

# NHD-2.4-240320CF-CSXN#-FT

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

|         |                                         |
|---------|-----------------------------------------|
| NHD-    | Newhaven Display                        |
| 2.4-    | 2.4" Diagonal                           |
| 240320- | 240 x 320 Pixels (Portrait Mode)        |
| CF-     | Model                                   |
| C-      | Built-in Controller                     |
| S-      | Sunlight Readable                       |
| X-      | TFT                                     |
| N-      | TN, 6:00 Optimal View, Wide Temperature |
| #-      | <b>RoHS Compliant</b>                   |
| F-      | FFC ZIF Connection Style                |
| T-      | 4-Wire Resistive Touch Panel            |

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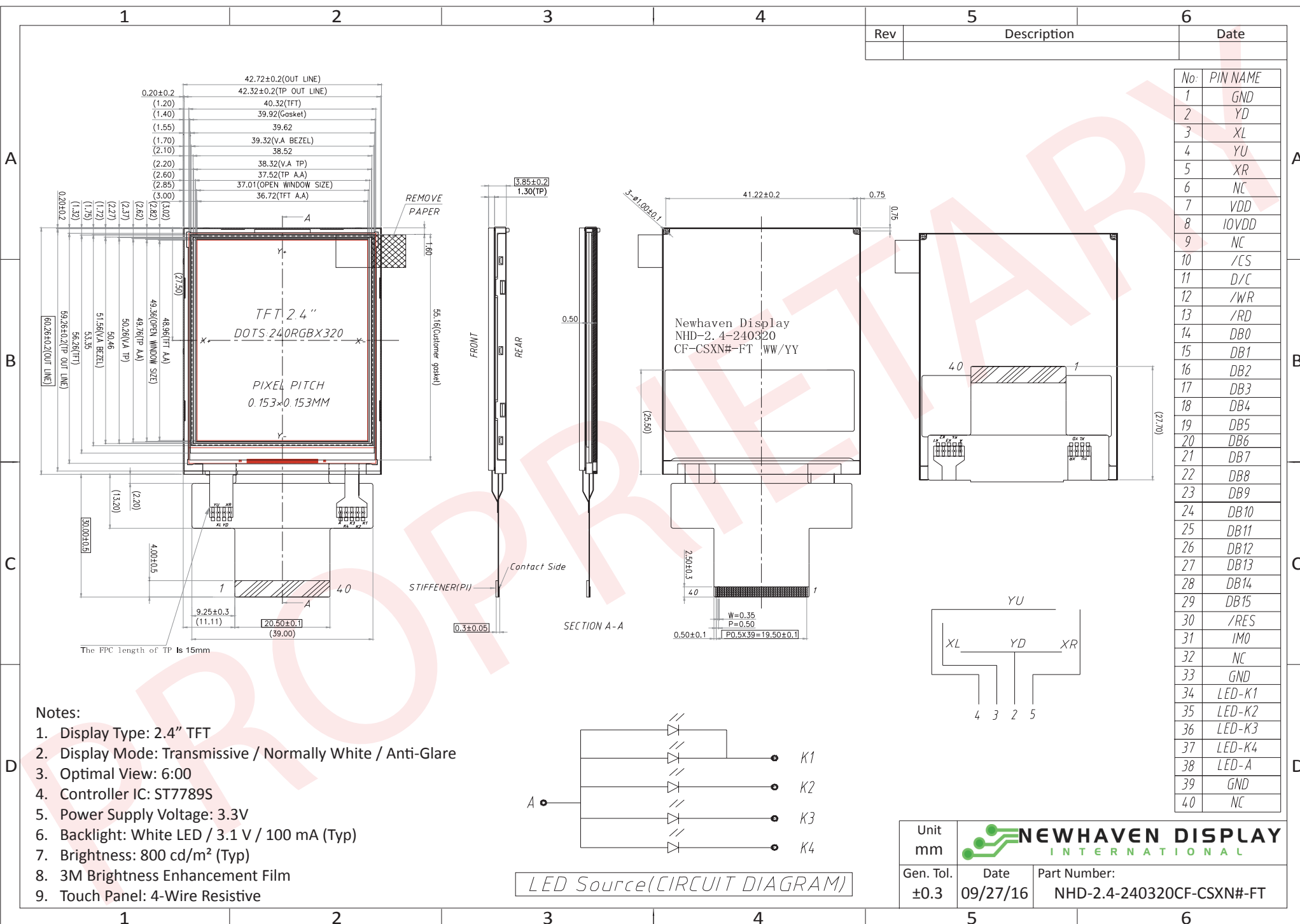
## Document Revision History

