

**Product Specification** 

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# NHD-2.7-12864WDW3

## Graphic OLED Display Module

|        |                         |
|--------|-------------------------|
| NHD-   | Newhaven Display        |
| 2.7-   | 2.7" Diagonal Size      |
| 12864- | 128x64 Pixel Resolution |
| WD-    | Model                   |
| W-     | Emitting Color: White   |
| 3-     | +3.3V Power Supply      |

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## Additional Resources

- **Support Forum:** <http://www.nhdforum.newhavendisplay.com>
- **Github:** <https://github.com/newhavendisplay>
- **Example Code:** [https://www.newhavendisplay.com/example\\_code.html](https://www.newhavendisplay.com/example_code.html)
- **Knowledge Center:** [https://www.newhavendisplay.com/knowledge\\_center.html](https://www.newhavendisplay.com/knowledge_center.html)
- **Quality Center:** [https://www.newhavendisplay.com/quality\\_center.html](https://www.newhavendisplay.com/quality_center.html)
- **Precautions for using LCDs/LCMs:** <https://www.newhavendisplay.com/specs/precautions.pdf>
- **Warranty / Terms & Conditions:** <https://www.newhavendisplay.com/terms.html>



## Document Revision History

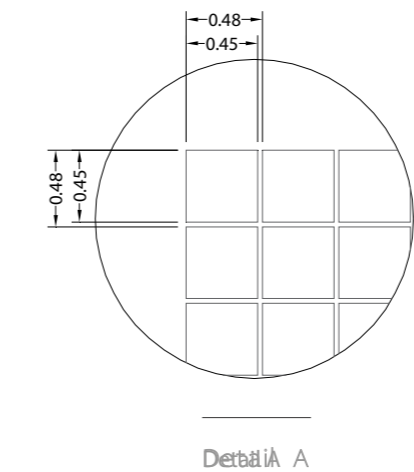
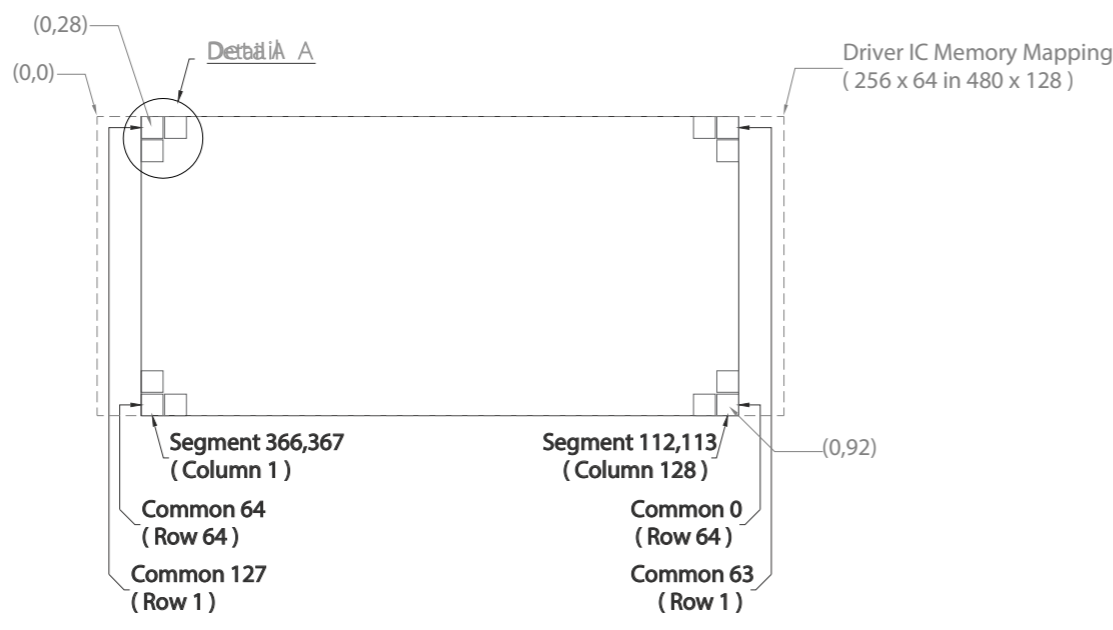
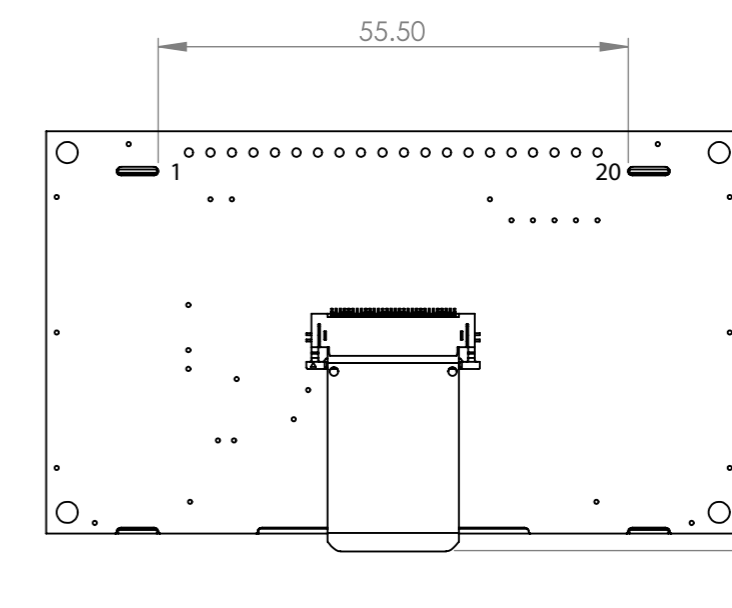
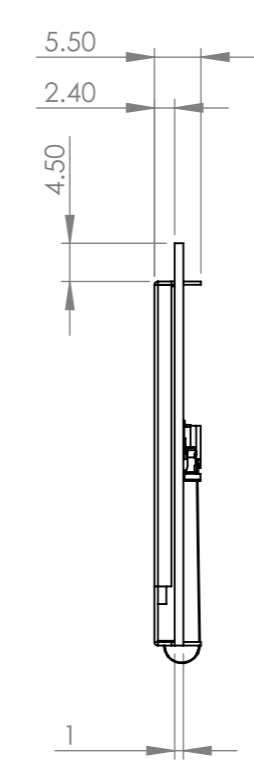
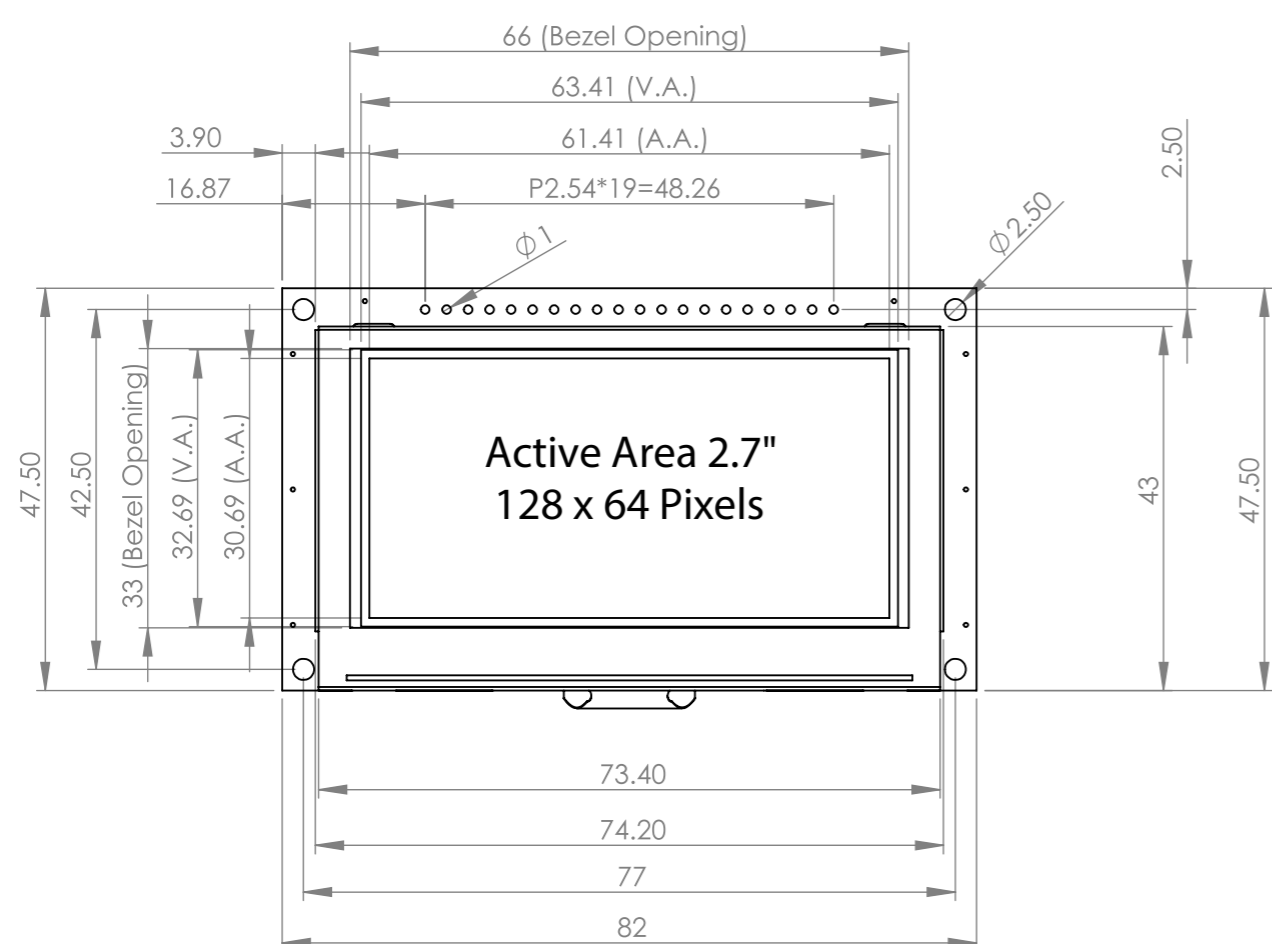
| Revision | Date      | Description  | Changed By |
|----------|-----------|--|------------|
| -        | 6/9/2017  | Initial Release                                      | ML         |
| 1        | 7/25/2017 | Update Storage Temperature range                     | ML         |
| 2        | 5/12/2020 | Included Additional Dimensions on Mechanical Drawing | AS         |
| 3        | 2/4/2021  | Bezel Redesign; Updated 2D Mechanical Drawing        | AS         |
| 4        | 2/26/2021 | Rectified error in MPU Pin Assignment Summary        | AS         |

