# NHD-1.27-AU-SHIELD

## Graphic Color OLED Display Module + Arduino UNO Shield

| | |
|---|---|
| NHD- | Newhaven Display |
| 1.27- | 1.27” Diagonal Size |
| AU- | Arduino Uno |
| SHIELD- | Shield |


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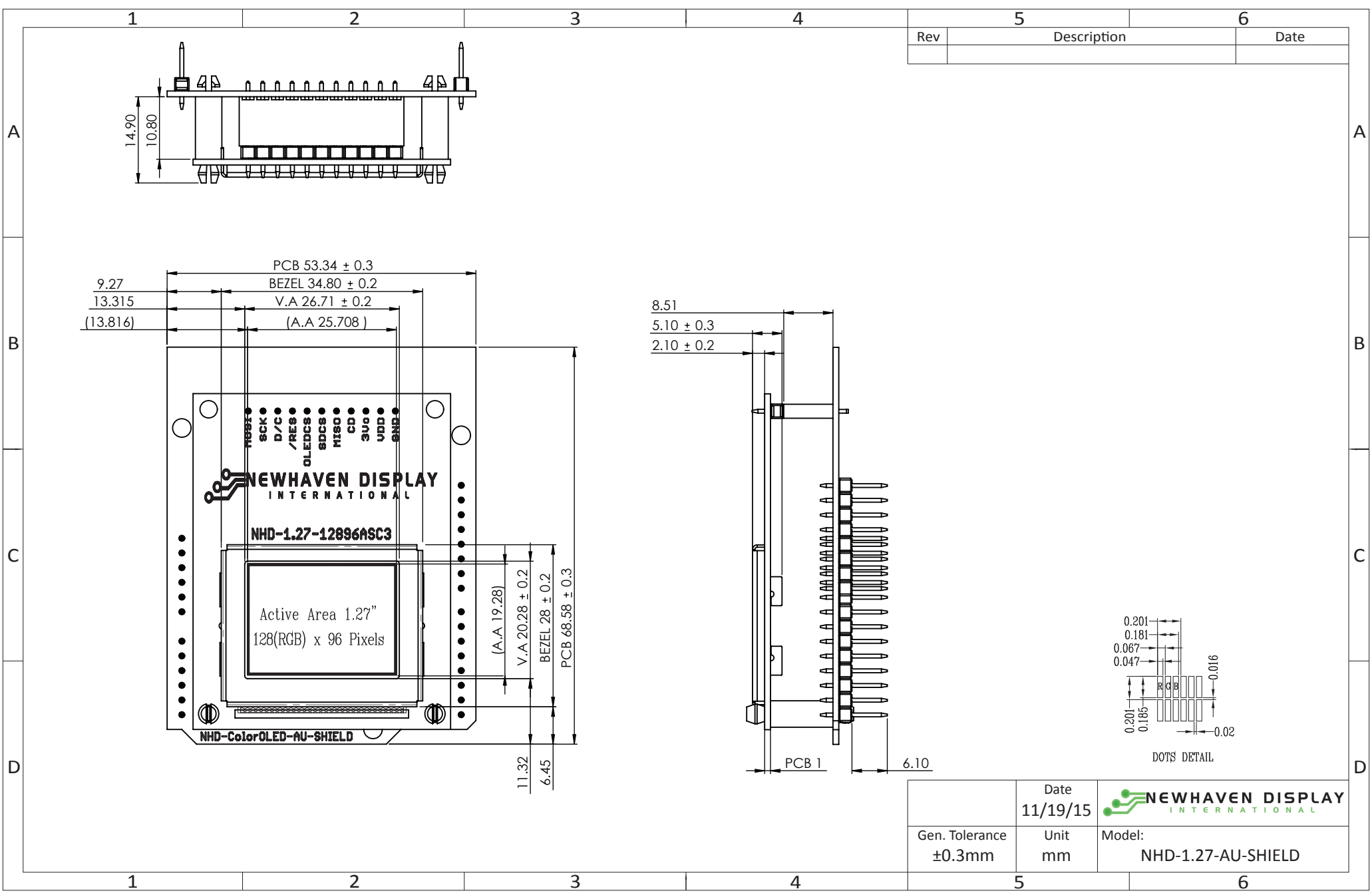
## Document Revision History

| Revision | Date | Description | Changed by |
|---|---|---|---|
| 0 | 11/19/2015 | Initial Release | PB |
| 1 | 1/11/2016 | Functions and Features Updated | PB |

