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NHD-0216MW-IB3

Character OLED Display Module

NHD-	Newhaven Display
0216-	2 lines x 16 characters
MW-	Character OLED Module
I-	Model
B-	Blue
3-	2.4V~5.5V Supply Voltage

Newhaven Display International, Inc.

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Document Revision History

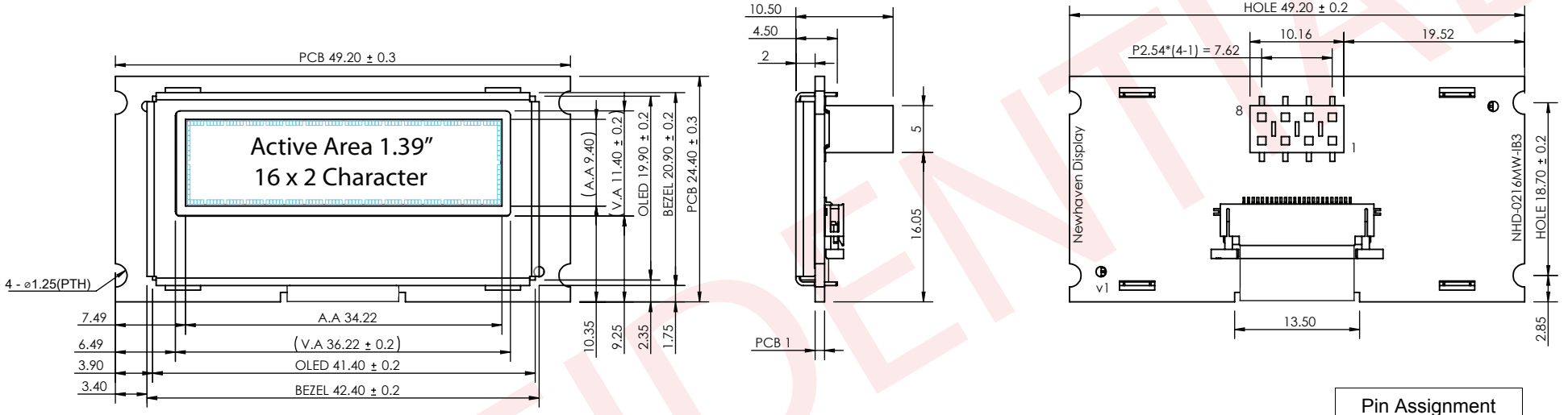
Revision	Date	Description	Changed by
0	07/05/2016	Initial Release	PB
1	10/14/2016	Pin Description Updated	PB

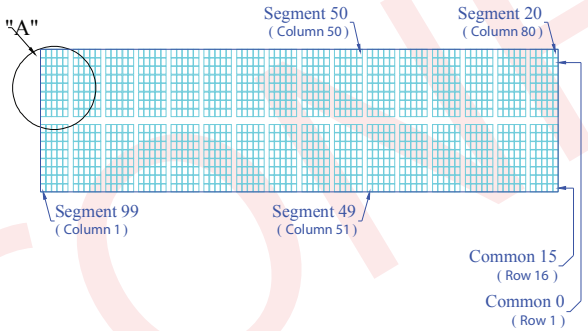
Functions and Features

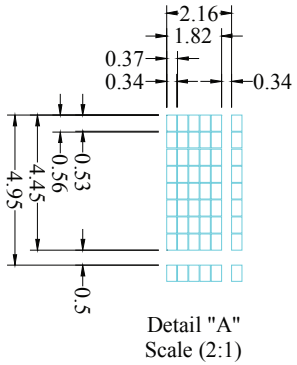
- **2 lines x 16 characters**
- **Built-in LCD comparable controller**
- **I^2C MPU interface**
- **2.8V or 5.0V operation**
- **RoHS compliant**
- **Slim design**
- **Low Power**
- **Ultra-High Contrast**

Mechanical Drawing

Rev	Description	Date







Detail "A"
Scale (2:1)

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

Notes:
1. Display color: Blue
2. Display format: 2 lines x 16 characters
3. Supply Voltage: 2.4V~5.5V
4. Interface: I2C
5. Controller: US2066

