

# NHD-C12865AZ-RN-GBW

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

|         |                           |
|---------|---------------------------|
| NHD-    | Newhaven Display          |
| C12865- | 128 x 65 pixels           |
| AZ-     | Model                     |
| R-      | Reflective                |
| N-      | No Backlight              |
| G-      | STN-Gray                  |
| B-      | 6:00 view                 |
| W-      | Wide Temp (-20°C ~ +70°C) |
|         | <b>RoHS Compliant</b>     |

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## Document Revision History

| Revision | Date       | Description                       | Changed by |
|----------|------------|-----------------------------------|------------|
| 0        | 5/17/2007  | Initial Release                   | -          |
| 1        | 9/18/2009  | User guide reformat               | BE         |
| 2        | 10/14/2009 | Updated Electrical Characteristic | MC         |
|          |            |                                   |            |

## Functions and Features

- 128 x 65 pixels
- Built-in SPLC501C controller
- +3.3V power supply
- 1/65 duty cycle; 1/9 bias
- Parallel/Serial Interface
- RoHS Compliant

# Mechanical Drawing

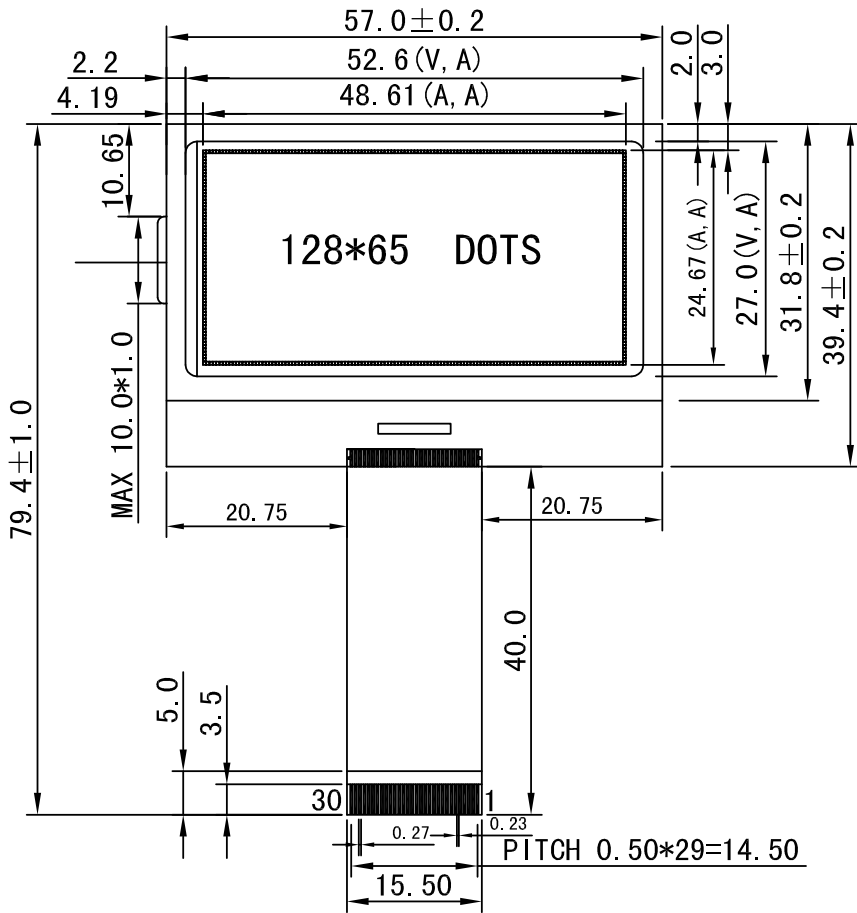
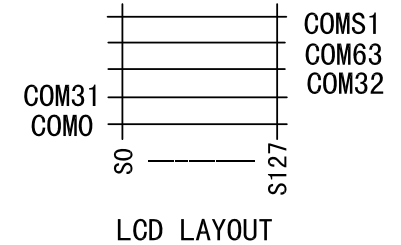
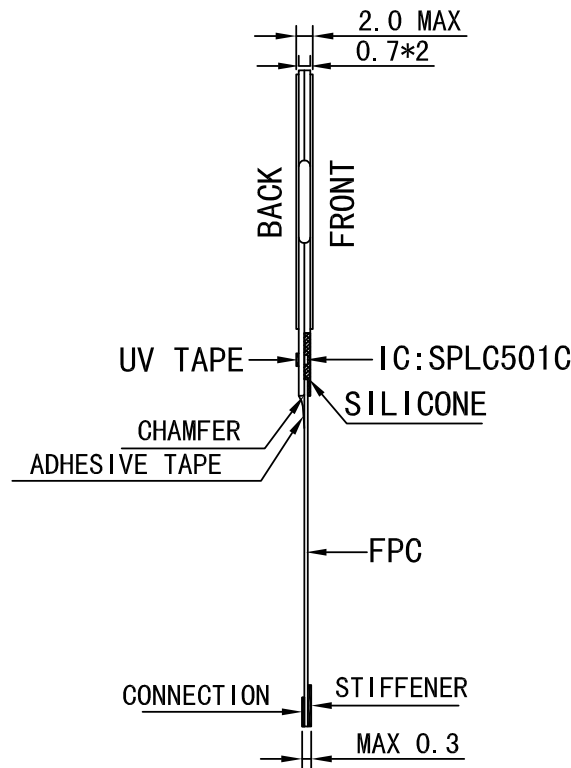


