

NHD-2.23-12832UMB3

OLED Display Module

| | |
|--------|----------------------------------|
| NHD- | Newhaven Display |
| 2.23- | 2.23" Diagonal Size |
| 12832- | 128 x 32 Pixel Resolution |
| UM- | Model – Includes Multi-Font Chip |
| B- | Emitting Color: Blue |
| 3- | +3V Power Supply |

Functions and Features

- 128 x 32 pixel resolution
- Built-in SSD1305 controller
- Parallel or serial MPU interface
- Single, low voltage power supply
- RoHS compliant
- Multi-Language Fonts built-in

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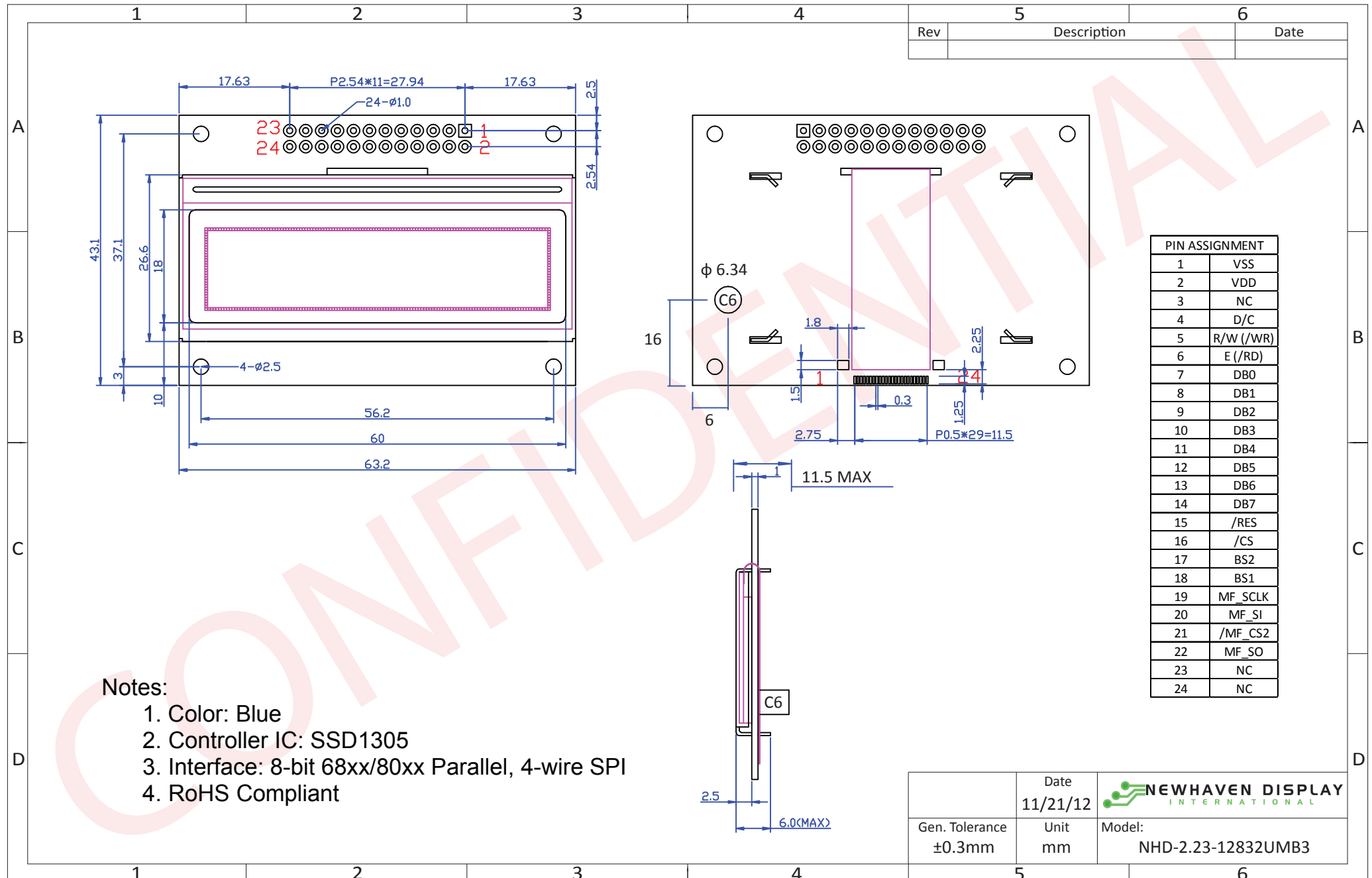
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1. Document Revision History

| Revision | Date | Description | Changed by |
|----------|------------|------------------------------------|------------|
| 0 | 10/15/2012 | Preliminary Release | - |
| 1 | 11/5/2012 | Initial Product Release | - |
| 2 | 9/10/2014 | Electrical Characteristics updated | ML |

2. Mechanical Drawing



Notes:

1. Color: Blue
2. Controller IC: SSD1305
3. Interface: 8-bit 68xx/80xx Parallel, 4-wire SPI
4. RoHS Compliant

| | | |
|--------------------|----------|--|
| | Date | NEWHAVEN DISPLAY INTERNATIONAL |
| | 11/21/12 | |
| Gen. Tolerance | Unit | Model: |
| $\pm 0.3\text{mm}$ | mm | NHD-2.23-12832UMB3 |

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3. Interface Description

3.1. Parallel Interface:

| Pin No. | Symbol | External Connection | Function Description |
|---------|------------|---------------------|---|
| 1 | VSS | Power Supply | Ground |
| 2 | VDD | Power Supply | Supply Voltage for OLED and logic. |
| 3 | NC | - | No Connect |
| 4 | D/C | MPU | Register select signal. D/C=0: Command, D/C=1: Data |
| 5 | R/W or /WR | MPU | 6800-interface: Read/Write select signal, R/W=1: Read R/W:=0: Write 8080-interface: Active LOW Write signal. |
| 6 | E or /RD | MPU | 6800-interface: Operation enable signal. Falling edge triggered. 8080-interface: Active LOW Read signal. |
| 7-14 | DB0 – DB7 | MPU | 8-bit Bi-directional data bus lines. |
| 15 | /RES | MPU | Active LOW Reset signal. |
| 16 | /CS | MPU | Active LOW Chip Enable signal. |
| 17 | BS2 | MPU | MPU Interface Select signal. |
| 18 | BS1 | MPU | MPU Interface Select signal. |
| 19 | MF_SCLK | MPU | Multi-font IC Serial Clock Input |
| 20 | MF_SI | MPU | Multi-font IC Serial Data Input |
| 21 | /MF_CS2 | MPU | Multi-font IC Active LOW Chip Enable signal. |
| 22 | MF_SO | MPU | Multi-font IC Serial Data Output |
| 23 | NC | - | No Connect |
| 24 | NC | - | No Connect |

