

# NHD-0216K3Z-FL-GBW

## Serial Liquid Crystal Display Module

NHD- Newhaven Display  
0216- 2 lines x 16 characters  
K3Z- Model  
F- Transflective  
L- Yellow/Green LED backlight  
G- STN- Gray  
B- 6:00 view  
W- Wide Temperature (-20°C ~ +70°C)  
**RoHS Compliant**

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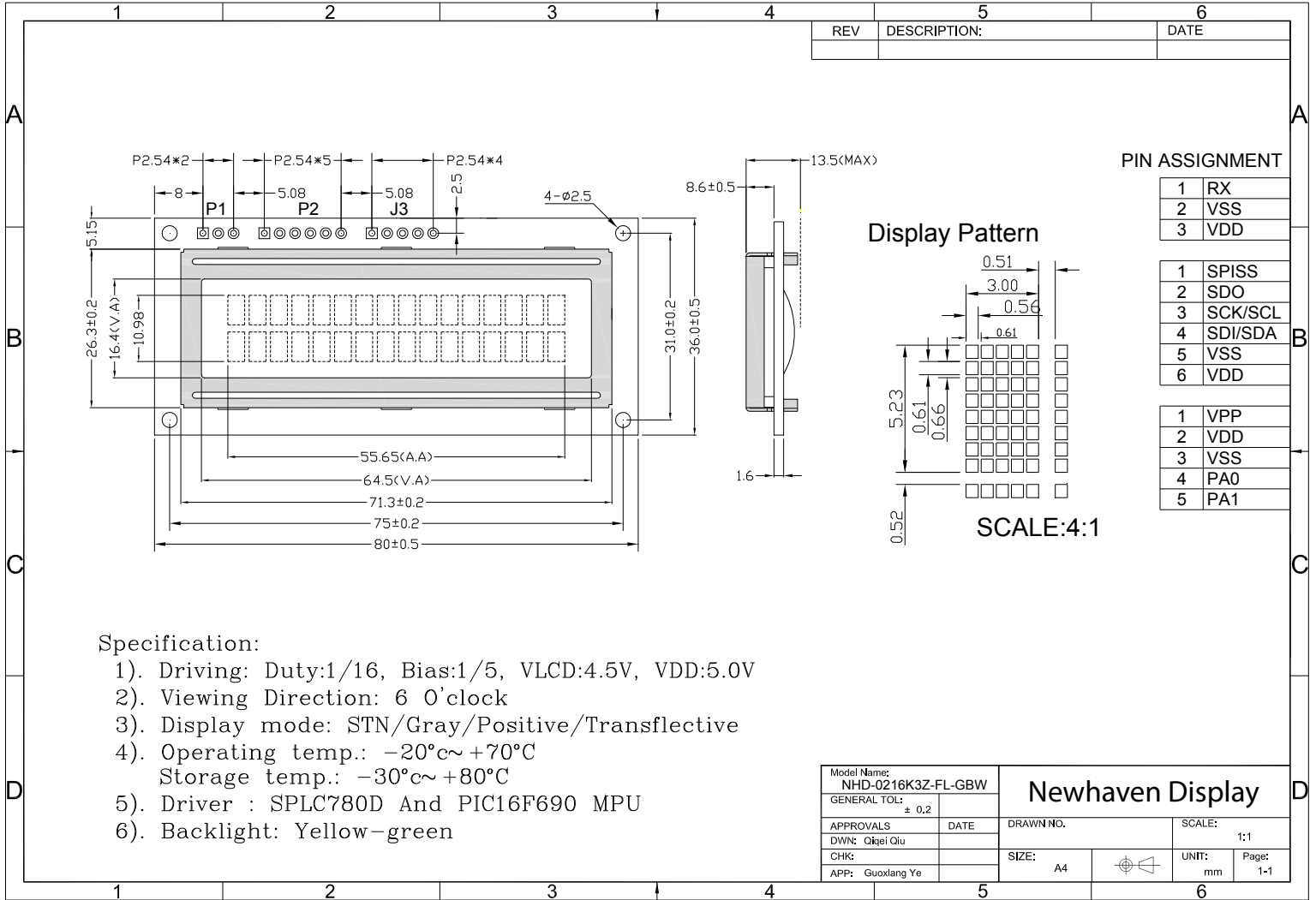
## Document Revision History

| Revision | Date       | Description         | Changed by |
|----------|------------|---------------------|------------|
| 0        | 7/11/2007  | Initial Release     | -          |
| 1        | 12/15/2009 | User guide reformat | CL         |
|          |            |                     |            |

