

**Product Specification**

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# NHD-1.91-176176B

## Graphic Color OLED Display

<b>NHD-</b>	Newhaven Display
<b>1.91-</b>	1.91" Diagonal Size
<b>176176-</b>	176 x 176 Pixels
<b>B-</b>	Model

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## Additional Resources

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



## Document Revision History

Revision	Date	Description	Changed By
-	12/28/2023	Initial Release	KL

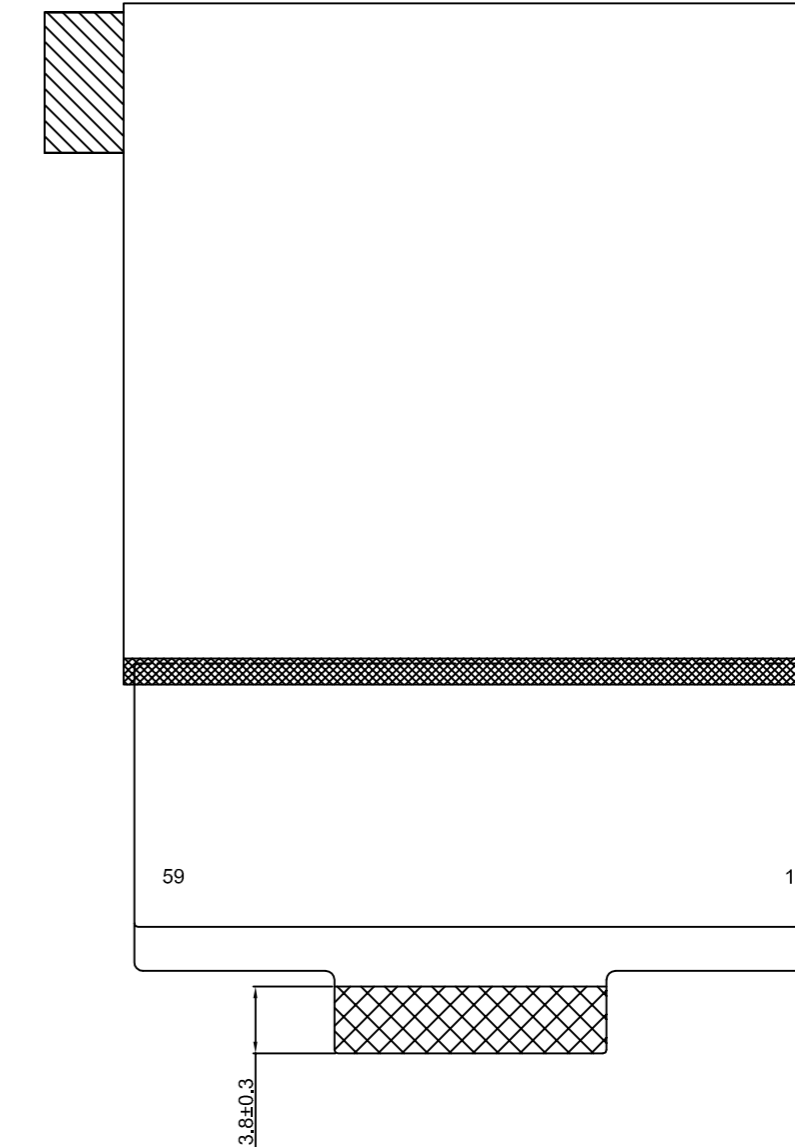
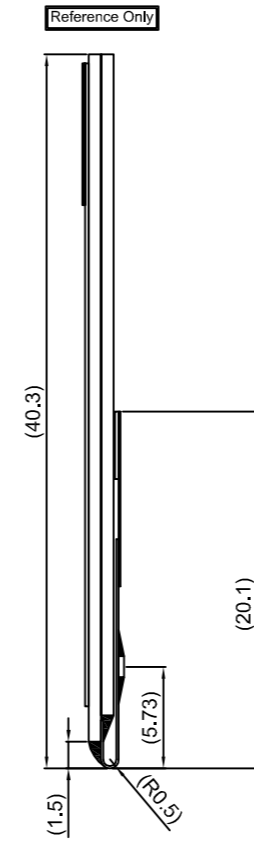
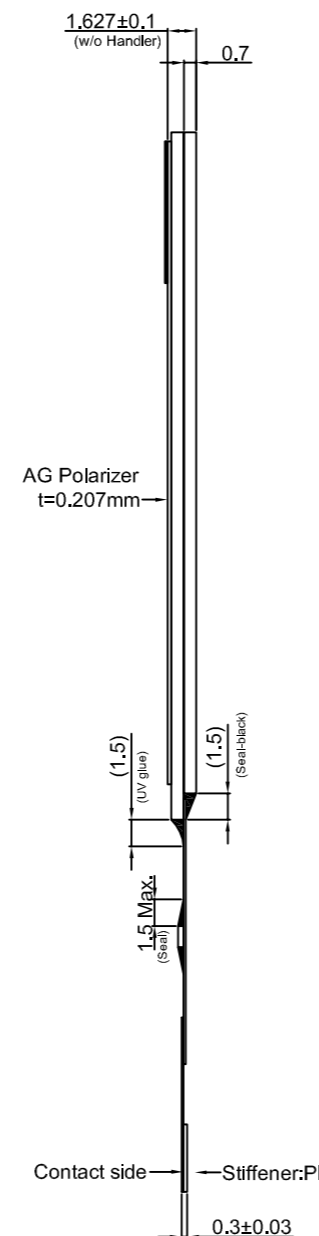
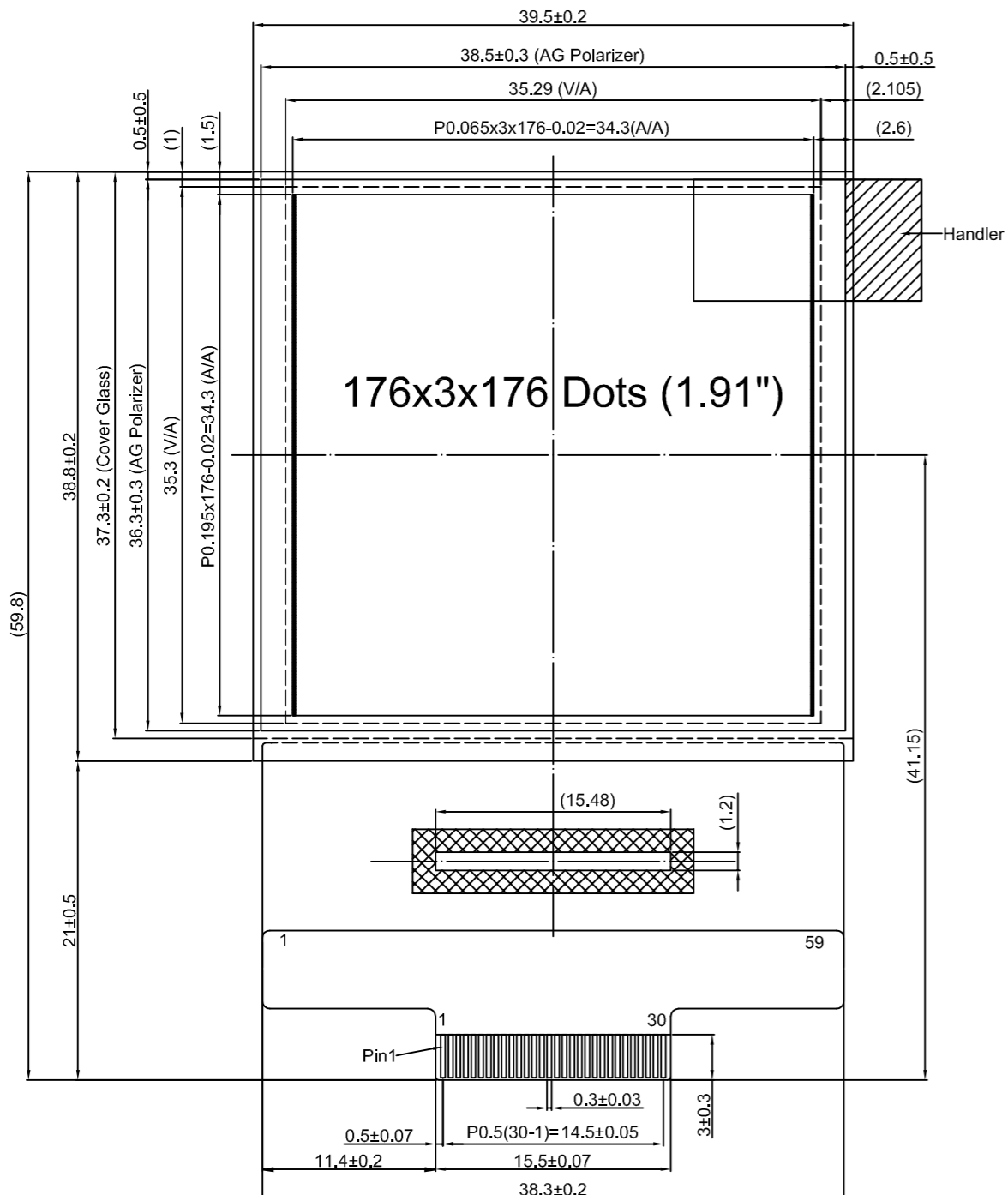
# Mechanical Drawing