TABLE1:

|   | R                                    | T                                      | F                                       |
|---|--------------------------------------|--|---|
| F | POSITIVE REFLECTIVE FSTN             | POSITIVE TRANSMISSIVE FSTN             | POSITIVE TRANSFLECTIVE FSTN             |
| Y | POSITIVE REFLECTIVE YELLOW-GREEN STN | POSITIVE TRANSMISSIVE YELLOW-GREEN STN | POSITIVE TRANSFLECTIVE YELLOW-GREEN STN |
| G | POSITIVE REFLECTIVE GRAY STN         |  | POSITIVE TRANSFLECTIVE GRAY STN         |
| B |                                      | NEGATIVE TRANSMISSIVE BLUE STN         | NEGATIVE TRANSFLECTIVE BLUE STN         |
| W |                                      | NEGATIVE TRANSMISSIVE BLACK-WHITE STN  | NEGATIVE TRANSFLECTIVE BLACK-WHITE STN  |

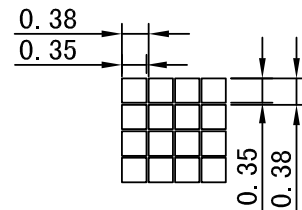


## PIN CONNECTIONS:

| PIN | SIGNAL | PIN | SIGNAL |
|-----|--------|-----|--------|
| 1   | /CS1   | 16  | VOUT   |
| 2   | /RES   | 17  | CAP3N  |
| 3   | A0     | 18  | CAP1P  |
| 4   | /RW    | 19  | CAP1N  |
| 5   | E      | 20  | CAP2N  |
| 6   | DB0    | 21  | CAP2P  |
| 7   | DB1    | 22  | V1     |
| 8   | DB2    | 23  | V2     |
| 9   | DB3    | 24  | V3     |
| 10  | DB4    | 25  | V4     |
| 11  | DB5    | 26  | V5     |
| 12  | DB6    | 27  | VR     |
| 13  | DB7    | 28  | C86    |
| 14  | VDD    | 29  | PS     |
| 15  | VSS    | 30  | IRS    |

## NOTE:

1. VIEWING ANGLE: 6:00 O' CLOCK
2. DISPLAY MODE: AS IS SHOWN IN TABLE1
3. DRIVING VOLTAGE: 9.5V, DUTY: 1/65, BIAS: 1/9, FREQUENCY: 64Hz
4. OPERATING TEMP.:  $-20^{\circ} \text{C}$  TO  $70^{\circ} \text{C}$
5. STORAGE TEMP.:  $-30^{\circ} \text{C}$  TO  $80^{\circ} \text{C}$
6. CONNECTOR: FPC TYPE



PIXEL DETAILS

## Newhaven Display

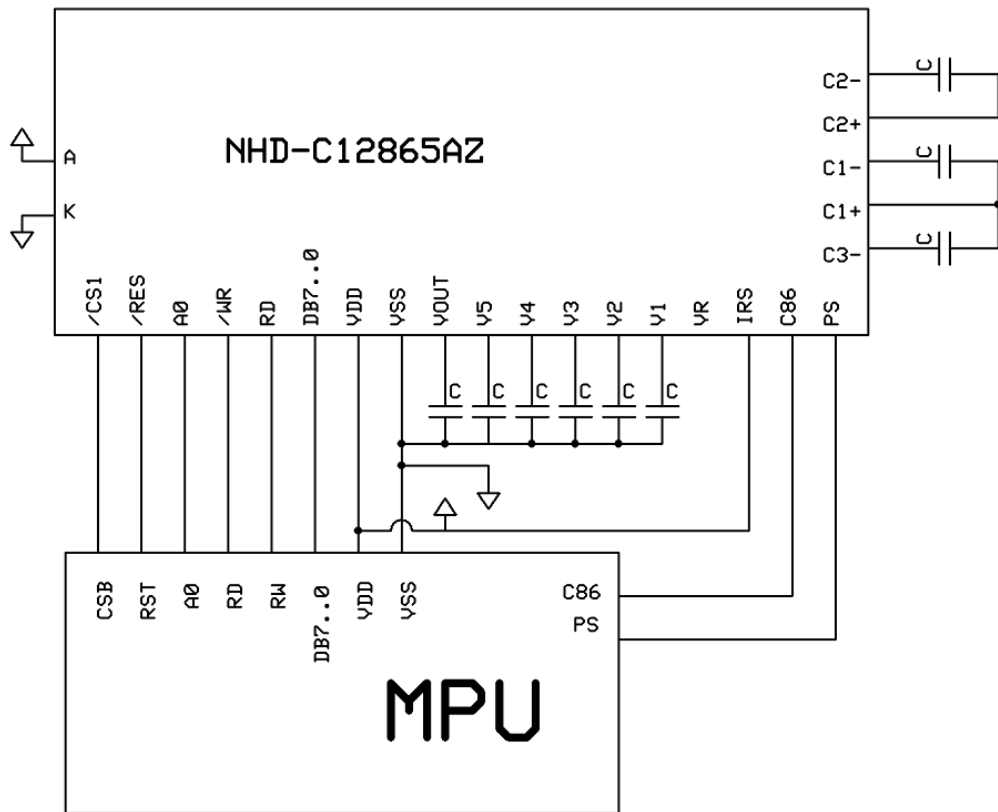
| DATE       | 9/18/2009      | PART NO.     | NHD-C12865AZ-RN-GBW |
|------------|----------------|--------------|---------------------|
| DESIGN BY  | CSL 24/06-2005 |              |                     |
| CHECKED BY |                |              |                     |
| APP BY     |                | SHEET 1 OF 1 |                     |

