

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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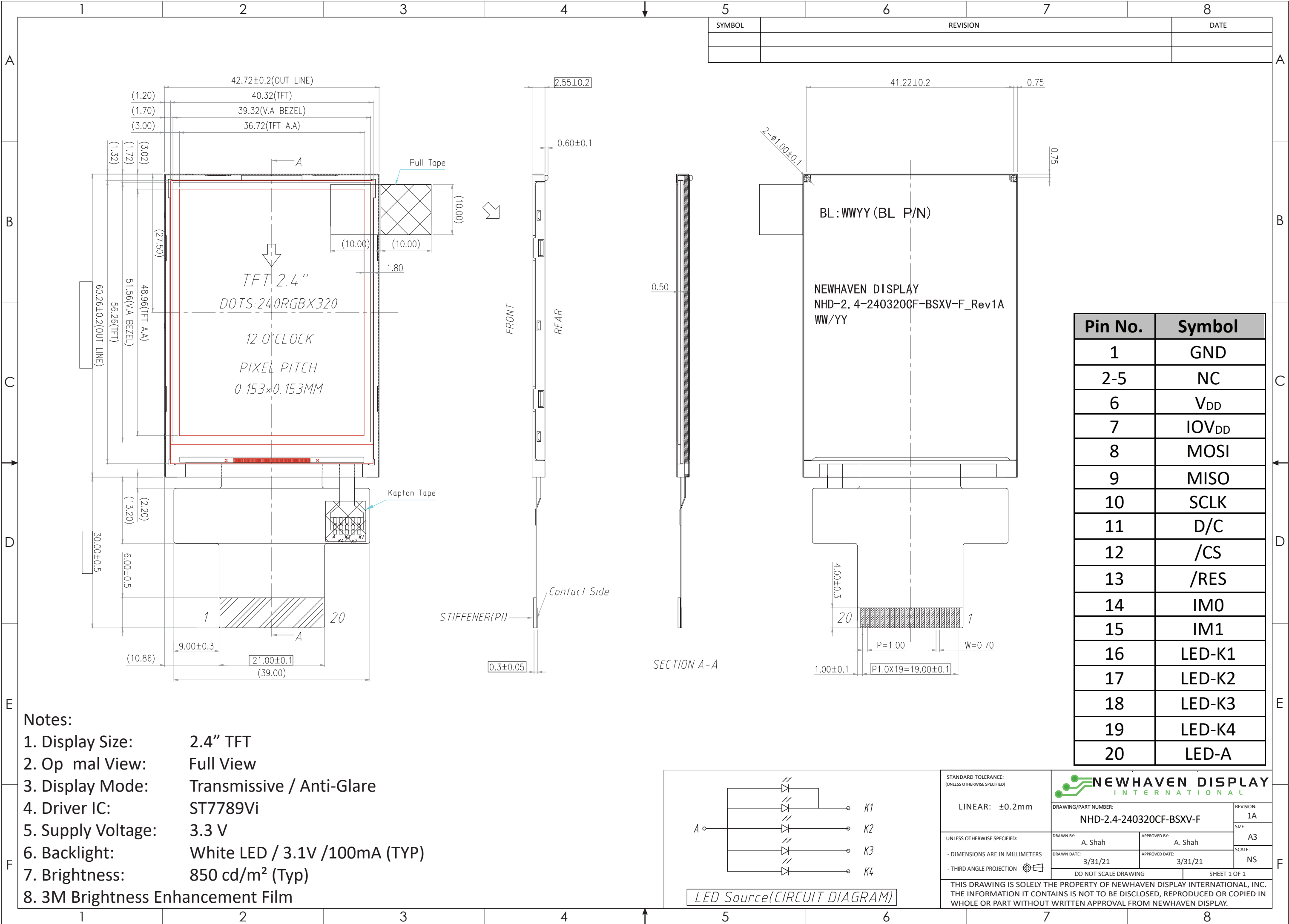
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Document Revision History

