

# NHD-0.95-9664G

## Graphic Color OLED Display

NHD-	Newhaven Display
0.95-	0.95" Diagonal Size
9664-	96 x 64 Pixels
G-	OLED Glass

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## Document Revision History

Revision	Date	Description	Changed by
-	1/21/19	Initial Release	ML

## Functions and Features

- 96 x 64 pixel resolution
- Built-in SSD1331 controller
- Serial or Parallel interface
- RoHS compliant



# Interface Description

Pin No.	Symbol	External Connection	Function Description
1	NC	-	No connect (can be tied to Ground)
2	V <sub>SS</sub>	Power Supply	Ground
3	V <sub>DD</sub>	Power Supply	Supply voltage for Logic
4	V <sub>DDIO</sub>	Power Supply	Supply voltage for I/O
5	BS1	MPU	MPU interface select signal
6	BS2	MPU	MPU interface select signal
7	I <sub>REF</sub>	Power Supply	Current reference for brightness adjustment
8	CS#	MPU	Active LOW Chip Select signal
9	RES#	MPU	Active LOW Reset signal
10	D/C#	MPU	Data/Command selection. LOW: Command. HIGH: Data
11	R/W# WR#	MPU	<b>6800 mode:</b> Read/Write signal. LOW: Write. HIGH: Read <b>8080 mode:</b> Active LOW Write signal
12	E RD#	MPU	<b>6800 mode:</b> Enable signal. Falling edge triggered <b>8080 mode:</b> Active LOW Read signal
13	D0	MPU	<b>Parallel interface:</b> 8-bit bi-directional data bus  <b>Serial interface:</b> D0 = Serial Clock signal (SCLK) D1 = Serial Data Input signal (SDIN)
14	D1	MPU	
15	D2	MPU	
16	D3	MPU	
17	D4	MPU	
18	D5	MPU	
19	D6	MPU	
20	D7	MPU	
21	V <sub>COMH</sub>	Power Supply	Voltage output high level for COM signal
22	V <sub>CC</sub>	Power Supply	Supply voltage for OLED panel
23	NC	-	No connect

**Recommended display connector:** n/a (Hot-bar solder directly to PCB)

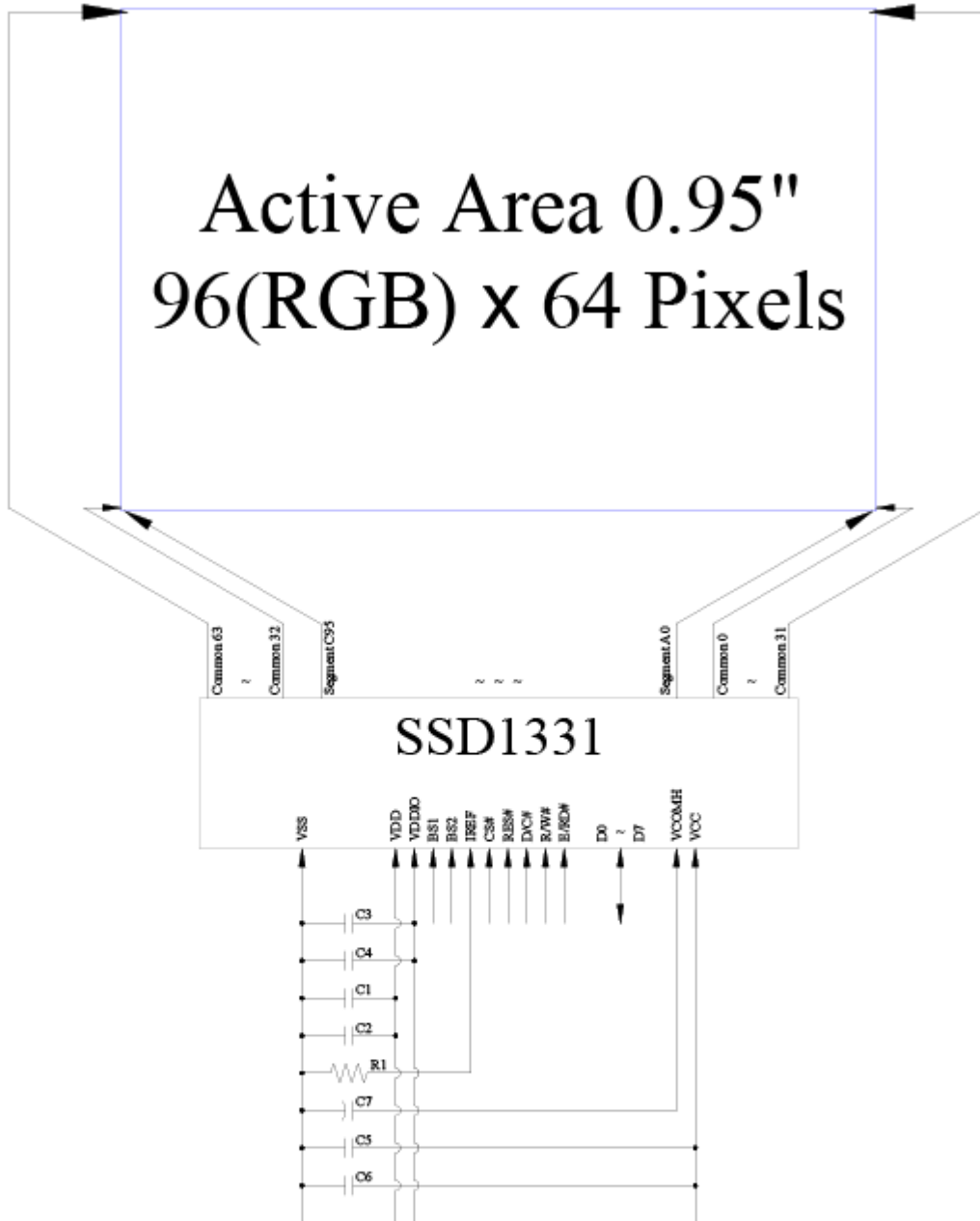
## MPU Interface Pin Assignment Summary

Bus Interface	D7	D6	D5	D4	D3	D2	D1	D0	E	R/W	BS1	BS2	/CS	D/C	/RES
8-bit 6800	D[7:0]								RD#	WR#	1	1	/CS	D/C	/RES
8-bit 8080	D[7:0]								E	R/W#	0	1	/CS	D/C	/RES
4-wire SPI	0				NC	SDIN	SCLK	0	0	0	0	/CS	D/C	/RES	

