

# NHD-1.8-128160EF-SSXN-FT

## TFT (Thin-Film-Transistor) Color Liquid Crystal Display Module

|         |                                                |
|---------|------------------------------------------------|
| NHD-    | Newhaven Display                               |
| 1.8-    | 1.8" Diagonal                                  |
| 128160- | 128xRGBx160 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-      | FCC ZIF Connection Style                       |
| T-      | 4-Wire Resistive Touch Panel                   |

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## Document Revision History

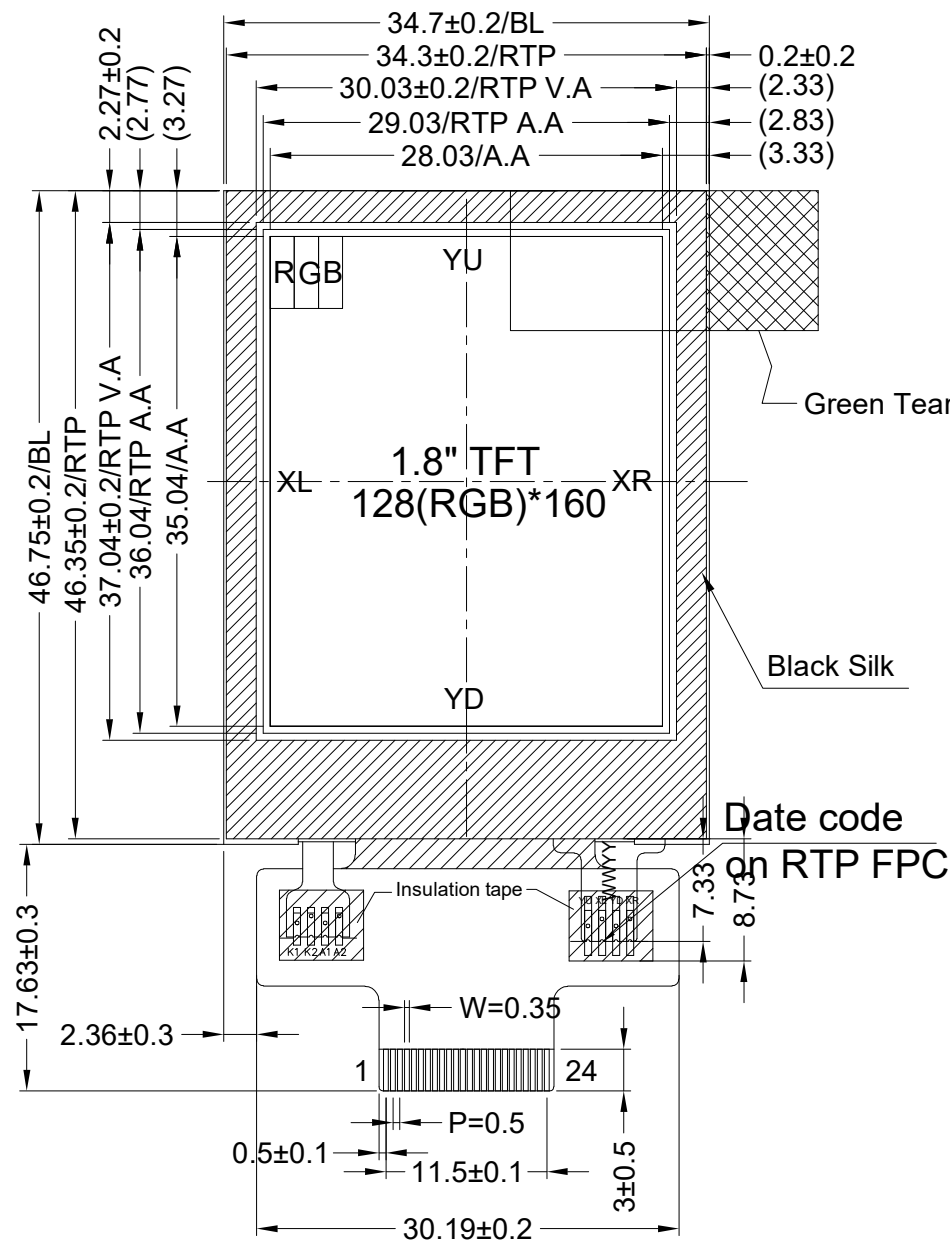
| Revision | Date     | Description                                                                                                                                          | Changed by |
|----------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| -        | 08/06/19 | Initial Release                                                                                                                                      | PK         |
| 1        | 10/31/19 | Adjusted Viewing Angles                                                                                                                              | SB         |
| 2        | 6/26/20  | FPC Redesign: Pin 12 changed from NC to TE.<br>Updated Response Times, Chromaticity Values & Touch<br>Panel Characteristics<br>P/N Upgraded to Rev1B | AS         |
| 3        | 1/13/21  | Updated 2D Mechanical Drawing & Quality Information                                                                                                  | AS         |
| 4        | 3/9/21   | 2D Mechanical Drawing Redesign                                                                                                                       | AS         |

