

Product Specification

NHD-0216MW-IB3

Character OLED Display Module

| | |
|--------------|--------------------------|
| NHD- | Newhaven Display |
| 0216- | 2 Lines x 16 Characters |
| MW- | Character OLED Module |
| I- | Model |
| B- | Blue |
| 3- | 2.7V~5.5V Supply Voltage |

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Additional Resources

- **Support Forum:** <https://support.newhavendisplay.com/hc/en-us/community/topics>
- **GitHub:** <https://github.com/newhavendisplay>
- **Example Code:** <https://support.newhavendisplay.com/hc/en-us/categories/4409527834135-Example-Code/>
- **Knowledge Center:** https://www.newhavendisplay.com/knowledge_center.html
- **Quality Center:** https://www.newhavendisplay.com/quality_center.html
- **Precautions for using LCDs/LCMs:** <https://www.newhavendisplay.com/specs/precautions.pdf>
- **Warranty / Terms & Conditions:** <https://www.newhavendisplay.com/terms.html>

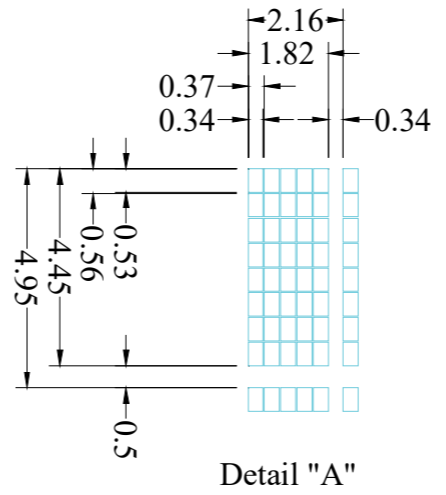
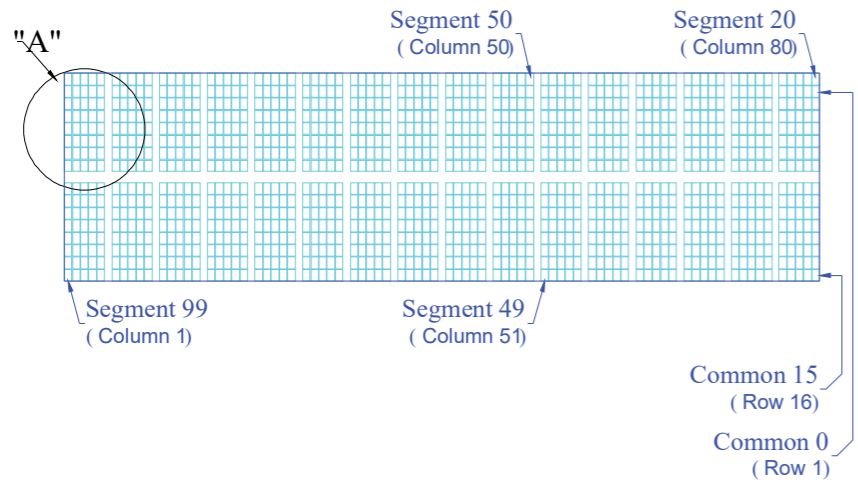
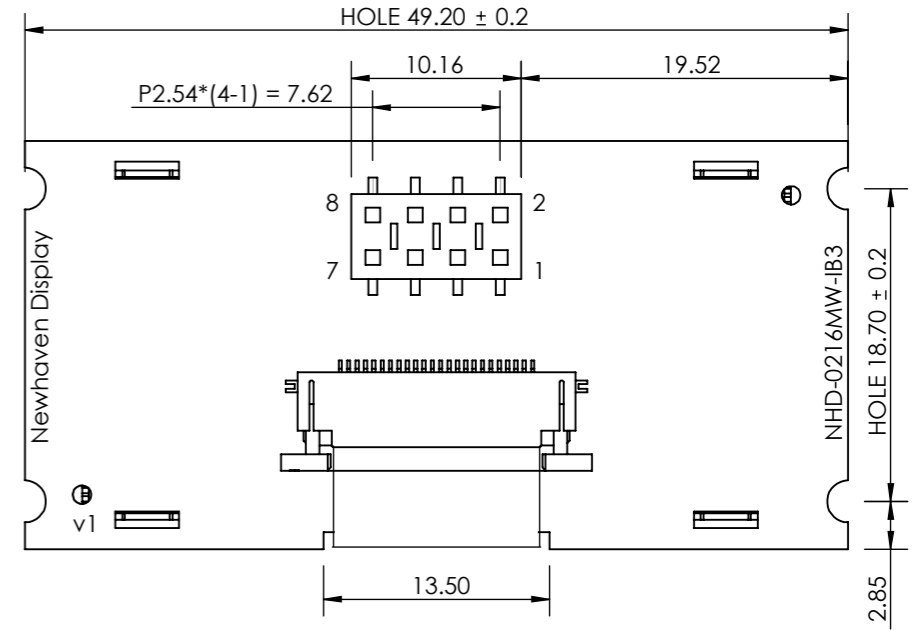
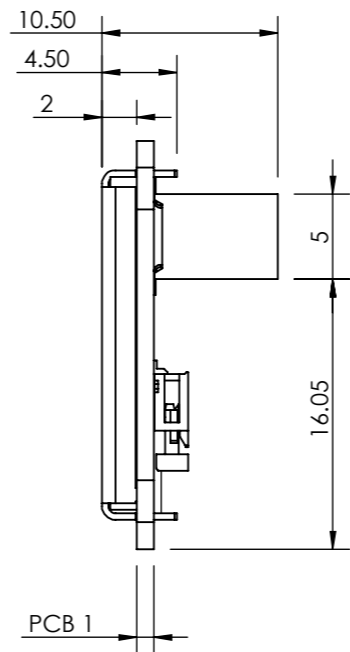
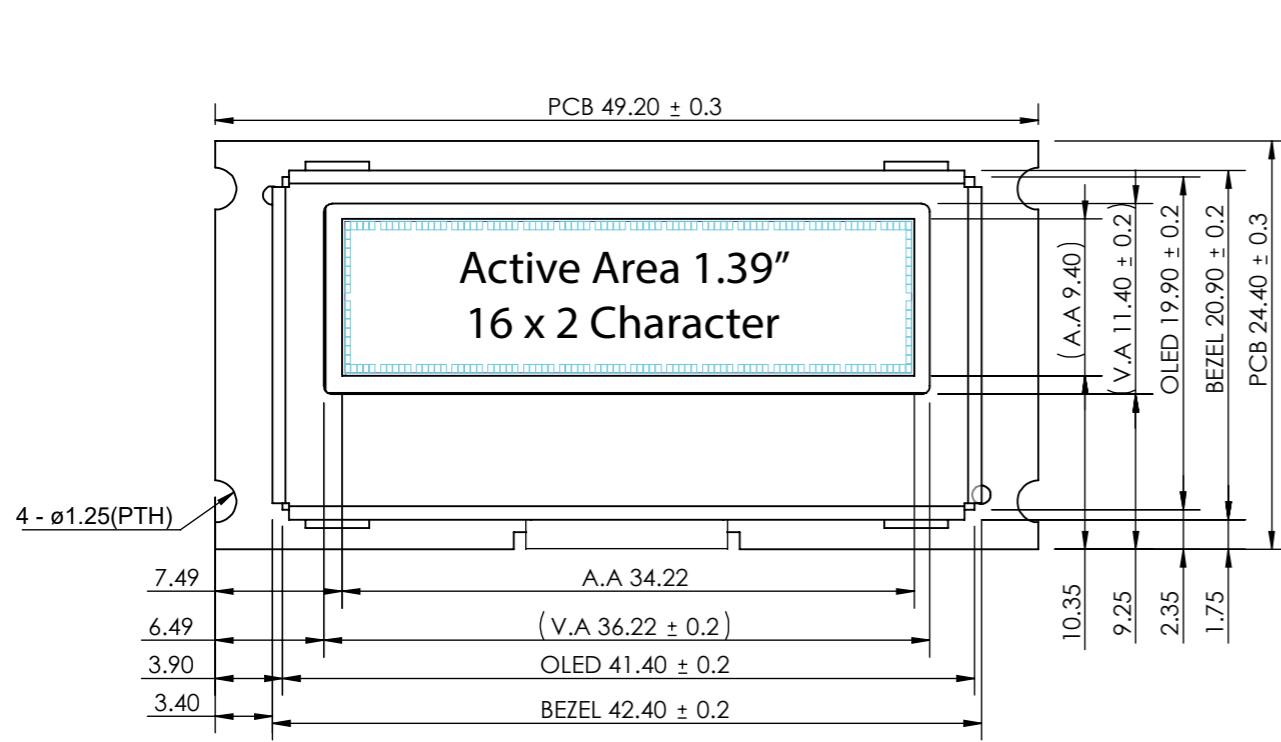


