

# NHD-2.4-240320CF-BSXV-F

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

NHD-	Newhaven Display
2.4-	2.4" Diagonal
240320-	240xRGBx320 Pixels
CF-	Model
B-	Built-in Controller, SPI interface
S-	High Brightness White LED Backlight
X-	TFT
V-	MVA, Wide Temperature
F-	FFC ZIF Connection Style

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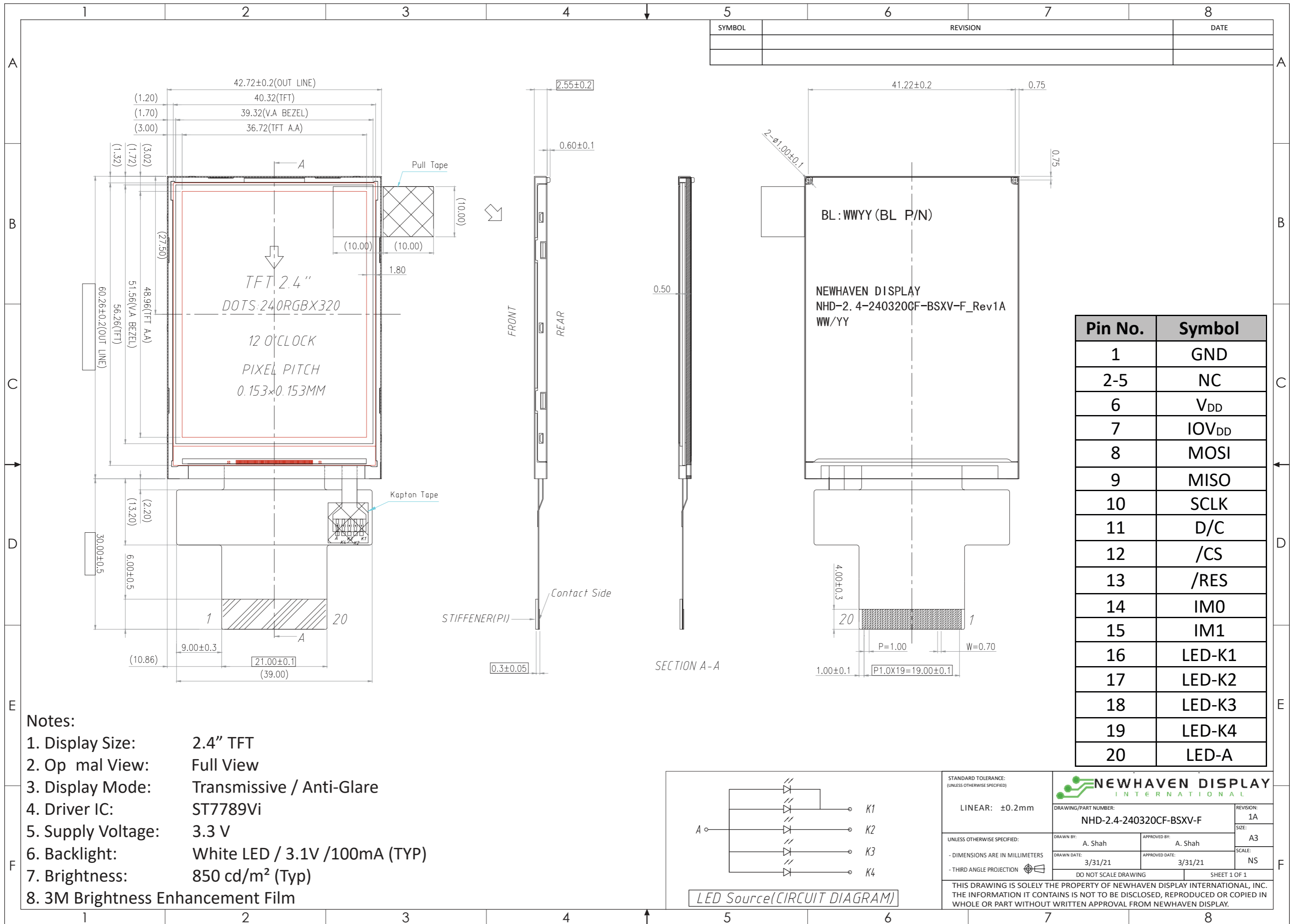
[nhsales@newhavendisplay.com](mailto:nhsales@newhavendisplay.com)