## 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. A0=1: Data, A0=0: Command                       |
| 4       | /RW    | MPU                 | Read/Write select signal, R/W=1: Read R/W=0: Write                      |
| 5       | E      | MPU                 | Operation enable signal. Falling edge triggered.                        |
| 6       | DB0    | MPU                 | Parallel Interface  |
| 7       | DB1    | MPU                 | DB0-DB7: Bi-directional 8-bit data bus                                  |
| 8       | DB2    | MPU                 |   |
| 9       | DB3    | MPU                 | Serial Interface:   |
| 10      | DB4    | MPU                 | DB0-DB5: No connect in serial mode                                      |
| 11      | DB5    | MPU                 |   |
| 12      | DB6    | MPU                 | DB6= Serial clock (CLK)   |
| 13      | DB7    | MPU                 | DB7= Serial data input (SDA)  |
| 14      | VDD    | Power Supply        | Power supply for LCD and logic (+3.3V)                                  |
| 15      | Vss    | Power Supply        | Ground  |
| 16      | VOUT   | Power Supply        | Voltage booster circuit – connect to 1uF cap to Vss or VDD              |
| 17      | CAP3-  | Power Supply        | Connect to 1uF Cap to CAP1+ (Pin-18)                                    |
| 18      | CAP1+  | Power Supply        | Connect to 1uF Cap to CAP1-(Pin-19) and CAP3-(Pin17)                    |
| 19      | CAP1-  | Power Supply        | Connect to 1uF Cap to CAP1+ (Pin-18)                                    |
| 20      | CAP2-  | Power Supply        | Connect to 1uF Cap to CAP2+ (Pin-21)                                    |
| 21      | CAP2+  | Power Supply        | Connect to 1uF Cap to CAP2- (Pin-20)                                    |
| 22      | V1     | Power Supply        | 1.0uF-2.2uF cap to VSS  |
| 23      | V2     | Power Supply        | 1.0uF-2.2uF cap to VSS  |
| 24      | V3     | Power Supply        | 1.0uF-2.2uF cap to VSS  |
| 25      | V4     | Power Supply        | 1.0uF-2.2uF cap to VSS  |
| 26      | V5     | Power Supply        | 1.0uF-2.2uF cap to VSS  |
| 27      | VR     | -                   | No Connect  |
| 28      | C86    | MPU                 | Select MPU interface pin. C86 = H: 6800; C86 = L: 8080                  |
| 29      | PS     | MPU                 | Parallel/Serial select. PS = H: Parallel; PS = L: Serial                |
| 30      | IRS    | MPU                 | This terminal selects the resistors for the V5 voltage level adjustment |

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

**Backlight connector:** -- Mates with: --



## Electrical Characteristics

| Item                        | Symbol | Condition        | Min. | Typ. | Max.   | Unit |
|-----------------------------|--------|------------------|------|------|--------|------|
| Operating Temperature Range | Top    | Absolute Max     | -20  | -    | +70    | °C   |
| Storage Temperature Range   | Tst    | Absolute Max     | -30  | -    | +80    | °C   |
| Supply Voltage              | VDD    |                  | -    | 3.3  | 3.4    | V    |
| Supply Current              | IDD    | Ta=25°, VDD=3.3V | -    | 1.5  | 2.5    | mA   |
| Supply for LCD (contrast)   | VDD-V0 | Ta =25           | -    | 9.5  | 10     | V    |
| "H" Level input             | Vih    |                  | 0.7  | -    | VDD    | V    |
| "L" Level input             | Vil    |                  | 0    | -    | 0.3VDD | V    |
| "H" Level output            | Voh    |                  | 2.4  | -    | -      | V    |
| "L" Level output            | Vol    |                  | -    | -    | 0.4    | V    |