	Date	
	07/05/16	NEWHAVEN DISPLAY INTERNATIONAL
Gen. Tolerance	Unit	Model:
±0.3mm	mm	NHD-0216MW-IB3

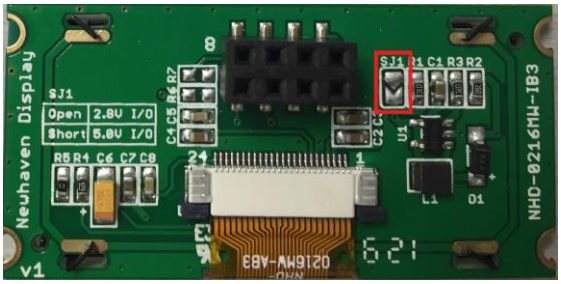
Pin Description

I²C Interface:

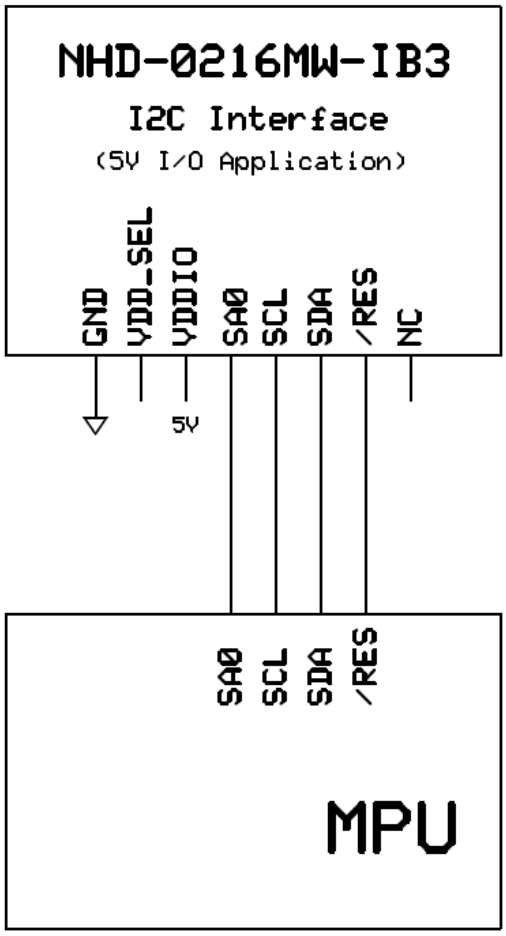
Pin No.	Symbol	External Connection	Function Description
1	GND	Power Supply	Ground
2	VDD_SEL	Power Supply	Supply Voltage for Logic Operation VDD_SEL must be No Connect for 5V operation, VDD_SEL=2.8V for low voltage operation.
3	VDDIO	Power Supply	Supply Voltage for Logic I/O VDDIO=5V for 5V operation, VDDIO=2.8V for low voltage operation.
4	SA0	MPU	Slave Address select signal (LOW = 3C, HIGH = 3D)
5	SCL	MPU	Serial Clock signal
6	SDA	MPU	Serial Data line
7	/RES	MPU	Active LOW Reset signal
8	NC	-	No Connect