## Functions and Features

- 128xRGBx160 resolution (portrait mode)
- High brightness LED backlight
- 3/4-wire serial interface
- Sunlight readable
- 4-wire resistive touch panel
- Built-in ILI9163V controller

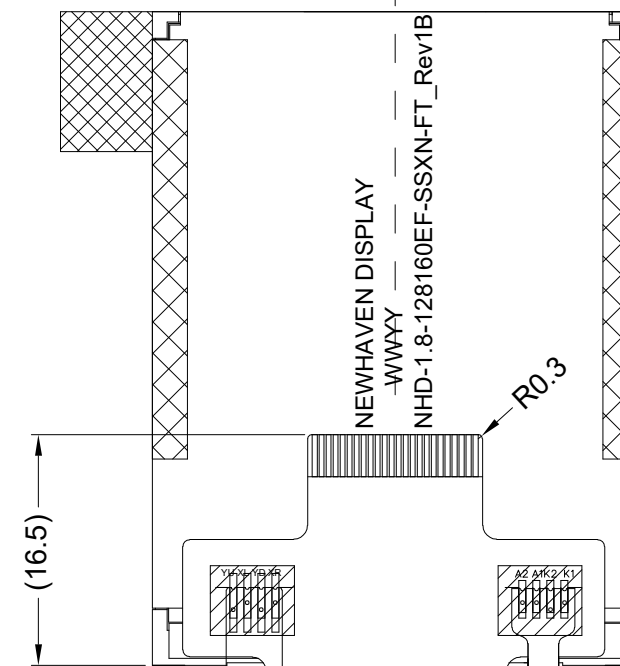
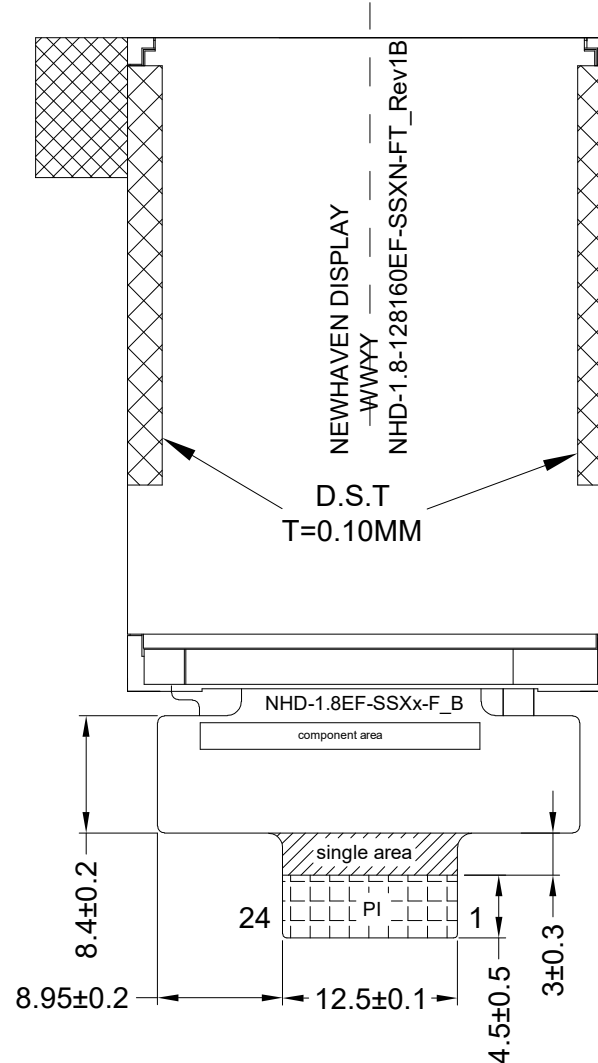
# Mechanical Drawing

