

# NHD-16032AZ-FL-YBW

## Graphic Liquid Crystal Display Module

NHD- Newhaven Display  
16032- 160 x 32 Pixels  
AZ- Model  
F- Transflective  
L- Yellow/Green LED Backlight  
Y- STN- Yellow/Green  
B- 6:00 Optimal View  
W- Wide Temperature  
**RoHS Compliant**

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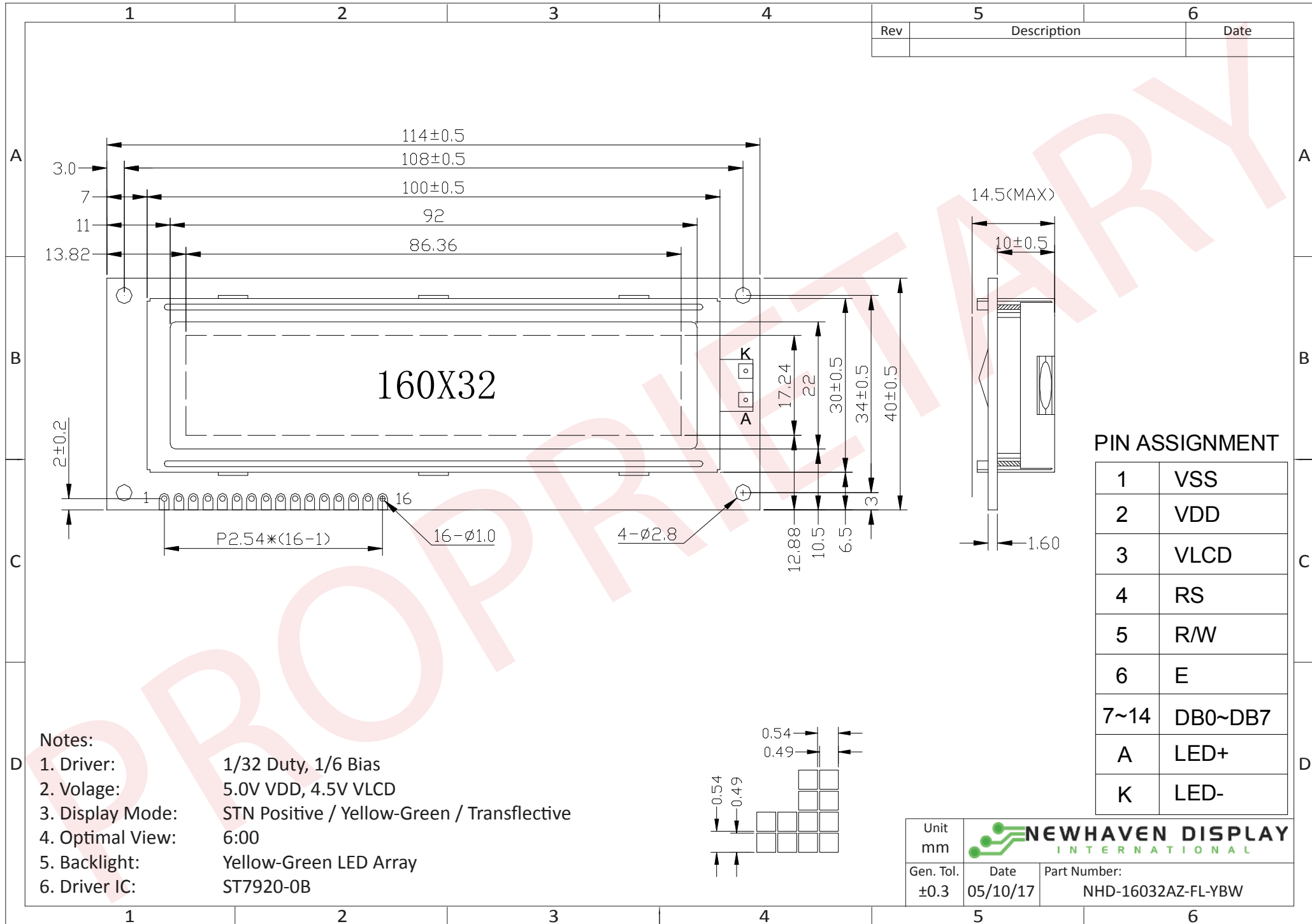
## Document Revision History