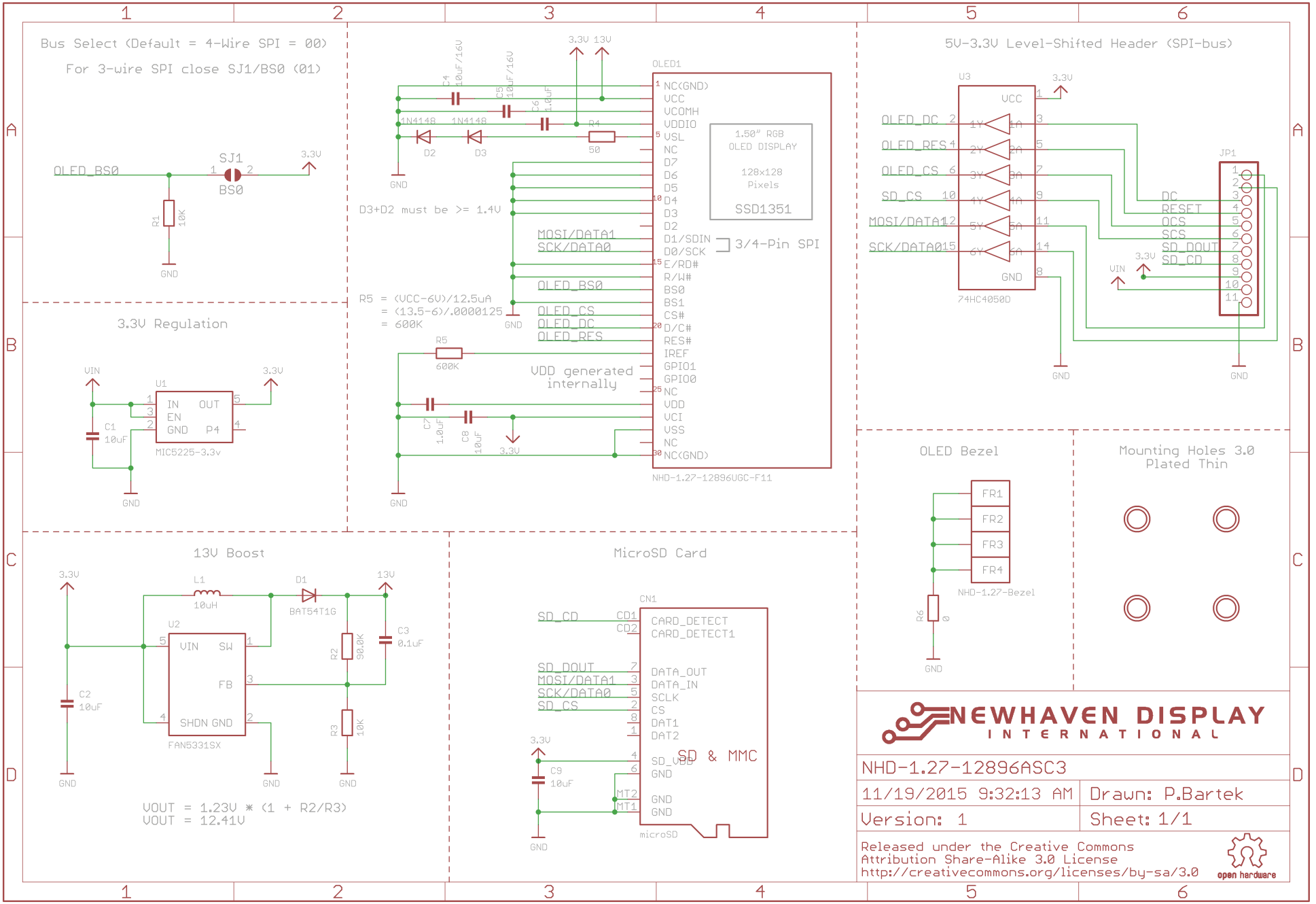
## Functions and Features

- **128 x 96 pixel resolution**
- **Built-in SSD1351 controller**
- **SPI MPU interface**
- **RoHS compliant**
- **microSD card reader (microSD card not included)**
- **Built-in logic level shifting for 3.3V ~ 5V operation**

