

# NHD-0220CW-AB3

## Character OLED Display Module

|       |                          |
|-------|--------------------------|
| NHD-  | Newhaven Display         |
| 0220- | 2 lines x 20 characters  |
| CW-   | Character OLED Module    |
| A-    | Model                    |
| B-    | Blue                     |
| 3-    | 2.4V~5.5V Supply Voltage |

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## Document Revision History

| Revision | Date       | Description                                         | Changed by |
|----------|------------|-----------------------------------------------------|------------|
| 0        | 12/15/2014 | Initial Release                                     | AK         |
| 1        | 4/6/2015   | Pin Description, Electrical Characteristics Updated | PB         |

## Functions and Features

- 2 lines x 20 characters
- Built-in LCD comparable controller
- 4/8-bit Parallel, SPI, or I<sup>2</sup>C MPU interface
- 2.8V or 5.0V operation
- RoHS compliant
- Slim design



# Pin Description

## Parallel Interface:

| Pin No. | Symbol    | External Connection | Function Description                                                                                         |
|---------|-----------|---------------------|--------------------------------------------------------------------------------------------------------------|
| 1       | VSS       | Power Supply        | Ground                                                                                                       |
| 2       | VDD       | Power Supply        | Supply Voltage for OLED and Logic<br>VDD=2.8V for 2.8V operation, VDD=5V for 5V operation                    |
| 3       | REGVDD    | Power Supply        | Internal 5V I/O Regulator select signal<br>REGVDD=0V for 2.8V operation, REGVDD=5V for 5V operation          |
| 4       | D/C       | MPU                 | Data/Command select signal. D/C=0: Command, D/C=1: Data                                                      |
| 5       | R/W       | MPU                 | Read/Write select signal, R/W=1: Read R/W=0: Write                                                           |
| 6       | E         | MPU                 | Operation Enable signal. Falling edge triggered.                                                             |
| 7-10    | DB0 – DB3 | MPU                 | Four low order bi-directional three-state data bus lines.<br>These four are not used during 4-bit operation. |
| 11-14   | DB4 – DB7 | MPU                 | Four high order bi-directional three-state data bus lines.                                                   |
| 15      | /CS       | MPU                 | Active LOW Chip Select signal                                                                                |
| 16      | /RES      | MPU                 | Active LOW Reset signal                                                                                      |
| 17-19   | BS0 – BS2 | MPU                 | MPU interface select signal                                                                                  |
| 20      | VSS       | Power Supply        | Ground                                                                                                       |

## Serial Interface:

| Pin No. | Symbol    | External Connection | Function Description                                                                                |
|---------|-----------|---------------------|-----------------------------------------------------------------------------------------------------|
| 1       | VSS       | Power Supply        | Ground                                                                                              |
| 2       | VDD       | Power Supply        | Supply Voltage for OLED and Logic<br>VDD=2.8V for 2.8V operation, VDD=5V for 5V operation           |
| 3       | REGVDD    | Power Supply        | Internal 5V I/O Regulator select signal<br>REGVDD=0V for 2.8V operation, REGVDD=5V for 5V operation |
| 4-6     | NC        | -                   | No Connect. Tie to Ground                                                                           |
| 7       | SCLK      | MPU                 | Serial Clock signal                                                                                 |
| 8       | SDI       | MPU                 | Serial Data Input signal                                                                            |
| 9       | SDO       | MPU                 | Serial Data Output signal                                                                           |
| 10-14   | NC        | -                   | No Connect. Tie to Ground                                                                           |
| 15      | /CS       | MPU                 | Active LOW Chip Select signal                                                                       |
| 16      | /RES      | MPU                 | Active LOW Reset signal                                                                             |
| 17-19   | BS0 – BS2 | MPU                 | MPU interface select signal                                                                         |
| 20      | VSS       | Power Supply        | Ground                                                                                              |

## I<sup>2</sup>C Interface:

| Pin No. | Symbol             | External Connection | Function Description                                                                                |
|---------|--------------------|---------------------|-----------------------------------------------------------------------------------------------------|
| 1       | VSS                | Power Supply        | Ground                                                                                              |
| 2       | VDD                | Power Supply        | Supply Voltage for OLED and Logic<br>VDD=2.8V for 2.8V operation, VDD=5V for 5V operation           |
| 3       | REGVDD             | Power Supply        | Internal 5V I/O Regulator select signal<br>REGVDD=0V for 2.8V operation, REGVDD=5V for 5V operation |
| 4       | SA0                | MPU                 | Slave Address select signal                                                                         |
| 5-6     | NC                 | -                   | No Connect. Tie to Ground                                                                           |
| 7       | SCL                | MPU                 | Serial Clock signal                                                                                 |
| 8       | SDA <sub>IN</sub>  | MPU                 | Serial Data Input.                                                                                  |
| 9       | SDA <sub>OUT</sub> | MPU                 | Serial Data Output. Tie together with SDA <sub>IN</sub> (pin 8)                                     |
| 10-15   | NC                 | -                   | No Connect. Tie to Ground                                                                           |
| 16      | /RES               | MPU                 | Active LOW Reset signal                                                                             |
| 17-19   | BS0 – BS2          | MPU                 | MPU interface select signal                                                                         |
| 20      | VSS                | Power Supply        | Ground                                                                                              |

