

Product Specification

NHD-2.4-240320AF-CTXP-CTP

TFT Liquid Crystal Display

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

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Additional Resources

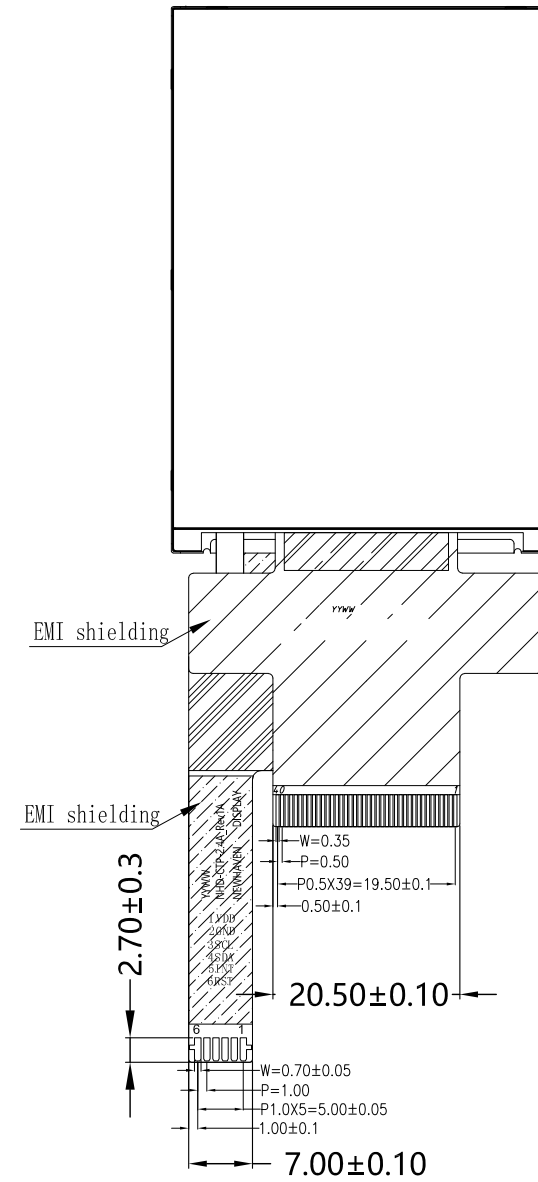
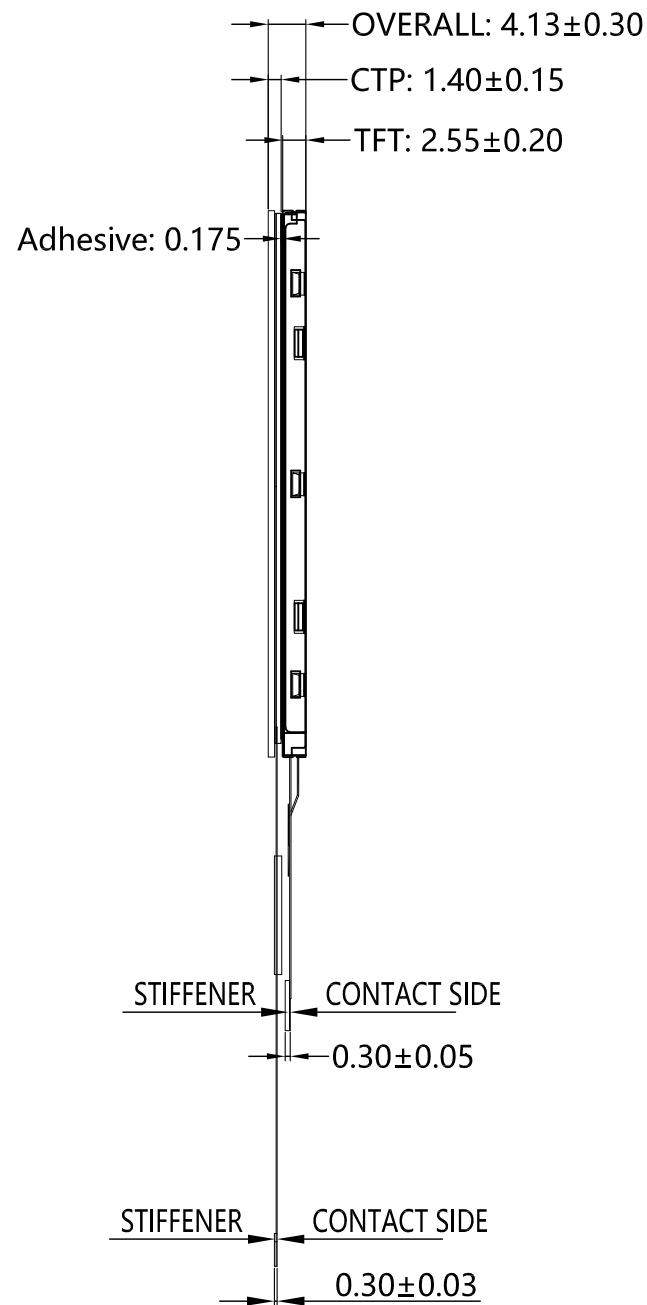
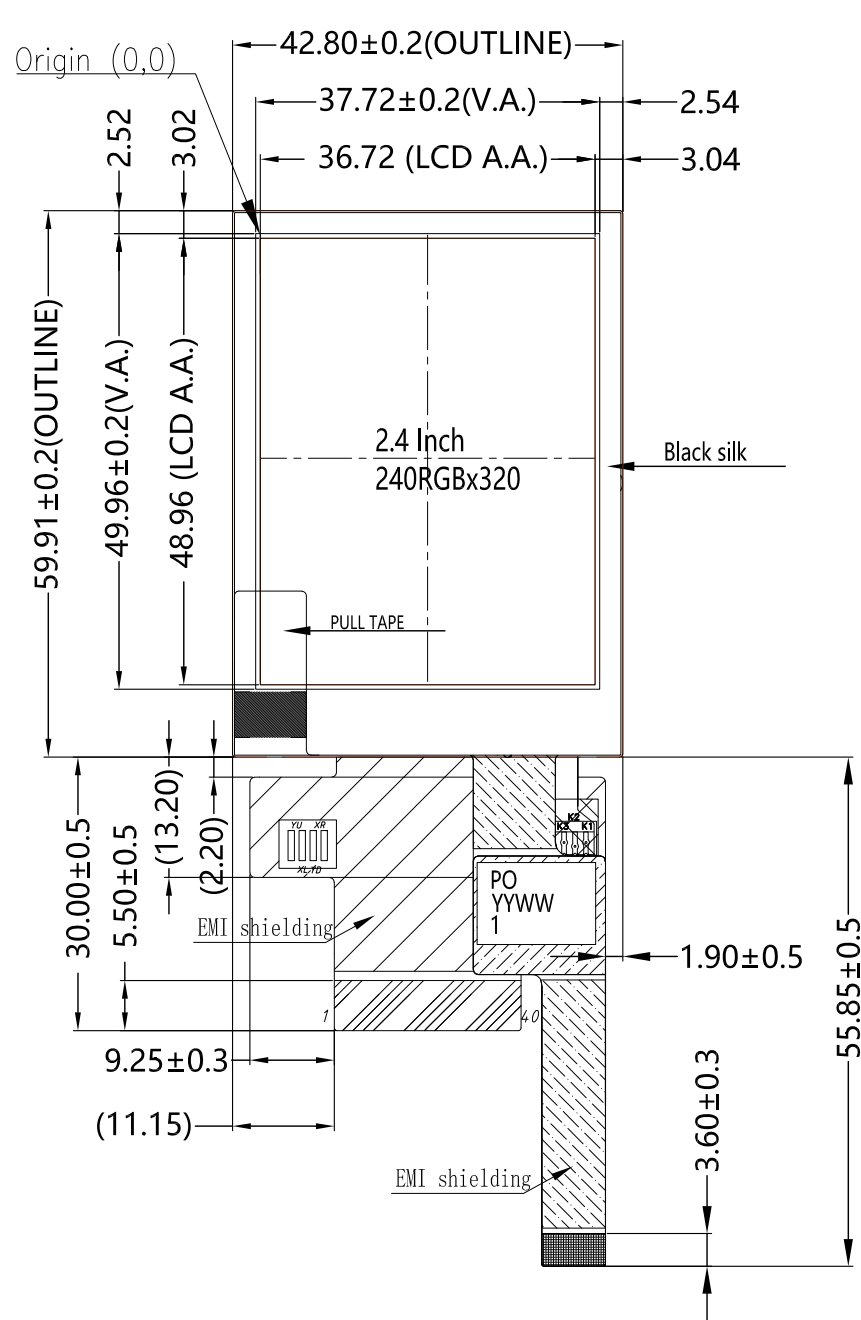
- **Support Forum:** <https://support.newhavendisplay.com/hc/en-us/community/topics>
- **GitHub:** <https://github.com/newhavendisplay>
- **Example Code:** <https://support.newhavendisplay.com/hc/en-us/categories/4409527834135-Example-Code/>
- **Knowledge Center:** https://www.newhavendisplay.com/knowledge_center.html
- **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