Newhaven Display

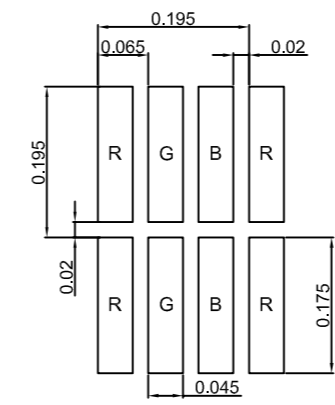
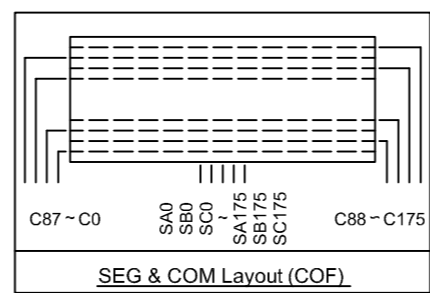
NHD-1.90-176176B

Date Code

Part Label (type/format may vary)



Pin Assignment	
NO.	SYMBOL
1	NC
2	VLSS
3	VSL
4	VCOMH
5	VCC
6	D7
7	D6
8	D5
9	D4
10	D3
11	D2
12	D1
13	D0
14	E(RD#)
15	R/W#(WR#)
16	BS1
17	BS2
18	CS#
19	D/C#
20	RES#
21	FR
22	VDD
23	VSS
24	IREF
25	VCC
26	VP
27	VCOMH
28	VSL
29	VLSS
30	NC



- Product Description: 1.91" 176x176 Color OLED**
1. Driver IC: SSD1333
  2. Interface: 8-bit 6800/8080 Parallel, 4-wire SPI, I<sup>2</sup>C
  3. Power Requirement: 1.8V OLED
  4. Optical Features: Full Color, Full View
  5. Recommended FFC Connector: 30pin 0.5mm pitch; Ex. Molex 54104-3031

<b>Standard Tolerance:</b> (Unless otherwise specified)  Linear: ±0.3mm		
	Drawing/Part Number: <b>NHD-1.91-176176B</b>	Revision: <b>1A</b>
<b>Unless otherwise specified:</b> • Dimensions are in Millimeters • Third Angle Projection	Drawn By: K. Lewis	Approved By: K. Lewis
	Drawn Date: 12/28/2023	Approved Date: 12/28/2023
This drawing is solely the property of Newhaven Display International, Inc. The information it contains is not to be disclosed, reproduced or copied in whole or part without written approval from Newhaven Display.		

## Pin Description

Pin No.	Symbol	External Connection	Function Description
1	NC	-	No Connect
2	VLSS	Power Supply	Ground
3	VSL	-	Voltage for Low Level SEG Signal
4	VCOMH	-	Voltage for High Level COM Signal
5	VCC	Power Supply	Supply Voltage for OLED Panel (+14V)
6-13	D7-D0	MPU	<b>Parallel Interface:</b> 8-bit Bi-directional data bus <b>4-wire SPI Interface:</b> D0 - Serial Clock signal (SCLK) D1 - Serial Data Input signal (SDIN) - connect together with D2 <b>I<sup>2</sup>C Interface:</b> D0 - Serial Clock signal (SCL) D1 - Serial Data Input signal (SDA <sub>IN</sub> ) D2 - Serial Data Output signal (SDA <sub>OUT</sub> )
14	E (RD#)	MPU	<b>6800 mode:</b> Enable signal. Falling edge triggered <b>8080 mode:</b> Active LOW Read signal
15	R/W# (WR#)	MPU	<b>6800 mode:</b> Read/Write signal. HIGH: Read, LOW: Write <b>8080 mode:</b> Active LOW Write signal
16	BS1	MPU	MPU Interface Select signal
17	BS2	MPU	MPU Interface Select signal
18	CS#	MPU	Active LOW Chip Select signal
19	D/C# SA0	MPU	Data/Command Control signal. HIGH: Data, LOW: Command <b>I<sup>2</sup>C:</b> Slave address selection signal
20	RES#	MPU	Active LOW Reset signal
21	FR	MPU	RAM write synchronization signal (No Connect if not used)
22	VDD	Power Supply	Supply Voltage for Core Logic Circuit (+3V)
23	VSS	Power Supply	Ground
24	IREF	-	Current for SEG Brightness
25	VCC	Power Supply	Supply Voltage for OLED Panel (+14V)
26	VP	-	Voltage for SEG pre-charge
27	VCOMH	-	Voltage for High Level COM signal
28	VSL	-	Voltage for Low Level SEG signal
29	VLSS	Power Supply	Ground
30	NC	-	No Connect

**Recommended display connector:** 30pin 0.5mm pitch top contact FFC connector (Molex 54104-3031)

## Interface Selection

### MPU Interface Pin Selections and Assignment Summary

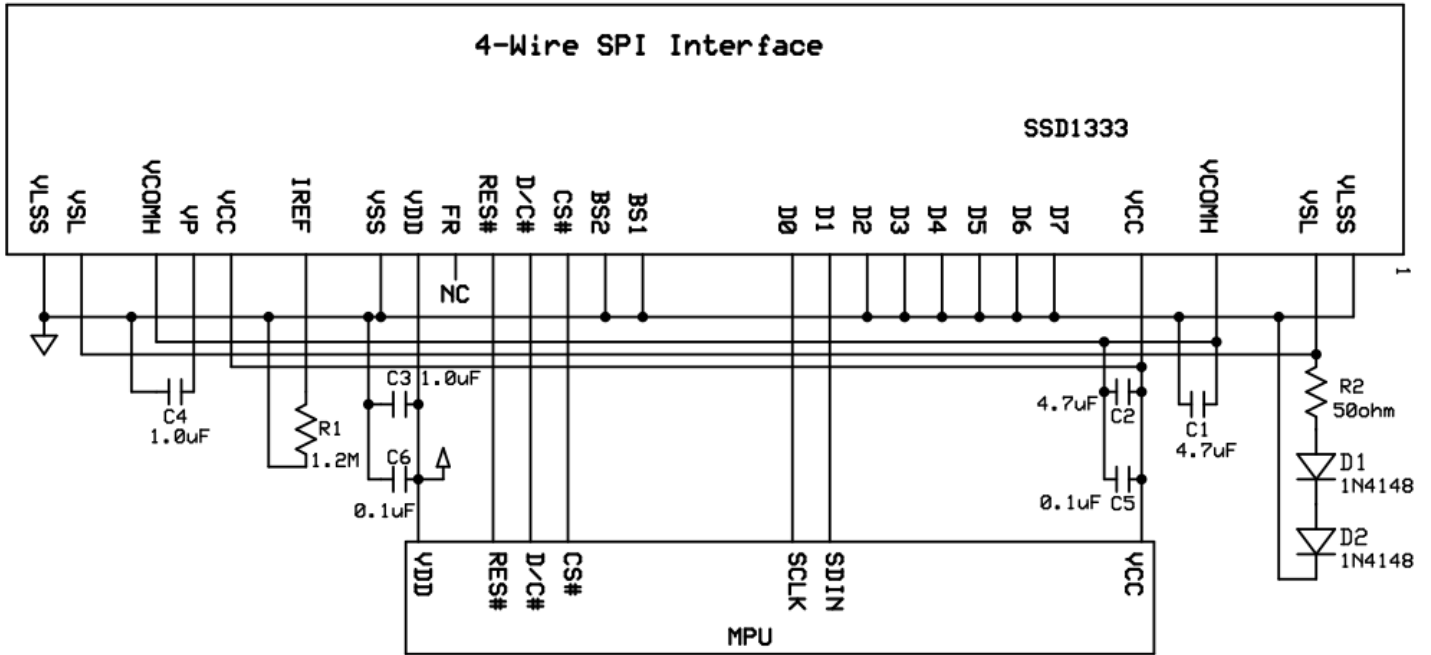
	6800 Parallel	8080 Parallel	4-Wire SPI	I <sup>2</sup> C
BS1	0	1	0	1
BS2	1	1	0	0

