

NHD-1.8-128160EF-SSXN-F

TFT (Thin-Film Transistor) Liquid Crystal Display Module

| | |
|---------|--|
| NHD- | Newhaven Display |
| 1.8- | 1.8" Diagonal |
| 128160- | 128 x 160 Pixels (Portrait Mode) |
| EF- | Model |
| S- | Built-in Controller, 3/4-wire Serial Interface |
| S- | Sunlight Readable |
| X- | TFT |
| N- | TN, 6:00 Optimal View, Wide Temperature |
| F- | FFC ZIF Connection Style |

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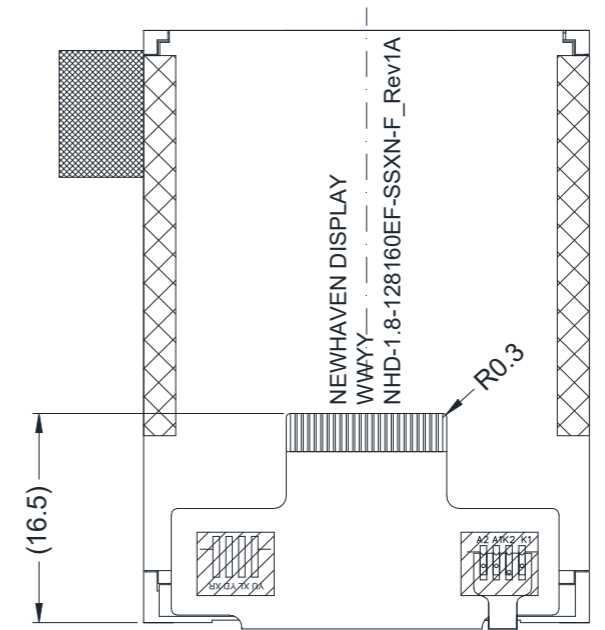
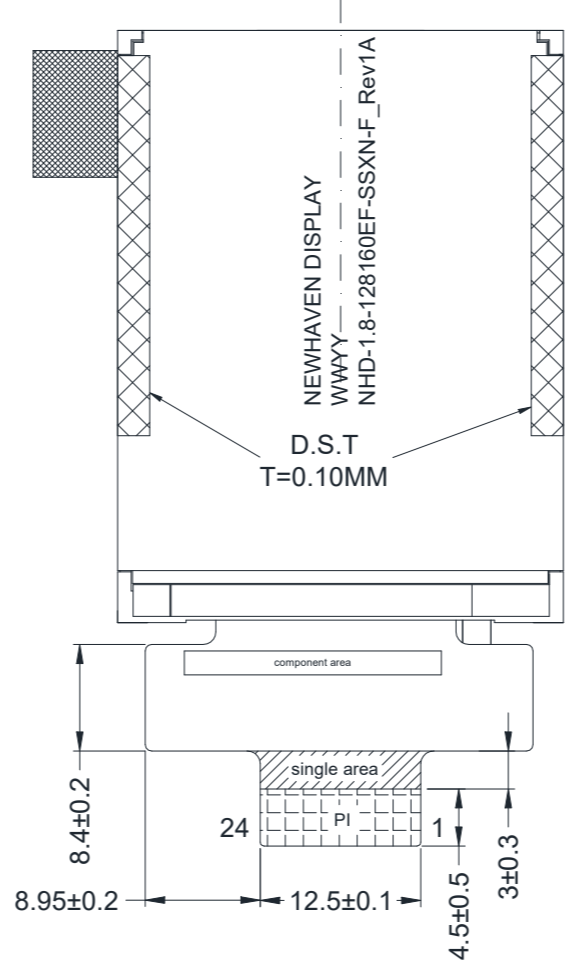
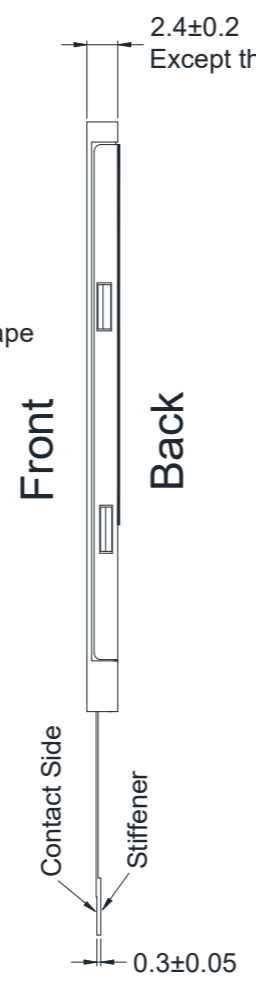
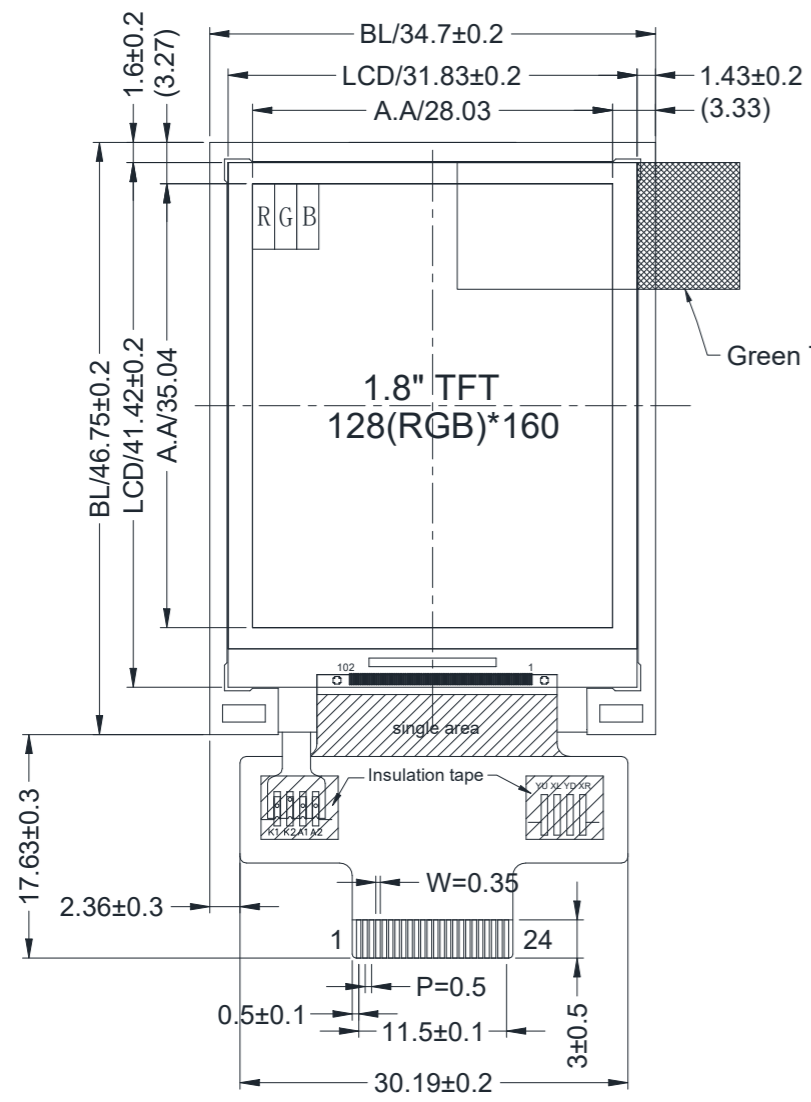
Document Revision History

