

# 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

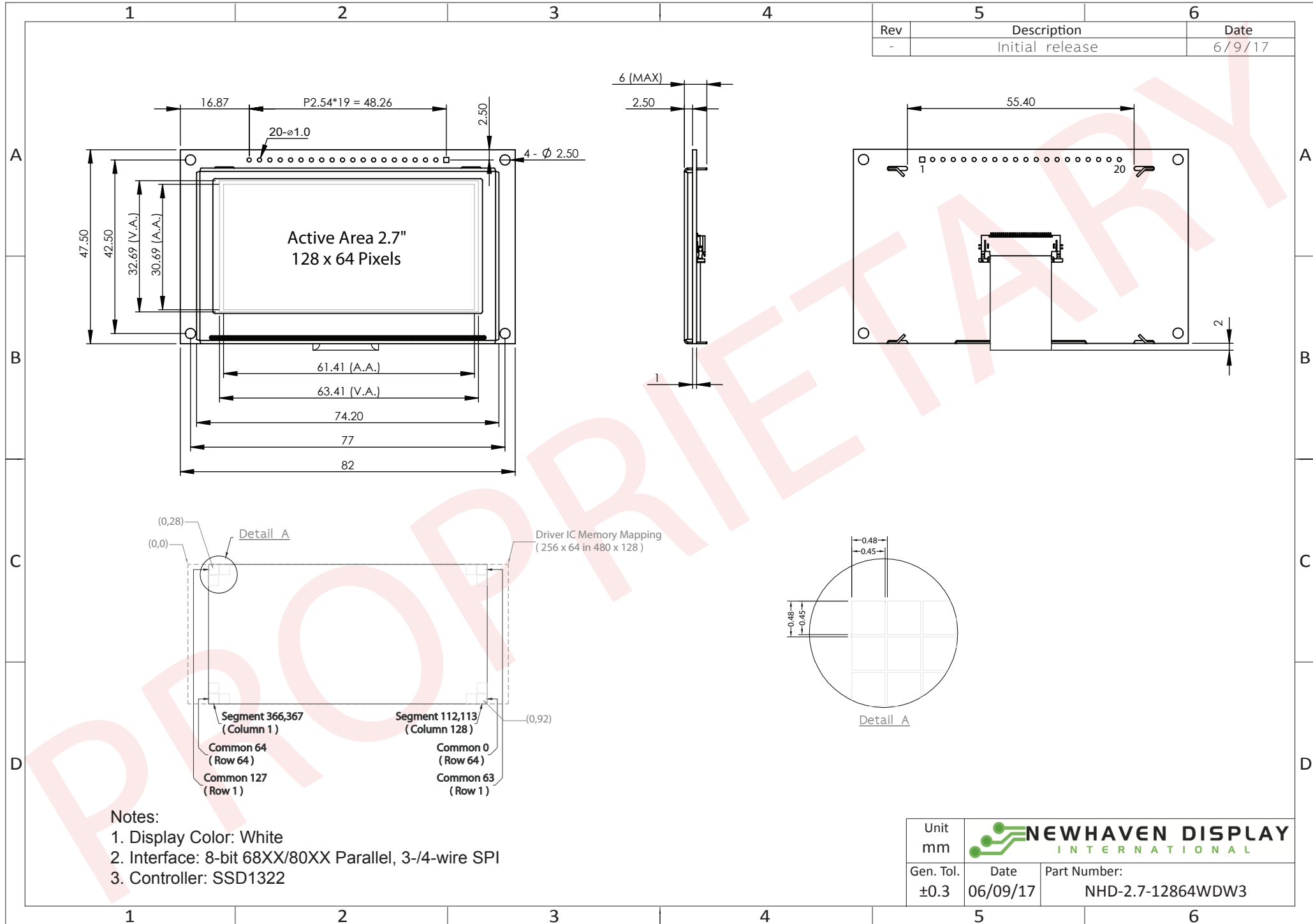
Revision	Date	Description	Changed by
-	6/9/2017	Initial Release	ML
1	7/25/2017	Update Storage Temperature range	ML

## 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

Rev	Description	Date
-	Initial release	6/9/17



**Notes:**

1. Display Color: White
2. Interface: 8-bit 68XX/80XX Parallel, 3-/4-wire SPI
3. Controller: SSD1322

Unit mm		
Gen. Tol. ±0.3	Date 06/09/17	Part Number: NHD-2.7-12864WDW3

# 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> Read/Write select signal, R/W=1: Read, R/W=0: Write <b>8080-interface:</b> Active LOW Write signal
6	E or /RD	MPU	<b>6800-interface:</b> Operation Enable signal, falling edge triggered <b>8080-interface:</b> 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) 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) 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.

