NEWHAVEN DISPLAY INTERNATIONAL

**Product Specification**

# NHD-2.4C-CTXP-BREAKOUT

## TFT Liquid Crystal Display Module

| | |
|---|---|
| **NHD-** | Newhaven Display |
| **2.4-** | 2.4" Diagonal |
| **C-** | Capacitive Touch Panel |
| **C-** | Built-in Controller |
| **T-** | White LED Backlight |
| **X-** | TFT |
| **P-** | IPS, Wide Temperature |
| **BREAKOUT-** | Breakout Board |

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

NEWHAVEN DISPLAY INTERNATIONAL

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## Additional Resources

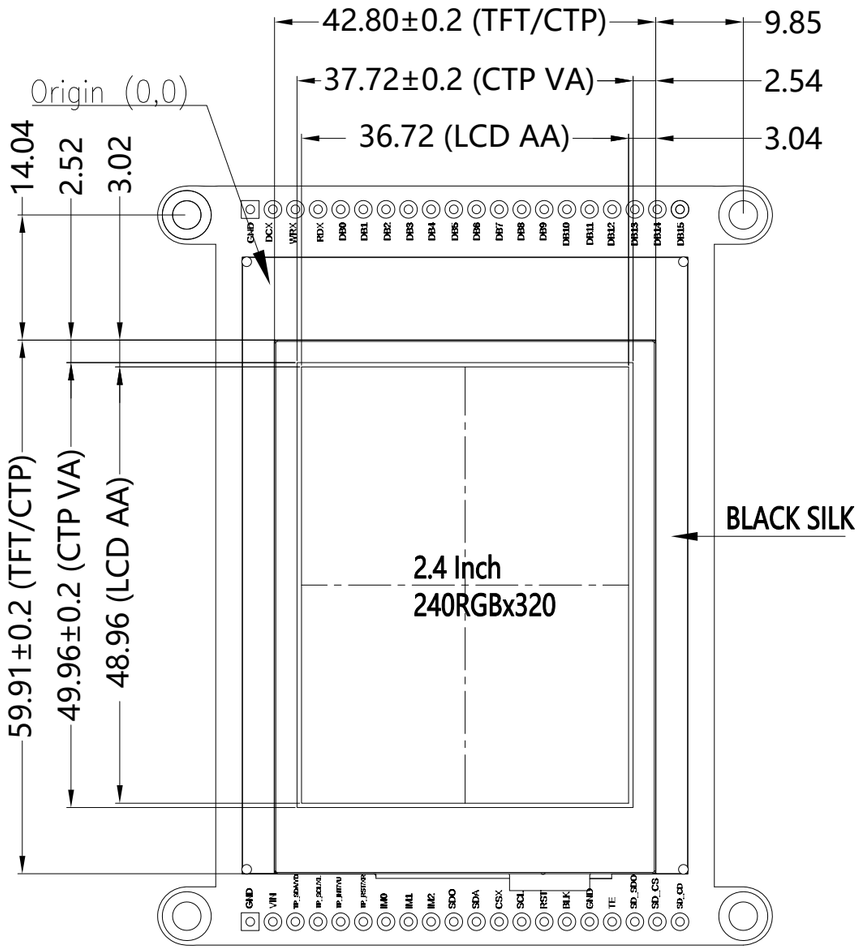
- **Support Forum:** https://support.newhavendisplay.com/hc/en-us/community/topics
- **GitHub:** https://github.com/newhavendisplay
- **Example Code:** https://support.newhavendisplay.com/hc/en-us/categories/4409527834135-Example-Code/
- **Knowledge Center:** https://www.newhavendisplay.com/knowledge_center.html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

