

# 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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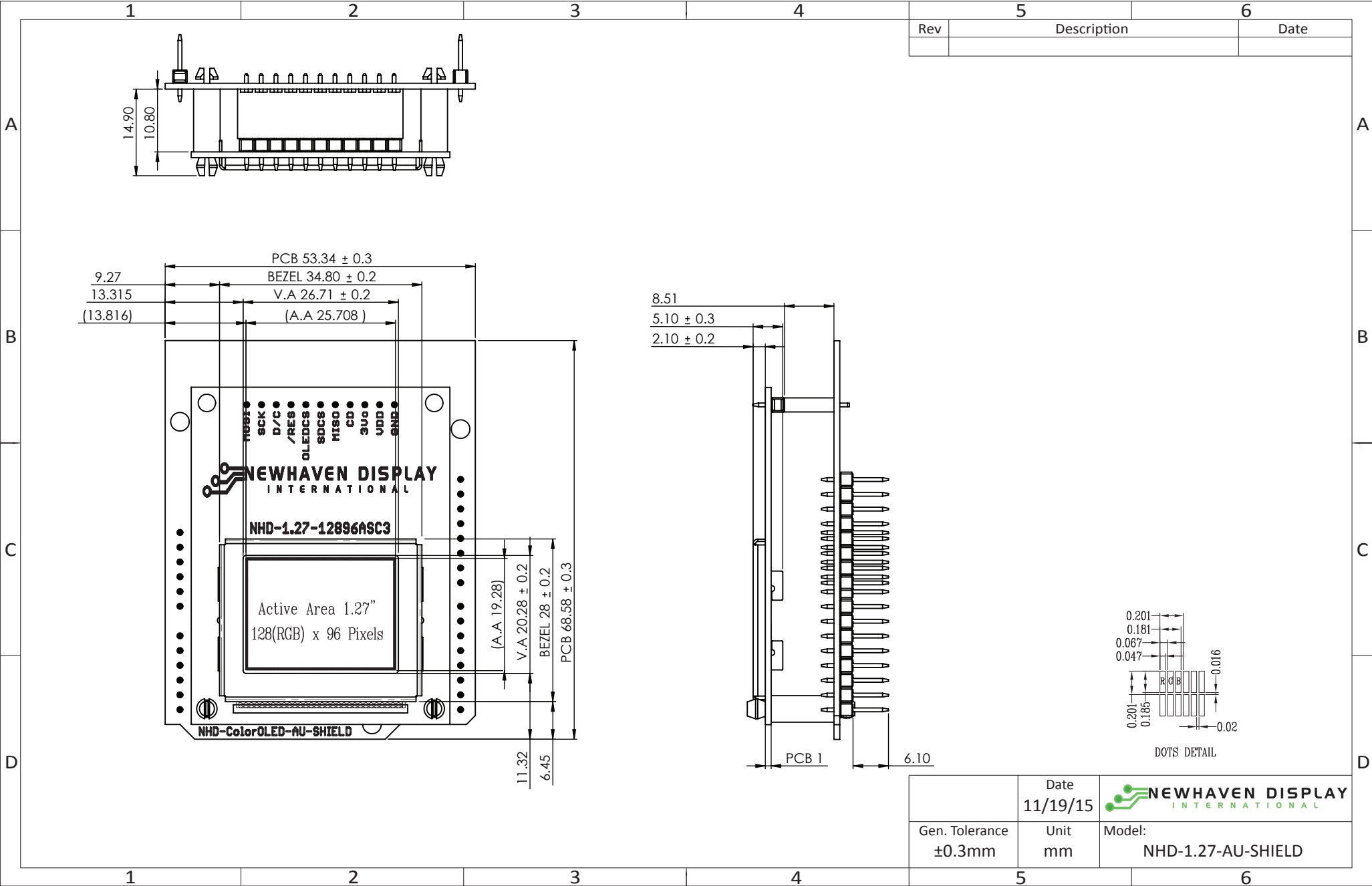
## Document Revision History

