

# 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-    | 6:00 Optimal View                |
| W-    | Wide Temperature                 |
| 33V3- | 3.3 VDD, 3 Volt Backlight        |
| C-    | Temperature Compensation Circuit |

**RoHS Compliant**

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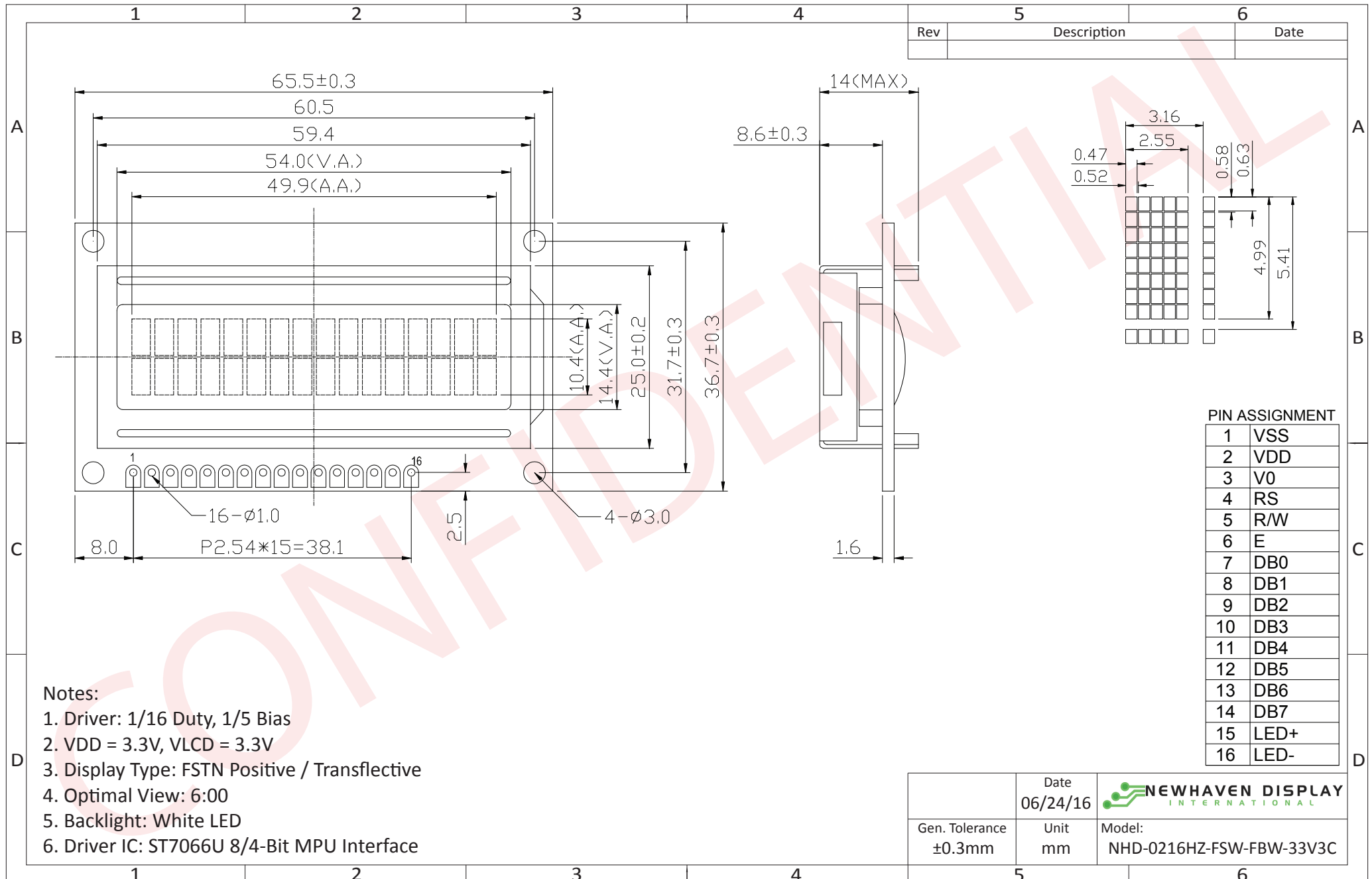
## Document Revision History

| Revision | Date       | Description   | Changed by |
|----------|------------|---|------------|
| 0        | 10/31/2011 | 33V – improved liquid; VDD = 3.3V   | SB         |
| 1        | 11/07/2013 | Datasheet reformatted   | ML         |
| 2        | 6/24/16    | Mechanical Drawing, Electrical & Optical Char., Quality Information Updated | SB         |