Document Revision History

| Revision | Date | Description | Changed By |
|----------|------------|--|------------|
| 0 | 07/05/2016 | Initial Release | PB |
| 1 | 10/14/2016 | Pin Description Updated | PB |
| 2 | 02/26/2018 | Mechanical Drawing Updated | SB |
| 3 | 08/31/2023 | V _{DD_SEL} /V _{DDIO} Voltage Range for Low Voltage Application (3.3V) Updated Mechanical Drawing Updated | KL |

Mechanical Drawing

Newhaven Display
 NHD-0216MW-IB3
 Date Code
 Part Label (type/format may vary)



| Pin Assignment | |
|----------------|---------|
| NO. | Symbol |
| 1 | GND |
| 2 | VDD_SEL |
| 3 | VDDIO |
| 4 | SA0 |
| 5 | SCL |
| 6 | SDA |
| 7 | /RES |
| 8 | NC |

- Product Description: 2x16 Character OLED
1. Driver IC: US2066
 2. Interface: I²C
 3. Power Requirement: 3.3V OLED
 4. Optical Features: Blue Color, Anti-Glare, Full View
 5. Recommended Pin Header: 2x4pin 2.54mm pitch

| | | |
|---|---|---------------------------|
| Standard Tolerance: (Unless otherwise specified) Linear: ±0.3mm | | |
| | Drawing/Part Number: NHD-0216MW-IB3 | Revision: - |
| Unless otherwise specified: • Dimensions are in Millimeters • Third Angle Projection | Drawn By: K. Lewis | Approved By: K. Lewis |
| | Drawn Date: 08/31/2023 | Approved Date: 08/31/2023 |
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Pin Description

I²C Interface:

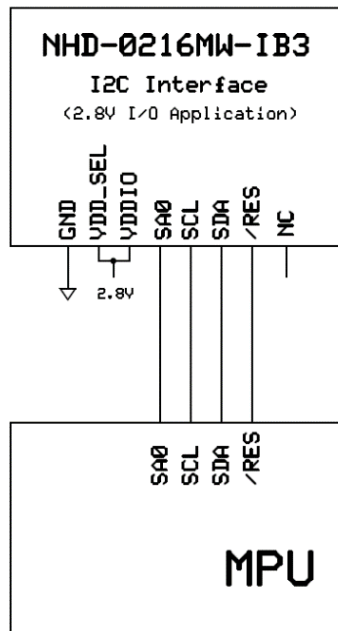
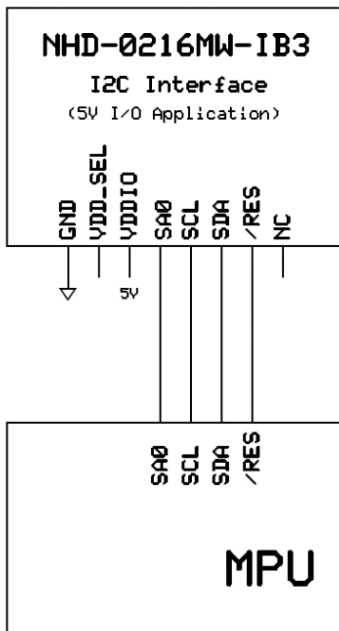
| Pin No. | Symbol | External Connection | Function Description |
|---------|---------------------|---------------------|---|
| 1 | GND | Power Supply | Ground |
| 2 | V _{DD_SEL} | Power Supply | Supply Voltage for Logic Operation V _{DD_SEL} must be No Connect for 5V operation, V _{DD_SEL} =3.3V for low voltage operation. |
| 3 | V _{DDIO} | Power Supply | Supply Voltage for Logic I/O V _{DDIO} =5V for 5V operation, V _{DDIO} =3.3V for low voltage operation. |
| 4 | SA0 | MPU | Slave Address select signal (LOW = 3C, HIGH = 3D) |
| 5 | SCL | MPU | Serial Clock signal |
| 6 | SDA | MPU | Serial Data line |
| 7 | /RES | MPU | Active LOW Reset signal |
| 8 | NC | - | No Connect |

On Board Jumper Options

| Solder Jumper Name | 3.3V Operation | 5V Operation |
|--------------------|----------------|--------------|
| SJ1 | Open (default) | Short |



Wiring Diagram



Electrical Characteristics

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|-----------------------------|-----------------------|------------------------|-----------------------|------|-----------------------|------|
| Operating Temperature Range | T _{OP} | Absolute Max | -40 | - | +85 | °C |
| Storage Temperature Range | T _{ST} | Absolute Max | -40 | - | +90 | °C |
| Supply Voltage for Logic | V _{DD_SEL} | (3.3V I/O Application) | 2.7 | 3.3 | 3.6 | V |
| Supply Voltage for I/O Pins | V _{DDIO} | | 2.7 | 3.3 | 3.6 | V |
| Supply Voltage for Logic | V _{DD_SEL} | (5V I/O Application) | - | - | - | V |
| Supply Voltage for I/O Pins | V _{DDIO} | | 4.4 | 5.0 | 5.5 | V |
| Supply Current | I _{DD} | - | 2 | 10 | 40 | mA |
| Sleep Mode Current | I _{DD_SLEEP} | - | - | .05 | 1 | mA |
| "H" Level input | V _{IH} | - | 0.8 * V _{DD} | - | - | V |
| "L" Level input | V _{IL} | - | - | - | 0.2 * V _{DD} | V |
| "H" Level output | V _{OH} | - | 0.9 * V _{DD} | - | - | V |
| "L" Level output | V _{OL} | - | - | - | 0.1 * V _{DD} | V |

Optical Characteristics

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|------------------------|----------------|---|--------|----------|------|-------------------|
| Optimal Viewing Angles | Top | CR ≥ 2 | 80 | - | - | ° |
| | Bottom | | 80 | - | - | ° |
| | Left | | 80 | - | - | ° |
| | Right | | 80 | - | - | ° |
| Contrast Ratio | CR | - | 2 | 10,000:1 | - | - |
| Response Time | Rise | T _R | - | 10 | - | μs |
| | Fall | T _F | - | 10 | - | μs |
| Brightness | L _V | 50% Checkerboard | 60 | 80 | - | cd/m ² |
| Lifetime | - | T _{OP} =25°C 50% Checkerboard | 25,000 | - | - | 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 US2066 Controller: <https://support.newhavendisplay.com/hc/en-us/articles/4414485495703--US2066>