| Revision | Date    | Description                                          | Changed by |
|----------|---------|------------------------------------------------------|------------|
| 0        | 9/25/15 | Initial Release                                      | SB         |
| 1        | 2/17/16 | Corrected Brightness Condition, Datasheet Reformat   | SB         |
| 2        | 3/21/16 | Updated Mechanical Drawing, Added Backlight Lifetime | SB         |
| 3        | 4/7/16  | Viewing Angle Clarification, Brightness Updated      | SB         |
| 4        | 7/11/16 | Touch Panel FFC Changed to 15mm                      | SB         |
| 5        | 9/27/16 | Brightness Updated                                   | SB         |

## Functions and Features

- 240 x 320 pixels
- White LED backlight
- 3.3V power supply
- 8-bit or 16-bit Parallel MPU interface
- FFC ZIF I/O connection
- Built-in ST7789S controller
- 262K colors
- 4-wire Resistive Touch Panel
- Sunlight Readable

# Mechanical Drawing



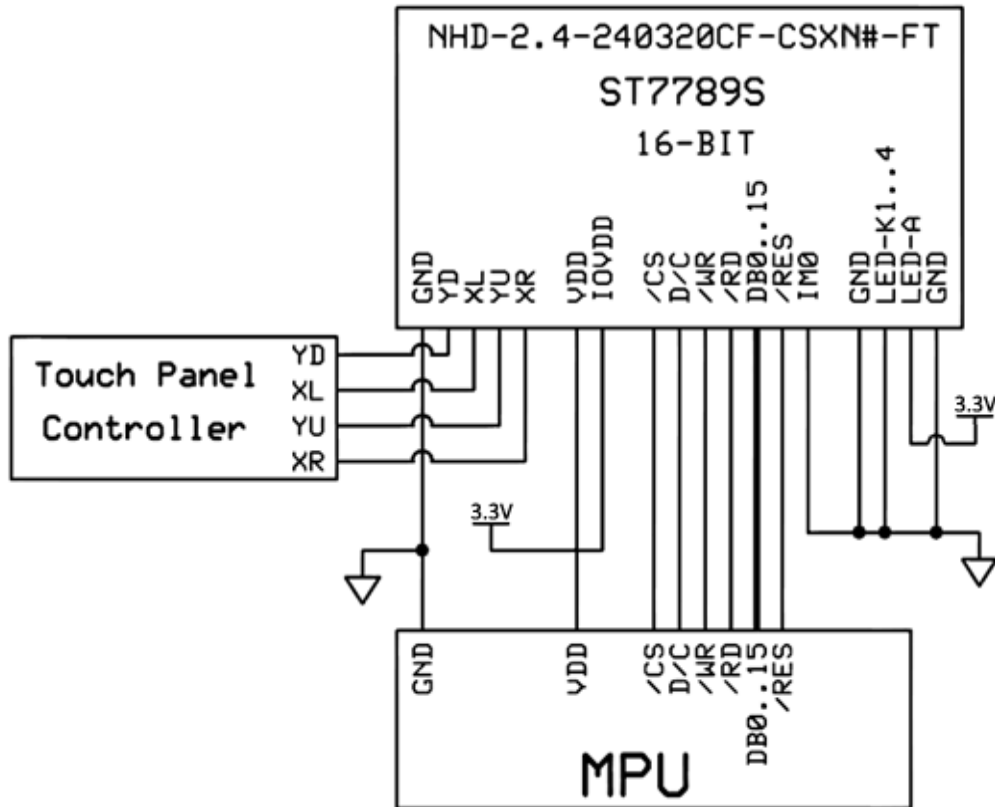
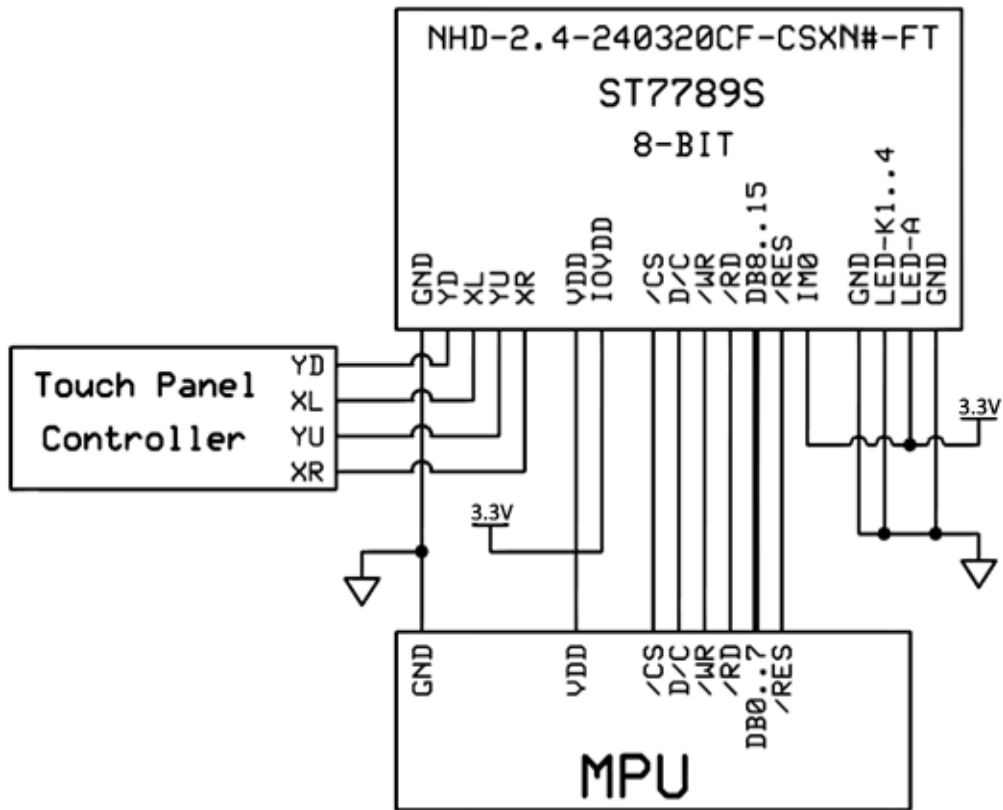
## Pin Description

