

# NHD-0216K1Z-FSB-FBW-L

## Character Liquid Crystal Display Module

NHD- Newhaven Display  
0216- 2 lines x 16 characters  
K1Z- Model  
F- Transflective  
SB- Side Blue LED Backlight  
F- FSTN(+)  
B- 6:00 view  
W- Wide Temperature (-20°C~+70°C)  
L- Low Power 20mA  
**RoHS Compliant**

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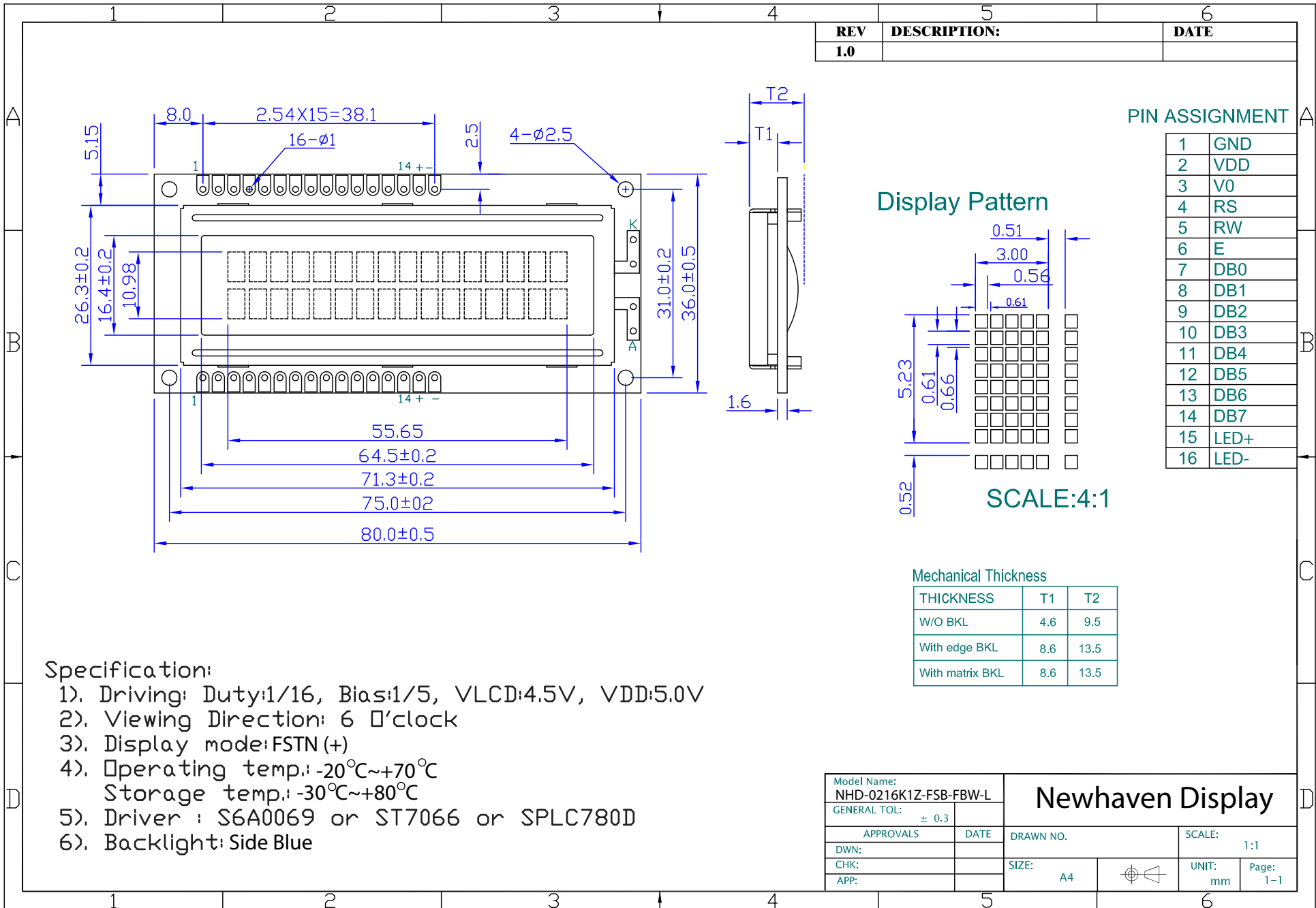
## Document Revision History

| Revision | Date       | Description                | Changed by |
|----------|------------|----------------------------|------------|
| 0        | 10/5/2007  | Initial Release            | -          |
| 1        | 12/11/2009 | User Guide Reformat        | BE         |
| 2        | 12/16/2009 | Mechanical drawing updated | BE         |
| 3        | 1/7/2010   | Optical updated            | BE         |