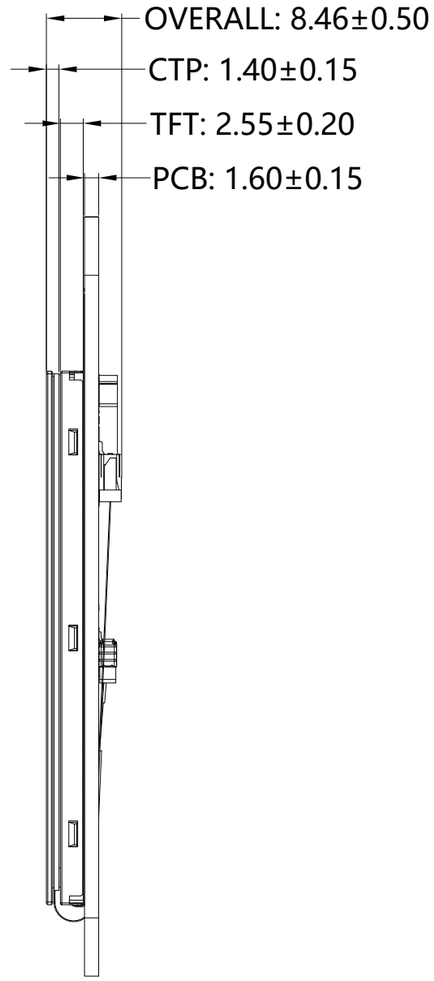
# Document Revision History

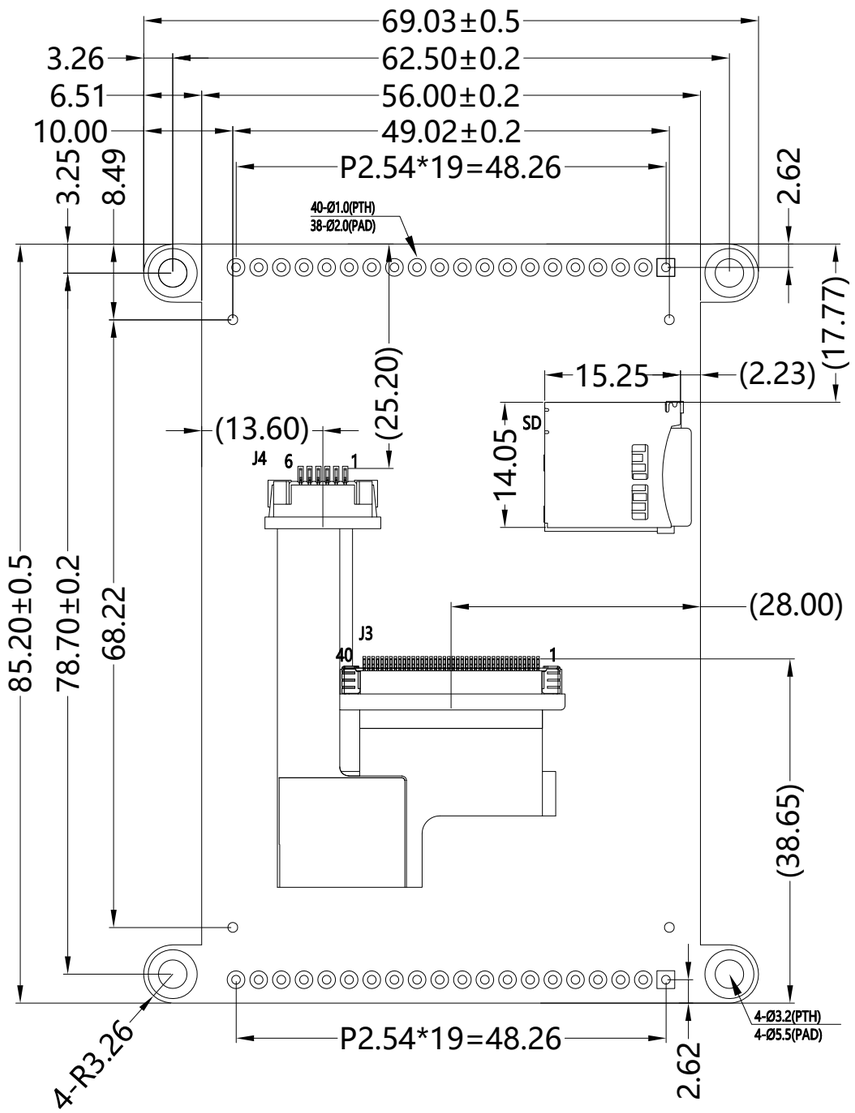
| Revision | Date | Description | Changed By |
|---|---|---|---|
| - | 12/01/2025 | Initial Release | KL |