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

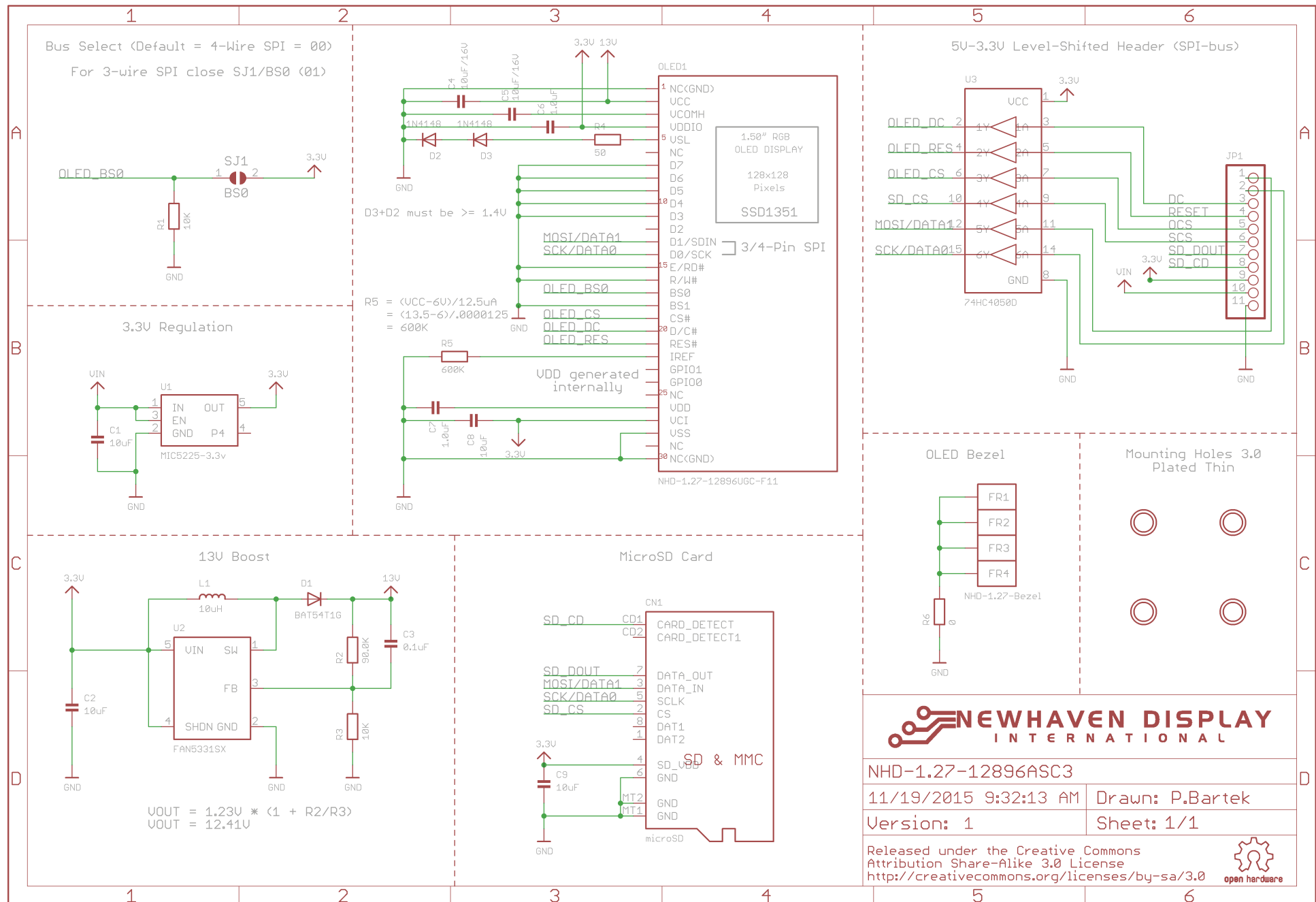
## Functions and Features

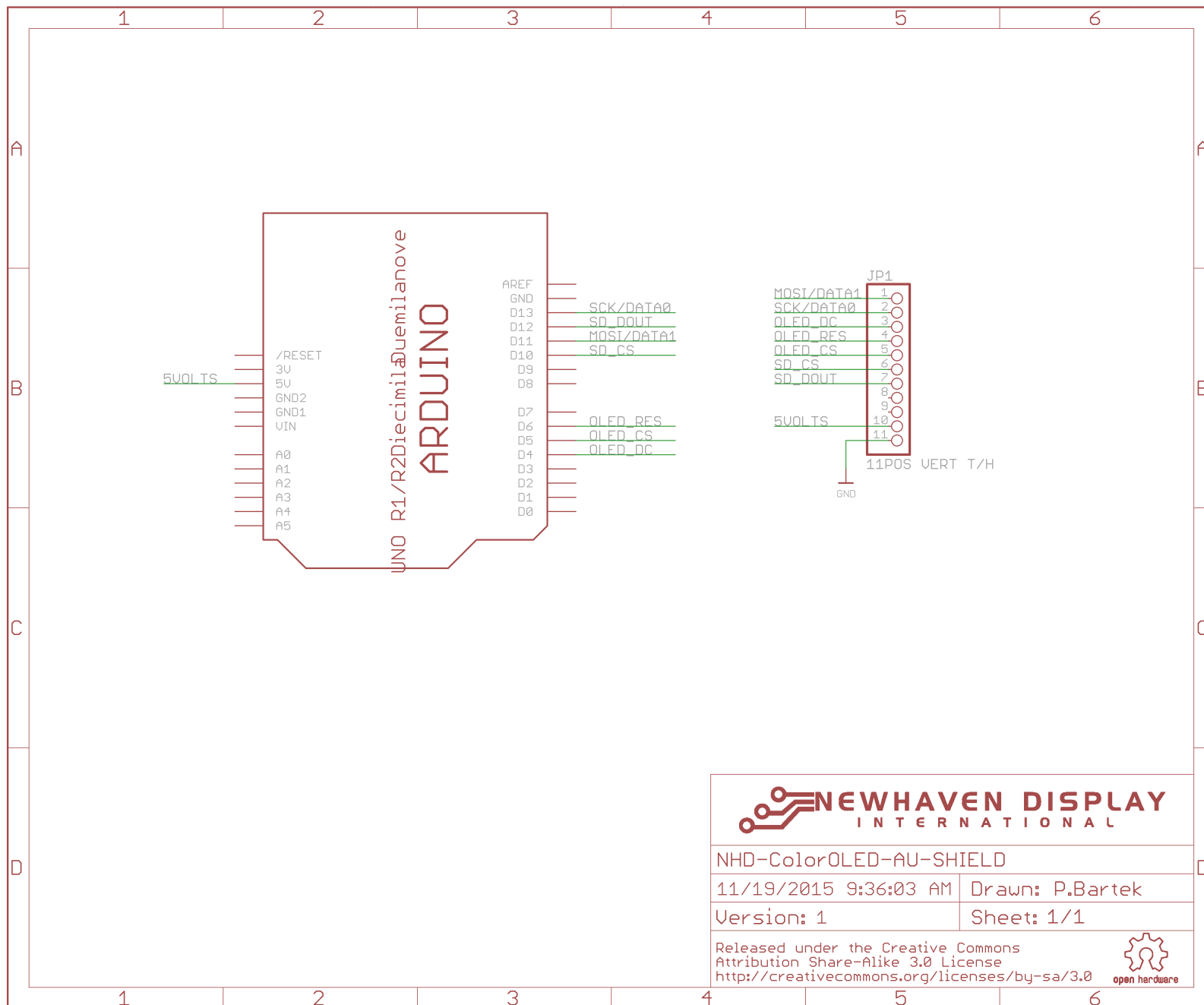
- 128 x 96 pixel resolution
- Built-in SSD1351 controller
- SPI MPU interface
- RoHS compliant
- microSD card reader (microSD card not included)
- Built-in logic level shifting for 3.3V ~ 5V operation

Mechanical Drawing



# Schematic





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 <sup>2</sup> |
| Lifetime               |        | 90 cd/m <sup>2</sup> , 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](http://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             | D1             | D0             | Command                                         | Description                                                                                                         |
| 0                         | 15     | 0              | 0              | 0              | 1              | 0              | 1              | 0              | 1              | Set Column Address                              | A[6:0]: Start Address. [reset=0]                                                                                    |
| 1                         | A[6:0] | *              | A <sub>6</sub> | A <sub>5</sub> | A <sub>4</sub> | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                                 | B[6:0]: End Address. [reset=127]                                                                                    |
| 1                         | B[6:0] | *              | B <sub>6</sub> | B <sub>5</sub> | B <sub>4</sub> | B <sub>3</sub> | B <sub>2</sub> | B <sub>1</sub> | B <sub>0</sub> |                                                 | Range from 0 to 127                                                                                                 |
| 0                         | 75     | 0              | 1              | 1              | 1              | 0              | 1              | 0              | 1              | Set Row Address                                 | A[6:0]: Start Address. [reset=0]                                                                                    |
| 1                         | A[6:0] | *              | A <sub>6</sub> | A <sub>5</sub> | A <sub>4</sub> | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                                 | B[6:0]: End Address. [reset=127]                                                                                    |
| 1                         | B[6:0] | *              | B <sub>6</sub> | B <sub>5</sub> | B <sub>4</sub> | B <sub>3</sub> | B <sub>2</sub> | B <sub>1</sub> | B <sub>0</sub> |                                                 | Range from 0 to 127                                                                                                 |