| Revision | Date      | Description                                            | Changed by |
|----------|-----------|--------------------------------------------------------|------------|
| 0        | 2/28/2009 | Initial Release                                        | -          |
| 1        | 4/9/2010  | User guide reformat                                    | BE         |
| 2        | 5/7/2010  | Block diagram/initialization update                    | BE         |
| 3        | 1/25/2012 | Mechanical drawing updated                             | AK         |
| 4        | 6/7/2013  | Controller information added                           | AK         |
| 5        | 9/22/16   | Mechanical Drawing, Electrical & Optical Char. Updated | SB         |
| 6        | 5/10/17   | Mechanical Drawing Updated                             | SB         |

## Functions and Features

- 160x32 pixels
- Built-in ST7920-0B Controller
- +5.0V power supply
- 1/32 duty, 1/9 bias
- RoHS Compliant

# Mechanical Drawing



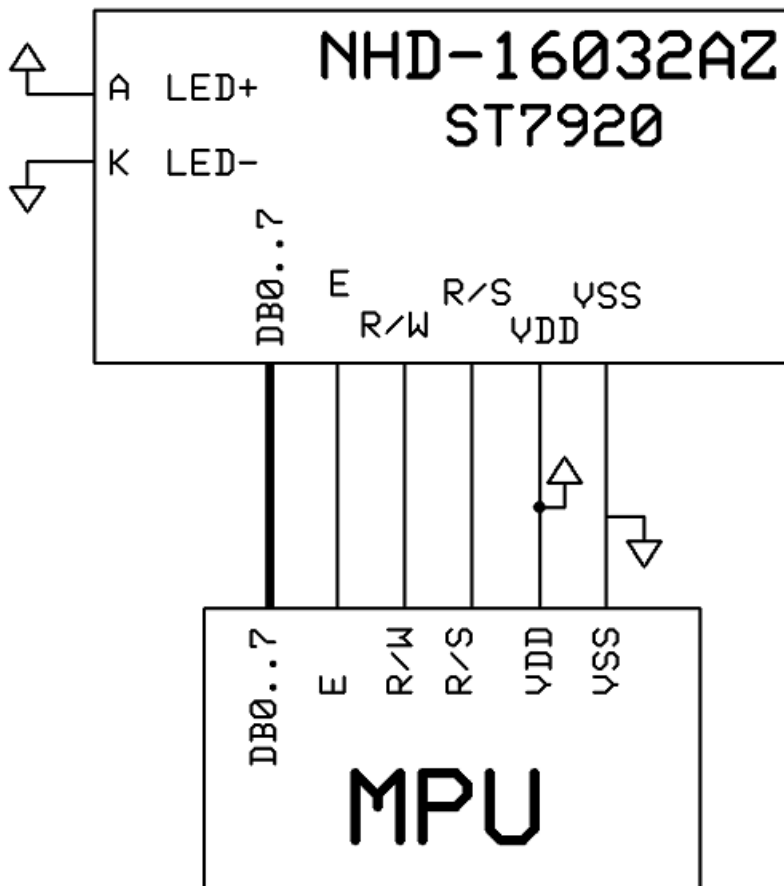
|                        |                  |                                    |
|------------------------|------------------|------------------------------------|
| Unit<br>mm             |                  |                                    |
| Gen. Tol.<br>$\pm 0.3$ | Date<br>05/10/17 | Part Number:<br>NHD-16032AZ-FL-YBW |