3.2. Serial Interface:

| Pin No. | Symbol | External Connection | Function Description |
|---------|---------|---------------------|---|
| 1 | VSS | Power Supply | Ground |
| 2 | VDD | Power Supply | Supply Voltage for OLED and logic. |
| 3 | NC | - | No Connect |
| 4 | D/C | MPU | Register select signal. D/C=0: Command, D/C=1: Data |
| 5-6 | VSS | Power Supply | Ground |
| 7 | SCLK | MPU | Serial Clock signal. |
| 8 | SDIN | MPU | Serial Data Input signal. |
| 9 | NC | - | No Connect |
| 10-14 | VSS | Power Supply | Ground |
| 15 | /RES | MPU | Active LOW Reset signal. |
| 16 | /CS | MPU | Active LOW Chip Enable signal. |
| 17 | BS2 | MPU | MPU Interface Select signal. |
| 18 | BS1 | MPU | MPU Interface Select signal. |
| 19 | MF_SCLK | MPU | Multi-font IC Serial Clock Input |
| 20 | MF_SI | MPU | Multi-font IC Serial Data Input |
| 21 | /MF_CS2 | MPU | Multi-font IC Active LOW Chip Enable signal. |
| 22 | MF_SO | MPU | Multi-font IC Serial Data Output |
| 23 | NC | - | No Connect |
| 24 | NC | - | No Connect |

3.3. I²C Interface:

| Pin No. | Symbol | External Connection | Function Description |
|---------|--------------------|---------------------|---|
| 1 | VSS | Power Supply | Ground |
| 2 | VDD | Power Supply | Supply Voltage for OLED and logic. |
| 3 | NC | - | No Connect |
| 4 | SA0 | MPU | Slave Address Selection signal. |
| 5-6 | VSS | Power Supply | Ground |
| 7 | SCL | MPU | Serial Clock signal. |
| 8 | SDA _{IN} | MPU | Serial Data input signal (pins 8 and 9 can be tied together). |
| 9 | SDA _{OUT} | MPU | Serial Data output signal (pin9 can be no connect). |
| 10-14 | VSS | Power Supply | Ground |
| 15 | /RES | MPU | Active LOW Reset signal. |
| 16 | /CS | MPU | Active LOW Chip Enable signal. |
| 17 | BS2 | MPU | MPU Interface Select signal. |
| 18 | BS1 | MPU | MPU Interface Select signal. |
| 19 | MF_SI | MPU | Multi-font IC Serial Data Input |
| 20 | MF_SCLK | MPU | Multi-font IC Serial Clock Input |
| 21 | /MF_CS2 | MPU | Multi-font IC Active LOW Chip Enable signal. |
| 22 | MF_SO | MPU | Multi-font IC Serial Data Output |
| 23 | NC | - | No Connect |
| 24 | NC | - | No Connect |

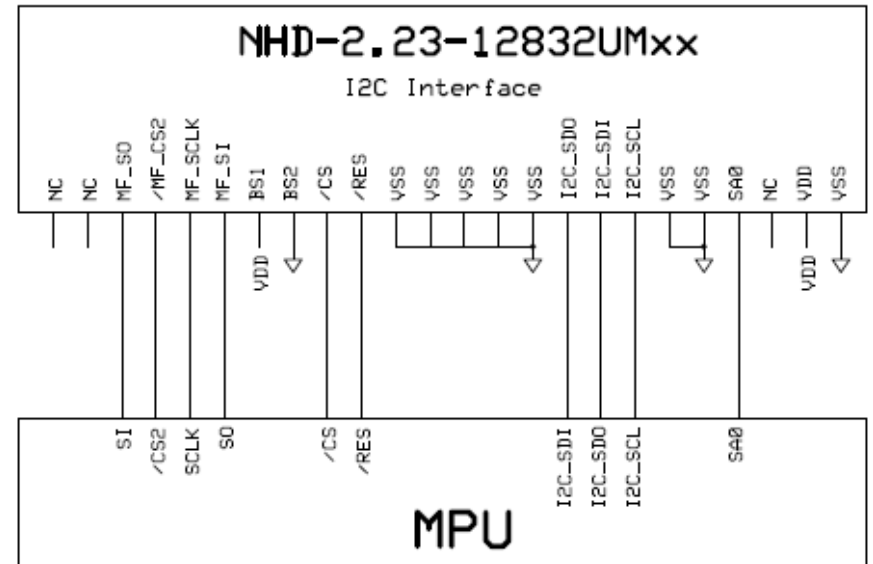
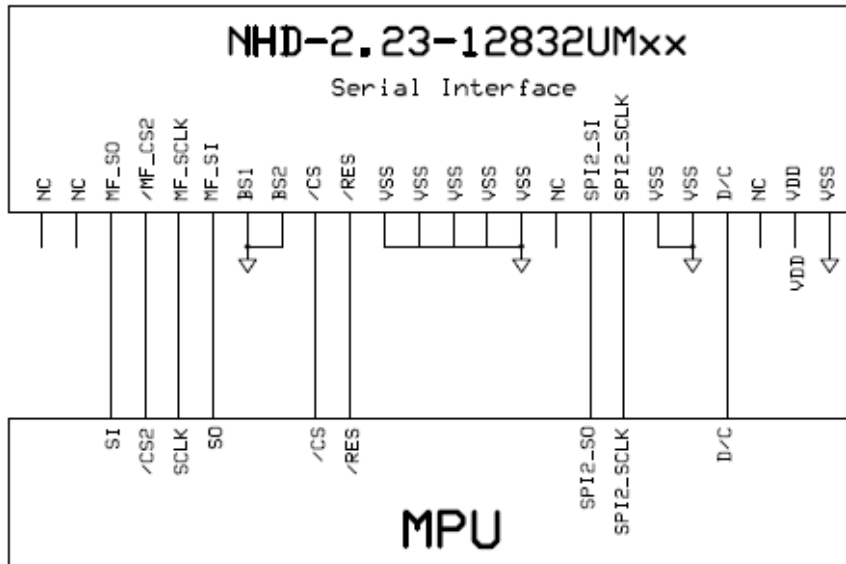
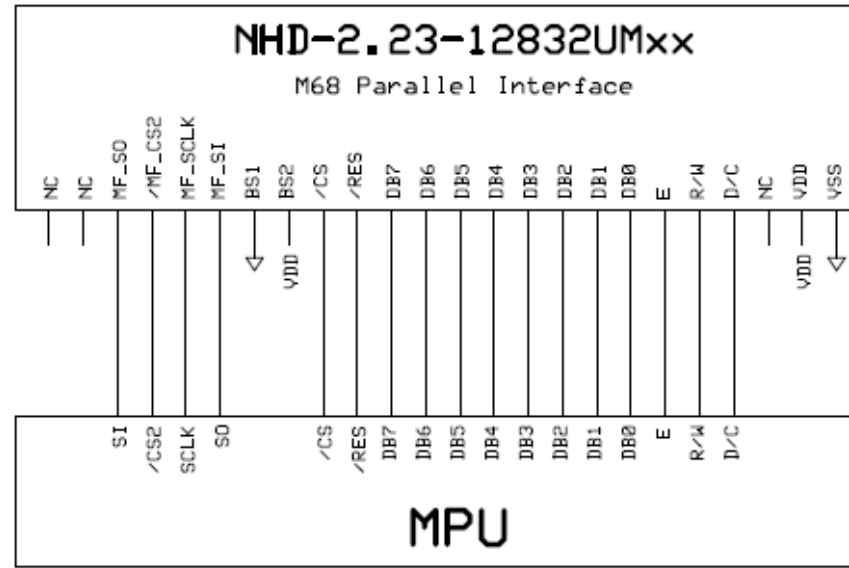
3.4. MPU Interface Pin Selections

| Pin Name | 6800 Parallel 8-bit interface | 8080 Parallel 8-bit interface | Serial Interface | I2C Interface |
|----------|-------------------------------|-------------------------------|------------------|---------------|
| BS2 | 1 | 1 | 0 | 0 |
| BS1 | 0 | 1 | 0 | 1 |