**Note:**

- “NC” : No Connect
- “1” : VDD
- “0” : VSS

## Wiring Diagram



MCU Interface Selection: BS1 and BS2  
 Pins connected to MCU interface: CS#, RES#, D/C#, R/W#, E/RD#, and D0~D7

C1, C3, C5: 0.1 $\mu$ F  
 C2, C4: 4.7 $\mu$ F  
 C6: 10 $\mu$ F  
 C7: 4.7 $\mu$ F / 25V Tantalum Capacitor  
 R1: 1.2M $\Omega$ ,  $R1 = (\text{Voltage at IREF} - \text{VSS}) / \text{IREF}$

## 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>	-	2.4	2.8	3.5	V
Supply Voltage for I/O Pins	V <sub>DDIO</sub>	-	1.6	2.8	V <sub>DD</sub>	
Supply Voltage for Display	V <sub>CC</sub>	-	13.5	14.0	14.5	V
Supply Current for Logic	I <sub>DD</sub>	V <sub>DD</sub> = 2.8V; 100% On	-	200	600	μA
Supply Current for Display	I <sub>CC</sub>	V <sub>CC</sub> = 14V; 50% On	-	8.0	11.0	mA
		V <sub>CC</sub> = 14V; 100% On	-	13.5	18.0	mA
Supply Current (Sleep)	I <sub>SLEEP</sub>	V <sub>DD</sub> = 2.8V	-	3	15	μA
"H" Level input	V <sub>IH</sub>	-	0.8 * V <sub>DDIO</sub>	-	V <sub>DDIO</sub>	V
"L" Level input	V <sub>IL</sub>	-	V <sub>SS</sub>	-	0.2 * V <sub>DDIO</sub>	V
"H" Level output	V <sub>OH</sub>	-	0.9 * V <sub>DDIO</sub>	-	V <sub>DDIO</sub>	V
"L" Level output	V <sub>OL</sub>	-	V <sub>SS</sub>	-	0.1 * V <sub>DDIO</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	-	μs
Response Time (fall)	T <sub>F</sub>	-	-	10	-	μs
Brightness	L <sub>V</sub>	50% Checkerboard	80	100	-	cd/m <sup>2</sup>
Lifetime	-	100 cd/m <sup>2</sup> , T <sub>OP</sub> =25°C 50% Checkerboard	10,000	-	-	Hrs

**Note:** Lifetime at typical temperature is based on accelerated high-temperature operation. Lifetime is tested at average 50% pixels on and is rated as Hours until **Half-Brightness**. The Display OFF command can be used to extend the lifetime of the display.

Luminance of active pixels will degrade faster than inactive pixels. Residual (burn-in) images may occur. To avoid this, every pixel should be illuminated uniformly.

## Controller information

Built-in SSD1331 controller.

Please download specification at <http://www.newhavendisplay.com/appnotes/datasheets/OLEDs/SSD1331.pdf>

## Table of Commands

Fundamental Commands												
D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description	Default
0 0 0	15 A[6:0] B[6:0]	0 *	0 A <sub>6</sub>	0 A <sub>5</sub>	1 A <sub>4</sub>	0 A <sub>3</sub>	1 A <sub>2</sub>	0 A <sub>1</sub>	1 A <sub>0</sub>	Set Column Address	Setup Column start and end address A[6:0] start address from 00d-95d B[6:0] end address from 00d-95d	00d (00h) 95d (5Fh)
0 0 0	75 A[5:0] B[5:0]	0 *	1 *	1 A <sub>5</sub>	1 A <sub>4</sub>	0 A <sub>3</sub>	1 A <sub>2</sub>	0 A <sub>1</sub>	1 A <sub>0</sub>	Set Row Address	Setup Row start and end address A[5:0] start address from 00d-63d B[5:0] end address from 00d-63d	00d (00h) 63d (3Fh)
0 0	81 A[7:0]	1 A <sub>7</sub>	0 A <sub>6</sub>	0 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 Contrast for Color "A"	Set contrast for all color "A" segment (Pins:SA0 – SA95) A[7:0] valid range: 00d to 255d	128d (80h)
0 0	82 A[7:0]	1 A <sub>7</sub>	0 A <sub>6</sub>	0 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 Contrast for Color "B"	Set contrast for all color "B" segment (Pins:SB0 – SB95). A[7:0] valid range: 00d to 255d	128d (80h)
0 0	83 A[7:0]	1 A <sub>7</sub>	0 A <sub>6</sub>	0 A <sub>5</sub>	0 A <sub>4</sub>	0 A <sub>3</sub>	0 A <sub>2</sub>	1 A <sub>1</sub>	1 A <sub>0</sub>	Set Contrast for Color "C"	Set contrast for all color "C" segment (Pins:SC0 – SC95). A[7:0] valid range: 00d to 255d	128d (80h)
0 0	87 A[3:0]	1 0	0 0	0 0	0 0	0 A <sub>3</sub>	1 A <sub>2</sub>	1 A <sub>1</sub>	1 A <sub>0</sub>	Master Current Control	Set master current attenuation factor A[3:0] from 00d to 15d corresponding to 1/16, 2/16... to 16/16 attenuation.	15d (0Fh)

