

# NHD-0116GZ-FSW-GBW

## Character Liquid Crystal Display Module

|       |                          |
|-------|--------------------------|
| NHD-  | Newhaven Display         |
| 0116- | 1 Line x 16 Characters   |
| GZ-   | Model                    |
| F-    | Transflective            |
| SW-   | Side White LED Backlight |
| G-    | STN Positive Gray        |
| B-    | 6:00 Optimal View        |
| W-    | Wide Temperature         |
|       | <b>RoHS Compliant</b>    |

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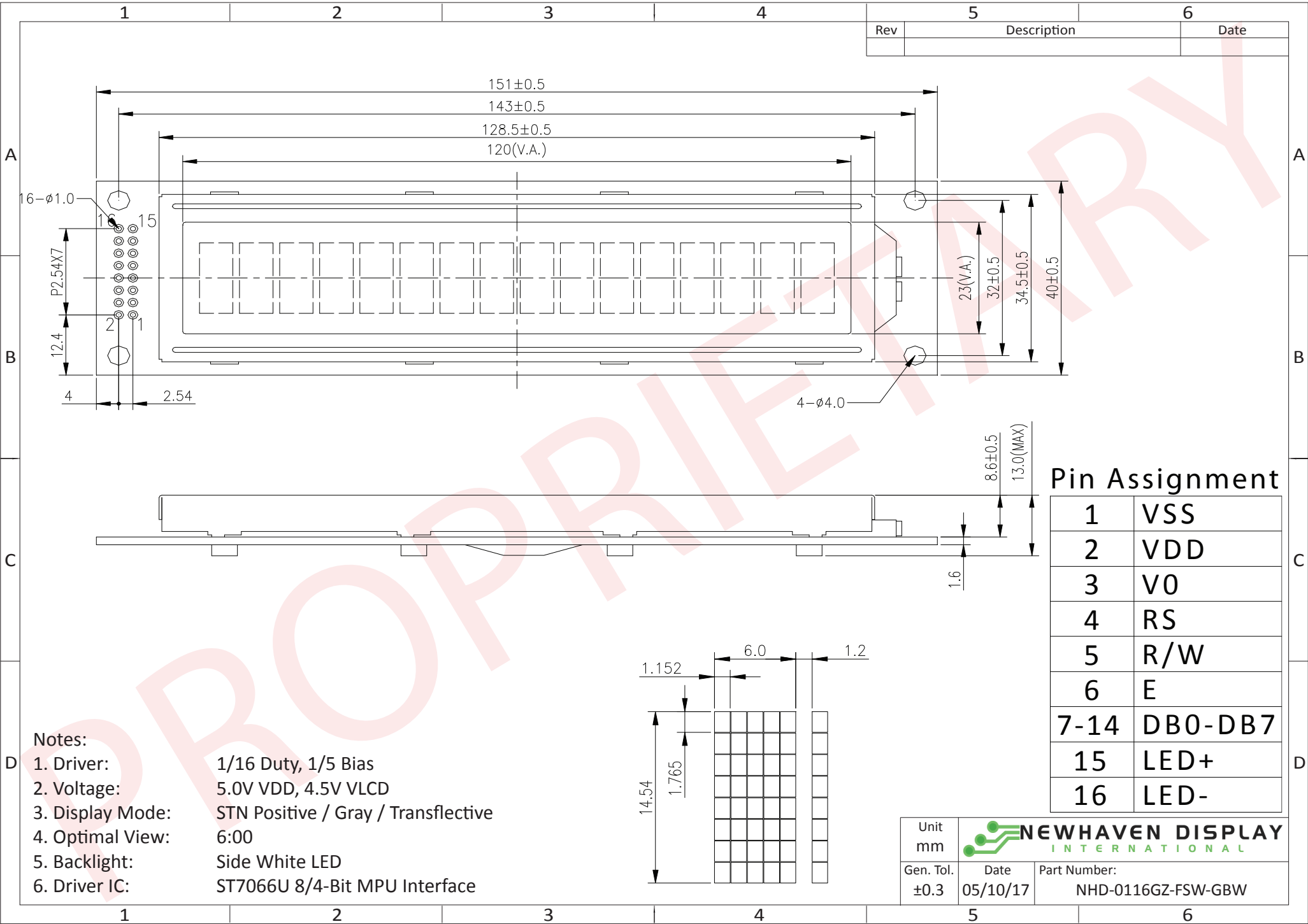
## Document Revision History

| Revision | Date    | Description                                              | Changed by |
|----------|---------|----------------------------------------------------------|------------|
| 0        | 9/25/07 | Initial Release                                          | -          |
| 1        | 11/6/09 | User Guide Reformat                                      | BE         |
| 2        | 12/8/09 | Pin description updated                                  | BE         |
| 3        | 1/5/10  | Optical revised                                          | BE         |
| 4        | 1/5/11  | Alternate controller information updated                 | AK         |
| 5        | 4/15/11 | Electrical characteristics updated                       | AK         |
| 6        | 5/10/17 | Mechanical, Electrical & Optical Characteristics Updated | SB         |
| 7        | 6/28/17 | Electrical & Optical Char. Updated                       | SB         |