Bus Interface	Data/Command Interface								Control Signals				
	D7	D6	D5	D4	D3	D2	D1	D0	E	R/W#	CS#	D/C#	RES#
8-bit 6800	D[7:0]								E	R/W#	CS#	D/C#	RES#
8-bit 8080	D[7:0]								RD#	WR#	CS#	D/C#	RES#
4-Wire SPI	Tie Low						SDIN	SCLK	Tie Low		CS#	D/C#	RES#
I <sup>2</sup> C	Tie Low					SDA <sub>OUT</sub>	SDA <sub>IN</sub>	SCL	Tie Low			SA0	RES#

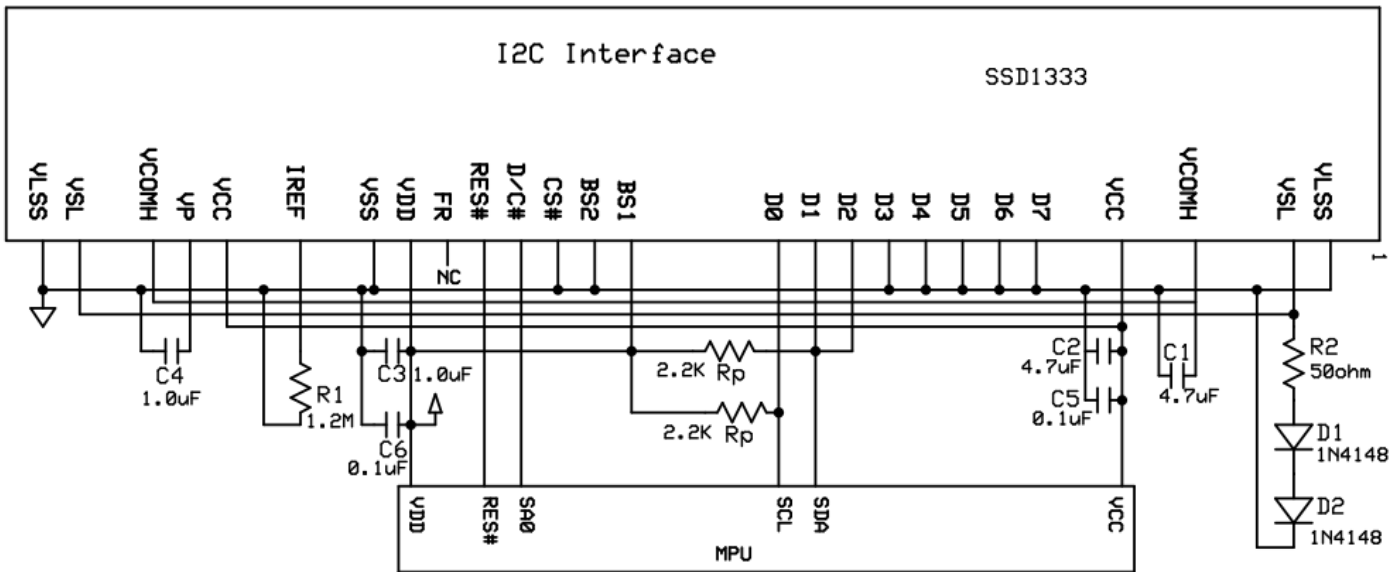




**4-Wire SPI Interface**



**I<sup>2</sup>C Interface**



## Electrical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Temperature Range	T <sub>OP</sub>	Absolute Max	-40	-	+70	°C
Storage Temperature Range	T <sub>ST</sub>	Absolute Max	-40	-	+85	°C
Supply Voltage for Logic	V <sub>DD</sub>	-	1.65	1.8	3.5	V
Supply Voltage for Display	V <sub>CC</sub>	-	16.5	17	17.5	V
Supply Current (Display)	I <sub>CC</sub>	V <sub>CC</sub> =17V, 100% ON	-	58	60	mA
Sleep mode Current	I <sub>CC_SLEEP</sub>	V <sub>CI</sub> = 1.8V	-	-	10	μA
"H" Level input	V <sub>IH</sub>	-	0.8*V <sub>DD</sub>	-	V <sub>DD</sub>	V
"L" Level input	V <sub>IL</sub>	-	V <sub>SS</sub>	-	0.2*V <sub>DD</sub>	V
"H" Level output	V <sub>OH</sub>	-	0.9*V <sub>DD</sub>	-	V <sub>DD</sub>	V
"L" Level output	V <sub>OL</sub>	-	V <sub>SS</sub>	-	0.1*V <sub>DD</sub>	V

## Optical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Optimal Viewing Angles	Top	-	-	80	-	°
	Bottom		-	80	-	°
	Left		-	80	-	°
	Right		-	80	-	°
Contrast Ratio	CR	-	-	>10,000:1	-	-
Response Time	Rise	T <sub>R</sub>	-	10	-	us
	Fall	T <sub>F</sub>	-	10	-	us
Brightness	L <sub>V</sub>	-	70	80	-	cd/m <sup>2</sup>
Lifetime		80cd/m <sup>2</sup> , T <sub>OP</sub> =25°C 50% Checkerboard	16,500	-	-	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 SSD1333 Controller: <https://support.newhavendisplay.com/hc/en-us/articles/11256414111767-SSD1333>