## Functions and Features

- 2 lines x 16 characters
- Serial Interface: I2C, SPI or RS232
- 5V power supply
- 1/16 duty, 1/5 bias
- 5x8 pixels with cursor
- RoHS Compliant

# Mechanical Drawing



## Pin Description

| Pin No. | Symbol  | External Connection | Function Description                     |
|---------|---------|---------------------|--|
| 1       | RX      | MPU                 | RS232 Serial input port                  |
| 2       | VSS     | Power Supply        | Ground                                   |
| 3       | VDD     | Power Supply        | Power supply for logic (+5.0V)           |
| 1       | SPISS   | MPU                 | SPI Slave Select (NC in I2C mode)        |
| 2       | SDO     | NC                  | No Connect                               |
| 3       | SCK/SCL | MPU                 | Serial Clock                             |
| 4       | SDI/SDA | MPU                 | Serial Data In (SPI) / Serial Data (I2C) |
| 5       | VSS     | Power Supply        | Ground                                   |
| 6       | VDD     | Power Supply        | Power Supply for logic (+5.0V)           |
| 1       | VPP     | NC                  | No Connect                               |
| 2       | VDD     | NC                  | No Connect                               |
| 3       | Vss     | NC                  | No Connect                               |
| 4       | PA0     | NC                  | No Connect                               |
| 5       | PA1     | NC                  | No Connect                               |

**Recommended LCD connector:** 2.54mm pitch pins on P1 or P2

**Backlight connector:** controlled by command **Mates with:** -

## Jumper Communication Selection

| R1    | R2    | Protocol | Description      |
|-------|-------|----------|------------------|
| Short | Short | TEST     | Self-test        |
| Open  | Short | SPI      | 100KHz max clock |
| Short | Open  | I2C      | 100KHz max clock |
| Open  | Open  | RS232    | 5V, TTL signal   |



## Electrical Characteristics

| Item                              | Symbol | Condition           | Min.   | Typ. | Max.   | Unit |
|-----------------------------------|--------|---------------------|--------|------|--------|------|
| Operating Temperature Range       | Top    |                     | -20    | -    | +70    | °C   |
| Storage Temperature Range         | Tst    |                     | -30    | -    | +80    | °C   |
| Supply Voltage                    | VDD    |                     | 4.7    | 5.0  | 5.5    | V    |
| Supply Current                    | IDD    | Ta=25°C<br>VDD=5.0V | -      | 125  | -      | mA   |
| Supply for LCD (contrast)         | VDD-V0 | Ta=25°C             | -      | -    | -      | V    |
| "H" Level input (Schmitt Trigger) | Vih    |                     | 0.8VDD | -    | VDD    | V    |
| "L" Level input (Schmitt Trigger) | Vil    |                     | VSS    | -    | 0.2VDD | V    |
| "H" Level output                  | Voh    |                     | -      | -    | -      | V    |
| "L" Level output                  | Vol    |                     | -      | -    | -      | V    |
|                                   |        |                     |        |      |        |      |
| Backlight Supply Current          | Iled   |                     | -      | 100  | -      | mA   |