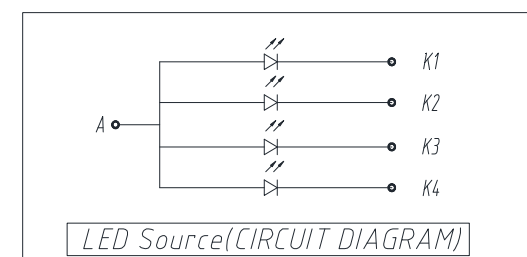
Pin No.	Symbol
1	GND
2	YD
3	XL
4	YU
5	XR
6	SDO
7	VDD
8	VDDI
9	SDA
10	CSX
11	DCX
12	WRX
13	RDX
14	DB0
15	DB1
16	DB2
17	DB3
18	DB4
19	DB5
20	DB6
21	DB7
22	DB8
23	DB9
24	DB10
25	DB11
26	DB12
27	DB13
28	DB14
29	DB15
30	RESX
31	IM0
32	IM2
33	GND
34	LED-K1
35	LED-K2
36	LED-K3
37	LED-K4
38	LED-A
39	GND
40	TE

CTP

Pin No.	Symbol
1	V _{DD}
2	V _{SS}
3	SCL
4	SDA
5	/INT
6	/RESET

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

1. Driver IC: ST7789VI TFT, FT5426-003 CTP
2. Interface: 8/16-bit 8080-II Parallel, 3-wire SPI TFT, I²C CTP
3. Power Requirement: 3.3V TFT, 3.1V/80mA Backlight
4. Optical Features: Normally Black, Transmissive, 298cd/m²
5. Recommended FFC Connector:
TFT: 40pin 0.5mm pitch; Ex. Molex 54132-4062
CTP: 6pin 1.0mm pitch; Ex. Molex 52271-0679
6. Key Features: EMI Shielded FPC, 5-point Multitouch



Standard Tolerance: (Unless otherwise specified) Linear: ±0.3mm			
	Drawing/Part Number: NHD-2.4-240320AF-CTXP-CTP	Revision: -	
Unless otherwise specified: • Dimensions are in Millimeters • Third Angle Projection	Drawn By: K. Lewis	Approved By: K. Lewis	
	Drawn Date: 06/12/2023	Approved Date: 06/12/2023	
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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 output
7	VDD	Power Supply	Supply Voltage for LCD (3.3V)
8	VDDI	Power Supply	Supply Voltage for Logic
9	SDA	MPU	Serial Data Input
10	CSX	MPU	Active LOW Chip Select signal
11	DCX	MPU	Parallel Interface: Data / Command selection: '1' = Data; '0' = Command Serial Interface: Serial Clock Signal
12	WRX	MPU	Active LOW Write signal
13	RDX	MPU	Active LOW Read signal
14-21	DB0-DB7	MPU	Bi-directional data bus
22-29	DB8-DB15	MPU	8-bit: use DB8-DB15 16-bit: use DB0-DB15
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 (3.1V/80mA)
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

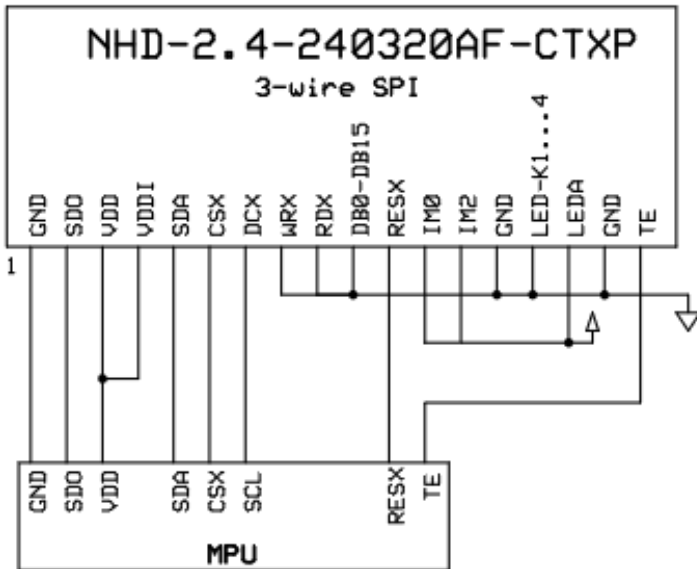
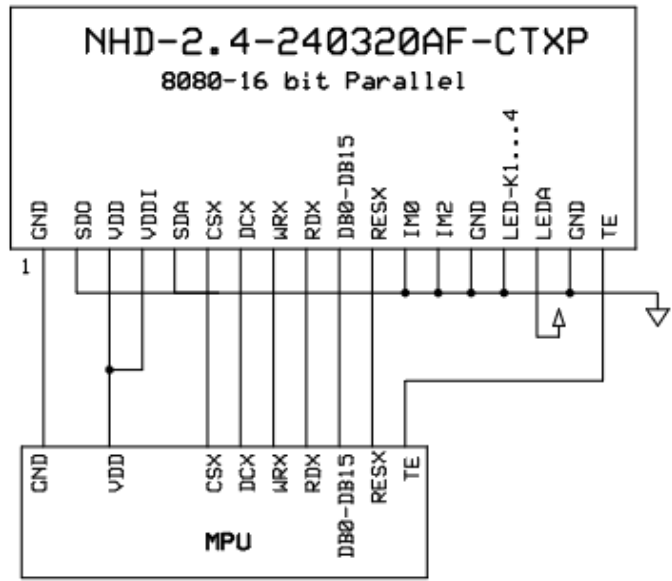
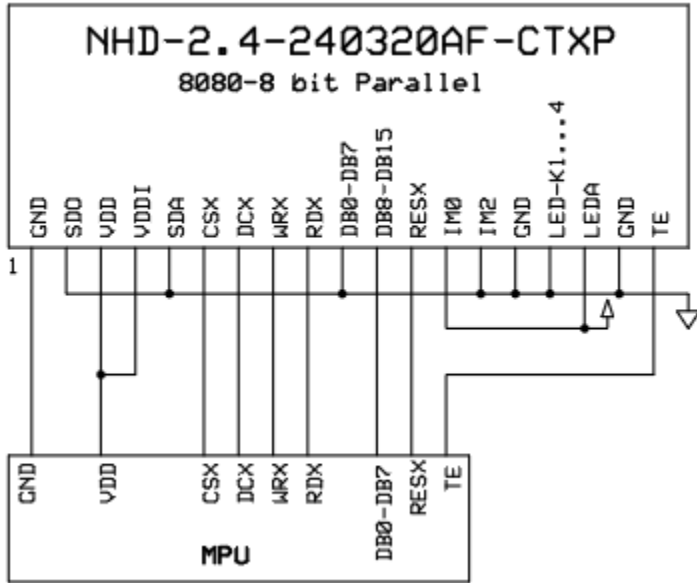
Recommended connector: 6pin, 1.0mm pitch, FFC connector. Molex P/N 52271-0679

