

# NHD-C12864WO-B1TFH#-M

## COG (Chip-On-Glass) Liquid Crystal Display Module

NHD-	Newhaven Display
C12864-	128 x 64 Pixels
WO-	Display Type: COG
B1-	Model
T-	White LED Backlight
F-	FSTN Positive
H-	Transflective, Wide Temperature, 6:00 Optimal View
#-M-	Mounting Holes
	<b>RoHS Compliant</b>

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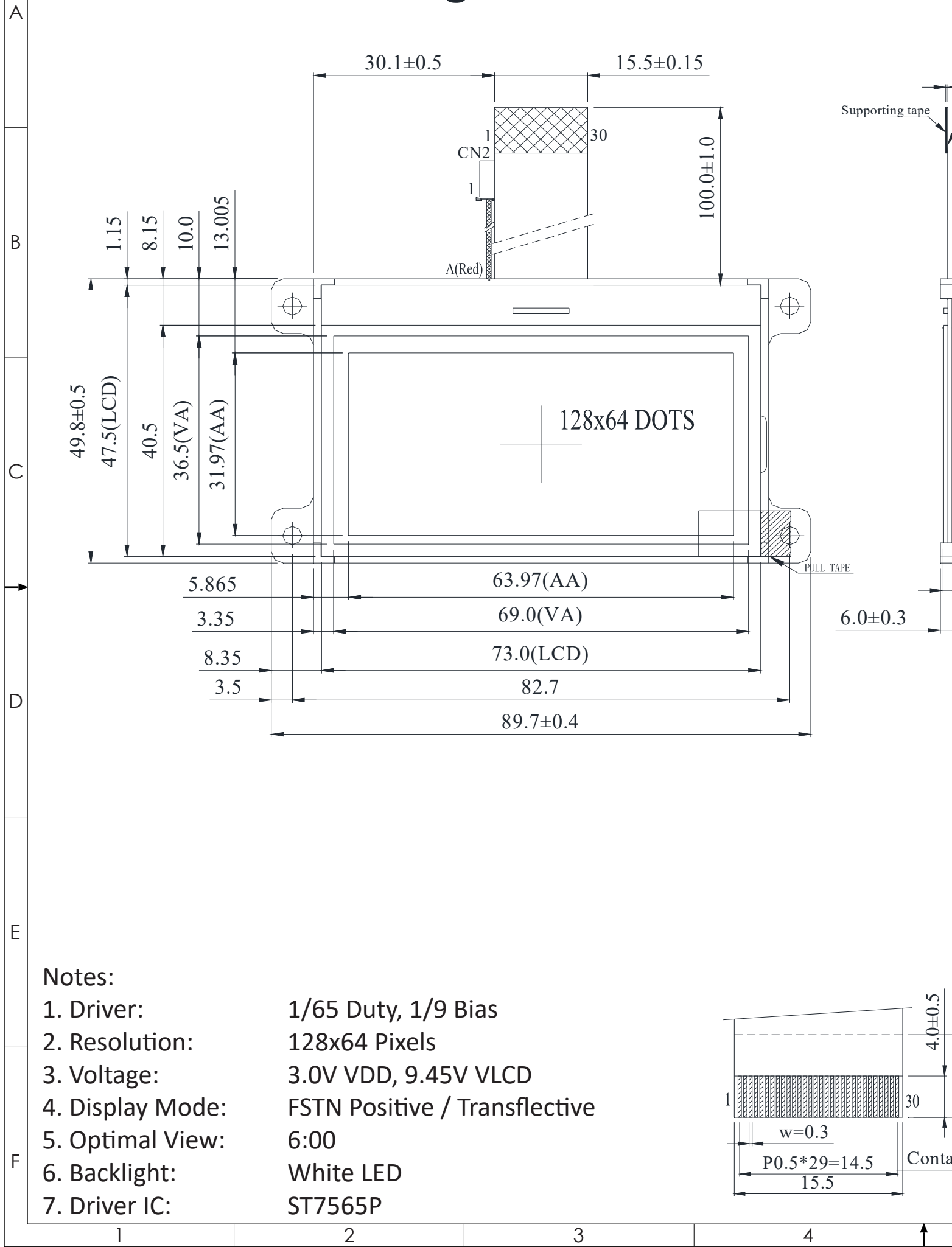
## Document Revision History