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



Front

Back

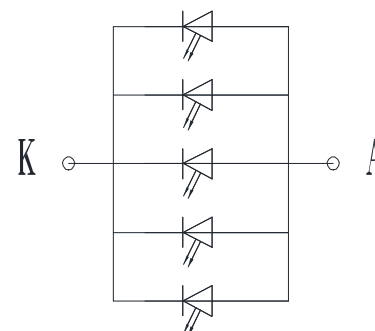


## TFT Pinout:

| Pin No. | Symbol |
|---------|--------|
| 1       | GND    |
| 2       | IOVDD  |
| 3       | VDD    |
| 4       | /CS    |
| 5       | /RST   |
| 6       | SDIO   |
| 7       | GND    |
| 8       | D/C    |
| 9       | SCL    |
| 10      | GND    |
| 11      | SPI4W  |
| 12      | TE     |
| 13      | NC     |
| 14      | NC     |
| 15      | NC     |
| 16      | NC     |
| 17      | LED-A  |
| 18      | LED-K1 |
| 19      | LED-K2 |
| 20      | GND    |
| 21      | YU     |
| 22      | XL     |
| 23      | YD     |
| 24      | XR     |

## Notes:

- Display Size: 1.77" TFT
- Optimal View: 6:00
- Display Mode: Transmissive /Normal White / Anti-Glare
- Driver IC: ILI9163V
- Supply Voltage: 2.8 V
- Backlight: White LED / 3.2 V / 100 mA (Typ)
- Luminance: 850 cd/m<sup>2</sup> (Typ)
- Touch Panel: 4-Wire Resistive



|                                                                                                                                                                                                                       |                                                         |                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|-------------------------------------------------|
| <b>Standard Tolerance:</b><br>(Unless otherwise specified)                                                                                                                                                            | <b>NEWHAVEN DISPLAY</b><br>INTERNATIONAL                |                                                 |
| Linear: ±0.3mm                                                                                                                                                                                                        | Drawing/Part Number:<br><b>NHD-1.8-128160EF-SSXN-FT</b> | Revision:<br>1B                                 |
| <b>Unless otherwise specified:</b><br>• Dimensions are in Millimeters<br>• Third Angle Projection                                                                                                                     | Drawn By: A. Shah<br>Drawn Date: 3/5/2021               | Approved By: A. Shah<br>Approved Date: 3/5/2021 |
|                                                                                                                                                                                                                       | Do Not Scale Drawing                                    |                                                 |
|                                                                                                                                                                                                                       | Sheet 1 of 1                                            |                                                 |
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## Pin Description

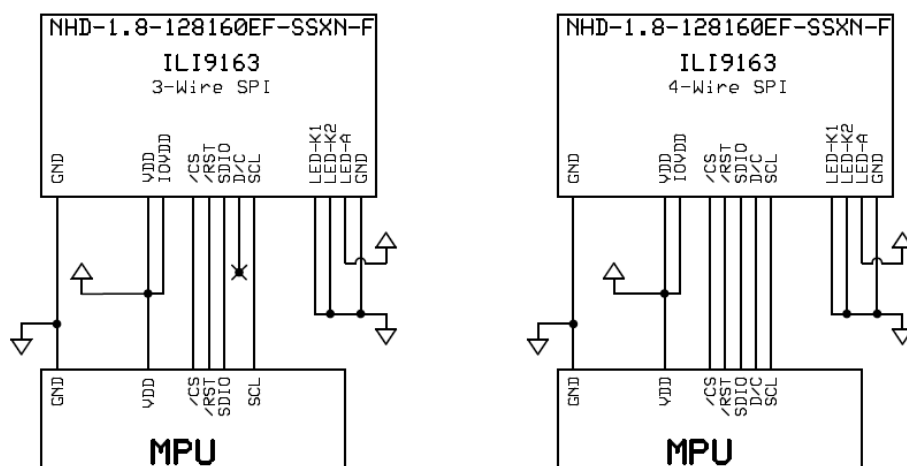
| Pin No. | Symbol            | External Connection | Function Description                                                                                                |
|---------|-------------------|---------------------|---------------------------------------------------------------------------------------------------------------------|
| 1       | GND               | Power Supply        | Ground                                                                                                              |
| 2       | IOV <sub>DD</sub> | Power Supply        | Supply Voltage for Logic (2.8V) – Can be tied to VDD                                                                |
| 3       | V <sub>DD</sub>   | 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<br>4-wire Serial: '1' = Data; '0' = Command<br>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      | TE                | MPU                 | Tearing Effect output pin to synchronize MCU to frame writing.<br>If not used, leave this pin floating (No Connect) |
| 13-16   | NC                | -                   | No Connect                                                                                                          |
| 17      | LED-A             | Power Supply        | Backlight Anode (100mA @ 3.2V)                                                                                      |
| 18      | LED-K1            | Power Supply        | Backlight Cathode                                                                                                   |
| 19      | LED-K2            | Power Supply        | Backlight Cathode                                                                                                   |
| 20      | GND               | Power Supply        | Ground                                                                                                              |
| 21      | YU                | Touch Controller    | Touch Panel – Up                                                                                                    |
| 22      | XL                | Touch Controller    | Touch Panel – Left                                                                                                  |
| 23      | YD                | Touch Controller    | Touch Panel – Down                                                                                                  |
| 24      | XR                | Touch Controller    | Touch Panel – Right                                                                                                 |