## Table of Commands

Fundamental Command Table											
D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	15	0	0	0	1	0	1	0	1	Set Column Address	A[7:0]: Start Address. [reset=0] B[7:0]: End Address. [reset=175d] Ranges from 0 to 175
1	A[7:0]	A <sub>7</sub>	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		
1	B[7:0]	B <sub>7</sub>	B <sub>6</sub>	B <sub>5</sub>	B <sub>4</sub>	B <sub>3</sub>	B <sub>2</sub>	B <sub>1</sub>	B <sub>0</sub>		
0	75	0	1	1	1	0	1	0	1	Set Row Address	A[7:0]: Start Address. [reset=0] B[7:0]: End Address. [reset=175d] Ranges from 0 to 175
1	A[7:0]	A <sub>7</sub>	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		
1	B[7:0]	B <sub>7</sub>	B <sub>6</sub>	B <sub>5</sub>	B <sub>4</sub>	B <sub>3</sub>	B <sub>2</sub>	B <sub>1</sub>	B <sub>0</sub>		
0	5C	0	1	0	1	1	1	0	0	Write RAM Command	Enable MCU to write Data into RAM
0	5D	0	1	0	1	1	1	0	1	Read RAM Command	Enable MCU to read Data from RAM
0	A0	1	0	1	0	0	0	0	0	Set Re-map / Color Depth (Display RAM to Panel)	A[0]=0b, Horizontal address increment [reset] A[0]=1b, Vertical address increment
1	A[7:0]	A <sub>7</sub>	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		<p>A[1]=0b, Column address 0 is mapped to SEG0 [reset] A[1]=1b, Column address 175 is mapped to SEG0</p> <p>A[2]=0b, Color sequence: A → B → C [reset] A[2]=1b, Color sequence is swapped: C → B → A</p> <p>A[3]=0b, Reserved [reset] A[3]=1b, Reserved</p> <p>A[4]=0b, Scan from COM0 to COM[N-1] [reset] A[4]=1b, Scan from COM[N-1] to COM0. Where N is the Multiplex ratio.</p> <p>A[5]=0b, Disable COM Split Odd Even A[5]=1b, Enable COM Split Odd Even [reset]</p> <p>A[7:6] Set Color Depth, 00b: 256color 01b: 65k color [reset] 10b: 262k color 11b Pseudo 262k color, 16-bit format 2</p> <p>Refer to Product Preview Table 6-7 for details</p>

Fundamental Command Table											
D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0 1	A1 A[7:0]	1 A <sub>7</sub>	0 A <sub>6</sub>	1 A <sub>5</sub>	0 A <sub>4</sub>	0 A <sub>3</sub>	0 A <sub>2</sub>	0 A <sub>1</sub>	1 A <sub>0</sub>	Set Display Start Line	Set vertical scroll by RAM from 0~175. [reset=00h]
0 1	A2 A[7:0]	1 A <sub>7</sub>	0 A <sub>6</sub>	1 A <sub>5</sub>	0 A <sub>4</sub>	0 A <sub>3</sub>	0 A <sub>2</sub>	1 A <sub>1</sub>	0 A <sub>0</sub>	Set Display Offset	Set vertical scroll by Row from 0-175. [reset=00h]
0	A4~A7	1	0	1	0	0	1	X <sub>1</sub>	X <sub>0</sub>	Set Display Mode	A4h: All OFF A5h: All ON (All pixels have GS63) A6h : Reset to normal display [reset] A7h: Inverse Display (GS0 -> GS63, GS1 -> GS62, ....)
0	AE~AF	1	0	1	0	1	1	1	X <sub>0</sub>	Set Sleep mode ON/OFF	A Eh = Sleep mode On (Display OFF) A Fh = Sleep mode OFF (Display ON)
0 1	B1 A[7:0]	1 A <sub>7</sub>	0 A <sub>6</sub>	1 A <sub>5</sub>	1 A <sub>4</sub>	0 A <sub>3</sub>	0 A <sub>2</sub>	0 A <sub>1</sub>	1 A <sub>0</sub>	Set Reset (Phase 1) / Pre-charge (Phase 2) period	A[3:0] Phase 1 period of 2~30 DCLK(s) clocks [reset=0100b] A[3:0]: 0 invalid 1 = 2 DCLKs 2 = 4 DCLKs : 15 = 30DCLKs  A[7:4] Phase 2 period of 2~30 DCLK(s) clocks [reset=1000b] A[7:4]: 0 invalid 1 = 2 DCLKs 2 = 4 DCLKs : 15 =30DCLKs  Note (1) 0 DCLK is invalid in phase 1 & phase 2

**Fundamental Command Table**

D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description																						
0	B3	1	0	1	1	0	0	1	1	Front Clock Divider (DivSet)/ Oscillator Frequency	A[3:0] [reset=0000b], divide by DIVSET where <table border="1" style="margin: 10px auto;"> <thead> <tr> <th>A[3:0]</th> <th>DIVSET</th> </tr> </thead> <tbody> <tr><td>0000</td><td>divide by 1</td></tr> <tr><td>0001</td><td>divide by 2</td></tr> <tr><td>0010</td><td>divide by 4</td></tr> <tr><td>0011</td><td>divide by 8</td></tr> <tr><td>0100</td><td>divide by 16</td></tr> <tr><td>0101</td><td>divide by 32</td></tr> <tr><td>0110</td><td>divide by 64</td></tr> <tr><td>0111</td><td>divide by 128</td></tr> <tr><td>1000</td><td>divide by 256</td></tr> <tr><td>&gt;=1001</td><td>invalid</td></tr> </tbody> </table>	A[3:0]	DIVSET	0000	divide by 1	0001	divide by 2	0010	divide by 4	0011	divide by 8	0100	divide by 16	0101	divide by 32	0110	divide by 64	0111	divide by 128	1000	divide by 256	>=1001	invalid
A[3:0]	DIVSET																																
0000	divide by 1																																
0001	divide by 2																																
0010	divide by 4																																
0011	divide by 8																																
0100	divide by 16																																
0101	divide by 32																																
0110	divide by 64																																
0111	divide by 128																																
1000	divide by 256																																
>=1001	invalid																																
1	A[7:0]	A <sub>7</sub>	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	A[7:4] Oscillator frequency, frequency increases as level increases [reset=1001b]																							
0	B6	1	0	1	1	0	1	0	0	Set Second Pre-charge Period	A[3:0] Set Second Pre-charge Period  0000b invalid 0001b 1 DCLKS 0010b 2 DCLKS ..... 1000 8 DCLKS [reset] ..... 1111 15 DCLKS																						
1	A[3:0]	0	0	0	0	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>																								
0	B8	1	0	1	1	1	0	0	0	Master Look Up Table for Gray Scale Pulse width (Color A,B,C)  <b>Note</b> (1) 0 ≤ Setting of GS1 < Setting of GS2 < Setting of GS3..... < Setting of GS62 < Setting of GS63 (2) GS0 does not has pre-charge and current drive stages. (3) GS1 can be set as only pre-charge but no current drive stage by input gamma setting for GS1 equals 0. (4) When command B8h is input only, color A, B, C will follow the master LUT. (5) When command BCh is input, it selects individual LUT for color A, GS1~31A; When command BDh is input, it selects individual LUT for color C, GS1~31C (6) To select individual LUT for color B, A and C, command B8h should be input before command BCh and BDh,																							
1	A1[7:0]	A1 <sub>7</sub>	A1 <sub>6</sub>	A1 <sub>5</sub>	A1 <sub>4</sub>	A1 <sub>3</sub>	A1 <sub>2</sub>	A1 <sub>1</sub>	A1 <sub>0</sub>		The next 63 data bytes define Gray Scale (GS) Table by setting the gray scale pulse width in unit of DCLK's (ranges from 0d ~ 180d).																						
1	A2[7:0]	A2 <sub>7</sub>	A2 <sub>6</sub>	A2 <sub>5</sub>	A2 <sub>4</sub>	A2 <sub>3</sub>	A2 <sub>2</sub>	A2 <sub>1</sub>	A2 <sub>0</sub>		A1[7:0]: Gamma Setting for GS1, A2[7:0]: Gamma Setting for GS2, .....																						
1	.	.	.	.	.	.	.	.	.		.																						
1	.	.	.	.	.	.	.	.	.		.																						
1	.	.	.	.	.	.	.	.	.		.																						
1	A62[7:0]	A62 <sub>7</sub>	A62 <sub>6</sub>	A62 <sub>5</sub>	A62 <sub>4</sub>	A62 <sub>3</sub>	A62 <sub>2</sub>	A62 <sub>1</sub>	A62 <sub>0</sub>		A62[7:0]: Gamma Setting for GS62, A63[7:0]: Gamma Setting for GS63																						
1	A63[7:0]	A63 <sub>7</sub>	A63 <sub>6</sub>	A63 <sub>5</sub>	A63 <sub>4</sub>	A63 <sub>3</sub>	A63 <sub>2</sub>	A63 <sub>1</sub>	A63 <sub>0</sub>																								
1	.	.	.	.	.	.	.	.	.		.																						
1	.	.	.	.	.	.	.	.	.		.																						