## 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

| SYMBOL | REVISION | DATE |
|--------|----------|------|
|        |          |      |
|        |          |      |



| Pin No. | Symbol       |
|---------|--------------|
| 1       | Vss          |
| 2       | Vdd          |
| 3       | NC (BC_VDD)  |
| 4       | D/C          |
| 5       | R/W          |
| 6       | E            |
| 7       | DB0          |
| 8       | DB1          |
| 9       | DB2          |
| 10      | DB3          |
| 11      | DB4          |
| 12      | DB5          |
| 13      | DB6          |
| 14      | DB7          |
| 15      | N.C. (Vcc)   |
| 16      | /RES         |
| 17      | /CS          |
| 18      | /SHDN (N.C.) |
| 19      | BS1          |
| 20      | BS0          |

- Notes:**
1. Display Color: White
  2. Interface: 8-bit 6800/8080 Parallel, 3/4-Wire SPI
  3. Controller: SSD1322

|   |  |                         |
|---|--|-------------------------|
| <b>Standard Tolerance:</b><br>(Unless otherwise specified)<br><br>Linear: ±0.3mm  |  |                         |
|   | Drawing/Part Number:<br><b>NHD-2.7-12864WDW3</b> | Revision:<br>-          |
| <b>Unless otherwise specified:</b><br>• Dimensions are in Millimeters<br>• Third Angle Projection   | Drawn By: A. Shah                                | Approved By: A. Shah    |
|   | Drawn Date: 2/4/2021                             | Approved Date: 2/4/2021 |
| <b>Do Not Scale Drawing</b>   |  | Sheet 1 of 1            |
| This drawing is solely the property of Newhaven Display International, Inc. The information it contains is not to be disclosed, reproduced or copied in whole or part without written approval from Newhaven Display. |  |                         |

## Pin 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 module   |
| 3       | N.C.<br>(BC_V <sub>DD</sub> ) | -                   | 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       | 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 Active High<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 section below)   |
| 16      | /RES                          | MPU                 | Active LOW Reset signal  |
| 17      | /CS                           | MPU                 | Active LOW Chip Select signal  |
| 18      | /SHDN<br>(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       | V <sub>SS</sub>               | Power Supply        | Ground   |
| 2       | V <sub>DD</sub>               | Power Supply        | Supply Voltage for OLED module   |
| 3       | N.C.<br>(BC_V <sub>DD</sub> ) | -                   | 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<br>(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. |

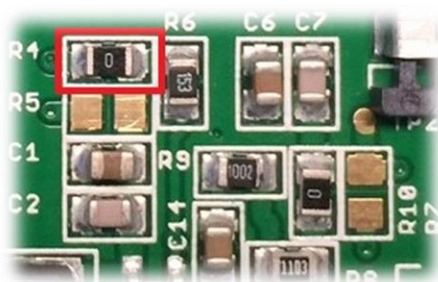
### Jumper Option #1 - Independent Supply Voltage for Boost Converter (BC\_VDD)

| 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). |

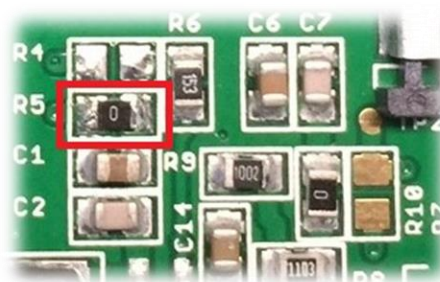
### Jumper Option #2 – External Supply Voltage for OLED Panel (VCC)

| 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. |

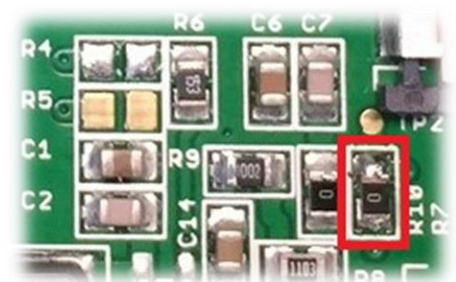
Default Jumper Setting



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        |
| <b>Default Jumper Setting</b>      |                       |                               |                       |            |                       |           |
| Supply Voltage for Module          | V <sub>DD</sub>       | -                             | <b>2.8</b>            | <b>3.3</b> | <b>3.5</b>            | <b>V</b>  |
| Supply Current for Module          | I <sub>DD</sub>       | <b>VDD=3.3V, 50% ON</b>       | -                     | <b>215</b> | <b>235</b>            | <b>mA</b> |
|                                    |                       | <b>VDD=3.3V, 100% ON</b>      | -                     | <b>345</b> | <b>375</b>            | <b>mA</b> |
| <b>Jumper Option #1</b>            |                       |                               |                       |            |                       |           |
| Supply Voltage for Module          | V <sub>DD</sub>       | -                             | 2.8                   | 3.3        | 3.5                   | V         |
| Supply Voltage for Boost Converter | BC_V <sub>DD</sub>    | -                             | 2.8                   | -          | 12                    | V         |
| Supply Current for Module          | I <sub>DD</sub>       | VDD=3.3V                      | -                     | 190        | 305                   | μA        |
| Supply Current for Boost Converter | I <sub>DD_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        |
| <b>Jumper Option #2</b>            |                       |                               |                       |            |                       |           |
| Supply Voltage for Module          | V <sub>DD</sub>       | -                             | 2.8                   | 3.3        | 3.5                   | V         |
| Supply Voltage for OLED Panel      | V <sub>CC</sub>       | -                             | 14.5                  | 15         | 15.5                  | V         |
| Supply Current for Module          | I <sub>DD</sub>       | V <sub>DD</sub> =3.3V         | -                     | 180        | 300                   | μA        |
| Supply Current for OLED Panel      | I <sub>CC</sub>       | V <sub>CC</sub> =15V, 50% ON  | -                     | 45         | 50                    | mA        |
|                                    |                       | V <sub>CC</sub> =15V, 100% ON | -                     | 60         | 70                    | mA        |
| Sleep Mode Current                 | I <sub>DD_SLEEP</sub> | -                             | -                     | 25         | 120                   | 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         |