## Functions and Features

- 1 line x 16 characters
- Built-in controller (ST7066U)
- +5.0V Power Supply
- 1/16 duty, 1/5 bias
- RoHS compliant

Mechanical Drawing

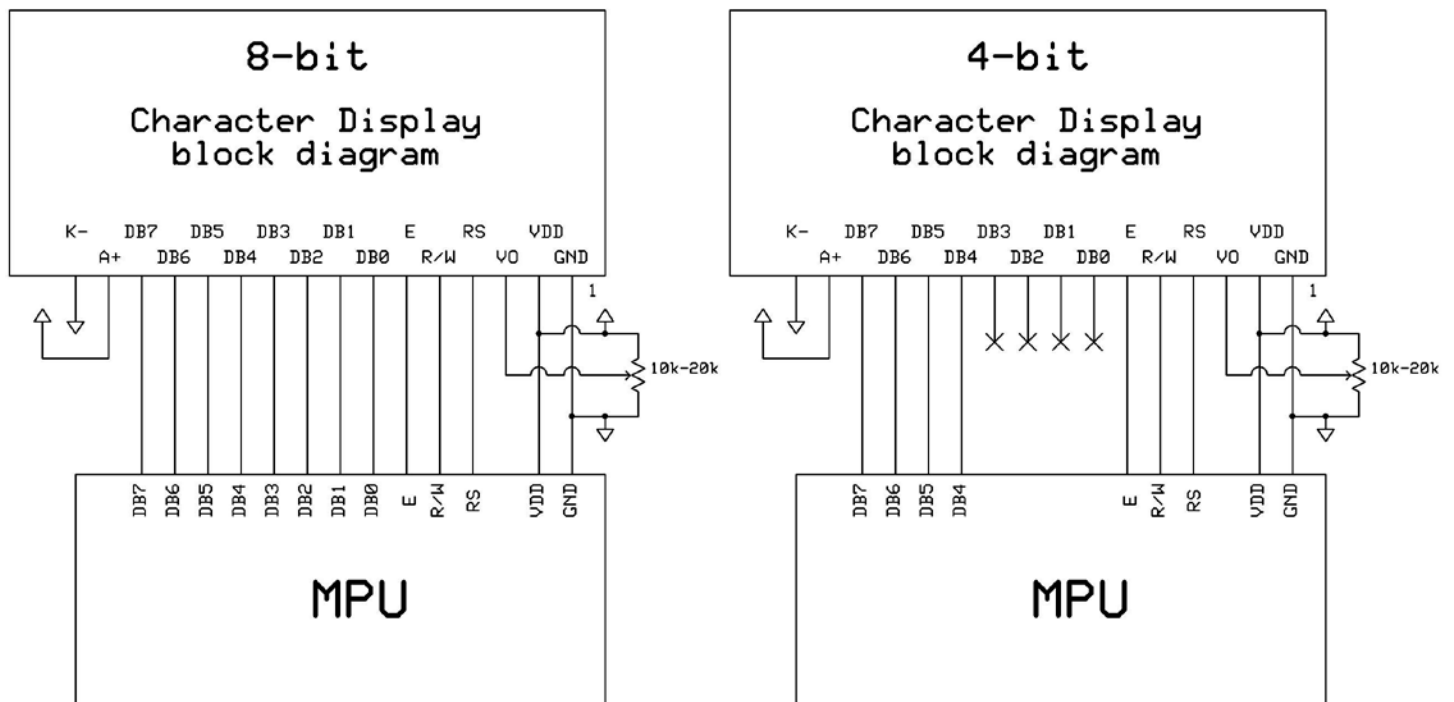


## Pin Description and Wiring Diagram

| Pin No. | Symbol    | External Connection | Function Description                                                                                      |
|---------|-----------|---------------------|-----------------------------------------------------------------------------------------------------------|
| 1       | $V_{SS}$  | Power Supply        | Ground                                                                                                    |
| 2       | $V_{DD}$  | Power Supply        | Supply Voltage for logic (+5.0V)                                                                          |
| 3       | $V_0$     | Adj. Power Supply   | Supply Voltage 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        | Backlight Anode (30 mA @ 5.0V)                                                                            |
| 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 | T <sub>OP</sub>  | Absolute Max                                     | -20                   | -    | +70             | °C   |
| Storage Temperature Range   | T <sub>ST</sub>  | Absolute Max                                     | -30                   | -    | +80             | °C   |
| Supply Voltage              | V <sub>DD</sub>  | -                                                | 4.7                   | 5.0  | 5.3             | V    |
| Supply Current              | I <sub>DD</sub>  | V <sub>DD</sub> = 5.0V<br>T <sub>OP</sub> = 25°C | 0.5                   | 1.5  | 3               | mA   |
| Supply for LCD (contrast)   | V <sub>LCD</sub> |                                                  | 4.3                   | 4.5  | 4.7             | V    |
| "H" Level input             | V <sub>IH</sub>  | -                                                | 0.7 * V <sub>DD</sub> | -    | V <sub>DD</sub> | V    |