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}	-	2.4	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	-	6	12	mA
"H" Level input	V _{IH}	-	0.7 * V _{DDI}	-	V _{DDI}	V
"L" Level input	V _{IL}	-	V _{SS}	-	0.3 * V _{DDI}	V
"H" Level output	V _{OH}	-	0.8 * V _{DDI}	-	V _{DDI}	V
"L" Level output	V _{OL}	-	V _{SS}	-	0.2 * V _{DDI}	V
Backlight Supply Current	I _{LED}	-	40	80	100	mA
Backlight Supply Voltage	V _{LED}	I _{LED} = 80mA	2.7	3.1	3.5	V
Backlight Lifetime*	-	I _{LED} = 80mA T _{OP} = 25°C	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.

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}	-	2.7	3.3	3.6	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	$\phi Y+$	CR \geq 10	70	80	-	$^{\circ}$
	Bottom	$\phi Y-$		70	80	-	$^{\circ}$
	Left	$\theta X-$		70	80	-	$^{\circ}$
	Right	$\theta X-$		70	80	-	$^{\circ}$
Contrast Ratio		CR	-	1000	1500	-	-
Luminance		L _V	I _{LED} = 80mA	214	298	380	cd/m ²
Response Time		T _R + T _F	T _{OP} = 25°C	-	35	45	ms
Chromaticity	Red	X _R	-	0.611	0.641	0.671	-
		Y _R	-	0.306	0.336	0.366	-
	Green	X _G	-	0.307	0.337	0.367	-
		Y _G	-	0.563	0.593	0.623	-
	Blue	X _B	-	0.113	0.143	0.173	-
		Y _B	-	0.038	0.068	0.098	-
	White	X _W	-	0.276	0.306	0.336	-
		Y _W	-	0.295	0.325	0.355	-

Driver/Controller Information

Built-in ST7789VI Controller: <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	Swipe Up
				14h	Swipe Down
				10h	Swipe Left
				18h	Swipe Right
				48h	Zoom In
				49h	Zoom Out
				00	No gesture
02h	RO	Touch Points	[7:0]	0-Ah	0: No touch detected A: 5touch points detected
03h	RO	TOUCH1_Event_Flag	[7:6]	0	Put Down
				1	Put Up
				2	Contact
				3	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	Put Down
				1	Put Up
				2	Contact
				3	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	Put Down
				1	Put Up
				2	Contact
				3	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	Put Down
				1	Put Up
				2	Contact
				3	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	Put Down
				1	Put Up
				2	Contact
				3	Reserved