**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            | φY+  | -         | 85   | -    | °                 |
|                        | Bottom         | φY-  | -         | 85   | -    | °                 |
|                        | Left           | θX-  | -         | 85   | -    | °                 |
|                        | Right          | θX+  | -         | 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>V</sub> | 50% Checkerboard   | 60        | 80   | 130  | cd/m <sup>2</sup> |
| Lifetime               | -              | T <sub>OP</sub> =25°C, L <sub>V</sub> =80cd/m <sup>2</sup> | 30,000    | -    | -    | hrs               |
|                        | -              | T <sub>OP</sub> =25°C, L <sub>V</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    | <b>00</b>     | <b>0</b> | <b>0</b>  | <b>0</b>  | <b>0</b>  | <b>0</b>  | <b>0</b>  | <b>0</b>  | <b>0</b>  | Enable the Grayscale table settings. (see command 0xB8)  |                            |
| Set Column Address     | 0    | <b>15</b>     | <b>0</b> | <b>0</b>  | <b>0</b>  | <b>1</b>  | <b>0</b>  | <b>1</b>  | <b>0</b>  | <b>1</b>  | 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    | <b>A[6:0]</b> | *        | <b>A6</b> | <b>A5</b> | <b>A4</b> | <b>A3</b> | <b>A2</b> | <b>A1</b> | <b>A0</b> |  |                            |
|                        | 1    | <b>B[6:0]</b> | *        | <b>B6</b> | <b>B5</b> | <b>B4</b> | <b>B3</b> | <b>B2</b> | <b>B1</b> | <b>B0</b> |  |                            |
| Write RAM Command      | 0    | <b>5C</b>     | <b>0</b> | <b>1</b>  | <b>0</b>  | <b>1</b>  | <b>1</b>  | <b>1</b>  | <b>0</b>  | <b>0</b>  | Enable MCU to write Data into RAM  |                            |
| Read RAM Command       | 0    | <b>5D</b>     | <b>0</b> | <b>1</b>  | <b>0</b>  | <b>1</b>  | <b>1</b>  | <b>1</b>  | <b>0</b>  | <b>1</b>  | Enable MCU to read Data from RAM   |                            |
| Set Row Address        | 0    | <b>75</b>     | <b>0</b> | <b>1</b>  | <b>1</b>  | <b>1</b>  | <b>0</b>  | <b>1</b>  | <b>0</b>  | <b>1</b>  | 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    | <b>A[6:0]</b> | *        | <b>A6</b> | <b>A5</b> | <b>A4</b> | <b>A3</b> | <b>A2</b> | <b>A1</b> | <b>A0</b> |  |                            |
|                        | 1    | <b>B[6:0]</b> | *        | <b>B6</b> | <b>B5</b> | <b>B4</b> | <b>B3</b> | <b>B2</b> | <b>B1</b> | <b>B0</b> |  |                            |
| Set Re-map             | 0    | <b>A0</b>     | <b>1</b> | <b>0</b>  | <b>1</b>  | <b>0</b>  | <b>0</b>  | <b>0</b>  | <b>0</b>  | <b>0</b>  | 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    | <b>A[5:0]</b> | <b>0</b> | <b>0</b>  | <b>A5</b> | <b>A4</b> | <b>0</b>  | <b>A2</b> | <b>A1</b> | <b>A0</b> |  |                            |
|                        | 1    | <b>B[4]</b>   | *        | *         | <b>0</b>  | <b>B4</b> | <b>0</b>  | <b>0</b>  | <b>0</b>  | <b>1</b>  |  |                            |
| Set Display Start Line | 0    | <b>A1</b>     | <b>1</b> | <b>0</b>  | <b>1</b>  | <b>0</b>  | <b>0</b>  | <b>0</b>  | <b>0</b>  | <b>1</b>  | Set display RAM display start line register from 0-127.  | 0                          |
|                        | 1    | <b>A[6:0]</b> | *        | <b>A6</b> | <b>A5</b> | <b>A4</b> | <b>A3</b> | <b>A2</b> | <b>A1</b> | <b>A0</b> |  |                            |
| Set Display Offset     | 0    | <b>A2</b>     | <b>1</b> | <b>0</b>  | <b>1</b>  | <b>0</b>  | <b>0</b>  | <b>0</b>  | <b>1</b>  | <b>0</b>  | Set vertical shift by COM from 0~127.  | 0                          |
|                        | 1    | <b>A[6:0]</b> | *        | <b>A6</b> | <b>A5</b> | <b>A4</b> | <b>A3</b> | <b>A2</b> | <b>A1</b> | <b>A0</b> |  |                            |
| Display Mode           | 0    | <b>A4~A7</b>  | <b>1</b> | <b>0</b>  | <b>1</b>  | <b>0</b>  | <b>0</b>  | <b>X2</b> | <b>X1</b> | <b>X0</b> | 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    | <b>A8</b>     | <b>1</b> | <b>0</b>  | <b>1</b>  | <b>0</b>  | <b>1</b>  | <b>0</b>  | <b>0</b>  | <b>0</b>  | 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    | <b>A[6:0]</b> | <b>0</b> | <b>A6</b> | <b>A5</b> | <b>A4</b> | <b>A3</b> | <b>A2</b> | <b>A1</b> | <b>A0</b> |  |                            |
|                        | 1    | <b>B[6:0]</b> | <b>0</b> | <b>B6</b> | <b>B5</b> | <b>B4</b> | <b>B3</b> | <b>B2</b> | <b>B1</b> | <b>B0</b> |  |                            |
| Exit Partial Display   | 0    | <b>A9</b>     | <b>1</b> | <b>0</b>  | <b>1</b>  | <b>0</b>  | <b>1</b>  | <b>0</b>  | <b>0</b>  | <b>1</b>  | Exit Partial Display mode  |                            |





