

# NHD-0216HZ-FSW-FBW-33V3C

## Character Liquid Crystal Display Module

|       |                                  |
|-------|----------------------------------|
| NHD-  | Newhaven Display                 |
| 0216- | 2 Lines x 16 Characters          |
| HZ-   | Model                            |
| F-    | Transflective                    |
| SW-   | Side White LED Backlight         |
| F-    | FSTN (+)                         |
| B-    | Optimal 6:00 View                |
| W-    | Wide Temperature                 |
| 33V3- | 3.3 VDD, 3 Volt Backlight        |
| C-    | Temperature Compensation Circuit |
|       | <b>RoHS Compliant</b>            |

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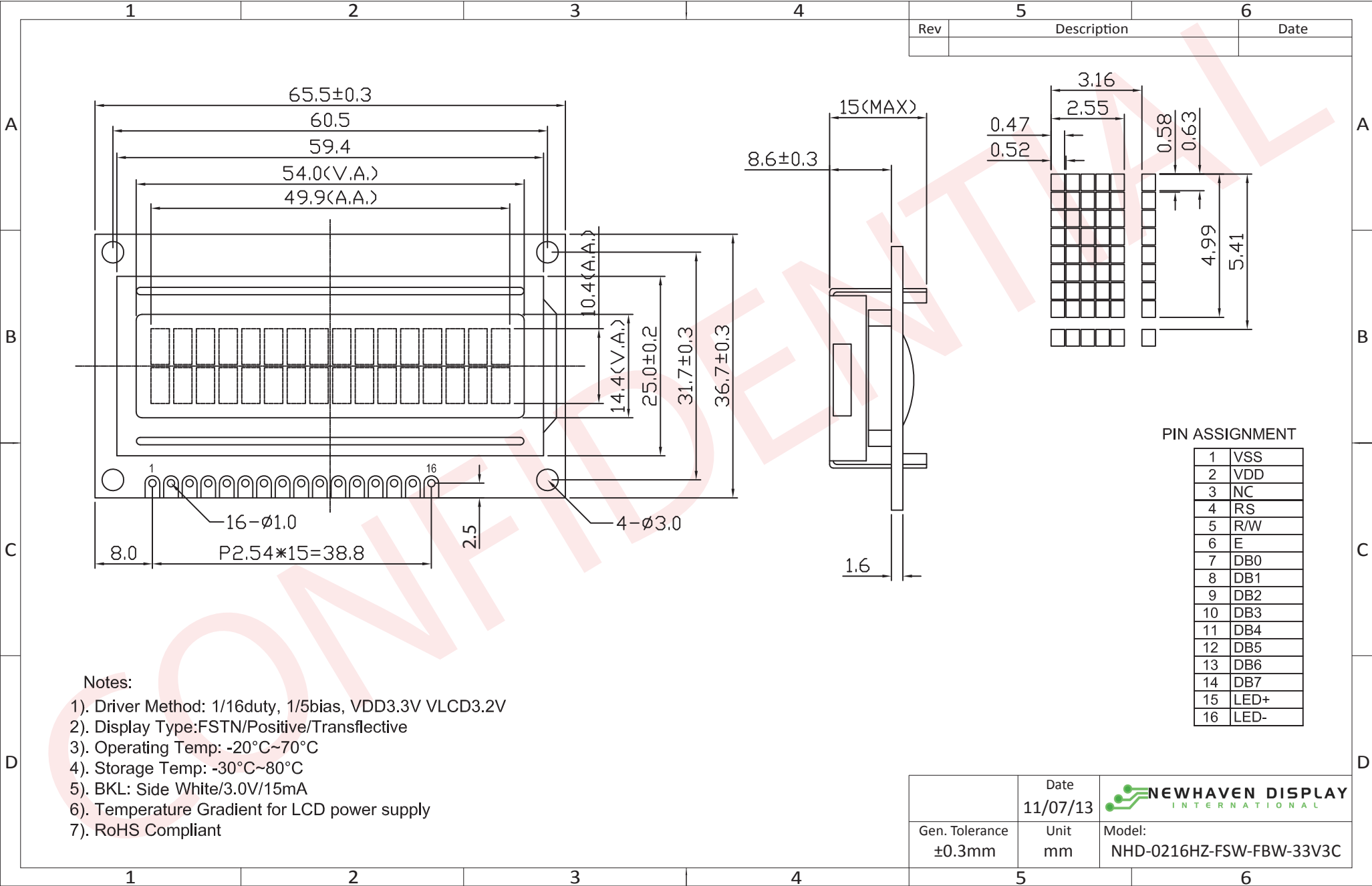
## Document Revision History