Revision	Date	Description	Changed by
0	9/1/08	Initial Release	-
1	11/12/09	User guide reformat	MC
2	12/14/09	Block Diagram Update	MC
3	2/12/10	Added –M to p/n to signify this part has mounting holes	MC
4	3/9/10	Block diagram updated	BE
5	5/4/10	Block diagram and pin description	MP
6	5/5/10	Backlight Connectors updated	BE
7	5/14/10	Pin description update	MP
8	5/2/11	Example initialization code updated	AK
9	5/13/11	Block diagram updated	AK
10	5/19/11	Block diagram & Pin description updated	AK
11	1/10/12	Pin description & Controller link updated	AK
12	6/15/12	Timing characteristics updated	AK
13	4/4/13	Backlight mating connector, LCD voltage levels updated	AK
14	4/15/13	Optical characteristics updated	AK
15	3/16/15	Pin description Updated	RM
16	12/30/16	Electrical Characteristics & Response Time Updated	SB
17	2/6/17	I <sub>LED</sub> Updated	SB
18	4/16/20	Initialization Code Updated	TM
19	3/3/21	Updated Tolerance on 2D Mechanical Drawing, MIN Supply Current, Backlight Drive Conditions & Quality Information	AS

## Functions and Features

- 128 x 64 pixels
- Built-in ST7565P controller
- +3.3V power supply
- 1/65 duty cycle; 1/9 bias
- RoHS Compliant

