NEWHAVEN DISPLAY INTERNATIONAL

Product Specification

NHD-2.4-240320AF-CSXP-CTP

TFT Liquid Crystal Display

NHD-	Newhaven Display
2.4-	2.4" Diagonal
240320-	240xRGBx320 Pixels
AF-	Model
C-	Built-in Controller
S-	High Brightness, White LED Backlight
X -	TFT
P-	IPS, Wide Temperature
CTP-	Capacitive Touch Panel

Newhaven Display International, Inc.
2661 Galvin Court, Elgin, IL 60124 USA

Ph: 847.844.8795 | Fx: 847.844.8796
www.newhavendisplay.com

REACH Compliant

RoHS Compliant

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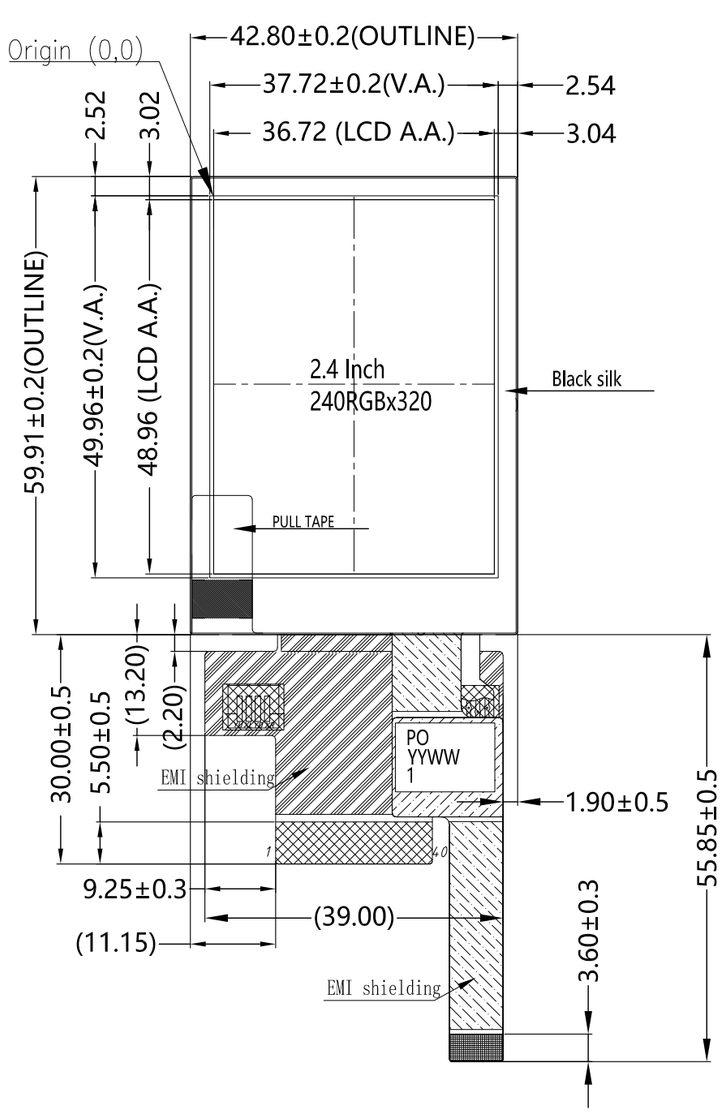
Additional Resources

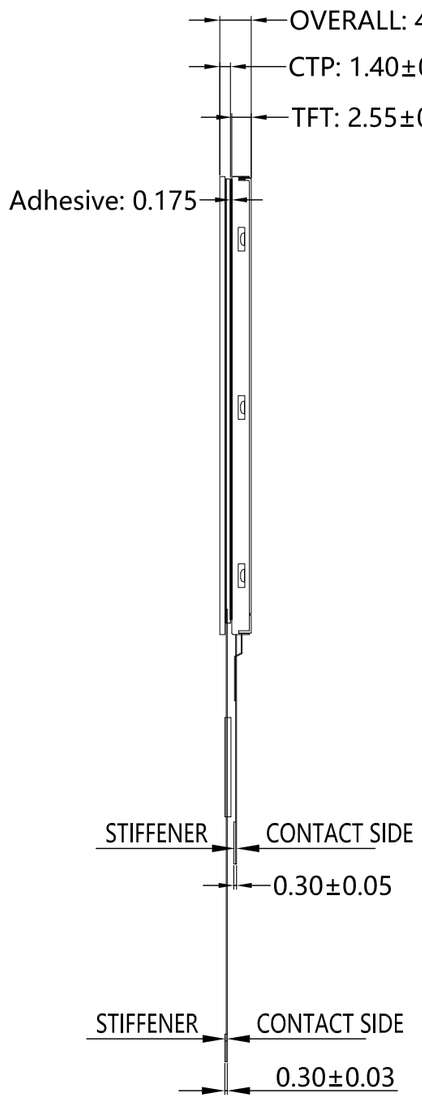
- **Support Forum:** https://support.newhavendisplay.com/hc/en-us/community/topics
- **GitHub:** https://github.com/newhavendisplay
- **Example Code:** https://support.newhavendisplay.com/hc/en-us/categories/4409527834135-Example-Code/
- **Knowledge Center:** https://www.newhavendisplay.com/knowledge_center.html
- **Quality Center:** https://www.newhavendisplay.com/quality_center.html
- **Precautions for using LCDs/LCMs:** https://www.newhavendisplay.com/specs/precautions.pdf
- **Warranty / Terms & Conditions:** https://www.newhavendisplay.com/terms.html

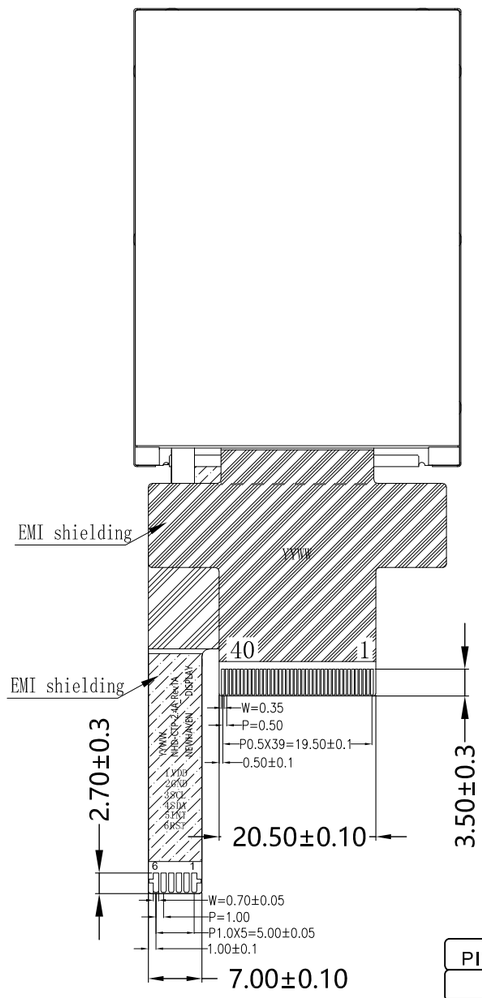
Document Revision History

Revision	Date	Description	Changed By
-	09/18/2023	Initial Release	KL

Mechanical Drawing







1	GND
2	NC
3	NC
4	NC
5	NC
6	SDO
7	VDD
8	VDDI
9	SDA
10	CSX
11	DCX
12	WRX
13	RDX
14-21	DB0-DB7
22-29	DB8-DB15
30	RESX
31	IM0
32	IM2
33	GND
34	LED-K1
35	LED-K2
36	LED-K3
37	LED-K4
38	LED-A
39	GND
40	TE