|  | 1<br>1 | A14[7:0]<br>A15[7:0] | A14 <sub>7</sub><br>A15 <sub>7</sub> | A14 <sub>6</sub><br>A15 <sub>6</sub> | A14 <sub>5</sub><br>A15 <sub>5</sub> | A14 <sub>4</sub><br>A15 <sub>4</sub> | A14 <sub>3</sub><br>A15 <sub>3</sub> | A14 <sub>2</sub><br>A15 <sub>2</sub> | A14 <sub>1</sub><br>A15 <sub>1</sub> | A14 <sub>0</sub><br>A15 <sub>0</sub> | A14[7:0] = Gamma Setting for GS14<br>A15[7:0] = Gamma Setting for GS15<br><br>Note: 0 < GS1 < GS2 < GS3 ... < GS14 < GS15<br>The setting must be followed by command 0x00.                               |      |
|--|--------|----------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--|------|
| 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>A[4:0]  | <b>1</b><br>*                        | <b>0</b><br>*                        | <b>1</b><br>*                        | <b>1</b><br>A4                       | <b>1</b><br>A3                       | <b>0</b><br>A2                       | <b>1</b><br>A1                       | <b>1</b><br>A0                       | 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>A[3:0]  | <b>1</b><br>*                        | <b>0</b><br>*                        | <b>1</b><br>*                        | <b>1</b><br>*                        | <b>1</b><br>A3                       | <b>1</b><br>A2                       | <b>1</b><br>A1                       | <b>0</b><br>A0                       | 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>A[7:0]  | <b>1</b><br>A7                       | <b>1</b><br>A6                       | <b>0</b><br>A5                       | <b>0</b><br>A4                       | <b>0</b><br>A3                       | <b>0</b><br>A2                       | <b>0</b><br>A1                       | <b>1</b><br>A0                       | 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>A[3:0]  | <b>1</b><br>*                        | <b>1</b><br>*                        | <b>0</b><br>*                        | <b>0</b><br>*                        | <b>0</b><br>A3                       | <b>1</b><br>A2                       | <b>1</b><br>A1                       | <b>1</b><br>A0                       | 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>A[6:0]  | <b>1</b><br>*                        | <b>1</b><br>A6                       | <b>0</b><br>A5                       | <b>0</b><br>A4                       | <b>1</b><br>A3                       | <b>0</b><br>A2                       | <b>1</b><br>A1                       | <b>0</b><br>A0                       | 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>A[2]    | <b>1</b><br>0                        | <b>1</b><br>0                        | <b>1</b><br>0                        | <b>1</b><br>1                        | <b>1</b><br>0                        | <b>1</b><br>A2                       | <b>0</b><br>1                        | <b>1</b><br>0                        | 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.

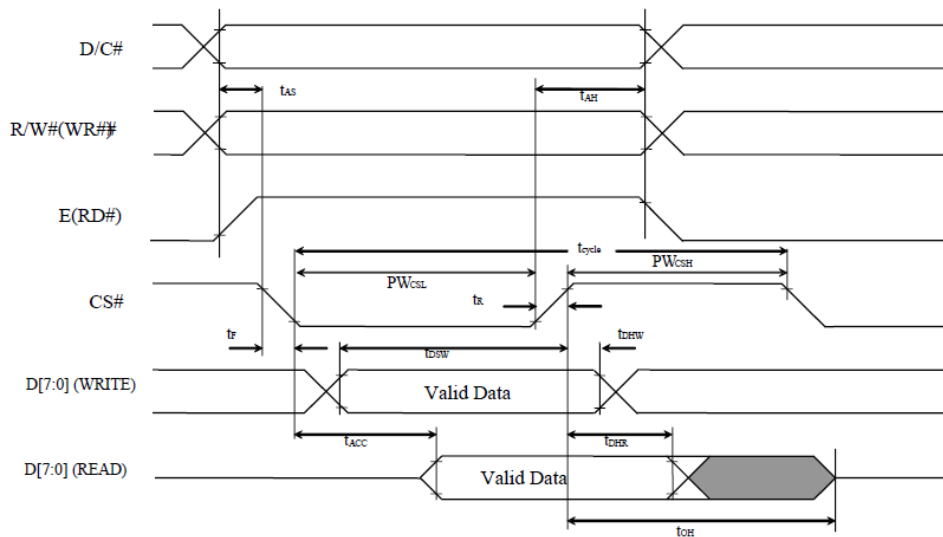
A LOW on D/C indicates “Command” read or write, and HIGH on D/C indicates “Data” read or write.