# Mechanical Drawing



## Schematic


Bus Select (Default = 4-Wire SPI = 00)
For 3-wire SPI close SJ1/BS0 (01)
OLED_BS0
SJ1
BS0
3.3V
R1
10K
GND
3.3V Regulation
VIN
U1
IN
OUT
EN
GND
P4
C1
10uF
MIC5225-3.3v
3.3V
GND
13V Boost
3.3V
L1
10uH
D1
BAT54T1G
13V
U2
VIN
SW
FB
SHDN
GND
C2
10uF
R2
90.0K
R3
10K
C3
0.1uF
FAN5331SX
VOUT = 1.23V * (1 + R2/R3)
VOUT = 12.41V
OLED1
NC(GND)
VCC
VCOMH
VDDIO
VSL
NC
D7
D6
D5
D4
D3
D2
D1/SDIN
D0/SCK
E/RD#
R/W#
BS0
BS1
CS#
D/C#
RES#
IREF
GPIO1
GPIO0
NC
VDD
VCI
VSS
NC
NC(GND)
1.50" RGB
OLED DISPLAY
128x128
Pixels
SSD1351
3/4-Pin SPI
NHD-1.27-12896UGC-F11
C4
10uF/16V
C5
10uF/16V
C6
1.0uF
1N4148
1N4148
D2
D3
R4
50
D3+D2 must be >= 1.4V
MOSI/DATA1
SCK/DATA0
OLED_BS0
OLED_CS
OLED_DC
OLED_RES
R5 = (VCC-6V)/12.5uA
= (13.5-6)/.0000125
= 600K
R5
600K
VDD generated
internally
C7
1.0uF
C8
10uF
MicroSD Card
CN1
SD_CD
CD1
CD2
CARD_DETECT
CARD_DETECT1
SD_DOUT
MOSI/DATA1
SCK/DATA0
SD_CS
DATA_OUT
DATA_IN
SCLK
CS
DAT1
DAT2
SD_VDD
GND
GND
MT2
MT1
SD & MMC
C9
10uF
microSD
5V-3.3V Level-Shifted Header (SPI-bus)
U3
VCC
OLED_DC
OLED_RES
OLED_CS
SD_CS
MOSI/DATA1
SCK/DATA0
1Y
2Y
3Y
4Y
5Y
6Y
1A
2A
3A
4A
5A
6A
GND
74HC4050D
JP1
DC
RESET
OCS
SCS
SD_DOUT
SD_CD
VIN
OLED Bezel
FR1
FR2
FR3
FR4
NHD-1.27-Bezel
R6
0
Mounting Holes 3.0
Plated Thin
NEWHAVEN DISPLAY
INTERNATIONAL
NHD-1.27-12896ASC3
11/19/2015 9:32:13 AM
Drawn: P.Bartek
Version: 1
Sheet: 1/1
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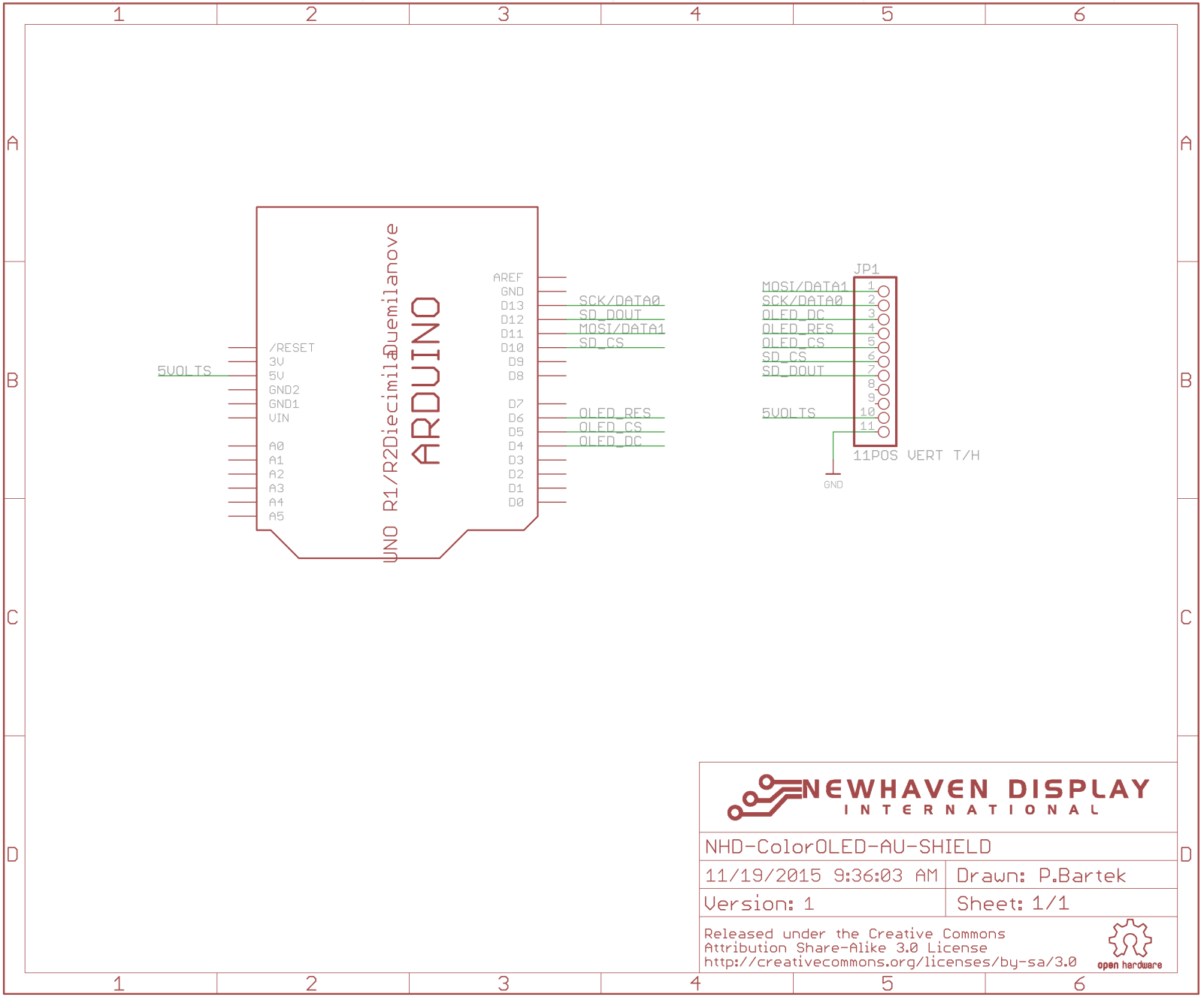
1
2
3
4
5
6
A
B
C
D
ARDUINO
UNO R1/R2Diecimila&Duemilanove
/RESET
3V
5V
GND2
GND1
VIN
A0
A1
A2
A3
A4
A5
5VOLTS
AREF
GND
D13
D12
D11
D10
D9
D8
D7
D6
D5
D4
D3
D2
D1
D0
SCK/DATA0
SD_DOUT
MOSI/DATA1
SD_CS
OLED_RES
OLED_CS
OLED_DC
JP1
MOSI/DATA1
SCK/DATA0
OLED_DC
OLED_RES
OLED_CS
SD_CS
SD_DOUT
5VOLTS
GND
11POS VERT T/H
NEWHAVEN DISPLAY
INTERNATIONAL
NHD-ColorOLED-AU-SHIELD
11/19/2015 9:36:03 AM
Drawn: P.Bartek
Version: 1
Sheet: 1/1
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# Interface Description

JP1 Interface:

| Pin No. | Symbol | External Connection | Function Description |
|---|---|---|---|
| 1 | MOSI | MPU | Master Out Slave In |
| 2 | SCK | MPU | Serial Clock signal |
| 3 | D/C | MPU | Register Select signal. D/C=0: Command, D/C=1: Data |
| 4 | /RES | MPU | Active LOW Reset signal |
| 5 | OLEDCS | MPU | OLED Active LOW Chip Select signal |
| 6 | SDCS | MPU | Micro SD Active LOW Chip Select signal |
| 7 | MISO | MPU | Master In / Slave Out |
| 8 | NC | - | No Connect |
| 9 | NC | - | No Connect |
| 10 | VDD | Power Supply | Supply Voltage for OLED and logic (3.3V~5V) |
| 11 | GND | Power Supply | Ground |

JP2 Interface:

| Shield Pin Symbol | Arduino UNO Pin Symbol | Function Description |
|---|---|---|
| AREF | AREF | No Connect |
| GND | GND | Ground |
| Digital 13 | 13 | Serial Clock signal |
| Digital 12 | 12 | Master In / Slave Out |
| Digital 11 | 11 | Master Out Slave In |
| Digital 10 | 10 | Micro SD Active LOW Chip Select signal |
| Digital 9 | 9 | No Connect |
| Digital 8 | 8 | No Connect |