| Revision | Date       | Description                       | Changed by |
|----------|------------|-----------------------------------|------------|
| 0        | 10/31/2011 | 33V – improved liquid; VDD = 3.3V | SB         |
| 1        | 11/07/2013 | Datasheet reformatted             | ML         |

## Functions and Features

- 2 lines x 16 characters
- Built-in controller (ST7066U or equivalent)
- +3.3V Power Supply
- 1/16 duty, 1/5 bias
- RoHS compliant

Mechanical Drawing



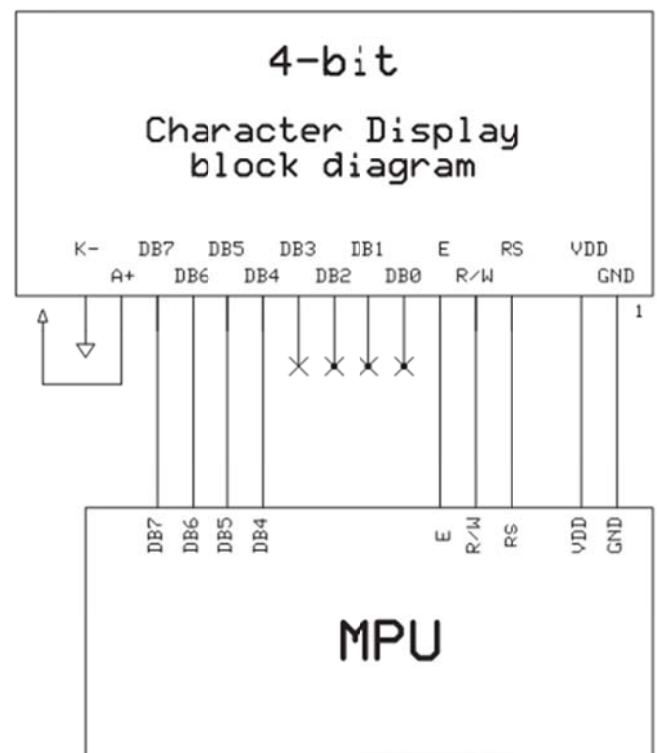
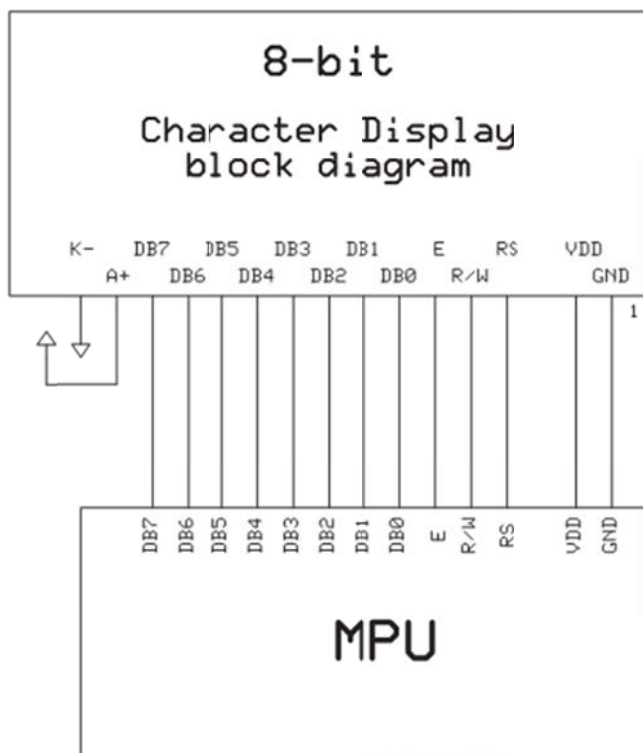
The drawing contained herein is the exclusive property of Newhaven Display International, Inc. and shall not be copied, reproduced, and/or disclosed in any format without permission.