# Mechanical Drawing

Newhaven Display
NHD-2.4C-CTXP-BREAKOUT
Date Code
Part Label (type/format may vary)




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

1. Driver IC: ST7789VI
2. Interface: Parallel, SPI
3. Power Requirement: 3.3V
4. Optical Features: Normally Black, Transmissive, 300cd/m²
5. Key Features: EMI Shielding, Backlight Driver, microSD Card Reader, Mounting Holes

| | | |
|---|---|---|
| **Standard Tolerance:** (Unless otherwise specified) Linear: ±0.3mm | NEWHAVEN DISPLAY INTERNATIONAL | |
| | Drawing/Part Number: NHD-2.4C-CTXP-BREAKOUT | Revision: - |
| **Unless otherwise specified:** • Dimensions are in Millimeters • Third Angle Projection | Drawn By: K. Lewis | Approved By: K. Lewis |
| | Drawn Date: 12/01/2025 | Approved Date: 12/01/2025 |

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# Pin Description

**J1:**

| Pin No. | Symbol | External Connection | Function Description |
|---|---|---|---|
| 1 | GND | Power Supply | Ground |
| 2 | DCX | MPU | Data / Command selection: '1' = Data ; '0' = Command |
| 3 | WRX | MPU | Active LOW Write signal |
| 4 | RDX | MPU | Active LOW Read signal |
| 5-20 | DB0-DB15 | MPU | Bi-directional data bus<br>8-bit: use DB8-DB15<br>16-bit: use DB0-DB15 |

**Recommended Connector:** 20pin, 1x20, 2.54mm pitch.

**J2:**

| Pin No. | Symbol | External Connection | Function Description |
|---|---|---|---|
| 1 | GND | Power Supply | Ground |
| 2 | VIN | Power Supply | Supply Voltage (3.3V) |
| 3 | TP_SDA/YD | MPU | **Capacitive Touch Panel:** |
| 4 | TP_SCL/XL | | |
| 5 | TP_INT/YU | | |
| 6 | TP_RST/XR | | |
| 7 | IM0 | MPU | No Connect |
| 8 | IM1 | | No Connect |
| 9 | IM2 | | No Connect |
| 10 | SDO | MPU | Serial Data Output |
| 11 | SDA | MPU | Serial Data Input |
| 12 | CSX | MPU | Active LOW Chip Select signal |
| 13 | SCL | MPU | Serial Clock |
| 14 | RST | MPU | Active LOW Reset signal |
| 15 | BLK | MPU | No Connect |
| 16 | GND | Power Supply | Ground |
| 17 | TE | MPU | Tearing Effect Output |
| 18 | SD_SDO | MPU | SD card Serial Data Output |
| 19 | SD_CS | MPU | SD card Chip select Signal |
| 20 | SD_CD | MPU | SD Card Detect Pin |

| | |
|---|---|
| TP_SDA | Serial I2C Data |
| TP_SCL | Serial I2C Clock |
| TP_INT | Interrupt signal from touch panel module to host |
| TP_RST | Active LOW Reset signal |

**Recommended Connector**: 20pin, 1x20, 2.54mm pitch.

# Interface Selection

| Interface | IM0 | | IM1 | | IM2 | |
|---|---|---|---|---|---|---|
| | R1 | R2 | R3 | R4 | R5 | R6 |
| 8-bit 8080-II Parallel | Close | Open | Open | Close | Open | Close |
| 16-bit 8080-II Parallel | Open | Close | Open | Close | Open | Close |
| 3-wire SPI | Close | Open | Close | Open | Open | Close |

.