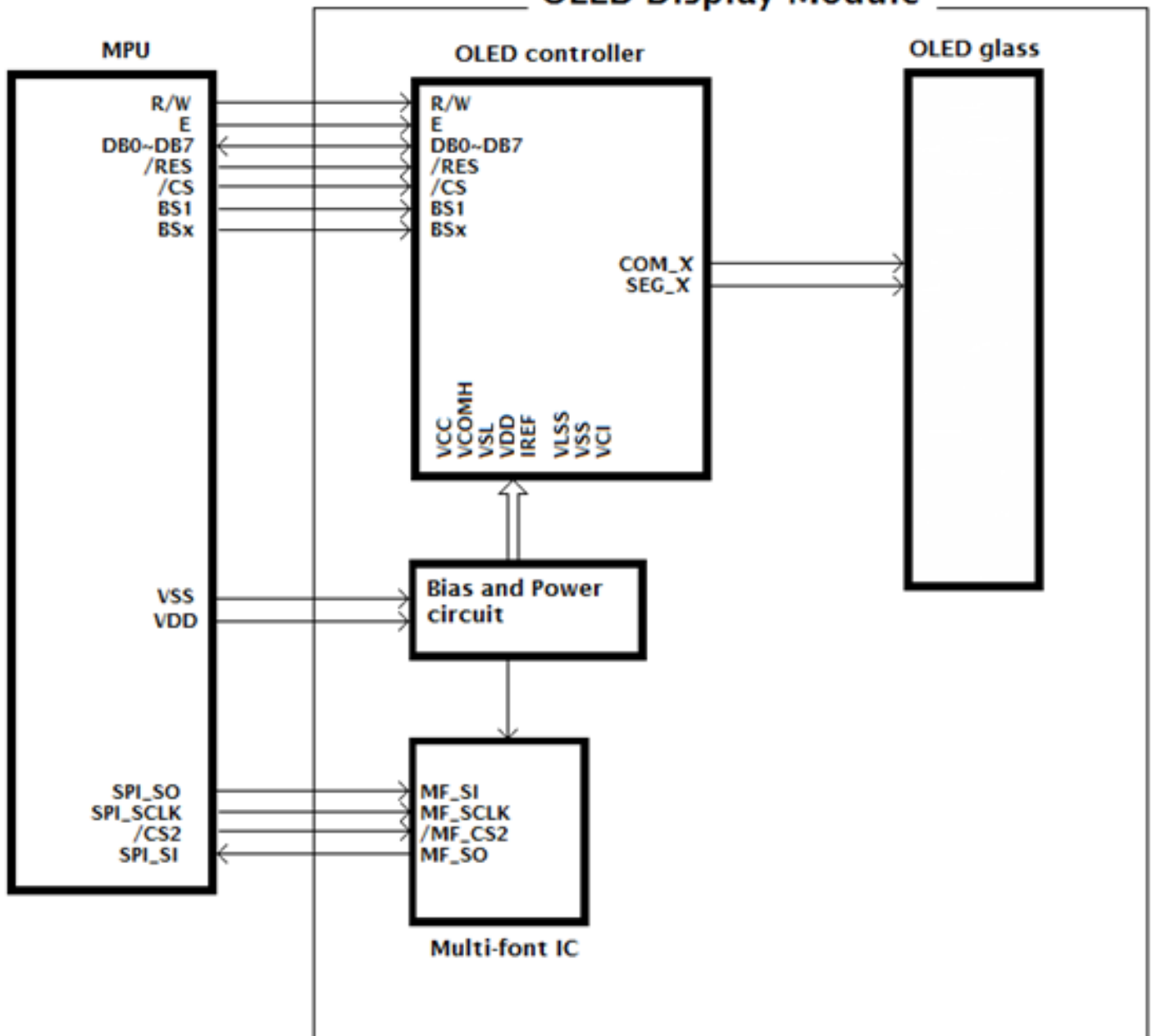
3.5. MPU Interface Pin Assignment Summary

| Bus Interface | Data/Command Interface | | | | | | | | Control Signals | | | | |
|---------------|------------------------|----|----|----|-------------------|--------------------|------|---------|-----------------|-----|-----|------|------|
| | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | E | s/W | /CS | D/C | /RES |
| 8-bit 6800 | D[7:0] | | | | | | | | E | R/W | /CS | D/C | /RES |
| 8-bit 8080 | D[7:0] | | | | | | | | /RD | /WR | /CS | D/C | /RES |
| SPI | Tie LOW | | | | NC | SDIN | SCLK | Tie LOW | | /CS | D/C | /RES | |
| I2C | Tie LOW | | | | SDA _{IN} | SDA _{OUT} | SCL | Tie LOW | | | SA0 | /RES | |

4. Wiring Diagrams



OLED Display Module



5. Electrical Characteristics

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|-----------------------------|----------------------|-------------------|---------|------|---------|------|
| Operating Temperature Range | Top | Absolute Max | -20 | - | +70 | °C |
| Storage Temperature Range | Tst | Absolute Max | -40 | - | +90 | °C |
| Supply Voltage | VDD | | - | 3.3 | 3.5 | V |
| Supply Current | IDD | VDD=3.3V, 50% ON | - | 77 | 90 | mA |
| | | VDD=3.3V, 100% ON | - | 128 | 140 | mA |
| Sleep Mode Current | IDD _{SLEEP} | | - | 4 | 17 | μA |
| “H” Level input | Vih | | 0.8*VDD | - | VDD | V |
| “L” Level input | Vil | | VSS | - | 0.2*VDD | V |
| “H” Level output | Voh | | 0.9*VDD | - | VDD | V |
| “L” Level output | Vol | | VSS | - | 0.1*VDD | V |

6. Optical Characteristics

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|------------------------------------|--------|---------------------------|--------|------|------|-------------------|
| Viewing Angle – Vertical (top) | AV | | 80 | - | - | ° |
| Viewing Angle – Vertical (bottom) | AV | | 80 | - | - | ° |
| Viewing Angle – Horizontal (left) | AH | | 80 | - | - | ° |
| Viewing Angle – Horizontal (right) | AH | | 80 | - | - | ° |
| Contrast Ratio | Cr | | 2000:1 | - | - | - |
| Response Time (rise) | Tr | - | - | 10 | - | us |
| Response Time (fall) | Tf | - | - | 10 | - | us |
| Brightness | | 50% checkerboard | 100 | 120 | - | cd/m ² |
| Lifetime | | 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.