| Pin No. | Symbol | External Connection | Function Description                                                       |
|---------|--------|---------------------|----------------------------------------------------------------------------|
| 1       | GND    | Power Supply        | Ground                                                                     |
| 2       | YD     | Touch Controller    | Touch Panel – Down                                                         |
| 3       | XL     | Touch Controller    | Touch Panel – Left                                                         |
| 4       | YU     | Touch Controller    | Touch Panel – Up                                                           |
| 5       | XR     | Touch Controller    | Touch Panel – Right                                                        |
| 6       | NC     | -                   | No Connect                                                                 |
| 7       | VDD    | Power Supply        | Supply Voltage for LCD (3.3V)                                              |
| 8       | IOVDD  | Power Supply        | Supply Voltage for Logic (1.8V)                                            |
| 9       | NC     | -                   | No Connect                                                                 |
| 10      | /CS    | MPU                 | Active LOW Chip Select signal (can tie to GND)                             |
| 11      | D/C    | MPU                 | Data / Command selection: '1' = Data ; '0' = Command                       |
| 12      | /WR    | MPU                 | Active LOW Write signal                                                    |
| 13      | /RD    | MPU                 | Active LOW Read signal                                                     |
| 14      | DB0    | MPU                 | Bi-directional data bus<br><br>8-bit: use DB8-DB15<br>16-bit: use DB0-DB15 |
| 15      | DB1    | MPU                 |                                                                            |
| 16      | DB2    | MPU                 |                                                                            |
| 17      | DB3    | MPU                 |                                                                            |
| 18      | DB4    | MPU                 |                                                                            |
| 19      | DB5    | MPU                 |                                                                            |
| 20      | DB6    | MPU                 |                                                                            |
| 21      | DB7    | MPU                 |                                                                            |
| 22      | DB8    | MPU                 |                                                                            |
| 23      | DB9    | MPU                 |                                                                            |
| 24      | DB10   | MPU                 |                                                                            |
| 25      | DB11   | MPU                 |                                                                            |
| 26      | DB12   | MPU                 |                                                                            |
| 27      | DB13   | MPU                 |                                                                            |
| 28      | DB14   | MPU                 |                                                                            |
| 29      | DB15   | MPU                 |                                                                            |
| 30      | /RES   | MPU                 | Active LOW Reset signal                                                    |
| 31      | IM0    | MPU                 | IM0=0: 16-bit i80      IM0=1: 8-bit i80                                    |
| 32      | NC     | -                   | No Connect                                                                 |
| 33      | GND    | Power Supply        | Ground                                                                     |
| 34      | LED-K1 | Power Supply        | Backlight Cathode (Ground)                                                 |
| 35      | LED-K2 | Power Supply        | Backlight Cathode (Ground)                                                 |
| 36      | LED-K3 | Power Supply        | Backlight Cathode (Ground)                                                 |
| 37      | LED-K4 | Power Supply        | Backlight Cathode (Ground)                                                 |
| 38      | LED-A  | Power Supply        | Backlight Anode (3.1V)                                                     |
| 39      | GND    | Power Supply        | Ground                                                                     |
| 40      | NC     | -                   | No Connect                                                                 |