| 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]                                                                       |
| 1                         | A[7:0] | A <sub>7</sub> | A <sub>6</sub> | A <sub>5</sub> | A <sub>4</sub> | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                                 | A[0]=1b, Vertical address increment                                                                                 |
|                           |        |                |                |                |                |                |                |                |                |                                                 | A[1]=0b, Column address 0 is mapped to SEG0 [reset]<br>A[1]=1b, Column address 127 is mapped to SEG0                |
|                           |        |                |                |                |                |                |                |                |                |                                                 | A[2]=0b, Color sequence: A → B → C [reset]<br>A[2]=1b, Color sequence is swapped: C → B → A                         |
|                           |        |                |                |                |                |                |                |                |                |                                                 | A[3]=0b, Reserved<br>A[3]=1b, Reserved                                                                              |
|                           |        |                |                |                |                |                |                |                |                |                                                 | 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. |
|                           |        |                |                |                |                |                |                |                |                |                                                 | A[5]=0b, Disable COM Split Odd Even<br>A[5]=1b, Enable COM Split Odd Even [reset]                                   |
|                           |        |                |                |                |                |                |                |                |                |                                                 | A[7:6] Set Color Depth,<br>00b / 01b: 65k color [reset]<br>10b: 262k color<br>11b: 262k color, 16-bit format 2      |
|                           |        |                |                |                |                |                |                |                |                |                                                 | Refer to Table 8-8 for details                                                                                      |