| Revision | Date | Description | Changed by |
|----------|----------|--|------------|
| - | 2/27/19 | Initial Release | AS |
| 1 | 6/10/19 | Added MPU Interface Summary & Pinout Details | AS |
| 2 | 10/31/19 | Adjusted Viewing Angles | SB |

Functions and Features

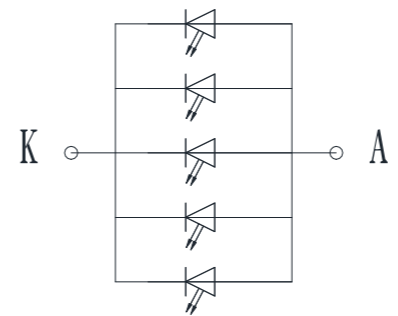
- 128 x 160 pixels (portrait mode)
- High brightness LED backlight
- Sunlight readable
- 2.8V power supply
- 3/4-wire serial MPU interface
- Built-in ILI9163V controller

| SYMBOL | REVISION | DATE |
|--------|----------|------|
| | | |



| Pin No. | Symbol |
|---------|-------------------|
| 1 | GND |
| 2 | IOV _{DD} |
| 3 | V _{DD} |
| 4 | /CS |
| 5 | /RST |
| 6 | SDIO |
| 7 | GND |
| 8 | D/C |
| 9 | SCL |
| 10 | GND |
| 11 | SPI4W |
| 12-16 | NC |
| 17 | LED-A |
| 18 | LED-K1 |
| 19 | LED-K2 |
| 20 | GND |
| 21-24 | NC |

- Notes:
- 1. Display Type: 1.8" TFT
 - 2. Display Mode: Transmissive / Normally White / Anti-glare
 - 3. Viewing Direction: 6:00
 - 4. Operating Voltage: 2.8V (TYP)
 - 5. Driver IC: ILI9163V
 - 6. Interface: 3/4-line SPI
 - 7. Backlight: White LED / 3.2V (TYP) / 100mA (TYP)
 - 8. Luminance: 1000 cd/m² (TYP)



STANDARD TOLERANCE: (UNLESS OTHERWISE SPECIFIED)

LINEAR: ±0.3mm

UNLESS OTHERWISE SPECIFIED: - DIMENSIONS ARE IN MILLIMETERS - THIRD ANGLE PROJECTION

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NEWHAVEN DISPLAY INTERNATIONAL