## MPU Interface Pin Selections

| Pin Name | 4-bit Parallel 6800 interface | 4-bit Parallel 8080 interface | 8-bit Parallel 6800 interface | 8-bit Parallel 8080 interface | Serial Interface | I <sup>2</sup> C Interface |
|----------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------|----------------------------|
| BS0      | 1                             | 1                             | 0                             | 0                             | 0                | 0                          |
| BS1      | 0                             | 1                             | 0                             | 1                             | 0                | 1                          |
| BS2      | 1                             | 1                             | 1                             | 1                             | 0                | 0                          |

## MPU Interface Pin Assignment Summary

| Bus Interface    | Data/Command Interface |    |    |    |         |                    |                   |      | Control Signals |     |     |         |      |
|------------------|------------------------|----|----|----|---------|--------------------|-------------------|------|-----------------|-----|-----|---------|------|
|                  | D7                     | D6 | D5 | D4 | D3      | D2                 | D1                | D0   | E               | R/W | /CS | D/C     | /RES |
| 4-bit 6800       | D[7:4]                 |    |    |    | Tie LOW |                    |                   |      | E               | R/W | /CS | D/C     | /RES |
| 4-bit 8080       | D[7:4]                 |    |    |    | Tie LOW |                    |                   |      | /RD             | /WR | /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                |    |    |    |         | SDO                | SDI               | SCLK | Tie LOW         |     | /CS | Tie LOW | /RES |
| I <sup>2</sup> C | Tie LOW                |    |    |    |         | SDA <sub>OUT</sub> | SDA <sub>IN</sub> | SCL  | Tie LOW         |     |     | SA0     | /RES |

## Electrical Characteristics

| Item                             | Symbol               | Condition    | Min.    | Typ. | Max.    | Unit |
|----------------------------------|----------------------|--------------|---------|------|---------|------|
| Operating Temperature Range      | Top                  | Absolute Max | -40     | -    | +85     | °C   |
| Storage Temperature Range        | Tst                  | Absolute Max | -40     | -    | +90     | °C   |
| Supply Voltage for logic         | VDD                  |              | 2.4     | 2.8  | 5.5     | V    |
| Supply Voltage for I/O Regulator | REGVDD               | VDD = 5V     | 4.4     | 5.0  | 5.5     | V    |
| Supply Current                   | IDD                  |              | -       | 70   | 135     | mA   |
| Sleep Mode Current               | IDD <sub>SLEEP</sub> |              | -       | 2    | 5       | mA   |
| “H” Level input                  | Vih                  |              | 0.8*VDD | -    | -       | V    |
| “L” Level input                  | Vil                  |              | -       | -    | 0.2*VDD | V    |
| “H” Level output                 | Voh                  |              | 0.9*VDD | -    | -       | V    |
| “L” Level output                 | Vol                  |              | -       | -    | 0.1*VDD | V    |

## Optical Characteristics

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

Please download specification at [http://www.newhavendisplay.com/app\\_notes/US2066.pdf](http://www.newhavendisplay.com/app_notes/US2066.pdf)

## DDRAM Address

| 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F | 10 | 11 | 12 | 13 |
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F | 50 | 51 | 52 | 53 |

# Table of Commands

| 1. Fundamental Command Set |    |    |    |                  |               |    |    |    |    |    |    |    |     |             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------|----|----|----|------------------|---------------|----|----|----|----|----|----|----|-----|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Command                    | IS | RE | SD | Instruction Code |               |    |    |    |    |    |    |    |     | Description |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                            |    |    |    | D/C#             | R/W#<br>(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.<br><br>I/D = "1": cursor/ blink moves to right and DDRAM address is increased by 1 (POR)<br><br>I/D = "0": cursor/ blink moves to left and DDRAM address is decreased by 1<br><br>Assign display shift with DDRAM address.<br><br>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.<br><br>S = "0": display shift disable (POR) |
|                            | X  | 1  | 0  | 0                | 0             | 0  | 0  | 0  | 0  | 0  | 0  | 1  | BDC | BDS         | Common bi-direction function.<br>BDC = "0": COM31 -> COM0<br>BDC = "1": COM0 -> COM31<br><br>Segment bi-direction function.<br>BDS = "0": SEG99 -> SEG0,<br>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<br><br>D = "1": display ON,<br>D = "0": display OFF (POR),<br><br>C = "1": cursor ON,<br>C = "0": cursor OFF (POR),<br><br>B = "1": blink ON,<br>B = "0": blink OFF (POR).                                                                                                                                                                                                                                                                                            |
| Extended Function Set      | X  | 1  | 0  | 0                | 0             | 0  | 0  | 0  | 0  | 0  | 1  | FW | B/W | NW          | Assign font width, black/white inverting of cursor, and 4-line display mode control bit.<br><br>FW = "1": 6-dot font width,<br>FW = "0": 5-dot font width (POR),<br><br>B/W = "1": black/white inverting of cursor enable,<br>B/W = "0": black/white inverting of cursor                                                                                                                                                                                                                              |