PIN Definition

PIN	DEFINE
1	VDD 3.3V
2	GND
3	SCL 3.3V
4	SDA 3.3V
5	INT 3.3V
6	RESET 3.3V

Product Description: 2.4” 240x320 IPS TFT w/ Capacitive Touch

1. Driver IC: ST7789VI TFT, FT5426-003 CTP
2. Interface: 8/16-bit Parallel, 3-Line SPI TFT, I²C CTP
3. Power Requirement: 3.3V TFT, 3.3V CTP
4. Optical Features: Normally Black, Transmissive, 1020cd/m²
5. Recommended FFC Connector:
   TFT: 40 pin 0.5mm pitch; Ex. Molex 54132-4062
   CTP: 6 pin 1.0mm pitch; Ex. Molex 52271-0679
6. Key Features: EMI Shielded FPC, 5-point Multitouch

Standard Tolerance:
(Unless otherwise specified)
Linear: ±0.3mm

NEWHAVEN DISPLAY INTERNATIONAL

Drawing/Part Number:	Revision:
NHD-2.4-240320AF-CSXP-CTP	2A

Unless otherwise specified:
• Dimensions are in Millimeters
• Third Angle Projection

Drawn By:	Approved By:
K. Lewis	K. Lewis
Drawn Date: 06/09/2023	Approved Date: 06/09/2023

Pin Description

TFT:

Pin No.	Symbol	External Connection	Function Description
1	GND	Power Supply	Ground
2	NC	-	No Connect
3	NC	-	No Connect
4	NC	-	No Connect
5	NC	-	No Connect
6	SDO	MPU	Serial Data Out
7	VDD	Power Supply	Supply Voltage for LCD (3.3V)
8	VDDI	Power Supply	Supply Voltage for Logic
9	SDA	MPU	Serial Data In
10	CSX	MPU	Active LOW Chip Select signal
11	DCX	MPU	Data / Command selection: '1' = Data; '0' = Command
12	WRX	MPU	Active LOW Write signal
13	RDX	MPU	Active LOW Read signal
14-21	DB0-DB7	MPU	Bi-directional data bus 8-bit: use DB8-DB15 16-bit: use DB0-DB15
22-29	DB8-DB15	MPU	
30	RESX	MPU	Active LOW Reset signal
31	IM0	MPU	Interface Mode Select
32	IM2	MPU	Interface Mode Select
33	GND	Power Supply	Ground
34	LED-K1	Power Supply	Backlight Cathode (Ground)
35	LED-K2	Power Supply	
36	LED-K3	Power Supply	
37	LED-K4	Power Supply	
38	LED-A	Power Supply	Backlight Anode (3.0V/160mA)
39	GND	Power Supply	Ground
40	TE	MPU	Tearing Effect Output

Recommended LCD connector: 40-pin, 0.5mm pitch FFC connector **Molex P/N**: 54132-4062 or similar

CTP:

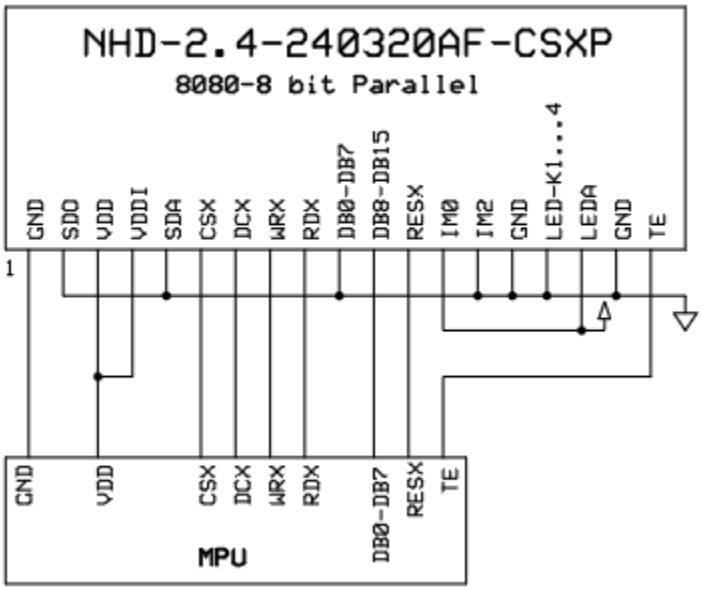
Pin No.	Symbol	External Connection	Function Description
1	V_{DD}	Power Supply	Supply voltage for Logic (3.3V)
2	V_{SS}	Power Supply	Ground
3	SCL	MPU	Serial I2C Clock (Requires 4.7KΩ pull-up resistor)
4	SDA	MPU	Serial I2C Data (Requires 4.7kΩ pull-up resistor)
5	/INT	MPU	Interrupt signal from touch panel module to host
6	/RESET	MPU	Active LOW Reset signal

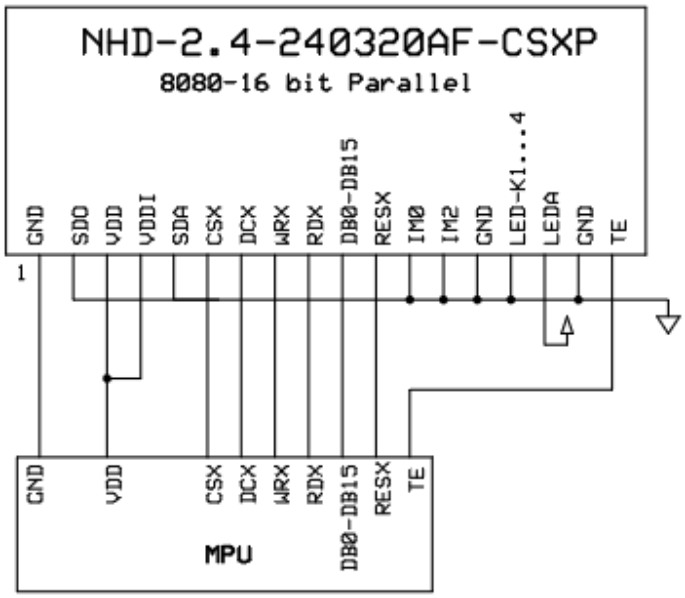
Recommended connector: 6pin, 1.0mm pitch, FFC connector. Molex P/N 52271-0679