**Recommended LCD connector:** 40-pin, 0.5mm pitch FFC connector

**Molex P/N:** 54132-4062 or similar

## 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>   | -                                                    | 2.4                 | 3.3    | 3.5                 | V    |
| Supply Voltage for Logic    | IOV <sub>DD</sub> | -                                                    | 1.65                | 1.8    | 3.3                 | V    |
| Supply Current              | I <sub>DD</sub>   | V <sub>DD</sub> =3.3V                                | -                   | 6      | 12                  | mA   |
| "H" Level input             | V <sub>IH</sub>   | -                                                    | 0.7*V <sub>DD</sub> | -      | V <sub>DD</sub>     | V    |
| "L" Level input             | V <sub>IL</sub>   | -                                                    | V <sub>SS</sub>     | -      | 0.3*V <sub>DD</sub> | V    |
| "H" Level output            | V <sub>OH</sub>   | -                                                    | 0.8*V <sub>DD</sub> | -      | V <sub>DD</sub>     | V    |
| "L" Level output            | V <sub>OL</sub>   | -                                                    | V <sub>SS</sub>     | -      | 0.2*V <sub>DD</sub> | V    |
|                             |                   |                                                      |                     |        |                     |      |
| Backlight Supply Voltage    | V <sub>LED</sub>  | -                                                    | 2.8                 | 3.1    | 3.5                 | V    |
| Backlight Supply Current    | I <sub>LED</sub>  | V <sub>LED</sub> =3.1V                               | -                   | 100    | 125                 | mA   |
| Backlight Lifetime*         | -                 | I <sub>LED</sub> = 100 mA<br>T <sub>OP</sub> = 25° C | 20,000              | 50,000 | -                   | Hrs. |

\*Backlight Lifetime is rated as Hours until **half-brightness**, under normal operating conditions.

## Optical Characteristics

| Item                   | Symbol         | Condition                | Min. | Typ. | Max. | Unit              |
|------------------------|----------------|--------------------------|------|------|------|-------------------|
| Optimal Viewing Angles | Top            | CR ≥ 10                  | -    | 50   | -    | °                 |
|                        | Bottom         |                          | -    | 55   | -    | °                 |
|                        | Left           |                          | -    | 55   | -    | °                 |
|                        | Right          |                          | -    | 55   | -    | °                 |
| Contrast Ratio         | CR             | -                        | 150  | 200  | -    | -                 |
| Luminance              | L <sub>V</sub> | I <sub>LED</sub> = 100mA | 680  | 800  | 1160 | cd/m <sup>2</sup> |
| Response Time          | Rise           | T <sub>OP</sub> = 25°C   | -    | 4    | 8    | ms                |
|                        | Fall           |                          | -    | 12   | 24   | ms                |

## Touch Panel Characteristics

| Item                        | Min.      | Typ. | Max. | Unit       |
|-----------------------------|-----------|------|------|------------|
| Linearity                   | -         | -    | 1.5  | %          |
| Circuit Resistance – X-Axis | 200       | -    | 600  | Ω          |
| Circuit Resistance – Y-Axis | 250       | -    | 900  | Ω          |
| Insulation Resistance       | 20        | -    | -    | MΩ         |
| Operating Voltage           | -         | -    | 5    | V          |
| Chattering                  | -         | -    | 15   | ms         |
| Activation Force            | 100       | -    | -    | g          |
| Pen Writing Durability      | 100,000   | -    | -    | Characters |
| Pitting Durability          | 1,000,000 | -    | -    | Touches    |
| Surface Hardness            | 3         | -    | -    | H          |

## Controller Information

Built-in ST7789S controller.