DDRAM Address

| | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F |
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F |



Table of Commands

| 1. Fundamental Command List | | | | | | | | | | | | | | | |
|-----------------------------|----|----|----|------------------|------------|----|----|----|----|----|----|----|-----|-------------|---|
| Command | IS | RE | SD | Instruction Code | | | | | | | | | | Description | |
| | | | | D/C# | R/W# (WR#) | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | | |
| Clear Display | X | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Write "20H" to DDRAM and set DDRAM address to "00H" from AC. |
| Return Home | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | * | Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed. |
| Entry Mode Set | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | S | Assign cursor / blink moving direction with DDRAM address. I/D = "1": cursor/ blink moves to right and DDRAM address is increased by 1 (POR) I/D = "0": cursor/ blink moves to left and DDRAM address is decreased by 1 Assign display shift with DDRAM address. S = "1": make display shift of the enabled lines by the DS4 to DS1 bits in the shift enable instruction. Left/ right direction depends on I/D bit selection. S = "0": display shift disable (POR) |
| | X | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | BDC | BDS | Common bi-direction function. BDC = "0": COM31 -> COM0 BDC = "1": COM0 -> COM31 Segment bi-direction function. BDS = "0": SEG99 -> SEG0, BDS = "1": SEG0 -> SEG99 |
| Display ON/OFF Control | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B | Set display/cursor/blink ON/OFF D = "1": display ON, D = "0": display OFF (POR), C = "1": cursor ON, C = "0": cursor OFF (POR), B = "1": blink ON, B = "0": blink OFF (POR). |
| Extended Function Set | X | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | FW | BW | NW | Assign font width, black/white inverting of cursor, and 4line display mode control bit. FW = "1": 6-dot font width, FW = "0": 5-dot font width (POR), B/W = "1": black/white inverting of cursor enable, B/W = "0": black/white inverting of cursor disable (POR) NW = "1": 3-line or 4-line display mode NW = "0": 1-line or 2-line display mode |

| 1. Fundamental Command Set | | | | | | | | | | | | | | | |
|---|----|----|----|------------------|------------|----|----|----|----|----|-----|-----|--------|-------------|---|
| Command | IS | RE | SD | Instruction Code | | | | | | | | | | Description | |
| | | | | D/C# | R/W# (WR#) | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | | |
| Cursor or Display Shift | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | * | * | Set cursor moving and display shift control bit, and the direction, without changing DDRAM data. S/C = "1": display shift, S/C = "0": cursor shift, R/L = "1": shift to right, R/L = "0": shift to left |
| Double Height (4-Line)/ Display-dot Shift | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | UD2 | UD1 | * | DH' | UD2~1: Assign different doubt height format (POR=11b) Refer to Table 7-2 for details DH' = "1": display shift enable DH' = "0": dot scroll enable (POR) |
| Shift Enable | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | DS4 | DS3 | DS2 | DS1 | DS[4:1]=1111b (POR) when DH' = 1b Determine the line for display shift. DS1 = "1/0": 1st line display shift enable/disable DS2 = "1/0": 2nd line display shift enable/disable DS3 = "1/0": 3rd line display shift enable/disable DS4 = "1/0": 4th line display shift enable/disable. |
| Scroll Enable | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | HS4 | HS3 | HS2 | HS1 | HS[4:1]=1111b (POR) when DH' = 0b Determine the line for horizontal smooth scroll. HS1 = "1/0": 1st line dot scroll enable/disable HS2 = "1/0": 2nd line dot scroll enable/disable HS3 = "1/0": 3rd line dot scroll enable/disable HS4 = "1/0": 4th line dot scroll enable/disable. |
| Function Set | X | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | * | N | DH | RE (0) | IS | Numbers of display line, N when N = "1": 2-line (NW=0b) / 4-line (NW=1b), when N = "0": 1-line (NW=0b) / 3-line (NW=1b) DH = "1/0": Double height font control for 2-line mode enable/ disable (POR=0) Extension register, RE ("0") Extension register, IS |
| | X | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | * | N | BE | RE (1) | REV | CGRAM blink enable BE = 1b: CGRAM blink enable BE = 0b: CGRAM blink disable (POR) Extension register, RE ("1") Reverse bit REV = "1": reverse display, REV = "0": normal display (POR) |