DRAWING/PART NUMBER: NHD-1.8-128160EF-SSXN-F

REVISION: 1A

SIZE: A3

SCALE: NS

SHEET 1 OF 1

Pin Description

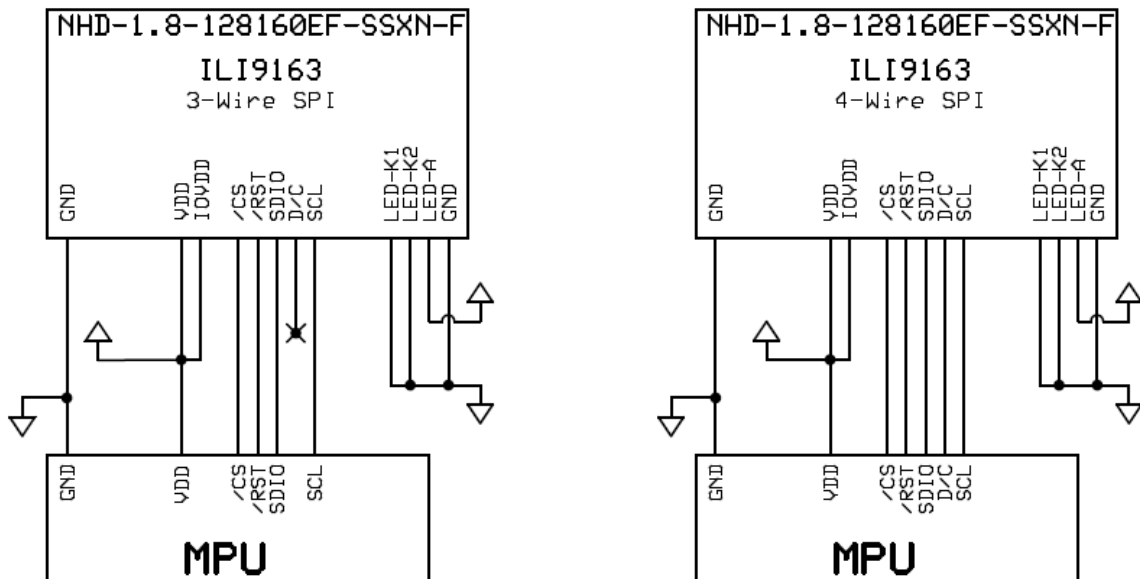
| Pin No. | Symbol | External Connection | Function Description |
|---------|-------------------|---------------------|--|
| 1 | GND | Power Supply | Ground |
| 2 | IOV _{DD} | Power Supply | Supply Voltage for Logic (2.8V) – Can be tied to VDD |
| 3 | V _{DD} | Power Supply | Supply Voltage for LCD (2.8V) |
| 4 | /CS | MPU | Active LOW Chip Select signal |
| 5 | /RST | MPU | Active LOW Reset signal |
| 6 | SDIO | MPU | Serial Data Input & Output signal |
| 7 | GND | Power Supply | Ground |
| 8 | D/C | MPU | Data / Command selection 4-wire Serial: '1' = Data ; '0' = Command 3-wire Serial: Ground |
| 9 | SCL | MPU | Serial Clock signal |
| 10 | GND | Power Supply | Ground |
| 11 | SPI4W | MPU | SPI4W: '1' = 4-wire SPI ; '0' = 3-wire SPI (default) |
| 12-16 | NC | - | No Connect |
| 17 | LED-A | Power Supply | Backlight Anode |
| 18 | LED-K1 | Power Supply | Backlight Cathode |
| 19 | LED-K2 | Power Supply | Backlight Cathode |
| 20 | GND | Power Supply | Ground |
| 21-24 | NC | - | No Connect |

Recommended LCD connector: 24pin 0.5mm FFC connector. Molex P/N: 52435-2471

MPU Interface Pin Assignment Summary

| | Pin 4 (/CS) | Pin 6 (SDIO) | Pin 8 (D/C) | Pin 9 (SCL) | Pin 11 (SPI4W) |
|-----------------------------|-------------|-----------------|--------------|--------------|----------------|
| 3-wire SPI (default) | Chip Select | Serial Data I/O | Tie LOW | Serial Clock | 0 |
| 4-wire SPI | Chip Select | Serial Data I/O | Data/Command | Serial Clock | 1 |

Wiring Diagram



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 for LCD | V _{DD} | - | 2.5 | 2.8 | 3.3 | V |
| Supply Voltage for Logic | IOV _{DD} | - | 1.65 | 2.8 | 3.3 | V |
| Supply Current | I _{DD} | V _{DD} = 2.8V | 1 | 3 | 5 | mA |
| "H" Level input | V _{IH} | - | 0.7*IOV _{DD} | - | IOV _{DD} | V |
| "L" Level input | V _{IL} | - | GND | - | 0.3*IOV _{DD} | V |
| "H" Level output | V _{OH} | - | 0.8*IOV _{DD} | - | IOV _{DD} | V |
| "L" Level output | V _{OL} | - | GND | - | 0.2*IOV _{DD} | V |
| Backlight Supply Current | I _{LED} | - | 75 | 100 | 125 | mA |
| Backlight Supply Voltage | V _{LED} | I _{LED} = 100mA | 2.8 | 3.2 | 3.4 | V |
| Backlight Lifetime* | - | I _{LED} = 100mA T _{OP} = 25°C | 20,000 | 30,000 | - | Hrs. |

*Backlight lifetime is rated as Hours until **half-brightness**, under normal operating conditions. The LED of the backlight is driven by current drain; drive voltage is for reference only. Drive voltage must be selected to ensure backlight current drain is below MAX level stated.