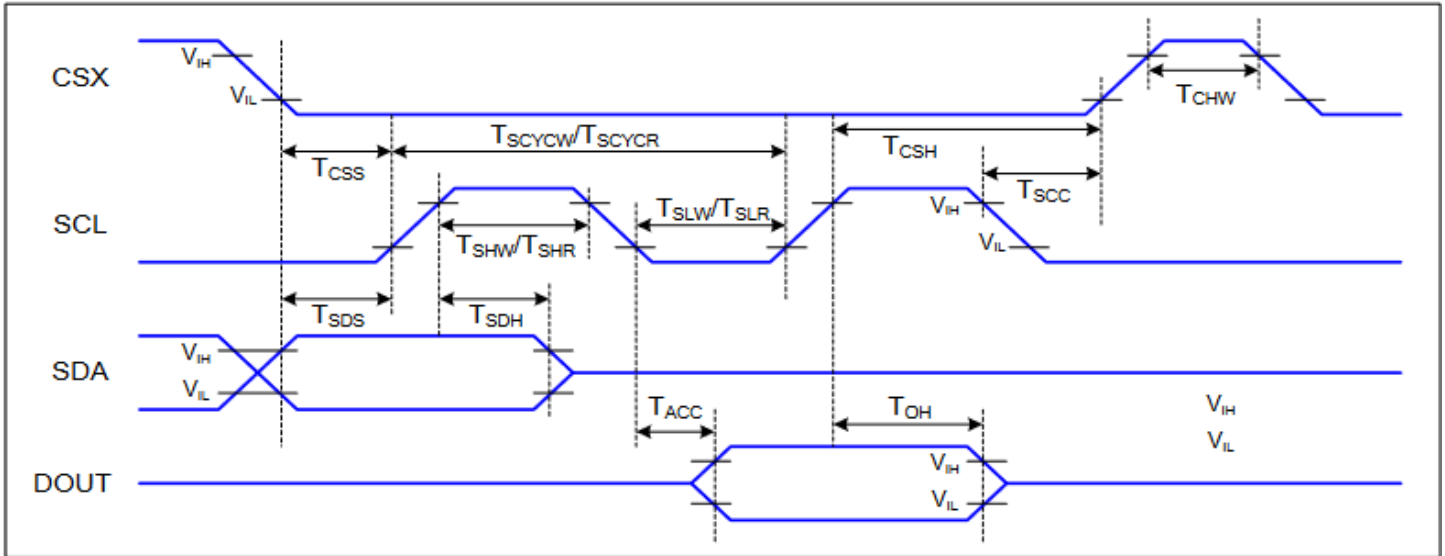


Register No.	Access	Register Name	Bits	Value	Description
1Bh	RO	TOUCH5_XH	[3:0]	0 -1	Upper 4 bits of X touch coordinate
1Ch	RO	TOUCH5_XL	[7:0]	00 – FFh	Lower 8 bits of X touch coordinate
1Dh	RO	TOUCH5_YH	[3:0]	0 -1	Upper 4 bits of Y touch coordinate
1Eh	RO	TOUCH5_YL	[7:0]	00 – FFh	Lower 8 bits of Y touch 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	Put Down
				1	Put Up
				2	Contact
				3	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	Put Down
				1	Put Up
				2	Contact
				3	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	Put Down
				1	Put Up
				2	Contact
				3	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	Put Down
				1	Put Up
				2	Contact
				3	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	Put Down
				1	Put Up
				2	Contact
				3	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



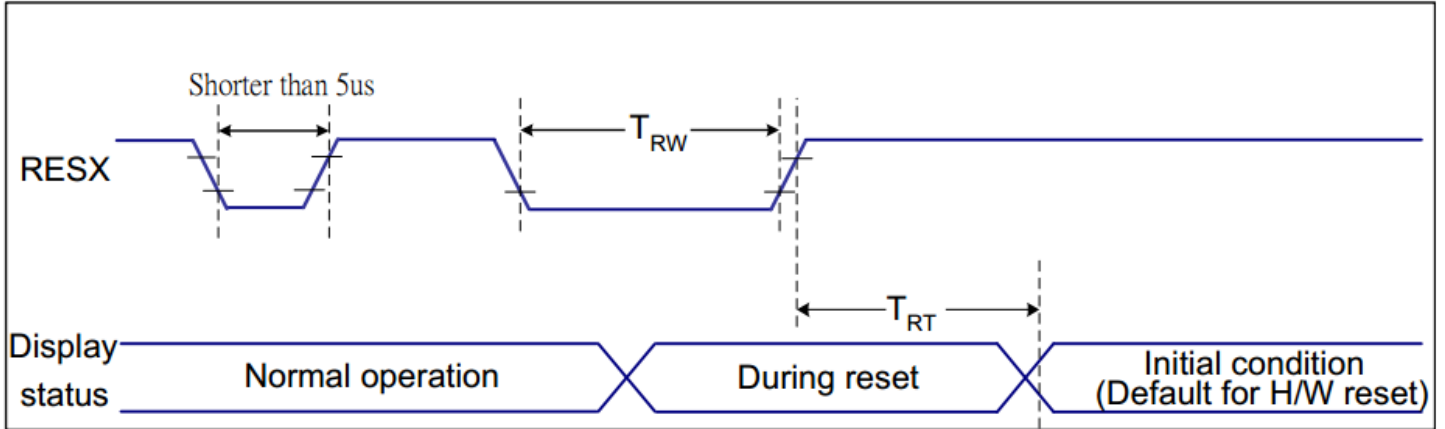
Register No.	Access	Register Name	Bits	Value	Description
3Dh	RO	TOUCH10_Weight	[7:0]	00-FFh	Touch Weight
3Eh	RO	TOUCH10_Misc	[3:0]	00-0Fh	Touch Area
A1h	RO	ID_G_LIB_VERSION_H	[7:0]	00-FFh	App library version high-byte Default: 0
A2h	RO	ID_G_LIB_VERSION_L	[7:0]	00-FFh	App library version low-byte Default: 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