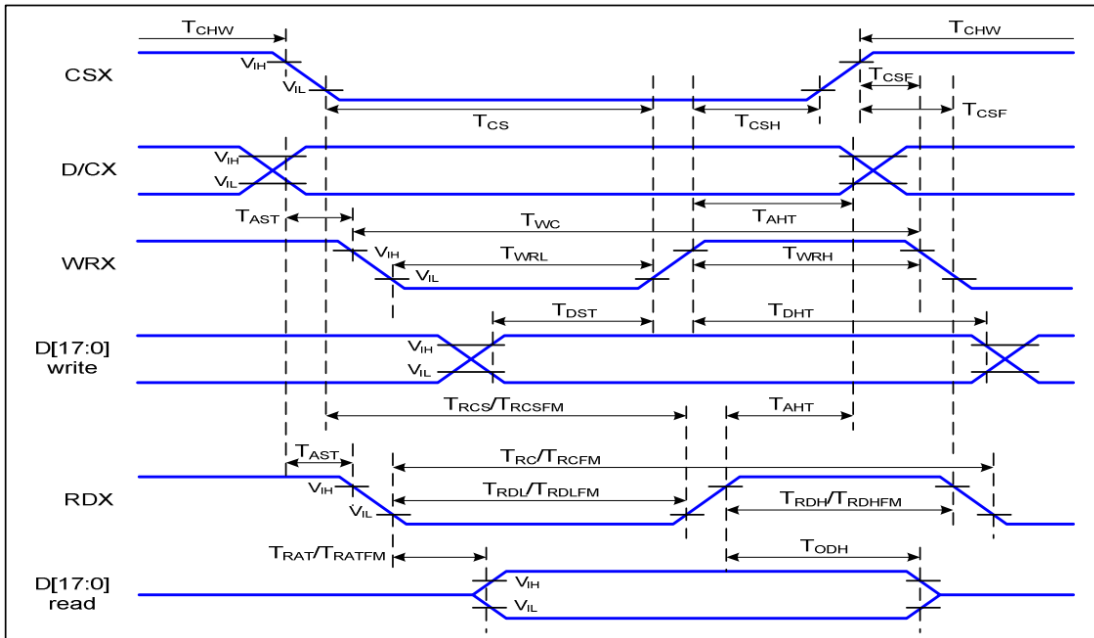
Please download specification at [http://www.newhavendisplay.com/app\\_notes/ST7789S.pdf](http://www.newhavendisplay.com/app_notes/ST7789S.pdf)

## Table of Commands

Please download specification at [http://www.newhavendisplay.com/app\\_notes/ST7789S.pdf](http://www.newhavendisplay.com/app_notes/ST7789S.pdf)