| 1. Fundamental Command Set | | | | | | | | | | | | | | |
|-------------------------------------|----|----|----|------------------|---------------|----|-----------|-----------|-----------|-----------|-----------|-------------------|-----------|---|
| Command | IS | RE | SD | Instruction Code | | | | | | | | | | Description |
| | | | | D/C# | R/W# (WR#) | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| | X | 1 | 0 | 0 | 0 | 0 | 0 | 1 | * | N | BE | RE (1) | REV | CGRAM blink enable BE = 1b: CGRAM blink enable BE = 0b: CGRAM blink disable (POR) Extension register, RE ("1") Reverse bit REV = "1": reverse display, REV = "0": normal display (POR) |
| Set CGRAM address | 0 | 0 | 0 | 0 | 0 | 0 | 1 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set CGRAM address in address counter. (POR=00 0000) |
| Set DDRAM Address | X | 0 | 0 | 0 | 0 | 1 | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set DDRAM address in address counter. (POR=000 0000) |
| Set Scroll Quantity | X | 1 | 0 | 0 | 0 | 1 | * | SQ5 | SQ4 | SQ3 | SQ2 | SQ1 | SQ0 | Set the quantity of horizontal dot scroll. (POR=00 0000) Valid up to SQ[5:0] = 110000b |
| Read Busy Flag and Address/ Part ID | X | X | 0 | 0 | 1 | BF | AC6 / ID6 | AC5 / ID5 | AC4 / ID4 | AC3 / ID3 | AC2 / ID2 | AC1 / ID1 | AC0 / ID0 | Can be known whether during internal operation or not by reading BF. The contents of address counter or the part ID can also be read. When it is read the first time, the address counter can be read. When it is read the second time, the part ID can be read. BF = "1": busy state BF = "0": ready state |
| Write data | X | X | 0 | 1 | 0 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Write data into internal RAM (DDRAM / CGRAM). |
| Read data | X | X | 0 | 1 | 1 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Read data from internal RAM (DDRAM / CGRAM). |

| 1. Extended Command Set | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-------------------------|---------|-------|----|------------------|------------|--------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---|----------|-------|-------|-----|-----|---|-----|-----|---|-----|-----|---|-----|-----|---|----------|-----|-----|---|-----|---|-----|---|-----|---------|
| Command | IS | RE | SD | Instruction Code | | | | | | | | | | | Description | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | D/C# | R/W# (WR#) | Hex | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Function Selection A | X | 1 | 0 | 0 | 0 | 71 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | A[7:0] = 00h, Disable internal V _{DD} regulator at 5V I/O application mode A[7:0] = 5Ch, Enable internal V _{DD} regulator at 5V I/O application mode (POR) | | | | | | | | | | | | | | | | | | | | | | | | | |
| | X | 1 | 0 | 1 | 0 | A[7:0] | A ₇ | A ₆ | A ₅ | A ₄ | A ₃ | A ₂ | A ₁ | A ₀ | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Function Selection B | X | 1 | 0 | 0 | 0 | 72 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | OPR[1:0]: Select the character no. of character generator ROM[1:0]: Select character ROM | | | | | | | | | | | | | | | | | | | | | | | | | |
| | X | 1 | 0 | 1 | 0 | | * | * | * | * | ROM 1 | ROM 0 | OPR 1 | OPR 0 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | <table border="1"> <tr> <td>OPR[1:0]</td> <td>CGROM</td> <td>CGRAM</td> </tr> <tr> <td>00b</td> <td>240</td> <td>8</td> </tr> <tr> <td>01b</td> <td>248</td> <td>8</td> </tr> <tr> <td>10b</td> <td>250</td> <td>6</td> </tr> <tr> <td>11b</td> <td>256</td> <td>0</td> </tr> </table> <table border="1"> <tr> <td>ROM[1:0]</td> <td>ROM</td> </tr> <tr> <td>00b</td> <td>A</td> </tr> <tr> <td>01b</td> <td>B</td> </tr> <tr> <td>01b</td> <td>C</td> </tr> <tr> <td>11b</td> <td>Invalid</td> </tr> </table> | OPR[1:0] | CGROM | CGRAM | 00b | 240 | 8 | 01b | 248 | 8 | 10b | 250 | 6 | 11b | 256 | 0 | ROM[1:0] | ROM | 00b | A | 01b | B | 01b | C | 11b | Invalid |
| OPR[1:0] | CGROM | CGRAM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 00b | 240 | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 01b | 248 | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10b | 250 | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11b | 256 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ROM[1:0] | ROM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 00b | A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 01b | B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 01b | C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11b | Invalid | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| OLED Characterization | X | 1 | X | 0 | 0 | 78/79 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | SD | Extension Register, SD SD=0b: OLED Command set is disabled (POR) SD=1b: OLED Command set is enabled. | | | | | | | | | | | | | | | | | | | | | | | | | |

