

# NHD-C0216CZ-NSW-BBW-3V3

## COG (Chip-on-Glass) Liquid Crystal Display Module

NHD- Newhaven Display  
C0216- COG, 2 Lines x 16 Characters  
CZ- Model  
N- Transmissive  
SW- Side White LED Backlight  
B- STN-Blue Negative  
B- 6:00 Optimal View  
W- Wide Temperature  
3V3- 3V LCD, 3V Backlight  
**RoHS Compliant**

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## Document Revision History

| Revision | Date       | Description  | Changed by |
|----------|------------|--|------------|
| 0        | 11/11/2008 | Initial Release  |            |
| 1        | 8/26/2009  | User guide reformat                                      | BE         |
| 2        | 10/9/2009  | Updated Electrical Characteristics                       | MC         |
| 3        | 10/27/2009 | Updated block diagram                                    | MC         |
| 4        | 11/19/2009 | Updated backlight supply current                         | MC         |
| 5        | 12/18/2009 | Pin description updated                                  | BE         |
| 6        | 2/17/2011  | Font table updated                                       | AK         |
| 7        | 7/19/2011  | Viewing angles updated                                   | AK         |
| 8        | 3/2/2012   | Interface information updated                            | AK         |
| 9        | 7/22/2013  | Electrical characteristics updated                       | ML         |
| 10       | 12/10/2014 | Recommended connector information updated                | AK         |
| 11       | 10/20/16   | Mechanical Drawing, Electrical & Optical Char. Updated   | SB         |
| 12       | 1/20/17    | P/N Printed on Back of Display, Electrical Char. Updated | SB         |
| 13       | 8/24/18    | Supply Current Updated                                   | SB         |
| 14       | 11/15/18   | Updated Font table for CGRAM                             | TM         |
| 15       | 6/24/19    | Added PCB Footprint Drawing                              | AS         |
| 16       | 9/12/19    | Supply Current Updated                                   | SB         |

## Functions and Features

- 2 lines x 16 characters
- Built-in controller (ST7032)
- 5x8 dots with cursor
- 4-line serial interface
- 1/16 duty, 1/5 bias