# 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 | $V_{DD}$ | - | 3.0 | 3.3 | 3.6 | V |
| Supply Current | $I_{DD}$ | $V_{DD}$ = 3.3V | - | 200 | 280 | mA |

# Optical Characteristics

| Item | | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Optimal Viewing Angles | Top | φY+ | CR ≥ 10 | - | 80 | - | ° |
| | Bottom | φY- | | - | 80 | - | ° |
| | Left | θX- | | - | 80 | - | ° |
| | Right | θX+ | | - | 80 | - | ° |
| Contrast Ratio | | CR | - | 800 | 1500 | - | - |
| Luminance | | $L_V$ | - | 214 | 300 | 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 | - |
| | | $Y_G$ | - | 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

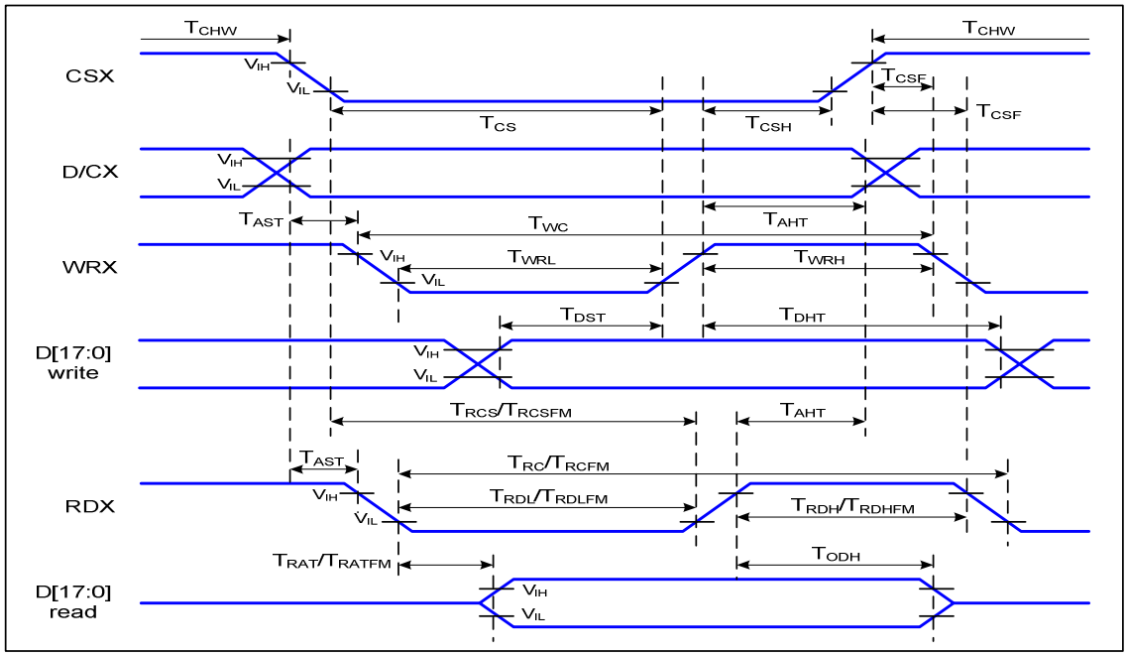
| Register No. | Access | Register Name | Bits | Value | Description |
|---|---|---|---|---|---|
| 01h | RO | Gesture ID | [7:0] | 1Ch<br>14h<br>10h<br>18h<br>48h<br>49h<br>00 | Swipe Up<br>Swipe Down<br>Swipe Left<br>Swipe Right<br>Zoom In<br>Zoom Out<br>No gesture |
| 02h | RO | Touch Points | [7:0] | 0-Ah | 0: No touch detected<br>A: 5touch points detected |
| 03h | RO | TOUCH1_Event_Flag | [7:6] | 0<br>1<br>2<br>3 | Put Down<br>Put Up<br>Contact<br>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<br>1<br>2<br>3 | Put Down<br>Put Up<br>Contact<br>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<br>1<br>2<br>3 | Put Down<br>Put Up<br>Contact<br>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<br>1<br>2<br>3 | Put Down<br>Put Up<br>Contact<br>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<br>1<br>2<br>3 | Put Down<br>Put Up<br>Contact<br>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<br>1<br>2<br>3 | Put Down<br>Put Up<br>Contact<br>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<br>1<br>2<br>3 | Put Down<br>Put Up<br>Contact<br>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<br>1<br>2<br>3 | Put Down<br>Put Up<br>Contact<br>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<br>1<br>2<br>3 | Put Down<br>Put Up<br>Contact<br>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<br>1<br>2<br>3 | Put Down<br>Put Up<br>Contact<br>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<br>Default: 0 |
| A2h | RO | ID_G_LIB_VERSION_L | [7:0] | 00-FFh | App library version low-byte<br>Default: 1h |
| A3h | RO | ID_G_CHIPER_HIGH | [7:0] | 00-FFh | Chip Vendor ID<br>Default: 0x54 |
| A6h | RO | ID_G_FIRMID | [7:0] | 00-FFh | Firmware ID Number<br>Default: 1 |
| A8h | RO | ID_G_VENODRID | [7:0] | 00-FFh | CTPM Vendor's Chip ID<br>Default: 79h |