## 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



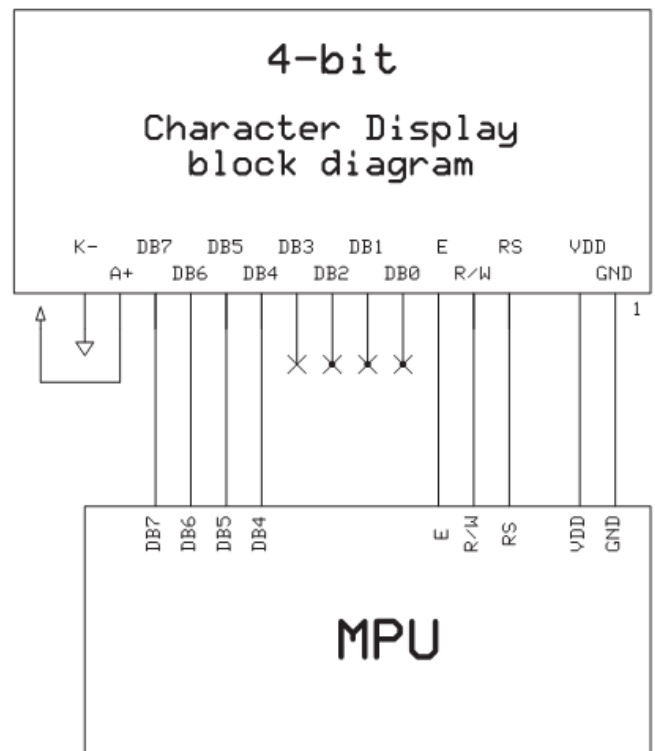
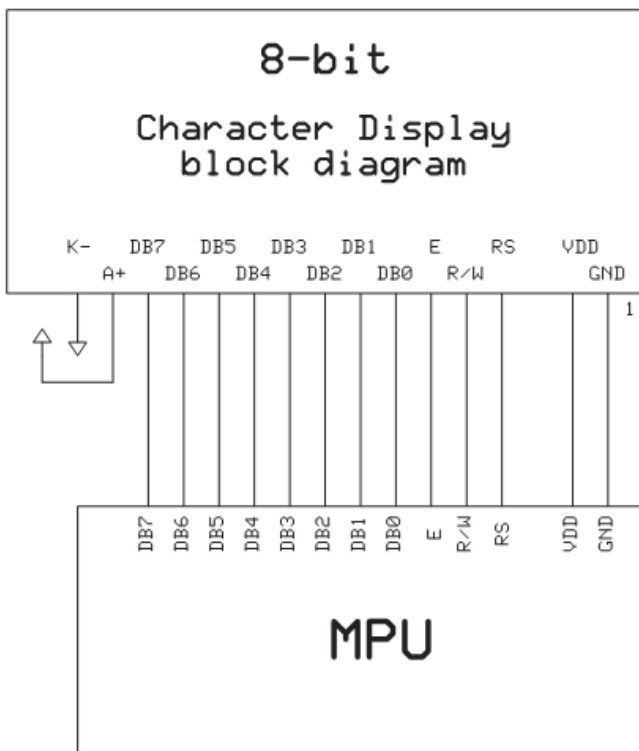
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## Pin Description and Wiring Diagram