A

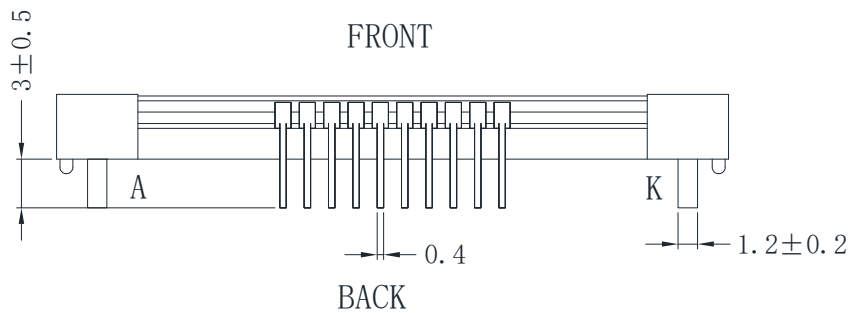
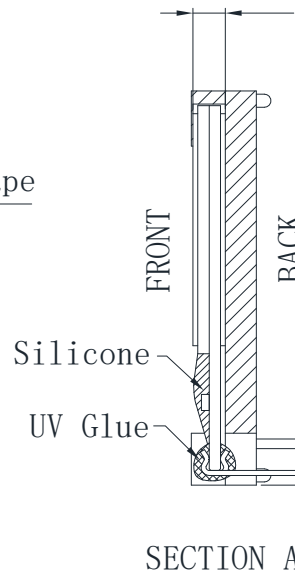
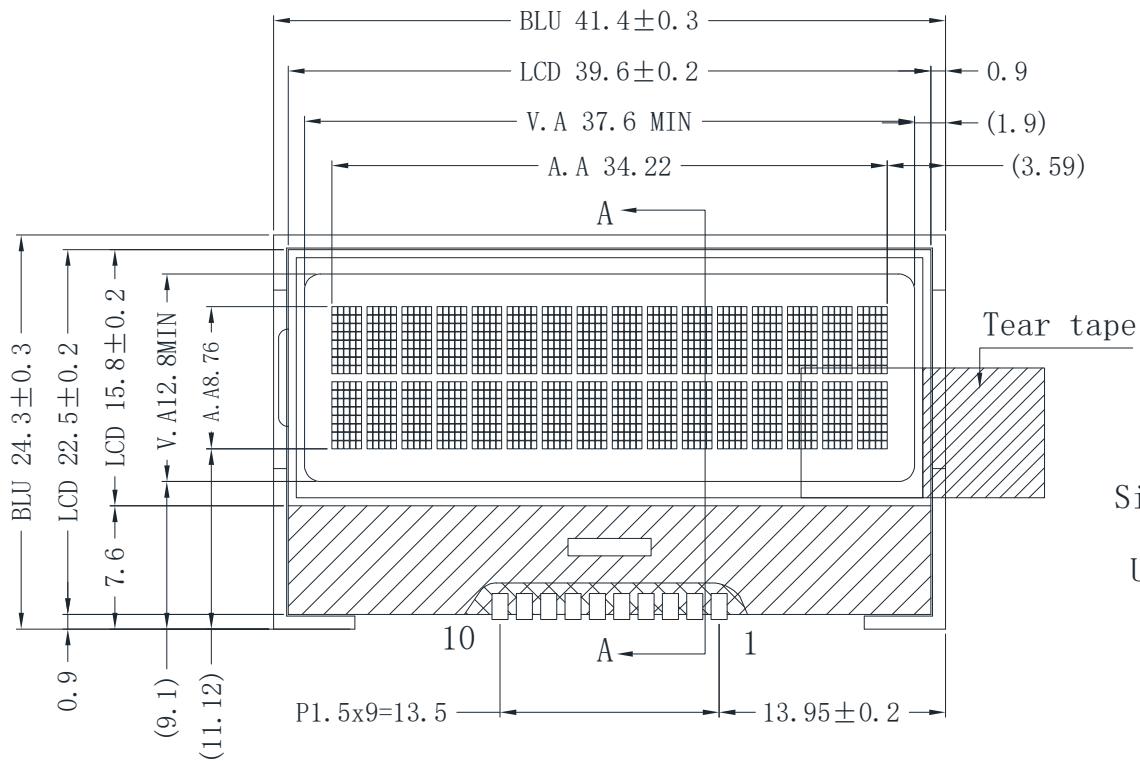
B

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**Notes:**

- 1. Driver: 1/16 Duty, 1/5 Bias
- 2. Voltage: 3.3V VDD, 5.5V VLCD
- 3. Display Mode: STN Negative / Blue / Transmissive
- 4. Optimal View: 6:00
- 5. Backlight: White LED
- 6. Driver IC: ST7032