Fundamental Commands																				
D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description	Default								
0 0 0 0 0 0	8A A[7:0] 8B A[7:0] 8C A[7:0]	1 A <sub>7</sub>	0 A <sub>6</sub>	0 A <sub>5</sub>	0 A <sub>4</sub>	1 A <sub>3</sub>	0 A <sub>2</sub>	1 A <sub>1</sub>	0 A <sub>0</sub>	Set Second Pre-charge Speed for Color "A", "B" and "C"	<p>A[7:0]: Set Second Pre-charge Speed Ranges: 0000000b to 1111111b, a higher value of A[7:0] gives a higher Second Pre-charge speed.</p> <p><b>Note</b>  <sup>(1)</sup> The default values of A[7:0] in 8Ah, A[7:0] in 8Bh and A[7:0] in 8Ch are equal to the contrast values for color A, B and C( refer to commands: 81h, 82h, 83h) respectively.  <sup>(2)</sup> All six bytes (8Ah A[7:0], 8Bh A[7:0] and 8Ch A[7:0]) must be inputted together. For example: the original value is like that</p> <table border="1"> <thead> <tr> <th colspan="2">Original value</th> </tr> </thead> <tbody> <tr> <td>8Ah A[7:0]:</td> <td>80h</td> </tr> <tr> <td>8Bh A[7:0]:</td> <td>80h</td> </tr> <tr> <td>8Ch A[7:0]:</td> <td>80h</td> </tr> </tbody> </table> <p>If it is wanted to change the value of 8Bh A[7:0] to 75h, then all the following 6 bytes must be inputted:  8Ah,80h,  8Bh,75h,  8Ch,80h.</p>	Original value		8Ah A[7:0]:	80h	8Bh A[7:0]:	80h	8Ch A[7:0]:	80h	A[7:0] of 81h A[7:0] of 82h A[7:0] of 83h
Original value																				
8Ah A[7:0]:	80h																			
8Bh A[7:0]:	80h																			
8Ch A[7:0]:	80h																			
0 0	A0 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>	0 A <sub>0</sub>			Remap & Color Depth setting	Set driver remap and color depth A[0]=0, Horizontal address increment A[0]=1, Vertical address increment  A[1]=0, RAM Column 0 to 95 maps to Pin Seg (SA,SB,SC) 0 to 95 A[1]=1, RAM Column 0 to 95 maps to Pin Seg (SA,SB,SC) 95 to 0  A[2]=0, normal order SA,SB,SC (e.g. RGB) A[2]=1, reverse order SC,SB,SA (e.g. BGR)  A[3]=0, Disable left-right swapping on COM A[3]=1, Set left-right swapping on COM  A[4]=0, Scan from COM 0 to COM [N -1] A[4]=1, Scan from COM [N-1] to COM0. Where N is the multiplex ratio.  A[5]=0, Disable COM Split Odd Even (RESET) A[5]=1, Enable COM Split Odd Even  A[7:6] = 00; 256 color format A[7:6] = 01; 65k color format A[7:6] = 10; 65k color format 2 If 9 / 18 bit mode is selected, color depth will be fixed to 65k regardless of the setting.	A[0]=0 A[1]=0 A[2]=0 A[3]=0 A[4]=0 A[5]=0 A[7:6]=01						
0 0	A1 A[5:0]	1 0	0 0	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 display start line register by Row A[5:0]: from 00d to 63d		00d (00h)							
0 0	A2 A[5:0]	1 0	0 0	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 offset by Com A[5:0]: from 00d to 63d		00d (00h)							



Fundamental Commands												
D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description	Default
00	A4 / A5 / A6 / A7 /	1	0	1	0	0	1	X <sub>1</sub>	X <sub>0</sub>	Set Display Mode	A4h=Normal Display A5h=Entire Display ON, all pixels turn ON at GS63 A6h=Entire Display OFF, all pixels turn OFF A7h=Inverse Display	A4h
00	A8 A[5:0]	1 0	0 0	1 A <sub>5</sub>	0 A <sub>4</sub>	1 A <sub>3</sub>	0 A <sub>2</sub>	0 A <sub>1</sub>	0 A <sub>0</sub>	Set Multiplex Ratio	Set MUX ratio to N+1 Mux N = A[5:0] from 15d to 63d A[5:0] from 00d to 14d are invalid entry	63d (3Fh)
000000	AB A[7:0] B[7:0] C[7:0] D[7:0] E[4:0]	1 A <sub>7</sub>	0 A <sub>6</sub>	1 A <sub>5</sub>	0 A <sub>4</sub>	1 A <sub>3</sub>	0 A <sub>2</sub>	1 A <sub>1</sub>	1 A <sub>0</sub>	Dim Mode Setting	Configure dim mode setting A[7:0] = Reserved. (Set as 00h)  B[7:0] = Contrast setting for Color A, valid range 0 to 255d.  C[7:0] = Contrast setting for Color B, valid range 0 to 255d.  D[7:0] = Contrast setting for Color C, valid range 0 to 255d.  E[4:0] = Precharge voltage setting, valid range 0 to 31d.	\
00	AD A[0]	1 1	0 0	1 0	0 0	1 1	1 1	0 1	1 A <sub>0</sub>	Set Master Configuration	A[0]=0b, Select external V <sub>CC</sub> supply A[0]=1b, Reserved (RESET)  <b>Note</b> (1) Bit A[0] must be set to 0b after RESET. (2) The setting will be activated after issuing Set Display ON command (AFh)	A[0] = 1
0	AC AE AF	1	0	1	0	1	1	A <sub>1</sub>	A <sub>0</sub>	Set Display ON/OFF	ACH = Display ON in dim mode AEh = Display OFF (sleep mode) AFh = Display ON in normal mode	AEh
00	B0 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>	0 A <sub>0</sub>	Power Save Mode	A[7:0]=1Ah, Enable Power save mode (RESET) A[7:0]=0Bh, Disable Power save mode	1Ah
00	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>	Phase 1 and 2 period adjustment	A[3:0] Phase 1 period in N DCLK. 1~15 DCLK allowed.  A[7:4] Phase 2 period in N DCLK. 1~15 DCLK allowed  <b>Note</b> (1) 0 DCLK is invalid in phase 1 & phase 2	74h
00	B3 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>	1 A <sub>1</sub>	1 A <sub>0</sub>	Display Clock Divider / Oscillator Frequency	A[3:0]: Define the divide ratio (D) of the display clocks (DCLK): Divide ratio (D) = A[3:0] + 1 (i.e., 1 to 16)  A[7:4] Fosc frequency. Frequency increases as setting value increases	D0h