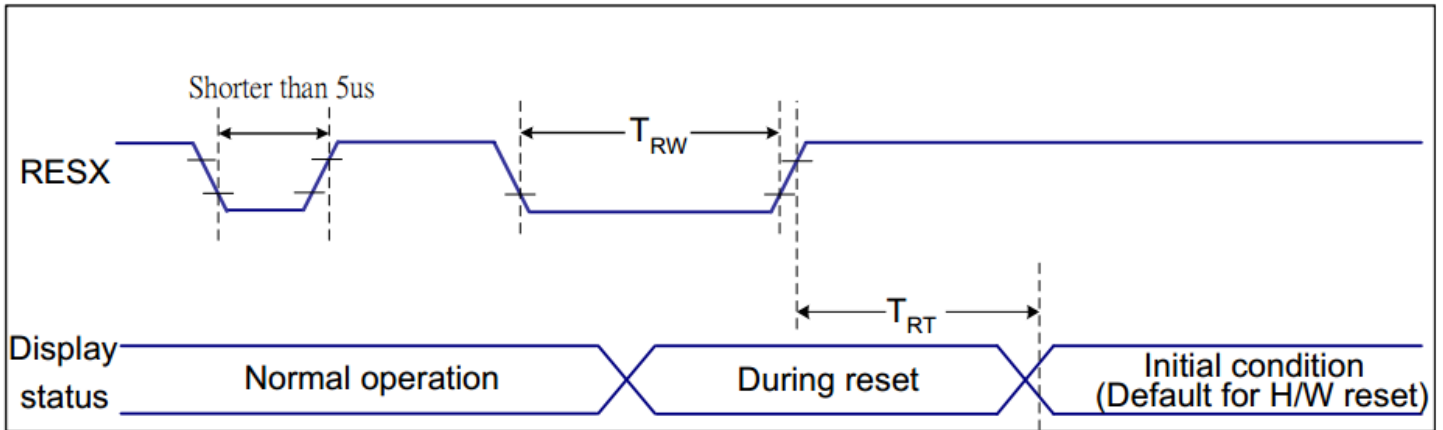
# Timing Characteristics

## Parallel 18/16/9/8-bit Interface Timing Characteristics (8080-II system)



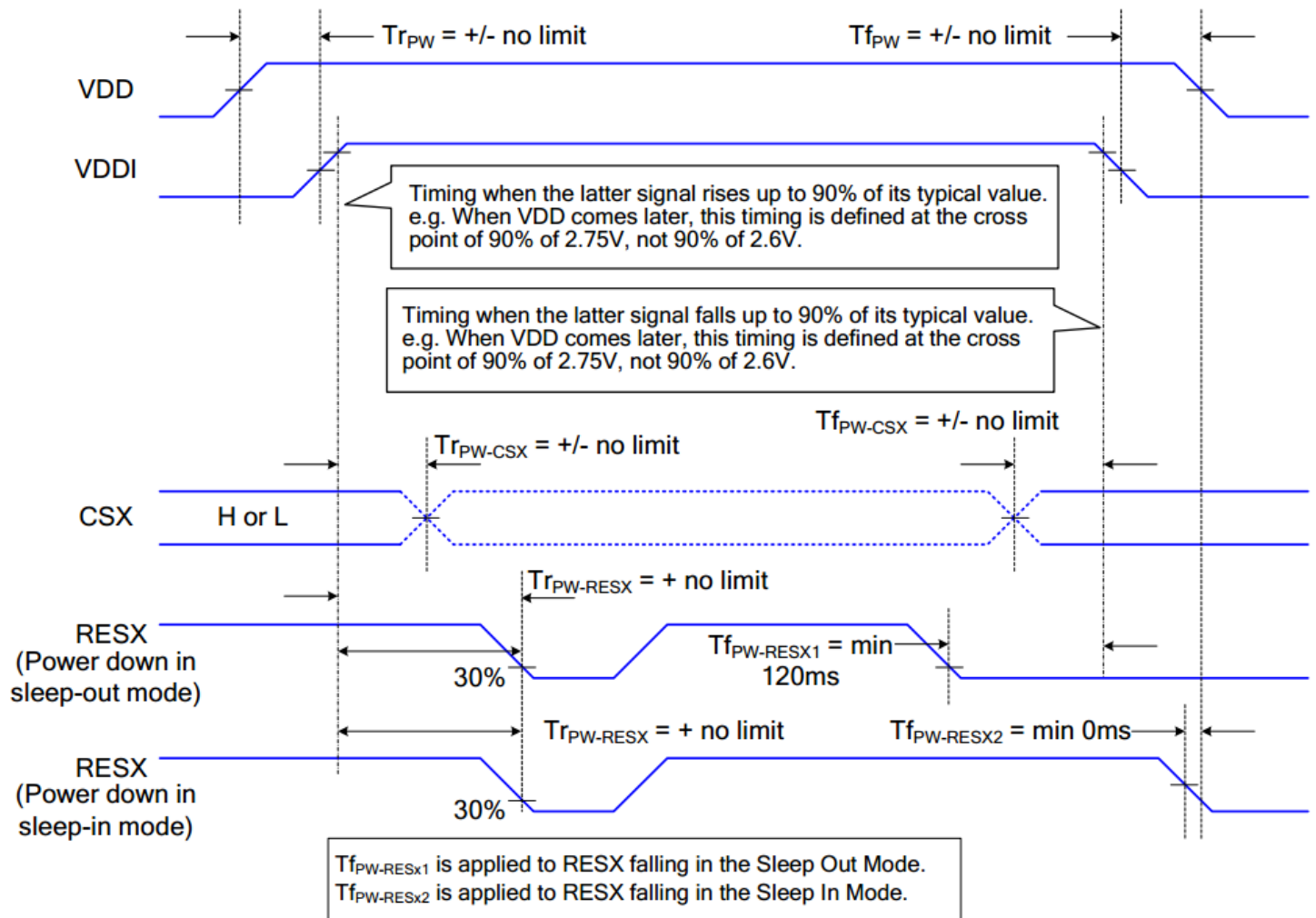
| Signal   | Symbol      | Parameter                          | Min | Max | Unit | Description                 |
|----------|-------------|------------------------------------|-----|-----|------|-----------------------------|
| D/CX     | $T_{AST}$   | Address setup time                 | 0   |     | ns   | -                           |
|          | $T_{AHT}$   | Address hold time (Write/Read)     | 10  |     | ns   |                             |
| CSX      | $T_{CHW}$   | Chip select "H" pulse width        | 0   |     | ns   | -                           |
|          | $T_{CS}$    | Chip select setup time (Write)     | 15  |     | ns   |                             |
|          | $T_{RCS}$   | Chip select setup time (Read ID)   | 45  |     | ns   |                             |
|          | $T_{RCSFM}$ | Chip select setup time (Read FM)   | 355 |     | ns   |                             |
|          | $T_{CSF}$   | Chip select wait time (Write/Read) | 10  |     | ns   |                             |
|          | $T_{CSH}$   | Chip select hold time              | 10  |     | ns   |                             |
| WRX      | $T_{WC}$    | Write cycle                        | 66  |     | ns   |                             |
|          | $T_{WRH}$   | Control pulse "H" duration         | 15  |     | ns   |                             |
|          | $T_{WRL}$   | Control pulse "L" duration         | 15  |     | ns   |                             |
| RDX (ID) | $T_{RC}$    | Read cycle (ID)                    | 160 |     | ns   | When read ID data           |
|          | $T_{RDH}$   | Control pulse "H" duration (ID)    | 90  |     | ns   |                             |
|          | $T_{RDL}$   | Control pulse "L" duration (ID)    | 45  |     | ns   |                             |
| RDX (FM) | $T_{RCFM}$  | Read cycle (FM)                    | 450 |     | ns   | When read from frame memory |
|          | $T_{RDHFM}$ | Control pulse "H" duration (FM)    | 90  |     | ns   |                             |
|          | $T_{RDLFM}$ | Control pulse "L" duration (FM)    | 355 |     | ns   |                             |
| D[17:0]  | $T_{DST}$   | Data setup time                    | 10  |     | ns   | For CL=30pF                 |
|          | $T_{DHT}$   | Data hold time                     | 10  |     | ns   |                             |
|          | $T_{RAT}$   | Read access time (ID)              |     | 40  | ns   |                             |
|          | $T_{RATFM}$ | Read access time (FM)              |     | 340 | ns   |                             |
|          | $T_{ODH}$   | Output disable time                | 20  | 80  | ns   |                             |