1

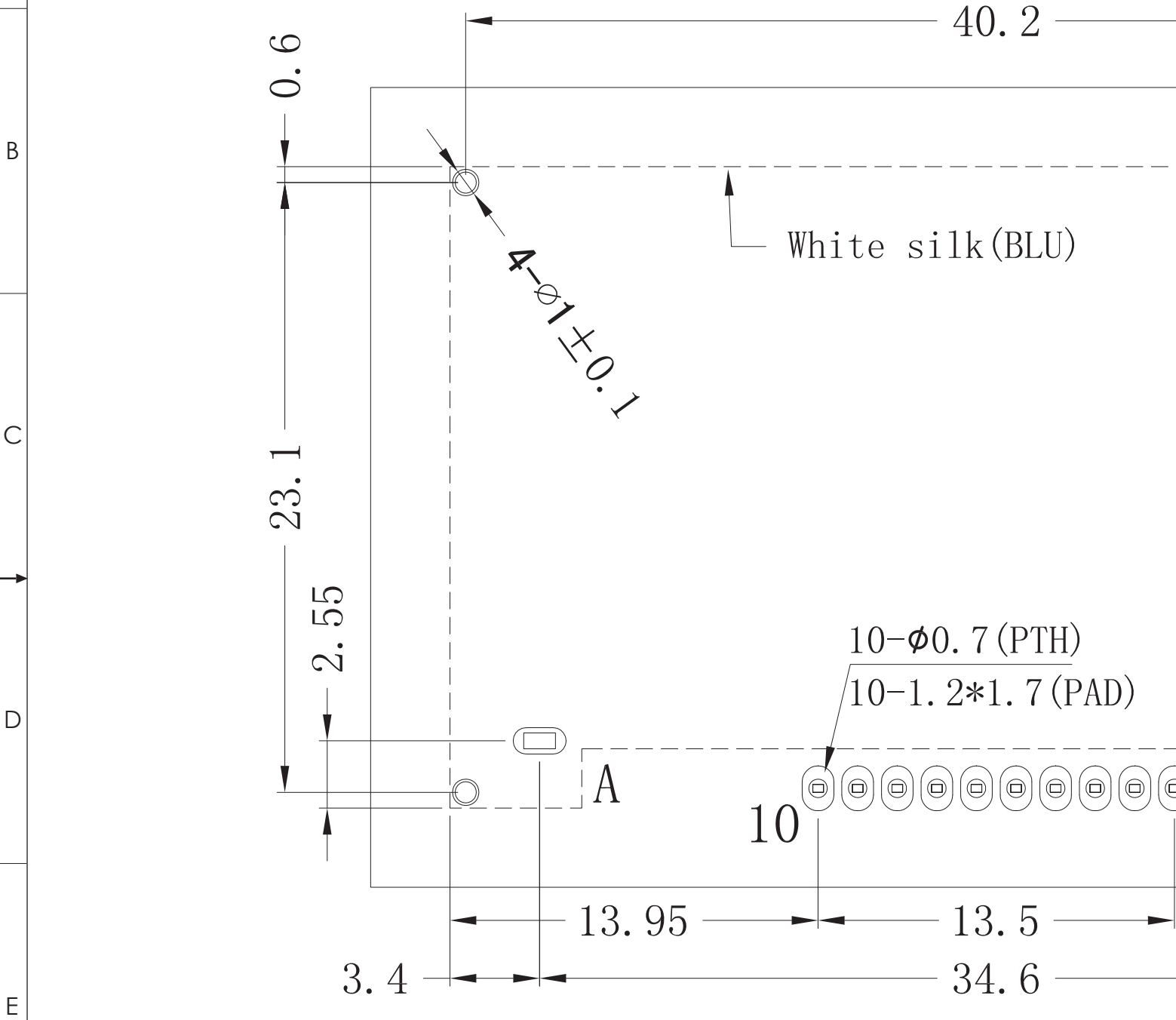
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# A Recommended PCB Footprint