**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) |
|-----------------------------|-------------|-----------------|--------------|--------------|----------------|
| <b>3-wire SPI (default)</b> | Chip Select | Serial Data I/O | Tie LOW      | Serial Clock | 0              |
| <b>4-wire SPI</b>           | 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 <sub>OP</sub>   | Absolute Max                                       | -20                   | -      | +70                   | °C   |
| Storage Temperature Range   | T <sub>ST</sub>   | Absolute Max                                       | -30                   | -      | +80                   | °C   |
| Supply voltage for LCD      | V <sub>DD</sub>   | -                                                  | 2.5                   | 2.8    | 3.3                   | V    |
| Supply voltage for Logic    | IOV <sub>DD</sub> | -                                                  | 1.65                  | 2.8    | 3.3                   | V    |
| Supply Current              | I <sub>DD</sub>   | V <sub>DD</sub> = 2.8V                             | 1                     | 3      | 5                     | mA   |
| "H" Level input             | V <sub>IH</sub>   | -                                                  | 0.7*IOV <sub>DD</sub> | -      | IOV <sub>DD</sub>     | V    |
| "L" Level input             | V <sub>IL</sub>   | -                                                  | GND                   | -      | 0.3*IOV <sub>DD</sub> | V    |
| "H" Level output            | V <sub>OH</sub>   | -                                                  | 0.8*IOV <sub>DD</sub> | -      | IOV <sub>DD</sub>     | V    |
| "L" Level output            | V <sub>OL</sub>   | -                                                  | GND                   | -      | 0.2*IOV <sub>DD</sub> | V    |
|                             |                   |                                                    |                       |        |                       |      |
| Backlight Supply Current    | I <sub>LED</sub>  | -                                                  | -                     | 100    | 125                   | mA   |
| Backlight Supply Voltage    | V <sub>LED</sub>  | I <sub>LED</sub> = 100mA<br>T <sub>OP</sub> = 25°C | 2.8                   | 3.2    | 3.4                   | V    |
| Backlight Lifetime*         | -                 |                                                    | 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 <sub>V</sub>                 | I <sub>LED</sub> =100mA | 680   | 850   | -     | cd/m <sup>2</sup> |
| Response Time          | Rise + Fall | T <sub>R</sub> +T <sub>F</sub> | T <sub>OP</sub> = 25°C  | -     | 8     | 16    | ms                |
| Chromaticity           | Red         | X <sub>R</sub>                 | -                       | 0.553 | 0.603 | 0.653 |                   |
|                        |             | Y <sub>R</sub>                 |                         | 0.322 | 0.372 | 0.422 |                   |
|                        | Green       | X <sub>G</sub>                 |                         | 0.268 | 0.318 | 0.368 |                   |
|                        |             | Y <sub>G</sub>                 |                         | 0.544 | 0.594 | 0.644 |                   |
|                        | Blue        | X <sub>B</sub>                 |                         | 0.089 | 0.139 | 0.189 |                   |
|                        |             | Y <sub>B</sub>                 |                         | 0.054 | 0.104 | 0.154 |                   |
|                        | White       | X <sub>W</sub>                 |                         | 0.255 | 0.305 | 0.355 |                   |
|                        |             | Y <sub>W</sub>                 |                         | 0.300 | 0.350 | 0.400 |                   |