# Mechanical Drawing



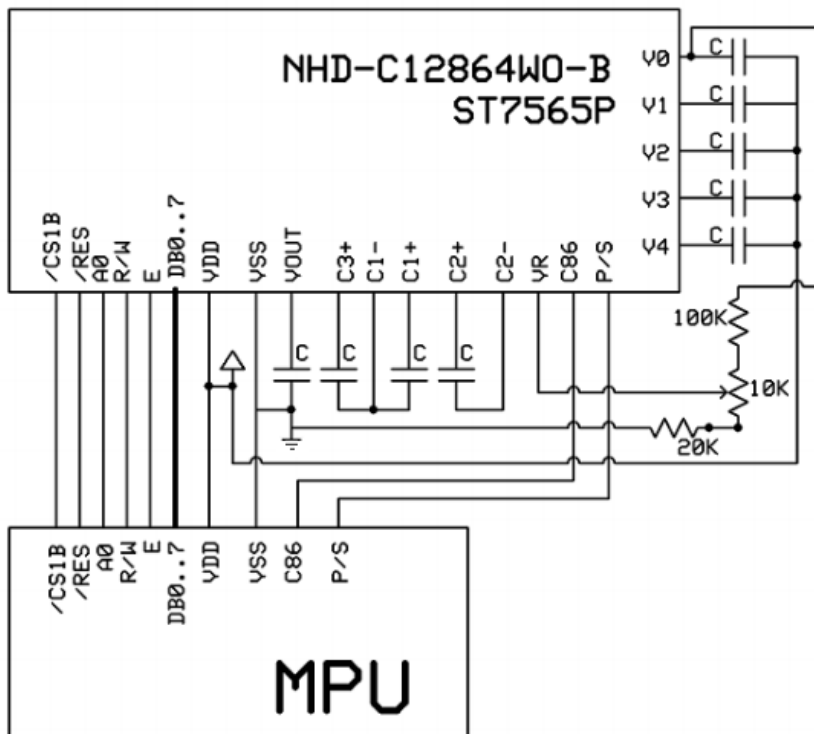
## Pin Description and Wiring Diagram

Pin No.	Symbol	External Connection	Function Description
1	/CS1	MPU	Active LOW chip select
2	/RES	MPU	Active LOW Reset signal
3	A0	MPU	Register select signal. 0: instruction; 1: data
4	R/W /WR	MPU	6800 Mode: Read/Write select signal. R/W=1: Read R/W=0: Write 8080 Mode: Active LOW Write Signal
5	E /RD	MPU	6800 Mode: Active HIGH Enable Signal 8080 Mode: Active LOW Read Signal
6-13	DB0~DB7	MPU	In parallel interface: 8-bit-directional data bus In serial interface: DB0~DB5 = VDD or NC D6 = Serial clock D7 = Serial data
14	V <sub>DD</sub>	Power Supply	Power supply for logic (+3V)
15	V <sub>SS</sub>	Power Supply	Ground
16	V <sub>OUT</sub>	Power Supply	1-4.7 μF cap to V <sub>SS</sub>
17	CAP3P	Power Supply	1-4.7 μF cap to CAP1N (pin-18)
18	CAP1N	Power Supply	1-4.7 μF cap to CAP3P (pin-17) and CAP1P (pin-19)
19	CAP1P	Power Supply	1-4.7 μF cap to CAP1N (pin-18)
20	CAP2P	Power Supply	1-4.7 μF cap to CAP2N (pin-21)
21	CAP2N	Power Supply	1-4.7 μF cap to CAP2P (pin-20)
22-26	V <sub>4</sub> ~V <sub>0</sub>	Power Supply	0.1-4.7 μF cap to VDD or VSS
27	V <sub>R</sub>	Adj. Power Supply	Wiper of 10kΩ pot (see schematic below)
28	C86	MPU	Select MPU interface pin. C86= H:6800; C86= L:8080
29	P/S	MPU	Parallel/Serial select. PS= H: Parallel; PS= L: Serial
30	NC	-	No connect

**Recommended LCD connector:** 0.5mm Pitch, 30 pin FFC. Molex p/n: 52892-3095

**Backlight connector:** A2001H-02P

**Mates with:** A2001WR-2P, A2001WR-S-2P, A2001WV-2P, A2001WV-S-2P



## Electrical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Temperature Range	T <sub>OP</sub>	Absolute Max	-20	-	+70	°C
Storage Temperature Range	T <sub>ST</sub>	Absolute Max	-30	-	+80	°C
Supply Voltage	V <sub>DD</sub>	-	2.7	3.0	3.3	V
Supply Current	I <sub>DD</sub>	V <sub>DD</sub> = 3.0V T <sub>OP</sub> = 25°C	0.1	0.6	2.0	mA
Supply for LCD (contrast)	V <sub>LCD</sub>		9.2	9.5	9.8	V
"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>	-	0.8 * V <sub>DD</sub>	-	V <sub>DD</sub>	V
"L" Level output	V <sub>OL</sub>	-	V <sub>SS</sub>	-	0.2 * V <sub>DD</sub>	V
LED Backlight voltage	V <sub>LED</sub>	I <sub>LED</sub> = 65mA	3.4	3.5	3.6	V
LED Backlight current	I <sub>LED</sub>	-	30	65	80	mA

\*The LED of the backlight is driven by current drain; drive voltage is for reference only. Drive voltage must be selected to ensure backlight current drain is below MAX level stated.

## Optical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Optimal Viewing Angles	Top	CR ≥ 2	-	30	-	°
	Bottom		-	60	-	°
	Left		-	45	-	°
	Right		-	45	-	°
Contrast Ratio	CR	-	2	5	-	-
Response Time	Rise	T <sub>OP</sub> = 25°C	-	200	300	ms
	Fall		-	250	350	ms