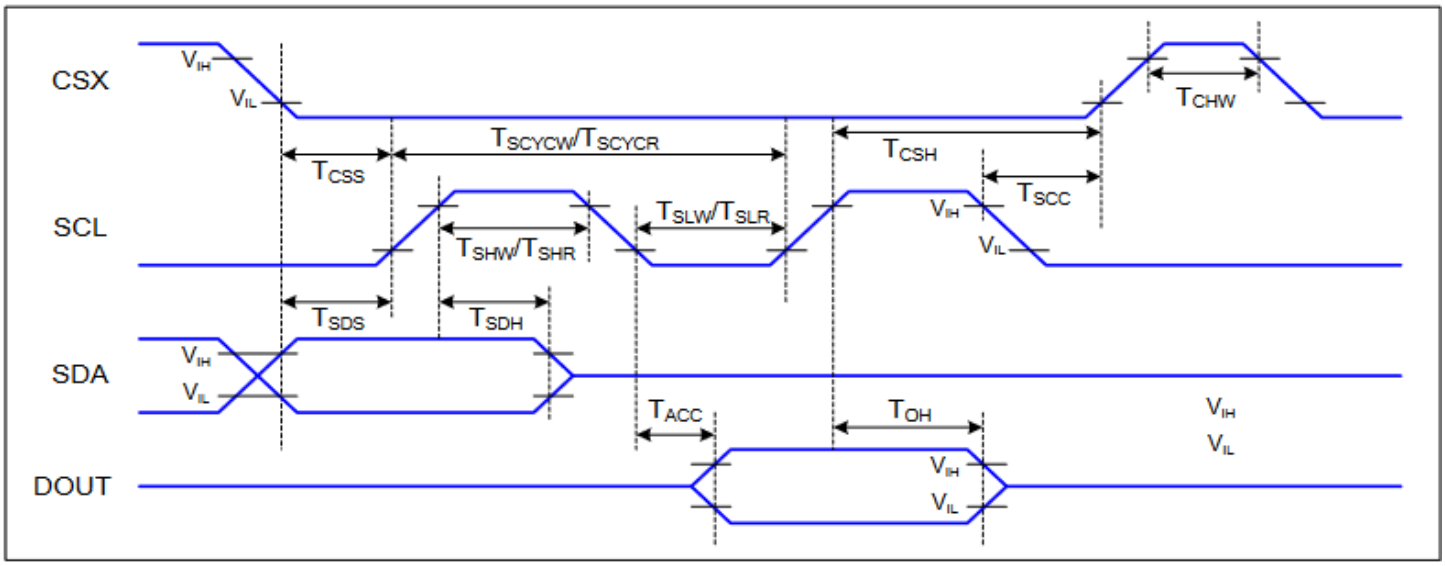
# Timing Characteristics for TFT

## Parallel 8/16-bit Interface Timing Characteristics



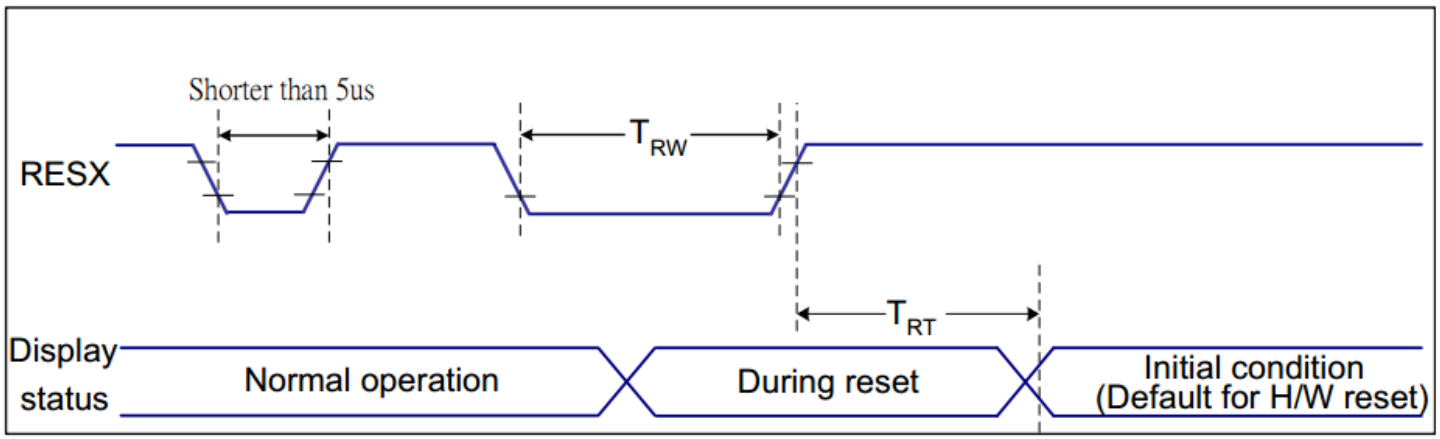

| Signal | Symbol | Parameter | Min | Max | Unit | Description |
|---|---|---|---|---|---|---|
| D/CX | $T_{AST}$ | Address setup time | 0 | | ns | - |
| | $T_{AHT}$ | Address hold time (Write/Read) | 10 | | ns | |
| CSX | $T_{CHW}$ | Chip select "H" pulse width | 0 | | ns | - |
| | $T_{CS}$ | Chip select 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-wire Serial interface Timing Characteristics**