## Optical Characteristics

| Item                   | Symbol   | Condition   | Min. | Typ. | Max. | Unit |
|------------------------|----------|-------------|------|------|------|------|
| Viewing Angle – Top    | $\theta$ | Cr $\geq$ 2 | -    | 10   | -    | °    |
| Viewing Angle – Bottom | $\theta$ | Cr $\geq$ 2 | -    | 60   | -    | °    |
| Viewing Angle – Left   | $\Phi$   | Cr $\geq$ 2 | -    | 45   | -    | °    |
| Viewing Angle – Right  | $\Phi$   | Cr $\geq$ 2 | -    | 45   | -    | °    |
| Contrast Ratio         | Cr       |             | -    | 3    | -    | -    |
| Response Time (rise)   | Tr       | -           | -    | 100  | 150  | ms   |
| Response Time (fall)   | Tf       | -           | -    | 150  | 200  | ms   |

## Built-in LCD Controller: PIC 16F690

[http://www.newhavendisplay.com/app\\_notes/PIC16F690.pdf](http://www.newhavendisplay.com/app_notes/PIC16F690.pdf)

## Communication Information

This display uses a built-in PIC 16F690 for serial communication.

### I2C protocol:

To enter the I2C mode, place a jumper on R1.

SDA and SDK have pull-up resistors (10K Ohm) on R7 and R8.

The default I2C address is 80 (50 hex). The I2C address can be changed to any 8-bit value by command function, with the exception that the LSB (least significant bit) must always be '0'. Once the I2C address has been changed, it will be saved in the system memory, and it will revert back to the default address if either RS232 or SPI protocol is selected.

The I2C interface is capable of receiving data at up to 100KHz-clock rate.

### SPI protocol:

To enter the SPI mode, place a jumper on R2.

SPI mode has a normally high level idle clock. When Slave Select is LOW, data is sampled on the rising edge of the Clock.

The SPI interface is capable of receiving data at up to 100KHz-clock rate.

### RS232 protocol:

To enter the RS232 mode, both R1 and R2 should be open.

The RS232 signal must be 5V TTL compatible. Communication format is 8-bit data, 1 Stop bit, no parity, no handshaking. Default BAUD rate is 9600, and is changeable with a command function. Once the BAUD rate has been changed, it will be saved in the system memory, and it will revert back to the default address if either I2C or SPI protocol is selected.

## ASCII TEXT

To display normal text, just enter its **ASCII** number. A number from **0x00 to 0x07** displays the user defined custom character, **0x20 to 0x7F** displays the standard set of characters, **0xA0 to 0xFD** display characters and symbols that are factory-masked on the SPLC780D controller. 0xFE is reserved.

## Table of Commands

| Prefix | CMD  | Param  | Description                         |
|--------|------|--------|-------------------------------------|
| 0xFE   | 0x41 | None   | Display on                          |
| 0xFE   | 0x42 | None   | Display off                         |
| 0xFE   | 0x45 | 1 Byte | Set cursor                          |
| 0xFE   | 0x46 | None   | Cursor home                         |
| 0xFE   | 0x47 | None   | Underline cursor on                 |
| 0xFE   | 0x48 | None   | Underline cursor off                |
| 0xFE   | 0x49 | None   | Move cursor left one place          |
| 0xFE   | 0x4A | None   | Move cursor right one place         |
| 0xFE   | 0x4B | None   | Blinking cursor on                  |
| 0xFE   | 0x4C | None   | Blinking cursor off                 |
| 0xFE   | 0x4E | None   | Backspace                           |
| 0xFE   | 0x51 | None   | Clear screen                        |
| 0xFE   | 0x52 | 1 Byte | Set contrast                        |
| 0xFE   | 0x53 | 1 Byte | Set backlight brightness            |
| 0xFE   | 0x54 | 9 Byte | Load custom character               |
| 0xFE   | 0x55 | None   | Move display one place to the left  |
| 0xFE   | 0x56 | None   | Move display one place to the right |
| 0xFE   | 0x61 | 1 Byte | Change RS232 BAUD rate 232          |
| 0xFE   | 0x62 | 1 Byte | Change I2C address                  |
| 0xFE   | 0x70 | None   | Display firmware version number     |
| 0xFE   | 0x71 | None   | Display RS232 BAUD rate             |
| 0xFE   | 0x72 | None   | Display I2C address                 |

### Changing the I2C Slave Address

Syntax      hexadecimal    0xFE    0x62    [adr]

| Parameter | Parameter | Length | Description   |
|-----------|-----------|--------|---|
|           | [adr]     | 1 byte | New I <sup>2</sup> C address, 0x00 – 0xFE<br>The LSB is always '0'. |

Description      This command sets the I2C address, the address must be an even number, (LSB = 0). The address change requires 20 microsecond to take effect; therefore, the subsequent input must have an appropriate delay. The default I2C address can be restored if SPI or RS232 is selected as the communication mode.