3-line Serial interface Timing Characteristics



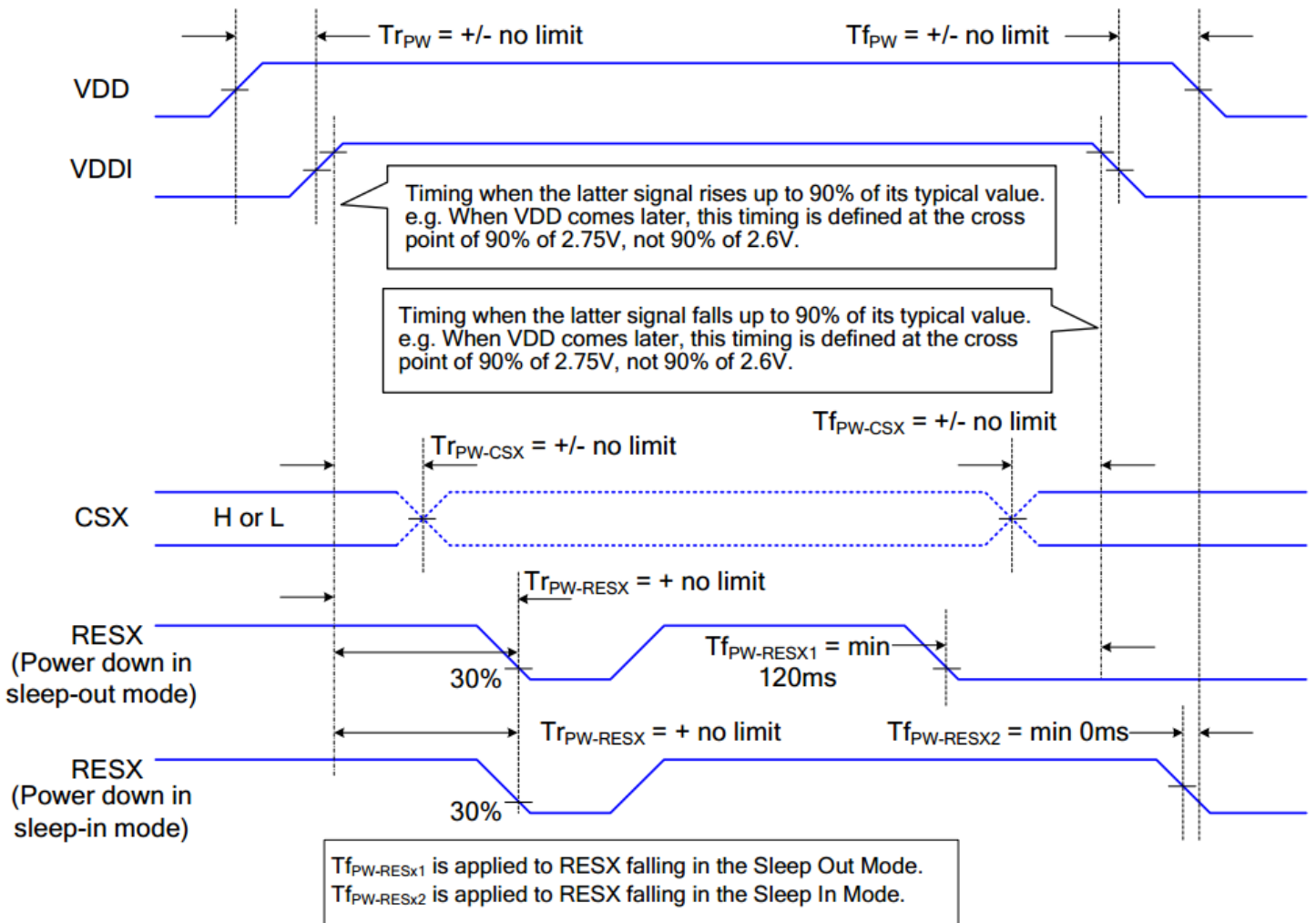
Signal	Symbol	Parameter	Min	Max	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15		ns	
	T_{CSH}	Chip select hold time (write)	15		ns	
	T_{CSS}	Chip select setup time (read)	60		ns	
	T_{SCC}	Chip select hold time (read)	65		ns	
	T_{CHW}	Chip select "H" pulse width	40		ns	
SCL	T_{SCYCW}	Serial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



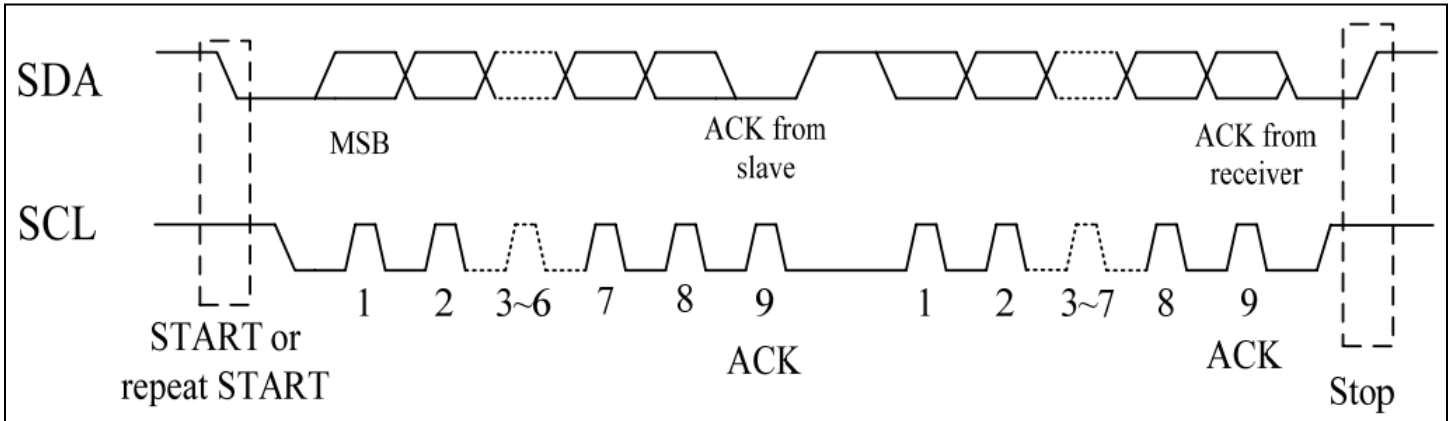
Related Pins	Symbol	Parameter	MIN	MAX	Unit
RESX	TRW	Reset pulse duration	10	-	us
	TRT	Reset cancel	-	5 (Note 1, 5)	ms
				120 (Note 1, 6, 7)	ms