Fundamental Commands																															
D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description	Default																			
0	B8	1	0	1	1	1	0	0	0	Set Gray Scale Table	These 32 parameters define pulse widths of GS1 to GS63 in terms of DCLK A[6:0]: Pulse width for GS1, RESET=01d B[6:0]: Pulse width for GS3, RESET=05d C[6:0]: Pulse width for GS5, RESET=09d .... AE[6:0]: Pulse width for GS61, RESET=121d AF[6:0]: Pulse width for GS63, RESET=125d <b>Note:</b> <sup>(1)</sup> GS0 has no pre-charge and current drive stages. <sup>(2)</sup> GS2, GS4...GS62 are derived by $P_n = (P_{n-1} + P_{n+1})/2$ <sup>(3)</sup> P <sub>n</sub> will be truncated to integer if it is with decimal point. <sup>(4)</sup> P <sub>n+1</sub> should always be set to larger than P <sub>n-1</sub> <sup>(5)</sup> Max pulse width is 125	\																			
0	A[6:0]	*	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>																						
0	B[6:0]	*	B <sub>6</sub>	B <sub>5</sub>	B <sub>4</sub>	B <sub>3</sub>	B <sub>2</sub>	B <sub>1</sub>	B <sub>0</sub>																						
0	C[6:0]	*	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	...	...	...	...	...	...	...	...	...																						
0	AE[6:0]	*	AE <sub>6</sub>	AE <sub>5</sub>	AE <sub>4</sub>	AE <sub>3</sub>	AE <sub>2</sub>	AE <sub>1</sub>	AE <sub>0</sub>																						
0	AF[6:0]	*	AF <sub>6</sub>	AF <sub>5</sub>	AF <sub>4</sub>	AF <sub>3</sub>	AF <sub>2</sub>	AF <sub>1</sub>	AF <sub>0</sub>																						
0	B9	1	0	1	1	1	0	0	1	Enable Linear Gray Scale Table	Reset built in gray scale table (Linear) Pulse width for GS1 = 1d; Pulse width for GS2 = 3d; Pulse width for GS3 = 5d; .... Pulse width for GS61 = 121d; Pulse width for GS62 = 123d; Pulse width for GS63 = 125d.	\																			
0	BB	1	0	1	1	1	0	1	1	Set Pre-charge level	Set pre-charge voltage level. All three color share the same pre-charge voltage.	3Eh																			
0	A[5:0]	0	0	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	0																						
													<table border="1"> <thead> <tr> <th>A[5:1]</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>11111</td> <td>3Eh</td> <td>0.50 x V<sub>CC</sub></td> </tr> </tbody> </table>	A[5:1]	Hex code	pre-charge voltage	00000	00h	0.10 x V <sub>CC</sub>	:	:	:	11111	3Eh	0.50 x V <sub>CC</sub>						
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Refer to Figure 30 for the details setting of A[5:1].																															
0	BC-BD	1	0	1	1	1	1	0	X <sub>0</sub>	NOP	Command for No operation	\																			
0	BE	1	0	1	1	1	1	1	0	Set V <sub>COMH</sub>	Set COM deselect voltage level (V <sub>COMH</sub> )	3Eh																			
0	A[5:1]	0	0	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	0																						
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0	E3	1	1	1	0	0	0	1	1	NOP	Command for No operation	\																			
0	FD	1	1	1	1	1	1	0	1	Set Command Lock	A[2]: MCU protection status A[2] = 0b, Unlock OLED driver IC MCU interface from entering command [reset]  A[2] = 1b, Lock OLED driver IC MCU interface from entering command	12h																			
0	A[2]	0	0	0	1	0	A <sub>2</sub>	1	0																						
											<b>Note</b> <sup>(1)</sup> The locked OLED driver IC MCU interface prohibits all commands and memory access except the FDh command.																				