## Optical Characteristics

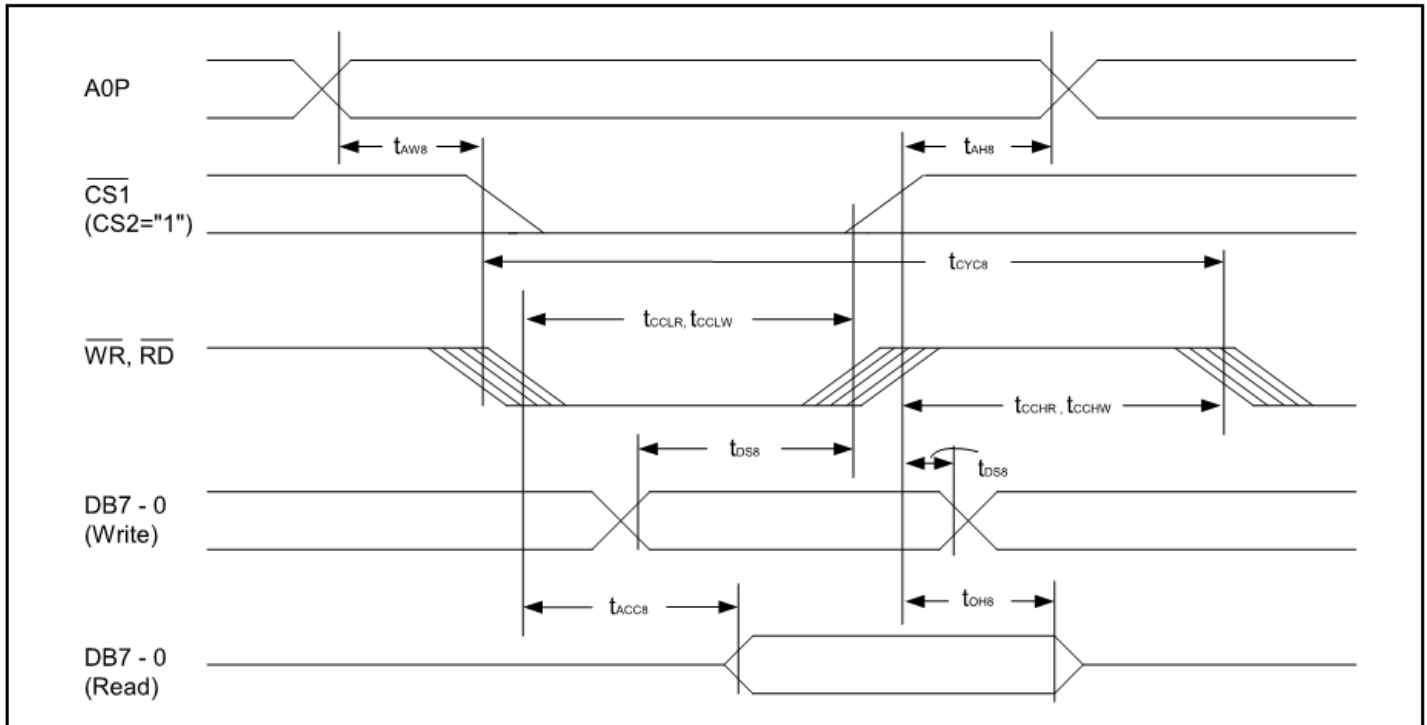
| Item                       | Symbol | Condition | Min. | Typ. | Max. | Unit |
|----------------------------|--------|-----------|------|------|------|------|
| Viewing Angle - Vertical   | Φ      | Cr≥3      | -45  | -    | +25  | °    |
| Viewing Angle - Horizontal |        |           | -35  | -    | +35  | °    |
| Contrast Ratio             | K      |           | 3.0  | -    | -    | -    |
| Response Time (rise)       | Tr     | 25°C      | -    | -    | 250  | ms   |
| Response Time (fall)       | Tf     | 25°C      | -    | -    | 250  | ms   |

# Controller Information

Built-in SPLC501C. Download specification at [http://www.newhavendisplay.com/app\\_notes/SPLC501C.pdf](http://www.newhavendisplay.com/app_notes/SPLC501C.pdf)