| "L" Level input             | V <sub>IL</sub>  | -                                                | V <sub>SS</sub>       | -    | 0.6             | V    |
| "H" Level output            | V <sub>OH</sub>  | -                                                | 3.9                   | -    | V <sub>DD</sub> | V    |
| "L" Level output            | V <sub>OL</sub>  | -                                                | V <sub>SS</sub>       | -    | 0.4             | V    |
|                             |                  |                                                  |                       |      |                 |      |
| Backlight Supply Voltage    | V <sub>LED</sub> | -                                                | 4.8                   | 5.0  | 5.2             | V    |
| Backlight Supply Current    | I <sub>LED</sub> | V <sub>LED</sub> = 5V                            | 15                    | 30   | 40              | mA   |

## Optical Characteristics

| Item                   |        | Symbol         | Condition              | Min. | Typ. | Max. | Unit |
|------------------------|--------|----------------|------------------------|------|------|------|------|
| Optimal Viewing Angles | Top    | φY+            | CR ≥ 2                 | 30   | 40   | -    | °    |
|                        | Bottom | φY-            |                        | 50   | 60   | -    | °    |
|                        | Left   | θX-            |                        | 50   | 60   | -    | °    |
|                        | Right  | θX+            |                        | 50   | 60   | -    | °    |
| Contrast Ratio         |        | CR             | -                      | 2    | 5    | -    | -    |
| Response Time          | Rise   | T <sub>R</sub> | T <sub>OP</sub> = 25°C | -    | 150  | 250  | ms   |
|                        | Fall   | T <sub>F</sub> |                        | -    | 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

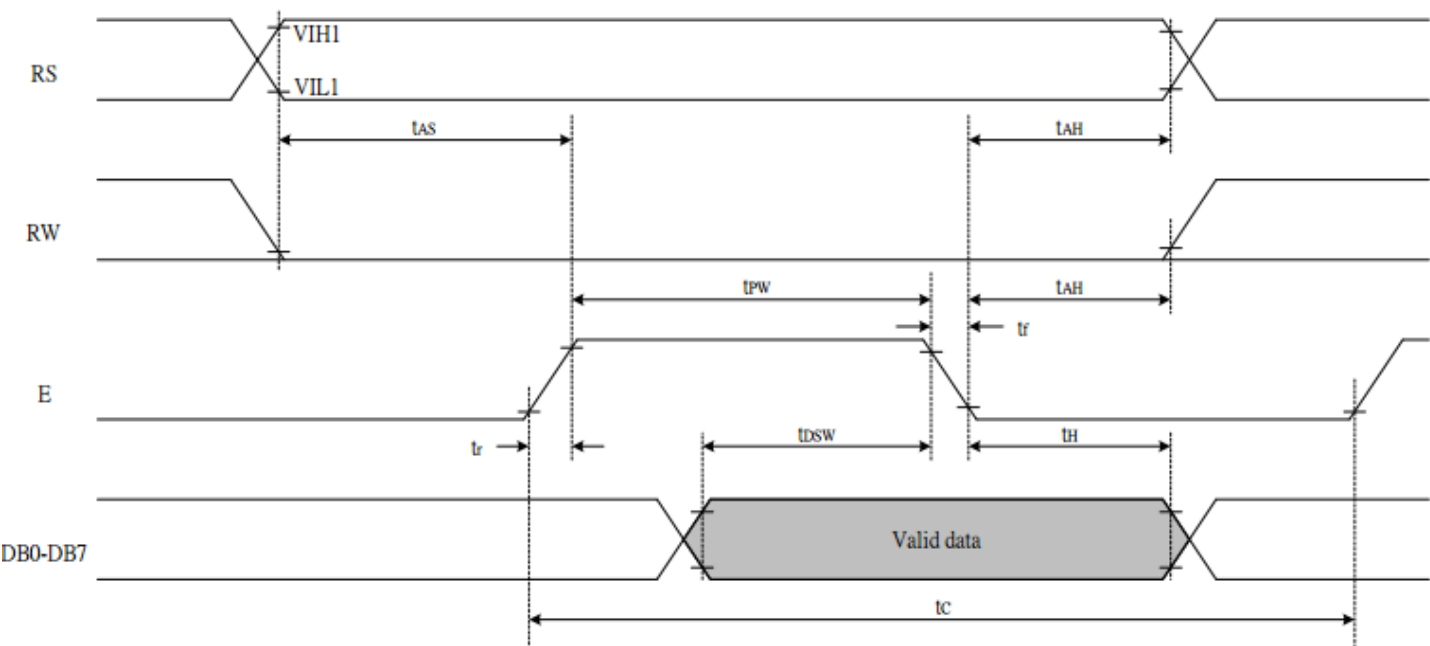
| 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F |