7. Font Content Address Table

| # | Type | Font Content | Character Set | Number of Characters | Base Address (decimal) | Base Address (hex) |
|----|-----------------------|----------------------------|---------------------|----------------------|------------------------|--------------------|
| 1 | ASCII | 5x7 ASCII | ASCII | 96 | 0 | 000000 |
| 2 | | 7x8 ASCII | ASCII | 96 | 768 | 000300 |
| 3 | | 8x16 BOLD ASCII | ASCII | 96 | 1,536 | 000600 |
| 4 | | Width-adjusted Arial ASCII | ASCII | 96 | 3,072 | 000C00 |
| 5 | | 8x16 Latin | Basic | 96 | 6,336 | 0018C0 |
| 6 | | 8x16 Latin | Supplement | 96 | 7,872 | 001EC0 |
| 7 | | 8x16 Latin | Extended A | 128 | 9,408 | 0024C0 |
| 8 | | 8x16 Latin | Extended B | 80 | 11,456 | 002CC0 |
| 9 | | 8x16 Latin | Extended Additional | 96 | 12,736 | 0031C0 |
| 10 | | 8x16 Greek | Basic | 96 | 14,272 | 0037C0 |
| 11 | UNICODE | 8x16 Cyrillic | Basic | 208 | 15,808 | 003DC0 |
| 12 | | 8x16 Hebrew | Basic | 112 | 19,136 | 004AC0 |
| 13 | | 8x16 Thai | Basic | 128 | 20,928 | 0051C0 |
| 14 | | Width-adjusted Latin | Basic | 96 | 22,976 | 0059C0 |
| 15 | | Width-adjusted Latin | Supplement | 96 | 26,240 | 006680 |
| 16 | | Width-adjusted Latin | Extended A | 128 | 29,504 | 007340 |
| 17 | | Width-adjusted Latin | Extended B | 80 | 33,856 | 008440 |
| 18 | | Width-adjusted Latin | Extended Additional | 96 | 36,576 | 008EE0 |
| 19 | | Width-adjusted Greek | Basic | 96 | 39,840 | 009BA0 |
| 20 | | Width-adjusted Cyrillic | Basic | 208 | 43,104 | 00A860 |
| 21 | Width-adjusted Arabic | Basic | 576 | 50,176 | 00C400 | |
| 22 | CJK | GB2312 | | 7,614 | 69,760 | 011080 |
| 23 | | KSC5605 | | 6,500 | 379,744 | 05CB60 |
| 24 | | JIS0208 | | 7,999 | 490,624 | 077C80 |
| 25 | LCM | 5x7 ISO8859 | | 1,792 | 946,992 | 0E7330 |
| 26 | | LCM 5x10 | | 1,792 | 961,328 | 0EAB30 |

8. Supported Languages

| Language Family | Area | Country | Language |
|--------------------|---------------|-----------------------|-----------------|
| Latin (English) | Europe | United Kingdom | English |
| | | Ireland | |
| | North America | USA | English |
| | | Canada | English, French |
| | | Belize | English |
| | | Jamaica | |
| | | Trinidad and Tobago | |
| | | Bahamas | |
| | | Antigua and Barbuda | |
| | | Dominica | |
| | | St. Vincent | |
| | | St. Lucia | |
| | | Grenada | |
| | | St. Kitts-Nevis | |
| | South Africa | Guyana | |
| | Australia | Australia | English |
| | | New Zealand | |
| | | Tonga | |
| | | Fiji | |
| | | Palau | |
| | | Solomon | |
| | | Vanuatu | |
| | | Kiribati | |
| | | Nauru | |
| | | Marshall Islands | |
| | | Africa | |
| | Zimbabwe | | English |
| | Gambia | | |
| Sierra Leone | | | |
| Liberia | | | |
| Ghana | | | |
| Nigeria | | | |
| Uganda | | | |
| Zambia | | | |
| Malawi | | | |
| Seychelles | | | |
| Mauritius | | | |
| Botswana | | | |
| Namibia | | | |
| Lesotho | | | |
| Latin (Portuguese) | Europe | Portugal | Portuguese |
| | South America | Brazil | |
| | | Cape Verde | |
| | Africa | Guinea-Bissau | |
| | | Sao Tome and Principe | |
| Angola | | | |
| Mozambique | | | |
| Latin (German) | Europe | Germany | German |
| | | Switzerland | German, French |
| | | Austria | German |
| | | Luxembourg | German, |

| Language Family | Area | Country | Language | |
|-----------------------|--------------------|------------------------------|------------------|---------|
| Latin (French) | Europe | France | French | |
| | | Belgium | French, Dutch | |
| | | Monaco | French, Italian | |
| | North America | Haiti | French | |
| | Africa | Senegal | French | |
| | | Mali | | |
| | | Burkina Faso | | |
| | | Guinea | | |
| | | Cote d'Ivoire | | |
| | | Togo | | |
| | | Benin | | |
| | | Niger | | |
| | | Cameroon | | |
| | | Chad | | |
| | | Central African Republic | | |
| | | Djibouti | | |
| | | Burundi | | |
| | | Republic of Democratic Congo | | |
| | | Congo | | |
| | | Gabon | | |
| Comoros | | | | |
| Madagascar | | | | |
| Latin (Spanish) | Europe | Spain | Spanish, Catalan | |
| | | Andorra | Spanish | |
| North America | Mexico | Spanish | | |
| | Guatemala | | | |
| | Costa Rica | | | |
| | Panama | | | |
| | Dominican Republic | | | |
| | El Salvador | | | |
| | Honduras | | | |
| | Nicaragua | | | |
| | Puerto Rico | | | |
| | Cuba | | | |
| | South America | | Venezuela | Spanish |
| | | | Colombia | |
| | | | Peru | |
| | | | Argentina | |
| Ecuador | | | | |
| Chile | | | | |
| Uruguay | | | | |
| Paraguay | | | | |
| Bolivia | | | | |
| Africa | New Guinea | Spanish | | |
| | Ceuta and Melilla | | | |
| Latin (Nordic Europe) | Europe | Denmark | Danish | |
| | | Norway | Norwegian | |
| | | Sweden | Swedish | |
| | | Faroes | Faroese | |
| | | Greenland | Greenlandic | |
| Iceland | Icelandic | | | |