## Document Revision History

Revision	Date	Description	Changed by
-	08/22/19	Initial Release	PK
1	3/19/20	Electrical Characteristics Updated	SB
2	3/31/21	Updated Alignment Tab Length + Tolerance on 2D Mechanical Drawing	AS
3	7/13/21	Updated SPI Timing Characteristics	ZP

## Functions and Features

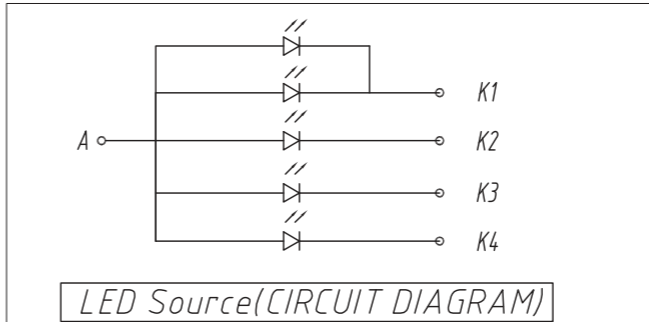
- 240 x 320 pixels
- LED backlight
- Premium high brightness display
- 3.3V power supply
- 3 or 4 wire SPI Interface
- FFC ZIF I/O connection
- Built-in ST7789Vi controller
- 262K colors
- Touch Panel available



SYMBOL	REVISION	DATE

Pin No.	Symbol
1	GND
2-5	NC
6	V <sub>DD</sub>
7	IOV <sub>DD</sub>
8	MOSI
9	MISO
10	SCLK
11	D/C
12	/CS
13	/RES
14	IM0
15	IM1
16	LED-K1
17	LED-K2
18	LED-K3
19	LED-K4
20	LED-A

- Notes:**
1. Display Size: 2.4" TFT
  2. Op mal View: Full View
  3. Display Mode: Transmissive / Anti-Glare
  4. Driver IC: ST7789Vi
  5. Supply Voltage: 3.3 V
  6. Backlight: White LED / 3.1V /100mA (TYP)
  7. Brightness: 850 cd/m<sup>2</sup> (Typ)
  8. 3M Brightness Enhancement Film



STANDARD TOLERANCE:  
(UNLESS OTHERWISE SPECIFIED)

LINEAR: ±0.2mm

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

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**NEWHAVEN DISPLAY INTERNATIONAL**

DRAWING/PART NUMBER: NHD-2.4-240320CF-BSXV-F

REVISION: 1A

SIZE: A3

SCALE: NS

DRAWN BY: A. Shah

APPROVED BY: A. Shah

DRAWN DATE: 3/31/21

APPROVED DATE: 3/31/21

DO NOT SCALE DRAWING

SHEET 1 OF 1

## Pin Description

Pin No.	Symbol	External Connection	Function Description
1	GND	Power Supply	Ground
2-5	NC	-	No connect
6	V <sub>DD</sub>	Power Supply	Supply voltage for LCD (3.3V)
7	IOV <sub>DD</sub>	Power Supply	Supply voltage for Logic (Can tie to V <sub>DD</sub> )
8	MOSI	MPU	Master device output, slave device input
9	MISO	MPU	Master device input, slave device out
10	SCLK	MPU	Serial Clock Input Signal
11	D/C	MPU	Data / Command selection 4-wire Serial: '1' = Data; '0' = Command 3-wire Serial: Ground
12	/CS	MPU	Active LOW Chip Select signal
13	/RES	MPU	Active LOW reset signal
14	IM0	MPU	IM0 = 1, IM1 = 0: 3-line 9-bit Serial mode
15	IM1	MPU	IM0 = 0, IM1 = 1: 4-line 8-bit Serial mode
16	LED-K1	Power Supply	LED Cathode 1 (Ground)
17	LED-K2	Power Supply	LED Cathode 2 (Ground)
18	LED-K3	Power Supply	LED Cathode 3 (Ground)
19	LED-K4	Power Supply	LED Cathode 4 (Ground)
20	LED-A	Power Supply	LED Anode (3.1V)