Graphic Acceleration Commands											
D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	21	0	0	1	0	0	0	0	1	Draw Line	A[6:0]: Column Address of Start
0	A[6:0]	*	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		B[5:0]: Row Address of Start
0	B[5:0]	*	*	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[6:0]: Column Address of End
0	C[6:0]	*	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>		D[5:0]: Row Address of End
0	D[5:0]	*	*	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>		E[5:1]: Color C of the line
0	E[5:1]	*	*	E <sub>5</sub>	E <sub>4</sub>	E <sub>3</sub>	E <sub>2</sub>	E <sub>1</sub>	*		F[5:0]: Color B of the line
0	F[5:0]	*	*	F <sub>5</sub>	F <sub>4</sub>	F <sub>3</sub>	F <sub>2</sub>	F <sub>1</sub>	F <sub>0</sub>		G[5:1]: Color A of the line
0	G[5:1]	*	*	G <sub>5</sub>	G <sub>4</sub>	G <sub>3</sub>	G <sub>2</sub>	G <sub>1</sub>	*		
0	22	0	0	1	0	0	0	1	0	Drawing Rectangle	A[6:0]: Column Address of Start
0	A[6:0]	*	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		B[5:0]: Row Address of Start
0	B[5:0]	*	*	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[6:0]: Column Address of End
0	C[6:0]	*	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>		D[5:0]: Row Address of End
0	D[5:0]	*	*	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>		E[5:1]: Color C of the line
0	E[5:1]	*	*	E <sub>5</sub>	E <sub>4</sub>	E <sub>3</sub>	E <sub>2</sub>	E <sub>1</sub>	*		F[5:0]: Color B of the line
0	F[5:0]	*	*	F <sub>5</sub>	F <sub>4</sub>	F <sub>3</sub>	F <sub>2</sub>	F <sub>1</sub>	F <sub>0</sub>		G[5:1]: Color A of the line
0	G[5:1]	*	*	G <sub>5</sub>	G <sub>4</sub>	G <sub>3</sub>	G <sub>2</sub>	G <sub>1</sub>	*		H[5:1]: Color C of the fill area
0	H[5:1]	*	*	H <sub>5</sub>	H <sub>4</sub>	H <sub>3</sub>	H <sub>2</sub>	H <sub>1</sub>	*		I[5:0]: Color B of the fill area
0	I[5:0]	*	*	I <sub>5</sub>	I <sub>4</sub>	I <sub>3</sub>	I <sub>2</sub>	I <sub>1</sub>	I <sub>0</sub>		J[5:1]: Color A of the fill area
0	J[5:1]	*	*	J <sub>5</sub>	J <sub>4</sub>	J <sub>3</sub>	J <sub>2</sub>	J <sub>1</sub>	*		
0	23	0	0	1	0	0	0	1	1	Copy	A[6:0]: Column Address of Start
0	A[6:0]	*	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		B[5:0]: Row Address of Start
0	B[5:0]	*	*	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[6:0]: Column Address of End
0	C[6:0]	*	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>		D[5:0]: Row Address of End
0	D[5:0]	*	*	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>		E[6:0]: Column Address of New Start
0	E[6:0]	*	E <sub>6</sub>	E <sub>5</sub>	E <sub>4</sub>	E <sub>3</sub>	E <sub>2</sub>	E <sub>1</sub>	E <sub>0</sub>		F[5:0]: Row Address of New Start
0	F[5:0]	*	*	F <sub>5</sub>	F <sub>4</sub>	F <sub>3</sub>	F <sub>2</sub>	F <sub>1</sub>	F <sub>0</sub>		
0	24	0	0	1	0	0	1	0	0	Dim Window	A[6:0]: Column Address of Start
0	A[6:0]	*	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		B[5:0]: Row Address of Start
0	B[5:0]	*	*	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[6:0]: Column Address of End
0	C[6:0]	*	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>		D[5:0]: Row Address of End
0	D[5:0]	*	*	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>		The effect of dim window: GS15~GS0 no change GS19~GS16 become GS4 GS23~GS20 become GS5 ... GS63~GS60 become GS15
0	25	0	0	1	0	0	1	0	1	Clear Window	A[6:0]: Column Address of Start
0	A[6:0]	*	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		B[5:0]: Row Address of Start
0	B[5:0]	*	*	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[6:0]: Column Address of End
0	C[6:0]	*	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>		D[5:0]: Row Address of End
0	D[5:0]	*	*	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>		
0	26	0	0	1	0	0	1	1	0	Fill Enable / Disable	A0 0 : Disable Fill for Draw Rectangle Command (RESET)
0	A[4:0]	*	*	*	A <sub>4</sub>	0	0	0	A <sub>0</sub>		1 : Enable Fill for Draw Rectangle Command A[3:1] 000: Reserved values A4 0 : Disable reverse copy (RESET) 1 : Enable reverse during copy command.

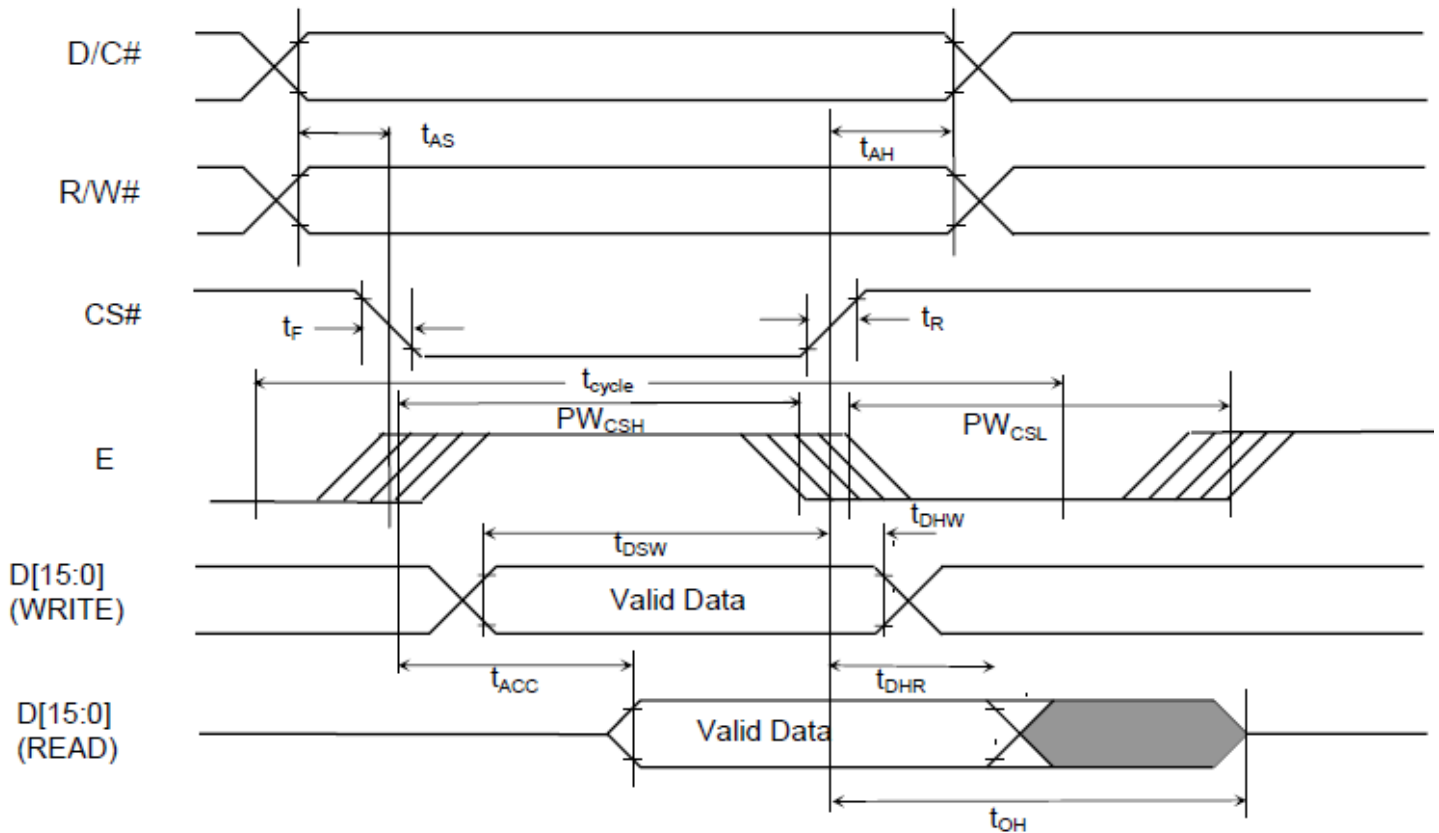
Graphic Acceleration Commands											
D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	27	0	0	1	0	0	1	1	1	Continuous Horizontal & Vertical Scrolling Setup	A[6:0]: Set number of column as horizontal scroll offset Range: 0d-95d ( no horizontal scroll if equals to 0)
0	A[6:0]	*	A <sub>6</sub>	A <sub>5</sub>	A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>		B[5:0]: Define start row address
0	B[5:0]	*	*	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[6:0]: Set number of rows to be horizontal scrolled B[5:0]+C[6:0] <=64
0	C[6:0]	*	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>		D[5:0]: Set number of row as vertical scroll offset Range: 0d-63d ( no vertical scroll if equals to 0)
0	D[5:0]	*	*	D <sub>5</sub>	D <sub>4</sub>	D <sub>3</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>0</sub>		E[1:0]: Set time interval between each scroll step 00b 6 frames 01b 10 frames 10b 100 frames 11b 200 frames
0	E[1:0]	*	*	*	*	*	*	E <sub>1</sub>	E <sub>0</sub>		<b>Note:</b> (1) Vertical scroll is run with 64MUX setting only (2) The parameters should not be changed after scrolling is activated
0	2E	0	0	1	0	1	1	1	0	Deactivate scrolling	This command deactivates the scrolling action.  <b>Note</b> (1) After sending 2Eh command to deactivate the scrolling action, the ram data needs to be rewritten.
0	2F	0	0	1	0	1	1	1	1	Activate scrolling	This command activates the scrolling function according to the setting done by Continuous Horizontal & Vertical Scrolling Setup command 27h.