| 1. Fundamental Command Set                 |    |    |    |                  |               |    |    |    |    |    |     |     |           |             |                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------|----|----|----|------------------|---------------|----|----|----|----|----|-----|-----|-----------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Command                                    | IS | RE | SD | Instruction Code |               |    |    |    |    |    |     |     |           | Description |                                                                                                                                                                                                                                                                                                                                                             |
|                                            |    |    |    | D/C#             | R/W#<br>(WR#) | D7 | D6 | D5 | D4 | D3 | D2  | D1  | D0        |             |                                                                                                                                                                                                                                                                                                                                                             |
|                                            |    |    |    |                  |               |    |    |    |    |    |     |     |           |             | disable (POR)<br><br>NW = "1": 3-line or 4-line display mode<br>NW = "0": 1-line or 2-line display mode                                                                                                                                                                                                                                                     |
| 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.<br><br>S/C = "1": display shift,<br>S/C = "0": cursor shift,<br><br>R/L = "1": shift to right,<br>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)<br>Refer to Table 7-2 for details<br><br>DH' = "1": display shift enable<br>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<br><br>Determine the line for display shift.<br><br>DS1 = "1/0": 1 <sup>st</sup> line display shift enable/disable<br>DS2 = "1/0": 2 <sup>nd</sup> line display shift enable/disable<br>DS3 = "1/0": 3 <sup>rd</sup> line display shift enable/disable<br>DS4 = "1/0": 4 <sup>th</sup> 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<br><br>Determine the line for horizontal smooth scroll.<br><br>HS1 = "1/0": 1 <sup>st</sup> line dot scroll enable/disable<br>HS2 = "1/0": 2 <sup>nd</sup> line dot scroll enable/disable<br>HS3 = "1/0": 3 <sup>rd</sup> line dot scroll enable/disable<br>HS4 = "1/0": 4 <sup>th</sup> line dot scroll enable/disable.  |
| Function Set                               | X  | 0  | 0  | 0                | 0             | 0  | 0  | 0  | 1  | *  | N   | DH  | RE<br>(0) | IS          | Numbers of display line, N<br>when N = "1":<br>2-line (NW=0b) / 4-line (NW=1b),<br>when N = "0":<br>1-line (NW=0b) / 3-line (NW=1b)<br><br>DH = "1/0": Double height font control for 2-line mode enable/ disable (POR=0)<br><br>Extension register, RE ("0")<br><br>Extension register, IS                                                                 |



| 1. Fundamental Command Set          |    |    |    |                  |               |    |           |           |           |           |           |           |           |                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------|----|----|----|------------------|---------------|----|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Command                             | IS | RE | SD | Instruction Code |               |    |           |           |           |           |           |           |           | Description                                                                                                                                                                                                                                                                                                           |
|                                     |    |    |    | D/C#             | R/W#<br>(WR#) | D7 | D6        | D5        | D4        | D3        | D2        | D1        | D0        |                                                                                                                                                                                                                                                                                                                       |
|                                     | X  | 1  | 0  | 0                | 0             | 0  | 0         | 1         | *         | N         | BE        | RE<br>(1) | REV       | CGRAM blink enable<br>BE = 1b: CGRAM blink enable<br>BE = 0b: CGRAM blink disable (POR)<br><br>Extension register, RE ("1")<br><br>Reverse bit<br>REV = "1": reverse display,<br>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)<br>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.<br><br>BF = "1": busy state<br>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).                                                                                                                                                                                                                                                                          |