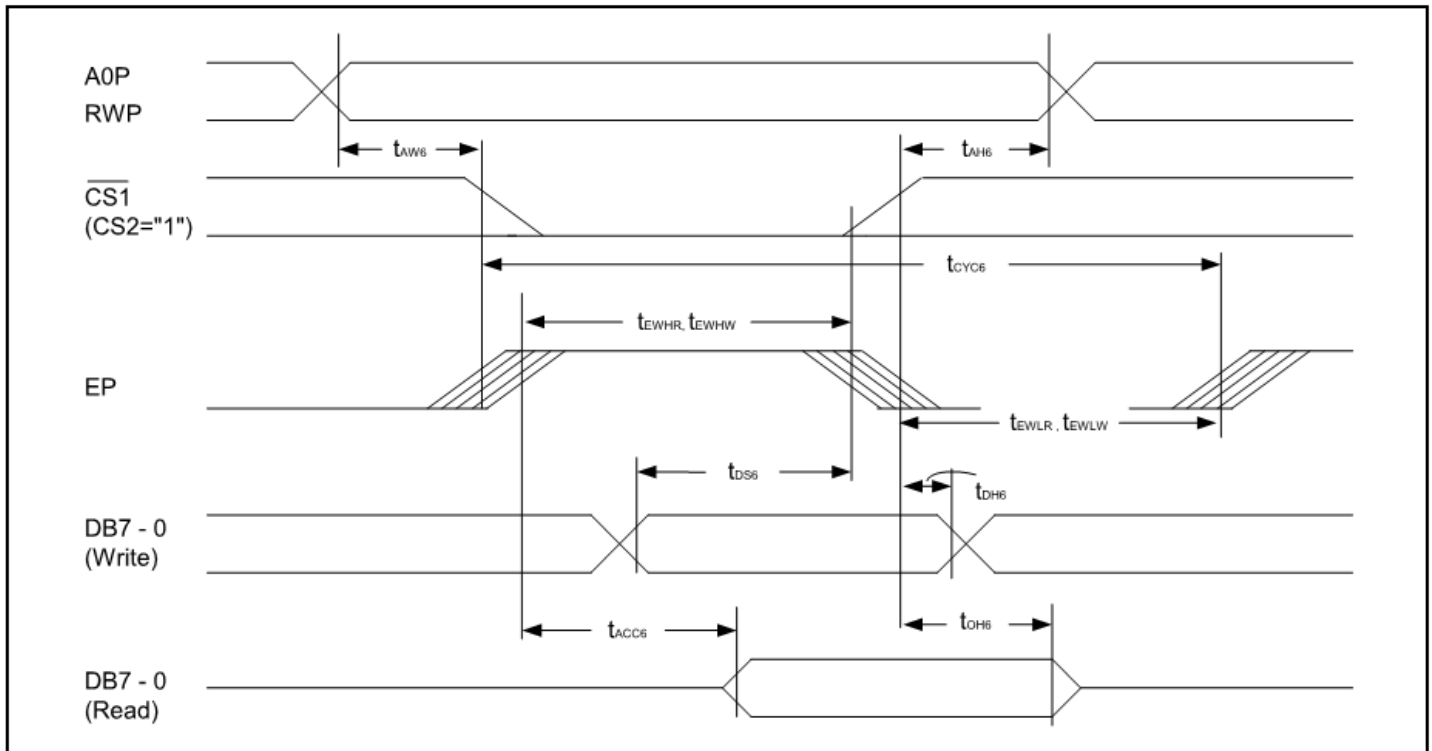
## Timing Characteristics

### 8.6.1. System bus read/write characteristics 1 (For the 8080 Series MPU)



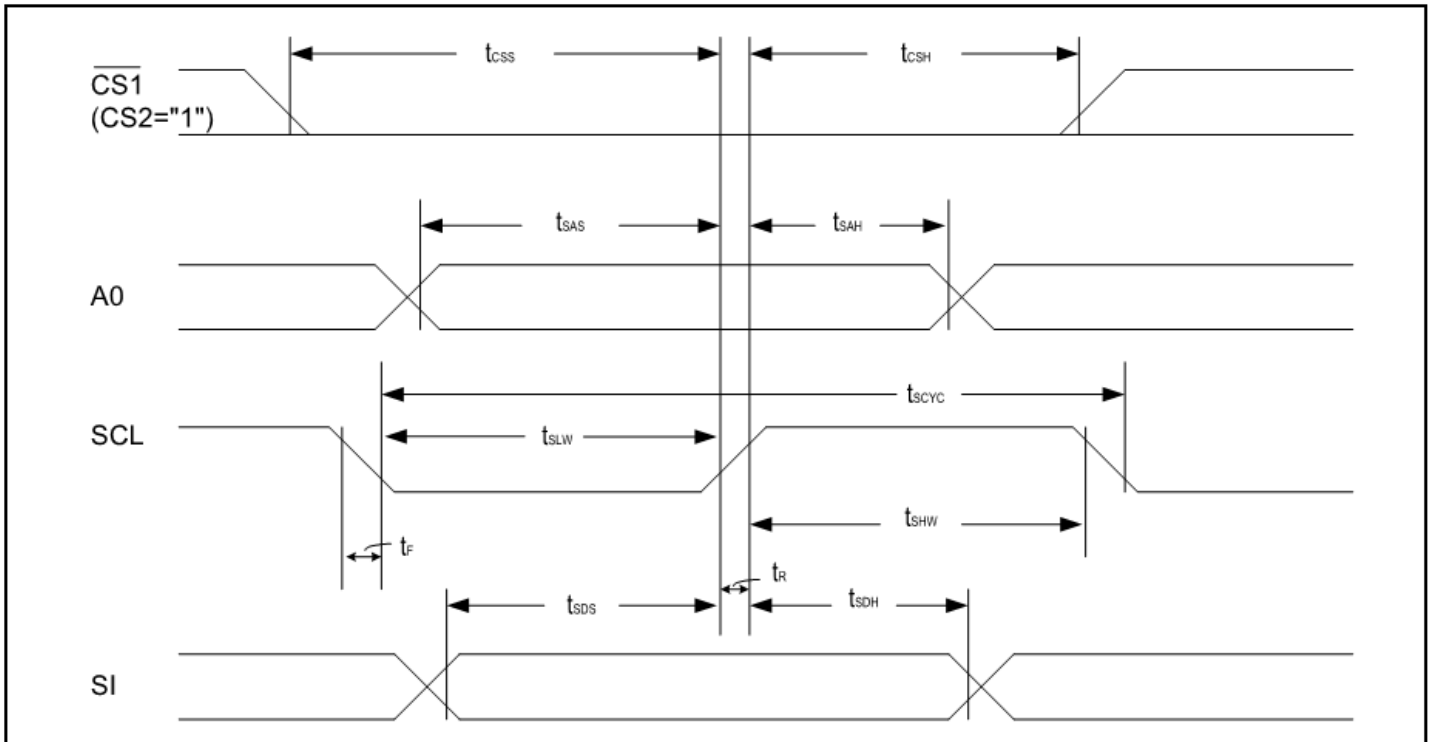
| Item                                      | Signal          | Symbol     | Condition     | Rating |      | Units |
|---|-----------------|------------|---------------|--------|------|-------|
|   |                 |            |               | Min.   | Max. |       |
| Address hold time                         | A0P             | $t_{AH8}$  |               | 0      | -    | ns    |
| Address setup time                        | A0P             | $t_{AW8}$  |               | 0      | -    | ns    |
| System cycle time                         | A0P             | $t_{CYCB}$ |               | 300    | -    | ns    |
| Control L pulse width ( $\overline{WR}$ ) | $\overline{WR}$ | $t_{CCLW}$ |               | 60     | -    | ns    |
| Control L pulse width ( $\overline{RD}$ ) | $\overline{RD}$ | $t_{CCLR}$ |               | 120    | -    | ns    |
| Control H pulse width ( $\overline{WR}$ ) | $\overline{WR}$ | $t_{CCHW}$ |               | 60     | -    | ns    |
| Control H pulse width ( $\overline{RD}$ ) | $\overline{RD}$ | $t_{CCHR}$ |               | 60     | -    | ns    |
| Data setup time                           | DB7 - 0         | $t_{DS8}$  |               | 40     | -    | ns    |
| Address hold time                         |                 | $t_{DH8}$  |               | 15     | -    | ns    |