| 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    | -            | 3.0      | 3.3  | 3.6     | V    |
| Supply Current              | IDD    | VDD=3.3V     | -        | 1.5  | 2.5     | mA   |
| Supply for LCD (contrast)   | VDD-V0 | Ta=25°C      | 3.1      | 3.3  | 3.5     | V    |
| "H" Level input             | Vih    | -            | 0.7*VDD  | -    | VDD     | V    |
| "L" Level input             | Vil    | -            | VSS      | -    | 0.2*VDD | V    |
| "H" Level output            | Voh    | -            | 0.75*VDD | -    | VDD     | V    |
| "L" Level output            | Vol    | -            | VSS      | -    | 0.2*VDD | V    |
| Backlight Supply Voltage    | Vled   | -            | 2.8      | 3.0  | 3.2     | V    |
| Backlight Supply Current    | Iled   | Vled=3.0V    | 5        | 10   | 15      | mA   |

## Optical Characteristics

| Item                   | Symbol | Condition | Min. | Typ. | Max. | Unit |
|------------------------|--------|-----------|------|------|------|------|
| Optimal Viewing Angles | Top    | Cr ≥ 2    | -    | 40   | -    | °    |
|                        | Bottom |           | -    | 60   | -    | °    |
|                        | Left   |           | -    | 60   | -    | °    |
|                        | Right  |           | -    | 60   | -    | °    |
| Contrast Ratio         | Cr     | -         | 2    | 5    | -    | -    |
| Response Time          | Rise   | Tr        | -    | 150  | 250  | ms   |
|                        | Fall   | Tf        | -    | 200  | 300  | 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

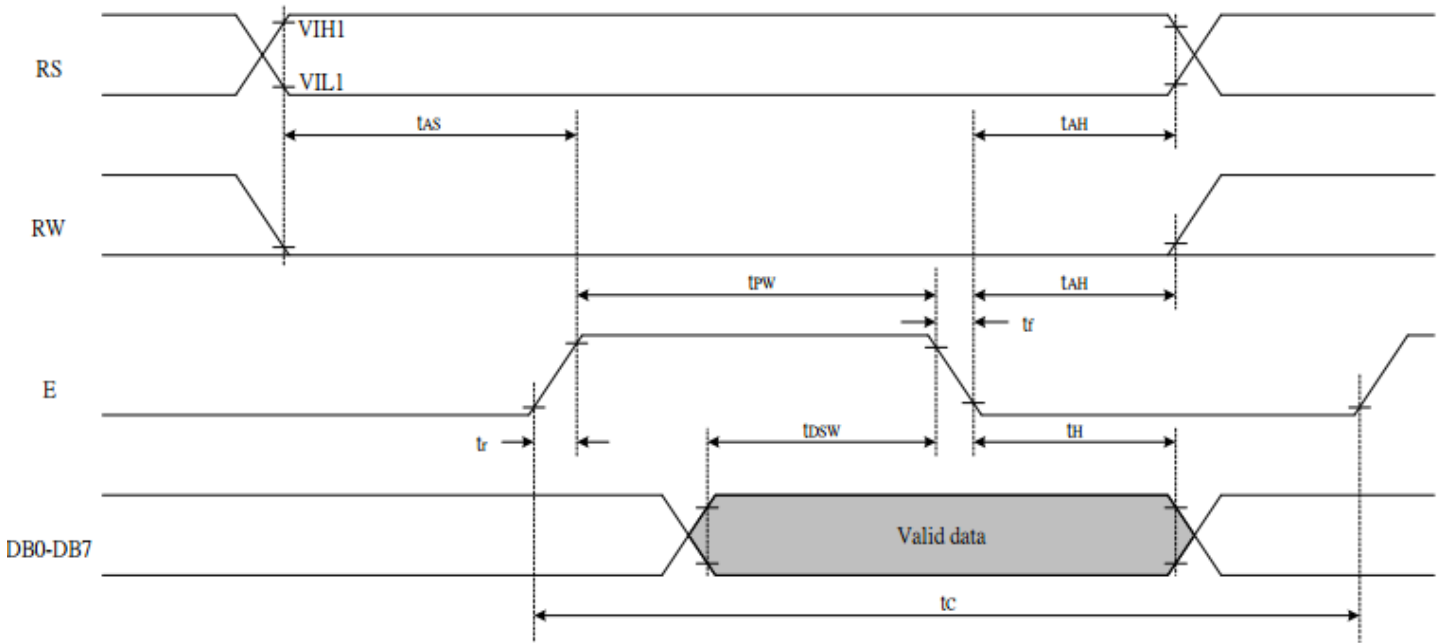
|          |          |          |          |          |          |          |          |          |           |           |           |           |           |           |           |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>12</b> | <b>13</b> | <b>14</b> | <b>15</b> | <b>16</b> |