| | | | |
|-------------------------|---------------|----------------------|------------------|
| | | Liechtenstein | French |
| | | Holland | German |
| Latin (Dutch) | Europe | | Dutch |
| | South America | Surinam | |
| Latin (Central Europe) | Europe | Czech | Czech |
| | | Slovakia | Slovak |
| | | Poland | Polish |
| | | Hungary | Hungarian |
| | | Romania | Romanian |
| | | Slovenia | Slovenian |
| Latin (Southern Europe) | Europe | Italy | Italian |
| | | San Marino | |
| | | Vatican | |
| | | Turkey | Turkish |
| | | Malta | Maltese |
| | | Albania | Albanian |
| Latin (Southeast Asia) | Asia | Vietnam | Vietnamese |
| | | Malaysia | Malaysian |
| | | Brunei | |
| | | Indonesia | Indonesian |
| | | East Timor | |
| | | Philippines | English, Tagalog |
| Arabic (Africa) | Africa | Egypt | Arabic |
| | | Tunisia | |
| | | Libya | |
| | | Morocco | |
| | | Algeria | |
| | | Sudan | |
| | | Somalia | |
| | | Djibouti | |
| | | Mauritania | |
| Arabic (Asia) | Asia | Syria | Arabic |
| | | United Arab Emirates | |
| | | Lebanon | |
| | | Yemen | |
| | | Kuwait | |
| | | Qatar | |
| | | Bahrain | |
| | | Oman | |
| | | Jordan | |
| | | Iraq | |
| | | Saudi Arabia | |
| | | Palestine | |
| | | Iran | |
| | | Pakistan | Urdu, Arabic |
| Afghanistan | Pashto | | |

| | | | |
|---------------------------|--------|--------------|-------------------|
| | | Finland | Finnish, Swedish |
| | | Estonia | Estonian |
| | | Latvia | Latvian |
| | | Lithuania | Lithuanian |
| Cyrillic (Eastern Europe) | Europe | Russia | Russian |
| | | Belarus | |
| | | Ukraine | Russian Ukrainian |
| | | Bulgaria | Bulgarian |
| | | Moldova | Russian |
| | | Yugoslavia | Serbian |
| | | Barbados | |
| | | Macedonia | Macedonian |
| Cyrillic (Asia) | Asia | Azerbaijan | Azeri |
| | | Kirghizstan | Kyrgyz |
| | | Tajikistan | Tajik |
| | | Turkmenistan | Turkmen |
| | | Uzbekistan | Uzbek |
| | | Kazakhstan | Kazakh |
| | | Mongolia | Mongolian |
| Greek | Europe | Greece | Greek |
| | | Cyprus | |
| Latin (Africa) | Africa | Kenya | Kiswahili |
| | | Tanzania | |
| Hebrew | Asia | Israel | Hebrew |
| Thai | Asia | Thailand | Thai |
| Japan | Asia | Japan | Japanese |
| Korea | Asia | Korea | Korean |
| China | Asia | China | Chinese |
| | | Singapore | |

9. OLED controller Instruction Table (Built-In SSD1305 Controller/Driver)

| Instruction | Code | | | | | | | | | | Description | RESET value |
|--|------|--|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---|------------------------------|
| | D/C | HEX | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 | | |
| Set Lower Column Start Address | 0 | 00~0F | 0 | 0 | 0 | 0 | X3 | X2 | X1 | X0 | Set the lower nibble of the column start address register for Page Addressing Mode. | 0 |
| Set Higher Column Start Address | 0 | 10~1F | 0 | 0 | 0 | 1 | X3 | X2 | X1 | X0 | Set the higher nibble of the column start address register for Page Addressing Mode. | 0 |
| Set Memory Addressing Mode | 0 | 20 A[1:0] | 0 * | 0 * | 1 * | 0 * | 0 * | 0 * | 0 A1 | 0 A0 | A[1:0] = 00b, Horizontal Addressing Mode A[1:0] = 01b, Vertical Addressing Mode A[1:0] = 10b, Page Addressing Mode A[1:0] = 11b, Invalid | 10b |
| Set Column Address | 0 | 21 A[7:0] B[7:0] | 0 A7 B7 | 0 A6 B6 | 1 A5 B5 | 0 A4 B4 | 0 A3 B3 | 0 A2 B2 | 0 A1 B1 | 1 A0 B0 | Setup column start and end address A[7:0]: Column start address. Range: 0-131d B[7:0]: Column end address. Range: 0-131d | 0 131d |
| Set Page Address | 0 | 22 A[2:0] B[2:0] | 0 * * | 0 * * | 1 * * | 0 * * | 0 * * | 0 A2 B2 | 1 A1 B1 | 0 A0 B0 | Setup page start and end address A[2:0]: Page start address. Range: 0-7d B[2:0]: Page end address. Range: 0-7d | 0 7d |
| Set Display Start Line | 0 | 40~7F | 0 | 1 | X5 | X4 | X3 | X2 | X1 | X0 | Set display RAM display start line register from 0-63d. | 0 |
| Set Contrast Control | 0 | 81 A[7:0] | 1 A7 | 0 A6 | 0 A5 | 0 A4 | 0 A3 | 0 A2 | 0 A1 | 1 A0 | Double byte command to select 1 out of 256 contrast steps. Contrast increases as the value increases. | 0x80 |
| Set Brightness | 0 | 82 A[7:0] | 1 A7 | 0 A6 | 0 A5 | 0 A4 | 0 A3 | 0 A2 | 1 A1 | 0 A0 | Double byte command to select 1 out of 256 brightness steps. Brightness increases as the value increases. | 0x80 |
| Set Look-Up Table | 0 | 91 X[5:0] A[5:0] B[5:0] C[5:0] | 1 * * * * | 0 * * * * | 0 X5 A5 B5 C5 | 1 X4 A4 B4 C4 | 0 X3 A3 B3 C3 | 0 X2 A2 B2 C2 | 0 X1 A1 B1 C1 | 1 X0 A0 B0 C0 | Set current drive pulse width of Bank 0, Color A, B and C. Bank 0: X[5:0] = 31 to 63. Pulse width set to 32 to 64 clocks. Color A: X[5:0] = 31 to 63. Pulse width set to 32 to 64 clocks. Color B: X[5:0] = 31 to 63. Pulse width set to 32 to 64 clocks. Color C: X[5:0] = 31 to 63. Pulse width set to 32 to 64 clocks. Note: Color D pulse width is fixed at 64 clocks. | 0x31 0x3F 0x3F 0x3F |
| Set Bank Color of Bank1 to Bank16 (Page 0) | 0 | 92 A[7:0] B[7:0] C[7:0] D[7:0] | 1 A7 B7 C7 D7 | 0 A6 B6 C6 D6 | 0 A5 B5 C5 D5 | 1 A4 B4 C4 D4 | 0 A3 B3 C3 D3 | 0 A2 B2 C2 D2 | 1 A1 B1 C1 D1 | 0 A0 B0 C0 D0 | Sets the bank color of Bank1~Bank16 to any one of the 4 colors A,B,C, and D. A[1:0] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK1. A[3:2] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK2. . . . D[5:4] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK15. D[7:6] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK16. | |
| Set Bank Color of Bank17 to Bank32 | 0 | 93 A[7:0] | 1 A7 | 0 A6 | 0 A5 | 1 A4 | 0 A3 | 0 A2 | 1 A1 | 1 A0 | Sets the bank color of Bank17~Bank32 to any one of the 4 colors A,B,C, and D. A[1:0] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK17. | |