| RD access time                            |                 | $t_{ACC8}$ | $C_L = 100pF$ | -      | 140  | ns    |
| Output disable time                       |                 | $t_{OH8}$  |               | 10     | 100  | ns    |

### 8.6.2. System bus read/write characteristics 2 (6800 series MPU)



| Item                | Signal  | Symbol     | Condition     | Rating |      | Units |
|---------------------|---------|------------|---------------|--------|------|-------|
|                     |         |            |               | Min.   | Max. |       |
| Address hold time   | A0P     | $t_{AH6}$  |               | 0      | -    | ns    |
| Address setup time  | A0P     | $t_{AW6}$  |               | 0      | -    | ns    |
| System cycle time   | A0P     | $t_{CYC6}$ |               | 300    | -    | ns    |
| Data setup time     | DB7 - 0 | $t_{DS6}$  | $C_L = 100pF$ | 40     | -    | ns    |
| Data hold time      |         | $t_{DH6}$  |               | 15     | -    | ns    |
| Access time         | DB7 - 0 | $t_{ACC6}$ |               | -      | 140  | ns    |
| Output disable time |         | $t_{OH6}$  |               | 10     | 100  | ns    |
| Enable H pulse time | Read    | EP         | $t_{EWHR}$    | 120    | -    | ns    |
|                     | Write   |            | $t_{EWHW}$    | 60     | -    | ns    |
| Enable L pulse time | Read    | EP         | $t_{EWLR}$    | 60     | -    | ns    |
|                     | Write   |            | $t_{EWLW}$    | 60     | -    | ns    |