| Fundamental Command Table |              |                     |                     |                     |                     |                     |                     |                     |                     |                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------|--------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| D/C#                      | Hex          | D7                  | D6                  | D5                  | D4                  | D3                  | D2                  | D2                  | D0                  | Command                                                       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 0<br>1                    | A1<br>A[6:0] | 1<br>*              | 0<br>A <sub>6</sub> | 1<br>A <sub>5</sub> | 0<br>A <sub>4</sub> | 0<br>A <sub>3</sub> | 0<br>A <sub>2</sub> | 0<br>A <sub>1</sub> | 1<br>A <sub>0</sub> | Set Display<br>Start Line                                     | Set vertical scroll by RAM from 0~127. [reset=00h]                                                                                                                                                                                                                                                                                                                                                                                                            |
| 0<br>1                    | A2<br>A[6:0] | 1<br>*              | 0<br>A <sub>6</sub> | 1<br>A <sub>5</sub> | 0<br>A <sub>4</sub> | 0<br>A <sub>3</sub> | 0<br>A <sub>2</sub> | 1<br>A <sub>1</sub> | 0<br>A <sub>0</sub> | Set Display<br>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<br>unlock it, please refer to Command FDh.                                                                                                                                                                                                                                                                                         |
| 0                         | A4~A7        | 1                   | 0                   | 1                   | 0                   | 0                   | 1                   | X <sub>1</sub>      | X <sub>0</sub>      | Set Display<br>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<br>1                    | AB<br>A[7:0] | 1<br>A <sub>7</sub> | 0<br>A <sub>6</sub> | 1<br>0              | 0<br>0              | 1<br>0              | 0<br>0              | 1<br>0              | 1<br>A <sub>0</sub> | Function<br>Selection                                         | A[0]=0b, Select external V <sub>DD</sub><br>A[0]=1b, Enable internal V <sub>DD</sub> 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                                                                                                                                                                                             |
| 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 <sub>0</sub>      | Set Sleep mode<br>ON/OFF                                      | A Eh = 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<br>1                    | B1<br>A[7:0] | 1<br>A <sub>7</sub> | 0<br>A <sub>6</sub> | 1<br>A <sub>5</sub> | 1<br>A <sub>4</sub> | 0<br>A <sub>3</sub> | 0<br>A <sub>2</sub> | 0<br>A <sub>1</sub> | 1<br>A <sub>0</sub> | Set Reset<br>(Phase 1) /<br>Pre-charge<br>(Phase 2)<br>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<br>unlock it, please refer to Command FDh. |