## Pin Description and Wiring Diagram

| Pin No. | Symbol    | External Connection | Function Description                                                                                      |
|---------|-----------|---------------------|-----------------------------------------------------------------------------------------------------------|
| 1       | VSS       | Power Supply        | Ground                                                                                                    |
| 2       | VDD       | Power Supply        | Supply Voltage for LCD and Logic (+3.3V)                                                                  |
| 3       | NC        | NC                  | No Connect                                                                                                |
| 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        | Backlight Anode (+3.0V)                                                                                   |
| 16      | LED-      | Power Supply        | Backlight Cathode (Ground)                                                                                |

**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    |                   | -        | 3.3  | -       | V    |
| Supply Current              | IDD    | Ta=25°C, VDD=3.3V | -        | 1.5  | 2.5     | mA   |
| Supply for LCD (contrast)   | VDD-V0 | Ta=25°C           | -        | 3.2  | -       | V    |
| "H" Level input             | Vih    |                   | 0.7*VDD  | -    | VDD     | V    |
| "L" Level input             | Vil    |                   | 0        | -    | 0.6     | V    |
| "H" Level output            | Voh    |                   | 0.75*VDD | -    | -       | V    |
| "L" Level output            | Vol    |                   | -        | -    | 0.2*VDD | V    |
|                             |        |                   |          |      |         |      |
| Backlight Supply Voltage    | Vled   | -                 | -        | 3.0  |         | V    |
| Backlight Supply Current    | Iled   | Vled=3.0V         | -        | 15   | -       | mA   |

## Optical Characteristics

| Item                   | Symbol | Condition | Min. | Typ. | Max. | Unit |
|------------------------|--------|-----------|------|------|------|------|
| Viewing Angle – Top    | -      | Cr ≥ 3    | -    | 20   | -    | °    |
| Viewing Angle – Bottom | -      |           | -    | 50   | -    | °    |
| Viewing Angle – Left   | -      |           | -    | 30   | -    | °    |
| Viewing Angle – Right  | -      |           | -    | 30   | -    | °    |
| Contrast Ratio         | Cr     |           | 3    | 5    | -    | -    |
| Response Time (rise)   | Tr     | -         | -    | 150  | 250  | ms   |
| Response Time (fall)   | Tf     | -         | -    | 150  | 250  | ms   |

## Controller Information

Built-in ST7066U controller.

Please download specification at [http://www.newhavendisplay.com/app\\_notes/ST7066U.pdf](http://www.newhavendisplay.com/app_notes/ST7066U.pdf)

## DDRAM Address

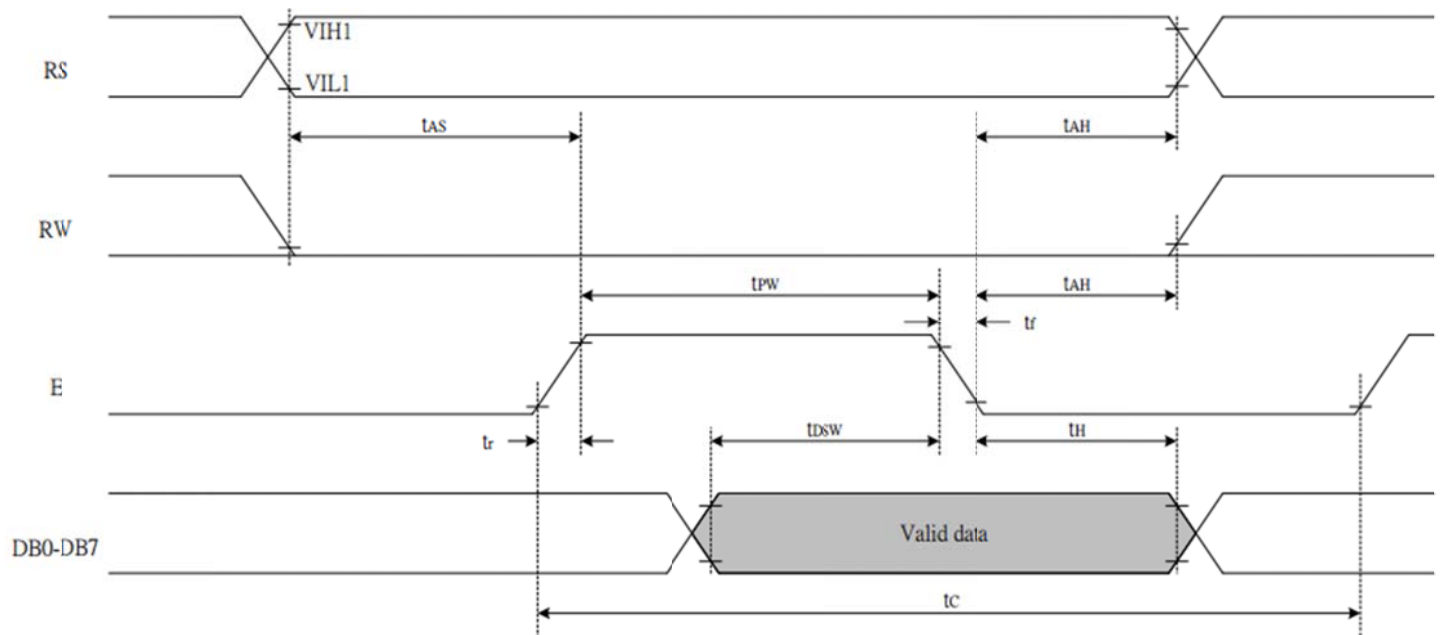
| 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F |
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A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