## Pin Description and Wiring Diagram

| Pin No. | Symbol          | External Connection | Function Description                                 |
|---------|-----------------|---------------------|------------------------------------------------------|
| 1       | V <sub>SS</sub> | Power Supply        | Ground                                               |
| 2       | V <sub>DD</sub> | Power Supply        | Power supply for LCD and Logic (+5.0V)               |
| 3       | NC              | -                   | No Connect                                           |
| 4       | RS              | MPU                 | Register Select signal: 1=Data, 0=Instruction        |
| 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.     |
| 7-14    | DB0-DB7         | MPU                 | 8-Bit Bi-directional data bus                        |
| 15      | LED+            | Power Supply        | Backlight Anode (150 mA @ 5V)                        |
| 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 | $T_{OP}$  | Absolute Max                              | -20            | -    | +70      | °C   |
| Storage Temperature Range   | $T_{ST}$  | Absolute Max                              | -30            | -    | +80      | °C   |
| Supply Voltage              | $V_{DD}$  | -                                         | 4.5            | 5.0  | 5.5      | V    |
| Supply Current              | $I_{DD}$  | $V_{DD} = 5.0V$<br>$T_{OP} = 25^{\circ}C$ | 1.0            | 1.5  | 2.5      | mA   |
| Supply for LCD (contrast)   | $V_{LCD}$ |                                           | 4.3            | 4.5  | 4.7      | -    |
| "H" Level input             | $V_{IH}$  | -                                         | $0.7 * V_{DD}$ | -    | $V_{DD}$ | V    |
| "L" Level input             | $V_{IL}$  | -                                         | $V_{SS}$       | -    | 0.6      | V    |
| "H" Level output            | $V_{OH}$  | -                                         | $0.8 * V_{DD}$ | -    | $V_{DD}$ | V    |
| "L" Level output            | $V_{OL}$  | -                                         | $V_{SS}$       | -    | 0.4      | V    |
| Backlight Supply Current    | $I_{LED}$ | -                                         | -              | 150  | 180      | mA   |
| Backlight Supply Voltage    | $V_{LED}$ | $I_{LED} = 150mA$                         | 4.7            | 5.0  | 5.3      | V    |

## Optical Characteristics

| Item                   | Symbol | Condition              | Min. | Typ. | Max. | Unit |
|------------------------|--------|------------------------|------|------|------|------|
| Optimal Viewing Angles | Top    | $CR \geq 2$            | -    | 40   | -    | °    |
|                        | Bottom |                        | -    | 60   | -    | °    |
|                        | Left   |                        | -    | 60   | -    | °    |
|                        | Right  |                        | -    | 60   | -    | °    |
| Contrast Ratio         | CR     | -                      | 2    | 5    | -    | -    |
| Response Time          | Rise   | $T_{OP} = 25^{\circ}C$ | -    | 150  | 250  | ms   |
|                        | Fall   |                        | -    | 200  | 300  | ms   |

## Controller Information

Built-in ST7920-0B.

Please download specification at [http://www.newhavendisplay.com/app\\_notes/ST7920.pdf](http://www.newhavendisplay.com/app_notes/ST7920.pdf)