Power ON/OFF Sequence

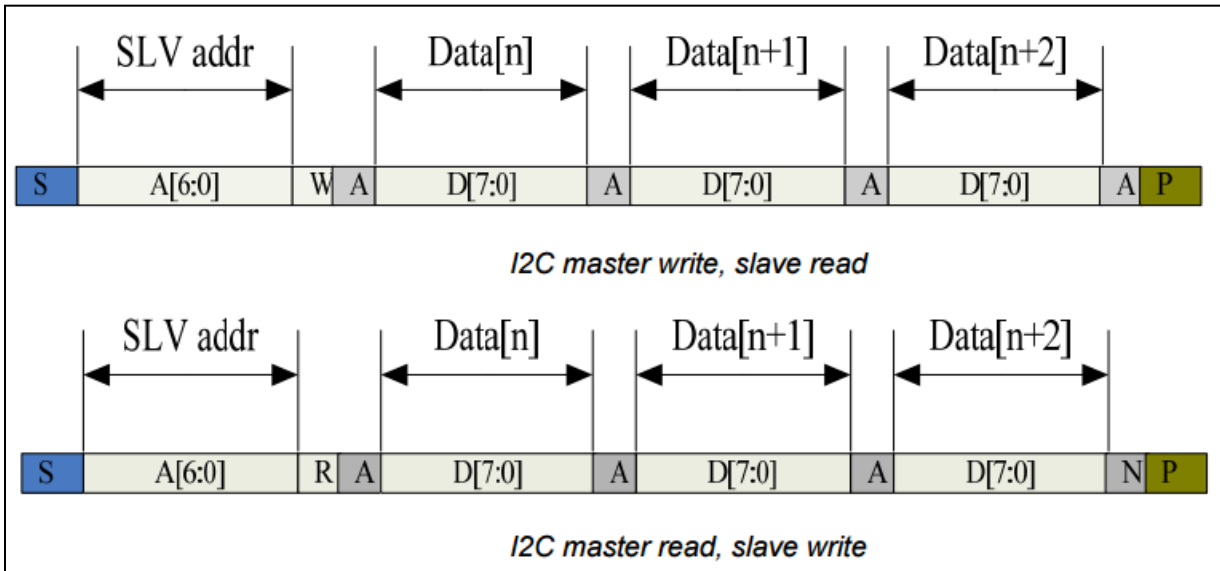


Timing Characteristics-Capacitive Touch Panel

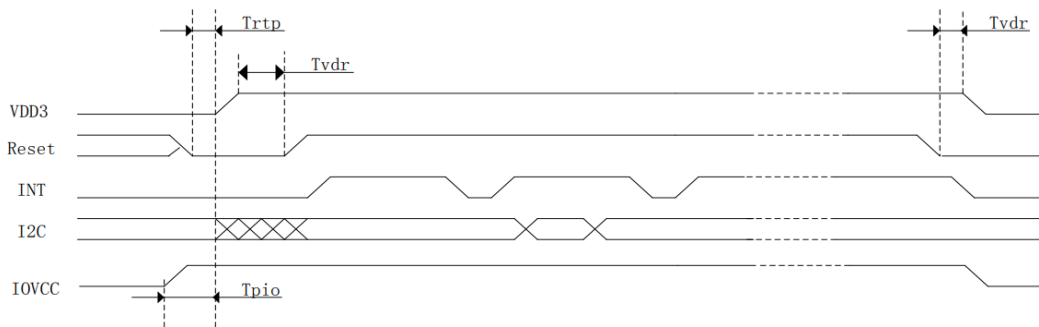
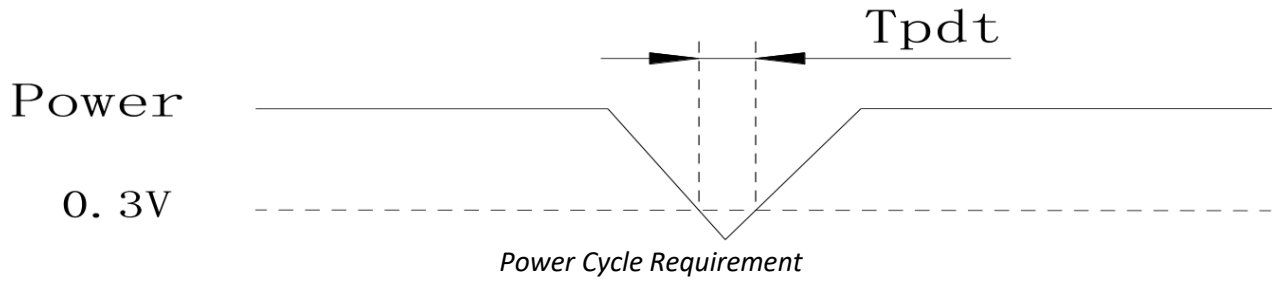
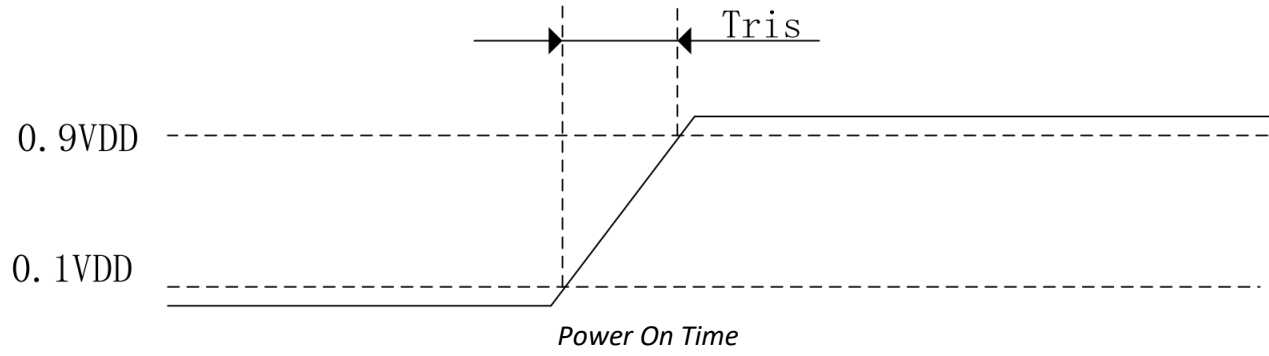
Data Transfer Format