Fundamental Command Table																																																																																																																																																																																																																																																											
D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description																																																																																																																																																																																																																																																
0	B9	1	0	1	1	1	0	0	1	Use Built-in Linear LUT [reset= linear]	Reset to default Look Up Table:																																																																																																																																																																																																																																																
											<table border="1"> <thead> <tr> <th>Color A</th> <th>Color B</th> <th>Color C</th> </tr> </thead> <tbody> <tr> <td>GS1A = 0 DCLK</td> <td>GS1B = 0 DCLK</td> <td>GS1C = 0 DCLK</td> </tr> <tr> <td>GS2A = 4 DCLK</td> <td>GS2B = 2 DCLK</td> <td>GS2C = 4 DCLK</td> </tr> <tr> <td>GS3A = 8 DCLK</td> <td>GS3B = 4 DCLK</td> <td>GS3C = 8 DCLK</td> </tr> <tr> <td>...</td> <td>...</td> <td>...</td> </tr> <tr> <td>GS31A = 120 DCLK</td> <td>GS62B = 122 DCLK</td> <td>GS31C = 120 DCLK</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>0</td> <td>BB</td> <td>1</td> <td>0</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> <td>1</td> <td>1</td> <td rowspan="5">Set Pre-charge voltage</td> <td rowspan="5">Set pre-charge voltage level. [reset = 01111b]</td> </tr> <tr> <td>1</td> <td>A[4:0]</td> <td>0</td> <td>0</td> <td>0</td> <td>A<sub>4</sub></td> <td>A<sub>3</sub></td> <td>A<sub>2</sub></td> <td>A<sub>1</sub></td> <td>A<sub>0</sub></td> <td> <table border="1"> <thead> <tr> <th>A[4:0]</th> <th>Hex code</th> <th>pre-charge voltage</th> </tr> </thead> <tbody> <tr> <td>00000</td> <td>00h</td> <td>0.10 x V<sub>CC</sub></td> </tr> <tr> <td>:</td> <td>:</td> <td>:</td> </tr> <tr> <td>10111</td> <td>17h</td> <td>0.40 x V<sub>CC</sub> [reset]</td> </tr> <tr> <td>:</td> <td>:</td> <td>:</td> </tr> <tr> <td>11111</td> <td>1Fh</td> <td>0.5133 x V<sub>CC</sub></td> </tr> </tbody> </table> </td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>0</td> <td>BC</td> <td>1</td> <td>0</td> <td>1</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> <td rowspan="11">Individual Look Up Table for Gray Scale Pulse width (Color A)</td> <td rowspan="11">The next 31 data bytes define Gray Scale (GS) Table by setting the gray scale pulse width in unit of DCLK's (ranges from 0d ~ 180d) for color A.</td> </tr> <tr> <td>1</td> <td>A1[7:0]</td> <td>A1<sub>7</sub></td> <td>A1<sub>6</sub></td> <td>A1<sub>5</sub></td> <td>A1<sub>4</sub></td> <td>A1<sub>3</sub></td> <td>A1<sub>2</sub></td> <td>A1<sub>1</sub></td> <td>A1<sub>0</sub></td> <td>A1[7:0]: Gamma Setting for GS1A,</td> </tr> <tr> <td>1</td> <td>A2[7:0]</td> <td>A2<sub>7</sub></td> <td>A2<sub>6</sub></td> <td>A2<sub>5</sub></td> <td>A2<sub>4</sub></td> <td>A2<sub>3</sub></td> <td>A2<sub>2</sub></td> <td>A2<sub>1</sub></td> <td>A2<sub>0</sub></td> <td>A2[7:0]: Gamma Setting for GS2A,</td> </tr> <tr> <td>1</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>:</td> </tr> <tr> <td>1</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> </tr> <tr> <td>1</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> <td>.</td> </tr> <tr> <td>1</td> <td>A30[7:0]</td> <td>A30<sub>7</sub></td> <td>A30<sub>6</sub></td> <td>A30<sub>5</sub></td> <td>A30<sub>4</sub></td> <td>A30<sub>3</sub></td> <td>A30<sub>2</sub></td> <td>A30<sub>1</sub></td> <td>A30<sub>0</sub></td> <td>A30[7:0]: Gamma Setting for GS30A,</td> </tr> <tr> <td>1</td> <td>A31[7:0]</td> <td>A31<sub>7</sub></td> <td>A31<sub>6</sub></td> <td>A31<sub>5</sub></td> <td>A31<sub>4</sub></td> <td>A31<sub>3</sub></td> <td>A31<sub>2</sub></td> <td>A31<sub>1</sub></td> <td>A31<sub>0</sub></td> <td>A31[7:0]: Gamma Setting for GS31A</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Color A	Color B	Color C	GS1A = 0 DCLK	GS1B = 0 DCLK	GS1C = 0 DCLK	GS2A = 4 DCLK	GS2B = 2 DCLK	GS2C = 4 DCLK	GS3A = 8 DCLK	GS3B = 4 DCLK	GS3C = 8 DCLK	...	...	...	GS31A = 120 DCLK	GS62B = 122 DCLK	GS31C = 120 DCLK													0	BB	1	0	1	1	1	0	1	1	Set Pre-charge voltage	Set pre-charge voltage level. [reset = 01111b]	1	A[4:0]	0	0	0	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	<table border="1"> <thead> <tr> <th>A[4:0]</th> <th>Hex code</th> <th>pre-charge voltage</th> </tr> </thead> <tbody> <tr> <td>00000</td> <td>00h</td> <td>0.10 x V<sub>CC</sub></td> </tr> <tr> <td>:</td> <td>:</td> <td>:</td> </tr> <tr> <td>10111</td> <td>17h</td> <td>0.40 x V<sub>CC</sub> [reset]</td> </tr> <tr> <td>:</td> <td>:</td> <td>:</td> </tr> <tr> <td>11111</td> <td>1Fh</td> <td>0.5133 x V<sub>CC</sub></td> </tr> </tbody> </table>	A[4:0]	Hex code	pre-charge voltage	00000	00h	0.10 x V <sub>CC</sub>	:	:	:	10111	17h	0.40 x V <sub>CC</sub> [reset]	:	:	:	11111	1Fh	0.5133 x V <sub>CC</sub>																																					0	BC	1	0	1	1	1	1	0	0	Individual Look Up Table for Gray Scale Pulse width (Color A)	The next 31 data bytes define Gray Scale (GS) Table by setting the gray scale pulse width in unit of DCLK's (ranges from 0d ~ 180d) for color A.	1	A1[7:0]	A1 <sub>7</sub>	A1 <sub>6</sub>	A1 <sub>5</sub>	A1 <sub>4</sub>	A1 <sub>3</sub>	A1 <sub>2</sub>	A1 <sub>1</sub>	A1 <sub>0</sub>	A1[7:0]: Gamma Setting for GS1A,	1	A2[7:0]	A2 <sub>7</sub>	A2 <sub>6</sub>	A2 <sub>5</sub>	A2 <sub>4</sub>	A2 <sub>3</sub>	A2 <sub>2</sub>	A2 <sub>1</sub>	A2 <sub>0</sub>	A2[7:0]: Gamma Setting for GS2A,	1	.	.	.	.	.	.	.	.	.	:	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	A30[7:0]	A30 <sub>7</sub>	A30 <sub>6</sub>	A30 <sub>5</sub>	A30 <sub>4</sub>	A30 <sub>3</sub>	A30 <sub>2</sub>	A30 <sub>1</sub>	A30 <sub>0</sub>	A30[7:0]: Gamma Setting for GS30A,	1	A31[7:0]	A31 <sub>7</sub>	A31 <sub>6</sub>	A31 <sub>5</sub>	A31 <sub>4</sub>	A31 <sub>3</sub>	A31 <sub>2</sub>	A31 <sub>1</sub>	A31 <sub>0</sub>	A31[7:0]: Gamma Setting for GS31A																																												
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1	A1[7:0]	A1 <sub>7</sub>	A1 <sub>6</sub>	A1 <sub>5</sub>	A1 <sub>4</sub>	A1 <sub>3</sub>	A1 <sub>2</sub>	A1 <sub>1</sub>	A1 <sub>0</sub>			A1[7:0]: Gamma Setting for GS1A,																																																																																																																																																																																																																																															
1	A2[7:0]	A2 <sub>7</sub>	A2 <sub>6</sub>	A2 <sub>5</sub>	A2 <sub>4</sub>	A2 <sub>3</sub>	A2 <sub>2</sub>	A2 <sub>1</sub>	A2 <sub>0</sub>			A2[7:0]: Gamma Setting for GS2A,																																																																																																																																																																																																																																															
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1	.	.	.	.	.	.	.	.	.			.																																																																																																																																																																																																																																															
1	.	.	.	.	.	.	.	.	.			.																																																																																																																																																																																																																																															
1	A30[7:0]	A30 <sub>7</sub>	A30 <sub>6</sub>	A30 <sub>5</sub>	A30 <sub>4</sub>	A30 <sub>3</sub>	A30 <sub>2</sub>	A30 <sub>1</sub>	A30 <sub>0</sub>			A30[7:0]: Gamma Setting for GS30A,																																																																																																																																																																																																																																															
1	A31[7:0]	A31 <sub>7</sub>	A31 <sub>6</sub>	A31 <sub>5</sub>	A31 <sub>4</sub>	A31 <sub>3</sub>	A31 <sub>2</sub>	A31 <sub>1</sub>	A31 <sub>0</sub>			A31[7:0]: Gamma Setting for GS31A																																																																																																																																																																																																																																															