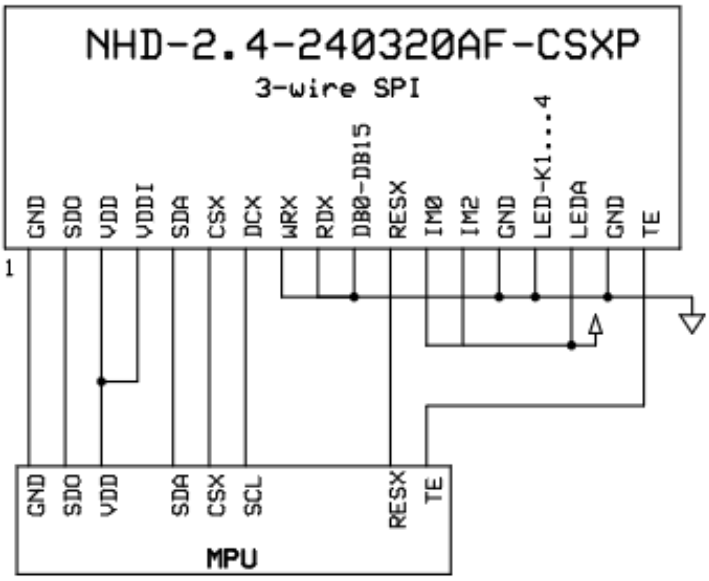
Interface Selection

Pin Name	8-bit 8080-II Parallel	16-bit 8080-II Parallel	3-wire SPI
IM0	1	0	1
IM2	0	0	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}	-	2.7	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	5	10	15	mA
"H" Level input	V_{IH}	-	0.7 * V_{DDI}	-	V_{DDI}	V
"L" Level input	V_{IL}	-	GND	-	0.3 * V_{DDI}	V
"H" Level output	V_{OH}	-	0.8 * V_{DDI}	-	V_{DDI}	V
"L" Level output	V_{OL}	-	GND	-	0.2 * V_{DDI}	V
Backlight Supply Current	I_{LED}	-	80	160	200	mA
Backlight Supply Voltage	V_{LED}	I_{LED} = 160mA	2.7	3.0	3.4	V
Backlight Lifetime*	-	I_{LED} = 160mA 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.

Capacitive Touch Panel:

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	V_{DD}	-	2.8	-	3.3	V
Supply Current – Operating	I_{DD}	-	-	15	23	mA
"H" Level input	V_{IH}	-	0.7*V_{DD}	-	V_{DD}	V
"L" Level input	V_{IL}	-	V_{SS}	-	0.3*V_{DD}	V
"H" Level output	V_{OH}	-	0.7*V_{DD}	-	V_{DD}	V
"L" Level output	V_{OL}	-	V_{SS}	-	0.3*V_{DD}	V

Optical Characteristics

Item		Symbol	Condition	Min.	Typ.	Max.	Unit
Optimal Viewing Angles	Top	φY+	CR ≥ 10	70	80	-	º
	Bottom	φY-		70	80	-	º
	Left	θX-		70	80	-	º
	Right	θX-		70	80	-	º
Contrast Ratio		CR	-	1000	1500	-	-
Luminance		L_V	I_{LED} = 160mA	850	1020	-	cd/m^2
Response Time		$T_R + T_F$	T_{OP} = 25°C	-	35	45	ms
Chromaticity	Red	X_R	-	0.585	0.635	0.685	-
		Y_R	-	0.291	0.341	0.391	-
	Green	X_G	-	0.276	0.326	0.376	-
		Y_G	-	0.569	0.619	0.669	-
	Blue	X_B	-	0.105	0.155	0.205	-
		Y_B	-	0.026	0.076	0.126	-
	White	X_W	-	0.283	0.313	0.343	-
		Y_W	-	0.299	0.329	0.359	-

Driver/Controller Information

Built-in ST7789VI Source Driver: https://support.newhavendisplay.com/hc/en-us/articles/10814990300823-ST7789VI

Built-in FT5426-003 Controller: https://support.newhavendisplay.com/hc/en-us/articles/4414392845079-FT5x26

Capacitive Touch Panel Registers

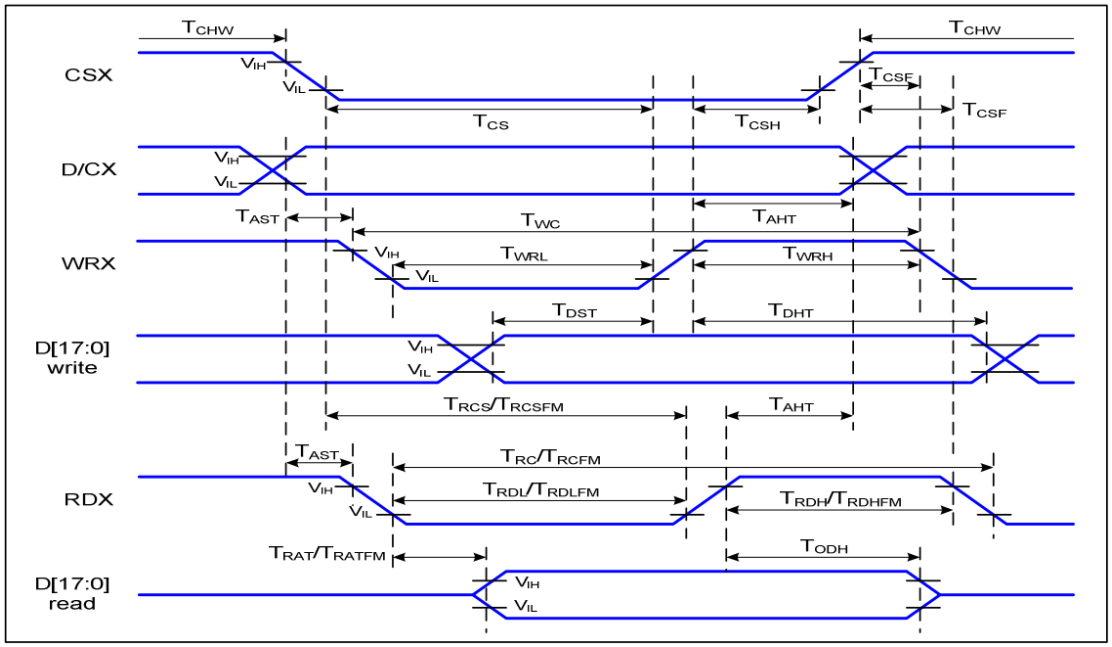
Register No.	Access	Register Name	Bits	Value	Description
01h	RO	Gesture ID	[7:0]	1Ch 14h 10h 18h 48h 49h 00	Swipe Up Swipe Down Swipe Left Swipe Right Zoom In Zoom Out No gesture
02h	RO	Touch Points	[7:0]	0-Ah	0: No touch detected A: 5 touch points detected
03h	RO	TOUCH1_Event_Flag	[7:6]	0 1 2 3	Put Down Put Up Contact Reserved
03h	RO	TOUCH1_XH	[3:0]	0 -1	Upper 4 bits of X touch coordinate
04h	RO	TOUCH1_XL	[7:0]	00 – FFh	Lower 8 bits of X touch coordinate
05h	RO	TOUCH1_YH	[3:0]	0 -1	Upper 4 bits of Y touch coordinate
06h	RO	TOUCH1_YL	[7:0]	00 – FFh	Lower 8 bits of Y touch coordinate
07h	RO	TOUCH1_Weight	[7:0]		Touch Weight
08h	RO	TOUCH1_Misc	[3:0]	00-0Fh	Touch Area
09h	RO	TOUCH2_Event_Flag	[7:6]	0 1 2 3	Put Down Put Up Contact Reserved
09h	RO	TOUCH1_XH	[3:0]	0 -1	Upper 4 bits of X touch coordinate
0Ah	RO	TOUCH2_XL	[7:0]	00 – FFh	Lower 8 bits of X touch coordinate
0Bh	RO	TOUCH2_YH	[3:0]	0 -1	Upper 4 bits of Y touch coordinate
0Ch	RO	TOUCH2_YL	[7:0]	00 – FFh	Lower 8 bits of Y touch coordinate
0Dh	RO	TOUCH2_Weight	[7:0]		Touch Weight
0Eh	RO	TOUCH2_Misc	[3:0]	00-0Fh	Touch Area
0Fh	RO	TOUCH3_Event_Flag	[7:6]	0 1 2 3	Put Down Put Up Contact Reserved
0Fh	RO	TOUCH3_XH	[3:0]	0 -1	Upper 4 bits of X touch coordinate
10	RO	TOUCH3_XL	[7:0]	00 – FFh	Lower 8 bits of X touch coordinate
11h	RO	TOUCH3_YH	[3:0]	0 -1	Upper 4 bits of Y touch coordinate
12h	RO	TOUCH3_YL	[7:0]	00 – FFh	Lower 8 bits of Y touch coordinate
13h	RO	TOUCH3_Weight	[7:0]		Touch Weight
14h	RO	TOUCH3_Misc	[3:0]	00-0Fh	Touch Area
15h	RO	TOUCH4_Event_Flag	[7:6]	0 1 2 3	Put Down Put Up Contact Reserved
15h	RO	TOUCH4_XH	[3:0]	0 -1	Upper 4 bits of X touch coordinate
16h	RO	TOUCH4_XL	[7:0]	00 – FFh	Lower 8 bits of X touch coordinate
17h	RO	TOUCH4_YH	[3:0]	0 -1	Upper 4 bits of Y touch coordinate
18h	RO	TOUCH4_YL	[7:0]	00 – FFh	Lower 8 bits of Y touch coordinate
1Ah	RO	TOUCH4_Misc	[3:0]	00-0Fh	Touch Area
1Bh	RO	TOUCH5_Event_Flag	[7:6]	0 1 2 3	Put Down Put Up Contact Reserved