## Applicable Displays:

- 1) NHD-C0216CZ-NSW-BBW-3V3
- 2) NHD-C0216CZ-FSW-FBW-3V3

F

1

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3

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B

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A

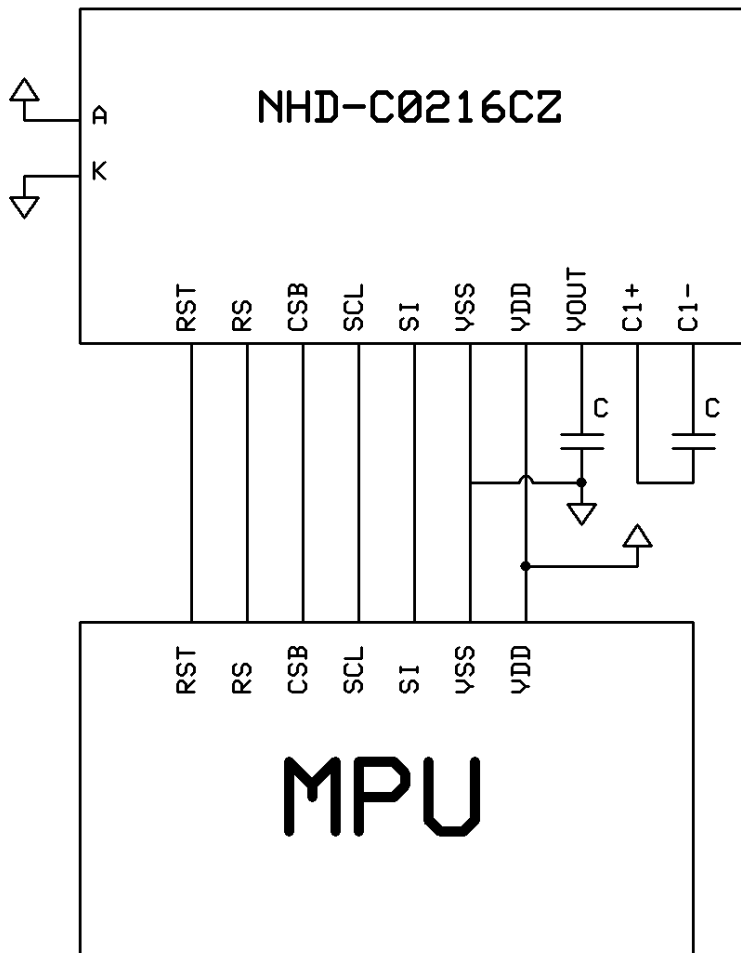
## Pin Description and Wiring Diagram

| Pin No. | Symbol           | External Connection | Function Description   |
|---------|------------------|---------------------|--|
| 1       | RST              | MPU                 | Active LOW Reset Signal  |
| 2       | RS               | MPU                 | Register Select signal. RS=0: instruction; RS=1: data                        |
| 3       | CSB              | MPU                 | Active LOW Chip Select signal  |
| 4       | SCL              | MPU                 | Serial Clock   |
| 5       | SI               | MPU                 | Serial Input data  |
| 6       | V <sub>SS</sub>  | Power Supply        | Ground   |
| 7       | V <sub>DD</sub>  |                     | Power supply for logic for LCD (3.0V).                                       |
| 8       | V <sub>OUT</sub> |                     | DC/DC voltage converter. 1uF capacitor to V <sub>DD</sub> or V <sub>SS</sub> |
| 9       | C1+              |                     | Voltage booster circuit. Connect to 0.47uF-2.2uF cap to PIN10.               |
| 10      | C1-              |                     | Voltage booster circuit. Connect to 0.47uF-2.2uF cap to PIN9.                |
| A       | LED+             | Power Supply        | Backlight Anode (3.0V)   |
| K       | LED-             | Power Supply        | Backlight Cathode (Ground)   |

**Recommended LCD connector:** LCD pins should be soldered directly onto thru-hole connection on PCB

**Backlight connector:** Backlight pins should be soldered directly onto thru-hole connection on PCB

**Recommended Breakout Board:** [NHD-PCB0216CZ](#)



## 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>  | -                       | 3.0                  | 3.3  | 3.6             | V    |
| Supply Current              | I <sub>DD</sub>  | V <sub>DD</sub> = 3.3V  | 40                   | 170  | 300             | μA   |
| Supply for LCD (contrast)   | V <sub>LCD</sub> | T <sub>OP</sub> = 25°C  | 5.2                  | 5.5  | 5.8             | V    |
| "H" Level input             | V <sub>IH</sub>  | -                       | 1.9                  | -    | V <sub>DD</sub> | V    |
| "L" Level input             | V <sub>IL</sub>  | -                       | V <sub>SS</sub>      | -    | 0.8             | V    |
| "H" Level output            | V <sub>OH</sub>  | -                       | 0.75*V <sub>DD</sub> | -    | V <sub>DD</sub> | V    |
| "L" Level output            | V <sub>OL</sub>  | -                       | V <sub>SS</sub>      | -    | 0.8             | V    |
| Backlight Supply Voltage    | V <sub>LED</sub> | -                       | 3.0                  | 3.1  | 3.2             | V    |
| Backlight Supply Current    | I <sub>LED</sub> | V <sub>LED</sub> = 3.1V | 10                   | 30   | 36              | mA   |

## Optical Characteristics

| Item                   | Symbol | Condition              | Min. | Typ. | Max. | Unit |
|------------------------|--------|------------------------|------|------|------|------|
| Optimal Viewing Angles | Top    | CR ≥ 2                 | -    | 20   | -    | °    |
|                        | Bottom |                        | -    | 40   | -    | °    |
|                        | Left   |                        | -    | 40   | -    | °    |
|                        | Right  |                        | -    | 40   | -    | °    |
| Contrast Ratio         | CR     | -                      | 2    | 6    | -    | -    |
| Response Time          | Rise   | T <sub>OP</sub> = 25°C | 150  | 200  | 300  | ms   |
|                        | Fall   |                        | 200  | 250  | 350  | ms   |

## Controller Information

Built-in ST7032 controller.