For the full command table descriptions, please download the following:  
<http://www.newhavendisplay.com/appnotes/datasheets/OLEDs/SSD1331.pdf>

# Timing Characteristics

## Parallel (6800 mode):

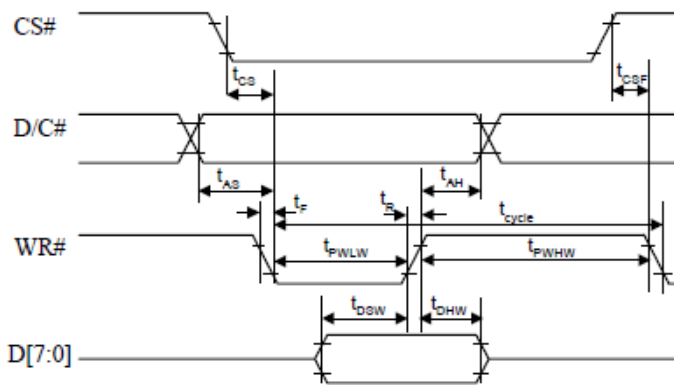
Symbol	Parameter	Min	Typ	Max	Unit
$t_{cycle}$	Clock Cycle Time (write cycle)	130	-	-	ns
$PW_{CSL}$	Control Pulse Low Width (write cycle)	60	-	-	ns
$PW_{CSH}$	Control Pulse High Width (write cycle)	60	-	-	ns
$t_{cycle}$	Clock Cycle Time (read cycle)	200	-	-	ns
$PW_{CSL}$	Control Pulse Low Width (read cycle)	100	-	-	ns
$PW_{CSH}$	Control Pulse High Width (read cycle)	100	-	-	ns
$t_{AS}$	Address Setup Time	0	-	-	ns
$t_{AH}$	Address Hold Time	10	-	-	ns
$t_{DSW}$	Data Setup Time	40	-	-	ns
$t_{DHW}$	Data Hold Time	10	-	-	ns
$t_{ACC}$	Data Access Time	-	-	140	ns
$t_{OH}$	Output Hold time	-	-	70	ns
$t_R$	Rise Time	-	-	15	ns
$t_F$	Fall Time	-	-	15	ns



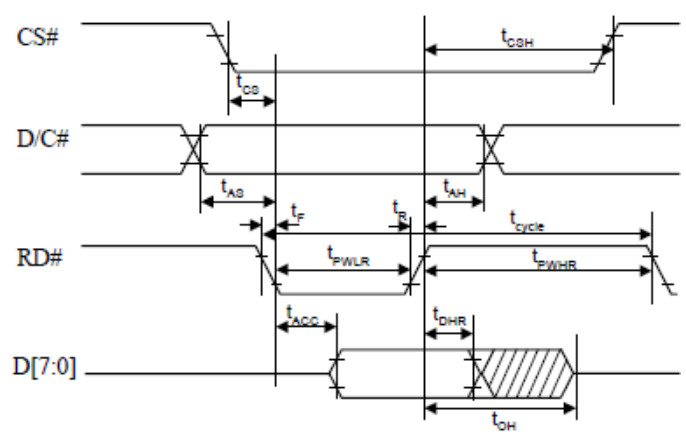
Parallel (8080 mode):

Symbol	Parameter	Min	Typ	Max	Unit
$t_{cycle}$	Clock Cycle Time	130	-	-	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	10	-	-	ns
$t_{DHR}$	Read Data Hold Time	20	-	-	ns
$t_{OH}$	Output Disable Time	-	-	70	ns
$t_{ACC}$	Access Time	-	-	140	ns
$t_{PWLW}$	Read Low Time	150	-	-	ns
$t_{PWLW}$	Write Low Time	60	-	-	ns
$t_{PWHR}$	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