**Fundamental Command Table**

D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description																		
0	BD	1	0	1	1	1	1	0	1	Individual Look Up Table for Gray Scale Pulse width (Color C)	The next 31 data bytes define Gray Scale (GS) Table by setting the gray scale pulse width in unit of DCLK's (ranges from 0d ~ 180d) for color C.  A1[7:0]: Gamma Setting for GS1C, A2[7:0]: Gamma Setting for GS2C, : A30[7:0]: Gamma Setting for GS30C, A31[7:0]: Gamma Setting for GS31C  <b>Note</b> (1) $0 \leq \text{Setting of GS1} < \text{Setting of GS2} < \text{Setting of GS3} \dots < \text{Setting of GS30} < \text{Setting of GS31}$ (2) GS0 does not has pre-charge and current drive stages. (3) GS1 can be set as only pre-charge but no current drive stage by input gamma setting for GS1 equals 0. (4) When command B8h is input, it selects one LUT for color A, B and C. i.e. GS1~31A, GS1~63B and GS1~31C are updated. (5) Command B8h should be input before command BCh and BDh to select individual LUT for color B, A and C.																		
1	A1[7:0]	A1 <sub>7</sub>	A1 <sub>6</sub>	A1 <sub>5</sub>	A1 <sub>4</sub>	A1 <sub>3</sub>	A1 <sub>2</sub>	A1 <sub>1</sub>	A1 <sub>0</sub>																				
1	A2[7:0]	A2 <sub>7</sub>	A2 <sub>6</sub>	A2 <sub>5</sub>	A2 <sub>4</sub>	A2 <sub>3</sub>	A2 <sub>2</sub>	A2 <sub>1</sub>	A2 <sub>0</sub>																				
1	.	.	.	.	.	.	.	.	.																				
1	.	.	.	.	.	.	.	.	.																				
1	.	.	.	.	.	.	.	.	.																				
1	A30[7:0]	A30 <sub>7</sub>	A30 <sub>6</sub>	A30 <sub>5</sub>	A30 <sub>4</sub>	A30 <sub>3</sub>	A30 <sub>2</sub>	A30 <sub>1</sub>	A30 <sub>0</sub>																				
1	A31[7:0]	A31 <sub>7</sub>	A31 <sub>6</sub>	A31 <sub>5</sub>	A31 <sub>4</sub>	A31 <sub>3</sub>	A31 <sub>2</sub>	A31 <sub>1</sub>	A31 <sub>0</sub>																				
0	BE	1	0	1	1	1	1	1	0			Set V <sub>COMH</sub> Voltage	Set COM deselect voltage level [reset = 05h]																
1	A[2:0]	0	0	0	0	0	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>																				
											<table border="1"> <thead> <tr> <th>A[2:0]</th> <th>Hex code</th> <th>V<sub>COMH</sub></th> </tr> </thead> <tbody> <tr> <td>000</td> <td>00h</td> <td>0.72 x V<sub>CC</sub></td> </tr> <tr> <td>:</td> <td>:</td> <td>:</td> </tr> <tr> <td>101</td> <td>05h</td> <td>0.82 x V<sub>CC</sub> [reset]</td> </tr> <tr> <td>:</td> <td>:</td> <td>:</td> </tr> <tr> <td>111</td> <td>07h</td> <td>0.86 x V<sub>CC</sub></td> </tr> </tbody> </table>	A[2:0]	Hex code	V <sub>COMH</sub>	000	00h	0.72 x V <sub>CC</sub>	:	:	:	101	05h	0.82 x V <sub>CC</sub> [reset]	:	:	:	111	07h	0.86 x V <sub>CC</sub>
A[2:0]	Hex code	V <sub>COMH</sub>																											
000	00h	0.72 x V <sub>CC</sub>																											
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101	05h	0.82 x V <sub>CC</sub> [reset]																											
:	:	:																											
111	07h	0.86 x V <sub>CC</sub>																											
0	C1	1	1	0	0	0	0	0	1	Set Contrast Current for Color A,B,C	A[7:0] Contrast Value Color A [reset=7Fh]																		
1	A[7:0]	A <sub>7</sub>	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		B[7:0] Contrast Value Color B [reset=7Fh]																		
1	B[7:0]	B <sub>7</sub>	B <sub>6</sub>	B <sub>5</sub>	B <sub>4</sub>	B <sub>3</sub>	B <sub>2</sub>	B <sub>1</sub>	B <sub>0</sub>		C[7:0] Contrast Value Color C [reset=7Fh]																		
1	C[7:0]	C <sub>7</sub>	C <sub>6</sub>	C <sub>5</sub>	C <sub>4</sub>	C <sub>3</sub>	C <sub>2</sub>	C <sub>1</sub>	C <sub>0</sub>																				
0	C7	1	1	0	0	0	1	1	1	Master Contrast Current Control	A[3:0] :																		
1	A[3:0]	0	0	0	0	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		0000b reduce output currents for all colors to 1/16 0001b reduce output currents for all colors to 2/16 .... 1110b reduce output currents for all colors to 15/16 1111b no change [reset]																		
0	CA	1	1	0	0	1	0	1	0	Set MUX Ratio	A[6:0] MUX ratio 4MUX ~ 176MUX, [reset=175]																		
1	A[7:0]	A <sub>7</sub>	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		(Ranges from 3 to 175)																		
0	E3	1	1	1	0	0	0	1	1	NOP	Command for No Operation																		

Fundamental Command Table											
D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	FD	1	1	1	1	1	1	0	1		A[7:0]: MCU protection status [reset = 12h]
1	A[7:0]	A <sub>7</sub>	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	Set Command Lock	A[7:0] = 12h, Unlock OLED driver IC MCU interface from entering command [reset] A[7:0] = 16h, Lock OLED driver IC MCU interface from entering command  <b>Note</b> <sup>(1)</sup> The locked OLED driver IC MCU interface prohibits all commands and memory access except the FDh command.