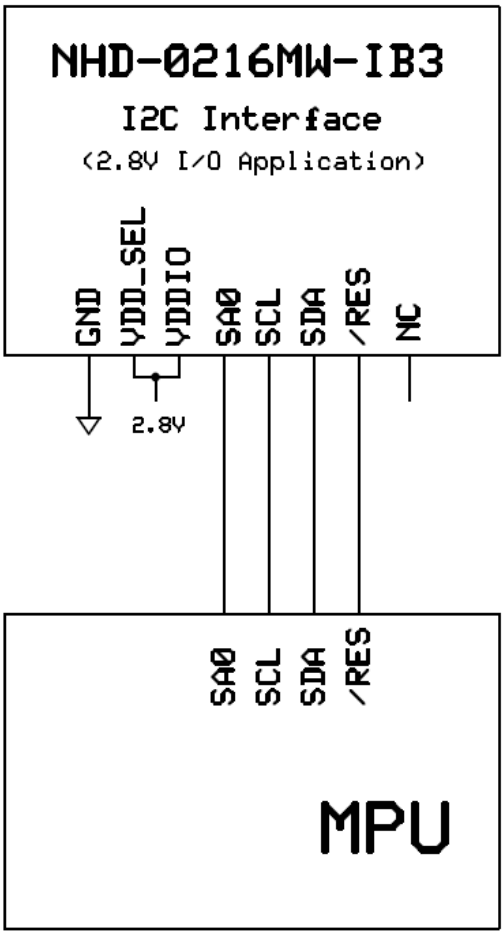
5V I/O Regulator Jumper Select

Solder Jumper Name	2.8V Operation	5V Operation
SJ1	Open (default)	Short



Wiring Diagram





Electrical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Temperature Range	Top	Absolute Max	-40	-	+85	ºC
Storage Temperature Range	Tst	Absolute Max	-40	-	+90	ºC
Supply Voltage for Logic	VDD	(2.8V I/O Application)	2.4	2.8	VDDIO	V
Supply Voltage for I/O Pins	VDDIO		2.4	2.8	3.6	V
Supply Voltage for Logic	VDD	(5V I/O Application)	-	-	-	V
Supply Voltage for I/O Pins	VDDIO		4.4	5.0	5.5	V
Supply Current	IDD	-	-	10	40	mA
Sleep Mode Current	IDD_{SLEEP}	-	-	.05	1	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	-	-	º
Viewing Angle – Bottom			80	-	-	º
Viewing Angle – Left			80	-	-	º
Viewing Angle – Right			80	-	-	º
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^2
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

DDRAM Address

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

Table of Commands

1. Fundamental Command Set														
Command	IS	RE	SD	Instruction Code										Description
				D/C#	R/W# (WR#)	D7	D6	D5	D4	D3	D2	D1	D0	
Clear Display	X	X	0	0	0	0	0	0	0	0	0	0	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	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	1	I/D	S	Assign cursor / blink moving direction with DDRAM address. I/D = "1": cursor/ blink moves to right and DDRAM address is increased by 1 (POR) I/D = "0": cursor/ blink moves to left and DDRAM address is decreased by 1 Assign display shift with DDRAM address. S = "1": make display shift of the enabled lines by the DS4 to DS1 bits in the shift enable instruction. Left/ right direction depends on I/D bit selection. S = "0": display shift disable (POR)
	X	1	0	0	0	0	0	0	0	0	1	BDC	BDS	Common bi-direction function. BDC = "0": COM31 -> COM0 BDC = "1": COM0 -> COM31 Segment bi-direction function. BDS = "0": SEG99 -> SEG0, BDS = "1": SEG0 -> SEG99
Display ON / OFF Control	X	0	0	0	0	0	0	0	0	1	D	C	B	Set display/cursor/blink ON/OFF D = "1": display ON, D = "0": display OFF (POR), C = "1": cursor ON, C = "0": cursor OFF (POR), B = "1": blink ON, B = "0": blink OFF (POR).
Extended Function Set	X	1	0	0	0	0	0	0	0	1	FW	B/W	NW	Assign font width, black/white inverting of cursor, and 4-line display mode control bit. FW = "1": 6-dot font width, FW = "0": 5-dot font width (POR), B/W = "1": black/white inverting of cursor enable, B/W = "0": black/white inverting of cursor

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

1. Fundamental Command Set

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

2. Extended Command Set

Command	IS	RE	SD	D/C#	R/W# (WR#)	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Description
Function Selection A	X	1	0	0	0	71	0	1	1	1	0	0	0	1	A[7:0] = 00h, Disable internal V_{DD} regulator at 5V I/O application mode A[7:0] = 5Ch, Enable internal V_{DD} regulator at 5V I/O application mode (POR)
	X	1	0	1	0	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0	
Function Selection B	X	1	0	0	0	72	0	1	1	1	0	0	1	0	OPR[1:0]: Select the character no. of character generator ROM[1:0]: Select character ROM
	X	1	0	1	0		*	*	*	*	ROM 1	ROM 0	OPR 1	OPR 0	
OLED Characterization	X	1	X	0	0	78 / 79	0	1	1	1	1	0	0	SD	Extension register, SD SD = 0b: OLED command set is disabled (POR) SD = 1b: OLED command set is enabled Details refer to Table 6-3.