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



Pin Description

Pin No.	Symbol	External Connection	Function Description
1	GND	Power Supply	Ground
2-5	NC	-	No connect
6	V _{DD}	Power Supply	Supply voltage for LCD (3.3V)
7	IOV _{DD}	Power Supply	Supply voltage for Logic (Can tie to V _{DD})
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 IM0 = 0, IM1 = 1: 4-line 8-bit Serial mode
15	IM1	MPU	
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)
3-wire SPI	Serial Data	Serial Data	Serial Clock	Tie LOW	Chip Select	1	0
4-wire SPI	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 _{OP}	Absolute Max	-20	-	+70	°C
Storage Temperature Range	T _{ST}	Absolute Max	-30	-	+80	°C
Supply Voltage for LCD	V _{DD}	-	2.4	3.3	3.6	V
Supply Voltage for Logic	IOV _{DD}	-	1.65	1.8	3.6	V
Supply Current	I _{DD}	V _{DD} = 3.3V	2	6	12	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}	-	-	100	125	mA
Backlight Supply Voltage	V _{LED}	I _{LED} = 100mA	2.8	3.1	3.5	V
Backlight Lifetime*	-	T _{OP} = 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 _V	I _{LED} = 100mA	700	850	1300	cd/m ²
Response Time		T _R + T _F	T _{OP} = 25°C	-	16	32	ms
Chromaticity	Red	X _R	T _A = 25°C, θX, φY = 0°	0.531	0.561	0.591	
		Y _R		0.314	0.334	0.374	
	Green	X _G		0.291	0.319	0.351	
		Y _G		0.524	0.564	0.614	
	Blue	X _B		0.112	0.142	0.162	
		Y _B		0.051	0.081	0.112	
	White	X _W		0.251	0.291	0.331	
		Y _W		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