Register No.	Access	Register Name	Bits	Value	Description
1Bh	RO	TOUCH5_XH	[3:0]	0 -1	Upper 4 bits of X touch coordinate
1Ch	RO	TOUCH5_XL	[7:0]	00 – FFh	Lower 8 bits of X touch coordinate
1Dh	RO	TOUCH5_YH	[3:0]	0 -1	Upper 4 bits of Y touch coordinate
1Eh	RO	TOUCH5_YL	[7:0]	00 – FFh	Lower 8 bits of Y touch coordinate
1Fh	RO	TOUCH5_Weight	[7:0]		Touch Weight
20	RO	TOUCH5_Misc	[3:0]	00-0Fh	Touch Area
21h	RO	TOUCH6_Event_Flag	[7:6]	0 1 2 3	Put Down Put Up Contact Reserved
21h	RO	TOUCH6_XH	[3:0]	0 -1	Upper 4 bits of X touch coordinate
22h	RO	TOUCH6_XL	[7:0]	00 – FFh	Lower 8 bits of X touch coordinate
23h	RO	TOUCH6_YH	[3:0]	0 -1	Upper 4 bits of Y touch coordinate
24h	RO	TOUCH6_YL	[7:0]	00 – FFh	Lower 8 bits of Y touch coordinate
25h	RO	TOUCH6_Weight	[7:0]		Touch Weight
26h	RO	TOUCH6_Misc	[3:0]	00-0Fh	Touch Area
27h	RO	TOUCH7_Event_Flag	[7:6]	0 1 2 3	Put Down Put Up Contact Reserved
27h	RO	TOUCH7_XH	[3:0]	0 -1	Upper 4 bits of X touch coordinate
28h	RO	TOUCH7_XL	[7:0]	00 – FFh	Lower 8 bits of X touch coordinate
29h	RO	TOUCH7_YH	[3:0]	0 – 1	Upper 4 bits of Y touch coordinate
2Ah	RO	TOUCH7_YL	[7:0]	00 – FFh	Lower 8 bits of Y touch coordinate
2Bh	RO	TOUCH7_Weight	[7:0]		Touch Weight
2Ch	RO	TOUCH7_Misc	[3:0]	00-0Fh	Touch Area
2Dh	RO	TOUCH8_Event_Flag	[7:6]	0 1 2 3	Put Down Put Up Contact Reserved
2Dh	RO	TOUCH8_XH	[3:0]	0 – 1	Upper 4 bits of X touch coordinate
2Eh	RO	TOUCH8_XL	[7:0]	00 – FFh	Lower 8 bits of X touch coordinate
2Fh	RO	TOUCH8_YH	[3:0]	0 – 1	Upper 4 bits of Y touch coordinate
30	RO	TOUCH8_YL	[7:0]	00 – FFh	Lower 8 bits of Y touch coordinate
31h	RO	TOUCH8_Weight	[7:0]		Touch Weight
32h	RO	TOUCH8_Misc	[3:0]	00-0Fh	Touch Area
33h	RO	TOUCH9_Event_Flag	[7:6]	0 1 2 3	Put Down Put Up Contact Reserved
33h	RO	TOUCH9_XH	[3:0]	0 – 1	Upper 4 bits of X touch coordinate
34h	RO	TOUCH9_XL	[7:0]	00 – FFh	Lower 8 bits of X touch coordinate
35h	RO	TOUCH9_YH	[3:0]	0 – 1	Upper 4 bits of Y touch coordinate
36h	RO	TOUCH9_YL	[7:0]	00 – FFh	Lower 8 bits of Y touch coordinate
37h	RO	TOUCH9_Weight	[7:0]		Touch Weight
38h	RO	TOUCH9_Misc	[3:0]	00 – 0Fh	Touch Area
39h	RO	TOUCH10_Event_Flag	[7:6]	0 1 2 3	Put Down Put Up Contact Reserved
39h	RO	TOUCH10_XH	[3:0]	0 – 1	Upper 4 bits of X touch coordinate
3Ah	RO	TOUCH10_XL	[7:0]	00 – FFh	Lower 8 bits of X touch coordinate
3Bh	RO	TOUCH10_YH	[3:0]	0 – 1	Upper 4 bits of Y touch coordinate
3Ch	RO	TOUCH10_YL	[7:0]	00 - FFh	Lower 8 bits of Y touch coordinate