**Recommended LCD connector:** 20-pin, 1.0mm FFC Connector **Molex P/N:** 522712069 or similar

## MPU Interface Pin Assignment Summary

	Pin 8 (MOSI)	Pin 9 (MISO)	Pin 10 (SCLK)	Pin 11 (D/C)	Pin 12 (/CS)	Pin 14 (IM0)	Pin 15 (IM1)
<b>3-wire SPI</b>	Serial Data	Serial Data	Serial Clock	Tie LOW	Chip Select	1	0
<b>4-wire SPI</b>	Serial Data	Serial Data	Serial Clock	Data/Command	Chip Select	0	1

## 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	3.6	V
Supply Voltage for Logic	IOV <sub>DD</sub>	-	1.65	1.8	3.6	V
Supply Current	I <sub>DD</sub>	V <sub>DD</sub> = 3.3V	2	6	12	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	2.8	3.1	3.5	V
Backlight Lifetime*	-	T <sub>OP</sub> = 25°C	30,000	50,000	-	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	-	70	-	°C
	Bottom	φY-		-	70	-	°C
	Left	θX-		-	70	-	°C
	Right	θX-		-	70	-	°C
Contrast Ratio		CR	-	150	200	-	-
Luminance		L <sub>V</sub>	I <sub>LED</sub> = 100mA	700	850	1300	cd/m <sup>2</sup>
Response Time		T <sub>R</sub> + T <sub>F</sub>	T <sub>OP</sub> = 25°C	-	16	32	ms
Chromaticity	Red	X <sub>R</sub>	T <sub>A</sub> = 25°C, θX, φY = 0°	0.531	0.561	0.591	
		Y <sub>R</sub>		0.314	0.334	0.374	
	Green	X <sub>G</sub>		0.291	0.319	0.351	
		Y <sub>G</sub>		0.524	0.564	0.614	
	Blue	X <sub>B</sub>		0.112	0.142	0.162	
		Y <sub>B</sub>		0.051	0.081	0.112	
	White	X <sub>W</sub>		0.251	0.291	0.331	
		Y <sub>W</sub>		0.271	0.311	0.351	

## Controller Information

Built-in ST7789Vi controller.

Please download specification at

[https://www.newhavendisplay.com/resources\\_dataFiles/datasheets/LCDs/ST7789Vi.pdf](https://www.newhavendisplay.com/resources_dataFiles/datasheets/LCDs/ST7789Vi.pdf)

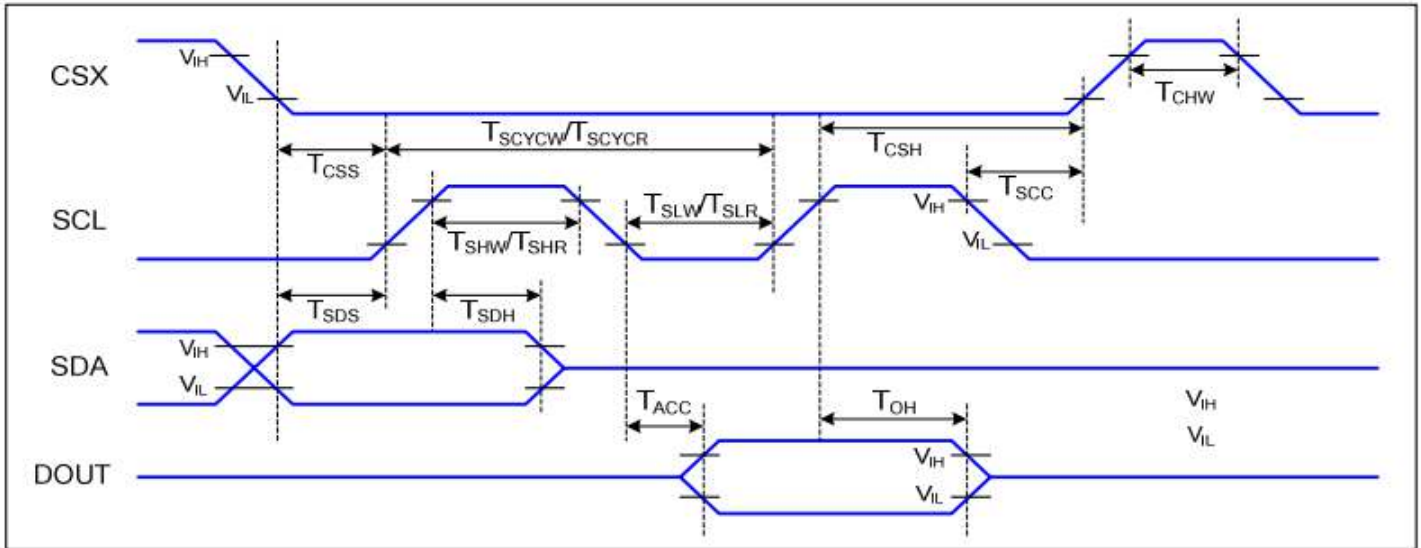
## Table of Commands

Please download specification at

[https://www.newhavendisplay.com/resources\\_dataFiles/datasheets/LCDs/ST7789Vi.pdf](https://www.newhavendisplay.com/resources_dataFiles/datasheets/LCDs/ST7789Vi.pdf)