# Table of Commands

## Instruction Set 1: (RE=0: Basic Instruction)

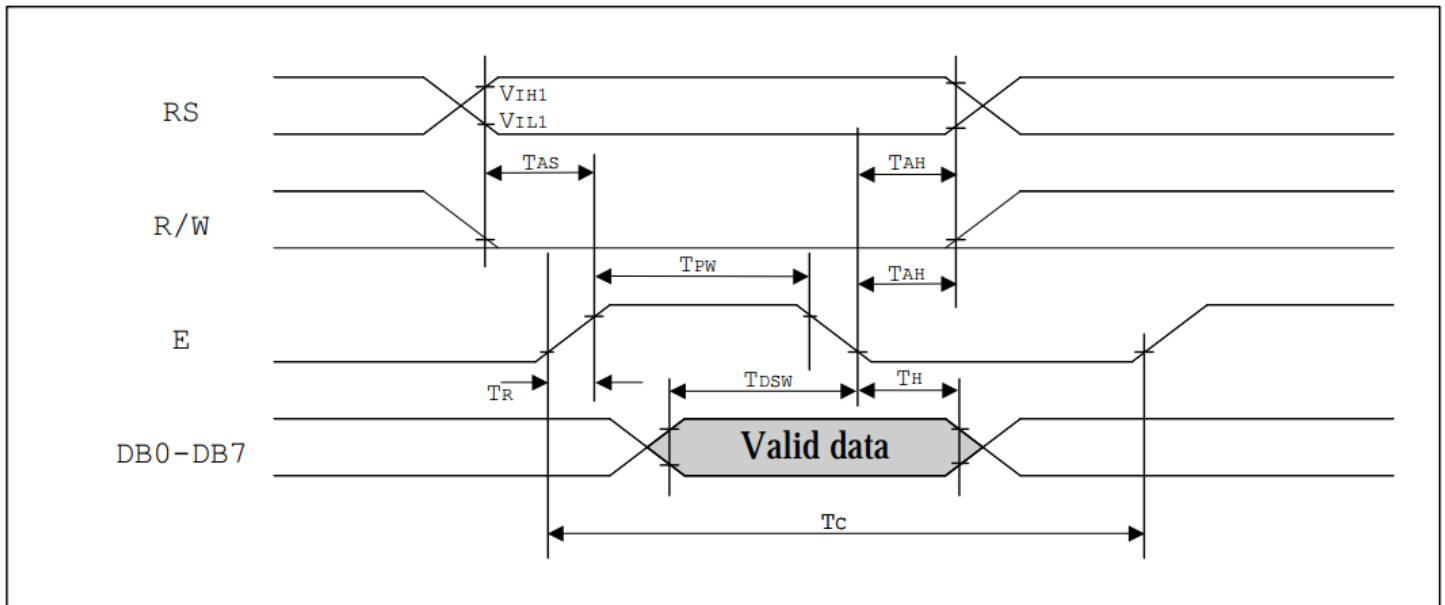
| Inst.                     | Code |    |     |          |     |     |     |         |     |     | Description                                                                                                                    | Exec time (540KHZ) |
|---------------------------|------|----|-----|----------|-----|-----|-----|---------|-----|-----|--------------------------------------------------------------------------------------------------------------------------------|--------------------|
|                           | RS   | RW | DB7 | DB6      | DB5 | DB4 | DB3 | DB2     | DB1 | DB0 |                                                                                                                                |                    |
| Display Clear             | 0    | 0  | 0   | 0        | 0   | 0   | 0   | 0       | 0   | 1   | Fill DDRAM with "20H" and set DDRAM address counter (AC) to "00H".                                                             | 1.6 ms             |
| Return Home               | 0    | 0  | 0   | 0        | 0   | 0   | 0   | 0       | 1   | X   | Set DDRAM address counter (AC) to "00H", and put cursor to origin ; the content of DDRAM are not changed                       | 72 us              |
| Entry Mode Set            | 0    | 0  | 0   | 0        | 0   | 0   | 0   | 1       | I/D | S   | Set cursor position and display shift when doing write or read operation                                                       | 72 us              |
| Display Control           | 0    | 0  | 0   | 0        | 0   | 0   | 1   | D       | C   | B   | D=1: Display ON<br>C=1: Cursor ON<br>B=1: Character Blink ON                                                                   | 72 us              |
| Cursor Display Control    | 0    | 0  | 0   | 0        | 0   | 1   | S/C | R/L     | X   | X   | Cursor position and display shift control; the content of DDRAM are not changed                                                | 72 us              |
| Function Set              | 0    | 0  | 0   | 0        | 1   | DL  | X   | 0<br>RE | X   | X   | DL=1 8-bit interface<br>DL=0 4-bit interface<br><b>RE=1: extended instruction</b><br><b>RE=0: basic instruction</b>            | 72 us              |
| Set CGRAM Address.        | 0    | 0  | 0   | 1        | AC5 | AC4 | AC3 | AC2     | AC1 | AC0 | Set CGRAM address to address counter (AC)<br><b>Make sure that in extended instruction SR=0 (scroll or RAM address select)</b> | 72 us              |
| Set DDRAM Address.        | 0    | 0  | 1   | 0<br>AC6 | AC5 | AC4 | AC3 | AC2     | AC1 | AC0 | Set DDRAM address to address counter (AC)<br>AC6 is fixed to 0                                                                 | 72 us              |
| Read Busy Flag (BF) & AC. | 0    | 1  | BF  | AC6      | AC5 | AC4 | AC3 | AC2     | AC1 | AC0 | Read busy flag (BF) for completion of internal operation, also Read out the value of address counter (AC)                      | 0 us               |
| Write RAM                 | 1    | 0  | D7  | D6       | D5  | D4  | D3  | D2      | D1  | D0  | Write data to internal RAM (DDRAM/CGRAM/GDRAM)                                                                                 | 72 us              |
| Read RAM                  | 1    | 1  | D7  | D6       | D5  | D4  | D3  | D2      | D1  | D0  | Read data from internal RAM (DDRAM/CGRAM/GDRAM)                                                                                | 72 us              |