## Touch Panel Characteristics

| Item                        | Min.      | Typ. | Max. | Unit       |
|-----------------------------|-----------|------|------|------------|
| Linearity                   | -1.5      | -    | 1.5  | %          |
| Circuit Resistance – X-Axis | 150       | -    | 550  | $\Omega$   |
| Circuit Resistance – Y-Axis | 250       | -    | 800  | $\Omega$   |
| Insulation Resistance       | 20        | -    | -    | M $\Omega$ |
| Operating Voltage           | -         | -    | 5    | V          |
| Chattering                  | -         | -    | 15   | ms         |
| Activation Force            | 20        | -    | 80   | g          |
| Pen Writing Durability      | 20,000    | -    | -    | Characters |
| Pitting Durability          | 1,000,000 | -    | -    | Touches    |
| Surface Hardness            | 3         | -    | -    | H          |

## 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              |                                                                                                                                                  |          |     |     |     |

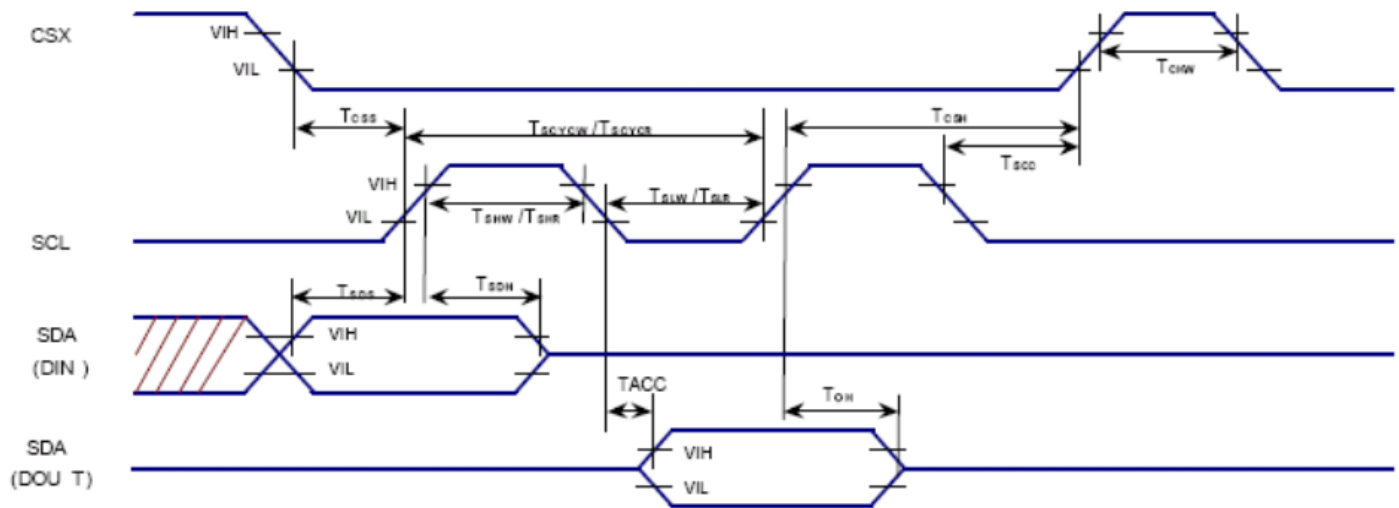
Notes:

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 10μs 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:



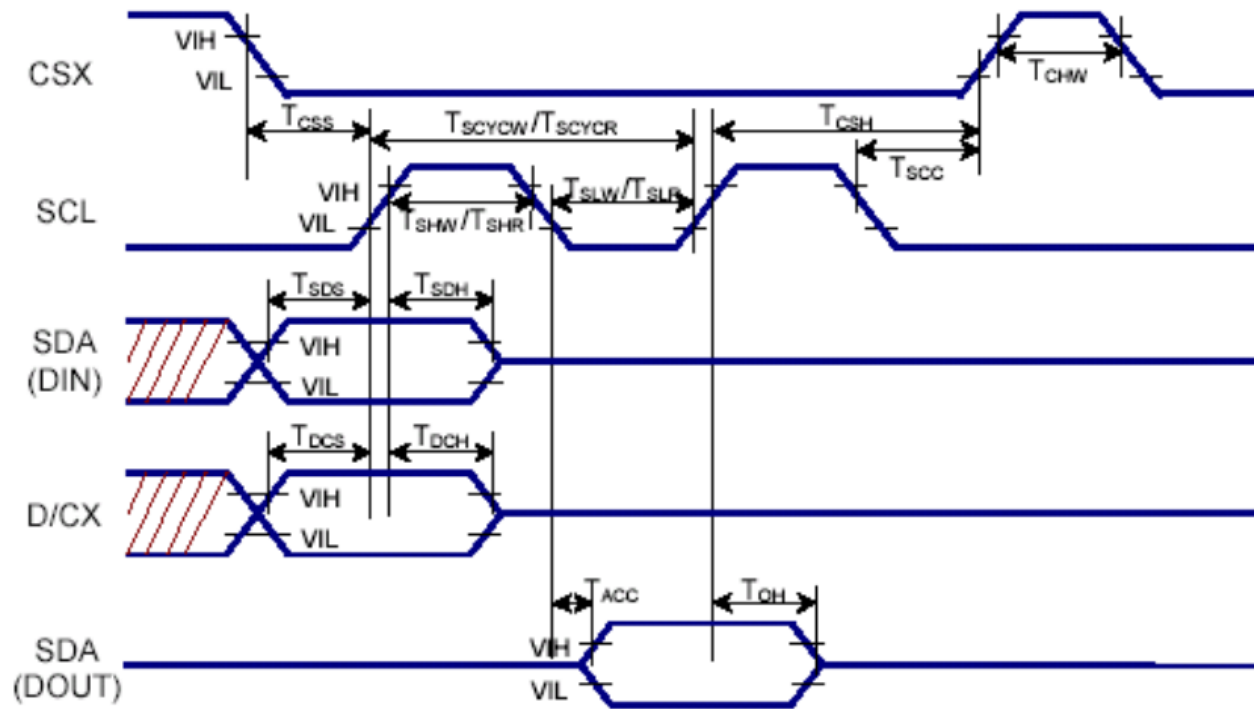
| Signal              | Symbol | Parameter                  | MIN | MAX | Unit | Description           |
|---------------------|--------|----------------------------|-----|-----|------|-----------------------|
| CSX                 | TCSS   | Chip select setup time     | 15  |     | ns   |                       |
|                     | 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)<br>(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                | 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 <sup>L</sup> "H" pulse width(Write) | 1   |     | ns   |                       |
|                    | TSLW   | S <sup>L</sup> "L" pulse width(Write) | 15  |     | ns   |                       |
|                    | TSCYCR | Serial clock cycle(Read)              | 150 |     | ns   |                       |
|                    | TSHR   | S <sup>L</sup> "H" pulse width(Read)  | 60  |     | ns   |                       |
|                    | TSLR   | S <sup>L</sup> "L" pulse width(Read)  | 60  |     | ns   |                       |
| D/CX               | TDCS   | D/CX setup time                       | 7   |     | ns   |                       |
|                    | TDCH   | D/CX hold time                        | 7   |     | ns   |                       |
| SDA(DIN)<br>(DOUT) | TSDS   | Data setup time                       | 10  |     | ns   |                       |
|                    | TS DH  | 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  |

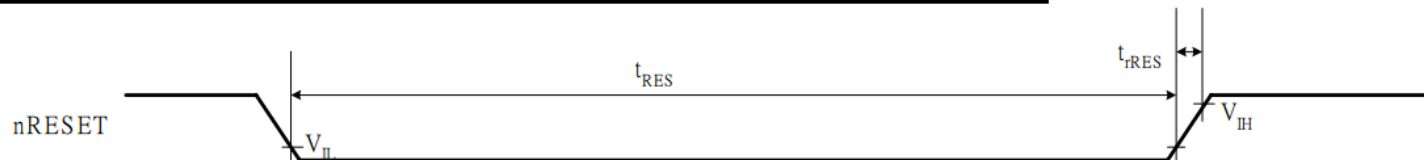
Note 1: VDDI=1.65 to 3.3V, VDD=2.6 to 3.3V, AGND=GND=0V. Ta=-30 to 70°C (to +85°C no damage)