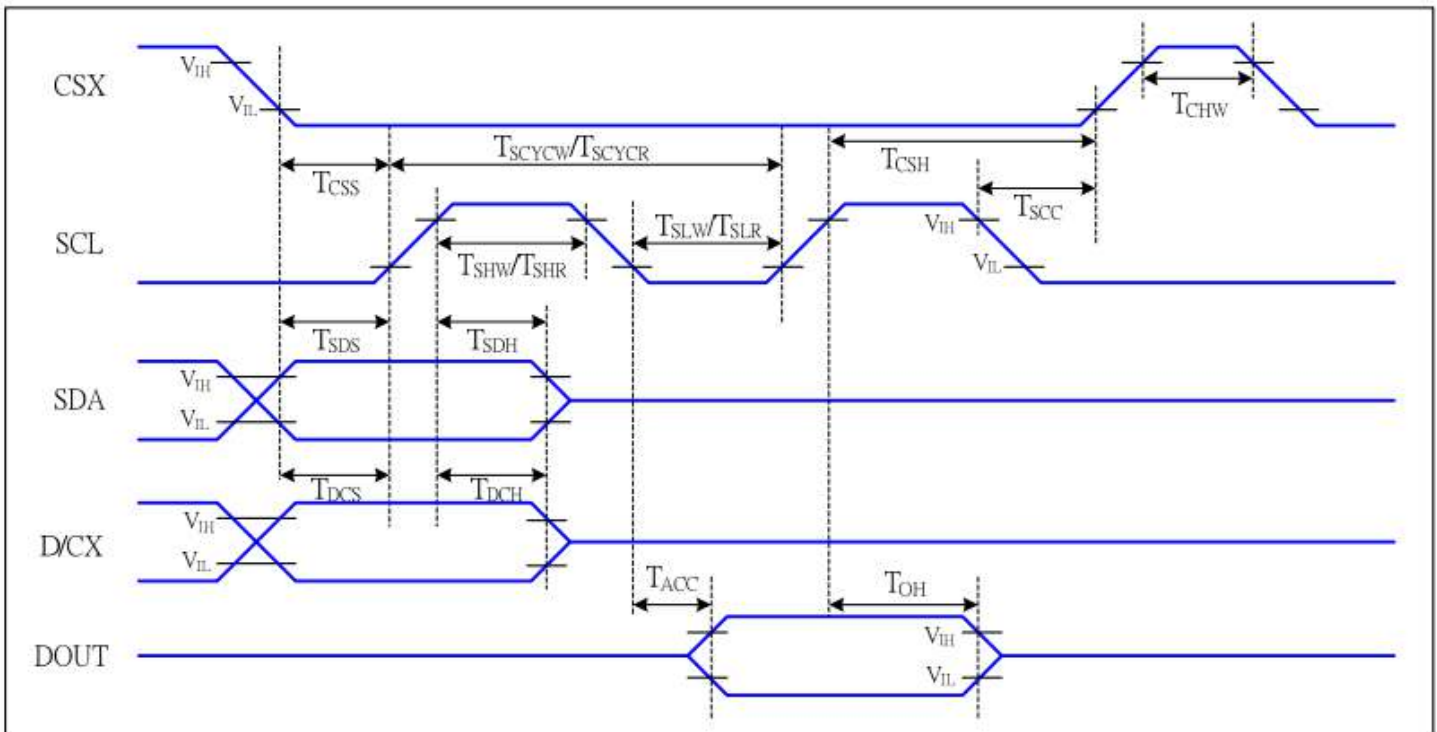
# Timing Characteristics

## 3-Wire Serial Peripheral Interface Timing Characteristics



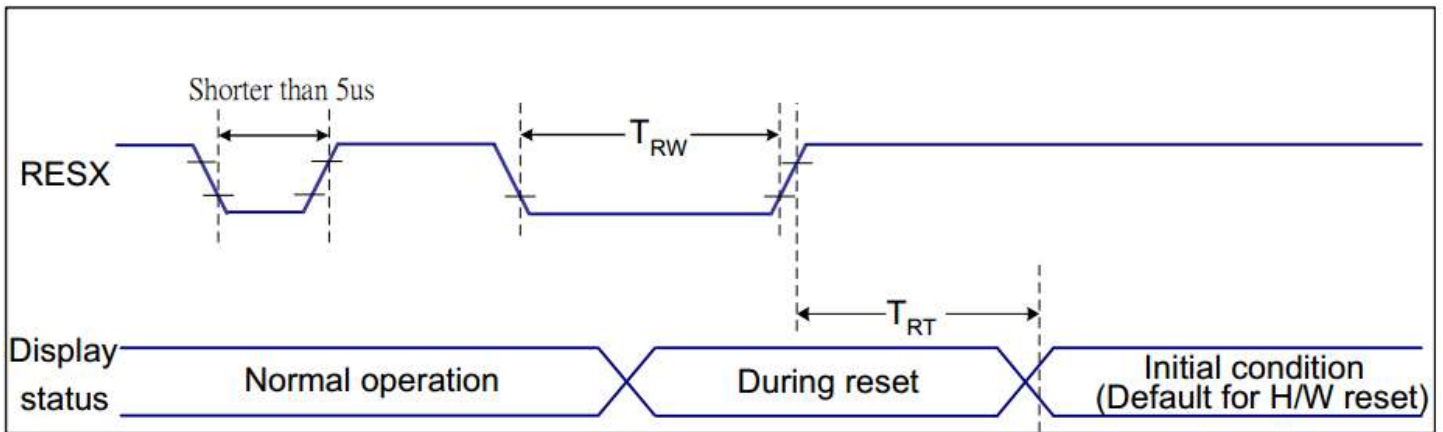
Signal	Symbol	Parameter	Min	Max	Unit	Description
CSX	T <sub>CSS</sub>	Chip select setup time (write)	15		ns	
	T <sub>CSH</sub>	Chip select hold time (write)	15		ns	
	T <sub>CSS</sub>	Chip select setup time (read)	60		ns	
	T <sub>SCC</sub>	Chip select hold time (read)	65		ns	
	T <sub>CHW</sub>	Chip select "H" pulse width	40		ns	
SCL	T <sub>SCYCW</sub>	Serial clock cycle (Write)	16		ns	
	T <sub>SHW</sub>	SCL "H" pulse width (Write)	7		ns	
	T <sub>SLW</sub>	SCL "L" pulse width (Write)	7		ns	
	T <sub>SCYCR</sub>	Serial clock cycle (Read)	150		ns	
	T <sub>SHR</sub>	SCL "H" pulse width (Read)	60		ns	
	T <sub>SLR</sub>	SCL "L" pulse width (Read)	60		ns	
SDA (DIN)	T <sub>SDS</sub>	Data setup time	7		ns	
	T <sub>SDH</sub>	Data hold time	7		ns	
DOUT	T <sub>ACC</sub>	Access time	10	50	ns	For maximum CL=30pF
	T <sub>OH</sub>	Output disable time	15	50	ns	For minimum CL=8pF