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   |

( $V_{DD} - V_{SS} = 2.4$  to  $2.6V$ ,  $V_{DDIO} = 1.6V$ ,  $V_{CI} = 3.3V$ ,  $T_A = 25^\circ C$ )

| Symbol      | Parameter                            | Min | Typ | Max | Unit |
|-------------|--------------------------------------|-----|-----|-----|------|
| $t_{cycle}$ | Clock Cycle Time                     | 300 | -   | -   | ns   |
| $t_{AS}$    | Address Setup Time                   | 10  | -   | -   | ns   |
| $t_{AH}$    | Address Hold Time                    | 0   | -   | -   | ns   |
| $t_{DSW}$   | Write Data Setup Time                | 40  | -   | -   | ns   |
| $t_{DHW}$   | Write Data Hold Time                 | 7   | -   | -   | ns   |
| $t_{DHR}$   | Read Data Hold Time                  | 20  | -   | -   | ns   |
| $t_{OH}$    | Output Disable Time                  | -   | -   | 70  | ns   |
| $t_{ACC}$   | Access Time                          | -   | -   | 140 | ns   |
| $PW_{CSL}$  | Chip Select Low Pulse Width (read)   | 120 | -   | -   | ns   |
|             | Chip Select Low Pulse Width (write)  | 60  | -   | -   | ns   |
| $PW_{CSH}$  | Chip Select High Pulse Width (read)  | 60  | -   | -   | ns   |
|             | Chip Select High Pulse Width (write) | 60  | -   | -   | ns   |
| $t_R$       | Rise Time                            | -   | -   | 15  | ns   |
| $t_F$       | Fall Time                            | -   | -   | 15  | ns   |



### 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.

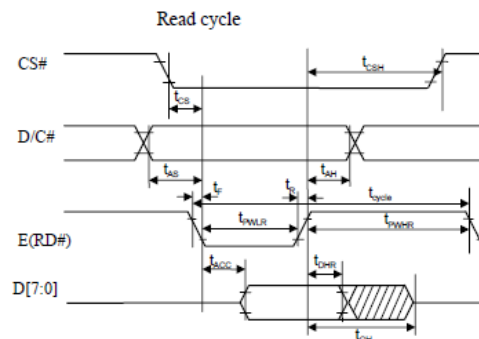
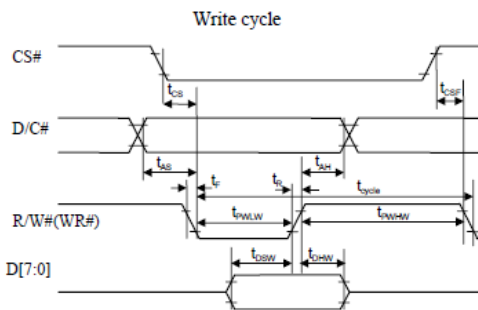
A rising edge of /RS input serves as a data read latch signal while /CS is LOW.

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   |

( $V_{DD} - V_{SS} = 2.4$  to  $2.6V$ ,  $V_{DDIO} = 1.6V$ ,  $V_{CI} = 3.3V$ ,  $T_A = 25^\circ C$ )

| Symbol      | Parameter                            | Min | Typ | Max | Unit |
|-------------|--------------------------------------|-----|-----|-----|------|
| $t_{cycle}$ | Clock Cycle Time                     | 300 | -   | -   | ns   |
| $t_{AS}$    | Address Setup Time                   | 10  | -   | -   | ns   |
| $t_{AH}$    | Address Hold Time                    | 0   | -   | -   | ns   |
| $t_{DSW}$   | Write Data Setup Time                | 40  | -   | -   | ns   |
| $t_{DHW}$   | Write Data Hold Time                 | 7   | -   | -   | ns   |
| $t_{DHR}$   | Read Data Hold Time                  | 20  | -   | -   | ns   |
| $t_{OH}$    | Output Disable Time                  | -   | -   | 70  | ns   |
| $t_{ACC}$   | Access Time                          | -   | -   | 140 | ns   |
| $t_{PWLr}$  | Read Low Time                        | 150 | -   | -   | ns   |
| $t_{PWLw}$  | Write Low Time                       | 60  | -   | -   | ns   |
| $t_{PWHr}$  | Read High Time                       | 60  | -   | -   | ns   |
| $t_{PWHw}$  | Write High Time                      | 60  | -   | -   | ns   |
| $t_r$       | Rise Time                            | -   | -   | 15  | ns   |
| $t_f$       | Fall Time                            | -   | -   | 15  | ns   |
| $t_{CS}$    | Chip select setup time               | 0   | -   | -   | ns   |
| $t_{CSH}$   | Chip select hold time to read signal | 0   | -   | -   | ns   |
| $t_{CSF}$   | Chip select hold time                | 20  | -   | -   | ns   |