Optical Characteristics

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit | | |
|------------------------|----------------|--------------------------------|------------------------|-------|-------|-------------------|----|----|
| Optimal Viewing Angles | Top | φY+ | CR ≥ 10 | - | 40 | - | ° | |
| | Bottom | φY- | | - | 60 | - | ° | |
| | Left | θX- | | - | 60 | - | ° | |
| | Right | θX+ | | - | 60 | - | ° | |
| Contrast Ratio | CR | - | 400 | 500 | - | - | | |
| Luminance | L _V | I _{LED} =100mA | 800 | 1000 | - | cd/m ² | | |
| Response Time | Rise + Fall | T _R +T _F | T _{OP} = 25°C | | - | 20 | 30 | ms |
| Chromaticity | Red | X _R | - | 0.559 | 0.609 | 0.659 | | |
| | | Y _R | | 0.315 | 0.365 | 0.415 | | |
| | Green | X _G | | 0.241 | 0.291 | 0.341 | | |
| | | Y _G | | 0.573 | 0.623 | 0.673 | | |
| | Blue | X _B | | 0.095 | 0.145 | 0.195 | | |
| | | Y _B | | 0.042 | 0.092 | 0.142 | | |
| | White | X _W | | 0.240 | 0.290 | 0.340 | | |
| | | Y _W | | 0.290 | 0.340 | 0.390 | | |

Controller Information

Built-in ILI9163V controller.

Please download specification at <https://www.newhavendisplay.com/appnotes/datasheets/LCDs/ILI9163V.pdf>

Table of Commands

| Hex Code | Command | Description | Number of Parameters | Display Architecture Implementation Requirement | | |
|----------|-----------------------|---|----------------------|---|--------|--------|
| | | | | Type 1 | Type 2 | Type 3 |
| 00h | nop | No Operation | 0 | Yes | Yes | Yes |
| 01h | soft_reset | Software Reset | 0 | Yes | Yes | Yes |
| 06h | get_red_channel | Get the red component of the pixel at (0, 0). | 1 | No | Yes | Yes |
| 07h | get_green_channel | Get the green component of the pixel at (0, 0). | 1 | No | Yes | Yes |
| 08h | get_blue_channel | Get the blue component of the pixel at (0, 0). | 1 | No | Yes | Yes |
| 0Ch | get_pixel_format | Get the current pixel format. | 1 | Yes | Yes | Yes |
| 0Ah | get_power_mode | Get the current power mode. | 1 | Yes | Yes | Yes |
| 0Bh | get_address_mode | Get the frame memory to the display panel read order. | 1 | Yes | Yes | Yes |
| 0Dh | get_display_mode | Get the current display mode from the peripheral. | 1 | Yes | Yes | Yes |
| 0Eh | get_signal_mode | Get display module signaling mode. | 1 | Yes | Yes | Yes |
| 0Fh | get_diagnostic_result | Get Peripheral Self-Diagnostic Result | 1 | Yes | Yes | Yes |
| 10h | enter_sleep_mode | Power for the display panel is off. | 0 | Yes | Yes | Yes |
| 11h | exit_sleep_mode | Power for the display panel is on. | 0 | Yes | Yes | Yes |
| 12h | enter_partial_mode | Part of the display area is used for image display. | 0 | Yes | Yes | No |
| 13h | enter_normal_mode | The whole display area is used for image display. | 0 | Yes | Yes | No |
| 20h | exit_invert_mode | Displayed image colors are not inverted. | 0 | Yes | Yes | Yes |
| 21h | enter_invert_mode | Displayed image colors are inverted. | 0 | Yes | Yes | Yes |
| 26h | set_gamma_curve | Selects the gamma curve used by the display device. | 1 | Yes | Yes | Yes |
| 28h | set_display_off | Blanks the display device. | 0 | Yes | Yes | Yes |
| 29h | set_display_on | Show the image on the display device. | 0 | Yes | Yes | Yes |
| 2Ah | set_column_address | Set the column extent. | 4 | Yes | Yes | No |
| 2Bh | set_page_address | Set the page extent. | 4 | Yes | Yes | No |
| 2Ch | write_memory_start | Transfer image data from the Host Processor to the peripheral starting at the location provided by set_column_address and set_page_address. | Variable | Yes | Yes | No |
| 2Dh | write_LUT | Fills the peripheral look-up table with the provided data. | Variable | optional | No | No |
| 2Eh | read_memory_start | Transfer image data from the peripheral to the Host Processor interface starting at the location provided by set_column_address and set_page_address. | Variable | Yes | Yes | No |
| 30h | set_partial_area | Defines the partial display area on the display device. | 4 | Yes | Yes | No |
| 33h | set_scroll_area | Defines the vertical scrolling and fixed area on display device. | 6 | Yes | No | No |
| 34h | set_tear_off | Synchronization information is not sent from the display module to the host processor. | 0 | Yes | No | No |
| 35h | set_tear_on | Synchronization information is sent from the display module to the host processor at the start of VFP. | 1 | Yes | No | No |