#### 4-Wire Serial Peripheral Interface Timing Characteristics



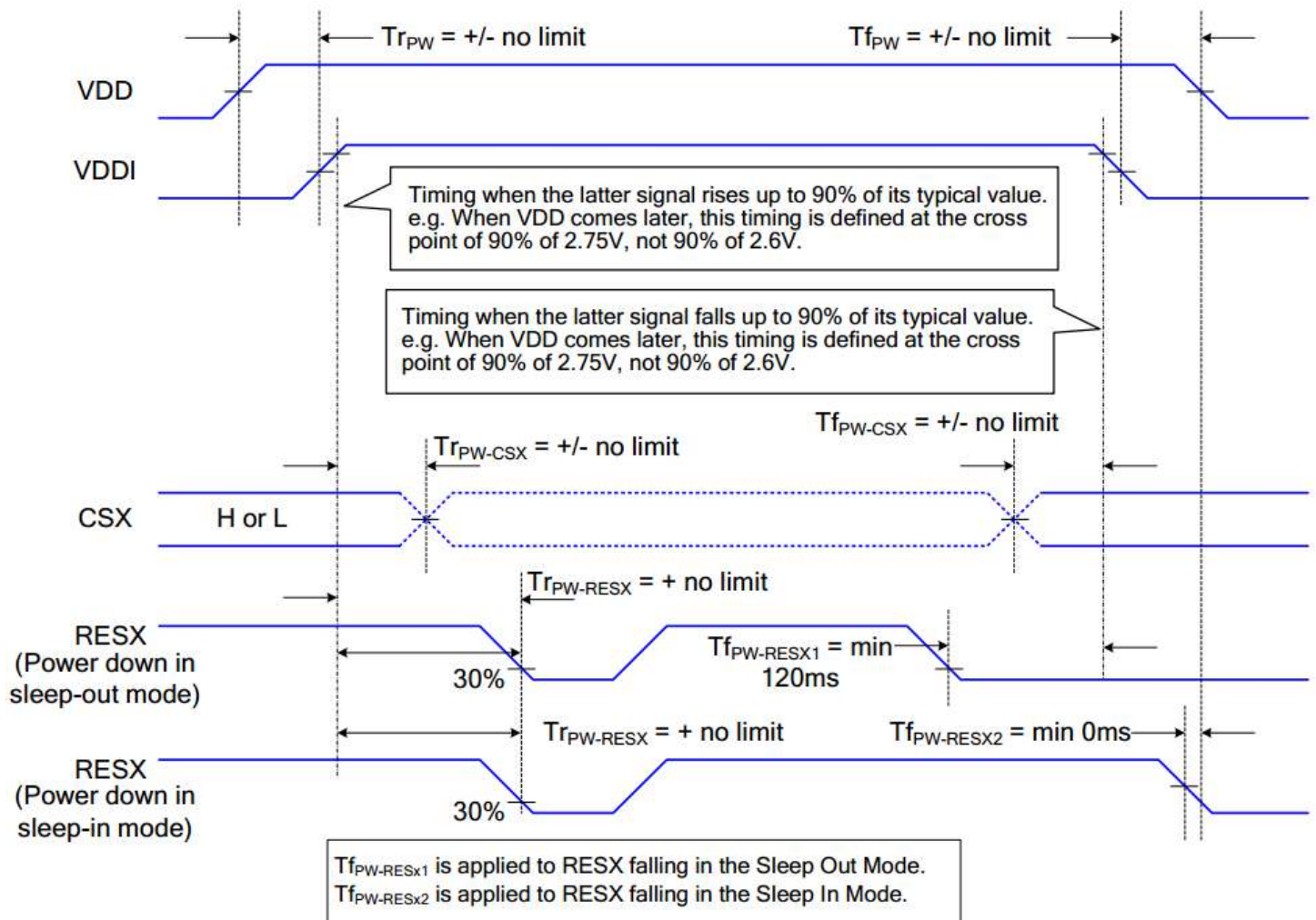
Signal	Symbol	Parameter	MIN	MAX	Unit	Description
CSX	T <sub>CSS</sub>	Chip select setup time (write)	15		ns	
	T <sub>CSH</sub>	Chip select hold time (write)	15		ns	
	T <sub>CSS</sub>	Chip select setup time (read)	60		ns	
	T <sub>SCC</sub>	Chip select hold time (read)	65		ns	
	T <sub>CHW</sub>	Chip select "H" pulse width	40		ns	
SCL	T <sub>SCYCW</sub>	Serial clock cycle (Write)	16		ns	-write command & data ram
	T <sub>SHW</sub>	SCL "H" pulse width (Write)	7		ns	
	T <sub>SLW</sub>	SCL "L" pulse width (Write)	7		ns	
	T <sub>SCYCR</sub>	Serial clock cycle (Read)	150		ns	-read command & data ram
	T <sub>SHR</sub>	SCL "H" pulse width (Read)	60		ns	
	T <sub>SLR</sub>	SCL "L" pulse width (Read)	60		ns	
D/CX	T <sub>DCS</sub>	D/CX setup time	10		ns	
	T <sub>DCH</sub>	D/CX hold time	10		ns	
SDA (DIN)	T <sub>SDS</sub>	Data setup time	7		ns	
	T <sub>SDH</sub>	Data hold time	7		ns	
DOUT	T <sub>ACC</sub>	Access time	10	50	ns	For maximum CL=30pF
	T <sub>OH</sub>	Output disable time	15	50	ns	For minimum CL=8pF