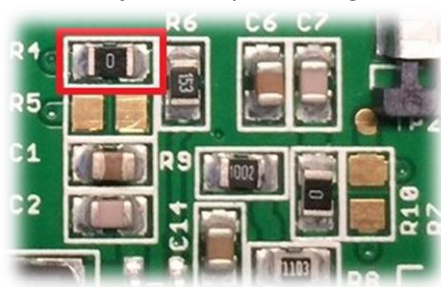
## Jumper Option #1 - Independent Supply Voltage for Boost Converter (BC\_VDD)

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).

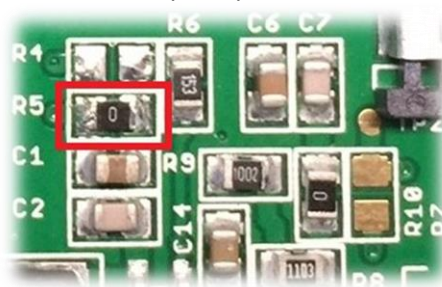
## Jumper Option #2 – External Supply Voltage for OLED Panel (VCC)

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.

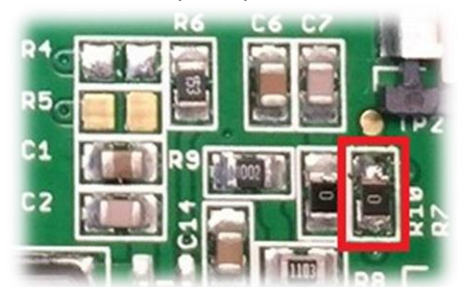
Default Jumper Setting



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	VDD	-	<b>2.8</b>	<b>3.3</b>	<b>3.5</b>	<b>V</b>
Supply Current for Module	IDD	VDD=3.3V, 50% ON	-	<b>215</b>	<b>235</b>	<b>mA</b>
		VDD=3.3V, 100% ON	-	<b>345</b>	<b>375</b>	<b>mA</b>
<b>Jumper Option #1</b>						
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
<b>Jumper Option #2</b>						
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	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>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	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	0 119d	
	1	A[6:0]	*	A6	A5	A4	A3	A2	A1	A0	A[6:0]: Column start address. Range: 0-119d		
	1	B[6:0]	*	B6	B5	B4	B3	B2	B1	B0	B[6:0]: Column end address. Range: 0-119d		
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	0 127d	
	1	A[6:0]	*	A6	A5	A4	A3	A2	A1	A0	A[6:0]: Row start address. Range: 0-127d		
	1	B[6:0]	*	B6	B5	B4	B3	B2	B1	B0	B[6:0]: Row end address. Range: 0-127d		
Set Re-map	0	A0	1	0	1	0	0	0	0	0	A[0] = 0; Horizontal Address Increment	0	
	1	A[5:0]	0	0	A5	A4	0	A2	A1	A0	A[0] = 1; Vertical Address Increment	0	
	1	B[4]	*	*	0	B4	0	0	0	1	A[1] = 0; Disable Column Address remap A[1] = 1; Enable Column Address remap A[2] = 0; Disable Nibble remap A[2] = 1; Enable Nibble remap A[4] = 0; Scan from COM0 to COM[N-1] A[4] = 1; Scan from COM[N-1] to COM0 A[5] = 0; Disable COM split Odd/Even A[5] = 1; Enable COM split Odd/Even B[4] = 0; Disable Dual COM mode B[4] = 1; Enable Dual COM mode Note: A[5] must be 0 if B[4] is 1.	0 0 0 0 0 0	
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 0xA5 = Entire display ON, all pixels Grayscale level 15 0xA6 = Normal display 0xA7 = Inverse display	0xA6	
Enable Partial Display	0	A8	1	0	1	0	1	0	0	0	Turns ON partial mode.		
	1	A[6:0]	0	A6	A5	A4	A3	A2	A1	A0	A[6:0] = Address of start row		
	1	B[6:0]	0	B6	B5	B4	B3	B2	B1	B0	B[6:0] = Address of end row (B[6:0] > A[6:0])		
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	1	
	1	A[0]	0	0	0	0	0	0	0	A0	A[0] = 1; Internal VDD regulator		