## Functions and Features

- 2 lines x 16 characters
- Built-in controller (SPLC780D or equivalent)
- +5.0V Power Supply
- 1/16 duty, 1/5 bias
- RoHS compliant

# Mechanical Drawing

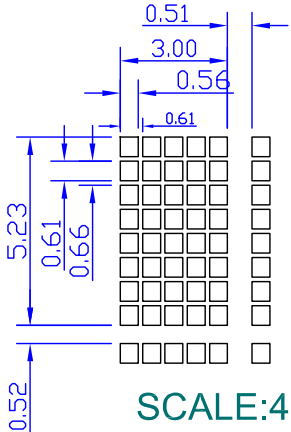


| REV | DESCRIPTION: | DATE |
|-----|--------------|------|
| 1.0 |              |      |

### PIN ASSIGNMENT

|    |      |
|----|------|
| 1  | GND  |
| 2  | VDD  |
| 3  | V0   |
| 4  | RS   |
| 5  | RW   |
| 6  | E    |
| 7  | DB0  |
| 8  | DB1  |
| 9  | DB2  |
| 10 | DB3  |
| 11 | DB4  |
| 12 | DB5  |
| 13 | DB6  |
| 14 | DB7  |
| 15 | LED+ |
| 16 | LED- |

### Display Pattern



SCALE:4:1

### Mechanical Thickness

| THICKNESS       | T1  | T2   |
|-----------------|-----|------|
| W/O BKL         | 4.6 | 9.5  |
| With edge BKL   | 8.6 | 13.5 |
| With matrix BKL | 8.6 | 13.5 |

- Specification:
- 1). Driving: Duty:1/16, Bias:1/5, VLCD:4.5V, VDD:5.0V
  - 2). Viewing Direction: 6 o'clock
  - 3). Display mode:FSTN(+)
  - 4). Operating temp:-20°C~+70°C  
Storage temp:-30°C~+80°C
  - 5). Driver : S6A0069 or ST7066 or SPLC780D
  - 6). Backlight: Side Blue

|                                      |      |                         |                    |
|--------------------------------------|------|-------------------------|--------------------|
| Model Name:<br>NHD-0216K1Z-FSB-FBW-L |      | <b>Newhaven Display</b> |                    |
| GENERAL TOL: ± 0.3                   |      |                         |                    |
| APPROVALS                            | DATE | DRAWN NO.               | SCALE: 1:1         |
| DWN:                                 |      | SIZE: A4                | UNIT: mm Page: 1-1 |
| CHK:                                 |      |                         |                    |
| APP:                                 |      |                         |                    |

## Pin Description and Wiring Diagram

| Pin No. | Symbol    | External Connection | Function Description                                                                                      |
|---------|-----------|---------------------|-----------------------------------------------------------------------------------------------------------|
| 1       | VSS       | Power Supply        | Ground                                                                                                    |
| 2       | VDD       | Power Supply        | Supply Voltage for logic (+5.0V)                                                                          |
| 3       | VO        | Adj Power Supply    | Power supply for contrast (approx. 0.5V)                                                                  |
| 4       | RS        | MPU                 | Register select signal. RS=0: Command, RS=1: Data                                                         |
| 5       | R/W       | MPU                 | Read/Write select signal, R/W=1: Read R/W: =0: Write                                                      |
| 6       | E         | MPU                 | Operation enable signal. Falling edge triggered.                                                          |
| 7-10    | DB0 – DB3 | MPU                 | Four low order bi-directional three-state data bus lines. These four are not used during 4-bit operation. |
| 11-14   | DB4 – DB7 | MPU                 | Four high order bi-directional three-state data bus lines.                                                |
| 15      | LED+      | Power Supply        | Power supply for LED Backlight (+5.0V via on-board resistor)                                              |
| 16      | LED-      | Power Supply        | Ground for Backlight                                                                                      |