Register No.	Access	Register Name	Bits	Value	Description
3Dh	RO	TOUCH10_Weight	[7:0]	00-FFh	Touch Weight
3Eh	RO	TOUCH10_Misc	[3:0]	00-0Fh	Touch Area
A1h	RO	ID_G_LIB_VERSION_H	[7:0]	00-FFh	App library version high-byte Default: 0
A2h	RO	ID_G_LIB_VERSION_L	[7:0]	00-FFh	App library version low-byte Default: 1h
A3h	RO	ID_G_CHIPER_HIGH	[7:0]	00-FFh	Chip Vendor ID Default: 0x54
A6h	RO	ID_G_FIRMID	[7:0]	00-FFh	Firmware ID Number Default: 1
A8h	RO	ID_G_VENODRID	[7:0]	00-FFh	CTPM Vendor's Chip ID Default: 79h

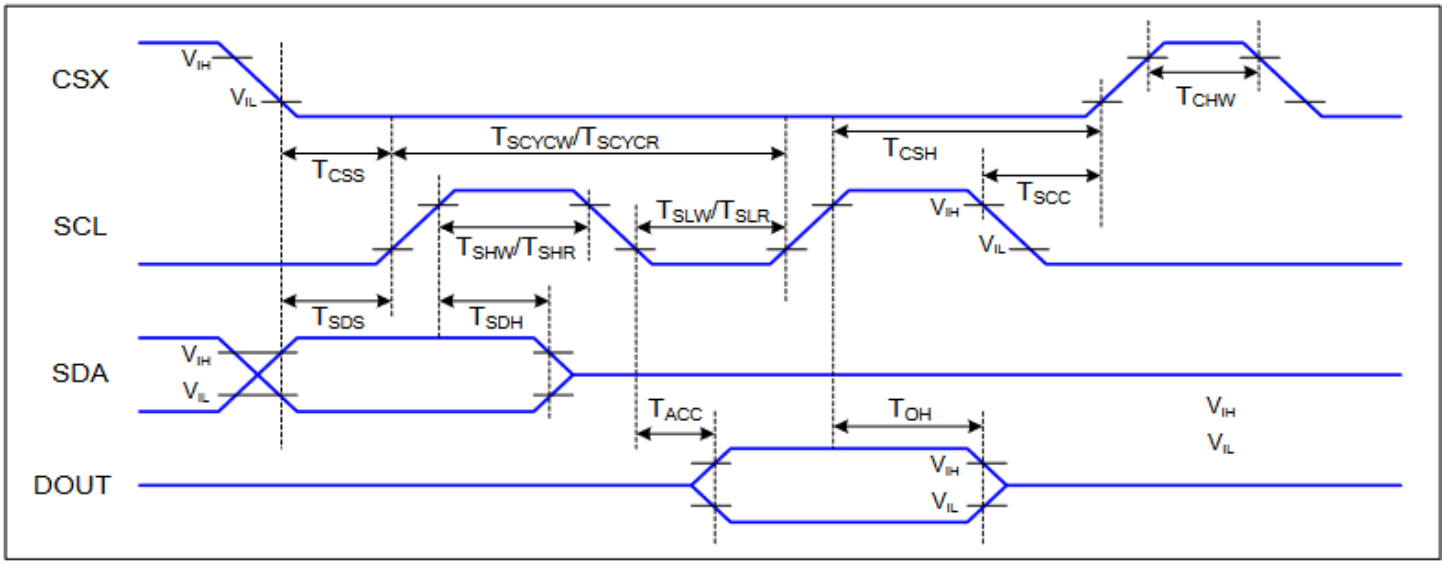
Timing Characteristics for TFT

Parallel 8/16-bit Interface Timing Characteristics



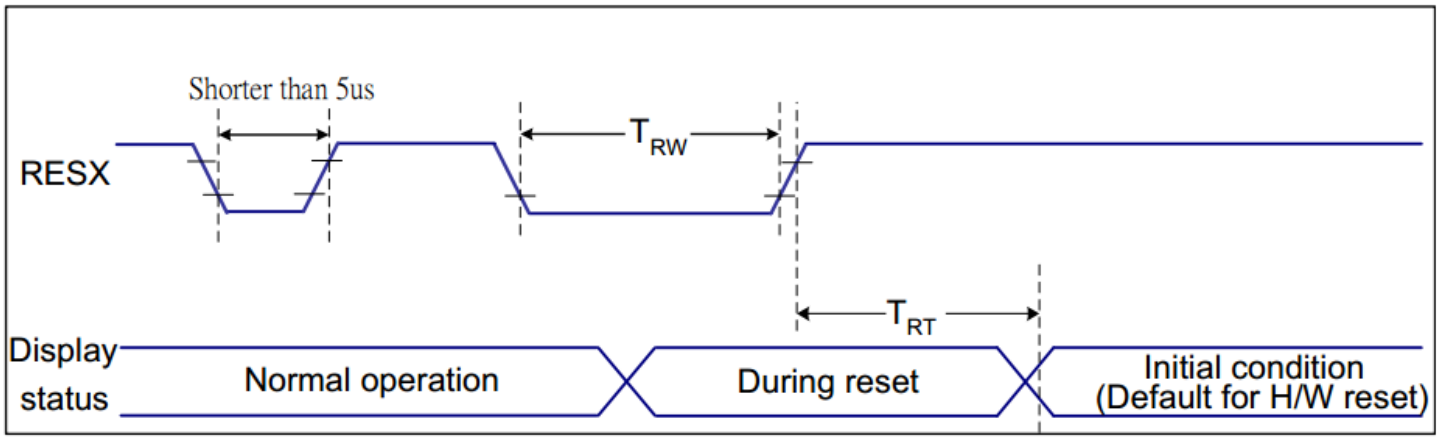
Signal	Symbol	Parameter	Min	Max	Unit	Description
D/CX	T_{AST}	Address setup time	0		ns	-
	T_{AHT}	Address hold time (Write/Read)	10		ns	
CSX	T_{CHW}	Chip select "H" pulse width	0		ns	-
	T_{CS}	Chip select setup time (Write)	15		ns	
	T_{RCS}	Chip select setup time (Read ID)	45		ns	
	T_{RCSFM}	Chip select 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	