| 2. Extended Command Set |          |       |       |                  |               |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
|-------------------------|----------|-------|-------|------------------|---------------|---------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------|-------|-----|-----|---|-----|-----|---|-----|-----|---|-----|-----|---|---------|-----|-----|---|-----|---|-----|---|-----|---------|
| Command                 | IS       | RE    | SD    | Instruction Code |               |         |                |                |                |                |                |                |                | Description    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
|                         |          |       |       | D/C#             | R/W#<br>(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 <sub>DD</sub> regulator at 5V I/O application mode<br><br>A[7:0] = 5Ch, Enable internal V <sub>DD</sub> regulator at 5V I/O application mode (POR)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
|                         | X        | 1     | 0     | 1                | 0             | 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> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| 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<br><br><table border="1" style="margin-left: 20px;"> <thead> <tr> <th>OPR[1:0]</th> <th>CGROM</th> <th>CGRAM</th> </tr> </thead> <tbody> <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> </tbody> </table><br>ROM[1:0]: Select character ROM<br><br><table border="1" style="margin-left: 20px;"> <thead> <tr> <th>RO[1:0]</th> <th>ROM</th> </tr> </thead> <tbody> <tr> <td>00b</td> <td>A</td> </tr> <tr> <td>01b</td> <td>B</td> </tr> <tr> <td>10b</td> <td>C</td> </tr> <tr> <td>11b</td> <td>Invalid</td> </tr> </tbody> </table> | OPR[1:0] | CGROM | CGRAM | 00b | 240 | 8 | 01b | 248 | 8 | 10b | 250 | 6 | 11b | 256 | 0 | RO[1:0] | ROM | 00b | A | 01b | B | 10b | C | 11b | Invalid |
|                         | OPR[1:0] | CGROM | CGRAM |                  |               |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| 00b                     | 240      | 8     |       |                  |               |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| 01b                     | 248      | 8     |       |                  |               |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| 10b                     | 250      | 6     |       |                  |               |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| 11b                     | 256      | 0     |       |                  |               |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| RO[1:0]                 | ROM      |       |       |                  |               |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| 00b                     | A        |       |       |                  |               |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| 01b                     | B        |       |       |                  |               |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| 10b                     | C        |       |       |                  |               |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| 11b                     | Invalid  |       |       |                  |               |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| X                       | 1        | 0     | 1     | 0                | 0             |         | *              | *              | *              | *              | ROM            | ROM            | OPR            | OPR            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
| OLED Characterization   | X        | 1     | X     | 0                | 0             | 78 / 79 | 0              | 1              | 1              | 1              | 1              | 0              | 0              | SD             | Extension register, SD<br>SD = 0b: OLED command set is disabled (POR)<br>SD = 1b: OLED command set is enabled<br>Details refer to Table 6-3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |
|                         | X        | 1     | X     | 1                | 0             |         |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |       |       |     |     |   |     |     |   |     |     |   |     |     |   |         |     |     |   |     |   |     |   |     |         |