JP3 Interface:

| Shield Pin Symbol | Arduino UNO Pin Symbol | Function Description |
|---|---|---|
| Digital 7 | 7 | No Connect |
| Digital 6 | 6 | Active LOW Reset signal |
| Digital 5 | 5 | OLED Active LOW Chip Select signal |
| Digital 4 | 4 | Register Select signal. D/C=0: Command, D/C=1: Data |
| Digital 3 | 3 | No Connect |
| Digital 2 | 2 | No Connect |
| Digital 1 | 1 | No Connect |
| Digital 0 | 0 | No Connect |

JP4 Interface:

| Shield Pin Symbol | Arduino UNO Pin Symbol | Function Description |
|---|---|---|
| Analog 5 | A5 | No Connect |
| Analog 4 | A4 | No Connect |
| Analog 3 | A3 | No Connect |
| Analog 2 | A2 | No Connect |
| Analog 1 | A1 | No Connect |
| Analog 0 | A0 | No Connect |

JP5 Interface:

| Shield Pin Symbol | Arduino UNO Pin Symbol | Function Description |
|---|---|---|
| RST | RESET | No Connect |
| 3V | 3.3V | No Connect |
| 5V | 5V | Supply Voltage for OLED and logic (5V) |
| GND | GND | No Connect |
| GND | GND | No Connect |
| Vin | Vin | No Connect |

## Electrical Characteristics

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Operating Temperature Range | Top | Absolute Max | -30 | - | +70 | °C |
| Storage Temperature Range | Tst | Absolute Max | -40 | - | +80 | °C |
| | | | | | | |
| Supply Voltage | VDD | | 3.0 | 3.3 | 5.5 | V |
| Supply Current | IDD | | - | 80 | 200 | mA |
| "H" Level input | Vih | | 0.8*VDD | - | VDD | V |
| "L" Level input | Vil | | 0 | - | 0.2*VDD | V |
| "H" Level output | Voh | | 0.9*VDD | - | VDD | V |
| "L" Level output | Vol | | 0 | - | 0.1*VDD | V |

## Optical Characteristics

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Viewing Angle – Top | | | 80 | - | - | ° |
| Viewing Angle – Bottom | | | 80 | - | - | ° |
| Viewing Angle – Left | | | 80 | - | - | ° |
| Viewing Angle – Right | | | 80 | - | - | ° |
| Contrast Ratio | Cr | | - | 2000:1 | - | - |
| Response Time (rise) | Tr | - | - | 10 | - | us |
| Response Time (fall) | Tf | - | - | 10 | - | us |
| Brightness | | 50% checkerboard | 60 | 75 | - | $cd/m^2$ |
| Lifetime | | 90 $cd/m^2$, Ta=25°C, 50% checkerboard | 10,000 | - | - | Hrs |

**Note**: Lifetime at typical temperature is based on accelerated high-temperature operation. Lifetime is tested at average 50% pixels on and is rated as Hours until **Half-Brightness**. The Display OFF command can be used to extend the lifetime of the display.
Luminance of active pixels will degrade faster than inactive pixels. Residual (burn-in) images may occur. To avoid this, every pixel should be illuminated uniformly.

## Controller information

Built-in SSD1351 controller.
Please download specification at www.newhavendisplay.com/app_notes/SSD1351.pdf

## Table of Commands

(D/C# = 0, R/W#(WR#)= 0, E(RD#) = 1) unless specific setting is stated
Single byte command (D/C# = 0), Multiple byte command (D/C# = 0 for first byte, D/C# = 1 for other bytes)

| Fundamental Command Table | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **D/C#** | **Hex** | **D7** | **D6** | **D5** | **D4** | **D3** | **D2** | **D2** | **D0** | **Command** | **Description** |
| 0 | 15 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | Set Column Address | A[6:0]: Start Address. [reset=0]<br>B[6:0]: End Address. [reset=127]<br>Range from 0 to 127 |
| 1 | A[6:0] | * | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 1 | B[6:0] | * | $B_6$ | $B_5$ | $B_4$ | $B_3$ | $B_2$ | $B_1$ | $B_0$ | | |
| 0 | 75 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | Set Row Address | A[6:0]: Start Address. [reset=0]<br>B[6:0]: End Address. [reset=127]<br>Range from 0 to 127 |
| 1 | A[6:0] | * | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 1 | B[6:0] | * | $B_6$ | $B_5$ | $B_4$ | $B_3$ | $B_2$ | $B_1$ | $B_0$ | | |
| 0 | 5C | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | Write RAM Command | Enable MCU to write Data into RAM |
| 0 | 5D | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | Read RAM Command | Enable MCU to read Data from RAM |
| 0 | A0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | Set Re-map / Color Depth (Display RAM to Panel) | A[0]=0b, Horizontal address increment [reset]<br>A[0]=1b, Vertical address increment<br><br>A[1]=0b, Column address 0 is mapped to SEG0 [reset]<br>A[1]=1b, Column address 127 is mapped to SEG0<br><br>A[2]=0b, Color sequence: A → B → C [reset]<br>A[2]=1b, Color sequence is swapped: C → B → A<br><br>A[3]=0b, Reserved<br>A[3]=1b, Reserved<br><br>A[4]=0b, Scan from COM0 to COM[N –1] [reset]<br>A[4]=1b, Scan from COM[N-1] to COM0. Where N is the Multiplex ratio.<br><br>A[5]=0b, Disable COM Split Odd Even<br>A[5]=1b, Enable COM Split Odd Even [reset]<br><br>A[7:6] Set Color Depth,<br>00b / 01b: 65k color [reset]<br>10b: 262k color<br>11b 262k color, 16-bit format 2<br><br>Refer to Table 8-8 for details |
| 1 | A[7:0] | $A_7$ | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |

| Fundamental Command Table | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **D/C#** | **Hex** | **D7** | **D6** | **D5** | **D4** | **D3** | **D2** | **D2** | **D0** | **Command** | **Description** |
| 0 | A1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | Set Display Start Line | Set vertical scroll by RAM from 0~127. [reset=00h] |
| 1 | A[6:0] | * | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 0 | A2 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | Set Display Offset | Set vertical scroll by Row from 0-127. [reset=60h]<br><br>**Note**<br>(1) This command is locked by Command FDh by default. To unlock it, please refer to Command FDh. |
| 1 | A[6:0] | * | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 0 | A4~A7 | 1 | 0 | 1 | 0 | 0 | 1 | $X_1$ | $X_0$ | Set Display Mode | A4h: All OFF<br><br>A5h: All ON (All pixels have GS63)<br><br>A6h : Reset to normal display [reset]<br><br>A7h: Inverse Display (GS0 -> GS63, GS1 -> GS62, ....) |
| 0 | AB | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | Function Selection | A[0]=0b, Select external $V_{DD}$<br>A[0]=1b, Enable internal $V_{DD}$ regulator [reset]<br><br>A[7:6]=00b, Select 8-bit parallel interface [reset]<br>A[7:6]=01b, Select 16-bit parallel interface<br>A[7:6]=11b, Select 18-bit parallel interface |
| 1 | A[7:0] | $A_7$ | $A_6$ | 0 | 0 | 0 | 0 | 0 | $A_0$ | | |
| 0 | AD | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | NOP | Command for no operation. |
| 0 | AE~AF | 1 | 0 | 1 | 0 | 1 | 1 | 1 | $X_0$ | Set Sleep mode ON/OFF | AEh = Sleep mode On (Display OFF)<br>AFh = Sleep mode OFF (Display ON) |
| 0 | B0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | NOP | Command for no operation. |
| 0 | B1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | Set Reset (Phase 1) / Pre-charge (Phase 2) period | A[3:0] Phase 1 period of 5~31 DCLK(s) clocks<br>[reset=0010b]<br>A[3:0]:<br>0-1 invalid<br>2 = 5 DCLKs<br>3 = 7 DCLKs<br>:<br>15 = 31DCLKs<br><br>A[7:4] Phase 2 period of 3~15 DCLK(s) clocks<br>[reset=1000b]<br>A[7:4]:<br>0-2 invalid<br>3 = 3 DCLKs<br>4 = 4 DCLKs<br>:<br>15 =15DCLKs<br><br>Note<br>(1) 0 DCLK is invalid in phase 1 & phase 2<br>(2) This command is locked by Command FDh by default. To unlock it, please refer to Command FDh. |
| 1 | A[7:0] | $A_7$ | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |

**Fundamental Command Table**

| D/C# | Hex | D7 | D6 | D5 | D4 | D3 | D2 | D2 | D0 | Command | Description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | B2 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | Display Enhancement | A[7:0] = 00h, B[7:0] = 00h, C[7:0] = 00h normal [reset]<br>A[7:0] = A4h, B[7:0] = 00h, C[7:0] = 00h enhance display performance |
| 1 | A[7:0] | $A_7$ | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 1 | B[7:0] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| 1 | C[7:0] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| 0 | B3 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | Front Clock Divider (DivSet)/ Oscillator Frequency | A[3:0] [reset=0001], divide by DIVSET where<br><br>A[7:4] Oscillator frequency, frequency increases as level increases [reset=1101b]<br><br>**Note**<br>(1) This command is locked by Command FDh by default. To unlock it, please refer to Command FDh. |
| 1 | A[7:0] | $A_7$ | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 0 | B4 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | Set Segment Low Voltage (VSL) | A[1:0]=00 External VSL [reset]<br>A[1:0]=01,10,11 are invalid<br>**Note**<br>(1) When external VSL is enabled, in order to avoid distortion in display pattern, an external circuit is needed to connect between VSL and $V_{SS}$ as shown in Figure 14-1 |
| 1 | A[7:0] | 1 | 0 | 1 | 0 | 0 | 0 | $A_1$ | $A_0$ | | |
| 1 | B[7:0] | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | | |
| 1 | C[7:0] | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | | |
| 0 | B5 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | Set GPIO | A[1:0] GPIO0: 00 pin HiZ, Input disabled<br>01 pin HiZ, Input enabled<br>10 pin output LOW [reset]<br>11 pin output HIGH<br><br>A[3:2] GPIO1: 00 pin HiZ, Input disabled<br>01 pin HiZ, Input enabled<br>10 pin output LOW [reset]<br>11 pin output HIGH |
| 1 | A[3:0] | * | * | * | * | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 0 | B6 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | Set Second Pre-charge Period | A[3:0] Set Second Pre-charge Period<br><br>0000b invalid<br>0001b 1 DCLKS<br>0010b 2 DCLKS<br>....<br>1000 8 DCLKS [reset]<br>....<br>1111 15 DCLKS |
| 1 | A[3:0] | * | * | * | * | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |

| A[3:0] | DIVSET |
|---|---|
| 0000 | divide by 1 |
| 0001 | divide by 2 |
| 0010 | divide by 4 |
| 0011 | divide by 8 |
| 0100 | divide by 16 |
| 0101 | divide by 32 |
| 0110 | divide by 64 |
| 0111 | divide by 128 |
| 1000 | divide by 256 |
| 1001 | divide by 512 |
| 1010 | divide by 1024 |
| >=1011 | invalid |