### 8.6.3. The serial interface



| Item                | Signal | Symbol     | Condition | Rating |      | Units |
|---------------------|--------|------------|-----------|--------|------|-------|
|                     |        |            |           | Min.   | Max. |       |
| Serial Clock Period |        | $t_{SCYC}$ | -         | 250    | -    | ns    |
| SCL 'H' pulse width | SCL    | $t_{SHW}$  | -         | 100    | -    | ns    |
| SCL 'L' pulse width |        | $t_{SLW}$  | -         | 100    | -    | ns    |
| Address setup time  | A0P    | $t_{SAS}$  | -         | 150    | -    | ns    |
| Address hold time   |        | $t_{SAH}$  | -         | 150    | -    | ns    |
| Data setup time     | SI     | $t_{SDS}$  | -         | 100    | -    | ns    |
| Data hold time      |        | $t_{SDH}$  | -         | 100    | -    | ns    |
| CS-SCL time         | CS     | $t_{CSS}$  | -         | 150    | -    | ns    |
|                     |        | $t_{CSH}$  | -         | 150    | -    | ns    |



## Table of Commands

| Command   | Command Code |    |    |            |     |                         |     |                                  |                |     |     | Function   |
|---|--------------|----|----|------------|-----|-------------------------|-----|----------------------------------|----------------|-----|-----|--|
|   | A0P          | RD | WR | DB7        | DB6 | DB5                     | DB4 | DB3                              | DB2            | DB1 | DB0 |  |
| 1). Display ON/OFF  | 0            | 1  | 0  | 1          | 0   | 1                       | 0   | 1                                | 1              | 1   | 0   | LCD display ON/OFF<br>0: OFF, 1: ON  |
| 2). Display start line set  | 0            | 1  | 0  | 0          | 1   | Display start address   |     |                                  |                |     | 1   | Sets the display RAM display start line address                                  |
| 3). Page address set  | 0            | 1  | 0  | 1          | 0   | 1                       | 1   | Page address                     |                |     |     | Sets the display RAM page address  |
| 4). Column address set upper bit                                  | 0            | 1  | 0  | 0          | 0   | 0                       | 1   | Most significant column address  |                |     |     | 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 |                |     |     | Set the least significant 4 bits of the display RAM column address.              |
| 5). Status read   | 0            | 0  | 1  | Status     |     |                         |     | 0                                | 0              | 0   | 0   | Reads the status data  |
| 6). Display data write  | 1            | 1  | 0  | Write data |     |                         |     |                                  |                |     |     | Writes to the display RAM  |
| 7). Display data read   | 1            | 0  | 1  | Read data  |     |                         |     |                                  |                |     |     | Reads from the display RAM   |
| 8). ADC select  | 0            | 1  | 0  | 1          | 0   | 1                       | 0   | 0                                | 0              | 0   | 0   | Sets the display RAM address SEG output correspondence<br>0: normal, 1:reverse   |
| 9). Display normal/reverse  | 0            | 1  | 0  | 1          | 0   | 1                       | 0   | 0                                | 1              | 1   | 0   | Sets the LCD display normal/ reverse<br>0: normal, 1:reverse                     |
| 10). Display all points ON/OFF                                    | 0            | 1  | 0  | 1          | 0   | 1                       | 0   | 0                                | 1              | 0   | 0   | Display all points<br>0: normal display<br>1: all points ON                      |
| 11). LCD bias set   | 0            | 1  | 0  | 1          | 0   | 1                       | 0   | 0                                | 0              | 1   | 0   | Sets the LCD driver voltage bias ratio<br>SPLC501C.....0:1/9, 1:1/7              |
| 12). Read/modify/write  | 0            | 1  | 0  | 1          | 1   | 1                       | 0   | 0                                | 0              | 0   | 0   | Column address increment<br>At write: +1<br>At read: 0                           |
| 13). End  | 0            | 1  | 0  | 1          | 1   | 1                       | 0   | 1                                | 1              | 1   | 0   | Clear read/modify/write  |
| 14). Reset  | 0            | 1  | 0  | 1          | 1   | 1                       | 0   | 0                                | 0              | 1   | 0   | Internal reset   |
| 15). Common output mode select                                    | 0            | 1  | 0  | 1          | 1   | 0                       | 0   | 0                                | *              | *   | *   | Select COM output scan direction<br>0: normal direction,<br>1: reverse direction |
| 16). Power control set  | 0            | 1  | 0  | 0          | 0   | 1                       | 0   | 1                                | Operating mode |     |     | Select internal power supply operating mode                                      |
| 17). V <sub>5</sub> voltage regulator internal resistor ratio set | 0            | 1  | 0  | 0          | 0   | 1                       | 0   | 0                                | Resistor ratio |     |     | Select internal resistor ratio (Rb/Ra) mode                                      |
| 18). Electronic volume mode set                                   | 0            | 1  | 0  | 1          | 0   | 0                       | 0   | 0                                | 0              | 0   | 1   | Set the V <sub>5</sub> output voltage electronic volume register                 |
| Electronic volume register set                                    | 0            | 1  | 0  | *          | *   | Electronic volume value |     |                                  |                |     |     |  |