## Table of Commands

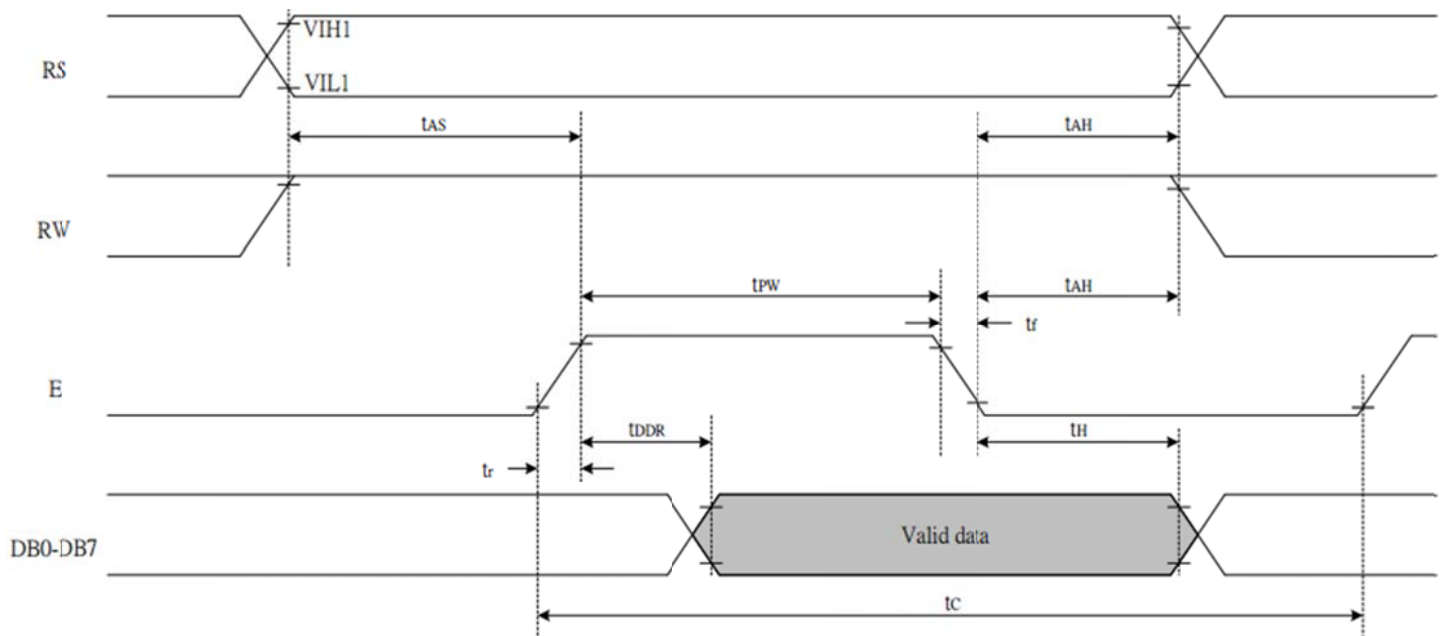
| Instruction                | Instruction code |     |     |     |     |     |     |     |     |     | Description                                                                                                                      | Execution time (fosc= 270 KHZ) |
|----------------------------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
|                            | 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 DDRA and set DDRAM address to "00H" from AC                                                                       | 1.53ms                         |
| 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. | 1.53ms                         |
| Entry mode Set             | 0                | 0   | 0   | 0   | 0   | 0   | 0   | 1   | I/D | SH  | Assign cursor moving direction And blinking of entire display                                                                    | 39us                           |
| 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.                                                      |                                |
| 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.                              | 39us                           |
| Function set               | 0                | 0   | 0   | 0   | 1   | DL  | N   | F   | -   | -   | Set interface data length (DL: 8-Bit/4-bit), numbers of display Line (N: =2-line/1-line) and, Display font type (F: 5x11/5x8)    | 39us                           |
| Set CGRAM Address          | 0                | 0   | 0   | 1   | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set CGRAM address in address counter.                                                                                            | 39us                           |
| Set DDRAM Address          | 0                | 0   | 1   | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set DDRAM address in address counter.                                                                                            | 39us                           |
| Read busy Flag and Address | 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.           | 0us                            |
| Write data To Address      | 1                | 0   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  | Write data into internal RAM (DDRAM/CGRAM).                                                                                      | 43us                           |
| Read data From RAM         | 1                | 1   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  | Read data from internal RAM (DDRAM/CGRAM).                                                                                       | 43us                           |