3-line Serial interface Timing Characteristics



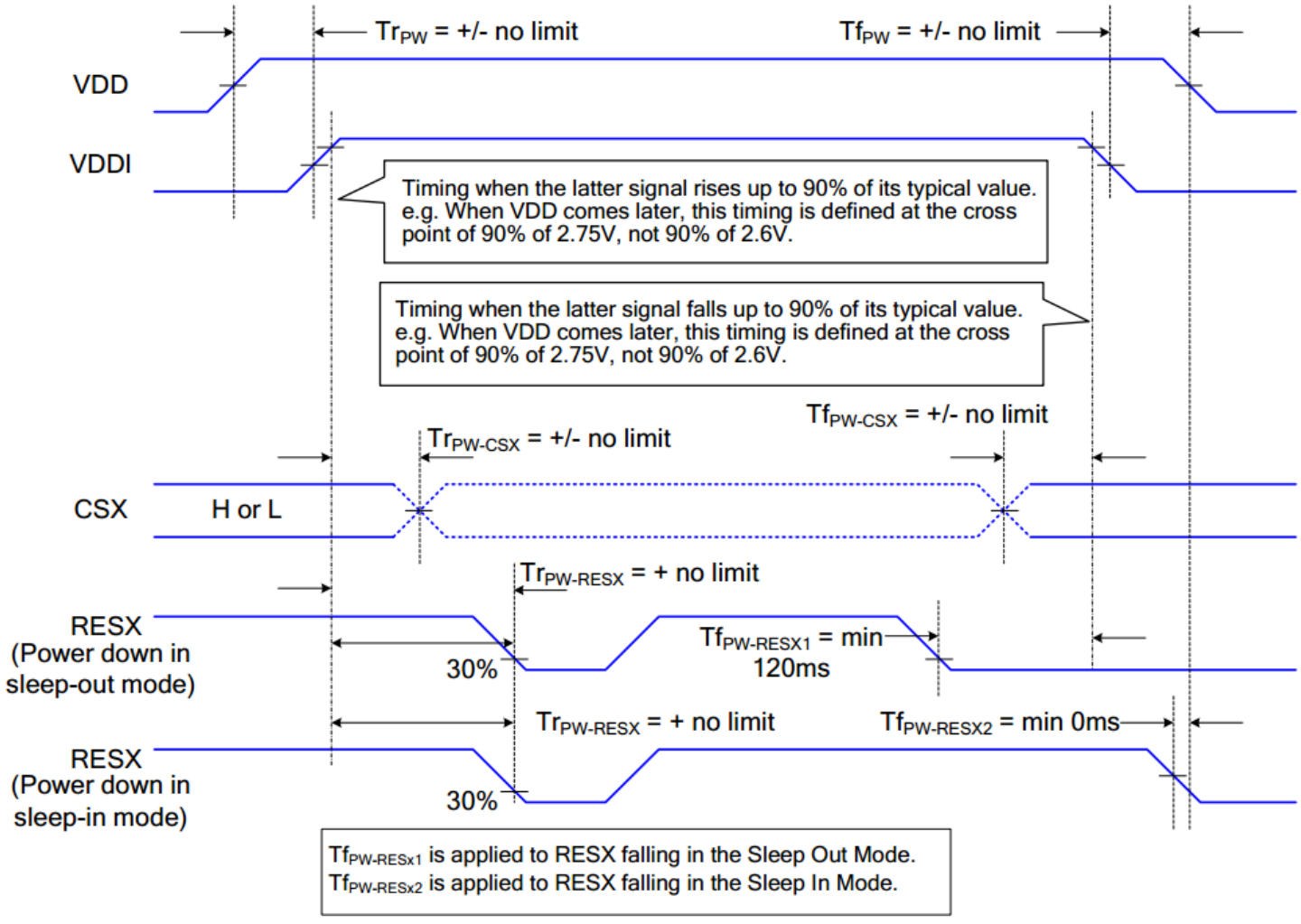
Signal	Symbol	Parameter	Min	Max	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15		ns	
	T_{CSH}	Chip select hold time (write)	15		ns	
	T_{CSS}	Chip select setup time (read)	60		ns	
	T_{SCC}	Chip select hold time (read)	65		ns	
	T_{CHW}	Chip select "H" pulse width	40		ns	
SCL	T_{SCYCW}	Serial 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

Reset Timing



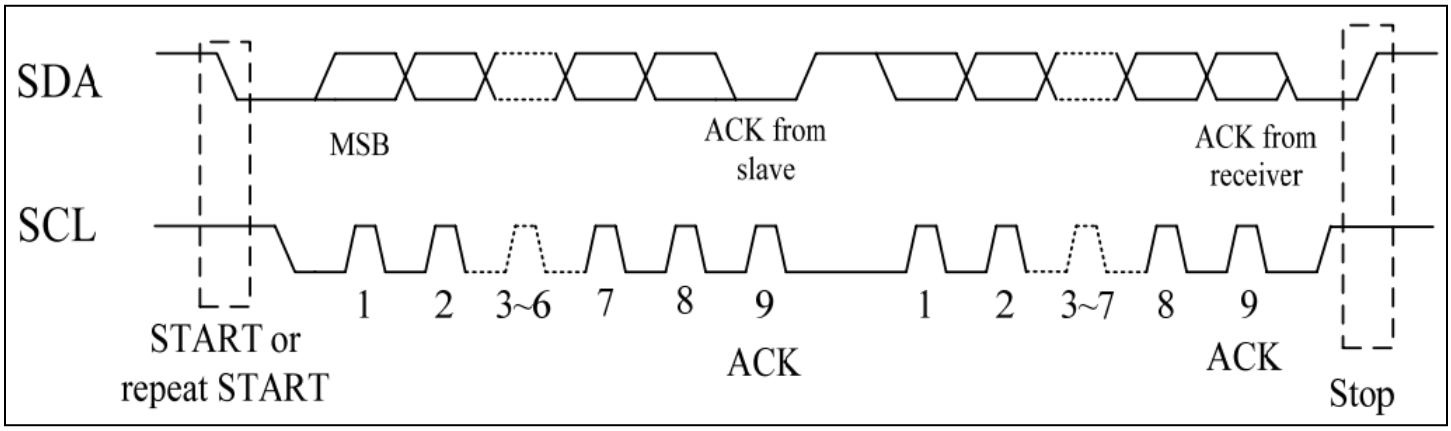
Related Pins	Symbol	Parameter	MIN	MAX	Unit
RESX	TRW	Reset pulse duration	10	-	us
	TRT	Reset cancel	-	5 (Note 1, 5)	ms
				120 (Note 1, 6, 7)	ms