| 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   | 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   | 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   | 0   | 1   | I/D | SH          | Sets cursor move direction and specifies display shift. These parameters are performed during data write and read.               | 37μs   |
| Display ON/OFF control     | 0                | 0   | 0   | 0   | 0   | 0   | 0   | 1   | D   | C   | B           | D=1: Entire display on<br>C=1: Cursor on<br>B=1: Blinking cursor on  | 37μs   |
| Cursor or Display shift    | 0                | 0   | 0   | 0   | 0   | 0   | 1   | S/C | R/L | -   | -           | Sets cursor moving and display shift control bit, and the direction without changing DDRAM data.                                 | 37μs   |
| Function set               | 0                | 0   | 0   | 0   | 1   | DL  | N   | F   | -   | -   | -           | DL: Interface data is 8/4 bits<br>N: Number of lines is 2/1<br>F: Font size is 5x11/5x8  | 37μs   |
| Set CGRAM Address          | 0                | 0   | 0   | 1   | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |             | Set CGRAM address in address counter   | 37μs   |
| Set DDRAM Address          | 0                | 0   | 1   | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |             | Set DDRAM address in address counter.  | 37μs   |
| 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.           | 0s     |
| Write data To Address      | 1                | 0   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  |             | Write data into internal RAM (DDRAM/CGRAM).  | 37μs   |
| Read data From RAM         | 1                | 1   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  |             | Read data from internal RAM (DDRAM/CGRAM).   | 37μs   |