## Timing Characteristics

### Writing data from MPU to ST7066U



### Reading data from ST7066U to MPU



| Symbol                                               | Characteristics       | Test Condition   | Min. | Typ. | Max. | Unit    |
|------------------------------------------------------|-----------------------|------------------|------|------|------|---------|
| <i>Internal Clock Operation</i>                      |                       |                  |      |      |      |         |
| $f_{OSC}$                                            | OSC Frequency         | R = 75K $\Omega$ | 190  | 270  | 350  | KHz     |
| <i>External Clock Operation</i>                      |                       |                  |      |      |      |         |
| $f_{EX}$                                             | External Frequency    | -                | 125  | 270  | 410  | KHz     |
|                                                      | Duty Cycle            | -                | 45   | 50   | 55   | %       |
| $T_{R,T_F}$                                          | Rise/Fall Time        | -                | -    | -    | 0.2  | $\mu$ s |
| <i>Write Mode (Writing data from MPU to ST7066U)</i> |                       |                  |      |      |      |         |
| $T_C$                                                | Enable Cycle Time     | Pin E            | 1200 | -    | -    | ns      |
| $T_{PW}$                                             | Enable Pulse Width    | Pin E            | 460  | -    | -    | ns      |
| $T_{R,T_F}$                                          | Enable Rise/Fall Time | Pin E            | -    | -    | 25   | ns      |
| $T_{AS}$                                             | Address Setup Time    | Pins: RS,RW,E    | 0    | -    | -    | ns      |
| $T_{AH}$                                             | Address Hold Time     | Pins: RS,RW,E    | 10   | -    | -    | ns      |
| $T_{DSW}$                                            | Data Setup Time       | Pins: DB0 - DB7  | 80   | -    | -    | ns      |
| $T_H$                                                | Data Hold Time        | Pins: DB0 - DB7  | 10   | -    | -    | ns      |
| <i>Read Mode (Reading Data from ST7066U to MPU)</i>  |                       |                  |      |      |      |         |
| $T_C$                                                | Enable Cycle Time     | Pin E            | 1200 | -    | -    | ns      |
| $T_{PW}$                                             | Enable Pulse Width    | Pin E            | 480  | -    | -    | ns      |
| $T_{R,T_F}$                                          | Enable Rise/Fall Time | Pin E            | -    | -    | 25   | ns      |
| $T_{AS}$                                             | Address Setup Time    | Pins: RS,RW,E    | 0    | -    | -    | ns      |
| $T_{AH}$                                             | Address Hold Time     | Pins: RS,RW,E    | 10   | -    | -    | ns      |
| $T_{DDR}$                                            | Data Setup Time       | Pins: DB0 - DB7  | -    | -    | 320  | ns      |
| $T_H$                                                | Data Hold Time        | Pins: DB0 - DB7  | 10   | -    | -    | ns      |
| <i>Interface Mode with LCD Driver(ST7065)</i>        |                       |                  |      |      |      |         |
| $T_{CWH}$                                            | Clock Pulse with High | Pins: CL1, CL2   | 800  | -    | -    | ns      |
| $T_{CWL}$                                            | Clock Pulse with Low  | Pins: CL1, CL2   | 800  | -    | -    | ns      |
| $T_{CST}$                                            | Clock Setup Time      | Pins: CL1, CL2   | 500  | -    | -    | ns      |
| $T_{SU}$                                             | Data Setup Time       | Pin: D           | 300  | -    | -    | ns      |
| $T_{DH}$                                             | Data Hold Time        | Pin: D           | 300  | -    | -    | ns      |
| $T_{DM}$                                             | M Delay Time          | Pin: M           | 0    | -    | 2000 | ns      |