**Fundamental Command Table**

| D/C# | Hex | D7 | D6 | D5 | D4 | D3 | D2 | D2 | D0 | Command | Description |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | B8 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | Look Up Table for Gray Scale Pulse width | The next 63 data bytes define Gray Scale (GS) Table by setting the gray scale pulse width in unit of DCLK's (ranges from 0d ~ 180d)<br><br>A1[7:0]: Gamma Setting for GS1,<br>A2[7:0]: Gamma Setting for GS2,<br>:<br>A62[7:0]: Gamma Setting for GS62,<br>A63[7:0]: Gamma Setting for GS63<br><br>**Note**<br>(1) 0 ≤ Setting of GS1 < Setting of GS2 < Setting of GS3..... < Setting of GS62 < Setting of GS63<br>(2) GS0 has only pre-charge but no current drive stages.<br>(3) GS1 can be set as only pre-charge but no current drive stage by input gamma setting for GS1 equals 0. |
| 1 | A1[7:0] | $A1_7$ | $A1_6$ | $A1_5$ | $A1_4$ | $A1_3$ | $A1_2$ | $A1_1$ | $A1_0$ | | |
| 1 | A2[7:0] | $A2_7$ | $A2_6$ | $A2_5$ | $A2_4$ | $A2_3$ | $A2_2$ | $A2_1$ | $A2_0$ | | |
| 1 | . | . | . | . | . | . | . | . | . | | |
| 1 | . | . | . | . | . | . | . | . | . | | |
| 1 | . | . | . | . | . | . | . | . | . | | |
| 1 | A62[7:0] | $A62_7$ | $A62_6$ | $A62_5$ | $A62_4$ | $A62_3$ | $A62_2$ | $A62_1$ | $A62_0$ | | |
| 1 | A63[7:0] | $A63_7$ | $A63_6$ | $A63_5$ | $A63_4$ | $A63_3$ | $A63_2$ | $A63_1$ | $A63_0$ | | |
| 0 | B9 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | Use Built-in Linear LUT [reset= linear] | Reset to default Look Up Table:<br>GS1 = 0 DCLK<br>GS2 = 2 DCLK<br>GS3 = 4 DCLK<br>GS4 = 6 DCLK<br>...<br>GS62 = 122 DCLK<br>GS63 = 124 DCLK |
| 0 | BB | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | Set Pre-charge voltage | Set pre-charge voltage level.[reset = 17h]<br><br>**Note**<br>(1)This command is locked by Command FDh by default. To unlock it, please refer to Command FDh. |
| 1 | A[4:0] | 0 | 0 | 0 | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 0 | BE | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | Set $V_{COMH}$ Voltage | Set COM deselect voltage level [reset = 05h]<br><br>**Note**<br>(1)This command is locked by Command FDh by default. To unlock it, please refer to Command FDh. |
| 1 | A[2:0] | 0 | 0 | 0 | 0 | 0 | $A_2$ | $A_1$ | $A_0$ | | |

| A[4:0] | Hex code | pre-charge voltage |
|---|---|---|
| 00000 | 00h | 0.20 x $V_{CC}$ |
| : | : | : |
| 11111 | 1Fh | 0.60 x $V_{CC}$ |

| A[2:0] | Hex code | $V_{COMH}$ |
|---|---|---|
| 000 | 00h | 0.72 x $V_{CC}$ |
| : | : | : |
| 101 | 05h | 0.82 x $V_{CC}$ [reset] |
| : | : | : |
| 111 | 07h | 0.86 x $V_{CC}$ |

| Fundamental Command Table | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **D/C#** | **Hex** | **D7** | **D6** | **D5** | **D4** | **D3** | **D2** | **D2** | **D0** | **Command** | **Description** |
| 0 | C1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | Set Contrast Current for Color A,B,C | A[7:0] Contrast Value Color A [reset=10001010b]<br>B[7:0] Contrast Value Color B [reset=01010001b]<br>C[7:0] Contrast Value Color C [reset=10001010b] |
| 1 | A[7:0] | $A_7$ | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 1 | B[7:0] | $B_7$ | $B_6$ | $B_5$ | $B_4$ | $B_3$ | $B_2$ | $B_1$ | $B_0$ | | |
| 1 | C[7:0] | $C_7$ | $C_6$ | $C_5$ | $C_4$ | $C_3$ | $C_2$ | $C_1$ | $C_0$ | | |
| 0 | C7 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | Master Contrast Current Control | A[3:0] :<br>0000b reduce output currents for all colors to 1/16<br>0001b reduce output currents for all colors to 2/16<br>....<br>1110b reduce output currents for all colors to 15/16<br>1111b no change [reset] |
| 1 | A[3:0] | * | * | * | * | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 0 | CA | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | Set MUX Ratio | A[6:0] MUX ratio 16MUX ~ 128MUX, [reset=127], (Range from 15 to 127) |
| 1 | A[6:0] | 0 | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 0 | D1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | NOP | Command for No Operation |
| 0 | E3 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | NOP | Command for No Operation |
| 0 | FD | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | Set Command Lock | A[7:0]: MCU protection status [reset = 12h]<br>A[7:0] = 12b, Unlock OLED driver IC MCU interface from entering command [reset]<br>A[7:0] = 16b, Lock OLED driver IC MCU interface from entering command<br><br>A[7:0] = B0b, Command A2,B1,B3,BB,BE,C1 inaccessible in both lock and unlock state [reset]<br>A[7:0] = B1b, Command A2,B1,B3,BB,BE,C1 accessible if in unlock state<br><br>**Note**<br>(1) The locked OLED driver IC MCU interface prohibits all commands and memory access except the FDh command. |
| 1 | A[7:0] | $A_7$ | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |

**Note**
(1) "*" stands for "Don't care".

Set (GAC) (D/C# = 0, R/W#(WR#)= 0, E(RD#) = 1) unless specific setting is stated
Single byte command (D/C# = 0), Multiple byte command (D/C# = 0 for first byte, D/C# = 1 for other bytes)

| **Graphic acceleration command** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **D/C#** | **Hex** | **D7** | **D6** | **D5** | **D4** | **D3** | **D2** | **D2** | **D0** | **Command** | **Description** |
| 0 | 96 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | Horizontal Scroll | A[7:0] = 00000000b No scrolling<br>A[7:0] = 00000001b to 00111111b<br>Scroll towards SEG127 with 1 column offset<br>A[7:0] = 01000000b to 11111111b<br>Scroll towards SEG0 with 1 column offset<br><br>B[6:0] : start row address<br><br>C[7:0] : number of rows to be H-scrolled<br>B+C <= 128<br><br>D[6:0] : Reserved (reset=00h)<br><br>E[1:0] : scrolling time interval<br>00b test mode<br>01b normal<br>10b slow<br>11b slowest<br>**Note**<br>(1) Operates during display ON. |
| 1 | A[7:0] | $A_7$ | $A_6$ | $A_5$ | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | | |
| 1 | B[6:0] | 0 | $B_6$ | $B_5$ | $B_4$ | $B_3$ | $B_2$ | $B_1$ | $B_0$ | | |
| 1 | C[7:0] | $C_7$ | $C_6$ | $C_5$ | $C_4$ | $C_3$ | $C_2$ | $C_1$ | $C_0$ | | |
| 1 | D[6:0] | 0 | $D_6$ | $D_5$ | $D_4$ | $D_3$ | $D_2$ | $D_1$ | $D_0$ | | |
| 1 | E[1:0] | 0 | 0 | 0 | 0 | 0 | 0 | $E_1$ | $E_0$ | | |
| 0 | 9E | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | Stop Moving | Stop horizontal scroll<br><br>**Note**<br>(1) After sending 9Eh command to stop the scrolling action, the ram data needs to be rewritten |
| 0 | 9F | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | Start Moving | Start horizontal scroll |

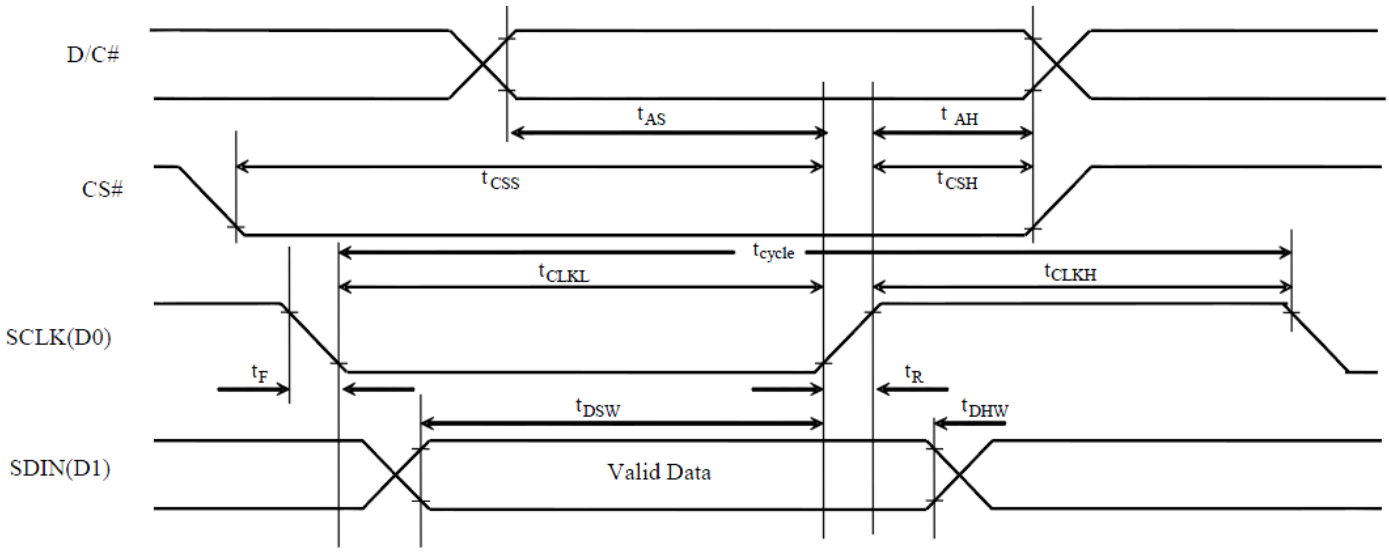
**Note**
(1) After executed the graphic command, waiting time is required for update GDDRAM content.
$V_{CI}$ =2.4~3.5V, waiting time = 500ns/pixel.

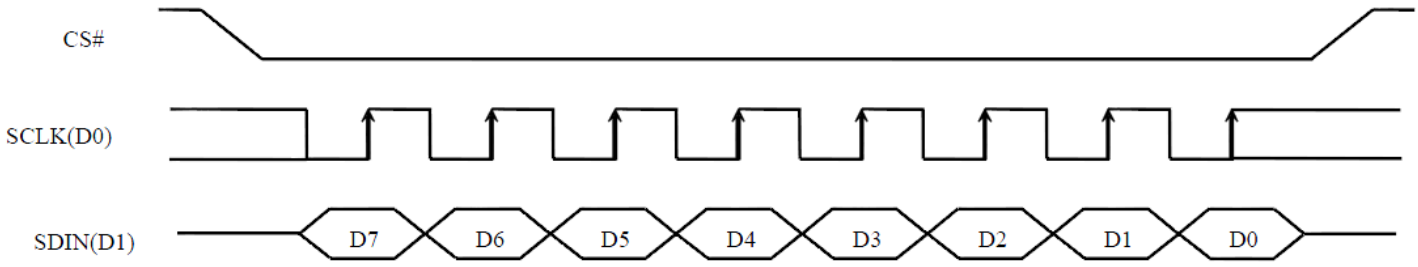
(2) "*" stands for "Don't care".