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

3. OLED Command Set

Command	IS	RE	SD	Instruction Code											Description
				D/C#	R/W# (WR#)	Hex	D7	D6	D5	D4	D3	D2	D1	D0	
Set Contrast Control	X	1	1	0	0	81	1	0	0	0	0	0	0	1	Double byte command to select 1 out of 256 contrast steps. Contrast increases as the value increases. (POR = 7Fh)
	X	1	1	0	0	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0	
Set Display Clock Divide Ratio/Oscillator Frequency	X	1	1	0	0	D5	1	1	0	1	0	1	0	1	A[3:0]: Define the divide ratio (D) of the display clocks (DCLK): divide ratio = A[3:0] + 1 (POR=0000b) A[7:4]: Set the Oscillator Frequency, F_{OSC}. Oscillator Frequency increases with the value of A[7:4] and vice versa. (POR=0111b) Range:0000b~1111b Frequency increases as setting value increases.
	X	1	1	0	0	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0	
Set Phase Length	X	1	1	0	0	D9	1	1	0	1	1	0	0	1	A[3:0]: Phase 1 period of up to 32 DCLK; clock 0 is an valid entry with 2 DCLK (POR=1000b) A[7:4]: Phase 2 period of up to 15 DCLK; clock 0 is invalid entry (POR=0111b)
	X	1	1	0	0	A[7:0]	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0	
Set SEG Pins Hardware Configuration	X	1	1	0	0	DA	1	1	0	1	1	0	1	0	A[4]=0b, Sequential SEG pin configuration A[4]=1b (POR), Alternative (odd/even) SEG pin configuration A[5]=0b (POR), Disable SEG Left/Right remap A[5]=1b, Enable SEG Left/Right remap Refer to Table 6-4 for details
	X	1	1	0	0	A[5:4]	0	0	A_5	A_4	0	0	0	0	
Set V_{COMH} Deselect Level	X	1	1	0	0	DB	1	1	0	1	1	0	1	1	
	X	1	1	0	0	A[6:4]	0	A_6	A_5	A_4	0	0	0	0	

A[6:4]	Hex code	V_{COMH} deselect level
000b	00h	~ 0.65 x V_{CC}
001b	10h	~ 0.71 x V_{CC}
010b	20h	~ 0.77 x V_{CC} (POR)
011b	30h	~ 0.83 x V_{CC}
100b	40h	1 x V_{CC}