## Reset Timing



| Related Pins | Symbol | Parameter            | MIN | MAX                | Unit |
|--------------|--------|----------------------|-----|--------------------|------|
| RESX         | TRW    | Reset pulse duration | 10  | -                  | us   |
|              | TRT    | Reset cancel         | -   | 5 (Note 1, 5)      | ms   |
|              |        |                      |     | 120 (Note 1, 6, 7) | ms   |

## Power ON/OFF Sequence



## Example Initialization Code

```

/*****/
void TFT_24_7789_Write_Command(unsigned int command)
{
    GPIO_ResetBits(GPIOC, CS1);
    GPIO_ResetBits(GPIOC, RS);
    GPIO_SetBits(GPIOC, nRD);
    GPIO_ResetBits(GPIOC, nWR);
    GPIO_Write(GPIOB, command);
    TFT_delay(10);
    GPIO_SetBits(GPIOC, nWR);
    TFT_delay(1);
}
/*****/
void TFT_24_7789_Write_Data(unsigned int data1)
{
    GPIO_Write(GPIOB, data1);
    GPIO_SetBits(GPIOC, RS);
    GPIO_ResetBits(GPIOC, nWR);
    TFT_delay(1);
    GPIO_SetBits(GPIOC, nWR);
}
/*****/
void TFT_24_7789_Init(void)
{
    int n;
    GPIO_ResetBits(GPIOC, CS1);
    GPIO_SetBits(GPIOC, nRD);
    GPIO_ResetBits(GPIOC, nWR);
    GPIO_WriteBit(GPIOC, RES, Bit_RESET);
    TFT_delay(100);
    GPIO_WriteBit(GPIOC, RES, Bit_SET);
    TFT_delay(100);
    TFT_24_7789_Write_Command(0x0011); //exit SLEEP mode
    TFT_delay(100);

    TFT_24_7789_Write_Command(0x0036);
    TFT_24_7789_Write_Data(0x0080); //MADCTL: memory data access control
    TFT_24_7789_Write_Command(0x003A);
    TFT_24_7789_Write_Data(0x0066); //COLMOD: Interface Pixel format
    TFT_24_7789_Write_Command(0x00B2);
    TFT_24_7789_Write_Data(0x000C);
    TFT_24_7789_Write_Data(0x0C);
    TFT_24_7789_Write_Data(0x00);
    TFT_24_7789_Write_Data(0x33);
    TFT_24_7789_Write_Data(0x33); //PORCTRK: Porch setting
    TFT_24_7789_Write_Command(0x00B7);
    TFT_24_7789_Write_Data(0x0035); //GCTRL: Gate Control
    TFT_24_7789_Write_Command(0x00BB);
    TFT_24_7789_Write_Data(0x002B); //VCOMS: VCOM setting
    TFT_24_7789_Write_Command(0x00C0);
    TFT_24_7789_Write_Data(0x002C); //LCMCTRL: LCM Control
    TFT_24_7789_Write_Command(0x00C2);
    TFT_24_7789_Write_Data(0x0001);
    TFT_24_7789_Write_Data(0xFF); //VDVVRHEN: VDV and VRH Command Enable
    TFT_24_7789_Write_Command(0x00C3);
    TFT_24_7789_Write_Data(0x0011); //VRHS: VRH Set
    TFT_24_7789_Write_Command(0x00C4);