| | | | | | | |
|-----|-----------------------|--|----------|-----|-----|-----|
| 36h | set_address_mode | Set the read order from frame memory to the display panel. | 1 | Yes | Yes | Yes |
| 37h | set_scroll_start | Defines the vertical scrolling starting point. | 2 | Yes | No | No |
| 38h | exit_idle_mode | Full color depth is used on the display panel. | 0 | Yes | No | No |
| 39h | enter_idle_mode | Reduced color depth is used on the display panel. | 0 | Yes | No | No |
| 3Ah | set_pixel_format | Defines how many bits per pixel are used in the interface. | 1 | Yes | Yes | Yes |
| 3Ch | write_memory_continue | Transfer image information from the Host Processor interface to the peripheral from the last written location. | Variable | Yes | Yes | No |
| 3Eh | read_memory_continue | Read image data from the peripheral continuing after the last read_memory_continue or read_memory_start. | Variable | Yes | Yes | No |
| 44h | set_tear_scanline | Synchronization information is sent from the display module to the host processor when the display device refresh reaches the provided scanline. | 2 | Yes | No | No |
| 45h | get_scanline | Get the current scanline. | 2 | Yes | Yes | No |
| Dah | Read ID1 | | | | | |
| DBh | Read ID2 | | | | | |
| DCh | Read ID3 | | | | | |

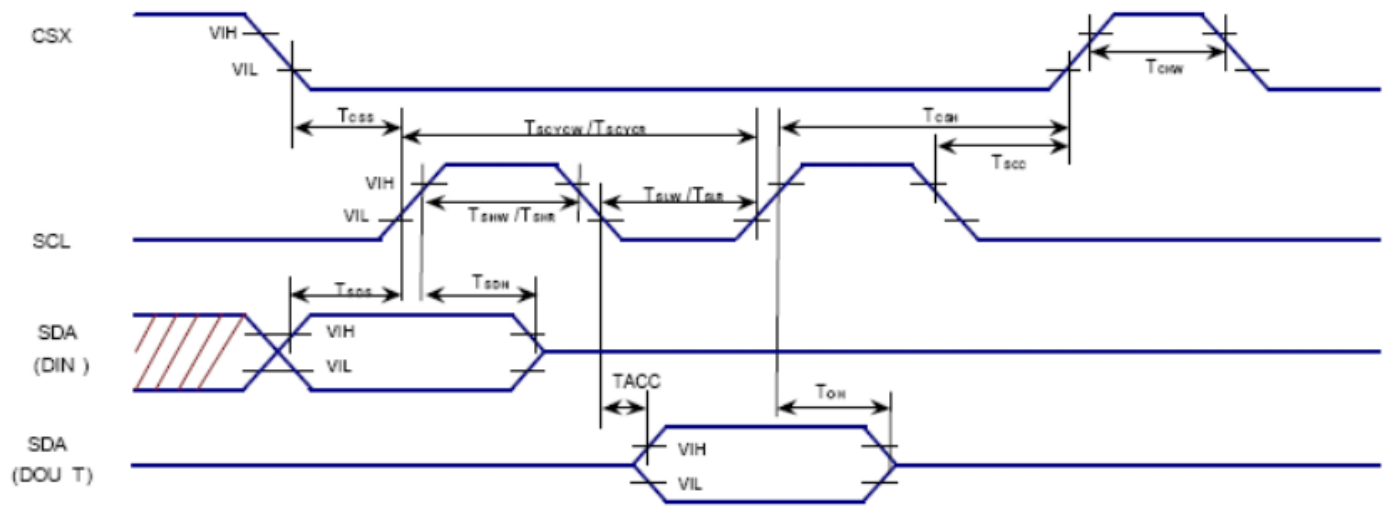
Notes:

1. There will be no abnormal visible effects on the display when S/W or H/W Reset are applied.
2. After Powered-On Reset finishes within 10 μ s after both VDD & VDDI are applied.
3. Mode 1 means Tearing Effect Output Line consists of V-Blanking Information only.

For Command Descriptions, please see: <https://www.newhavendisplay.com/appnotes/datasheets/LCDs/ILI9163V.pdf>

Timing Characteristics

3-wire Serial Interface:



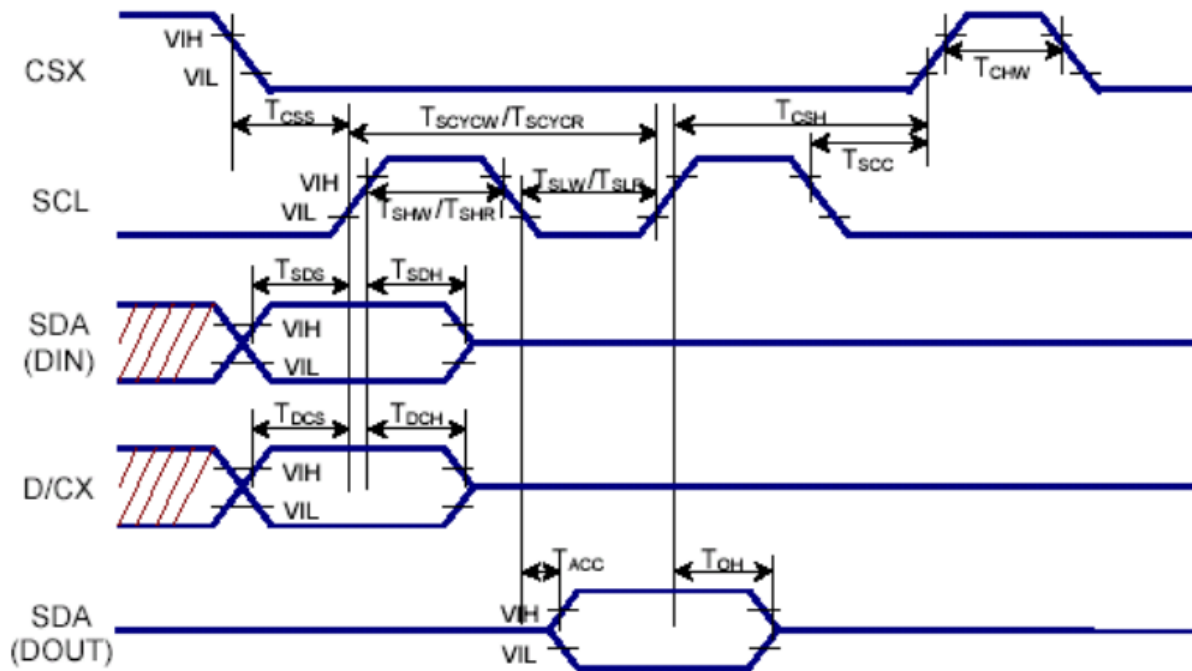
| Signal | Symbol | Parameter | MIN | MAX | Unit | Description |
|---------------------|--------|----------------------------|-----|-----|------|-----------------------|
| CSX | TCSS | Chip select setup time | 15 | | ns | |
| | TCSH | Chip select hold time | 60 | | ns | |
| | TCHW | Chip select setup time | 40 | | ns | |
| SCL | TSCYCW | Serial clock cycle(Write) | 66 | | ns | |
| | TSHW | S"L""H" pulse width(Write) | 1 | | ns | |
| | TSLW | S"L""L" pulse width(Write) | 15 | | ns | |
| | TSCYCR | Serial clock cycle(Read) | 150 | | ns | |
| | TSHR | S"L""H" pulse width(Read) | 60 | | ns | |
| | TSLR | S"L""L" pulse width(Read) | 60 | | ns | |
| SDA(DIN) (DOU T) | TSDS | Data setup time | 10 | | ns | |
| | TSDH | Data hold time | 10 | | ns | |
| | TACC | Access time | 10 | 50 | ns | For maximum CL = 30pF |
| | TOH | Output disable time | 15 | | ns | For minimum CL = 8pF |

Note 1: VDDI=1.65 to 3.3V, VDD=2.6 to 3.3V, AGND=GND=0V. Ta=-30 to 70°C (to +85°C no damage)

Note 2 : The input signal rise time and fall time(tr, tf) is specified at 15 ns or less.

Logic high and low levels are specified as 10% and 90% of VDDI for Input signals.

4-wire Serial Interface



| Signal | Symbol | Parameter | MIN | MAX | Unit | Description |
|---------------------|-------------|-----------------------------|-----|-----|------|--------------------------------|
| CSX | T_{CSS} | Chip select setup time | 15 | | ns | |
| | T_{CSH} | Chip select hold time | 60 | | ns | |
| | T_{CHW} | Chip select setup time | 40 | | ns | |
| SCL | T_{SCYCW} | Serial clock cycle (Write) | 66 | | ns | |
| | T_{SHW} | S"L""H" pulse width (Write) | 1 | | ns | |
| | T_{SLW} | S"L""L" pulse width (Write) | 15 | | ns | |
| | T_{SCYCR} | Serial clock cycle (Read) | 150 | | ns | |
| | T_{SHR} | S"L""H" pulse width (Read) | 60 | | ns | |
| | T_{SLR} | S"L""L" pulse width (Read) | 60 | | ns | |
| D/CX | T_{DCS} | D/CX setup time | 7 | | ns | |
| | T_{DCH} | D/CX hold time | 7 | | ns | |
| SDA (DIN) (DOUT) | T_{SDS} | Data setup time | 10 | | ns | |
| | T_{SDH} | Data hold time | 10 | | ns | |
| | T_{ACC} | Access time | 10 | 50 | ns | For maximum $CL = 30\text{pF}$ |
| | T_{OH} | Output disable time | 15 | | ns | For minimum $CL = 8\text{pF}$ |

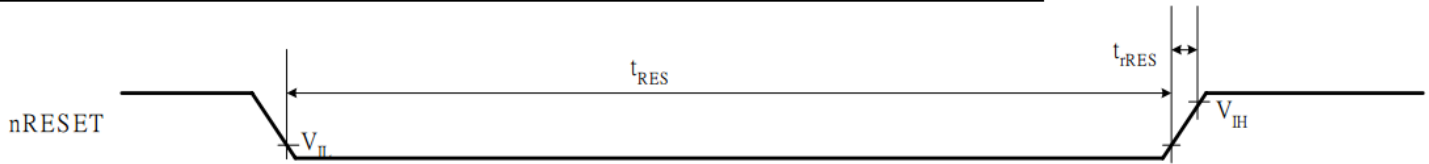
Note 1: $V_{DDI}=1.65$ to 3.3V , $V_{DD}=2.6$ to 3.3V , $AGND=GND=0\text{V}$. $T_a=-30$ to 70°C (to $+85^\circ\text{C}$ no damage)

Note 2 : The input signal rise time and fall time (t_r , t_f) is specified at 15 ns or less.