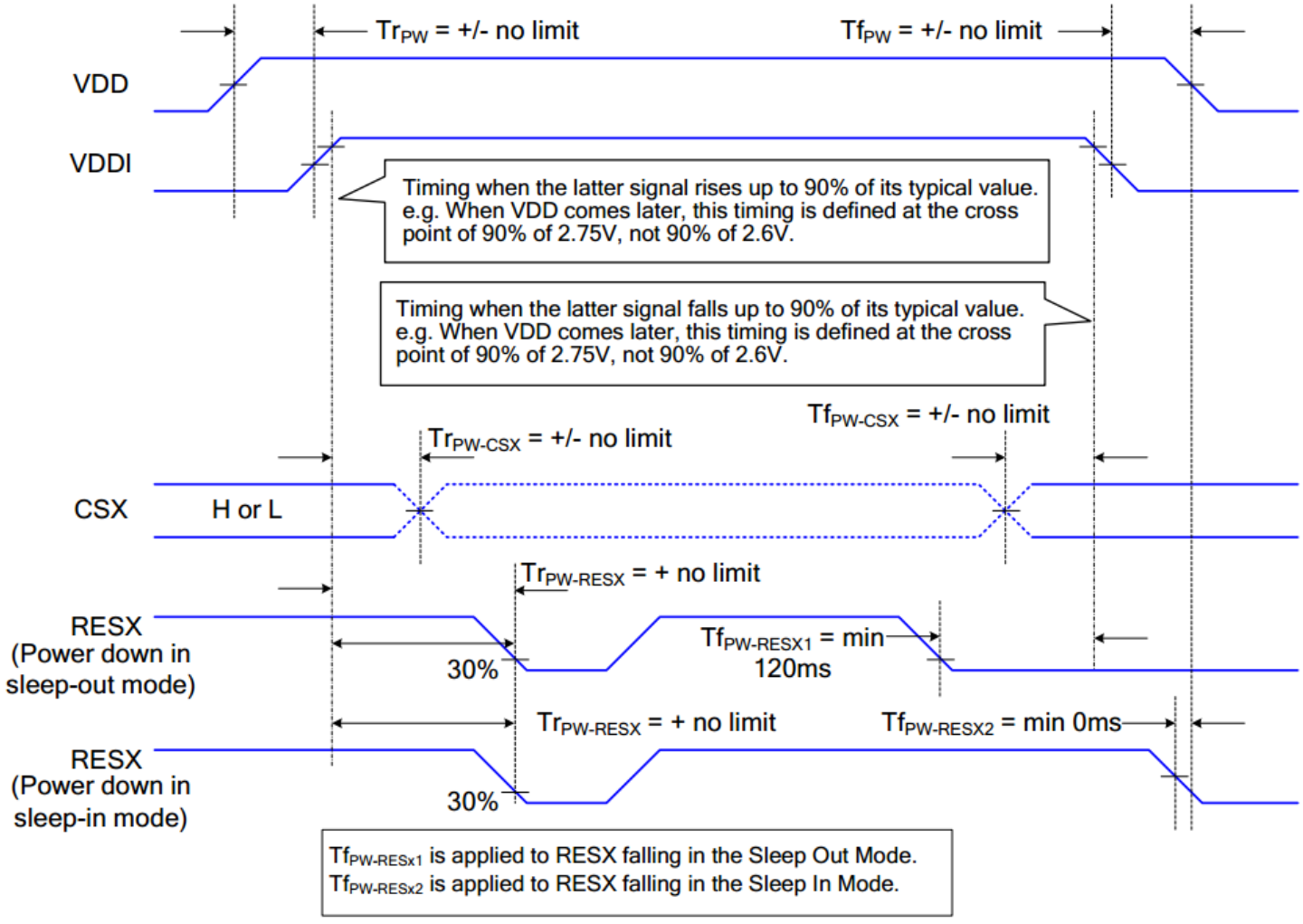

| Signal | Symbol | Parameter | Min | Max | Unit | Description |
|---|---|---|---|---|---|---|
| CSX | $T_{CSS}$ | Chip select setup time (write) | 15 | | ns | |
| | $T_{CSH}$ | Chip select hold time (write) | 15 | | ns | |
| | $T_{CSS}$ | Chip select setup time (read) | 60 | | ns | |