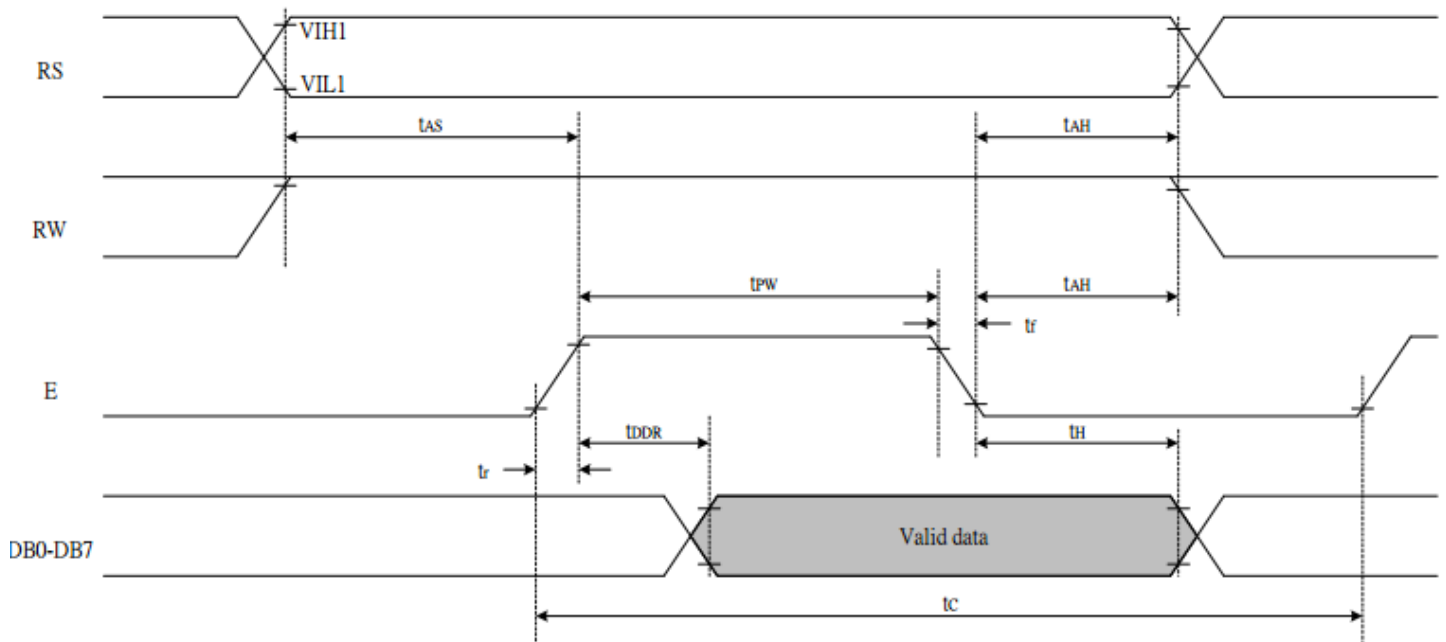
# Timing Characteristics

## Writing data from MPU to ST7066U



| Write Mode (Writing data from MPU to ST7066U) |                       |                 |      |   |    |    |
|---|-----------------------|-----------------|------|---|----|----|
| $T_C$   | 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 |

## Reading data from ST7066U to MPU



| <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 |



## Built-in Font Table

| b7-b4<br>b3-b0 | 0000             | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|----------------|------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0000           | CG<br>RAM<br>(1) |      |      | 0    | 1    | 2    | 3    | 4    |      |      |      | 5    | 6    | 7    | 8    | 9    |
| 0001           | (2)              | !    | 1    | A    | Q    | a    | 9    |      |      |      | .    | 7    | 8    | 4    | ã    | g    |
| 0010           | (3)              | "    | 2    | B    | R    | b    | r    |      |      |      | 7    | 4    | 9    | ×    | p    | ø    |
| 0011           | (4)              | #    | 3    | C    | S    | c    | s    |      |      |      | 7    | 9    | 7    | e    | e    | ø    |
| 0100           | (5)              | \$   | 4    | D    | T    | d    | t    |      |      |      | √    | 1    | 1    | 1    | μ    | α    |
| 0101           | (6)              | %    | 5    | E    | U    | e    | u    |      |      |      | *    | 7    | 7    | 1    | α    | 0    |
| 0110           | (7)              | &    | 6    | F    | V    | f    | v    |      |      |      | 7    | 0    | 2    | 3    | p    | Σ    |
| 0111           | (8)              | '    | 7    | G    | W    | g    | w    |      |      |      | 7    | 7    | 7    | 7    | g    | π    |
| 1000           | (1)              | (    | 8    | H    | X    | h    | x    |      |      |      | 4    | 0    | *    | 9    | 7    | ×    |
| 1001           | (2)              | )    | 9    | I    | Y    | i    | y    |      |      |      | ø    | 7    | 1    | 1    | 1    | 1    |
| 1010           | (3)              | *    | :    | J    | Z    | j    | z    |      |      |      | ±    | 0    | 0    | 0    | 0    | 0    |
| 1011           | (4)              | +    | ;    | K    | L    | k    | l    |      |      |      | *    | 7    | 0    | 0    | 0    | π    |
| 1100           | (5)              | ,    | <    | L    | *    | 1    | 1    |      |      |      | 7    | 0    | 0    | 0    | 0    | π    |
| 1101           | (6)              | -    | =    | M    | I    | m    | 1    |      |      |      | ±    | 7    | 7    | 7    | 7    | 7    |
| 1110           | (7)              | .    | >    | N    | ^    | n    | +    |      |      |      | 3    | 0    | 0    | 0    | ñ    |      |
| 1111           | (8)              | /    | ?    | O    | _    | o    | +    |      |      |      | 9    | 9    | 7    | 7    | 0    |      |

## 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=HIGH : 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 >40 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 >40 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

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