| 2. OLED Command Set | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|----------|----------------------------------|----|------------------|------------|--------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--|---|----------|----------------------------------|------|-----|-------------------------|------|-----|-------------------------|------|-----|-------------------------------|-----|-----|-------------------------|------|-----|---------------------|
| Command | IS | RE | SD | Instruction Code | | | | | | | | | | | Description | | | | | | | | | | | | | | | | | | |
| | | | | D/C # | R/W# (WR#) | Hex | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | | | | | | | | | | | | | | | | | | | |
| Set Contrast Control | X | 1 | 1 | 0 | 0 | 81 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Double byte command to select 1 out of 256 contrast steps. Contrast increases as the value increases. (POR = 7Fh) | | | | | | | | | | | | | | | | | |
| | X | 1 | 1 | 0 | 0 | A[7:0] | A ₇ | A ₆ | A ₅ | A ₄ | A ₃ | A ₂ | A ₁ | A ₀ | | | | | | | | | | | | | | | | | | | |
| Set Display Clock Divide Ratio / Oscillator Frequency | X | 1 | 1 | 0 | 0 | D5 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | A[3:0]: Define the divide ratio (D) of the display clocks (DCLK) divide ratio = A[3:0] + 1 (POR=0000b) A[7:4]: Set the Oscillator Frequency, FOSC. Oscillator Frequency increases with the value of A[7:4] and vice versa. (POR=0111b) Range:0000b~1111b Frequency increases as setting value increases. | | | | | | | | | | | | | | | | | | |
| | X | 1 | 1 | 0 | 0 | A[7:0] | A ₇ | A ₆ | A ₅ | A ₄ | A ₃ | A ₂ | A ₁ | A ₀ | | | | | | | | | | | | | | | | | | | |
| Set Phase Length | X | 1 | 1 | 0 | 0 | D9 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | A[3:0]: Phase 1 period of up to 32 DCLK; clock 0 is an valid entry with 2 DCLK (POR=1000b) A[7:4]: Phase 2 period of up to 15 DCLK; clock 0 is invalid entry (POR=0111b) | | | | | | | | | | | | | | | | | | |
| | X | 1 | 1 | 0 | 0 | A[7:0] | A ₇ | A ₆ | A ₅ | A ₄ | A ₃ | A ₂ | A ₁ | A ₀ | | | | | | | | | | | | | | | | | | | |
| Set SEG Pins Hardware Configuration | X | 1 | 1 | 0 | 0 | DB | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | A[4] = 0b, Sequential SEG pin Configuration A[4] = 1b (POR), Alternative (Odd/Even) SEG pin configuration A[5] = 0b (POR), Disable SEG Left/Right remap A[5]=1b, Enable SEG Left/Right remap Refer to table 6-4 for details | | | | | | | | | | | | | | | | | | |
| | X | 1 | 1 | 0 | 0 | A[6:4] | 0 | A ₆ | A ₅ | A ₄ | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | |
| Set V _{COMH} Deselect Level | X | 1 | 1 | 0 | 0 | DB | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | <table border="1"> <thead> <tr> <th>A[6:4]</th> <th>Hex Code</th> <th>V_{COMH} Deselect level</th> </tr> </thead> <tbody> <tr> <td>000b</td> <td>00h</td> <td>~0.65 x V_{CC}</td> </tr> <tr> <td>001b</td> <td>10h</td> <td>~0.71 x V_{CC}</td> </tr> <tr> <td>010B</td> <td>20h</td> <td>~0.77 x V_{CC} (POR)</td> </tr> <tr> <td>011</td> <td>30h</td> <td>~0.83 x V_{CC}</td> </tr> <tr> <td>100b</td> <td>40h</td> <td>1 x V_{CC}</td> </tr> </tbody> </table> | A[6:4] | Hex Code | V _{COMH} Deselect level | 000b | 00h | ~0.65 x V _{CC} | 001b | 10h | ~0.71 x V _{CC} | 010B | 20h | ~0.77 x V _{CC} (POR) | 011 | 30h | ~0.83 x V _{CC} | 100b | 40h | 1 x V _{CC} |
| A[6:4] | Hex Code | V _{COMH} Deselect level | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 000b | 00h | ~0.65 x V _{CC} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 001b | 10h | ~0.71 x V _{CC} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 010B | 20h | ~0.77 x V _{CC} (POR) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 011 | 30h | ~0.83 x V _{CC} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 100b | 40h | 1 x V _{CC} | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | X | 1 | 1 | 0 | 0 | A[6:4] | 0 | A ₆ | A ₅ | A ₄ | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| 1. OLED Command Set | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------------------------|------------|-------------------------------------|----|------------------|------------|--------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---|--------|-------------------------------------|-------|----------|-------|-----------|-------|-----------|---|---|-------|------------|-------|------------|
| Command | IS | RE | SD | Instruction Code | | | | | | | | | | | Description | | | | | | | | | | | | | | |
| | | | | D/C # | R/W# (WR#) | Hex | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | | | | | | | | | | | | | | | |
| Function Selection C | X | 1 | 1 | 0 | 0 | DC | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | Set VSL & GPIO Set VSL: A[7] = 0b: Internal VSL (POR) A[7] = 1b: Enable external VSL Set GPIO: A[1:0]= 00b represents GPIO pin HiZ, input disabled (always read as low) A[1:0]= 01b represents GPIO pin HiZ, input enabled A[1:0]= 10b represents GPIO pin output Low (RESET) A[1:0]= 11b represents GPIO pin output High | | | | | | | | | | | | | | |
| | X | 1 | 1 | 0 | 0 | A[7:0] | A ₇ | A ₆ | A ₅ | A ₄ | A ₃ | A ₂ | A ₁ | A ₀ | | | | | | | | | | | | | | | |
| Set Fade Out and Blinking | X | 1 | 1 | 0 | 0 | 23 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | A[5:4] = 00b Disable Fade Out / Blinking Mode[RESET] A[5:4] = 10b Enable Fade Out mode. Once Fade Mode is enabled, contrast decrease gradually to all pixels OFF. Output follows RAM content when Fade mode is disabled. A[5:4] = 11b Enable Blinking mode. Once Blinking Mode is enabled, contrast decrease gradually to all pixels OFF and then contrast increases gradually to normal display. This process loops continuously until the Blinking mode is disabled. A[3:0] : Set time interval for each fade step <table border="1" data-bbox="1295 1136 1539 1438"> <tr> <td>A[3:0]</td> <td>Time interval of for each fade step</td> </tr> <tr> <td>0000b</td> <td>8 Frames</td> </tr> <tr> <td>0001b</td> <td>16 Frames</td> </tr> <tr> <td>0010b</td> <td>24 Frames</td> </tr> <tr> <td>:</td> <td>:</td> </tr> <tr> <td>1110b</td> <td>120 Frames</td> </tr> <tr> <td>1111b</td> <td>128 Frames</td> </tr> </table> | A[3:0] | Time interval of for each fade step | 0000b | 8 Frames | 0001b | 16 Frames | 0010b | 24 Frames | : | : | 1110b | 120 Frames | 1111b | 128 Frames |
| | A[3:0] | Time interval of for each fade step | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0000b | 8 Frames | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0001b | 16 Frames | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0010b | 24 Frames | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| : | : | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1110b | 120 Frames | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1111b | 128 Frames | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| X | 1 | 1 | 0 | 0 | A[5:0] | * | * | A ₅ | A ₄ | A ₃ | A ₂ | A ₁ | A ₀ | | | | | | | | | | | | | | | | |