3. OLED Command Set

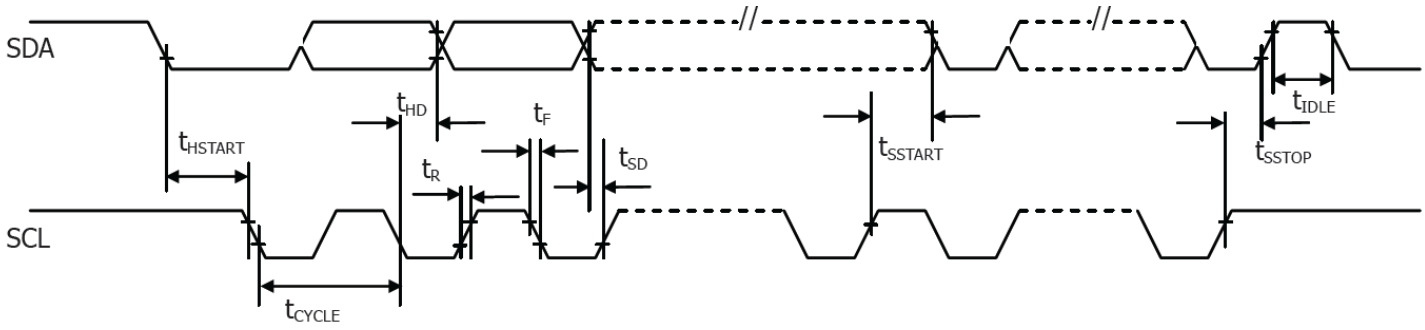
Command	IS	RE	SD	Instruction Code										Description
				D/C#	R/W# (WR#)	Hex	D7	D6	D5	D4	D3	D2	D1	D0	
Function Selection C	X	1	1	0	0	DC	1	1	0	1	1	1	0	0	Set VSL & GPIO
	X	1	1	0	0	A[7:0]	A_7	0	0	0	0	0	A_1	A_0	Set VSL: A[7] = 0b: Internal VSL (POR) A[7] = 1b: Enable external VSL Set GPIO: A[1:0]= 00b represents GPIO pin HiZ, input disabled (always read as low) A[1:0]= 01b represents GPIO pin HiZ, input enabled A[1:0]= 10b represents GPIO pin output Low (RESET) A[1:0]= 11b represents GPIO pin output High
Set Fade Out and Blinking	X	1	1	0	0	23	0	0	1	0	0	0	1	1	A[5:4] = 00b Disable Fade Out / Blinking Mode[RESET] A[5:4] = 10b Enable Fade Out mode. Once Fade Mode is enabled, contrast decrease gradually to all pixels OFF. Output follows RAM content when Fade mode is disabled. A[5:4] = 11b Enable Blinking mode. Once Blinking Mode is enabled, contrast decrease gradually to all pixels OFF and than contrast increase gradually to normal display. This process loop continuously until the Blinking mode is disabled. A[3:0] : Set time interval for each fade step
	X	1	1	0	0	A[5:0]	*	*	A_5	A_4	A_3	A_2	A_1	A_0	

A[3:0]	Time interval for each fade step
0000b	8 Frames
0001b	16 Frames
0010b	24 Frames
:	:
1110b	120 Frames
1111b	128 Frames

Timing Characteristics

I²C Interface:

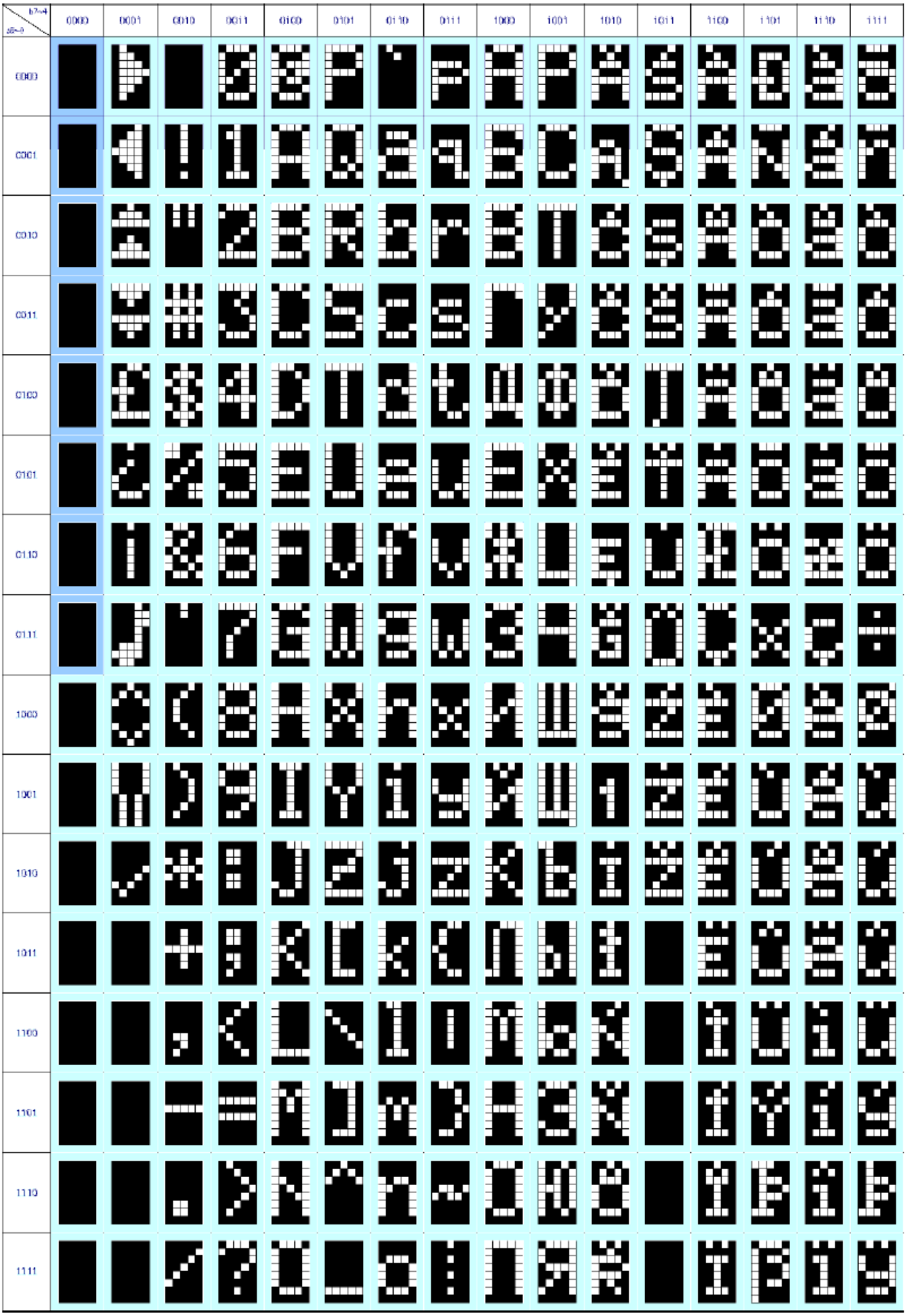
Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	2.5	-	-	us
t_{HSTART}	Start condition Hold Time	0.6	-	-	us
t_{HD}	Data Hold Time (for "SDA_{OUT}" pin)	5	-	-	ns
	Data Hold Time (for "SDA_{IN}" pin)	460	-	-	ns
t_{SD}	Data Setup Time	100	-	-	ns
t_{SSTART}	Start condition Setup Time (Only relevant for a repeated Start condition)	0.6	-	-	us
t_{SSTOP}	Stop condition Setup Time	0.6	-	-	us
t_R	Rise Time for data and clock pin	-	-	300	ns
t_F	Fall Time for data and clock pin	-	-	300	ns
t_{IDLE}	Idle Time before a new transmission can start	1.3	-	-	us