**Instruction set 2: (RE=1: extended instruction)**

| Inst.                                    | Code |    |     |     |     |     |     |     |     |          | Description                                                                                                                                                                                                            | Exec time<br>(540KHZ) |
|------------------------------------------|------|----|-----|-----|-----|-----|-----|-----|-----|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
|                                          | RS   | RW | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0      |                                                                                                                                                                                                                        |                       |
| Standby                                  | 0    | 0  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1        | Enter standby mode, any other instruction can terminate.<br>COM1...32 are halted.                                                                                                                                      | 72 us                 |
| Scroll or<br>RAM<br>Address.<br>Select   | 0    | 0  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1        | SR<br>SR=1: enable vertical scroll position<br>SR=0: enable CGRAM address ( <b>basic instruction</b> )                                                                                                                 | 72 us                 |
| Reverse<br>(by line)                     | 0    | 0  | 0   | 0   | 0   | 0   | 0   | 0   | 1   | R1<br>R0 | Select 1 out of 4 line (in DDRAM) and decide whether to<br>reverse the display by toggling this instruction<br><b>R1,R0 initial value is 0,0</b>                                                                       | 72 us                 |
| Extended<br>Function<br>Set              | 0    | 0  | 0   | 0   | 1   | DL  | X   | 1   | RE  | G        | DL=1 :8-bit interface<br>DL=0 :4-bit interface<br><b>RE=1: extended instruction set</b><br><b>RE=0: basic instruction set</b><br>G=1 :graphic display ON<br>G=0 :graphic display OFF                                   | 72 us                 |
| Set Scroll<br>Address                    | 0    | 0  | 0   | 1   | AC5 | AC4 | AC3 | AC2 | AC1 | AC0      | SR=1: AC5~AC0 the address of vertical scroll                                                                                                                                                                           | 72 us                 |
| Set Graphic<br>Display<br>RAM<br>Address | 0    | 0  | 1   | 0   | 0   | 0   | AC3 | AC2 | AC1 | AC0      | Set GDRAM address to address counter (AC)<br>Set the vertical address first and followed the horizontal<br>address by consecutive writings<br>Vertical address range: AC5...AC0<br>Horizontal address range: AC3...AC0 | 72 us                 |