| | | | | | | | | | | | | |
|--|---|--|---|---|---|---|---|---|---|---|--|----------------|
| (Page 1) | | B[7:0] C[7:0] D[7:0] | B7 C7 D7 | B6 C6 D6 | B5 C5 D5 | B4 C4 D4 | B3 C3 D3 | B2 C2 D2 | B1 C1 D1 | B0 C0 D0 | A[3:2] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK18. . . . D[5:4] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK31. D[7:6] : 00b, 01b, 10b, or 11b for Color = A, B, C, or D of BANK32. | |
| Set Segment Remap | 0 | A0/A1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | X0 | X[0] = 0; Column address 0 is mapped to SEG0 X[0] = 1; Column address 131 is mapped to SEG0 | 0 |
| Entire Display ON | 0 | A4/A5 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | X0 | X[0] = 0; Resume RAM content display. Output follows RAM content. X[0] = 1; Entire display ON. Output ignores RAM content. | 0 |
| Set Normal/ Inverse Display | 0 | A6/A7 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | X0 | X[0] = 0; Normal display. X[0] = 1; Inverse display. | 0 |
| Set Multiplex Ratio | 0 | A8 A[5:0] | 1 * | 0 * | 1 A5 | 0 A4 | 1 A3 | 0 A2 | 0 A1 | 0 A0 | Set MUX ratio to N+1 MUX N=A[5:0]; from 16MUX to 64MUX (0 to 14 are invalid) | 64 |
| Dim mode setting | 0 | AB A[3:0] B[7:0] C[7:0] | 1 * B7 C7 | 0 * B6 C6 | 1 * B5 C5 | 0 * B4 C4 | 1 A3 B3 C3 | 0 A2 B2 C2 | 1 A1 B1 C1 | 1 A0 B0 C0 | A[3:0] = reserved. Set as 0000b B[7:0] = Set contrast for BANK0. Range 0-255d. Refer to command 81h. C[7:0] = Set brightness for color bank. Range 0-255d. Refer to command 82h. | |
| Master configuration | 0 | AD AE | 1 1 | 0 0 | 1 0 | 0 0 | 1 1 | 1 1 | 0 1 | 1 0 | Selects external VCC supply | AEh |
| Set Display ON/ OFF | 0 | AC/ AE/ AF | 1 | 0 | 1 | 0 | 1 | 1 | A1 | A0 | ACh = Display ON in dim mode AEh = Display OFF (sleep mode) AFh = Display ON in normal mode | AEh |
| Set Page Start Address | 0 | B0~B7 | 1 | 0 | 1 | 1 | 0 | X2 | X1 | X0 | Set GDRAM Page Start Address for Page Addressing Mode using X[2:0]. PAGE0~PAGE7 | |
| Set COM Output Scan Direction | 0 | C0/C8 | 1 | 1 | 0 | 0 | X3 | 0 | 0 | 0 | X[3] = 0; Normal mode. Scan from COM0 to COM[N-1] X[3] = 1; Remapped mode. Scan from COM[N-1] to COM0 | 0 |
| Set Display Offset | 0 | D3 A[5:0] | 1 * | 1 * | 0 A5 | 1 A4 | 0 A3 | 0 A2 | 1 A1 | 1 A0 | Set vertical shift by COM from 0~63. | 0 |
| Set Display Clock Divide Ratio / Oscillator Frequency | 0 | D5 A[7:0] | 1 A7 | 1 A6 | 0 A5 | 1 A4 | 0 A3 | 1 A2 | 0 A1 | 1 A0 | A[3:0] = Define the divide ratio of the display clocks. Divide ratio = A[3:0] +1 A[7:4] = Set the Oscillator Frequency. Frequency increases with the value of A[7:4]. Range 0000b~1111b. | 0000b 0111b |
| Set Area Color Mode ON/OFF & Low Power Display Mode | 0 | D8 X[5:0] | 1 0 | 1 0 | 0 X5 | 1 X4 | 1 0 | 0 X2 | 0 0 | 0 X0 | X[5:4] = 00b; Monochrome mode X[5:4] = 11b; Area Color mode X[2] = 0 and X[0] = 0; Normal power mode X[2] = 1 and X[0] = 1; Set low power display mode | 00 00 |
| Set Pre-charge Period | 0 | D9 A[7:0] | 1 A7 | 1 A6 | 0 A5 | 1 A4 | 1 A3 | 0 A2 | 0 A1 | 1 A0 | A[3:0] = Phase 1 period of up to 15 DCLK clocks. 0 is invalid. A[7:4] = Phase 2 period of up to 15 DCLK clocks. 0 is invalid. | 2h 2h |
| Set COM pins | 0 | DA | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | X[4] = 0; Sequential COM pin configuration | |

| | | | | | | | | | | | | |
|------------------------------|---|----------------------------|----------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------|----------------------|--|--------|
| Hardware configuration | | X[5:4] | 0 | 0 | X5 | X4 | 0 | 0 | 1 | 0 | X[4] = 1; Alternative COM pin configuration X[5] = 0; Disable COM Left/Right remap X[5] = 1; Enable COM Left/Right remap | 1 1 |
| Set VCOMH Deselect Level | 0 | DB A[5:2] | 1 0 | 1 0 | 0 A5 | 1 A4 | 1 A3 | 0 A2 | 1 0 | 1 0 | A[5:2] = 0000b; VCOMH = ~0.43*VCC A[5:2] = 1101b; VCOMH = ~0.77*VCC A[5:2] = 1111b; VCOMH = ~0.83*VCC | 1101 |
| Enter Read Modify Write mode | 0 | E0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | Enter the Read/Modify/Write mode. | |
| NOP | 0 | E3 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | Command for No Operation | |
| Exit Read Modify Write mode | 0 | EE | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | Exit the Read/Modify/Write mode. | |

For detailed instruction information, see datasheet: http://www.newhavendisplay.com/app_notes/SSD1305.pdf

10. OLED Controller -> MPU Interface

For detailed timing information, see datasheet: http://www.newhavendisplay.com/app_notes/SSD1305.pdf

10.1. 6800-MPU Parallel Interface

The parallel interface consists of 8 bi-directional data pins, R/W, D/C, E, and /CS.

A LOW on R/W indicates write operation, and HIGH on R/W indicates read operation.

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

The E input serves as data latch signal, while /CS is LOW. Data is latched at the falling edge of E signal.

| Function | E | R/W | /CS | D/C |
|---------------|---|-----|-----|-----|
| Write Command | ↓ | 0 | 0 | 0 |
| Read Status | ↓ | 1 | 0 | 0 |
| Write Data | ↓ | 0 | 0 | 1 |
| Read Data | ↓ | 1 | 0 | 1 |

10.2. 8080-MPU Parallel Interface

The parallel interface consists of 8 bi-directional data pins, /RD, /WR, D/C, and /CS.