## 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    | `    | F    |      |      |      | -    | 9    | ≡    | ×    | p    |      |
| xxxx0001        | (2)              |      |      | !    | 1    | A    | Q    | a    | 9    |      |      | 。    | ア    | チ    | △    | ≡    | q    |
| xxxx0010        | (3)              |      |      | "    | 2    | B    | R    | b    | r    |      |      | 「    | イ    | ウ    | ×    | β    | θ    |
| xxxx0011        | (4)              |      |      | #    | 3    | C    | S    | c    | s    |      |      | 」    | ウ    | テ    | モ    | ε    | ∞    |
| xxxx0100        | (5)              |      |      | \$   | 4    | D    | T    | d    | t    |      |      | 、    | エ    | ト    | ホ    | μ    | Ω    |
| xxxx0101        | (6)              |      |      | %    | 5    | E    | U    | e    | u    |      |      | ・    | オ    | ナ    | 1    | ℃    | Ù    |
| 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    | フ    | ⊗    |
| xxxx1001        | (2)              |      |      | )    | 9    | I    | Y    | i    | y    |      |      | ウ    | ケ    | ル    | ル    | ´    | y    |
| xxxx1010        | (3)              |      |      | *    | :    | J    | Z    | j    | z    |      |      | エ    | コ    | ハ    | レ    | j    | 〒    |
| xxxx1011        | (4)              |      |      | +    | ;    | K    | [    | k    | {    |      |      | オ    | サ    | ヒ    | ロ    | *    | ⌘    |
| xxxx1100        | (5)              |      |      | ,    | <    | L    | ¥    | l    | l    |      |      | ハ    | シ    | フ    | ワ    | Φ    | ⌘    |
| xxxx1101        | (6)              |      |      | -    | =    | M    | ]    | m    | }    |      |      | ユ    | ズ    | ハ    | ン    | モ    | ÷    |
| xxxx1110        | (7)              |      |      | .    | >    | N    | ^    | n    | ÷    |      |      | ヨ    | セ    | ホ    | °    | °    |      |
| xxxx1111        | (8)              |      |      | /    | ?    | O    | _    | o    | +    |      |      | ッ    | リ    | マ    | °    | °    | ■    |

## 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 , 96hrs                                                                       | 2    |
| Low Temperature storage               | Endurance test applying the low storage temperature for a long time.                                                            | -30°C , 96hrs                                                                       | 1,2  |
| High Temperature Operation            | Endurance test applying the electric stress (voltage & current) and the high thermal stress for a long time.                    | +70°C, 96hrs                                                                        | 2    |
| Low Temperature Operation             | Endurance test applying the electric stress (voltage & current) and the low thermal stress for a long time.                     | -20°C , 96hrs                                                                       | 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 , 96hrs                                                              | 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

See Terms and Conditions at [http://www.newhavendisplay.com/index.php?main\\_page=terms](http://www.newhavendisplay.com/index.php?main_page=terms)