## Table of Commands

| Instruction                | Instruction code |     |     |     |     |     |     |     |     |     | Description                                                                                                                      | Execution time (f <sub>osc</sub> = 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 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 | 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   | 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   | 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 <sub>C</sub>                                | Enable Cycle Time     | Pin E           | 1200 | - | -  | ns |
| T <sub>PW</sub>                               | Enable Pulse Width    | Pin E           | 140  | - | -  | ns |
| T <sub>R</sub> , T <sub>F</sub>               | Enable Rise/Fall Time | Pin E           | -    | - | 25 | ns |
| T <sub>AS</sub>                               | Address Setup Time    | Pins: RS,RW,E   | 0    | - | -  | ns |
| T <sub>AH</sub>                               | Address Hold Time     | Pins: RS,RW,E   | 10   | - | -  | ns |
| T <sub>DSW</sub>                              | Data Setup Time       | Pins: DB0 - DB7 | 40   | - | -  | ns |
| T <sub>H</sub>                                | 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           | 140  | - | -   | 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 | -    | - | 100 | 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    | a    | P    | ˘    | F    |      |      |      | —    | 9    | 3    | a    | p    |      |
| 0001           | (2)              |      | !    | 1    | A    | Q    | a    | A    |      |      |      | •    | 7    | 7    | 4    | ä    | q    |
| 0010           | (3)              |      | "    | 2    | B    | R    | b    | r    |      |      |      | ˆ    | 4    | ʷ    | ×    | ß    | ø    |
| 0011           | (4)              |      | #    | 3    | C    | S    | c    | s    |      |      |      | ˆ    | 9    | 7    | e    | ε    | ×    |
| 0100           | (5)              |      | \$   | 4    | D    | T    | d    | t    |      |      |      | ˆ    | I    | †    | †    | µ    | α    |
| 0101           | (6)              |      | %    | 5    | E    | U    | e    | u    |      |      |      | •    | †    | †    | 1    | ε    | 0    |
| 0110           | (7)              |      | &    | 6    | F    | V    | f    | v    |      |      |      | 9    | †    | 二    | ヨ    | ρ    | Σ    |
| 0111           | (8)              |      | '    | 7    | G    | W    | g    | w    |      |      |      | 7    | †    | 又    | う    | g    | π    |
| 1000           | (1)              |      | (    | 8    | H    | X    | h    | x    |      |      |      | 4    | 9    | ※    | リ    | フ    | 又    |
| 1001           | (2)              |      | )    | 9    | I    | Y    | i    | y    |      |      |      | •    | 7    | ノ    | ル    | ˆ    | y    |
| 1010           | (3)              |      | *    | :    | J    | Z    | j    | z    |      |      |      | ε    | コ    | ∩    | レ    | j    | ¥    |
| 1011           | (4)              |      | +    | :    | K    | Ɔ    | k    | Ɔ    |      |      |      | ※    | 9    | ヒ    | ロ    | ×    | ¥    |
| 1100           | (5)              |      | ,    | <    | L    | ¥    | l    | l    |      |      |      | †    | 9    | フ    | ワ    | •    | ¥    |
| 1101           | (6)              |      | —    | =    | N    | Ɔ    | n    | Ɔ    |      |      |      | ε    | 又    | ˆ    | ノ    | ト    | ÷    |
| 1110           | (7)              |      | •    | >    | N    | ˆ    | n    | ˆ    |      |      |      | ヨ    | ヒ    | 本    | ˆ    | ん    |      |
| 1111           | (8)              |      | /    | ?    | 0    | _    | o    | ←    |      |      |      | •    | 9    | 又    | ˆ    | ó    | ■    |

## 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 upper 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 upper 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 and Terms & Conditions

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