| 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 <sub>7</sub> | A <sub>6</sub> | A <sub>5</sub> | A <sub>4</sub> | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
| 1                         | A[7:0]         | A <sub>7</sub> | A <sub>6</sub> | A <sub>5</sub> | A <sub>4</sub> | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                                                                                                 | <table><tr><th>A[3:0]</th><th>DIVSET</th></tr><tr><td>0000</td><td>divide by 1</td></tr><tr><td>0001</td><td>divide by 2</td></tr><tr><td>0010</td><td>divide by 4</td></tr><tr><td>0011</td><td>divide by 8</td></tr><tr><td>0100</td><td>divide by 16</td></tr><tr><td>0101</td><td>divide by 32</td></tr><tr><td>0110</td><td>divide by 64</td></tr><tr><td>0111</td><td>divide by 128</td></tr><tr><td>1000</td><td>divide by 256</td></tr><tr><td>1001</td><td>divide by 512</td></tr><tr><td>1010</td><td>divide by 1024</td></tr><tr><td>&gt;=1011</td><td>invalid</td></tr></table> | 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 |
| 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        |                |                |                |                |                |                |                |                |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
|                           |                |                |                |                |                |                |                |                |                | A[7:4] Oscillator frequency, frequency increases as level increases [reset=1101b]                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
|                           |                |                |                |                |                |                |                |                |                | <b>Note</b><br>(1) This command is locked by Command FDh by default. To unlock it, please refer to Command FDh. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
| 0                         | B4             | 1              | 0              | 1              | 1              | 0              | 1              | 0              | 0              | Set Segment Low Voltage (VSL)                                                                                   | A[1:0]=00 External VSL [reset]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
| 1                         | A[7:0]         | 1              | 0              | 1              | 0              | 0              | 0              | A <sub>1</sub> | A <sub>0</sub> |                                                                                                                 | A[1:0]=01,10,11 are invalid                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
| 1                         | B[7:0]         | 1              | 0              | 1              | 1              | 0              | 1              | 0              | 1              |                                                                                                                 | <b>Note</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
| 1                         | C[7:0]         | 0              | 1              | 0              | 1              | 0              | 1              | 0              | 1              |                                                                                                                 | (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 <sub>SS</sub> as shown in Figure 14-1.                                                                                                                                                                                                                                                                                                                                                                                                        |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
| 1                         | A[3:0]         | *              | *              | *              | *              | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                                                                                                 | 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
|                           |                |                |                |                |                |                |                |                |                |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
|                           |                |                |                |                |                |                |                |                |                |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
| 0                         | B6             | 1              | 0              | 1              | 1              | 0              | 1              | 0              | 0              | Set Second Pre-charge Period                                                                                    | A[3:0] Set Second Pre-charge Period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
| 1                         | A[3:0]         | *              | *              | *              | *              | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                                                                                                 | 0000b invalid<br>0001b 1 DCLKS<br>0010b 2 DCLKS<br>....<br>1000 8 DCLKS [reset]<br>....<br>1111 15 DCLKS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
|                           |                |                |                |                |                |                |                |                |                |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |
|                           |                |                |                |                |                |                |                |                |                |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |      |             |      |             |      |             |      |             |      |              |      |              |      |              |      |               |      |               |      |               |      |                |        |         |