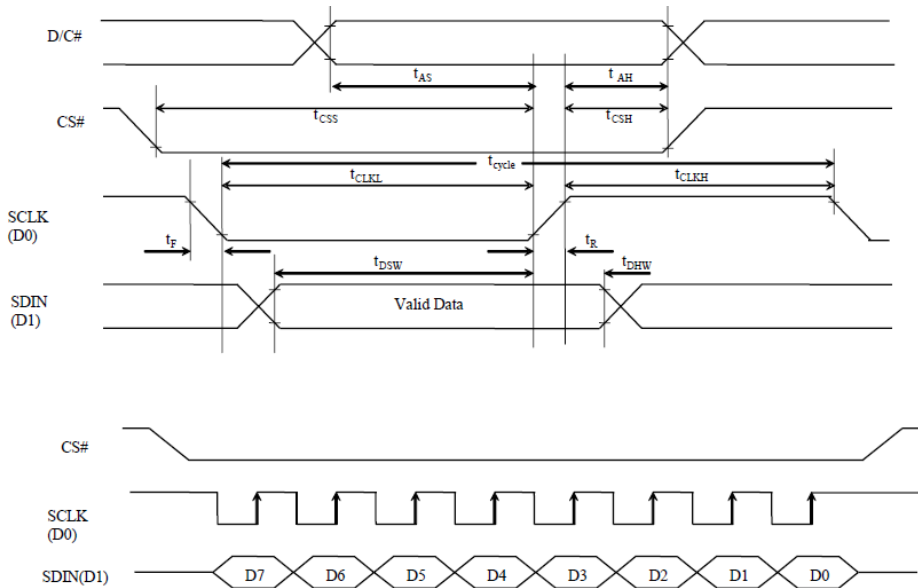
### Serial Interface (4-wire)

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   | ↑  |

( $V_{DD} - V_{SS} = 2.4$  to  $2.6V$ ,  $V_{DDIO} = 1.6V$ ,  $V_{CI} = 3.3V$ ,  $T_A = 25^\circ C$ )

| Symbol      | Parameter              | Min | Typ | Max | Unit  |           |                      |    |   |   |    |            |                |    |   |   |    |            |                 |    |   |   |    |       |           |   |   |    |    |       |           |   |   |    |    |
|-------------|------------------------|-----|-----|-----|---|-----------|----------------------|----|---|---|----|------------|----------------|----|---|---|----|------------|-----------------|----|---|---|----|-------|-----------|---|---|----|----|-------|-----------|---|---|----|----|
| $t_{cycle}$ | Clock Cycle Time       | 100 | -   | -   | ns  |           |                      |    |   |   |    |            |                |    |   |   |    |            |                 |    |   |   |    |       |           |   |   |    |    |       |           |   |   |    |    |
| $t_{AS}$    | Address Setup Time     | 15  | -   | -   | ns  |           |                      |    |   |   |    |            |                |    |   |   |    |            |                 |    |   |   |    |       |           |   |   |    |    |       |           |   |   |    |    |
| $t_{AH}$    | Address Hold Time      | 15  | -   | -   | ns  |           |                      |    |   |   |    |            |                |    |   |   |    |            |                 |    |   |   |    |       |           |   |   |    |    |       |           |   |   |    |    |
| $t_{CSS}$   | Chip Select Setup Time | 20  | -   | -   | ns  |           |                      |    |   |   |    |            |                |    |   |   |    |            |                 |    |   |   |    |       |           |   |   |    |    |       |           |   |   |    |    |
| $t_{CSH}$   | Chip Select Hold Time  | 10  | -   | -   | ns  |           |                      |    |   |   |    |            |                |    |   |   |    |            |                 |    |   |   |    |       |           |   |   |    |    |       |           |   |   |    |    |
| $t_{DSW}$   | Write Data Setup Time  | 15  | -   | -   | ns </tr <tr> <td><math>t_{DHW}</math></td> <td>Write Data Hold Time</td> <td>15</td> <td>-</td> <td>-</td> <td>ns</td> </tr> <tr> <td><math>t_{CLKL}</math></td> <td>Clock Low Time</td> <td>20</td> <td>-</td> <td>-</td> <td>ns</td> </tr> <tr> <td><math>t_{CLKH}</math></td> <td>Clock High Time</td> <td>20</td> <td>-</td> <td>-</td> <td>ns</td> </tr> <tr> <td><math>t_r</math></td> <td>Rise Time</td> <td>-</td> <td>-</td> <td>15</td> <td>ns</td> </tr> <tr> <td><math>t_f</math></td> <td>Fall Time</td> <td>-</td> <td>-</td> <td>15</td> <td>ns</td> </tr> | $t_{DHW}$ | Write Data Hold Time | 15 | - | - | ns | $t_{CLKL}$ | Clock Low Time | 20 | - | - | ns | $t_{CLKH}$ | Clock High Time | 20 | - | - | ns | $t_r$ | Rise Time | - | - | 15 | ns | $t_f$ | Fall Time | - | - | 15 | ns |
| $t_{DHW}$   | Write Data Hold Time   | 15  | -   | -   | ns  |           |                      |    |   |   |    |            |                |    |   |   |    |            |                 |    |   |   |    |       |           |   |   |    |    |       |           |   |   |    |    |
| $t_{CLKL}$  | Clock Low Time         | 20  | -   | -   | ns  |           |                      |    |   |   |    |            |                |    |   |   |    |            |                 |    |   |   |    |       |           |   |   |    |    |       |           |   |   |    |    |
| $t_{CLKH}$  | Clock High Time        | 20  | -   | -   | ns  |           |                      |    |   |   |    |            |                |    |   |   |    |            |                 |    |   |   |    |       |           |   |   |    |    |       |           |   |   |    |    |
| $t_r$       | Rise Time              | -   | -   | 15  | ns  |           |                      |    |   |   |    |            |                |    |   |   |    |            |                 |    |   |   |    |       |           |   |   |    |    |       |           |   |   |    |    |
| $t_f$       | Fall Time              | -   | -   | 15  | ns  |           |                      |    |   |   |    |            |                |    |   |   |    |            |                 |    |   |   |    |       |           |   |   |    |    |       |           |   |   |    |    |