Recommended LCD connector: 2.54mm pitch pins

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    |                   | 4.7  | 5.0  | 5.5  | V    |
| Supply Current              | IDD    | Ta=25°C, VDD=5.0V | -    | 1.5  | 2.5  | mA   |
| Supply for LCD (contrast)   | VDD-V0 | Ta=25°C           | -    | 4.5  | -    | V    |
| "H" Level input             | Vih    |                   | 2.2  | -    | VDD  | V    |
| "L" Level input             | Vil    |                   | 0    | -    | 0.6  | V    |
| "H" Level output            | Voh    |                   | 2.4  | -    | -    | V    |
| "L" Level output            | Vol    |                   | -    | -    | 0.4  | V    |
|                             |        |                   |      |      |      |      |
| Backlight Supply Voltage    | Vled   | -                 | -    | 5.0  | -    | V    |
| Backlight Supply Current    | Iled   | Vled=5.0V         | -    | 20   | -    | mA   |

## Optical Characteristics

| Item                               | Symbol | Condition | Min. | Typ. | Max. | Unit |
|------------------------------------|--------|-----------|------|------|------|------|
| Viewing Angle – Vertical (top)     | AV     | Cr ≥ 3    | -    | 20   | -    | °    |
| Viewing Angle – Vertical (bottom)  | AV     | Cr ≥ 3    | -    | 50   | -    | °    |
| Viewing Angle – Horizontal (left)  | AH     | Cr ≥ 3    | -    | 30   | -    | °    |
| Viewing Angle – Horizontal (right) | AH     | Cr ≥ 3    | -    | 30   | -    | °    |
| Contrast Ratio                     | Cr     |           | 3    | 5    | -    | -    |
| Response Time (rise)               | Tr     | -         | -    | 150  | 250  | ms   |
| Response Time (fall)               | Tf     | -         | -    | 150  | 250  | ms   |

## Controller Information

Built-in SPLC780D. Download specification at [http://www.newhavendisplay.com/app\\_notes/SPLC780D.pdf](http://www.newhavendisplay.com/app_notes/SPLC780D.pdf)

## Table of Commands

| Instruction                        | Instruction Code |     |     |     |     |     |     |     |     |     | Description                                                                                                                          | Execution time<br>(fosc=270KHz) |
|------------------------------------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
|                                    | RS               | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |                                                                                                                                      |                                 |
| Clear Display                      | 0                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | Write "20H" to DDRAM and set DDRAM address to "00H" from AC                                                                          | 1.52ms                          |
| Return Home                        | 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.     | 1.52ms                          |
| Entry Mode Set                     | 0                | 0   | 0   | 0   | 0   | 0   | 0   | 1   | I/D | S   | Assign cursor moving direction and enable the shift of entire display                                                                | 38μs                            |
| Display ON/OFF Control             | 0                | 0   | 0   | 0   | 0   | 0   | 1   | D   | C   | B   | Set display(D), cursor(C), and blinking of cursor(B) on/off control bit.                                                             | 38μs                            |
| Cursor or Display Shift            | 0                | 0   | 0   | 0   | 0   | 1   | S/C | R/L | -   | -   | Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data.                                  | 38μs                            |
| Function Set                       | 0                | 0   | 0   | 0   | 1   | DL  | N   | F   | -   | -   | Set interface data length (DL: 8bit/4-bit), numbers of display line (N: 2-line/1-line) and, display font type (F:5x10 dots/5x8 dots) | 38μs                            |
| Set CGRAM Address                  | 0                | 0   | 0   | 1   | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set CGRAM address in address counter.                                                                                                | 38μs                            |
| Set DDRAM Address                  | 0                | 0   | 1   | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set DDRAM address in counter                                                                                                         | 38μs                            |
| Read Busy Flag and Address Counter | 0                | 1   | BF  | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.               |                                 |
| Write Data to RAM                  | 1                | 0   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  | Write data into internal RAM (DDRAM/CGRAM).                                                                                          | 38μs                            |
| Read Data from RAM                 | 1                | 1   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  | Read data from internal RAM (DDRAM/CGRAM).                                                                                           | 38μs                            |