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

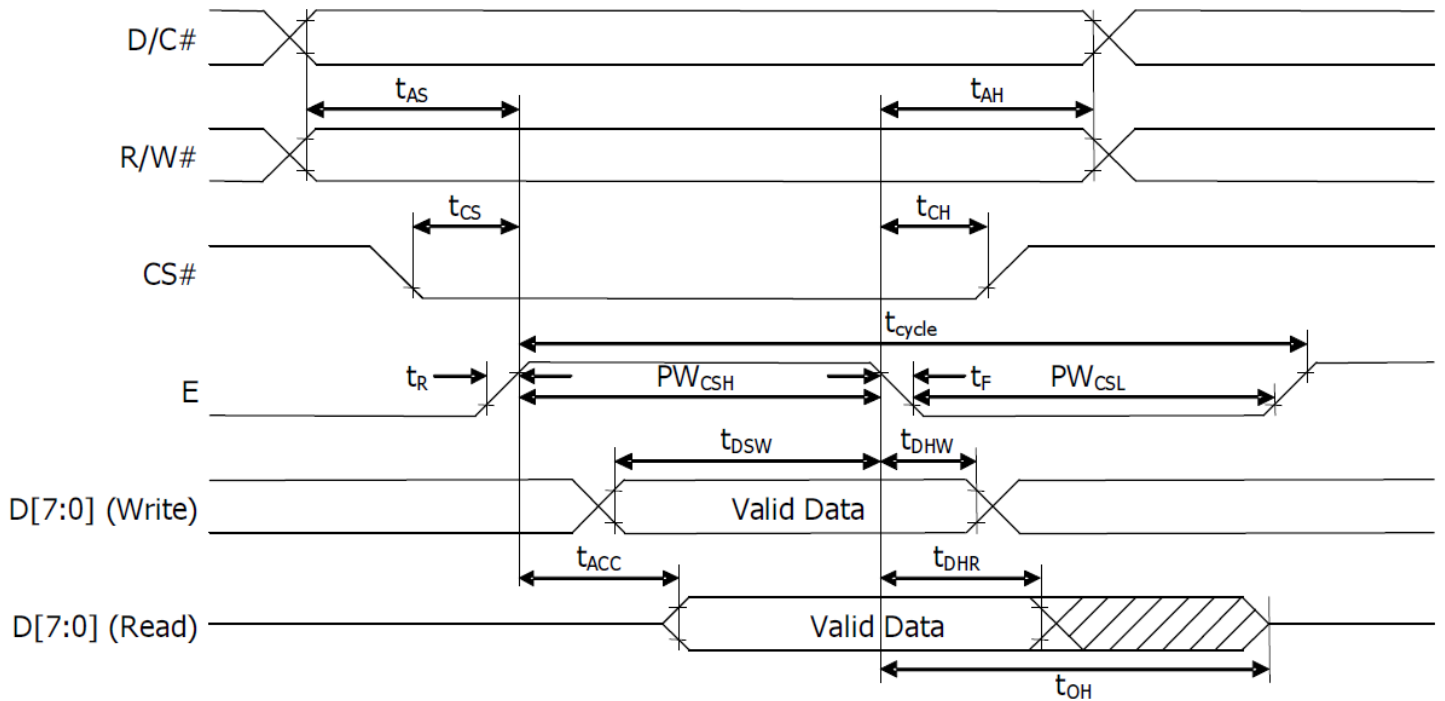
| 3. OLED Command Set       |            |                                  |    |                  |               |        |                |                |                |                |                |                |                |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |                                  |       |          |       |           |       |           |   |   |       |            |       |            |
|---------------------------|------------|----------------------------------|----|------------------|---------------|--------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------------------------------|-------|----------|-------|-----------|-------|-----------|---|---|-------|------------|-------|------------|
| Command                   | IS         | RE                               | SD | Instruction Code |               |        |                |                |                |                |                |                |                | Description    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |                                  |       |          |       |           |       |           |   |   |       |            |       |            |
|                           |            |                                  |    | D/C#             | R/W#<br>(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<br><br>Set VSL:<br>A[7] = 0b: Internal VSL (POR)<br>A[7] = 1b: Enable external VSL<br><br>Set GPIO:<br>A[1:0]= 00b represents GPIO pin HiZ, input disabled (always read as low)<br>A[1:0]= 01b represents GPIO pin HiZ, input enabled<br>A[1:0]= 10b represents GPIO pin output Low (RESET)<br>A[1:0]= 11b represents GPIO pin output High                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |                                  |       |          |       |           |       |           |   |   |       |            |       |            |
|                           | X          | 1                                | 1  | 0                | 0             | A[7:0] | A <sub>7</sub> | 0              | 0              | 0              | 0              | 0              | A <sub>1</sub> | A <sub>0</sub> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |                                  |       |          |       |           |       |           |   |   |       |            |       |            |
| 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]<br><br>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.<br><br>A[5:4] = 11b Enable Blinking mode. Once Blinking Mode is enabled, contrast decrease gradually to all pixels OFF and then contrast increase gradually to normal display. This process loop continuously until the Blinking mode is disabled.<br><br>A[3:0] : Set time interval for each fade step<br><br><table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>A[3:0]</th> <th>Time interval for each fade step</th> </tr> </thead> <tbody> <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> </tbody> </table> | A[3:0] | Time interval for each fade step | 0000b | 8 Frames | 0001b | 16 Frames | 0010b | 24 Frames | : | : | 1110b | 120 Frames | 1111b | 128 Frames |
|                           | A[3:0]     | Time interval 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 <sub>5</sub> | A <sub>4</sub> | A <sub>3</sub> | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |                                  |       |          |       |           |       |           |   |   |       |            |       |            |

# Timing Characteristics

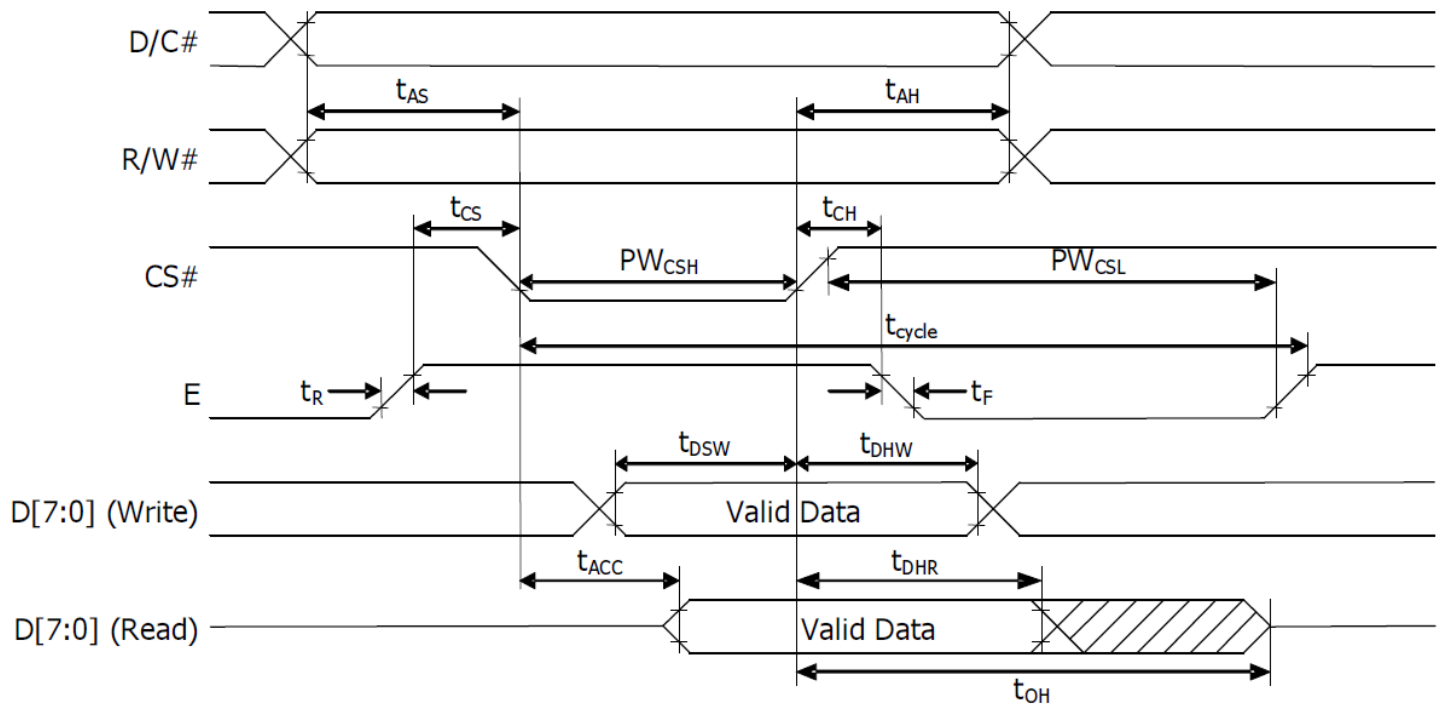
6800-Series Parallel Interface:

| Symbol      | Parameter                                  | Min | Typ | Max | Unit |
|-------------|--------------------------------------------|-----|-----|-----|------|
| $t_{cycle}$ | Clock Cycle Time (write cycle)             | 400 | -   | -   | ns   |
| $t_{AS}$    | Address Setup Time                         | 13  | -   | -   | ns   |
| $t_{AH}$    | Address Hold Time                          | 17  | -   | -   | ns   |
| $t_{CS}$    | Chip Select Time                           | 0   | -   | -   | ns   |
| $t_{CH}$    | Chip Select Hold Time                      | 0   | -   | -   | ns   |
| $t_{DSW}$   | Write Data Setup Time                      | 35  | -   | -   | ns   |
| $t_{DHW}$   | Write Data Hold Time                       | 18  | -   | -   | ns   |
| $t_{DHR}$   | Read Data Hold Time                        | 13  | -   | -   | ns   |
| $t_{OH}$    | Output Disable Time                        | 10  | -   | 90  | ns   |
| $t_{ACC}$   | Access Time (RAM)                          | -   | -   | 125 | ns   |
|             | Access Time (command)                      | -   | -   | 125 | ns   |
| $PW_{CSL}$  | Chip Select Low Pulse Width (read RAM)     | 250 | -   | -   | ns   |
|             | Chip Select Low Pulse Width (read Command) | 250 | -   | -   | ns   |
|             | Chip Select Low Pulse Width (write)        | 50  | -   | -   | ns   |
| $PW_{CSH}$  | Chip Select High Pulse Width (read)        | 155 | -   | -   | ns   |
|             | Chip Select High Pulse Width (write)       | 55  | -   | -   | ns   |
| $t_R$       | Rise Time                                  | -   | -   | 15  | ns   |
| $t_F$       | Fall Time                                  | -   | -   | 15  | ns   |

Condition 1: /CS low pulse width > E high pulse width

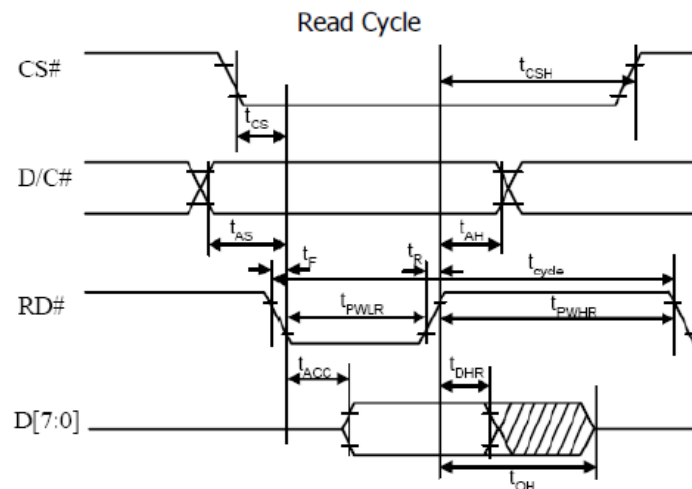
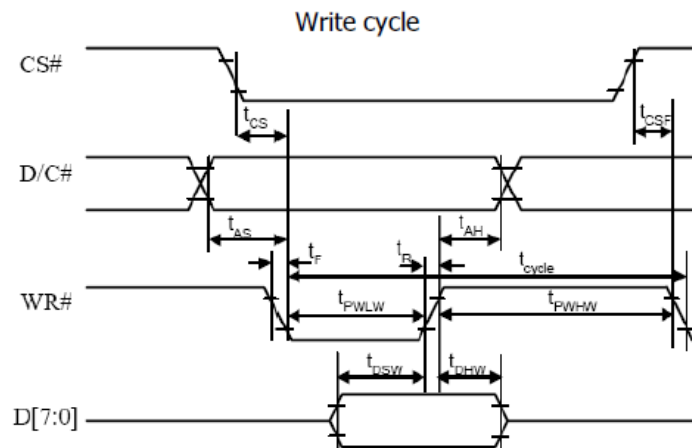