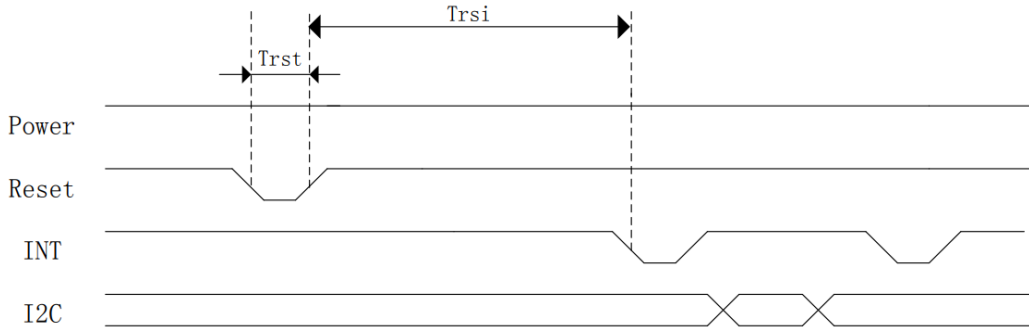
Parameter	Min	Max	Unit
SCL Frequency	0	400	KHz
Bus free time between a STOP & START condition	1.3	-	μs
Hold time Repeated START condition	0.6	-	μs
Data Setup Time	100	-	ns
Setup time for a repeated START condition	0.6	-	μs
Setup time for a STOP condition	0.6	-	μs



Power ON/Reset Sequence



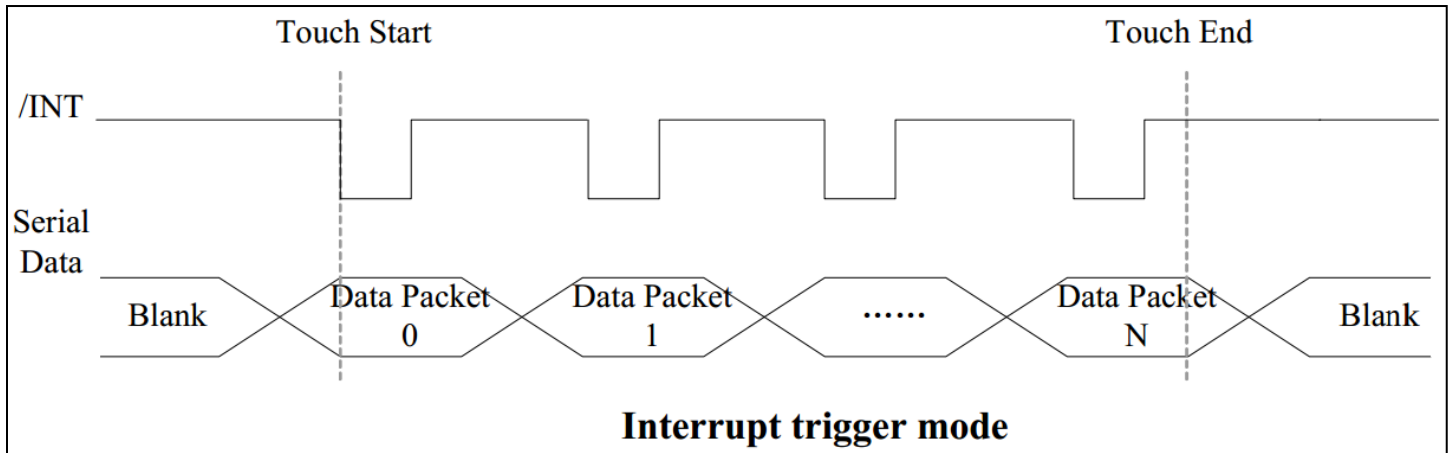
Power ON Sequence



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(RESEX, LOW);
  delay(250);
  digitalWrite(RESEX, 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, 120hrs	2
Low Temperature Operation	Endurance test applying the electric stress (voltage & current) and the low thermal stress for a long time.	-20°C, 120hrs	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 5min -> 80°C 30min = 1 cycle. For 100 cycles	
Vibration test	Endurance test applying vibration to simulate transportation and use.	10Hz-55Hz, 1.5mm amplitude. 10min in each of 3 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.