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.

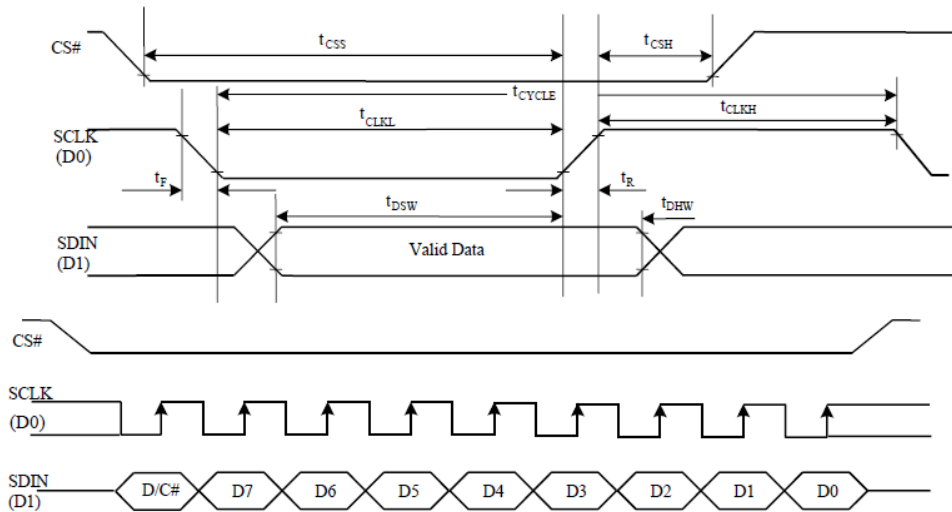
### Serial Interface (3-wire)

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 | ↑  |

( $V_{DD} - V_{SS} = 2.4$  to  $2.6V$ ,  $V_{DDIO} = 1.6V$ ,  $V_{CI} = 3.3V$ ,  $T_A = 25^{\circ}C$ )

| Symbol      | Parameter              | Min | Typ | Max | Unit |
|-------------|------------------------|-----|-----|-----|------|
| $t_{cycle}$ | Clock Cycle Time       | 100 | -   | -   | ns   |
| $t_{CSS}$   | Chip Select Setup Time | 20  | -   | -   | ns   |
| $t_{CSH}$   | Chip Select Hold Time  | 10  | -   | -   | ns   |
| $t_{DSW}$   | Write Data Setup Time  | 15  | -   | -   | ns   |
| $t_{DHW}$   | Write Data Hold Time   | 15  | -   | -   | ns   |
| $t_{CLKL}$  | Clock Low Time         | 20  | -   | -   | ns   |
| $t_{CLKH}$  | Clock High Time        | 20  | -   | -   | ns   |
| $t_R$       | Rise Time              | -   | -   | 15  | ns   |
| $t_F$       | Fall Time              | -   | -   | 15  | ns   |



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(RES, LOW);           //pull /RES (pin #16) low
    delayUS(200);                    //keep /RES low for minimum 200µs
    digitalWrite(RES, 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            | Endurance test applying the high storage temperature for a long time.   | +85°C, 240hrs   | 2    |
| Low Temperature storage             | Endurance test applying the low storage temperature for a long time.  | -40°C, 240hrs   | 1,2  |
| High Temperature Operation          | Endurance test applying the electric stress (voltage & current) and the high thermal stress for a long time.                    | +85°C, 240hrs   | 2    |
| Low Temperature Operation           | Endurance test applying the electric stress (voltage & current) and the low thermal stress for a long time.                     | -40°C, 240hrs   | 1,2  |
| High Temperature / Humidity Storage | Endurance test applying the electric stress (voltage & current) and the high thermal with high humidity stress for a long time. | +60°C, 90% RH, 240hrs   | 1,2  |
| Thermal Shock resistance            | Endurance test applying the electric stress (voltage & current) during a cycle of low and high thermal stress.                  | -40°C, 30min -> +25°C, 5min -> +85°C, 30min = 1 cycle<br>100 cycles                 |      |
| Vibration test                      | Endurance test 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             | Endurance test applying electric static discharge.  | Air: ±8KV; 300Ω, 150pF  |      |
|                                     |   | Contact: ±4KV; 300Ω, 150pF  |      |

**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