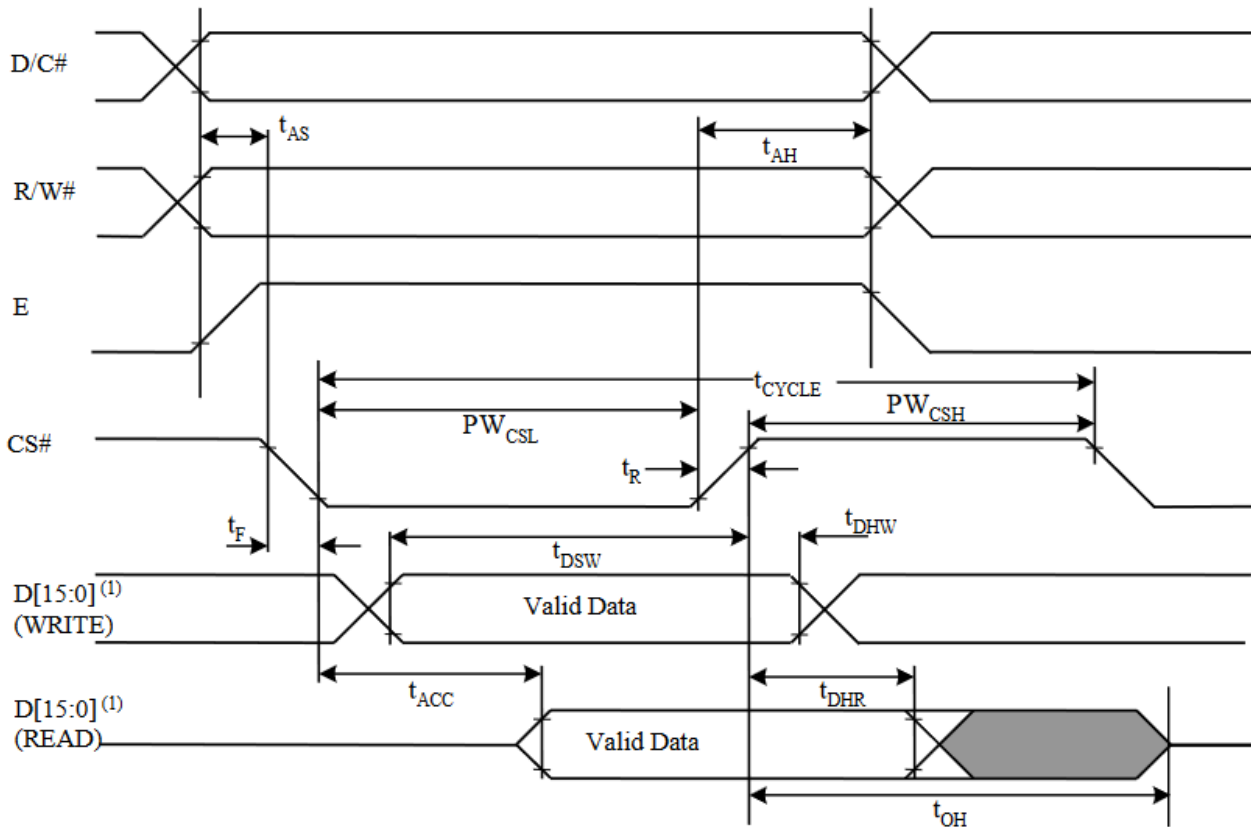
**Note**

<sup>(1)</sup> “\*” stands for “Don’t care”.

# Timing Characteristics

## 6800-Series MCU Parallel Interface:

Symbol	Parameter	Min	Typ	Max	Unit
$t_{CYCLE}$	Clock Cycle Time (write)	300	-	-	ns
$t_{AS}$	Address Setup Time	24	-	-	ns
$t_{AH}$	Address Hold Time	0	-	-	ns
$t_{DSW}$	Write Data Setup Time	40	-	-	ns
$t_{DHW}$	Write Data Hold Time	20	-	-	ns
$t_{DHR}$	Read Data Hold Time	20	-	-	ns
$t_{OH}$	Output Disable Time	-	-	70	ns
$t_{ACC}$	Access Time	-	-	180	ns
$PW_{CSL}$	Chip Select Low Pulse Width (read)	160	-	-	ns
	Chip Select Low Pulse Width (write)	60	-	-	ns
$PW_{CSH}$	Chip Select High Pulse Width (read)	60	-	-	ns
	Chip Select High Pulse Width (write)	60	-	-	ns
$t_R$	Rise Time	-	-	15	ns
$t_F$	Fall Time	-	-	15	ns



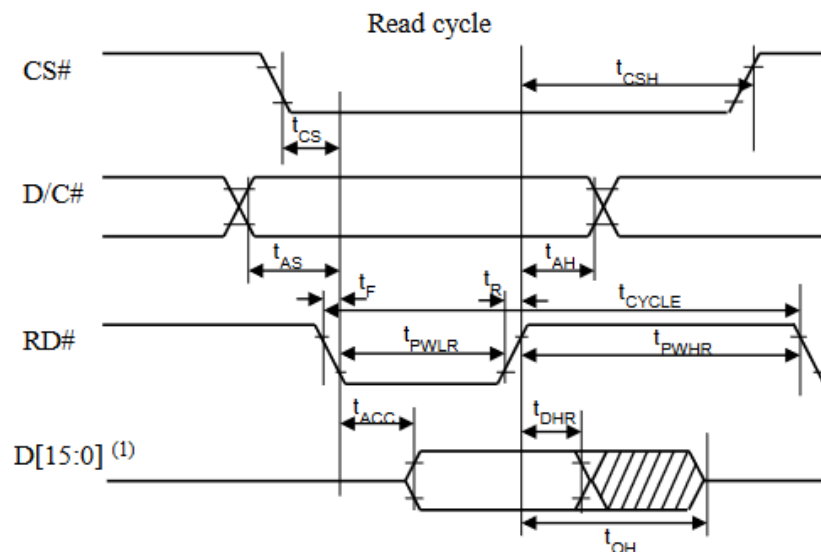
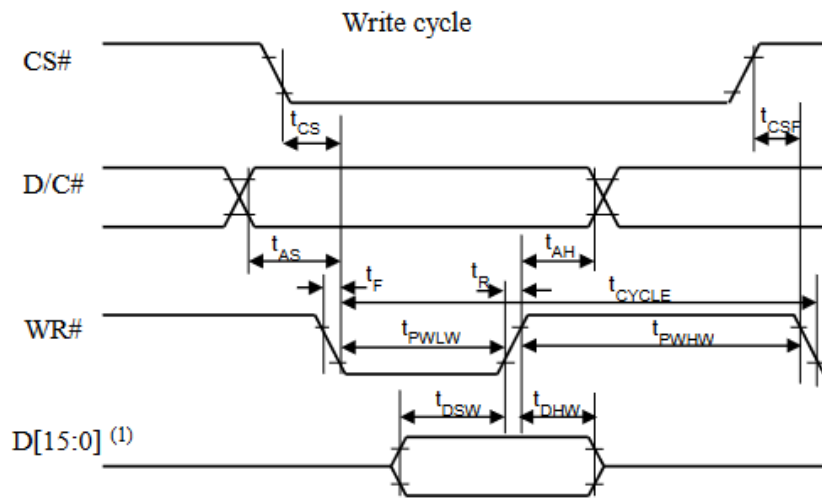
**Note**

<sup>(1)</sup> when 8 bit used: D[7:0] instead; when 16 bit used: D[15:0] instead.