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

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

A rising edge of /WR input serves as a data/command write latch signal while /CS is LOW.

| Function | /RD | /WR | /CS | D/C |
|---------------|-----|-----|-----|-----|
| Write Command | 1 | ↑ | 0 | 0 |
| Read Status | ↑ | 1 | 0 | 0 |
| Write Data | 1 | ↑ | 0 | 1 |
| Read Data | ↑ | 1 | 0 | 1 |

Alternatively, /RD and /WR can be kept stable while /CS serves as the data/command latch signal.

| Function | /RD | /WR | /CS | D/C |
|---------------|-----|-----|-----|-----|
| Write Command | 1 | 0 | ↑ | 0 |
| Read Status | 0 | 1 | ↑ | 0 |
| Write Data | 1 | 0 | ↑ | 1 |
| Read Data | 0 | 1 | ↑ | 1 |

10.3. Serial Interface

The serial interface consists of serial clock SCLK, serial data SDIN, D/C, and /CS.

D0 acts as SCLK and D1 acts as SDIN. D2 should be left open. D3~D7, E, and R/W should be connected to GND.

| Function | /RD | /WR | /CS | D/C | D0 |
|---------------|-----|-----|-----|-----|----|
| Write Command | 0 | 0 | 0 | 0 | ↑ |
| Write Data | 0 | 0 | 0 | 1 | ↑ |

SDIN is shifted into an 8-bit shift register on every rising edge of SCLK in the order of D7, D6,...D0.

D/C is sampled on every eighth clock and the data byte in the shift register is written to the GDRAM or command register in the same clock.

Note: Read is not available in serial mode.

10.4. I²C Interface

The I2C interface consists of a slave address bit SA0, I2C-bus data signal SDA, and I2C-bus clock signal SCL.

D1 and D2 can be tied together, and act as SDA. D0 acts as SCL. Both the data and clock signals must be connected to pull-up resistors. /RES is used to initialize the device.

Note: SA0 bit allows the device to have a slave address of either "0111100" or "0111101".

Note: Data and acknowledgement are sent through the SDA. The ITO track resistance and the pull-up resistance at SDA becomes a voltage potential divider. As a result, it may not be possible to attain a valid logic "0" level on SDA for the ACK signal. SDA_{IN} must be connected, but SDA_{OUT} may be disconnected and the ACK signal will be ignored on the I2C bus.

For detailed protocol information, see datasheet: http://www.newhavendisplay.com/app_notes/SSD1305.pdf

11. Example Initialization Sequence:

```
Set_Display_On_Off(0x00);           // Display Off (0x00/0x01)
Set_Display_Clock(0x10);           // Set Clock as 160 Frames/Sec
Set_Multiplex_Ratio(0x1F);         // 1/32 Duty (0x0F~0x3F)
Set_Display_Offset(0x00);          // Shift Mapping RAM Counter (0x00~0x3F)
Set_Start_Line(0x00);              // Set Mapping RAM Display Start Line (0x00~0x3F)
Set_Master_Config(0x00);           // Disable Embedded DC/DC Converter (0x00/0x01)
Set_Area_Color(0x05);              // Set Monochrome & Low Power Save Mode
Set_Addresssing_Mode(0x02);        // Set Page Addressing Mode (0x00/0x01/0x02)
Set_Segment_Remap(0x01);           // Set SEG/Column Mapping (0x00/0x01)
Set_Common_Remap(0x08);            // Set COM/Row Scan Direction (0x00/0x08)
Set_Common_Config(0x10);           // Set Alternative Configuration (0x00/0x10)
Set_LUT(0x3F,0x3F,0x3F,0x3F);     // Define All Banks Pulse Width as 64 Clocks
Set_Contrast_Control(Brightness);  // Set SEG Output Current
Set_Area_Brightness(Brightness);   // Set Brightness for Area Color Banks
Set_Precharge_Period(0xD2);        // Set Pre-Charge as 13 Clocks & Discharge as 2 Clock
Set_VCOMH(0x08);                   // Set VCOM Deselect Level
Set_Entire_Display(0x00);          // Disable Entire Display On (0x00/0x01)
Set_Inverse_Display(0x00);         // Disable Inverse Display On (0x00/0x01)
Fill_RAM(0x00);                     // Clear Screen
Set_Display_On_Off(0x01);          // Display On (0x00/0x01)
```

12. Multi-Font IC -> MPU Interface

12.1. Serial Interface

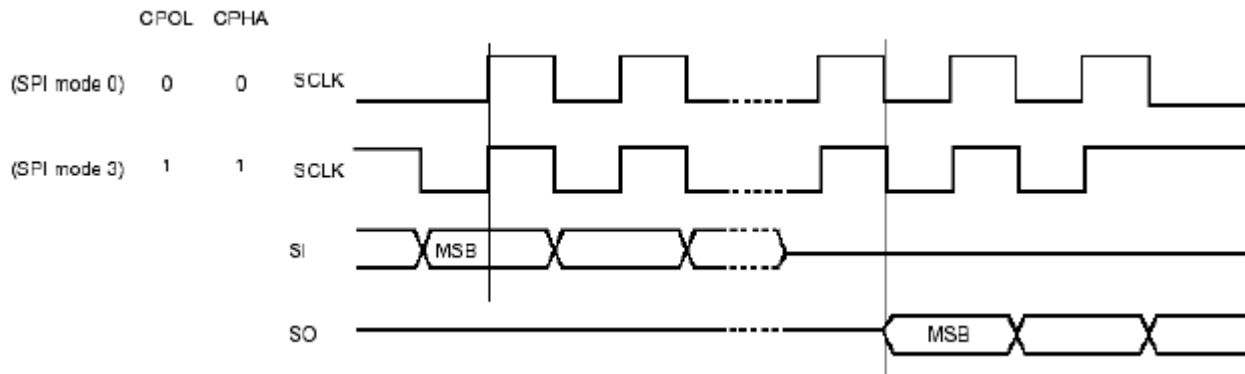
The serial interface consists of serial clock MF_SCLK, serial data in MF_SI, serial data out MF_SO, chip enable /MF_CS2.

| Function | MF_SCLK | MF_SI | MF_SO | /MF_CS2 |
|-------------------|---------|-------|-------|---------|
| Send Font Address | ↑ | DATA | X | 0 |
| Read Font Data | ↓ | X | DATA | 0 |

The Multi-Font device is enabled by a high-to-low transition on /MF_CS2. /MF_CS2 must remain LOW for the duration of any command-in or data-out sequence.

The Font Address is shifted in on the MF_SI line on the rising edge of MF_SCLK.

The Font Data is shifted out on the MF_SO line on the falling edge of MF_SCLK.



12.2. Communication Protocol

Font data can be accessed and read by using the READ command instruction.