```

```

TFT_24_7789_Write_Data(0x0020); //VDVS: VDV Set
TFT_24_7789_Write_Command(0x00C6);
TFT_24_7789_Write_Data(0x000F); //FRCTRL2: Frame Rate control in normal mode
TFT_24_7789_Write_Command(0x00D0);
TFT_24_7789_Write_Data(0x00A4);
TFT_24_7789_Write_Data(0xA1); //PWCTRL1: Power Control 1
TFT_24_7789_Write_Command(0x00E0);
TFT_24_7789_Write_Data(0x00D0);
TFT_24_7789_Write_Data(0x0000);
TFT_24_7789_Write_Data(0x0005);
TFT_24_7789_Write_Data(0x000E);
TFT_24_7789_Write_Data(0x0015);
TFT_24_7789_Write_Data(0x000D);
TFT_24_7789_Write_Data(0x0037);
TFT_24_7789_Write_Data(0x0043);
TFT_24_7789_Write_Data(0x0047);
TFT_24_7789_Write_Data(0x0009);
TFT_24_7789_Write_Data(0x0015);
TFT_24_7789_Write_Data(0x0012);
TFT_24_7789_Write_Data(0x0016);
TFT_24_7789_Write_Data(0x0019); //PVGAMCTRL: Positive Voltage Gamma control
TFT_24_7789_Write_Command(0x00E1);
TFT_24_7789_Write_Data(0x00D0);
TFT_24_7789_Write_Data(0x0000);
TFT_24_7789_Write_Data(0x0005);
TFT_24_7789_Write_Data(0x000D);
TFT_24_7789_Write_Data(0x000C);
TFT_24_7789_Write_Data(0x0006);
TFT_24_7789_Write_Data(0x002D);
TFT_24_7789_Write_Data(0x0044);
TFT_24_7789_Write_Data(0x0040);
TFT_24_7789_Write_Data(0x000E);
TFT_24_7789_Write_Data(0x001C);
TFT_24_7789_Write_Data(0x0018);
TFT_24_7789_Write_Data(0x0016);
TFT_24_7789_Write_Data(0x0019); //NVGAMCTRL: Negative Voltage Gamma control
TFT_24_7789_Write_Command(0x002A);
TFT_24_7789_Write_Data(0x0000);
TFT_24_7789_Write_Data(0x0000);
TFT_24_7789_Write_Data(0x0000);
TFT_24_7789_Write_Data(0x00EF); //X address set
TFT_24_7789_Write_Command(0x002B);
TFT_24_7789_Write_Data(0x0000);
TFT_24_7789_Write_Data(0x0000);
TFT_24_7789_Write_Data(0x0001);
TFT_24_7789_Write_Data(0x003F); //Y address set

TFT_delay(10);
}
/*****/

```

## 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, 90-95% 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,30min -> 25°C,5min -> 70°C,30min -> 25°C,5min = 1 cycle. 10 cycles |      |
| Vibration test                        | Endurance test applying vibration to simulate transportation and use.                                                           | 10Hz-55Hz, 1.5mm amplitude. 2hrs in each of 3 directions X,Y,Z           | 3    |
| Static electricity test               | Endurance test applying electric static discharge.                                                                              | VS=8KV, RS=330kΩ, CS=150pF<br>Ten 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

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