| | $T_{SCC}$ | 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**



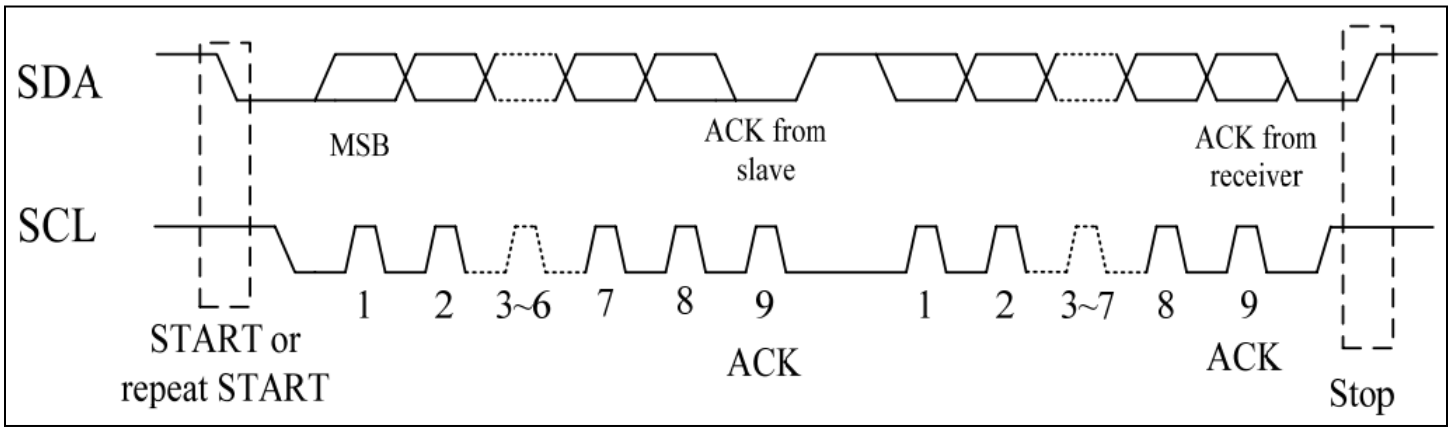

| Related Pins | Symbol | Parameter | MIN | MAX | Unit |
|---|---|---|---|---|---|
| RESX | TRW | Reset pulse duration | 10 | - | us |
| | TRT | Reset cancel | - | 5 (Note 1, 5) | ms |
| | | | | 120 (Note 1, 6, 7) | ms |