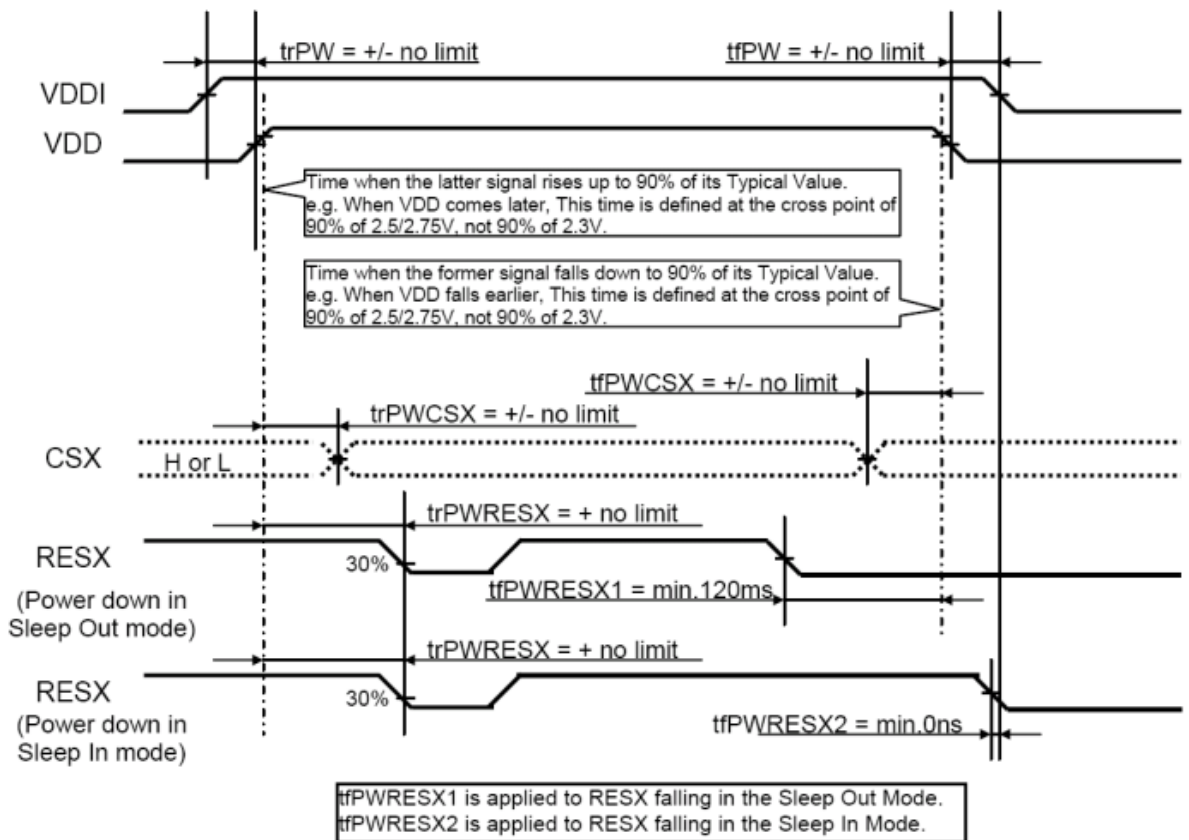
Logic high and low levels are specified as 10% and 90% of V_{DDI} for Input signals.

Reset Timing

| Item | Symbol | Unit | Min. | Typ. | Max. |
|-----------------------|------------|---------|------|------|------|
| Reset low-level width | t_{RES} | ms | 1 | - | - |
| Reset rise time | t_{rRES} | μ s | - | - | 10 |



Power ON/OFF Sequence



Note: Unless otherwise specified, timings herein show cross point at 50% of signal/power level.

Example Program Code

```
*****/
*      Initialization and Setup Routine for 3-Line & 4-Line      *
*****/
```

```
void setup()
{
  DDRB = 0xFF;           //Enable All outputs on PortB
  PORTB = 0x00;
  DDRD = 0xFF;           //Enable All outputs on PortD
  PORTD = 0x00;
  DDRD |= (1<<DDD6);     //SDIO = 1
  DDRD |= (1<<DDD7);     //SCL = 1
  digitalWrite(RST, LOW);
  delay(150);
  digitalWrite(RST, HIGH);
  delay(150);
  command(0x11);         //exit SLEEP mode
  delay(100);
  command(0x28);         //display off
  command(0x26);         //select gamma curve
  data(0x04);

  command(0xB1);         //frame rate control
  data(0x0A);
  data(0x14);

  command(0xC0);         //power control 1
  data(0x0A);
  data(0x00);

  command(0xC1);         //power control 2
  data(0x02);

  command(0xC5);         //VCOM control 1
  data(0x2F);
  data(0x3E);

  command(0xC7);         //VCOM control 2
  data(0x40);

  command(0x2A);         //column address set
  data(0x00);

  data(0x00);           //start 0x0000
  data(0x00);

  data(0x7F);           //end 0x007F
  command(0x2B);         //page address set
  data(0x00);
  data(0x00);           //start 0x0000
  data(0x00);
  data(0x9F);           //end 0x009F

  command(0x36);         //memory access control
  data(0xC0);           //C0 = RGB; C8 = BGR
  command(0x3A);         //pixel format = 18 bit per pixel
  data(0x06);

  command(0x29);         //display ON
  delay(10);
}
```