Default          0x50

## Changing BAUD Rate

Syntax hexadecimal 0xFE 0x61 [baud]

| Parameter | Parameter | Length | Description                |
|-----------|-----------|--------|----------------------------|
|           | [baud]    | 1 byte | New RS232 BAUD Rate, 1 - 8 |

Description This command sets the RS232 BAUD rate, the single byte parameter select the desired BAUD rate as in the table below. The new BAUD rate requires 20 microsecond to take effect, therefore, the subsequent input must have an appropriate delay. The default BAUD rate can be restored if I2C or SPI is selected as the communication mode. Illegal parameter input will be discarded.

Default 9600 BAUD

| Parameter | BAUD   |
|-----------|--------|
| 1         | 300    |
| 2         | 1200   |
| 3         | 2400   |
| 4         | 9600   |
| 5         | 14400  |
| 6         | 19.2K  |
| 7         | 57.6K  |
| 8         | 115.2K |

## Turn On Display

Syntax hexadecimal 0xFE 0x41

| Parameter | Parameter | Length | Description        |
|-----------|-----------|--------|--------------------|
|           | None      | None   | Turn on LCD screen |

Description This command turns on the LCD display screen, the display text is not altered.  
Default LCD screen is on

## Turn Off Display

Syntax hexadecimal 0xFE 0x42

| Parameter | Parameter | Length | Description         |
|-----------|-----------|--------|---------------------|
|           | None      | None   | Turn off LCD screen |

Description This command turns off the LCD display screen, the display text is not altered.  
Default LCD screen is on



## Set Cursor Position

Syntax hexadecimal 0xFE 0x45 [pos]

| Parameter | Parameter | Length | Description   |
|-----------|-----------|--------|---|
| [pos]     | 1 byte    |        | Put cursor at location specified by [pos], 0x00 to 0x67 |

Description This command moves the cursor to a specified location where the next character will be displayed. The typical cursor position for a 4-line display is show below; a cursor position outside these ranges will not be viewable.

| .      | Column1 | Column20 |
|--------|---------|----------|
| Line1  | 0x00    | 0x13     |
| Line 2 | 0x40    | 0x53     |
| Line 3 | 0x14    | 0x27     |
| Line 4 | 0x54    | 0x67     |

Default After a reset, the cursor is on position 0x00.

## Home Cursor

Syntax hexadecimal 0xFE 0x46

| Parameter | Parameter | Length | Description                        |
|-----------|-----------|--------|------------------------------------|
|           | None      | None   | Position cursor at line 1 column 1 |

Description This command move the cursor to line 1, column 1 of the LCD screen, the display text is not altered.  
Default None

## Turn On Underline Cursor

Syntax hexadecimal 0xFE 0x47

| Parameter | Parameter | Length | Description              |
|-----------|-----------|--------|--------------------------|
|           | None      | None   | Turn on underline cursor |

Description This command turns on the underline cursor, the cursor position is where the next character will appear.

Default The underline cursor is off.

## Turn Off Underline Cursor

Syntax hexadecimal 0xFE 0x48

| Parameter | Parameter | Length | Description               |
|-----------|-----------|--------|---------------------------|
|           | None      | None   | Turn off underline cursor |

Description This command turns off the underline cursor.

Default The underline cursor is off.