**Condition 2: /CS low pulse width < E high pulse width**



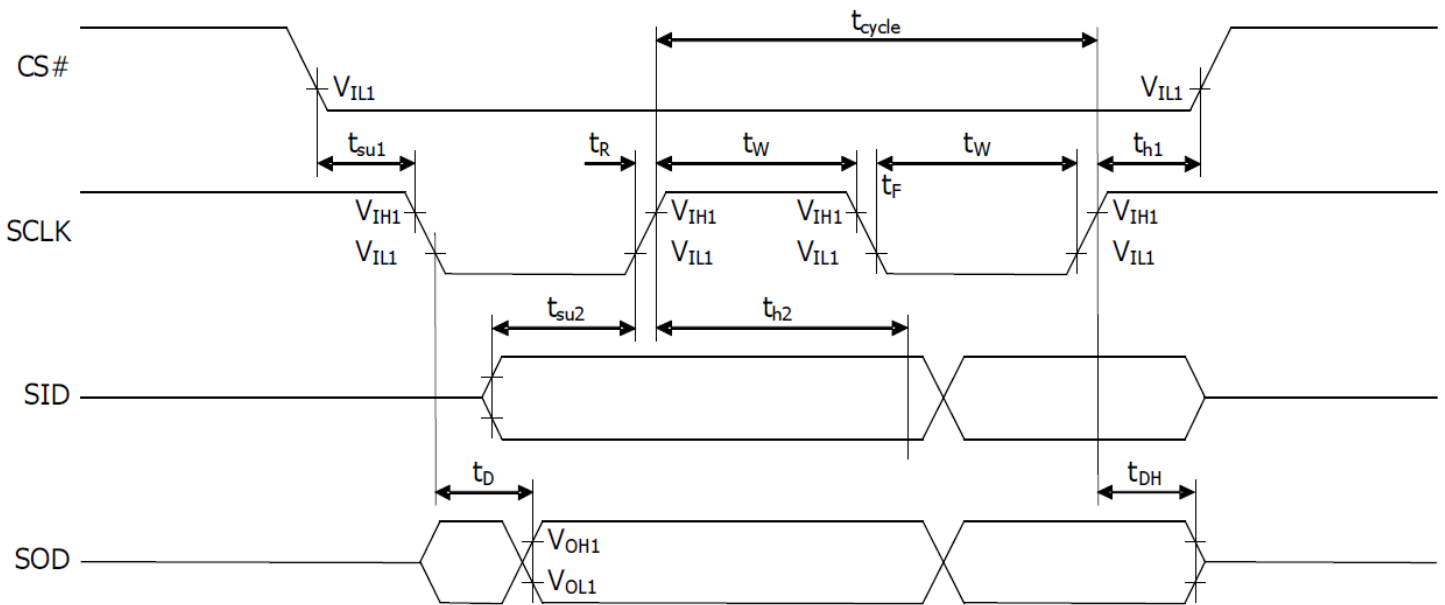
8080-Series Parallel Interface:

| Symbol      | Parameter                                               | Min | Typ | Max | Unit     |
|-------------|---------------------------------------------------------|-----|-----|-----|----------|
| $t_{cycle}$ | Clock Cycle Time (write cycle)                          | 400 | -   | -   | ns       |
| $t_{AS}$    | Address Setup Time                                      | 13  | -   | -   | ns       |
| $t_{AH}$    | Address Hold Time                                       | 17  | -   | -   | ns       |
| $t_{CS}$    | Chip Select Time                                        | 0   | -   | -   | ns       |
| $t_{CSH}$   | Chip select hold time to read signal                    | 0   | -   | -   | ns       |
| $t_{CSF}$   | Chip select hold time                                   | 0   | -   | -   | ns       |
| $t_{DSW}$   | Write Data Setup Time                                   | 35  | -   | -   | ns       |
| $t_{DHW}$   | Write Data Hold Time                                    | 18  | -   | -   | ns       |
| $t_{DHR}$   | Read Data Hold Time                                     | 13  | -   | -   | ns       |
| $t_{OH}$    | Output Disable Time                                     | 10  | -   | 70  | ns       |
| $t_{ACC}$   | Access Time (RAM)<br>Access Time (command)              | -   | -   | 125 | ns<br>ns |
| $PW_{CSL}$  | Chip Select Low Pulse Width (read RAM) - $t_{PWLR}$     | 250 | -   | -   | ns       |
|             | Chip Select Low Pulse Width (read Command) - $t_{PWLR}$ | 250 | -   | -   | ns       |
|             | Chip Select Low Pulse Width (write) - $t_{PWLW}$        | 50  | -   | -   | ns       |
| $PW_{CSH}$  | Chip Select High Pulse Width (read) - $t_{PWHR}$        | 155 | -   | -   | ns       |
|             | Chip Select High Pulse Width (write) - $t_{PWHW}$       | 55  | -   | -   | ns       |
| $t_R$       | Rise Time                                               | -   | -   | 15  | ns       |
| $t_F$       | Fall Time                                               | -   | -   | 15  | ns       |