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

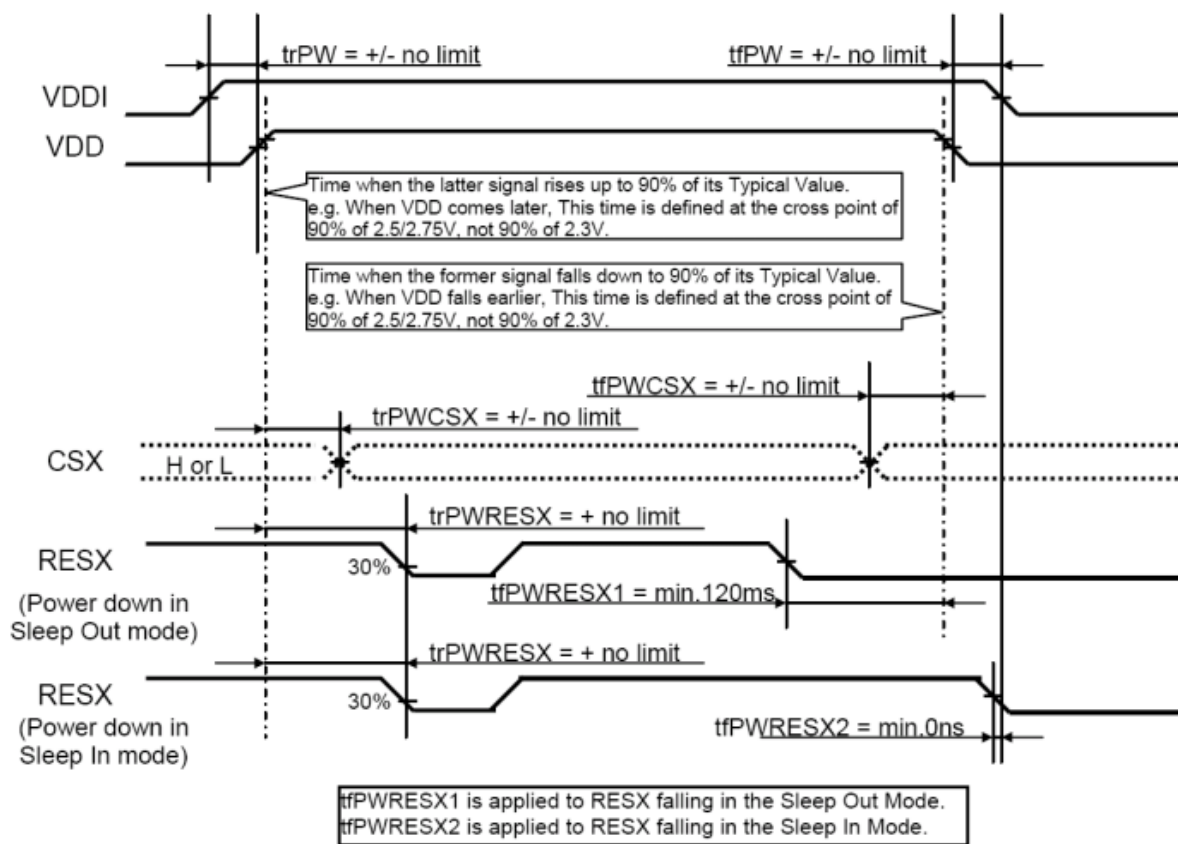
Logic high and low levels are specified as 10% and 90% of VDDI for Input signals.

## Reset Timing

| Item                  | Symbol     | Unit    | Min. | Typ. | Max. |
|-----------------------|------------|---------|------|------|------|
| Reset low-level width | $t_{RES}$  | ms      | 1    | -    | -    |
| Reset rise time       | $t_{rRES}$ | $\mu s$ | -    | -    | 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 Storage | 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 , 5G amplitude.<br>30min in each of 3 directions X, Y, Z | 3    |
| Static electricity test             | Endurance test applying electric static discharge.                                                                              | Air: ±8kV 150pF/330Ω, 5 Times                                    |      |
|                                     |                                                                                                                                 | Contact: ±4kV 150pF/330Ω, 5 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

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