Power ON/OFF Sequence

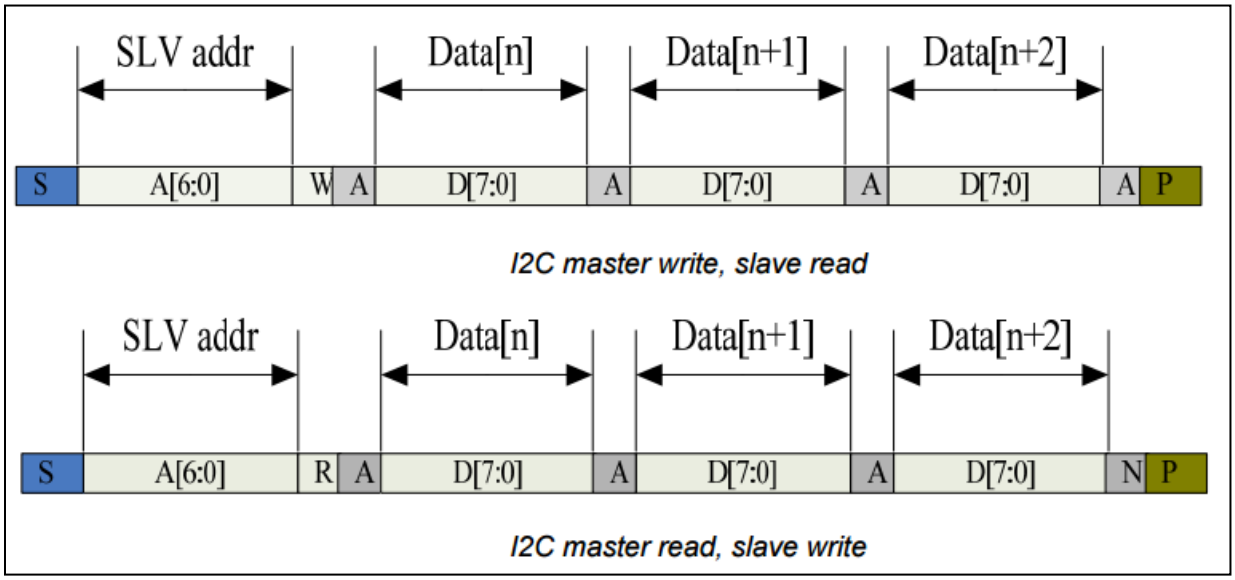


Timing Characteristics – Capacitive Touch Panel

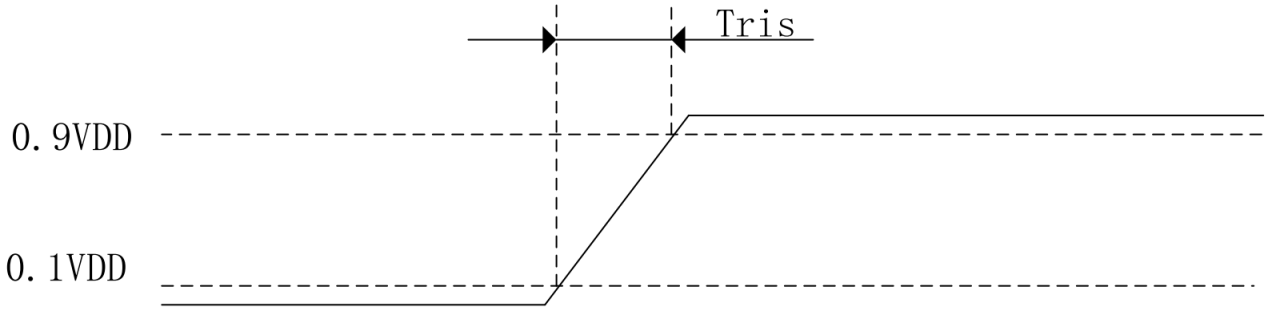
Data Transfer Format



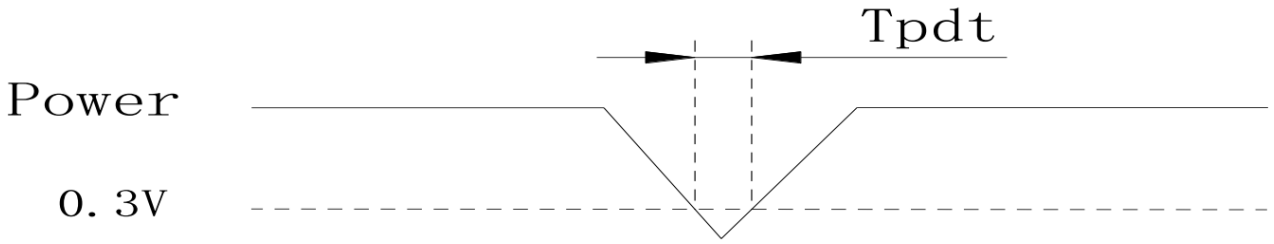
Parameter	Min	Max	Unit
SCL Frequency	0	400	KHz
Bus free time between a STOP & START condition	1.3	-	µs
Hold time Repeated START condition	0.6	-	µs
Data Setup Time	100	-	ns
Setup time for a repeated START condition	0.6	-	µs
Setup time for a STOP condition	0.6	-	µs