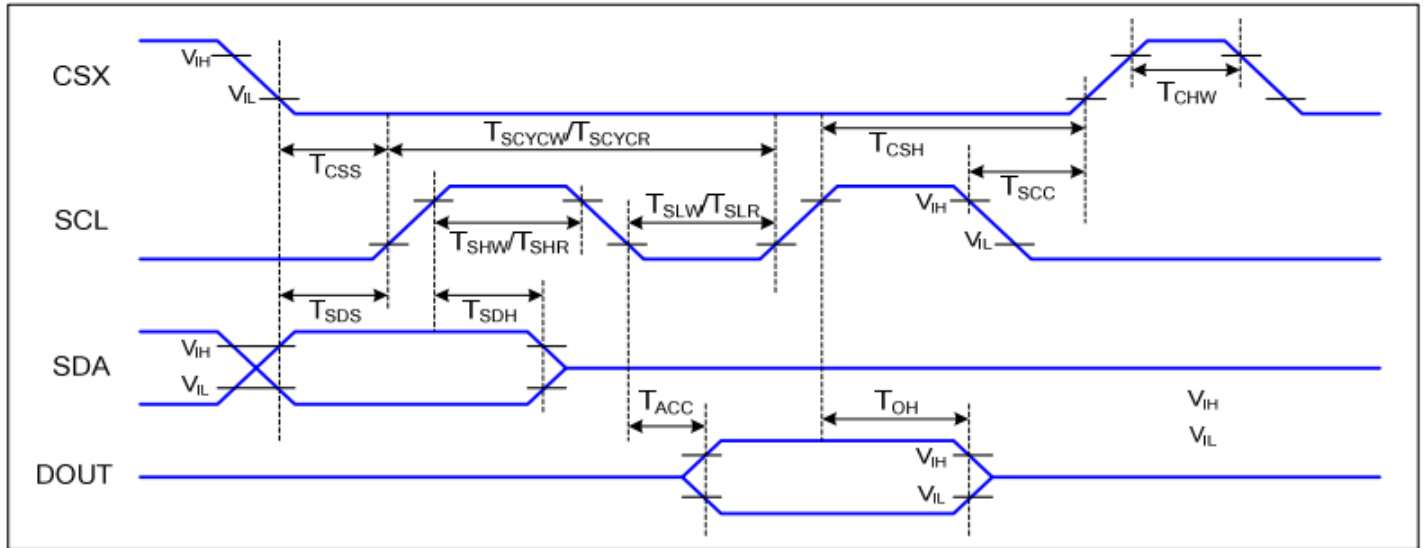
Table of Commands

Please download specification at

https://www.newhavendisplay.com/resources_dataFiles/datasheets/LCDs/ST7789Vi.pdf

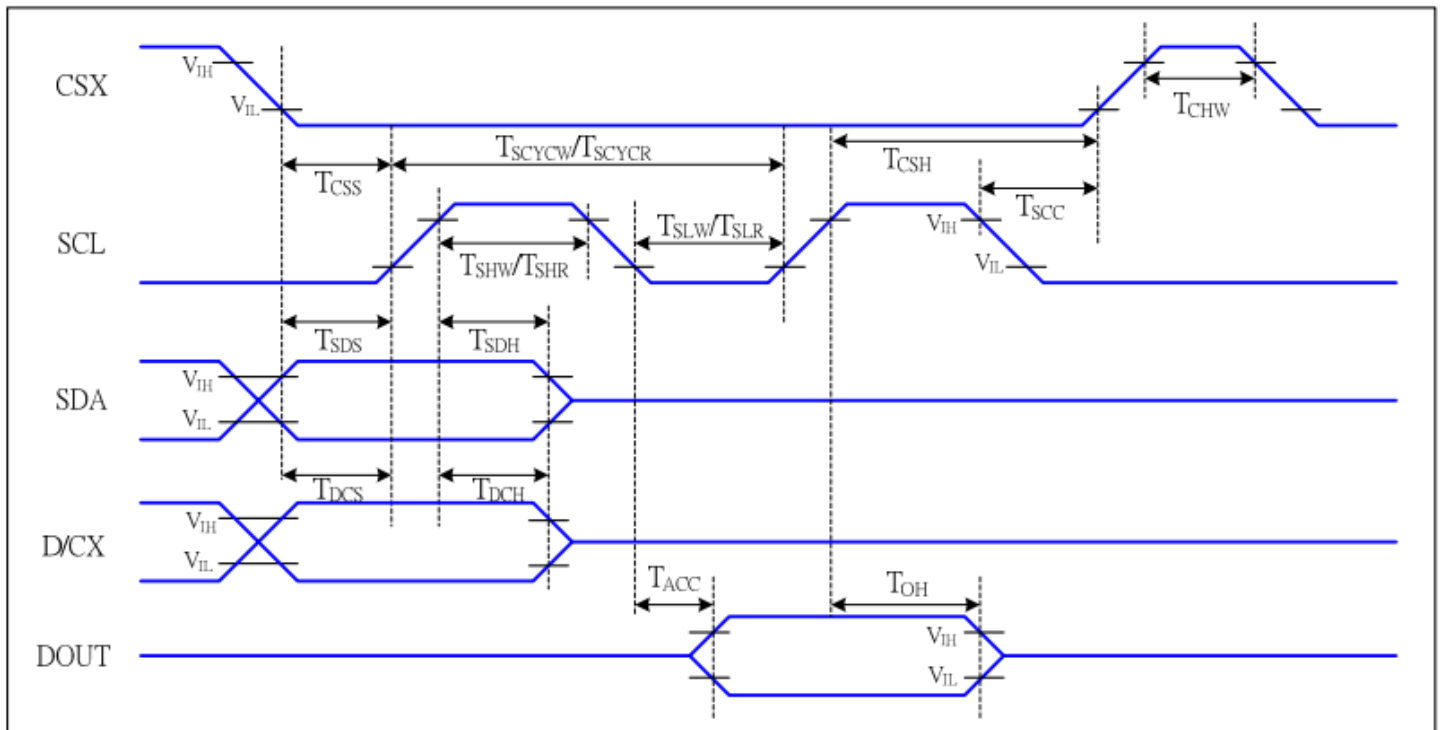
Timing Characteristics

3-Wire Serial Peripheral Interface Timing Characteristics



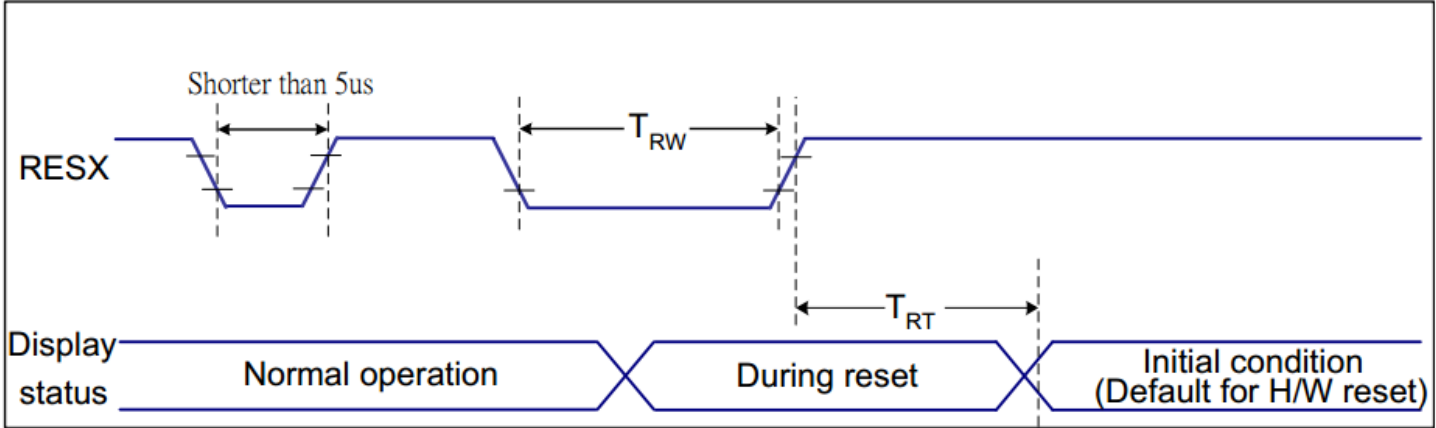
Signal	Symbol	Parameter	Min	Max	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15		ns	
	T_{CSH}	Chip select hold time (write)	15		ns	
	T_{CSS}	Chip select setup time (read)	60		ns	
	T_{SCC}	Chip select hold time (read)	65		ns	
	T_{CHW}	Chip select "H" pulse width	40		ns	
SCL	T_{SCYCW}	Serial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