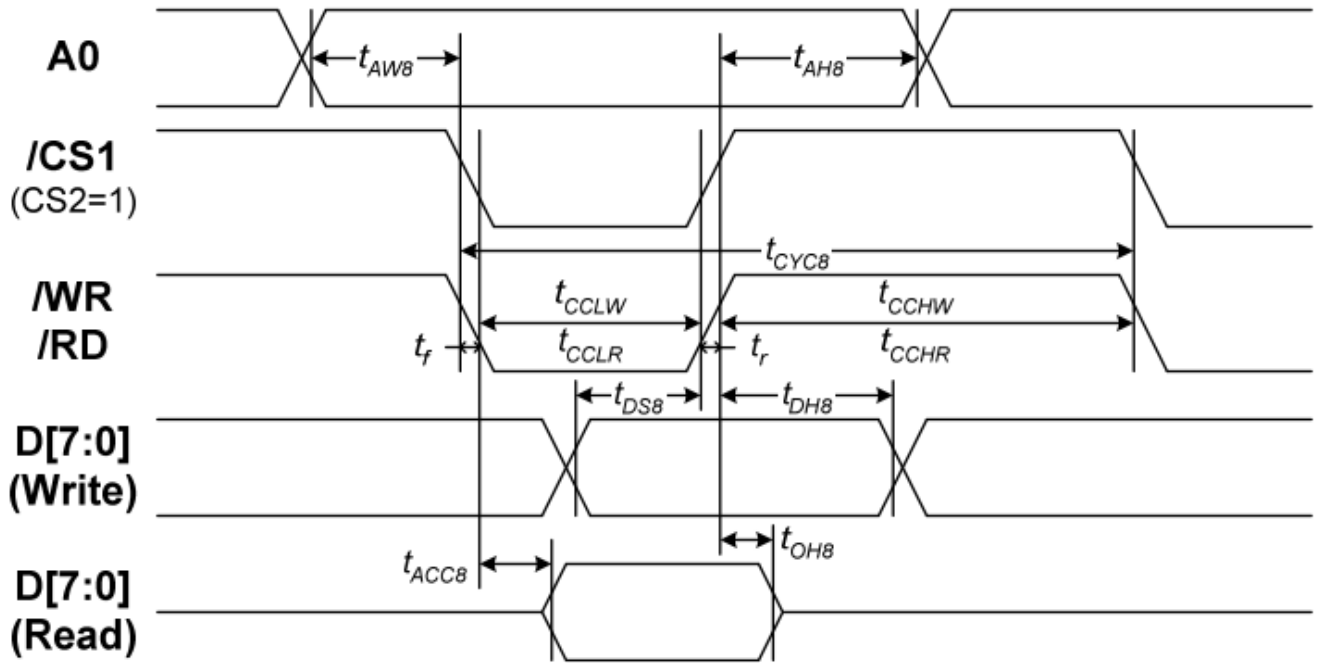
## Controller Information

Built-in ST7565P controller

Please download specification at [http://www.newhavendisplay.com/app\\_notes/ST7565P.pdf](http://www.newhavendisplay.com/app_notes/ST7565P.pdf)

# Timing Characteristics

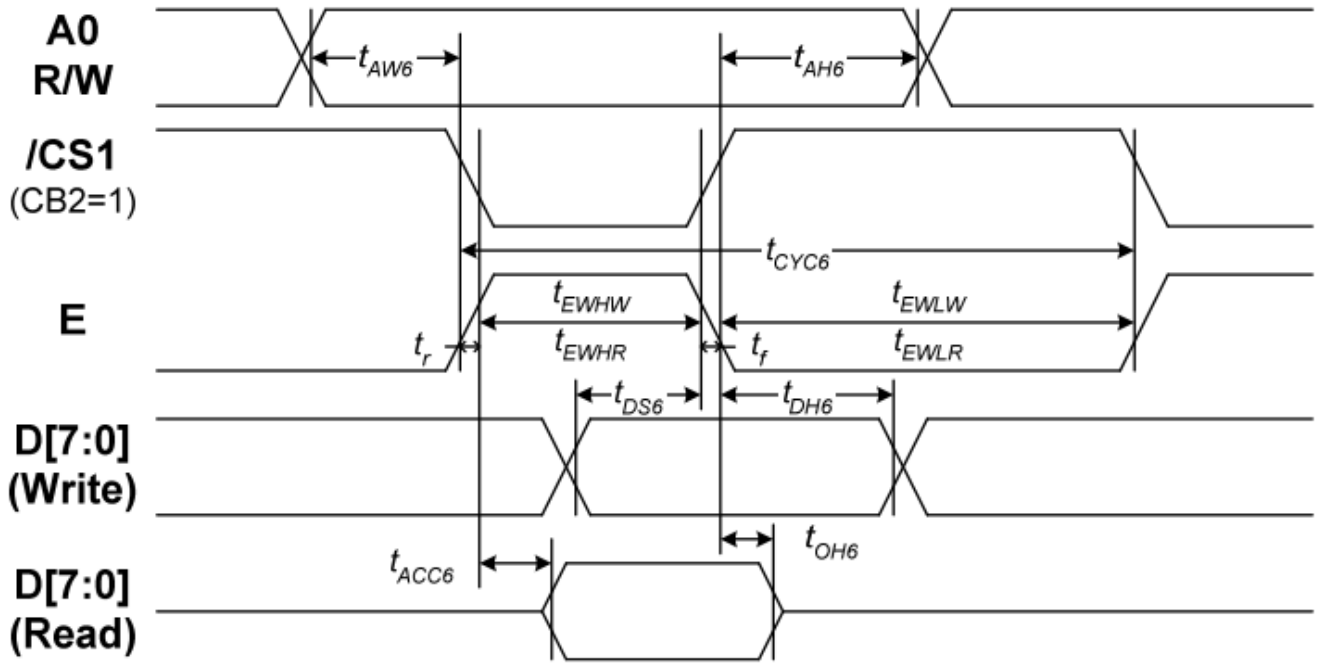
## System Bus Read/Write Characteristics 1 (For the 8080 Series MPU)



