00; Reduce output for all colors to 1/16<br>A[3:0] = 0x01; Reduce output for all colors to 2/16<br>.<br>.<br>A[3:0] = 0x0E; Reduce output for all colors to 15/16<br>A[3:0] = 0x0F; no change | 0x0f |
| Set Multiplex Ratio                    | 0<br>1 | <b>CA</b><br><b>A[6:0]</b> | <b>1</b><br>*         | <b>1</b><br><b>A6</b> | <b>0</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>1</b><br><b>A1</b> | <b>0</b><br><b>A0</b> | Set MUX ratio to N+1 MUX<br>N=A[6:0]; from 16MUX to 128MUX (0 to 14 are invalid)                                                                                                                         | 127d |
| Set Command Lock                       | 0<br>1 | <b>FD</b><br><b>A[2]</b>   | <b>1</b><br><b>0</b>  | <b>1</b><br><b>0</b>  | <b>1</b><br><b>0</b>  | <b>1</b><br><b>1</b>  | <b>1</b><br><b>0</b>  | <b>1</b><br><b>A2</b> | <b>0</b><br><b>1</b>  | <b>1</b><br><b>0</b>  | A[2] = 0; Unlock OLED to enable commands<br>A[2] = 1; Lock OLED from entering commands                                                                                                                   | 0x12 |

For detailed instruction information, view full SSD1322 datasheet here (pages 32-47):

[http://www.newhavendisplay.com/app\\_notes/SSD1322.pdf](http://www.newhavendisplay.com/app_notes/SSD1322.pdf)

## MPU Interface

### 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   |

### Serial Interface (4-wire)

The 4-wire serial interface consists of Serial Clock (SCLK), Serial Data (SDIN), Data/Command (D/C), and Chip Select (/CS). D0 acts as SCLK and D1 acts as SDIN. D2 must be left as a No Connect

D3~D7, E, and R/W should be connected to GND.

| Function      | /RD     | /WR     | /CS | D/C | D0 |
|---------------|---------|---------|-----|-----|----|
| Write Command | Tie LOW | Tie LOW | 0   | 0   | ↑  |
| Write Data    | Tie LOW | Tie LOW | 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 GDDRAM or command register in the same clock.

Note: Read functionality is not available in serial mode.

### Serial Interface (3-wire)

The 3-wire serial interface consists of Serial Clock (SCLK), Serial Data In (SDIN), and Chip Select (/CS). D0 acts as SCLK and D1 acts as SDIN. D2 must be left as a No Connect. D3~D7, E, R/W, and D/C should be connected to Ground.

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

SDIN is shifted into an 9-bit shift register on every rising edge of SCLK in the order of D/C, D7, D6,...D0. D/C (first bit of the sequential data) will determine if the following data byte is written to the Display Data RAM (D/C = 1) or the command register (D/C = 0).

Note: Read functionality is not available in serial mode.

**For detailed timing information for each interface mode, view full SSD1322 datasheet here (pages 50-54):**  
[http://www.newhavendisplay.com/app\\_notes/SSD1322.pdf](http://www.newhavendisplay.com/app_notes/SSD1322.pdf)

### Recommended Initialization

```
void NHD12864WDY3_Init(void){
    digitalWrite(RESE, LOW);           //pull /RES (pin #16) low
    delayUS(200);                      //keep /RES low for minimum 200µs
    digitalWrite(RESE, HIGH);          //pull /RES high
    delayUS(200);                      //wait minimum 200µs before sending commands
    writeCommand(0xAE);                //display OFF
    writeCommand(0xB3);                //set CLK div. & OSC freq.
    writeData(0x91);
    writeCommand(0xCA);                //set MUX ratio
    writeData(0x3F);
    writeCommand(0xA2);                //set offset
    writeData(0x00);
    writeCommand(0xAB);                //function selection
    writeData(0x01);
    writeCommand(0xA0);                //set re-map
    writeData(0x16);
    writeData(0x11);
    writeCommand(0xC7);                //master contrast current
    writeData(0x0F);
    writeCommand(0xC1);                //set contrast current
    writeData(0x9F);
    writeCommand(0xB1);                //set phase length
    writeData(0xF2);
    writeCommand(0xBB);                //set pre-charge voltage
    writeData(0x1F);
    writeCommand(0xB4);                //set VSL
    writeData(0xA0);
    writeData(0xFD);
    writeCommand(0xBE);                //set VCOMH
    writeData(0x04);
    writeCommand(0xA6);                //set display mode
    writeCommand(0xAF);                //display ON
}
```

## Example Software Routines

```
void setColumn(unsigned char xStart, unsigned char xEnd){
    writeCommand(0x15);    //set column (x-axis) start/end address
    writeData(xStart);     //column start; 28 is left-most column
    writeData(xEnd);       //column end; 91 is right-most column
}

void setRow(unsigned char yStart, unsigned char yEnd){
    writeCommand(0x75);    //set row (y-axis) start/end address
    writeData(yStart);     //row start; 0 is top row
    writeData(yEnd);       //row end; 63 is bottom row
}

void clearDisplay(void){
    unsigned int i;
    setColumn(28,91);      //set column (x-axis) start/end address
    setRow(0,63);          //set row (y-axis) start/end address
    writeRAM();            //single byte command (0x5C) to initiate pixel data write to GDDRAM;
    for(i=0;i<4096;i++){   // ((91-28)+1)*((63-0)+1)
        writeData(0x00);
        writeData(0x00);
    }
}

void write2Pixels(unsigned char xPos, unsigned char yPos, unsigned char pixel1, unsigned char pixel2){
    if(pixel1>=1) pixel1 = 0xFF;    //set 1st pixel value to ON
    else pixel1 = 0x00;            //set 1st pixel value to OFF
    if(pixel2>=1) pixel2 = 0xFF;    //set 2nd pixel value to ON
    else pixel2 = 0x00;            //set 2nd pixel value to OFF
    if(xPos>127) xPos = 127;        //boundary check (MIN xPos = 0, MAX xPos = 127)
    xPos = xPos/2;                //account for GDDRAM address mapping
    xPos+=28;                     //account for GDDRAM address mapping
    if(yPos>63) yPos = 63;         //boundary check (MIN yPos = 0, MAX yPos = 63)
    setColumn(xPos,xPos);          //set column (x-axis) start/end address
    setRow(yPos,yPos);            //set row (y-axis) start/end address
    writeRAM();                   //single byte command (0x5C) to initiate pixel data write to GDDRAM;
    writeData(pixel1);            //write 1st of 2 pixels to the display
    writeData(pixel2);            //write 2nd of 2 pixels to the display
}

void displayArray12864(const unsigned char arr[]){    //display 128x64 monochrome bitmap, horizontal pixel arrangement, 8-pixels per byte
    unsigned int i, j;
    setColumn(28,91);            //set column (x-axis) start/end address
    setRow(0,63);                //set row (y-axis) start/end address
    writeRAM();                  //single byte command (0x5C) to initiate pixel data write to GDDRAM;
    for(i=0;i<1024;i++){        //translate each byte/bit into pixel data
        for(j=0;j<8;j++){
            if(((arr[i]<<j)&0x80)==0x80){
                writeData(0xFF);
            }
            else{
                writeData(0x00);
            }
        }
    }
}
```

## Quality Information

| Test Item                             | Content of Test                                                                                                                | Test Condition                                                                    | Note |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------|
| High Temperature storage              | Test the endurance of the display at high storage temperature.                                                                 | +85°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

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

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