| 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<br>for Gray Scale<br>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)                                                                                                                                                                                                                                  |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 1                         | A1[7:0]  | A1 <sub>7</sub>                | A1 <sub>6</sub>  | A1 <sub>5</sub>  | A1 <sub>4</sub>  | A1 <sub>3</sub>  | A1 <sub>2</sub>  | A1 <sub>1</sub>  | A1 <sub>0</sub>  |                                                | A1[7:0]: Gamma Setting for GS1,                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 1                         | A2[7:0]  | A2 <sub>7</sub>                | A2 <sub>6</sub>  | A2 <sub>5</sub>  | A2 <sub>4</sub>  | A2 <sub>3</sub>  | A2 <sub>2</sub>  | A2 <sub>1</sub>  | A2 <sub>0</sub>  |                                                | A2[7:0]: Gamma Setting for GS2,                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 1                         | .        | .                              | .                | .                | .                | .                | .                | .                | .                |                                                | :                                                                                                                                                                                                                                                                                                                                                                    |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 1                         | .        | .                              | .                | .                | .                | .                | .                | .                | .                |                                                | :                                                                                                                                                                                                                                                                                                                                                                    |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 1                         | .        | .                              | .                | .                | .                | .                | .                | .                | .                |                                                | :                                                                                                                                                                                                                                                                                                                                                                    |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 1                         | A62[7:0] | A62 <sub>7</sub>               | A62 <sub>6</sub> | A62 <sub>5</sub> | A62 <sub>4</sub> | A62 <sub>3</sub> | A62 <sub>2</sub> | A62 <sub>1</sub> | A62 <sub>0</sub> |                                                | A62[7:0]: Gamma Setting for GS62,                                                                                                                                                                                                                                                                                                                                    |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 1                         | A63[7:0] | A63 <sub>7</sub>               | A63 <sub>6</sub> | A63 <sub>5</sub> | A63 <sub>4</sub> | A63 <sub>3</sub> | A63 <sub>2</sub> | A63 <sub>1</sub> | A63 <sub>0</sub> |                                                | A63[7:0]: Gamma Setting for GS63                                                                                                                                                                                                                                                                                                                                     |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
|                           |          |                                |                  |                  |                  |                  |                  |                  |                  |                                                | <b>Note</b><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.                                                                            |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 0                         | B9       | 1                              | 0                | 1                | 1                | 1                | 0                | 0                | 1                | Use Built-in<br>Linear LUT<br>[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<br>voltage                      | Set pre-charge voltage level.[reset = 17h]                                                                                                                                                                                                                                                                                                                           |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 1                         | A[4:0]   | 0                              | 0                | 0                | A <sub>4</sub>   | A <sub>3</sub>   | A <sub>2</sub>   | A <sub>1</sub>   | A <sub>0</sub>   |                                                | <table><tr><th>A[4:0]</th><th>Hex code</th><th>pre-charge voltage</th></tr><tr><td>00000</td><td>00h</td><td>0.20 x V<sub>CC</sub></td></tr><tr><td>:</td><td>:</td><td>:</td></tr><tr><td>11111</td><td>1Fh</td><td>0.60 x V<sub>CC</sub></td></tr></table>                                                                                                         | A[4:0] | Hex code | pre-charge voltage | 00000 | 00h | 0.20 x V <sub>CC</sub> | : | : | : | 11111 | 1Fh | 0.60 x V <sub>CC</sub>         |   |   |   |     |     |                        |
| A[4:0]                    | Hex code | pre-charge voltage             |                  |                  |                  |                  |                  |                  |                  |                                                |                                                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 00000                     | 00h      | 0.20 x V <sub>CC</sub>         |                  |                  |                  |                  |                  |                  |                  |                                                |                                                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| :                         | :        | :                              |                  |                  |                  |                  |                  |                  |                  |                                                |                                                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 11111                     | 1Fh      | 0.60 x V <sub>CC</sub>         |                  |                  |                  |                  |                  |                  |                  |                                                |                                                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
|                           |          |                                |                  |                  |                  |                  |                  |                  |                  |                                                | <b>Note</b><br>(1) This command is locked by Command FDh by default. To unlock it, please refer to Command FDh.                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 0                         | BE       | 1                              | 0                | 1                | 1                | 1                | 1                | 1                | 0                | Set V <sub>COMH</sub><br>Voltage               | Set COM deselect voltage level [reset = 05h]                                                                                                                                                                                                                                                                                                                         |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 1                         | A[2:0]   | 0                              | 0                | 0                | 0                | 0                | A <sub>2</sub>   | A <sub>1</sub>   | A <sub>0</sub>   |                                                | <table><tr><th>A[2:0]</th><th>Hex code</th><th>V<sub>COMH</sub></th></tr><tr><td>000</td><td>00h</td><td>0.72 x V<sub>CC</sub></td></tr><tr><td>:</td><td>:</td><td>:</td></tr><tr><td>101</td><td>05h</td><td>0.82 x V<sub>CC</sub> [reset]</td></tr><tr><td>:</td><td>:</td><td>:</td></tr><tr><td>111</td><td>07h</td><td>0.86 x V<sub>CC</sub></td></tr></table> | A[2:0] | Hex code | V <sub>COMH</sub>  | 000   | 00h | 0.72 x V <sub>CC</sub> | : | : | : | 101   | 05h | 0.82 x V <sub>CC</sub> [reset] | : | : | : | 111 | 07h | 0.86 x V <sub>CC</sub> |
| A[2:0]                    | Hex code | V <sub>COMH</sub>              |                  |                  |                  |                  |                  |                  |                  |                                                |                                                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 000                       | 00h      | 0.72 x V <sub>CC</sub>         |                  |                  |                  |                  |                  |                  |                  |                                                |                                                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| :                         | :        | :                              |                  |                  |                  |                  |                  |                  |                  |                                                |                                                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 101                       | 05h      | 0.82 x V <sub>CC</sub> [reset] |                  |                  |                  |                  |                  |                  |                  |                                                |                                                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| :                         | :        | :                              |                  |                  |                  |                  |                  |                  |                  |                                                |                                                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
| 111                       | 07h      | 0.86 x V <sub>CC</sub>         |                  |                  |                  |                  |                  |                  |                  |                                                |                                                                                                                                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |
|                           |          |                                |                  |                  |                  |                  |                  |                  |                  |                                                | <b>Note</b><br>(1) This command is locked by Command FDh by default. To unlock it, please refer to Command FDh.                                                                                                                                                                                                                                                      |        |          |                    |       |     |                        |   |   |   |       |     |                                |   |   |   |     |     |                        |