Serial Interface:

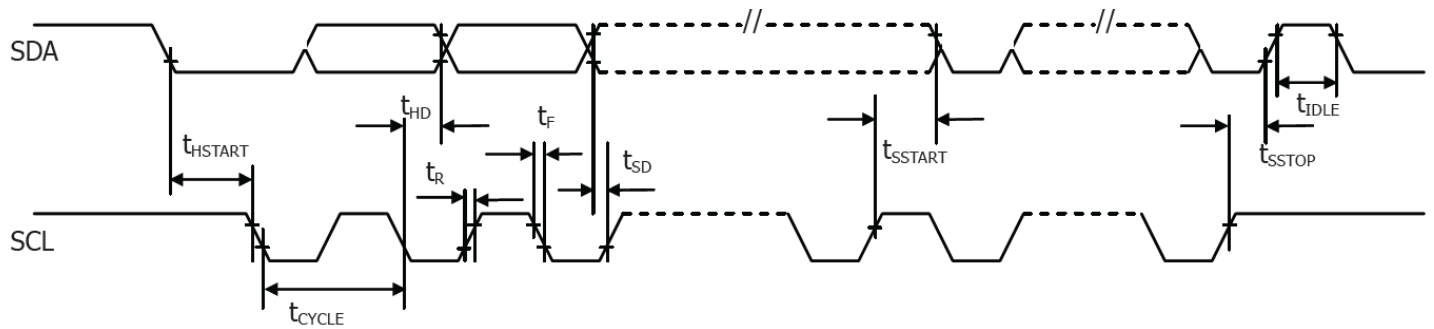
| Symbol     | Parameter                      | Min | Typ | Max | Unit |
|------------|--------------------------------|-----|-----|-----|------|
| $t_c$      | Serial clock cycle time        | 1   | -   | 20  | us   |
| $t_r, t_f$ | Serial clock rise/fall time    | -   | -   | 15  | ns   |
| $t_w$      | Serial clock width (high, low) | 400 | -   | -   | ns   |
| $t_{su1}$  | Chip select setup time         | 60  | -   | -   | ns   |
| $t_{h1}$   | Chip select hold time          | 20  | -   | -   | ns   |
| $t_{su2}$  | Serial input data setup time   | 200 | -   | -   | ns   |
| $t_{h2}$   | Serial input data hold time    | TBD | -   | -   | ns   |
| $t_D$      | Serial output data delay time  | -   | -   | TBD | ns   |
| $t_{DH}$   | Serial output data hold time   | 10  | -   | -   | ns   |





## I<sup>2</sup>C Interface:

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



# Built-in Font Tables

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

| b7-4<br>3D=0 | 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] )**

| 17-0<br>25-0 | 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 C ( ROM[1:0] = [1:0] )

| b7-b0<br>a7-a0 | 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           |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

## Example Program Code

```
void command(char i)
{
    C_S = 0;          //chip select LOW – active
    P1 = i;          //data on port
    D_C = 0;          //data/command select LOW – command
    R_W = 0;          //read/write select LOW – write
    E = 1;           //enable HIGH
    delayms(1);      //delay
    E = 0;           //enable LOW – data latched
}
```

---

```
void data(char i)
{
    C_S = 0;          //chip select LOW – active
    P1 = i;          //data on port
    D_C = 1;          //data/command select HIGH – data
    R_W = 0;          //read/write select LOW – write
    E = 1;           //enable HIGH
    delayms(1);      //delay
    E = 0;           //enable LOW – data latched
}
```

---

```
void output()
{
    int i;
    command(0x01);    //clear display
    command(0x02);    //return home
    for(i=0;i<20;i++)
    {
        data(0x1F);    //write solid blocks
    }
    command(0xC0);    //line 2
    for(i=0;i<20;i++)
    {
        data(0x1F);    //write solid blocks
    }
}
```

---

```
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(0x10); //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
}

```

---

```

void main(void)
{
    init();
    while(1)
    {
        output();
        delayms(2000);
    }
}

```

---

## 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)

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