### Move Cursor Left One Space

Syntax hexadecimal 0xFE 0x49

| Parameter | Parameter | Length | Description              |
|-----------|-----------|--------|--------------------------|
|           | None      | None   | Move cursor left 1 space |

Description This command moves the cursor position left 1 space, regardless the cursor is displayed or not, and the displayed character is not altered

Default None

### Move Cursor Right One Space

Syntax hexadecimal 0xFE 0x4A

| Parameter | Parameter | Length | Description               |
|-----------|-----------|--------|---------------------------|
|           | None      | None   | Move cursor right 1 space |

Description This command moves the cursor position right 1 space, regardless the cursor is displayed or not, and the displayed character is not altered

Default None

### Turn On Blinking Cursor

Syntax hexadecimal 0xFE 0x4B

| Parameter | Parameter | Length | Description                 |
|-----------|-----------|--------|-----------------------------|
|           | None      | None   | Turn on the blinking cursor |

Description This command turns on the blinking cursor, both the cursor and the character on the cursor will blink.

Default The blinking cursor is off.

### Turn Off Blinking Cursor

Syntax hexadecimal 0xFE 0x4C

| Parameter | Parameter | Length | Description                  |
|-----------|-----------|--------|------------------------------|
|           | None      | None   | Turn off the blinking cursor |

Description This command turns off the blinking cursor.

Default The blinking cursor is off.

### Back Space

Syntax hexadecimal 0xFE 0x4E

| Parameter | Parameter | Length | Description  |
|-----------|-----------|--------|--|
|           | None      | None   | Move cursor back one space, deletes the character on the cursor. |

Description This command is destructive backspace, the cursor is moved back one space and the character on the cursor is deleted.

Default None.

## Clear Screen

Syntax hexadecimal 0xFE 0x51

---

| Parameter | Parameter | Length | Description                                   |
|-----------|-----------|--------|---|
|           | None      | None   | Clear LCD and move cursor to line 1 column 1. |

Description This command clears the entire display and place the cursor at line 1 column 1.  
Default None.

## Set Display Contrast

Syntax hexadecimal 0xFE 0x52 [contrast]

---

| Parameter | Parameter  | Length | Description                                     |
|-----------|------------|--------|---|
|           | [contrast] | 1 byte | Set the display contrast, value between 1 to 50 |

Description This command sets the LCD character display contrast, the contrast setting is between 1 to 50, where 50 is the highest contrast.  
Default Default contrast value is 40.

## Set Backlight Brightness

Syntax hexadecimal 0xFE 0x53 [brightness]

---

| Parameter | Parameter    | Length | Description  |
|-----------|--------------|--------|--|
|           | [brightness] | 1 byte | Set the LCD backlight brightness level, value between 1 to 8 |

Description This command set the LCD display backlight brightness level, the value is between 1 to 8.  
Default Default brightness value is 1.

## Load Custom Characters

Syntax hexadecimal 0xFE 0x54 [addr] [d0 ...d7]

---

| Parameter | Parameter | Length  | Description                      |
|-----------|-----------|---------|----------------------------------|
|           | [addr]    | 1 byte  | Custom character address, 0 – 7  |
|           | [D0..D7]  | 8 bytes | Custom character pattern bit map |

Description There are space for eight user defined custom characters, this command load the custom character into one of the eight locations. The custom character pattern is bit mapped into 8 data bytes, the bit map for Spanish character '¿' is shown in table below, to display the custom character, user simply enter the address of the character (0 to 8).  
Default None.

| Bit    | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Hex  |
|--------|---|---|---|---|---|---|---|---|------|
| Byte 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0x04 |
| Byte 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0x00 |
| Byte 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0x04 |
| Byte 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0x08 |
| Byte 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0x10 |
| Byte 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0x11 |
| Byte 7 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0x0E |
| Byte 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0x00 |

### Shift Display to the Left

Syntax hexadecimal 0xFE 0x55

---

| Parameter | Parameter | Length | Description |
|-----------|-----------|--------|-------------|
|-----------|-----------|--------|-------------|

None None Shift the LCD screen to the left one Place.

Description This command shifts the display one place to the left, the cursor position also moves with the display, and the display data is not altered.