Please download specification at [http://www.newhavendisplay.com/app\\_notes/ST7032.pdf](http://www.newhavendisplay.com/app_notes/ST7032.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 | Instruction Execution Time   |            |            |         |
|----------------------------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------------|--|------------|------------|---------|
|                            | RS               | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |             | OSC=380kHz   | OSC=540kHz | OSC=700kHz |         |
| 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  | 1.08 ms    | 0.76 ms    | 0.59 ms |
| Return Home                | 0                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | X           | Set DDRAM Address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed. | 1.08 ms    | 0.76 ms    | 0.59 ms |
| Entry Mode Set             | 0                | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | I/D | S           | Sets cursor move direction and specifies display shift. These parameters are performed during data write and read.               | 26.3 μs    | 18.5 μs    | 14.3 μs |
| Display ON/OFF             | 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  | 26.3 μs    | 18.5 μs    | 14.3 μs |
| Function set               | 0                | 0   | 0   | 0   | 1   | DL  | N   | DH  | IS2 | IS1 |             | DL: Interface data is 8/4 bits<br>N: Number of lines is 2/1<br>DH: Double Height Font<br>IS 2-1: Instruction Table Select        | 26.3 μs    | 18.5 μs    | 14.3 μs |
| Set DDRAM Address          | 0                | 0   | 1   | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |             | Set DDRAM address in address counter.  | 26.3 μs    | 18.5 μs    | 14.3 μs |
| 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.           | 0          | 0          | 0       |
| Write data To Address      | 1                | 0   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  |             | Write data into internal RAM (DDRAM/CGRAM).  | 26.3 μs    | 18.5 μs    | 14.3 μs |
| Read data From RAM         | 1                | 1   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  |             | Read data from internal RAM (DDRAM/CGRAM/ICONRAM).   | 26.3 μs    | 18.5 μs    | 14.3 μs |