(V<sub>DD</sub> = 3.3V, T<sub>a</sub> = -30 to 85°C)

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Address hold time	A0	t <sub>AH8</sub>		0	—	Ns
Address setup time		t <sub>AW8</sub>		0	—	
System cycle time		t <sub>CYC8</sub>		240	—	
Write L pulse width	/WR	t <sub>CCLW</sub>		80	—	
Write H pulse width		t <sub>CCHW</sub>		80	—	
Read L pulse width	/RD	t <sub>CCLR</sub>		140	—	
Read H pulse width		t <sub>CCHR</sub>		80	—	
Write Data setup time	D0 to D7	t <sub>DS8</sub>		40	—	
Write Address hold time		t <sub>DH8</sub>		0	—	
Read access time		t <sub>ACC8</sub>	CL = 100 pF	—	70	
Read Output disable time		t <sub>OH8</sub>	CL = 100 pF	5	50	

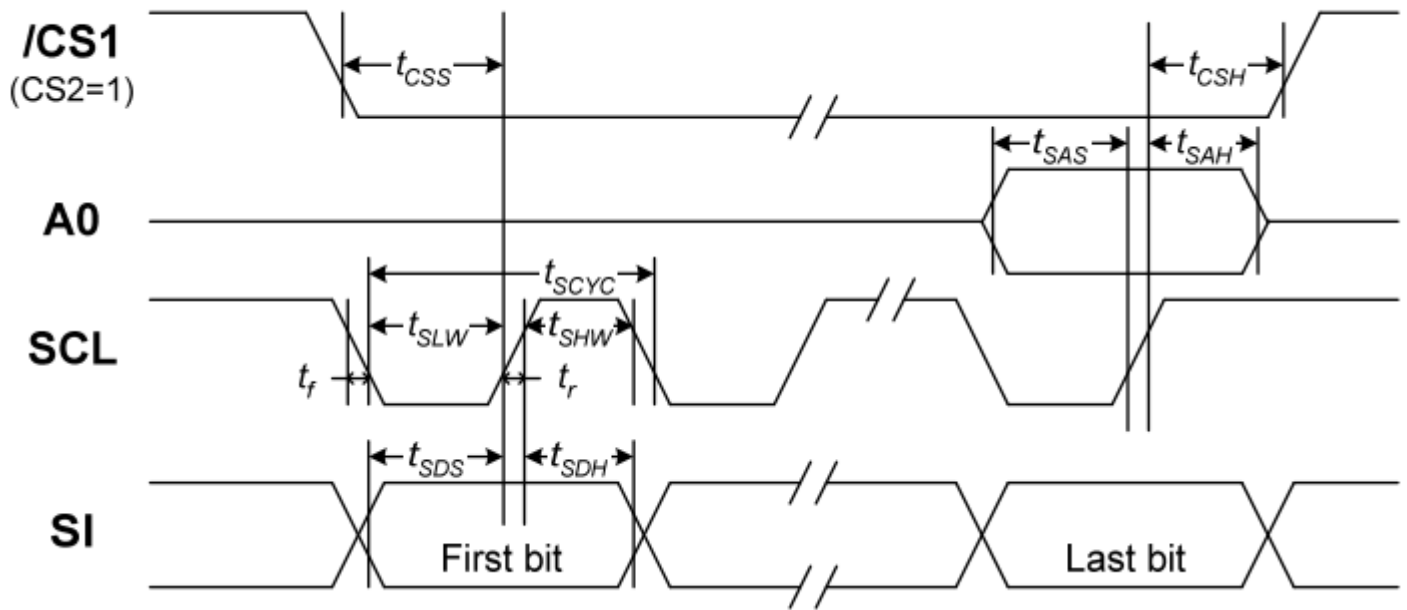
## System Bus Read/Write Characteristics 2 (For the 6800 Series MPU)