**8080-Series MCU Parallel Interface:**

Symbol	Parameter	Min	Typ	Max	Unit
$t_{CYCLE}$	Clock Cycle Time (write)	300	-	-	ns
$t_{AS}$	Address Setup Time	10	-	-	ns
$t_{AH}$	Address Hold Time	0	-	-	ns
$t_{DSW}$	Write Data Setup Time	40	-	-	ns
$t_{DHW}$	Write Data Hold Time	20	-	-	ns
$t_{DHR}$	Read Data Hold Time	20	-	-	ns
$t_{OH}$	Output Disable Time	-	-	46	ns
$t_{ACC}$	Access Time	-	-	180	ns
$t_{PWLW}$	Read Low Time	160	-	-	ns
$t_{PWLW}$	Write Low Time	60	-	-	ns
$t_{PWHW}$	Read High Time	60	-	-	ns
$t_{PWHW}$	Write High Time	60	-	-	ns
$t_R$	Rise Time	-	-	15	ns
$t_F$	Fall Time	-	-	15	ns
$t_{CS}$	Chip select setup time	0	-	-	ns
$t_{CSH}$	Chip select hold time to read signal	0	-	-	ns
$t_{CSF}$	Chip select hold time	20	-	-	ns

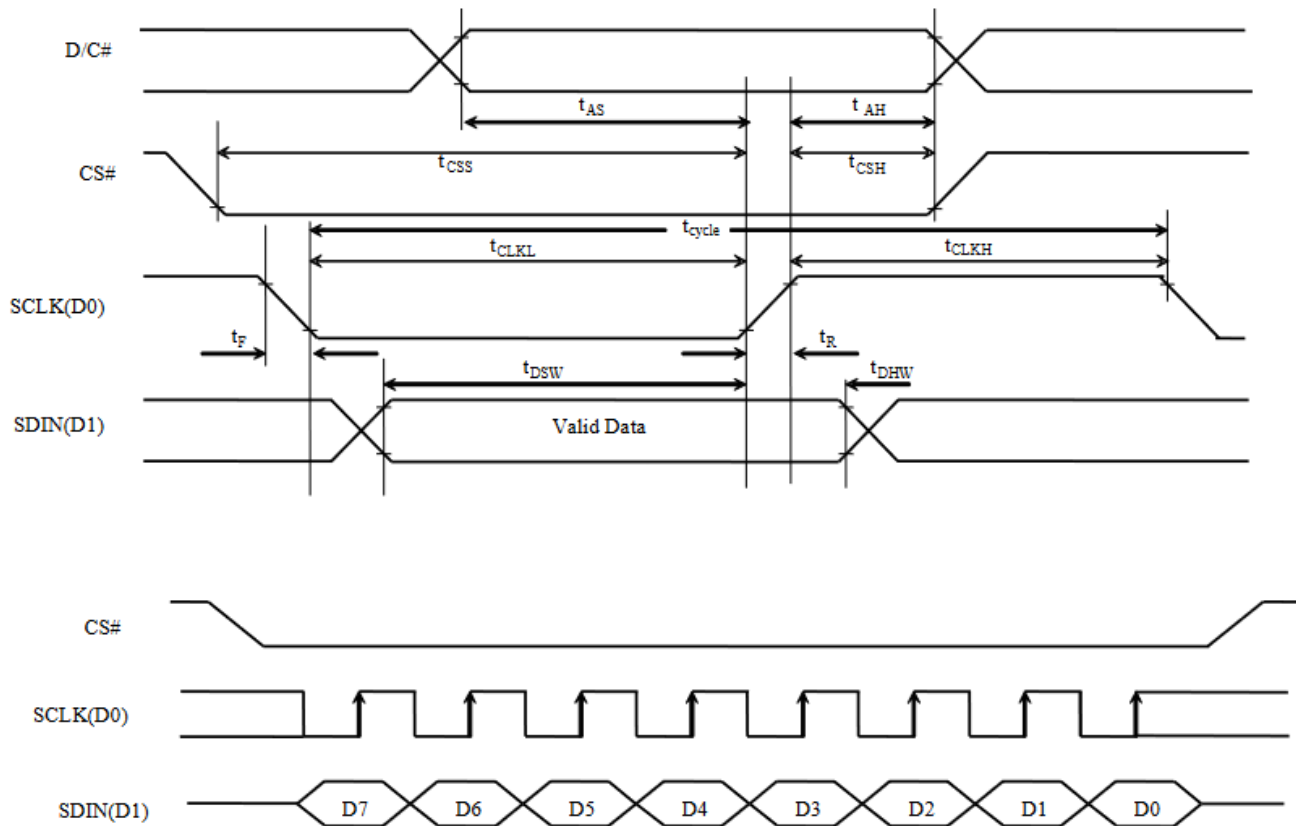

**Note**

<sup>(1)</sup> when 8 bit used: D[7:0] instead; when 16 bit used: [15:0] instead.



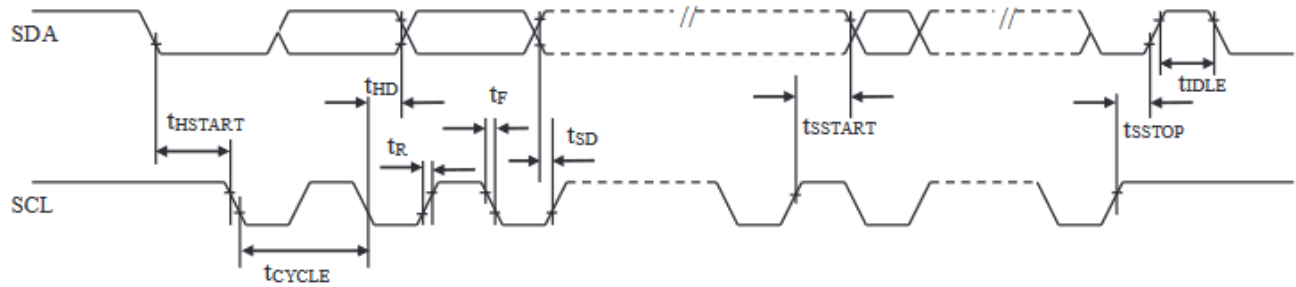
**4-wire SPI:**

Symbol	Parameter	Min	Typ	Max	Unit
$t_{\text{cycle}}$	Clock Cycle Time	100	-	-	ns
$t_{\text{AS}}$	Address Setup Time	15	-	-	ns
$t_{\text{AH}}$	Address Hold Time	42	-	-	ns
$t_{\text{CSS}}$	Chip Select Setup Time	20	-	-	ns
$t_{\text{CSH}}$	Chip Select Hold Time	20	-	-	ns
$t_{\text{DSW}}$	Write Data Setup Time	15	-	-	ns
$t_{\text{DHW}}$	Write Data Hold Time	25	-	-	ns
$t_{\text{CLKL}}$	Clock Low Time	30	-	-	ns
$t_{\text{CLKH}}$	Clock High Time	30	-	-	ns
$t_{\text{R}}$	Rise Time	-	-	15	ns
$t_{\text{F}}$	Fall Time	-	-	15	ns



**I2C:**

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)	0	-	-	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

**Figure 9-5 : I<sup>2</sup>C interface Timing characteristics**


## Example Initialization Sequence

## Quality Information

Test Item	Content of Test	Test Condition	Note
High Temperature storage	Test the endurance of the display at high storage temperature.	+85°C, 240hrs	2
Low Temperature storage	Test the endurance of the display at low storage temperature.	-40°C, 240hrs	1,2
High Temperature Operation	Test the endurance of the display by applying electric stress (voltage & current) at high temperature.	+70°C, 240hrs	2
Low Temperature Operation	Test the endurance of the display by applying electric stress (voltage & current) at low temperature.	-40°C, 240hrs	1,2
High Temperature / Humidity Operation	Test the endurance of the display by applying electric stress (voltage & current) at high temperature with high humidity.	+65°C, 90% RH, 96hrs	1,2
Thermal Shock resistance	Test the endurance of the display by applying electric stress (voltage & current) during a cycle of low and high temperatures.	-40°C, 30min-> 85°C,30min = 1 cycle 20 cycles	
Vibration test	Test the endurance of the display by applying vibration to simulate transportation and use.	5-50Hz, 0.5G 2hrs in each of 3 directions X,Y,Z	3
Static electricity test	Test the endurance of the display by applying electric static discharge.	Air discharge ±8kV 10 times	

**Note 1:** No condensation to be observed.

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

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