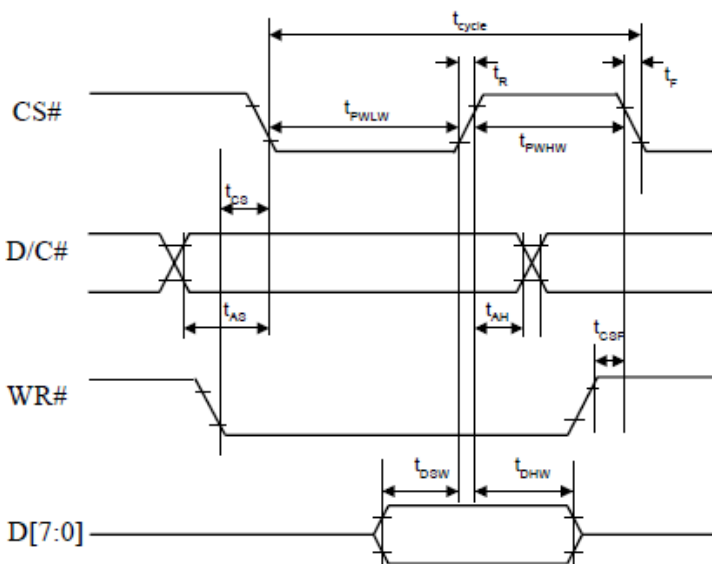
Write cycle (Form 1)



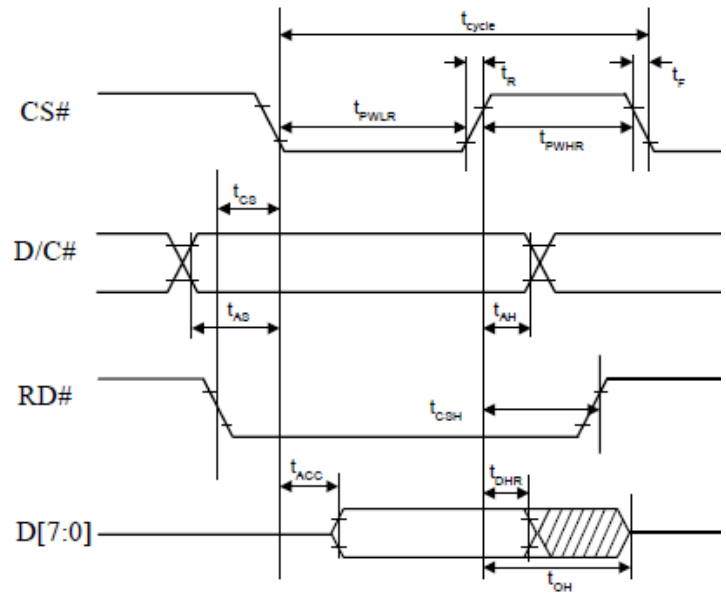
Read cycle (Form 1)



Write cycle (Form 2)