## Timing Characteristics

### MPU write data to ST7920

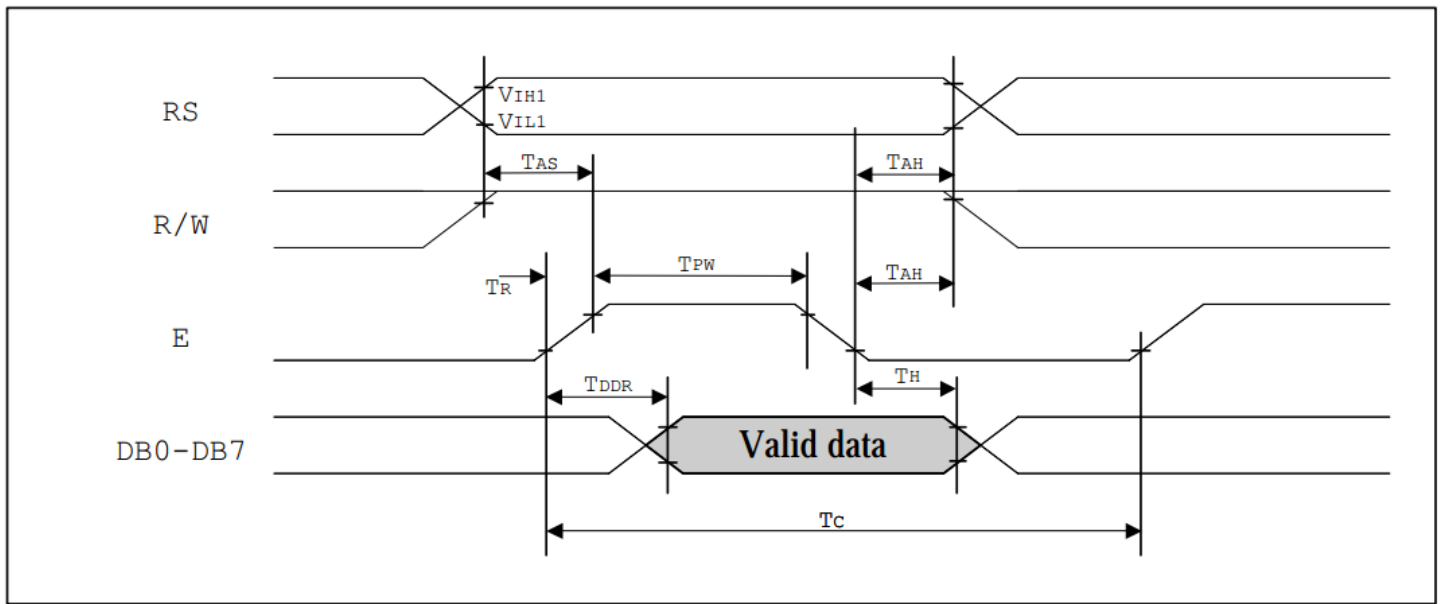


*Write Mode (Writing data from MPU to ST7920)*

|            |                       |                 |      |   |    |    |
|------------|-----------------------|-----------------|------|---|----|----|
| $T_C$      | 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 | 10   | - | -  | ns |
| $T_{AH}$   | Address Hold Time     | Pins: RS, RW, E | 20   | - | -  | ns |
| $T_{DSW}$  | Data Setup Time       | Pins: DB0 - DB7 | 40   | - | -  | ns |
| $T_H$      | Data Hold Time        | Pins: DB0 - DB7 | 20   | - | -  | ns |



## MPU read data from ST7920



| <i>Read Mode (Reading Data from ST7920 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   | 10   | - | -   | ns |
| $T_{AH}$                                           | Address Hold Time     | Pins: RS,RW,E   | 20   | - | -   | ns |
| $T_{DDR}$                                          | Data Delay Time       | Pins: DB0 - DB7 | -    | - | 100 | ns |
| $T_H$                                              | Data Hold Time        | Pins: DB0 - DB7 | 20   | - | -   | ns |

## Built-in Font Table

Please see: [http://www.newhavendisplay.com/app\\_notes/ST7920-0B\\_font.pdf](http://www.newhavendisplay.com/app_notes/ST7920-0B_font.pdf)

### Example Initialization Program

```
//-----  
#include <REG52.H>  
#include "AL.h"  
sbit ID = P3^0;  
sbit RW = P3^7;  
sbit E = P3^4;  
  
//-----  
void Init()  
{  
    Wcom(0x38);  
    Wcom(0x0C);  
    Wcom(0x06);  
    Wcom(0x02);  
    Wcom(0x01);  
    delay(10);  
    Row = 0x80;  
    for(Counthi = 1; Counthi <=32; Counthi++)  
    {  
        Wcom(0x3E);  
        Wcom(Row);  
        Wcom(0x80);  
        for(Count = 1; Count <=40; Count++)  
        {  
            Wdata(0x00);  
        }  
        Row++;  
    }  
}  
//-----  
void Wcom(char i)  
{  
    P1 = i;  
    ID = 0;  
    RW = 0;  
    E = 1;  
    delay(1);  
    E = 0;  
}  
//-----  
void Wdata(char i)  
{  
    P1 = i;  
    ID = 1;  
    RW = 0;  
    E = 1;  
    delay(1);  
    E = 0;  
}  
//-----
```

## 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)