3-line Serial Interface

```
/******  
*           Functions           *  
*****/  
  
void command(unsigned char c) //9-bit Transmission  
{  
    digitalWrite(CS, LOW);           ///CS = 0  
    PORTD &= ~(1<<PORTD6);           //SDIO = 0 (Set D/C bit LOW for Command)  
    PORTD &= ~(1<<PORTD7);           //SCL = 0  
    PORTD |= (1<<PORTD7);            //SCL = 1  
    PORTD &= ~(1<<PORTD7);           //SCL = 0  
    for (int i=0;i<8;i++)  
    {  
        if((c & 0x80)== 0x80)         //Send MSB  
            PORTD |= (1<<PORTD6);     //SDIO = 1  
        else  
            PORTD &= ~(1<<PORTD6);     //SDIO = 0  
        c = (c<<1);  
        PORTD &= ~(1<<PORTD7);         //SCL = 0  
        PORTD |= (1<<PORTD7);          //SCL = 1  
        PORTD &= ~(1<<PORTD7);         //SCL = 0  
    }  
    digitalWrite(CS, HIGH);           ///CS = 1  
}
```

```
void data(unsigned char d) //9-bit Transmission  
{  
    digitalWrite(CS, LOW);           ///CS = 0  
    PORTD |= (1<<PORTD6);           //SDIO = 1 (Set D/C bit HIGH for Data)  
    PORTD &= ~(1<<PORTD7);           //SCL = 0  
    PORTD |= (1<<PORTD7);            //SCL = 1  
    PORTD &= ~(1<<PORTD7);           //SCL = 0  
    for (int i=0;i<8;i++)  
    {  
        if((d & 0x80)== 0x80)         //Send MSB  
            PORTD |= (1<<PORTD6);     //SDIO = 1  
        else  
            PORTD &= ~(1<<PORTD6);     //SDIO = 0  
        d = (d<<1);  
        PORTD &= ~(1<<PORTD7);         //SCL = 0  
        PORTD |= (1<<PORTD7);          //SCL = 1  
        PORTD &= ~(1<<PORTD7);         //SCL = 0  
    }  
    digitalWrite(CS, HIGH);           ///CS = 1  
}
```

4-line Serial Interface

```
/******  
*           Functions           *  
*****/
```

```
void command(unsigned char c) //8-bit Transmission  
{  
    digitalWrite(CS, LOW);           ///CS = 0  
    digitalWrite(DC, LOW);          //D/C = 0  
    for (int i=0;i<8;i++)  
    {  
        if((c & 0x80)== 0x80)       //Send MSB  
            PORTD |= (1<<PORTD6);   //SDIO = 1  
        else  
            PORTD &= ~(1<<PORTD6);  //SDIO = 0  
        c = (c<<1);  
        PORTD &= ~(1<<PORTD7);      //SCL = 0  
        PORTD |= (1<<PORTD7);       //SCL = 1  
        PORTD &= ~(1<<PORTD7);      //SCL = 0  
    }  
    digitalWrite(CS, HIGH);         ///CS = 1  
}
```

```
void data(unsigned char d) //8-bit Transmission  
{  
    digitalWrite(CS, LOW);           ///CS = 0  
    digitalWrite(DC, HIGH);          //D/C = 1  
    for (int i=0;i<8;i++)  
    {  
        if((d & 0x80)== 0x80)       //Send MSB  
            PORTD |= (1<<PORTD6);   //SDIO = 1  
        else  
            PORTD &= ~(1<<PORTD6);  //SDIO = 0  
        d = (d<<1);  
        PORTD &= ~(1<<PORTD7);      //SCL = 0  
        PORTD |= (1<<PORTD7);       //SCL = 1  
        PORTD &= ~(1<<PORTD7);      //SCL = 0  
    }  
    digitalWrite(CS, HIGH);         ///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. | +50°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 -> 70°C,60min = 1 cycle, 20 cycles. | |
| Vibration test | Endurance test applying vibration to simulate transportation and use. | 10-50Hz, 1.5mm amplitude. Acceleration of gravity: 5G 30 min in each of 3 directions X, Y, Z | 3 |
| Static electricity test | Endurance test applying electric static discharge. | VS=4KV, RS=330Ω, CS=150pF 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

Warranty Information

See Terms & Conditions at http://www.newhavendisplay.com/index.php?main_page=terms