## Display character address code:

|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 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 |

## Timing Characteristics

### 6.5.3. Write mode (Writing Data from MPU to SPLC780D)

| Characteristics    | Symbol     | Limit |      |      | Unit | Test Condition   |
|--------------------|------------|-------|------|------|------|------------------|
|                    |            | Min.  | Typ. | Max. |      |                  |
| E Cycle Time       | $t_C$      | 500   | -    | -    | ns   | Pin E            |
| E Pulse Width      | $t_{PW}$   | 230   | -    | -    | ns   | Pin E            |
| E Rise/Fall Time   | $t_R, t_F$ | -     | -    | 20   | ns   | Pin E            |
| Address Setup Time | $t_{SP1}$  | 40    | -    | -    | ns   | Pins: RS, R/W, E |
| Address Hold Time  | $t_{HD1}$  | 10    | -    | -    | ns   | Pins: RS, R/W, E |
| Data Setup Time    | $t_{SP2}$  | 80    | -    | -    | ns   | Pins: DB0 - DB7  |
| Data Hold Time     | $t_{HD2}$  | 10    | -    | -    | ns   | Pins: DB0 - DB7  |

### 6.5.4. Read mode (Reading Data from SPLC780D to MPU)

| Characteristics        | Symbol     | Limit |      |      | Unit | Test Condition   |
|------------------------|------------|-------|------|------|------|------------------|
|                        |            | Min.  | Typ. | Max. |      |                  |
| E Cycle Time           | $t_C$      | 500   | -    | -    | ns   | Pin E            |
| E Pulse Width          | $t_W$      | 230   | -    | -    | ns   | Pin E            |
| E Rise/Fall Time       | $t_R, t_F$ | -     | -    | 20   | ns   | Pin E            |
| Address Setup Time     | $t_{SP1}$  | 40    | -    | -    | ns   | Pins: RS, R/W, E |
| Address Hold Time      | $t_{HD1}$  | 10    | -    | -    | ns   | Pins: RS, R/W, E |
| Data Output Delay Time | $t_D$      | -     | -    | 120  | ns   | Pins: DB0 - DB7  |
| Data hold time         | $t_{HD2}$  | 5.0   | -    | -    | ns   | Pin DB0 - DB7    |

### 6.5.6. Write mode timing diagram (Writing Data from MPU to SPLC780D)



### 6.5.7. Read mode timing diagram (Reading Data from SPLC780D to MPU)



## Built-in Font Table



| Lower<br>4 Bits | Upper 4<br>Bits  | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|-----------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| xxxx0000        | CG<br>RAM<br>(1) |      |      | 0    | a    | P    | `    | P    |      |      |      | -    | タ    | ミ    | &    | P    |      |
| xxxx0001        | (2)              |      | !    | 1    | A    | Q    | a    | q    |      |      | 。    | ア    | チ    | △    | ä    | q    |      |
| xxxx0010        | (3)              |      | "    | 2    | B    | R    | b    | r    |      |      | 「    | イ    | ツ    | ×    | ß    | θ    |      |
| xxxx0011        | (4)              |      | #    | 3    | C    | S    | c    | s    |      |      | 」    | ウ    | テ    | モ    | ε    | 8    |      |
| xxxx0100        | (5)              |      | \$   | 4    | D    | T    | d    | t    |      |      | 、    | エ    | ト    | ト    | μ    | Ω    |      |
| xxxx0101        | (6)              |      | %    | 5    | E    | U    | e    | u    |      |      | ・    | オ    | ナ    | 1    | ø    | ü    |      |
| xxxx0110        | (7)              |      | &    | 6    | F    | V    | f    | v    |      |      | ヲ    | カ    | ニ    | ヨ    | ρ    | Σ    |      |
| xxxx0111        | (8)              |      | '    | 7    | G    | W    | g    | w    |      |      | ヲ    | キ    | ヌ    | ラ    | g    | π    |      |
| xxxx1000        | (1)              |      | (    | 8    | H    | X    | h    | x    |      |      | イ    | ク    | ネ    | リ    | √    | ∞    |      |
| xxxx1001        | (2)              |      | )    | 9    | I    | Y    | i    | y    |      |      | ウ    | ケ    | ノ    | ル    | '    | γ    |      |
| xxxx1010        | (3)              |      | *    | :    | J    | Z    | j    | z    |      |      | エ    | コ    | ハ    | レ    | j    | κ    |      |
| xxxx1011        | (4)              |      | +    | ;    | K    | [    | k    | <    |      |      | オ    | サ    | ヒ    | ロ    | *    | π    |      |
| xxxx1100        | (5)              |      | ,    | <    | L    | ¥    | l    | l    |      |      | カ    | シ    | フ    | ク    | φ    | π    |      |
| xxxx1101        | (6)              |      | -    | =    | M    | ]    | m    | )    |      |      | ユ    | ス    | ハ    | ン    | も    | ÷    |      |
| xxxx1110        | (7)              |      | .    | >    | N    | ^    | n    | →    |      |      | ヨ    | セ    | ホ    | °    | ñ    |      |      |
| xxxx1111        | (8)              |      | /    | ?    | O    | _    | o    | ←    |      |      | ツ    | リ    | マ    | °    | ö    | ■    |      |