Built-in Font Tables

ROM A (ROM[1:0] = [0:0])

| b7-4 | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0000 | | | | | | | | | | | | | | | | |
| 0001 | | | | | | | | | | | | | | | | |
| 0010 | | | | | | | | | | | | | | | | |
| 0011 | | | | | | | | | | | | | | | | |
| 0100 | | | | | | | | | | | | | | | | |
| 0101 | | | | | | | | | | | | | | | | |
| 0110 | | | | | | | | | | | | | | | | |
| 0111 | | | | | | | | | | | | | | | | |
| 1000 | | | | | | | | | | | | | | | | |
| 1001 | | | | | | | | | | | | | | | | |
| 1010 | | | | | | | | | | | | | | | | |
| 1011 | | | | | | | | | | | | | | | | |
| 1100 | | | | | | | | | | | | | | | | |
| 1101 | | | | | | | | | | | | | | | | |
| 1110 | | | | | | | | | | | | | | | | |
| 1111 | | | | | | | | | | | | | | | | |

ROM B (ROM[1:0] = [0:1])

| 17-4 25-0 | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|--------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0000 | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E |
| 0001 | | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T |
| 0010 | | U | V | W | X | Y | Z | [| \ | ^ | _ | ` | a | b | c | d |
| 0011 | | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s |
| 0100 | | t | u | v | w | x | y | z | { | | } | ~ | ! | " | # | \$ |
| 0101 | | % | & | ' | (|) | * | + | = | < | > | ?@ | AB | CD | EF | GH |
| 0110 | | HI | JK | LM | NO | OP | QR | ST | UV | WX | YZ | [| \ | ^ | _ | ` |
| 0111 | | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o |
| 1000 | | p | q | r | s | t | u | v | w | x | y | z | { | | } | ~ |
| 1001 | | ! | " | # | \$ | % | & | ' | (|) | * | + | = | < | > | ?@ |
| 1010 | | AB | CD | EF | GH | HI | JK | LM | NO | OP | QR | ST | UV | WX | YZ | [|
| 1011 | | \ | ^ | _ | ` | a | b | c | d | e | f | g | h | i | j | k |
| 1100 | | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z |
| 1101 | | { | | } | ~ | ! | " | # | \$ | % | & | ' | (|) | * | + |
| 1110 | | = | < | > | ?@ | AB | CD | EF | GH | HI | JK | LM | NO | OP | QR | ST |
| 1111 | | UV | WX | YZ | [| \ | ^ | _ | ` | a | b | c | d | e | f | g |

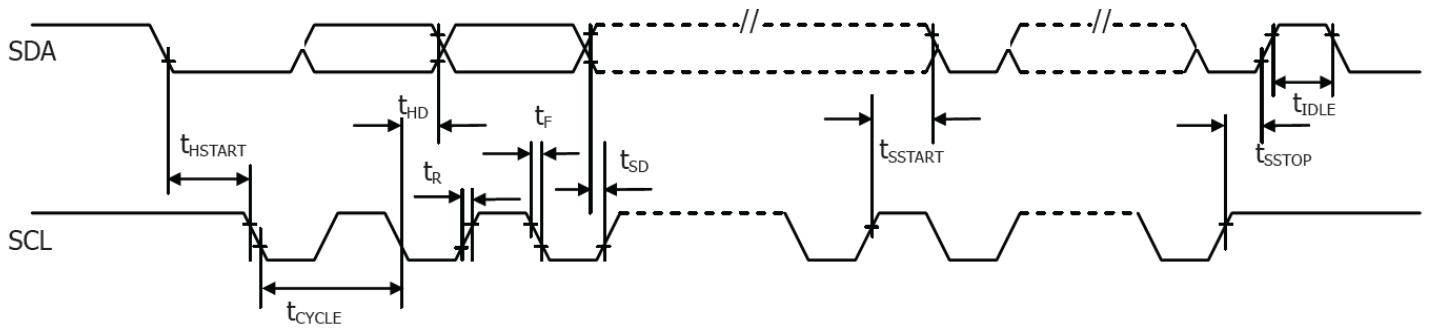
ROM C (ROM[1:0] = [1:0])