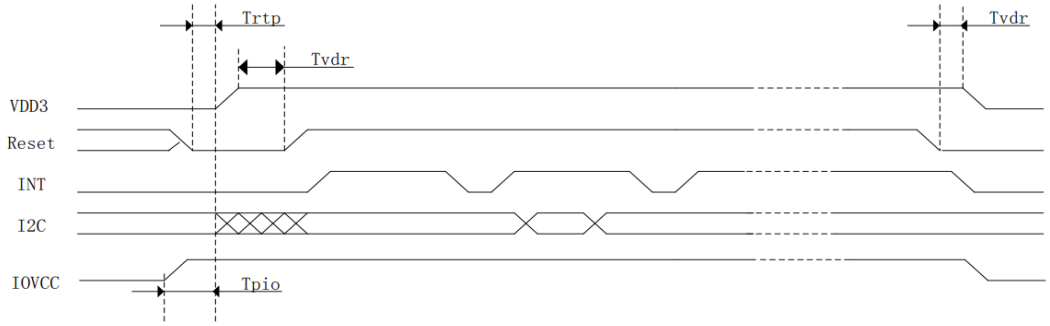
Power ON/Reset Sequence



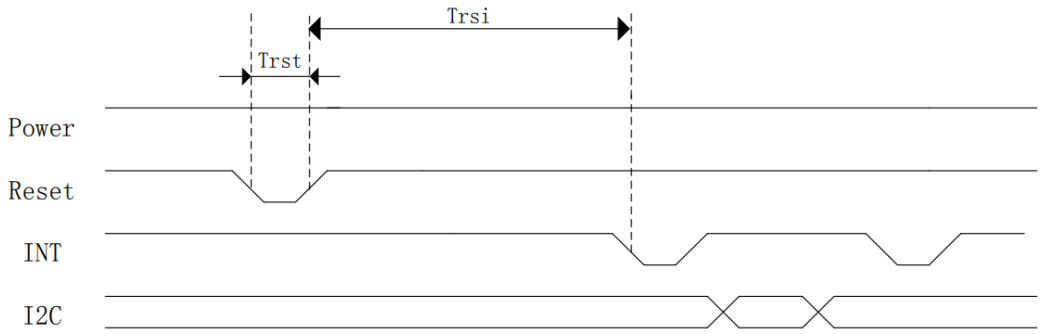
Power On Time



Power Cycle Requirement



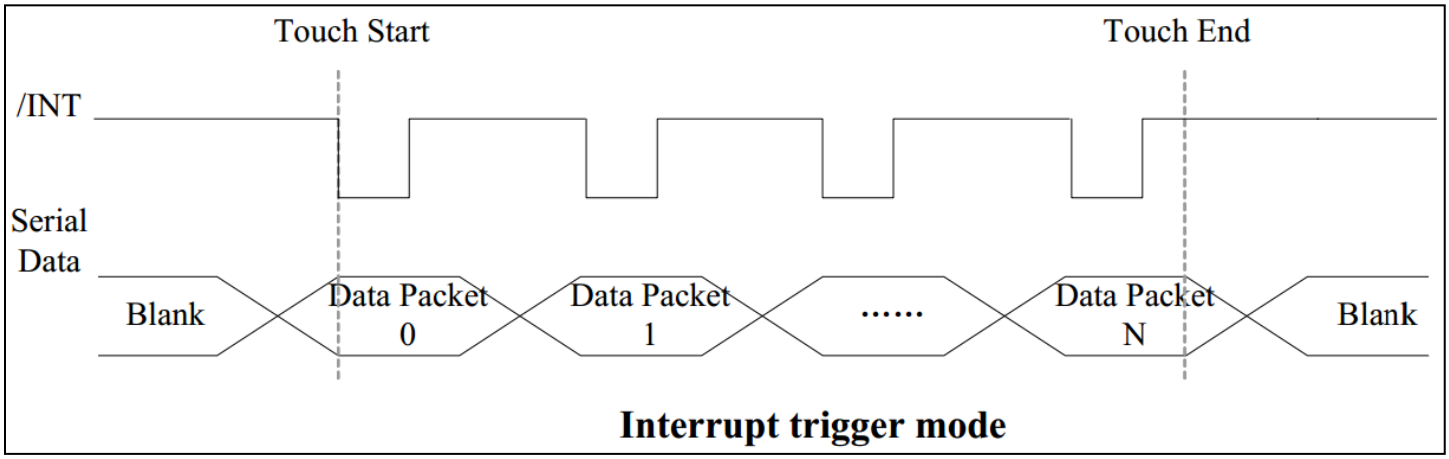
Power ON Sequence



Reset sequence

Parameter	Description	Min	Max	Unit
Tris	Rise time from 0.1V_{DD} to 0.9V_{DD}	-	5	ms
Tpdt	Time of the voltage of supply being below 0.3V	5	-	ms
Trtp	Time of resetting to be low before powering on	100	-	µs
Tpon	Time to start reporting after power on	-	200	ms
Tvdr*	Reset time after applying V_{DD}	1	-	ms
Trsi	Time to start reporting after reset	-	200	ms
Trst*	Reset Time	1	-	ms

*Note: If Reset is tied to V_{DD} data corruption can occur



Sample code to read touch data:

```
i2c_start();
i2c_tx(0x70);        //Slave Address (Write)
i2c_tx(0x00);        //Start reading address
i2c_stop();

i2c_start();
i2c_tx(0x71);        //Slave Address (Read)
for(i=0x00;i<0x1F;i++)
{touchdata_buffer[i] = i2c_rx(1);}
i2c_stop();
```

Sample code to overwrite default register values:

```
i2c_start();
i2c_tx(0x70);        //Slave Address (Write)
i2c_tx(0xA4);        //ID_G_Mode
i2c_tx(0x01);        //Disable interrupt status to host
i2c_stop();
```

Example Initialization Code

```
void Command_out(unsigned char c)  //Function used for sending commands to TFT
{
  PORTA &= ~(1 << PORTA3);   // Set DCX pin to LOW
  PORTL=c;                   // Assigning the Command Byte 'c' to PortL
  PORTA &= ~(1 << PORTA7);   // Set WRX pin to LOW
  PORTA |=  (1 << PORTA7);   // Set WRX pin to HIGH
 }

void data_out(unsigned char d) //Function used for sending data to TFT
{

  PORTA |=  (1 << PORTA3);   // Set DCX pin to HIGH
  PORTL=d;                   // Assigning the Data Byte 'd' to PortL
  PORTA &= ~(1 << PORTA7);   // Set WRX pin to LOW
  PORTA |=  (1 << PORTA7);   // Set WRX pin to HIGH
}


void TFT_init(){

  digitalWrite(RESX, LOW);
  delay(250);
  digitalWrite(RESX, HIGH);
  delay(250);

  Command_out(0x28);  //display off
  Command_out(0x11);  //exit SLEEP mode
  delay(100);

  Command_out(0x36);  //MADCTL: memory data access control
  data_out(0x88);

  Command_out(0x3A);  //COLMOD: Interface Pixel format  *** 65K-colors in 16bit/pixel (5-
6-5) format when using 16-bit interface to allow 1-byte per pixel
  data_out(0x55);

  Command_out(0xB2);  //PORCTRK: Porch setting
  data_out(0x0C);
  data_out(0x0C);
  data_out(0x00);
  data_out(0x33);
  data_out(0x33);

  Command_out(0xB7);  //GCTRL: Gate Control
  data_out(0x35);

  Command_out(0xBB);  //VCOMS: VCOM setting
  data_out(0x2B);

  Command_out(0xC0);  //LCMCTRL: LCM Control
  data_out(0x2C);

  Command_out(0xC2);  //VDVVRHEN: VDV and VRH Command Enable
  data_out(0x01);
  data_out(0xFF);

  Command_out(0xC3);  //VRHS: VRH Set
  data_out(0x11);
```

```
  Command_out(0xC4);  //VDVS: VDV Set
  data_out(0x20);

  Command_out(0xC6);  //FRCTRL2: Frame Rate control in normal mode
  data_out(0x0F);

  Command_out(0xD0);  //PWCTRL1: Power Control 1
  data_out(0xA4);
  data_out(0xA1);

  Command_out(0xE0);  //PVGAMCTRL: Positive Voltage Gamma control
  data_out(0xD0);
  data_out(0x00);
  data_out(0x05);
  data_out(0x0E);
  data_out(0x15);
  data_out(0x0D);
  data_out(0x37);
  data_out(0x43);
  data_out(0x47);
  data_out(0x09);
  data_out(0x15);
  data_out(0x12);
  data_out(0x16);
  data_out(0x19);

  Command_out(0xE1);  //NVGAMCTRL: Negative Voltage Gamma control
  data_out(0xD0);
  data_out(0x00);
  data_out(0x05);
  data_out(0x0D);
  data_out(0x0C);
  data_out(0x06);
  data_out(0x2D);
  data_out(0x44);
  data_out(0x40);
  data_out(0x0E);
  data_out(0x1C);
  data_out(0x18);
  data_out(0x16);
  data_out(0x19);

  Command_out(0x2A);  //X address set
  data_out(0x00);
  data_out(0x00);
  data_out(0x00);
  data_out(0xEF);

  Command_out(0x2B);  //Y address set
  data_out(0x00);
  data_out(0x00);
  data_out(0x01);
  data_out(0x3F);
  delay(10);
  Command_out(0x21);  //Color inversion for IPS
  Command_out(0x29);  //display ON
  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, 240hrs	2
Low Temperature Storage	Endurance test applying the low storage temperature for a long time.	-30°C, 240hrs	1,2
High Temperature Operation	Endurance test applying the electric stress (voltage & current) and the high thermal stress for a long time.	+70°C, 240hrs	2
Low Temperature Operation	Endurance test applying the electric stress (voltage & current) and the low thermal stress for a long time.	-20°C, 240hrs	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.	+60°C, 90% RH, 240hrs	1,2
Thermal Shock resistance	Endurance test applying the electric stress (voltage & current) during a cycle of low and high thermal stress.	-30°C 30min -> 25°C 3min -> 80°C 30min = 1 cycle. For 100 cycles	
Vibration test	Endurance test applying vibration to simulate transportation and use.	10Hz-55Hz (1 min.), 1.5mm amplitude. 30 min. exposure for each directions X,Y,Z	3
Static electricity test	Endurance test applying electric static discharge.	Air discharge: ±8kV 10 Times Contact discharge: ±4kV 10 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.