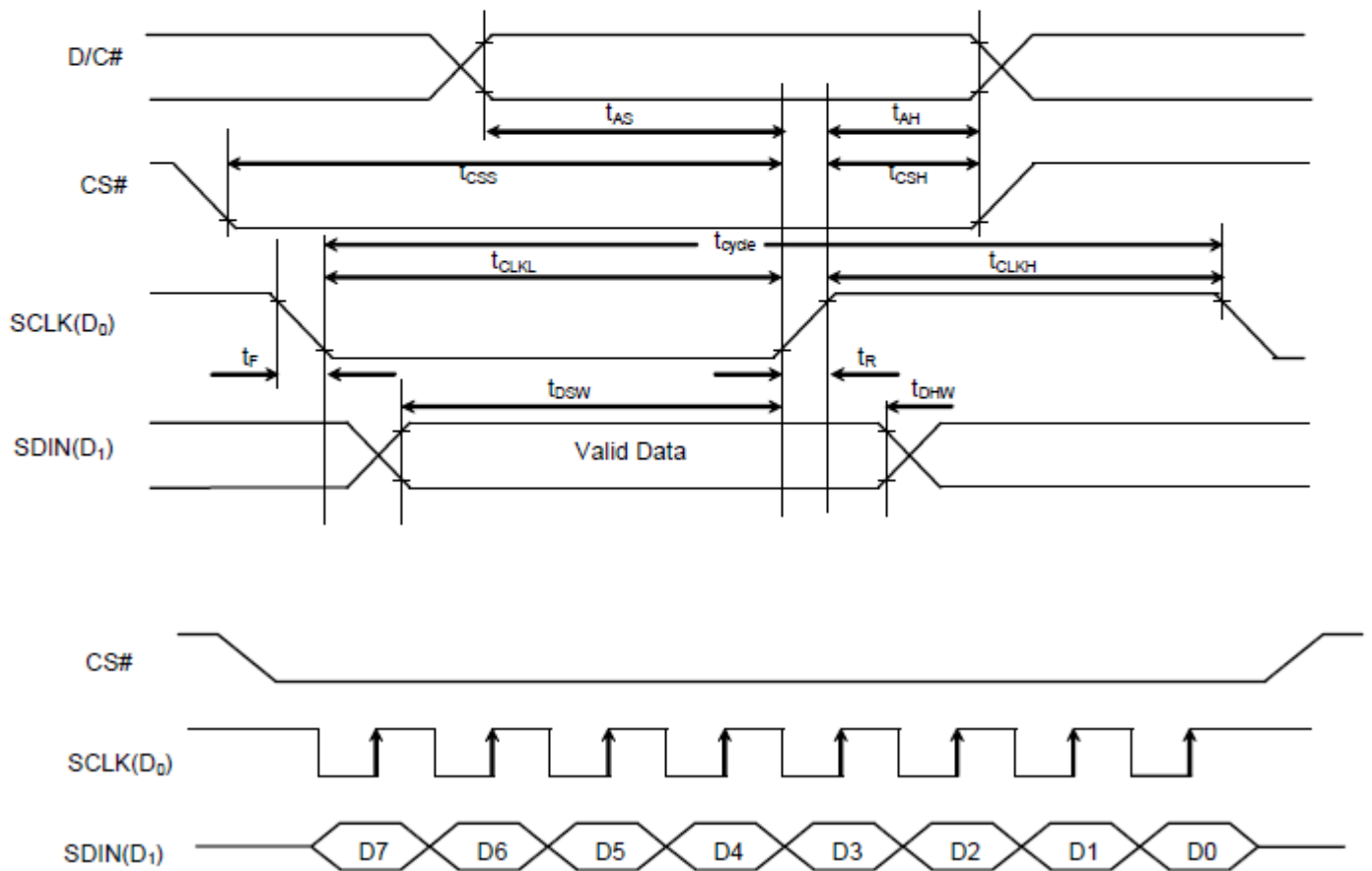


Read cycle (Form 2)



#### 4-wire SPI:

Symbol	Parameter	Min	Typ	Max	Unit
$t_{cycle}$	Clock Cycle Time	150	-	-	ns
$t_{AS}$	Address Setup Time	40	-	-	ns
$t_{AH}$	Address Hold Time	40	-	-	ns
$t_{CSS}$	Chip Select Setup Time	75	-	-	ns
$t_{CSH}$	Chip Select Hold Time	60	-	-	ns
$t_{OSW}$	Write Data Setup Time	40	-	-	ns
$t_{OHV}$	Write Data Hold Time	40	-	-	ns
$t_{CLKL}$	Clock Low Time	75	-	-	ns
$t_{CLKH}$	Clock High Time	75	-	-	ns
$t_R$	Rise Time	-	-	15	ns
$t_F$	Fall Time	-	-	15	ns



## Example Initialization Sequence:

```
void OLED_Init_9664RGB(void)
{
  GPIO_ResetBits(RES_pin);
  delay_ms(300);
  GPIO_SetBits(RES_pin);
  delay_ms(10);

  oled_Command_9664RGB(0xFD); //Command Unlock
  oled_Command_9664RGB(0x12);

  oled_Command_9664RGB(0xAE); //Set Display OFF

  oled_Command_9664RGB(0xB3); //Set Display Clock Divide Ratio/Oscillator Frequency
  oled_Command_9664RGB(0xF0);

  oled_Command_9664RGB(0xA8); //Set MUX Ratio
  oled_Command_9664RGB(0x3F);

  oled_Command_9664RGB(0xA2); //Set Display Offset
  oled_Command_9664RGB(0x00);

  oled_Command_9664RGB(0xA1); //Set Display Start Line
  oled_Command_9664RGB(0x00);

  oled_Command_9664RGB(0xA0); //Set Re-map & Color Depth
  oled_Command_9664RGB(0x74);

  oled_Command_9664RGB(0xAD); //Set Master Configuration
  oled_Command_9664RGB(0x8E);

  oled_Command_9664RGB(0xB0); //Set Power Saving Mode
  oled_Command_9664RGB(0x0B);

  oled_Command_9664RGB(0xB1); //Set Contrast Current for A
  oled_Command_9664RGB(0x91);

  oled_Command_9664RGB(0xB2); //Set Contrast Current for B
  oled_Command_9664RGB(0x50);

  oled_Command_9664RGB(0xB3); //Set Contrast Current for C
  oled_Command_9664RGB(0x7D);

  oled_Command_9664RGB(0x87); //Master Current Control
  oled_Command_9664RGB(0x06);

  oled_Command_9664RGB(0xB1); //Set Phase Length
  oled_Command_9664RGB(0x31);

  oled_Command_9664RGB(0xBB); //Set Pre-charge Voltage
  oled_Command_9664RGB(0x3A);

  oled_Command_9664RGB(0x8A); //Set Second Pre-Charge Speed for Color A
  oled_Command_9664RGB(0x64);
```



```
oled_Command_9664RGB(0x8B); //Set Second Pre-Charge Speed for Color B
oled_Command_9664RGB(0x78);

oled_Command_9664RGB(0x8C); //Set Second Pre-Charge Speed for Color C
oled_Command_9664RGB(0x64);

oled_Command_9664RGB(0xBE); //Set VCOMH
oled_Command_9664RGB(0x3E);

oled_Command_9664RGB(0xA4); //Set Display Mode

oled_Clear_Screen();          //Clear Display

oled_Command_9664RGB(0xAF); //Set Display ON

delay_ms(100);
}
```

## 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, 240 Hrs.	2
Low Temperature storage	Test the endurance of the display at low storage temperature.	-40°C, 240 Hrs.	1,2
High Temperature Operation	Test the endurance of the display by applying electric stress (voltage & current) at high temperature.	+70°C, 240 Hrs.	2
Low Temperature Operation	Test the endurance of the display by applying electric stress (voltage & current) at low temperature.	-40°C, 240 Hrs.	1,2
High Temperature / Humidity Operation	Test the endurance of the display by applying electric stress (voltage & current) at high temperature with high humidity.	+60°C, 90% RH, 120 Hrs.	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, 30 min -> 25°C, 5 min -> 70°C, 30 min = 1 cycle 100 Cycles	
Vibration test	Test the endurance of the display by applying vibration to simulate transportation and use.	10-22Hz , 15mm amplitude. 22-500Hz, 1.5G 30min in each of 3 directions X,Y,Z	3
Atmospheric Pressure test	Test the endurance of the display by applying atmospheric pressure to simulate transportation by air.	115mbar, 40hrs	3
Static electricity test	Test the endurance of the display by applying electric static discharge.	V <sub>s</sub> =800V, R <sub>s</sub> =1.5kΩ, C <sub>s</sub> =100pF One time	

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

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

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

### Evaluation Criteria:

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

## Precautions for using OLEDs/LCDs/LCMs

See Precautions at [www.newhavendisplay.com/specs/precautions.pdf](http://www.newhavendisplay.com/specs/precautions.pdf)

## Warranty Information

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

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