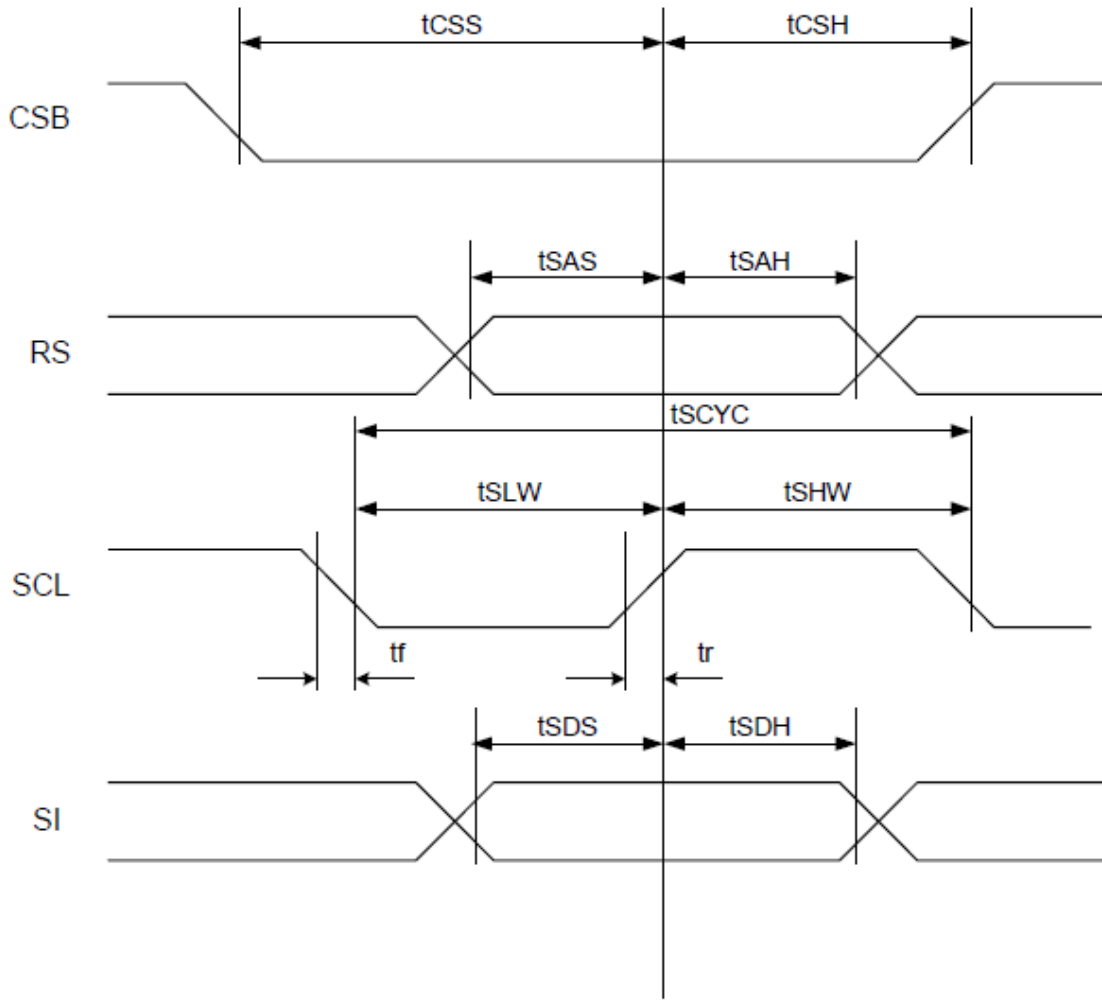
| Instruction Table 0 (IS[2:1] = [0,0]) |   |   |   |   |     |     |     |     |     |     |  |  |         |         |         |
|---------------------------------------|---|---|---|---|-----|-----|-----|-----|-----|-----|--|--|---------|---------|---------|
| Cursor or Display shift               | 0 | 0 | 0 | 0 | 0   | 1   | S/C | R/L | X   | X   |  | Sets cursor moving and display shift control bit, and the direction without changing DDRAM data. | 26.3 μs | 18.5 μs | 14.3 μs |
| Set CGRAM                             | 0 | 0 | 0 | 1 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |  | Set CGRAM address in address counter   | 26.3 μs | 18.5 μs | 14.3 μs |

| Instruction Table 1 (IS[2:1] = [0,1]) |   |   |   |   |   |   |     |                  |                  |                  |  |   |         |         |         |
|---------------------------------------|---|---|---|---|---|---|-----|------------------|------------------|------------------|--|---|---------|---------|---------|
| Internal OSC Frequency                | 0 | 0 | 0 | 0 | 0 | 1 | BS  | F2               | F1               | F0               |  | BS = 1 : 1/4 bias<br>BS= 0 : 1/5 bias<br>F2-0 : Adjust internal OSC frequency for FR frequency                | 26.3 μs | 18.5 μs | 14.3 μs |
| Set ICON Address                      | 0 | 0 | 0 | 1 | 0 | 0 | AC3 | AC2              | AC1              | AC0              |  | Set ICON address in address counter   | 26.3 μs | 18.5 μs | 14.3 μs |
| Power/ICON control/Contrast set       | 0 | 0 | 0 | 1 | 0 | 1 | Ion | Bon              | C5               | C4               |  | Ion: ICON display on/off<br>Bon: Set booster circuit on/off<br>C5,C4: Contrast set for internal follower mode | 26.3 μs | 18.5 μs | 14.3 μs |
| Follower Control                      | 0 | 0 | 0 | 1 | 1 | 0 | Fon | Rab <sub>2</sub> | Rab <sub>1</sub> | Rab <sub>0</sub> |  | Fon: Set follower circuit on/off<br>Rab 2-0: select follower amplified ratio                                  | 26.3 μs | 18.5 μs | 14.3 μs |
| Contrast Set                          | 0 | 0 | 0 | 1 | 1 | 1 | C3  | C2               | C1               | C0               |  | Contrast set for internal follower mode.  | 26.3 μs | 18.5 μs | 14.3 μs |

| Instruction Table 2 (IS[2:1] = [1,0]) |   |   |   |   |   |   |    |   |   |   |  |                                   |         |         |         |
|---------------------------------------|---|---|---|---|---|---|----|---|---|---|--|-----------------------------------|---------|---------|---------|
| Double Height Position Select         | 0 | 0 | 0 | 0 | 0 | 1 | UD | X | X | X |  | UD: Double height position Select | 26.3 μs | 18.5 μs | 14.3 μs |
| Reserved                              | 0 | 0 | 0 | 1 | X | X | X  | X | X | X |  | Do not use (Reserved for Test)    | 26.3 μs | 18.5 μs | 14.3 μs |