| Fundamental Command Table |        |                |                |                |                |                |                |                |                |                                      |                                                                                                                                                                                                       |
|---------------------------|--------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| D/C#                      | Hex    | D7             | D6             | D5             | D4             | D3             | D2             | D1             | 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]                                                                                                                                                       |
| 1                         | A[7:0] | A <sub>7</sub> | A <sub>6</sub> | A <sub>5</sub> | A <sub>4</sub> | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                      | B[7:0] Contrast Value Color B [reset=01010001b]                                                                                                                                                       |
| 1                         | B[7:0] | B <sub>7</sub> | B <sub>6</sub> | B <sub>5</sub> | B <sub>4</sub> | B <sub>3</sub> | B <sub>2</sub> | B <sub>1</sub> | B <sub>0</sub> |                                      | C[7:0] Contrast Value Color C [reset=10001010b]                                                                                                                                                       |
| 1                         | C[7:0] | C <sub>7</sub> | C <sub>6</sub> | C <sub>5</sub> | C <sub>4</sub> | C <sub>3</sub> | C <sub>2</sub> | C <sub>1</sub> | C <sub>0</sub> |                                      |                                                                                                                                                                                                       |
| 0                         | C7     | 1              | 1              | 0              | 0              | 0              | 1              | 1              | 1              | Master Contrast Current Control      | A[3:0] :                                                                                                                                                                                              |
| 1                         | A[3:0] | *              | *              | *              | *              | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                      | 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] |
| 0                         | CA     | 1              | 1              | 0              | 0              | 1              | 0              | 1              | 0              | Set MUX Ratio                        | A[6:0] MUX ratio 16MUX ~ 128MUX, [reset=127],                                                                                                                                                         |
| 1                         | A[6:0] | 0              | A <sub>6</sub> | A <sub>5</sub> | A <sub>4</sub> | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                      | (Range from 15 to 127)                                                                                                                                                                                |
| 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]                                                                                                                                                           |
| 1                         | A[7:0] | A <sub>7</sub> | A <sub>6</sub> | A <sub>5</sub> | A <sub>4</sub> | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                      | A[7:0] = 12b, Unlock OLED driver IC MCU interface from entering command [reset]                                                                                                                       |
|                           |        |                |                |                |                |                |                |                |                |                                      | A[7:0] = 16b, Lock OLED driver IC MCU interface from entering command                                                                                                                                 |
|                           |        |                |                |                |                |                |                |                |                |                                      | 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                                   |
|                           |        |                |                |                |                |                |                |                |                |                                      | <b>Note</b><br>(1) The locked OLED driver IC MCU interface prohibits all commands and memory access except the FDh command.                                                                           |

#### 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             | D1             | D0             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 0                            | 96     | 1              | 0              | 0              | 1              | 0              | 1              | 1              | 0              | Horizontal Scroll                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 1                            | A[7:0] | A <sub>7</sub> | A <sub>6</sub> | A <sub>5</sub> | A <sub>4</sub> | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 1                            | B[6:0] | 0              | B <sub>6</sub> | B <sub>5</sub> | B <sub>4</sub> | B <sub>3</sub> | B <sub>2</sub> | B <sub>1</sub> | B <sub>0</sub> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 1                            | C[7:0] | C <sub>7</sub> | C <sub>6</sub> | C <sub>5</sub> | C <sub>4</sub> | C <sub>3</sub> | C <sub>2</sub> | C <sub>1</sub> | C <sub>0</sub> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 1                            | D[6:0] | 0              | D <sub>6</sub> | D <sub>5</sub> | D <sub>4</sub> | D <sub>3</sub> | D <sub>2</sub> | D <sub>1</sub> | D <sub>0</sub> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 1                            | E[1:0] | 0              | 0              | 0              | 0              | 0              | 0              | E <sub>1</sub> | E <sub>0</sub> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                              |        |                |                |                |                |                |                |                |                | 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><br><b>Note</b><br><sup>(1)</sup> Operates during display ON. |
| 0                            | 9E     | 1              | 0              | 0              | 1              | 1              | 1              | 1              | 0              | Stop Moving                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                              |        |                |                |                |                |                |                |                |                | <b>Note</b><br><sup>(1)</sup> 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**