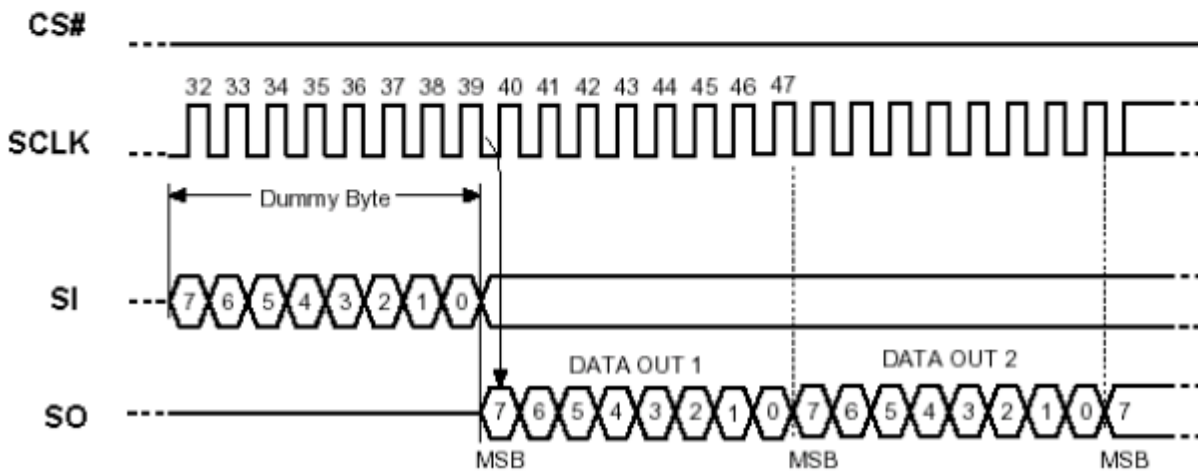
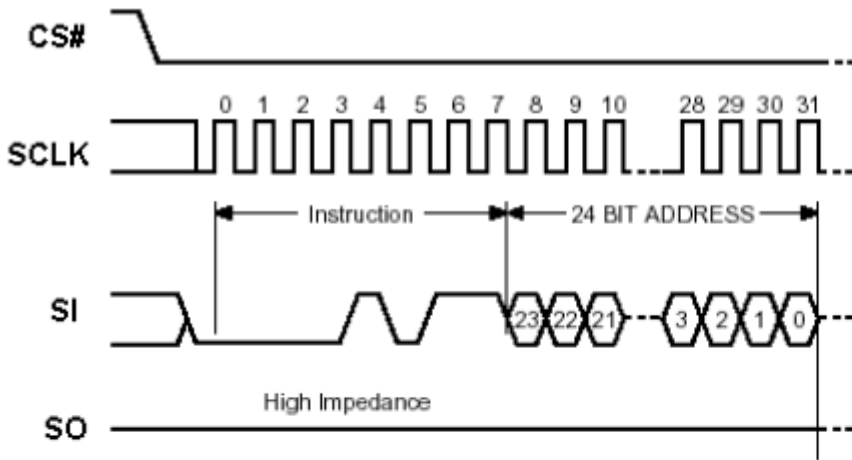
| Instruction | Description | Instruction Code | Address Bytes | Dummy Bytes | Data Bytes |
|-------------|-----------------------|------------------|---------------|-------------|------------|
| READ | Read Data (30MHz MAX) | 0Bh | 3 | 1 | 1 ~ ∞ |

READ mode supports up to 30MHz frequency on MF_SCLK.

READ mode outputs the data starting from the specified address location. The data output stream is continuous through all addresses until terminated by a low-to-high transition on /MF_CS2. The internal address pointer will automatically increment after each byte is read.

READ instruction is initiated by executing an 8-bit command [0x0B] on the MF_SI line, followed by the desired font address bits [A23-A0], and followed by an 8-bit dummy write [0x00]. The font data will then be output on MF_SO line, MSB first.

/MF_CS2 must remain active LOW for the duration of the read cycle.



12.3. Timing Characteristics

| Symbol | Parameter | Condition | Min. | Max. | Unit |
|--------|-------------------------------|---------------------|------|------|------|
| Fc | Clock Frequency | | - | 30 | MHz |
| tCH | Clock High Time | | 15 | - | ns |
| tCL | Clock Low Time | | 15 | - | ns |
| tCLCH | Clock Rise Time | peak to peak | 0.1 | - | V/ns |
| tCHCL | Clock Fall Time | peak to peak | 0.1 | - | V/ns |
| tSLCH | /MF_CS2 Active Setup Time | relative to MF_SCLK | 5 | - | ns |
| tCHSL | /MF_CS2 Not Active Hold Time | relative to MF_SCLK | 5 | - | ns |
| tDVCH | Data IN Setup Time | | 2 | - | ns |
| tCHDX | Data IN Hold Time | | 5 | - | ns |
| tCHSH | /MF_CS2 Active Hold Time | relative to MF_SCLK | 5 | - | ns |
| tSHCH | /MF_CS2 Not Active Setup Time | relative to MF_SCLK | 5 | - | ns |
| tSHSL | /MF_CS2 Deselect Time | | 100 | - | ns |
| tSHQZ | Output Disable Time | | - | 9 | ns |
| tCLQV | Clock Low to Output Valid | | - | 9 | ns |
| tCLQX | Output Hold Time | | 0 | - | ns |

13. Font Tables

See file: www.newhavendisplay.com/app_notes/MultiFont.pdf

14. Font Data Arrangement

See file: www.newhavendisplay.com/app_notes/MultiFont.pdf

15. Calculation of Font Addresses

See file: www.newhavendisplay.com/app_notes/MultiFont.pdf

16. Multi-Font program code example

17. Quality Information

| Test Item | Content of Test | Test Condition | Note |
|---------------------------------------|--|--|------|
| High Temperature storage | Test the endurance of the display at high storage temperature. | +90°C , 240hrs | 2 |
| Low Temperature storage | Test the endurance of the display at low storage temperature. | -40°C , 240hrs | 1,2 |
| High Temperature Operation | Test the endurance of the display by applying electric stress (voltage & current) at high temperature. | +70°C 240hrs | 2 |
| Low Temperature Operation | Test the endurance of the display by applying electric stress (voltage & current) at low temperature. | -20°C , 240hrs | 1,2 |
| High Temperature / Humidity Operation | Test the endurance of the display by applying electric stress (voltage & current) at high temperature with high humidity. | +60°C , 90% RH , 240hrs | 1,2 |
| Thermal Shock resistance | Test the endurance of the display by applying electric stress (voltage & current) during a cycle of low and high temperatures. | -20°C,30min -> 25°C,5min -> 70°C,30min = 1 cycle 100 cycles | |
| Vibration test | Test the endurance of the display by applying vibration to simulate transportation and use. | 10-22Hz , 15mm amplitude. 22-500Hz, 1.5G 30min in each of 3 directions X,Y,Z | 3 |
| Atmospheric Pressure test | Test the endurance of the display by applying atmospheric pressure to simulate transportation by air. | 115mbar, 40hrs | 3 |
| Static electricity test | Test the endurance of the display by applying electric static discharge. | VS=800V, RS=1.5kΩ, CS=100pF One time | |

Note 1: No condensation to be observed.

Note 2: Conducted after 2 hours of storage at 25°C, 0%RH.

Note 3: Test performed on product itself, not inside a container.

Evaluation Criteria:

- 1: Display is fully functional during operational tests and after all tests, at room temperature.
- 2: No observable defects.
- 3: Luminance >50% of initial value.
- 4: Current consumption within 50% of initial value

Precautions for using OLEDs/LCDs/LCMs

See Precautions at www.newhavendisplay.com/specs/precautions.pdf

Warranty Information and Terms & Conditions

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