## Example Initialization Program

8-bit Initialization:

```

/*****/
void command(char i)
{
    P1 = i;                //put data on output Port
    D_I =0;                //D/I=LOW : send instruction
    R_W =0;                //R/W=LOW : Write
    E = 1;
    Delay(1);              //enable pulse width >= 300ns
    E = 0;                //Clock enable: falling edge
}
/*****/
void write(char i)
{
    P1 = i;                //put data on output Port
    D_I =1;                //D/I=LOW : send data
    R_W =0;                //R/W=LOW : Write
    E = 1;
    Delay(1);              //enable pulse width >= 300ns
    E = 0;                //Clock enable: falling edge
}
/*****/
void init()
{
    E = 0;
    Delay(100);            //Wait >15 msec after power is applied
    command(0x30);         //command 0x30 = Wake up
    Delay(30);             //must wait 5ms, busy flag not available
    command(0x30);         //command 0x30 = Wake up #2
    Delay(10);             //must wait 160us, busy flag not available
    command(0x30);         //command 0x30 = Wake up #3
    Delay(10);             //must wait 160us, busy flag not available
    command(0x38);         //Function set: 8-bit/2-line
    command(0x10);         //Set cursor
    command(0x0c);         //Display ON; Cursor ON
    command(0x06);         //Entry mode set
}
/*****/

```

```

4-bit Initialization:
/*****/
void command(char i)
{
    P1 = i;                //put data on output Port
    D_I =0;                //D/I=LOW : send instruction
    R_W =0;                //R/W=LOW : Write
    Nybble();              //Send lower 4 bits
    i = i<<4;              //Shift over by 4 bits
    P1 = i;                //put data on output Port
    Nybble();              //Send upper 4 bits
}
/*****/
void write(char i)
{
    P1 = i;                //put data on output Port
    D_I =1;                //D/I=HIGH : send data
    R_W =0;                //R/W=LOW : Write
    Nybble();              //Clock lower 4 bits
    i = i<<4;              //Shift over by 4 bits
    P1 = i;                //put data on output Port
    Nybble();              //Clock upper 4 bits
}
/*****/
void Nybble()
{
    E = 1;
    Delay(1);              //enable pulse width >= 300ns
    E = 0;                 //Clock enable: falling edge
}
/*****/
void init()
{
    P1 = 0;
    P3 = 0;
    Delay(100);            //Wait >15 msec after power is applied
    P1 = 0x30;             //put 0x30 on the output port
    Delay(30);             //must wait 5ms, busy flag not available
    Nybble();              //command 0x30 = Wake up
    Delay(10);             //must wait 160us, busy flag not available
    Nybble();              //command 0x30 = Wake up #2
    Delay(10);             //must wait 160us, busy flag not available
    Nybble();              //command 0x30 = Wake up #3
    Delay(10);             //can check busy flag now instead of delay
    P1= 0x20;              //put 0x20 on the output port
    Nybble();              //Function set: 4-bit interface
    command(0x28);         //Function set: 4-bit/2-line
    command(0x10);         //Set cursor
    command(0x0F);         //Display ON; Blinking cursor
    command(0x06);         //Entry Mode set
}
/*****/

```

## 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)