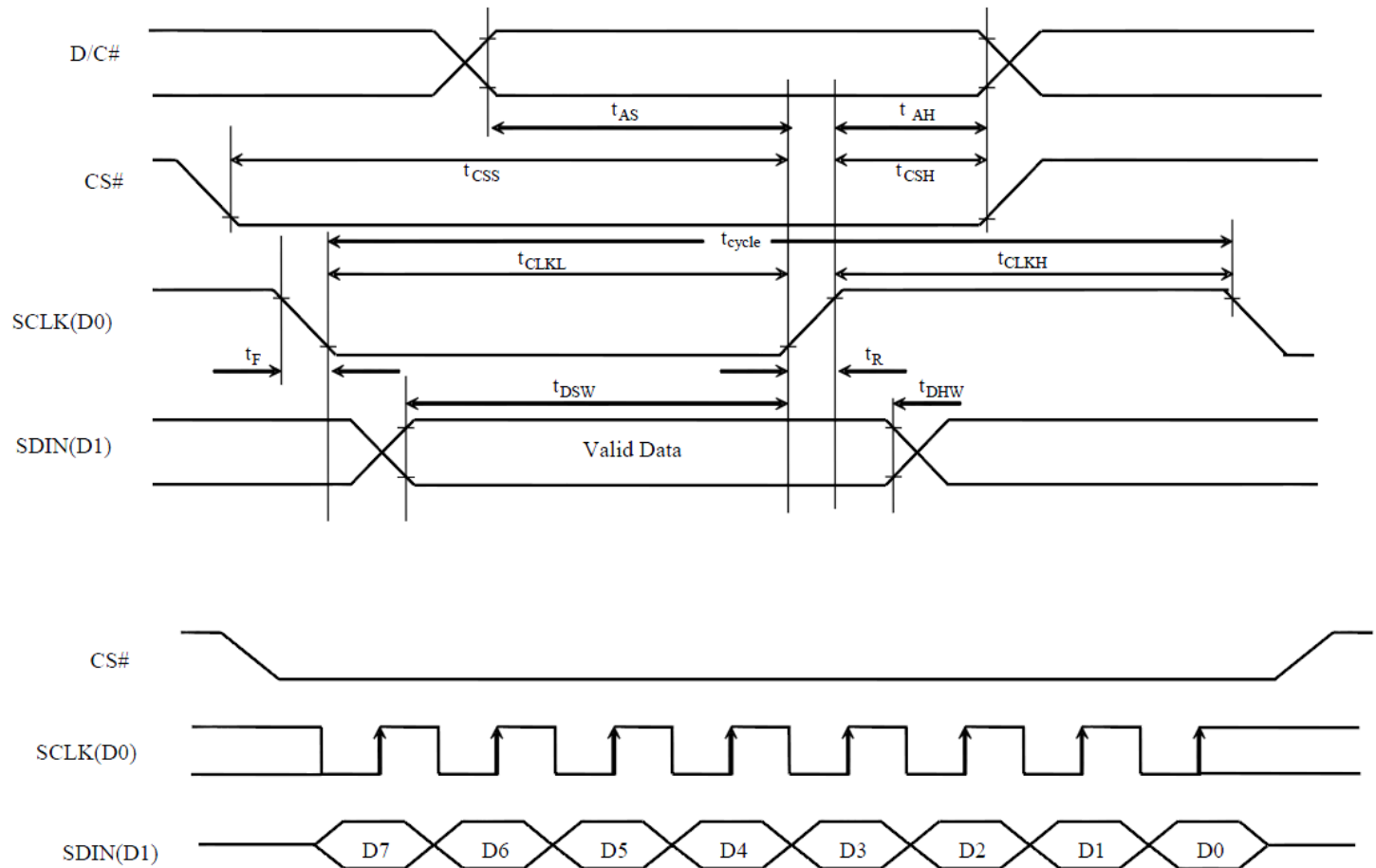
<sup>(1)</sup> After executed the graphic command, waiting time is required for update GDDRAM content.  
 V<sub>CI</sub> = 2.4~3.5V, waiting time = 500ns/pixel.

<sup>(2)</sup> “\*” stands for “Don’t care”.

## Timing Characteristics

### 4-wire SPI:

| Symbol             | Parameter              | Min | Typ | Max | Unit |
|--------------------|------------------------|-----|-----|-----|------|
| $t_{\text{cycle}}$ | Clock Cycle Time       | 220 | -   | -   | ns   |
| $t_{\text{AS}}$    | Address Setup Time     | 15  | -   | -   | ns   |
| $t_{\text{AH}}$    | Address Hold Time      | 42  | -   | -   | ns   |
| $t_{\text{CSS}}$   | Chip Select Setup Time | 20  | -   | -   | ns   |
| $t_{\text{CSH}}$   | Chip Select Hold Time  | 10  | -   | -   | ns   |
| $t_{\text{DSW}}$   | Write Data Setup Time  | 15  | -   | -   | ns   |
| $t_{\text{DHW}}$   | Write Data Hold Time   | 20  | -   | -   | ns   |
| $t_{\text{CLKL}}$  | Clock Low Time         | 20  | -   | -   | ns   |
| $t_{\text{CLKH}}$  | Clock High Time        | 20  | -   | -   | ns   |
| $t_{\text{R}}$     | Rise Time              | -   | -   | 15  | ns   |
| $t_{\text{F}}$     | 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](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](http://www.newhavendisplay.com/specs/precautions.pdf)

## Warranty Information and Terms & Conditions

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