| 7-4 3-0 | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0000 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
| 0001 | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V |
| 0010 | W | X | Y | Z | [| \ | ^ | _ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0011 | 8 | 9 | A | B | C | D | E | F | G | H | I | J | K | L | M | N |
| 0100 | O | P | Q | R | S | T | U | V | W | X | Y | Z | [| \ | ^ | _ |
| 0101 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
| 0110 | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V |
| 0111 | W | X | Y | Z | [| \ | ^ | _ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1000 | 8 | 9 | A | B | C | D | E | F | G | H | I | J | K | L | M | N |
| 1001 | O | P | Q | R | S | T | U | V | W | X | Y | Z | [| \ | ^ | _ |
| 1010 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
| 1011 | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V |
| 1100 | W | X | Y | Z | [| \ | ^ | _ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1101 | 8 | 9 | A | B | C | D | E | F | G | H | I | J | K | L | M | N |
| 1110 | O | P | Q | R | S | T | U | V | W | X | Y | Z | [| \ | ^ | _ |
| 1111 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |

Timing Characteristics

I²C Interface:

| Symbol | Parameter | Min | Typ | Max | Unit |
|---------------------|--|-----|-----|-----|---------------|
| t_{cycle} | Clock Cycle Time | 2.5 | - | - | μs |
| t_{HSTART} | Start Condition Hold Time | 0.6 | - | - | μs |
| t_{HD} | Data Hold Time (for "SDA _{OUT} " pin) | 5 | - | - | ns |
| | Data Hold Time (for "SDA _{IN} " pin) | 300 | - | - | ns |
| t_{SD} | Data Setup Time | 100 | - | - | ns |
| t_{SSTART} | Start condition setup time (Only for a repeated Start Condition) | 0.6 | - | - | μs |
| t_{SSTOP} | Stop condition Setup Time | 0.6 | - | - | μs |
| t_{R} | Rise Time for data and clock pin | - | - | 300 | ns |
| t_{F} | Fall Time for data and clock pin | - | - | 300 | ns |
| t_{IDLE} | Idle Time before a new transmission can start | 1.3 | - | - | μs |



Example Initialization Sequence

```
void init()
{
    RES = 1;           //reset HIGH – inactive
    delayms(1);       //delay
    command(0x2A);    //function set (extended command set)
    command(0x71);    //function selection A
    data(0x00);       // disable internal VDD regulator (2.8V I/O). data(0x5C) = enable regulator (5V I/O)
    command(0x28);    //function set (fundamental command set)
    command(0x08);    //display off, cursor off, blink off
    command(0x2A);    //function set (extended command set)
    command(0x79);    //OLED command set enabled
    command(0xD5);    //set display clock divide ratio/oscillator frequency
    command(0x70);    //set display clock divide ratio/oscillator frequency
    command(0x78);    //OLED command set disabled
    command(0x08);    //extended function set (2-lines)
    command(0x06);    //COM SEG direction
    command(0x72);    //function selection B
    data(0x00);       //ROM CGRAM selection
    command(0x2A);    //function set (extended command set)
    command(0x79);    //OLED command set enabled
    command(0xDA);    //set SEG pins hardware configuration
    command(0x00);    //set SEG pins hardware configuration
    command(0xDC);    //function selection C
    command(0x00);    //function selection C
    command(0x81);    //set contrast control
    command(0x7F);    //set contrast control
    command(0xD9);    //set phase length
    command(0xF1);    //set phase length
    command(0xDB);    //set VCOMH deselect level
    command(0x40);    //set VCOMH deselect level
    command(0x78);    //OLED command set disabled
    command(0x28);    //function set (fundamental command set)
    command(0x01);    //clear display
    command(0x80);    //set DDRAM address to 0x00
    command(0x0C);    //display ON
    delayms(100);    //delay
}
```

Example Arduino Code

Please see: https://github.com/NewhavenDisplay/NHD_US2066



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. | +85°C, 240hrs | 2 |
| Low Temperature Operation | Test the endurance of the display by applying electric stress (voltage & current) at low temperature. | -40°C, 240hrs | 1,2 |
| High Temperature / Humidity Operation | Test the endurance of the display by applying electric stress (voltage & current) at high temperature with high humidity. | +60°C, 90% RH, 240hrs | 1,2 |
| Thermal Shock resistance | Test the endurance of the display by applying electric stress (voltage & current) during a cycle of low and high temperatures. | -40°C, 30min -> 25°C, 5min -> 85°C, 30min = 1 cycle 100 cycles | |
| Vibration test | Test the endurance of the display by applying vibration to simulate transportation and use. | 10-22Hz, 15mm amplitude. 22-500Hz, 1.5G 30min in each of 3 directions X,Y,Z | 3 |
| 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