## Timing Characteristics

### 4-wire SPI:

| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $t_{cycle}$ | Clock Cycle Time | 220 | - | - | ns |
| $t_{AS}$ | Address Setup Time | 15 | - | - | ns |
| $t_{AH}$ | Address Hold Time | 42 | - | - | 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 | 20 | - | - | 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 |



## Example Initialization Sequence

```
void OLED_Init_12896RGB(void)
{
int i,j;
GPIO_ResetBits(GPIOC, RES);
graphic_delay(500000);
GPIO_SetBits(GPIOC, RES);
graphic_delay(500000);

oled_Command_12896RGB(0xFD);      //Command lock setting
oled_Data_12896RGB(0x12);         //unlock
oled_Command_12896RGB(0xFD);      //Command lock setting
oled_Data_12896RGB(0xB1);         //unlock

oled_Command_12896RGB(0xAE);

oled_Command_12896RGB(0xB3);      //clock & frequency
oled_Data_12896RGB(0xF1);         //clock=Diviser+1 frequency=fh

oled_Command_12896RGB(0xCA);      //Duty
oled_Data_12896RGB(0x7F);         //OLED _END+1

oled_Command_12896RGB(0xA2);      //Display offset
oled_Data_12896RGB(0x00);

oled_Command_12896RGB(0xA1);      //Set display start line
oled_Data_12896RGB(0x00);         //0x00 start line

oled_Command_12896RGB(0xA0);      //Set Re-map, color depth
oled_Data_12896RGB(0xA0);         //8-bit 262K

oled_Command_12896RGB(0xB5);      //set GPIO
oled_Data_12896RGB(0x00);         //disabled

oled_Command_12896RGB(0xAB);      //Function Set
oled_Data_12896RGB(0x01);         //8-bit interface, internal VDD regulator

oled_Command_12896RGB(0xB4);      //set VSL
oled_Data_12896RGB(0xA0);         //external VSL
oled_Data_12896RGB(0xB5);
oled_Data_12896RGB(0x55);

oled_Command_12896RGB(0xC1);      //Set contrast current for A,B,C
oled_Data_12896RGB(0x8a);         //Color A        //8a
oled_Data_12896RGB(0x51);         //Color B        //51
oled_Data_12896RGB(0x8a);         //Color C        //8a

oled_Command_12896RGB(0xC7);      //Set master contrast
oled_Data_12896RGB(0x0F);         //
```

```
oled_Command_12896RGB(0xB9);        //use linear grayscale LUT

oled_Command_12896RGB(0xB1);        //Set pre & dis-charge
oled_Data_12896RGB(0x32);           //pre=1h, dis=1h

oled_Command_12896RGB(0xBB);        //Set precharge voltage of color A,B,C
oled_Data_12896RGB(0x07);           //

oled_Command_12896RGB(0xB2);   //display enhancement
oled_Data_12896RGB(0xa4);
oled_Data_12896RGB(0x00);
oled_Data_12896RGB(0x00);

oled_Command_12896RGB(0xB6);        //precharge period
oled_Data_12896RGB(0x01);

oled_Command_12896RGB(0xBE);        //Set VcomH
oled_Data_12896RGB(0x07);

oled_Command_12896RGB(0xA6);        //Normal display

oled_Command_12896RGB(0x15);        //set column start and end addresses
oled_Data_12896RGB(0x00);     //
oled_Data_12896RGB(0x7F);           //
oled_Command_12896RGB(0x75);        //set row start and end addresses
oled_Data_12896RGB(0x00);           //
oled_Data_12896RGB(0x5F);           //
oled_Command_12896RGB(0x5C);        //write to RAM command

        for(i=0;i<128;i++)
        {
                for(j=0;j<96;j++)
                {
                        oled_Data_12896RGB(0x00);
                        oled_Data_12896RGB(0x00);
                        oled_Data_12896RGB(0x00);
                }
        }
oled_Command_12896RGB(0xAF);        //Display on
}

int oled_12896RGB(void)
{
column = 0x00;
byte1 = 0x00;
byte2 = 0x00;
oled_Command_12896RGB(0x15);        //set column start and end addresses
oled_Data_12896RGB(column);         //
oled_Data_12896RGB(0x7F);           //
```

```
oled_Command_12896RGB(0x75);        //set row start and end addresses
oled_Data_12896RGB(0x00);           //
oled_Data_12896RGB(0x5F);           //
oled_Command_12896RGB(0x5C);        //write to RAM command

for (i=0;i<12288;i++)      //for each 24-bit pixel...128*96=12288
{
        f_read(&File1, &red, 1, &blen);          //read the red 8-bits
        f_read(&File1, &green, 1, &blen);        //read the green 8-bits
        f_read(&File1, &blue, 1, &blen);//read the blue 8-bits

        red = red >> 2;
        green = green >> 2;
        blue = blue >> 2;
        oled_Data_12896RGB(red);
        oled_Data_12896RGB(green);
        oled_Data_12896RGB(blue);

}
////////////////////////////////////////////////////
```

## Example Arduino Code

Please see: https://github.com/NewhavenDisplay/NHD-1.27-12896ASC3_Example

# Quality Information

| Test Item | Content of Test | Test Condition | Note |
|---|---|---|---|
| High Temperature storage | Test the endurance of the display at high storage temperature. | +800°C , 96hrs | 2 |
| Low Temperature storage | Test the endurance of the display at low storage temperature. | -40°C , 96hrs | 1,2 |
| High Temperature Operation | Test the endurance of the display by applying electric stress (voltage & current) at high temperature. | +70°C 96hrs | 2 |
| Low Temperature Operation | Test the endurance of the display by applying electric stress (voltage & current) at low temperature. | -30°C , 96hrs | 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 , 96hrs | 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. | -30°C,30min -> 25°C,5min -> 70°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

# Warranty Information and Terms & Conditions

http://www.newhavendisplay.com/index.php?main_page=terms

Общество с ограниченной ответственностью «МосЧип» ИНН 7719860671 / КПП 771901001
Адрес: 105318, г.Москва, ул.Щербаковская д.3, офис 1107

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