( $V_{DD} = 3.3V$ ,  $T_a = -30$  to  $85^\circ C$ )

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Address hold time	A0	$t_{AH6}$		0	—	ns
Address setup time		$t_{AW6}$		0	—	
System cycle time		$t_{CYC6}$		240	—	
Enable L pulse width (WRITE)	E	$t_{EWLW}$		80	—	
Enable H pulse width (WRITE)		$t_{EHWLW}$		80	—	
Enable L pulse width (READ)		$t_{EWLR}$		80	—	
Enable H pulse width (READ)		$t_{EHWLR}$		140	—	
WRITE Data setup time	D0 to D7	$t_{DS6}$		40	—	
WRITE Address hold time		$t_{DH6}$		0	—	
READ access time		$t_{ACC6}$	$C_L = 100$ pF	—	70	
READ Output disable time		$t_{OH6}$	$C_L = 100$ pF	5	50	

## The Serial Interface



( $V_{DD} = 3.3V$ ,  $T_a = -30$  to  $85^{\circ}C$ )

Item	Signal	Symbol	Condition	Rating		Units
				Min.	Max.	
Serial Clock Period	SCL	$t_{SCYC}$		50	—	ns
SCL "H" pulse width		$t_{SHW}$		25	—	
SCL "L" pulse width		$t_{SLW}$		25	—	
Address setup time	A0	$t_{SAS}$		20	—	
Address hold time		$t_{SAH}$		10	—	
Data setup time	SI	$t_{SDS}$		20	—	
Data hold time		$t_{SDH}$		10	—	
CS-SCL time	CS	$t_{CSS}$		20	—	
CS-SCL time		$t_{CSH}$		40	—	



## Table of Commands

Command	Command Code									Function			
	A0	/RD	/WR	D7	D6	D5	D4	D3	D2		D1	D0	
(1) Display ON/OFF	0	1	0	1	0	1	0	1	1	1	0	1	LCD display ON/OFF 0: OFF, 1: ON
(2) Display start line set	0	1	0	0	1	Display start address						0	Sets the display RAM display start line address
(3) Page address set	0	1	0	1	0	1	1	Page address				0	Sets the display RAM page address
(4) Column address set upper bit	0	1	0	0	0	0	1	Most significant column address				0	Sets the most significant 4 bits of the display RAM column address.
Column address set lower bit	0	1	0	0	0	0	0	Least significant column address				0	Sets the least significant 4 bits of the display RAM column address.
(5) Status read	0	0	1	Status				0	0	0	0	0	Reads the status data
(6) Display data write	1	1	0	Write data							0	Writes to the display RAM	
(7) Display data read	1	0	1	Read data							0	Reads from the display RAM	
(8) ADC select	0	1	0	1	0	1	0	0	0	0	0	0	Sets the display RAM address SEG output correspondence 0: normal, 1: reverse
(9) Display normal/reverse	0	1	0	1	0	1	0	0	1	1	0	1	Sets the LCD display normal/reverse 0: normal, 1: reverse
(10) Display all points ON/OFF	0	1	0	1	0	1	0	0	1	0	0	1	Display all points 0: normal display 1: all points ON
(11) LCD bias set	0	1	0	1	0	1	0	0	0	1	0	1	Sets the LCD drive voltage bias ratio 0: 1/9 bias, 1: 1/7 bias (ST7565)
(12) Read/modify/write	0	1	0	1	1	1	0	0	0	0	0	0	Column address increment At write: +1 At read: 0
(13) End	0	1	0	1	1	1	0	1	1	1	0	0	Clear read/modify/write
(14) Reset	0	1	0	1	1	1	0	0	0	1	0	0	Internal reset
(15) Common output mode select	0	1	0	1	1	0	0	0	0	*	*	*	Select COM output scan direction 0: normal direction 1: reverse direction
(16) Power control set	0	1	0	0	0	1	0	1	Operating mode			0	Select internal power supply operating mode
(17) Vs voltage regulator internal resistor ratio set	0	1	0	0	0	1	0	0	Resistor ratio			0	Select internal resistor ratio(Rb/Ra) mode
(18) Electronic volume mode set	0	1	0	1	0	0	0	0	0	0	0	1	Set the Vs output voltage electronic volume register
Electronic volume register set	0	1	0	0	0	Electronic volume value						0	
(19) Static indicator ON/OFF	0	1	0	1	0	1	0	1	1	0	0	0	0: OFF, 1: ON
Static indicator register set	0	1	0	0	0	0	0	0	0	0	Mode	1	Set the flashing mode
(20) Power saver													Display OFF and display all points ON compound command
(21) NOP	0	1	0	1	1	1	0	0	0	1	1	1	Command for non-operation
(22) Test	0	1	0	1	1	1	1	*	*	*	*	*	Command for IC test. Do not use this command