## 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

```

/*****/
command(unsigned int d)
{
  unsigned char i;
  unsigned char mask = 0x80;

  digitalWrite(DC, LOW); //Setting Data/command pin to command
  digitalWrite(CS_PIN, LOW); //Enabling controller

  //For loop to pass data one bit at a time
  for(i=0;i<8;i++)
  {
    digitalWrite(SCLK_PIN, LOW); //Setting clock low

    //Determine if 1 or zero
    if((d & mask) >> 7 == 1)
    {
      digitalWrite(MOSI_PIN, HIGH); //Sending bit as 1
    }
    else
    {
      digitalWrite(MOSI_PIN, LOW); //Sending bit as 0
    }
    digitalWrite(SCLK_PIN, HIGH); //Data clocked in on rising edge
    d = d << 1; //shift byte value over by one bit
  }
  digitalWrite(CS_PIN, HIGH); //disabling controller
}
/*****/
data(unsigned int d)
{
  unsigned char i;
  unsigned char mask = 0x80;

  digitalWrite(DC, HIGH); //Setting Data/command pin to data
  digitalWrite(CS_PIN, LOW); //Enabling controller

  //For loop to pass data one bit at a time in each byte
  for(i=0;i<8;i++)
  {
    digitalWrite(SCLK_PIN, LOW); //Setting clock low

    //Determine if 1 or 0
    if((d & mask) >> 7 == 1)
    {
      digitalWrite(MOSI_PIN, HIGH); //Sending bit as 1
    }
    else
    {
      digitalWrite(MOSI_PIN, LOW); //Sending bit as 0
    }
    digitalWrite(SCLK_PIN, HIGH); //Data clocked in on rising edge
    d = d << 1; //shift byte value over by one bit
  }
  digitalWrite(CS_PIN, HIGH); //disabling controller
}

/*****/

```

```

void setup() {
  pinMode(SCLK_PIN, OUTPUT);
  pinMode(MOSI_PIN, OUTPUT);
  pinMode(DC, OUTPUT);
  pinMode(CS_PIN, OUTPUT);
  pinMode(RST, OUTPUT);
  digitalWrite(RST, HIGH);

  //Factory initialization
  command(0x28); //Turn off display
  command(0x11); //Exit sleep mode
  command(0x36);
  data(0x88); //MADCTL: memory data access control Old: 0x88
  command(0x3A);
  data(0x66); //COLMOD: Interface Pixel format (18-bits per pixel @ 262K colors)
  command(0xB2);
  data(0x0C);
  data(0x0C);
  data(0x00);
  data(0x33);
  data(0x33); //PORCTRK: Porch setting
  command(0xB7);
  data(0x35); //GCTRL: Gate Control
  command(0xBB);
  data(0x2B); //VCOMS: VCOM setting
  command(0xC0);
  data(0x2C); //LCMCTRL: LCM Control
  command(0xC2);
  data(0x01);
  data(0xFF); //VDVVRHEN: VDV and VRH Command Enable
  command(0xC3);
  data(0x11); //VRHS: VRH set
  command(0xC4);
  data(0x20); //VDVS: VDV Set
  command(0xC6);
  data(0x0F); //FRCTRL2: Frame Rate control in normal mode
  command(0xD0);
  data(0xA4);
  data(0xA1); //PWCTRL1: Power Control 1
  command(0xE0);
  data(0xD0);
  data(0x00);
  data(0x05);
  data(0x0E);
  data(0x15);
  data(0x0D);
  data(0x37);
  data(0x43);
  data(0x47);
  data(0x09);
  data(0x15);
  data(0x12);
  data(0x16);
  data(0x19); //PVGAMCTRL: Positive Voltage Gamma control
  command(0xE1);
  data(0xD0);
  data(0x00);
  data(0x05);
  data(0x0D);
  data(0x0C);
  data(0x06);

```

```
data(0x2D);
data(0x44);
data(0x40);
data(0x0E);
data(0x1C);
data(0x18);
data(0x16);
data(0x19); //NVGAMCTRL: Negative Voltage Gamma control
command(0x2A);
data(0x00);
data(0x00);
data(0x00);
data(0xEF); //X address set
command(0x2B);
data(0x00);
data(0x00);
data(0x01);
data(0x3F); //Y address set
command(0x29);
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 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

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