\*Instruction Table 3 (IS[2,1] = [1,1]): Do not use (Reserved for Test)

# Timing Characteristics



( $T_a = 25^\circ\text{C}$ )

| Item                | Signal | Symbol     | Condition | VDD=2.7 to 4.5V Rating |      | VDD=4.5 to 5.5V Rating |      | Units |
|---------------------|--------|------------|-----------|------------------------|------|------------------------|------|-------|
|                     |        |            |           | Min.                   | Max. | Min.                   | Max. |       |
| Serial Clock Period | SCL    | $t_{SCYC}$ | —         | 200                    | -    | 100                    | -    | ns    |
| SCL "H" pulse width |        | $t_{SHW}$  |           | 20                     | -    | 20                     | -    |       |
| SCL "L" pulse width |        | $t_{SLW}$  |           | 160                    | -    | 120                    | -    |       |
| SCL Rise/Fall time  | SCL    | $t_r, t_f$ | —         | -                      | 20   | -                      | 20   | ns    |
| Address setup time  | RS     | $t_{SAS}$  | —         | 10                     | -    | 10                     | -    | ns    |
| Address hold time   |        | $t_{SAH}$  |           | 250                    | -    | 150                    | -    |       |
| Data setup time     | SI     | $t_{SDS}$  | —         | 10                     | -    | 10                     | -    | ns    |
| Data hold time      |        | $t_{SDH}$  |           | 10                     | -    | 20                     | -    |       |
| CS-SCL time         | CS     | $t_{CSS}$  | —         | 20                     | -    | 20                     | -    | ns    |
|                     |        | $t_{CSH}$  |           | 350                    | -    | 200                    | -    |       |



# Built-In Font Table

ST7032-0D (ITO option OPR1=0, OPR2=0)

| b7-b4<br>b3-b0 | 0000                      | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|----------------|---------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 0000           | Replaced By CGRAM Pattern | À    | Á    | Â    | Ã    | Ä    | Å    | Æ    | Ç    | È    | É    | Ê    | Ë    | Ì    | Í    | Î    |
| 0001           |                           | Ï    | Ð    | Ñ    | Ò    | Ó    | Ô    | Õ    | Ö    | ×    | ¸    | ¹    | º    | »    | ¼    | ½    |
| 0010           |                           | ¾    | ¿    | À    | Á    | Â    | Ã    | Ä    | Å    | Æ    | Ç    | È    | É    | Ê    | Ë    | Ì    |
| 0011           |                           | Í    | Î    | Ï    | Ð    | Ñ    | Ò    | Ó    | Ô    | Õ    | Ö    | ×    | ¸    | ¹    | º    | »    |
| 0100           |                           | ¼    | ½    | ¾    | ¿    | À    | Á    | Â    | Ã    | Ä    | Å    | Æ    | Ç    | È    | É    | Ê    |
| 0101           |                           | Ë    | Ì    | Í    | Î    | Ï    | Ð    | Ñ    | Ò    | Ó    | Ô    | Õ    | Ö    | ×    | ¸    | ¹    |
| 0110           |                           | º    | »    | ¼    | ½    | ¾    | ¿    | À    | Á    | Â    | Ã    | Ä    | Å    | Æ    | Ç    | È    |
| 0111           |                           | É    | Ê    | Ë    | Ì    | Í    | Î    | Ï    | Ð    | Ñ    | Ò    | Ó    | Ô    | Õ    | Ö    | ×    |
| 1000           | Replaced By CGRAM Pattern | ¸    | ¹    | º    | »    | ¼    | ½    | ¾    | ¿    | À    | Á    | Â    | Ã    | Ä    | Å    |      |
| 1001           |                           | Æ    | Ç    | È    | É    | Ê    | Ë    | Ì    | Í    | Î    | Ï    | Ð    | Ñ    | Ò    | Ó    | Ô    |
| 1010           |                           | Õ    | Ö    | ×    | ¸    | ¹    | º    | »    | ¼    | ½    | ¾    | ¿    | À    | Á    | Â    | Ã    |
| 1011           |                           | Ä    | Å    | Æ    | Ç    | È    | É    | Ê    | Ë    | Ì    | Í    | Î    | Ï    | Ð    | Ñ    | Ò    |
| 1100           |                           | Ó    | Ô    | Õ    | Ö    | ×    | ¸    | ¹    | º    | »    | ¼    | ½    | ¾    | ¿    | À    | Á    |
| 1101           |                           | À    | Á    | Â    | Ã    | Ä    | Å    | Æ    | Ç    | È    | É    | Ê    | Ë    | Ì    | Í    | Î    |
| 1110           |                           | Ï    | Ð    | Ñ    | Ò    | Ó    | Ô    | Õ    | Ö    | ×    | ¸    | ¹    | º    | »    | ¼    | ½    |
| 1111           |                           | ¾    | ¿    | À    | Á    | Â    | Ã    | Ä    | Å    | Æ    | Ç    | È    | É    | Ê    | Ë    | Ì    |