| Command                          | Command Code |    |    |     |     |     |     |     |     |      |     | Function   |
|----------------------------------|--------------|----|----|-----|-----|-----|-----|-----|-----|------|-----|--|
|                                  | A0P          | RD | WR | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1  | DB0 |  |
| 19). Static indicator<br>ON/OFF  | 0            | 1  | 0  | 1   | 0   | 1   | 0   | 1   | 1   | 0    | 0   | 0: OFF, 1: ON  |
| Static indicator<br>Register set | 0            | 1  | 0  | *   | *   | *   | *   | *   | *   | Mode | 1   | Set the flashing mode  |
| 20). Page Blink                  | 0            | 1  | 0  | 1   | 1   | 0   | 1   | 0   | 1   | 0    | 1   | P7 - 0: 1 - blinking page<br>0 - no blinking, normal display |
| Page selection                   | 0            | 1  | 0  | P7  | P6  | P5  | P4  | P3  | P2  | P1   | P0  |  |
| 21). Driving Mode Set            | 0            | 1  | 0  | 1   | 1   | 0   | 1   | 0   | 0   | 1    | 0   | Set the driving mode register                                |
| Mode selection                   | 0            | 1  | 0  | D1  | D0  | 0   | 0   | 0   | 0   | 0    | 0   | Driving capability (D1, D0):<br>(1,1)>(0,0)>(0,1)>(1,0)      |
| 22). Power saver                 |              |    |    |     |     |     |     |     |     |      |     | Display OFF and display all points ON<br>compound command    |
| 23). NOP                         | 0            | 1  | 0  | 1   | 1   | 1   | 0   | 0   | 0   | 1    | 1   | Command for non-operation                                    |
| 24). Test                        | 0            | 1  | 0  | 1   | 1   | 1   | 1   | *   | *   | *    | *   | Command for IC test. Do not use<br>this command              |
|                                  |              |    |    | 1   | 1   | 0   | 1   | 0   | 1   | 0    | 0   |  |

# Example Initialization Program

```
.....  
Sub Init  
Set P3.0  
Set P3.1  
Reset P3.4  
Set P3.3          'reset  
Reset P3.3  
Waitms 2  
Set P3.3  
Waitms 20  
A = &HA2          '1/9 BIAS  
Call Writecom  
A = &HA0          'ADC SELECT , NORMAL  
Call Writecom  
A = &HC8          'COM OUTPUT REVERSE  
Call Writecom  
A = &HA4          'DISPLAY ALL POINTS NORMAL  
Call Writecom  
A = &H40          'DISPLAY START LINE SET  
Call Writecom  
A = &H25          'INTERNAL RESISTOR RATIO  
Call Writecom  
A = &H81          'ELECTRONIC VOLUME MODE SET  
Call Writecom  
A = &H07          'ELECTRONIC VOLUME  
Call Writecom  
A = &H2F          'POWER CONTROLLER SET  
Call Writecom  
A = &HAF          'DISPLAY ON  
Call Writecom  
End Sub
```

```
.....  
Sub Writecom  
Reset P3.2        'A0  
Reset P3.1        'R/W  
Reset P3.4        'CS1  
Set P3.0          'E  
P1 = A  
Reset P3.0  
Set P3.4  
End Sub
```

```
.....  
Sub Writedata  
Set P3.2  
Reset P3.1  
Reset P3.4  
Set P3.0  
P1 = A  
Reset P3.0  
Set P3.4  
End Sub  
.....
```

## 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 , 48hrs   | 2    |
| Low Temperature storage               | Endurance test applying the low storage temperature for a long time.  | -30°C , 48hrs   | 1,2  |
| High Temperature Operation            | Endurance test applying the electric stress (voltage & current) and the high thermal stress for a long time.                    | +70°C 48hrs   | 2    |
| Low Temperature Operation             | Endurance test applying the electric stress (voltage & current) and the low thermal stress for a long time.                     | -20°C , 48hrs   | 1,2  |
| High Temperature / Humidity Operation | Endurance test applying the electric stress (voltage & current) and the high thermal with high humidity stress for a long time. | +40°C , 90% RH , 48hrs  | 1,2  |
| Thermal Shock resistance              | Endurance test applying the electric stress (voltage & current) during a cycle of low and high thermal stress.                  | -0°C,30min -> 25°C,5min -> 50°C,30min = 1 cycle<br>10 cycles                        |      |
| Vibration test                        | Endurance test applying vibration to simulate transportation and use.   | 10-55Hz , 15mm amplitude.<br>60 sec in each of 3 directions X,Y,Z<br>For 15 minutes | 3    |
| Static electricity test               | Endurance test applying electric static discharge.  | VS=800V, RS=1.5kΩ, CS=100pF<br>One time   |      |

**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)