## Example Initialization Program

```
/******  
void comm_out(unsigned int c)  
{  
    CS1 = 0; //Active Low  
    AO = 0; //LOW = instruction  
    delay(1);  
    WRT = 0; // /WR in 8080 mode; R/W in 6800 mode  
    P1 = c;  
    delay(1);  
    WRT = 1; // /WR in 8080 mode; R/W in 6800 mode  
    CS1 = 1; //inactive  
}  
  
void data_out(unsigned int d)  
{  
    CS1 = 0; //Active Low  
    AO = 1; //High = Data  
    delay(1);  
    WRT = 0;  
    P1 = d;  
    delay(1);  
    WRT = 1;  
    CS1 = 1; //inactive  
}  
  
void init()  
{  
    C86 = 1;           // Interface set to 8080 mode  
    RDD = 1;          // /RD in 8080 mode; E in 6800 mode  
    WRT = 1;          // /WR in 8080 mode; R/W in 6800 mode  
    CS1 = 0;  
    RST = 1;          // /RST in 8080 mode; /RES in 6800 mode  
    RST = 0;          // /RST in 8080 mode; /RES in 6800 mode  
    delay(2);  
    RST = 1;          // /RST in 8080 mode; /RES in 6800 mode  
    delay(2);  
    comm_out(0xA2);   // LCD drive voltage bias ratio. 1/9 bias  
    comm_out(0xA0);   // ADC segment driver direction (A0=Normal)  
    comm_out(0xC0);   // COM output scan direction (C0= Normal)  
    comm_out(0x40);   // Display Start Line address  
    comm_out(0x25);   // Resistor ratio set  
    comm_out(0x10);   // Column address upper 4 bits + 0x10  
    comm_out(0x00);   // Column address lower 4 bits + 0x00  
    comm_out(0x81);   // Electronic Volume Command (set contrast) Double Byte: 1 of 2  
    comm_out(0x25);   // Electronic Volume value (contrast value) Double Byte: 2 of 2 //was 0x19  
    comm_out(0x2F);   // Power Control Set  
    comm_out(0xAF);   // Display ON  
}  
/******
```

## Quality Information

Test Item	Content of Test	Test Condition	Note
High Temperature storage	Endurance test applying the high storage temperature for a long time.	+80°C , 200hrs	2
Low Temperature storage	Endurance test applying the low storage temperature for a long time.	-30°C , 200hrs	1,2
High Temperature Operation	Endurance test applying the electric stress (voltage & current) and the high thermal stress for a long time.	+70°C 200hrs	2
Low Temperature Operation	Endurance test applying the electric stress (voltage & current) and the low thermal stress for a long time.	-20°C , 200hrs	1,2
High Temperature / Humidity Storage	Endurance test applying the electric stress (voltage & current) and the high thermal with high humidity stress for a long time.	+60°C , 90% RH , 96hrs	1,2
Thermal Shock resistance	Endurance test applying the electric stress (voltage & current) during a cycle of low and high thermal stress.	-20°C,30min -> 25°C,5min -> 70°C,30min = 1 cycle 10 cycles	
Vibration test	Endurance test applying vibration to simulate transportation and use.	10-55Hz , 1.5mm amplitude. 60 sec in each of 3 directions X,Y,Z For 15 minutes	3
Static electricity test	Endurance test applying electric static discharge.	Air: ±800V 150pF/330Ω, 10 Times Contact: ±600V 150pF/330Ω, 10 Times	

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

**Note 2:** Conducted after 4 hours of storage at 25°C, 0%RH.

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

## Precautions for using 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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