## Example Initialization Program

```
void init()
//initialize the LCD
{
    P3 = 1;
    P1 = 1;
    RST = 0;                //RESET
    delay(2);
    RST = 1;                //end reset
    delay(20);
    Writecom(0x30);         //wake up
    delay(2);
    Call writecom(0x30);    //wake up
    Call writecom(0x30);    //wake up
    Call writecom(0x39);    //function set
    Call writecom(0x14);    //internal osc frequency
    Call writecom(0x56);    //power control
    Call writecom(0x6D);    //follower control
    Call writecom(0x70);    //contrast
    Call writecom(0x0C);    //display on
    Call writecom(0x06);    //entry mode
    Call writecom(0x01);    //clear
    delay(10);
}

void writecom(int d)
{
    CS = 0;                //CS
    RS = 0;                //A0 = Command
    for(serialcounter = 1; serialcounter <= 8; serialcounter++) //send 8 bits
    {
        if((d&0x80)==0x80) //get only the MSB
            SI=1;         //if 1, then SI=1
        else
            SI=0;         //if 0, then SI=0
        d=(d<<1);        //shift data byte left
        SCL = 0;
        SCL = 1;
        SCL = 0;         //SCL
    }
    CS = 1;
}

void writedata(int d)
{
    CS = 0;                //CS
    RS = 1;                //A0 = Data
    for(serialcounter = 1; serialcounter <= 8; serialcounter++) //send 8 bits
    {
        if((d&0x80)==0x80) //get only the MSB
            SI=1;         //if 1, then SI=1
        else
            SI=0;         //if 0, then SI=0
        d=(d<<1);        //shift data byte left
        SCL = 0;
        SCL = 1;
        SCL = 0;         //SCL
    }
    CS = 1;
}
```

## 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.                  | -20°C, 60min -> 25°C, 5min -> 70°C, 60min = 1 cycle<br>For 20 cycles             |      |
| Vibration test                        | Endurance test applying vibration to simulate transportation and use.   | 10-55Hz, 5G Acceleration.<br>60 sec in each of 3 directions X,Y,Z for 30 minutes | 3    |
| Static electricity test               | Endurance test applying electric static discharge.  | VS=8kV, RS=330Ω, CS=150pF<br>five times  |      |

**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)

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[DEM 16209 SBH-PW-N](#) [DEM 16210 SGH](#) [DEM 16214 FGH-PW](#) [DEM 16216 FDH-P\(RGB\)-N](#) [DEM16216SYH-LY](#) [DEM 16217 SYH-PY](#)  
[DEM 16221 SYH](#) [DEM 16221 SYH \(FFCF/TR\)/V](#) [DEM 16227 FGH-PW](#) [DEM 16227 SBH-PW-N](#) [DEM 16227 SYH-LY](#) [DEM 20231 SYH-](#)  
[PY-CYR22](#) [DEM 20232 SBH-PW-N](#)