4-Wire Serial Peripheral Interface Timing Characteristics



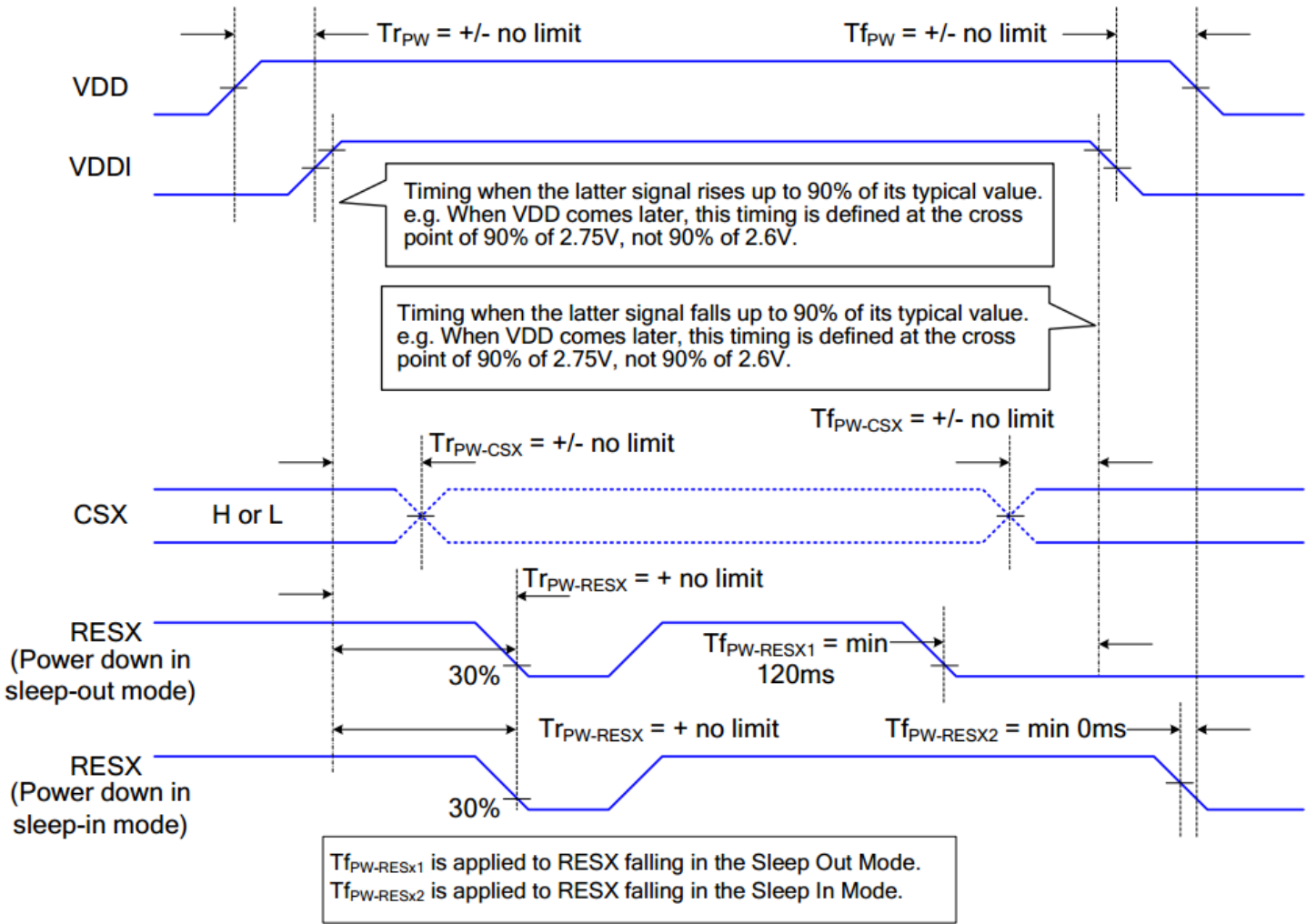
Signal	Symbol	Parameter	MIN	MAX	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15		ns	
	T_{CSH}	Chip select hold time (write)	15		ns	
	T_{CSS}	Chip select setup time (read)	60		ns	
	T_{SCC}	Chip select hold time (read)	65		ns	
	T_{CHW}	Chip select "H" pulse width	40		ns	
SCL	T_{SCYCW}	Serial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

Warranty Information

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

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