Select Default Linear Gray Scale Table	0 1	<b>B9</b> <b>A[4:0]</b>	<b>1</b> *	<b>0</b> *	<b>1</b> *	<b>1</b> <b>A4</b>	<b>1</b> <b>A3</b>	<b>0</b> <b>A2</b>	<b>0</b> <b>A1</b>	<b>1</b> <b>A0</b>	Sets Linear Grayscale table GSO pulse width = 0 GSO pulse width = 0 GSO pulse width = 8 GSO pulse width = 16 . . . GSO pulse width = 104 GSO pulse width = 112	
Set Pre-charge Voltage	0 1	<b>BB</b> <b>A[4:0]</b>	<b>1</b> *	<b>0</b> *	<b>1</b> *	<b>1</b> <b>A4</b>	<b>1</b> <b>A3</b>	<b>0</b> <b>A2</b>	<b>1</b> <b>A1</b>	<b>1</b> <b>A0</b>	Set precharge voltage level. A[4:0] = 0x00; 0.20*VCC . . A[4:0] = 0x3E; 0.60*VCC	0x17
Set VCOMH Voltage	0 1	<b>BE</b> <b>A[3:0]</b>	<b>1</b> *	<b>0</b> *	<b>1</b> *	<b>1</b> *	<b>1</b> <b>A3</b>	<b>1</b> <b>A2</b>	<b>1</b> <b>A1</b>	<b>0</b> <b>A0</b>	Sets the VCOMH voltage level A[3:0] = 0x00; 0.72*VCC . . A[3:0] = 0x04; 0.8*VCC . . A[3:0] = 0x07; 0.86*VCC	0x04
Set Contrast Control	0 1	<b>C1</b> <b>A[7:0]</b>	<b>1</b> <b>A7</b>	<b>1</b> <b>A6</b>	<b>0</b> <b>A5</b>	<b>0</b> <b>A4</b>	<b>0</b> <b>A3</b>	<b>0</b> <b>A2</b>	<b>0</b> <b>A1</b>	<b>1</b> <b>A0</b>	Double byte command to select 1 out of 256 contrast steps. Contrast increases as the value increases.	0x7F
Master Contrast Control	0 1	<b>C7</b> <b>A[3:0]</b>	<b>1</b> *	<b>1</b> *	<b>0</b> *	<b>0</b> *	<b>0</b> <b>A3</b>	<b>1</b> <b>A2</b>	<b>1</b> <b>A1</b>	<b>1</b> <b>A0</b>	A[3:0] = 0x00; Reduce output for all colors to 1/16 A[3:0] = 0x01; Reduce output for all colors to 2/16 . . A[3:0] = 0x0E; Reduce output for all colors to 15/16 A[3:0] = 0x0F; no change	0x0f
Set Multiplex Ratio	0 1	<b>CA</b> <b>A[6:0]</b>	<b>1</b> *	<b>1</b> <b>A6</b>	<b>0</b> <b>A5</b>	<b>0</b> <b>A4</b>	<b>1</b> <b>A3</b>	<b>0</b> <b>A2</b>	<b>1</b> <b>A1</b>	<b>0</b> <b>A0</b>	Set MUX ratio to N+1 MUX N=A[6:0]; from 16MUX to 128MUX (0 to 14 are invalid)	127d
Set Command Lock	0 1	<b>FD</b> <b>A[2]</b>	<b>1</b> <b>0</b>	<b>1</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> <b>A2</b>	<b>0</b> <b>1</b>	<b>1</b> <b>0</b>	A[2] = 0; Unlock OLED to enable commands 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(RESET, LOW);           //pull /RES (pin #16) low
    delayUS(200);                       //keep /RES low for minimum 200µs
    digitalWrite(RESET, 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 100 cycles	
Vibration test	Test the endurance of the display by applying vibration to simulate transportation and use.	10-22Hz, 15mm amplitude. 22-500Hz, 1.5G 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 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)