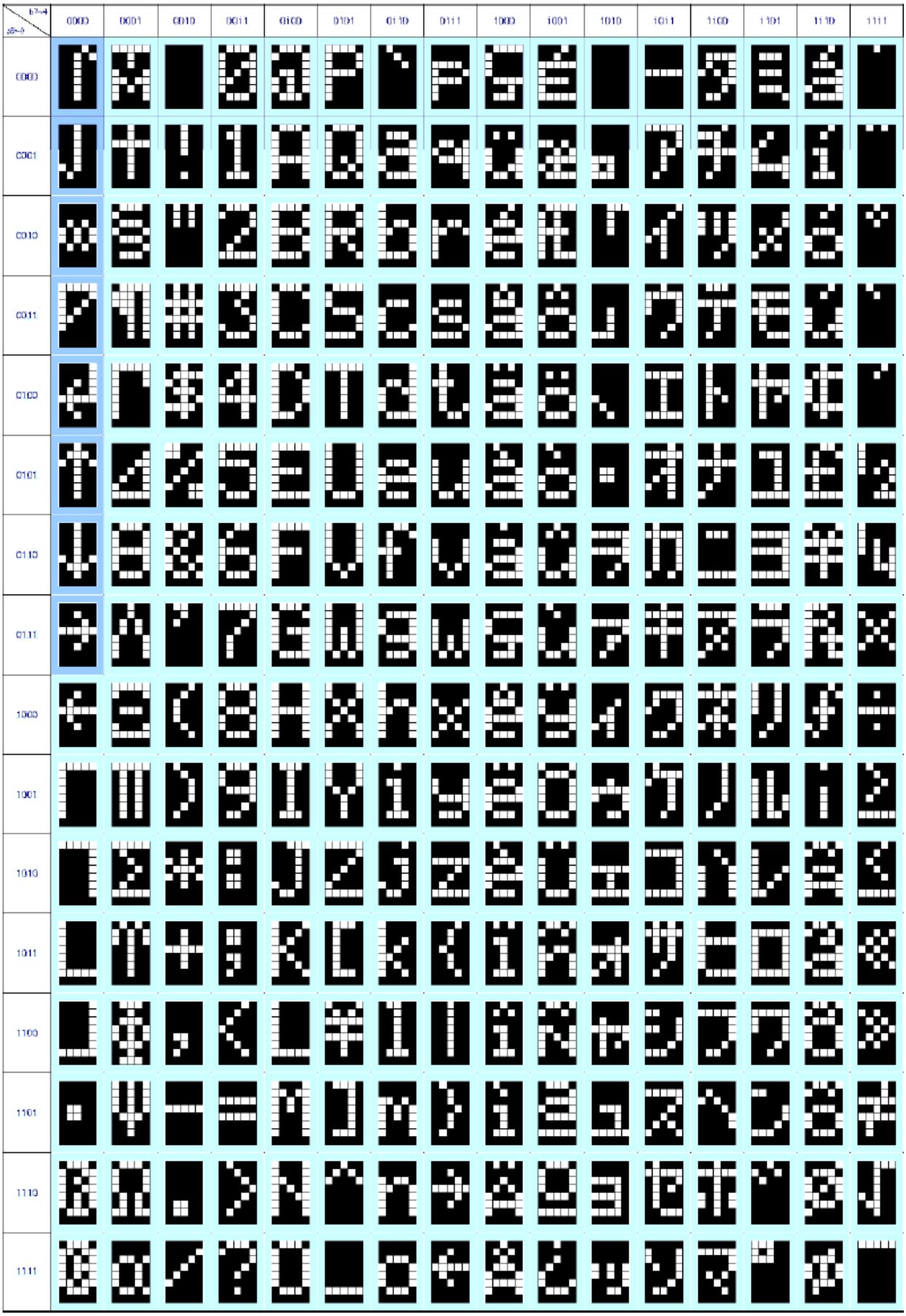
Built-in Font Tables

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

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



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



Example Initialization Sequence

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

Example Arduino Code

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

Quality Information

Test Item	Content of Test	Test Condition	Note
High Temperature storage	Test the endurance of the display at high storage temperature.	+90°C, 240hrs	2
Low Temperature storage	Test the endurance of the display at low storage temperature.	-40°C , 240hrs	1,2
High Temperature Operation	Test the endurance of the display by applying electric stress (voltage & current) at high temperature.	+85°C, 240hrs	2
Low Temperature Operation	Test the endurance of the display by applying electric stress (voltage & current) at low temperature.	-40°C, 240hrs	1,2
High Temperature / Humidity Operation	Test the endurance of the display by applying electric stress (voltage & current) at high temperature with high humidity.	+60°C, 90% RH, 240hrs	1,2
Thermal Shock resistance	Test the endurance of the display by applying electric stress (voltage & current) during a cycle of low and high temperatures.	-40°C, 30min -> 25°C, 5min -> 85°C, 30min = 1 cycle 100 cycles	
Vibration test	Test the endurance of the display by applying vibration to simulate transportation and use.	10-22Hz, 15mm amplitude. 22-500Hz, 1.5G 30min in each of 3 directions X,Y,Z	3
Static electricity test	Test the endurance of the display by applying electric static discharge.	VS=800V, RS=1.5kΩ, CS=100pF One time	

Note 1: No condensation to be observed.
Note 2: Conducted after 2 hours of storage at 25°C, 0%RH.
Note 3: Test performed on product itself, not inside a container.
Evaluation Criteria:
1: Display is fully functional during operational tests and after all tests, at room temperature.
2: No observable defects.
3: Luminance >50% of initial value.
4: Current consumption within 50% of initial value

Precautions for using OLEDs/LCDs/LCMs

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

Warranty Information and Terms & Conditions

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