Default None

### Shift Display to the Right

Syntax hexadecimal 0xFE 0x56

---

| Parameter | Parameter | Length | Description |
|-----------|-----------|--------|-------------|
|-----------|-----------|--------|-------------|

None None Shift the LCD screen to the right one Place.

Description This command shifts the display one place to the right, the cursor position also moves with the display, and the display data is not altered.

Default None

### Display Firmware Version Number

Syntax hexadecimal 0xFE 0x70

---

| Parameter | Parameter | Length | Description |
|-----------|-----------|--------|-------------|
|-----------|-----------|--------|-------------|

None None Display the firmware version number.

Description This command displays the micro-controller firmware version number.

Default None.

### Display RS232 Baud Rate

Syntax hexadecimal 0xFE 0x71

---

| Parameter | Parameter | Length | Description |
|-----------|-----------|--------|-------------|
|-----------|-----------|--------|-------------|

None None Display Baud Rate

Description This command displays the current RS232 BAUD rate.

Default None.

### Display I<sup>2</sup>C Address

Syntax hexadecimal 0xFE 0x72

---

| Parameter | Parameter | Length | Description |
|-----------|-----------|--------|-------------|
|-----------|-----------|--------|-------------|

None None Display I<sup>2</sup>C Address

Description This command displays the current I<sup>2</sup>C slave address.

Default None.

# Built-in Font Table

| Lower 4 Bits \ Upper 4 Bits | 0000       | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|-----------------------------|------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| xxxx0000                    | CG RAM (1) |      |      | 0    | a    | P    | `    | P    |      |      |      | -    | 夕    | 三    | &    | P    |
| xxxx0001                    | (2)        |      | !    | 1    | A    | Q    | a    | q    |      |      | 。    | ア    | チ    | △    | △    | q    |
| xxxx0010                    | (3)        |      | "    | 2    | B    | R    | b    | r    |      |      | 「    | イ    | ツ    | ×    | ⊗    | ⊗    |
| xxxx0011                    | (4)        |      | #    | 3    | C    | S    | c    | s    |      |      | 」    | ウ    | テ    | モ    | ε    | ε    |
| xxxx0100                    | (5)        |      | \$   | 4    | D    | T    | d    | t    |      |      | 、    | エ    | ト    | ⊂    | ⊂    | Ω    |
| xxxx0101                    | (6)        |      | %    | 5    | E    | U    | e    | u    |      |      | ・    | オ    | ナ    | ⊂    | ε    | ü    |
| xxxx0110                    | (7)        |      | &    | 6    | F    | V    | f    | v    |      |      | ヲ    | カ    | ニ    | ヨ    | ρ    | Σ    |
| xxxx0111                    | (8)        |      | '    | 7    | G    | W    | g    | w    |      |      | ア    | 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    | ル    | ル    | '    | y    |
| xxxx1010                    | (3)        |      | *    | :    | J    | Z    | j    | z    |      |      | エ    | コ    | ン    | レ    | j    | ≠    |
| xxxx1011                    | (4)        |      | +    | ;    | K    | [    | k    | (    |      |      | オ    | サ    | ヒ    | ロ    | ×    | ≠    |
| xxxx1100                    | (5)        |      | ,    | <    | L    | ¥    | l    | l    |      |      | カ    | シ    | フ    | ワ    | ⊗    | ⊗    |
| xxxx1101                    | (6)        |      | -    | =    | M    | ]    | m    | )    |      |      | ユ    | ス    | ハ    | ン    | ⊗    | ÷    |
| xxxx1110                    | (7)        |      | .    | >    | N    | ^    | n    | →    |      |      | ヨ    | セ    | ホ    | ッ    | ⊗    |      |
| xxxx1111                    | (8)        |      | /    | ?    | O    | _    | o    | €    |      |      | ッ    | リ    | マ    | □    | ö    | ■    |

## Example Initialization Program

See program code at [http://www.newhavendisplay.com/app\\_notes/Serial\\_LCD.txt](http://www.newhavendisplay.com/app_notes/Serial_LCD.txt)

## 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)