**Power ON/OFF Sequence**

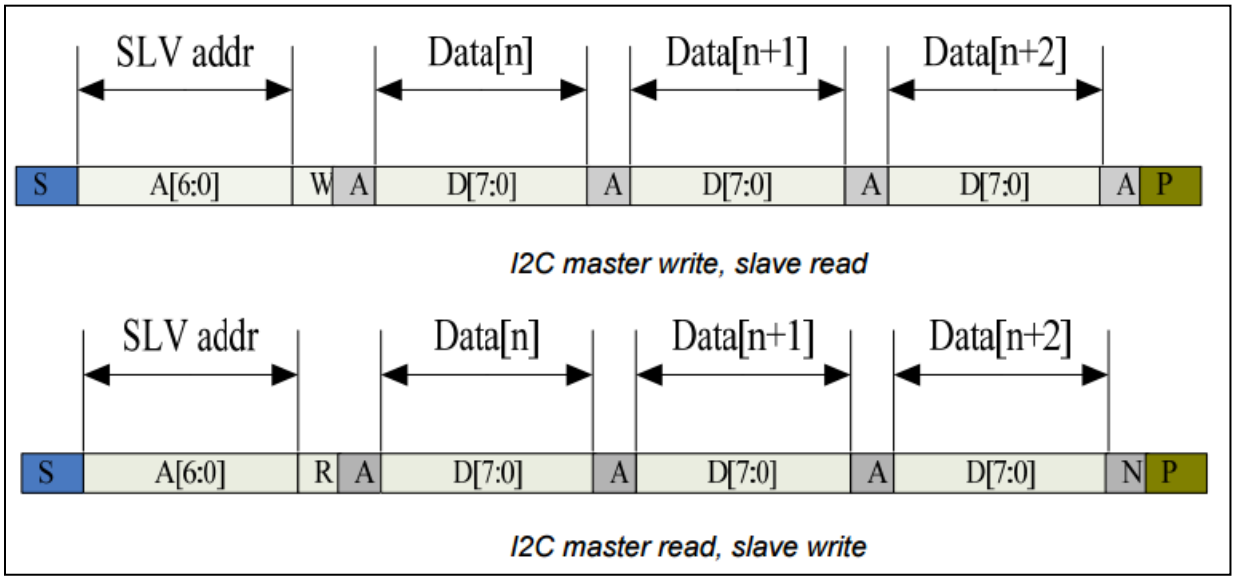


# Timing Characteristics-Capacitive Touch Panel

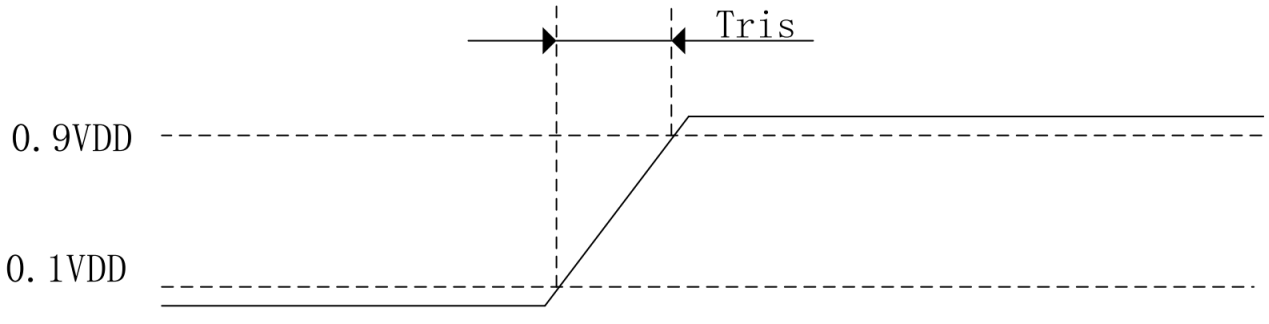
**Data Transfer Format**



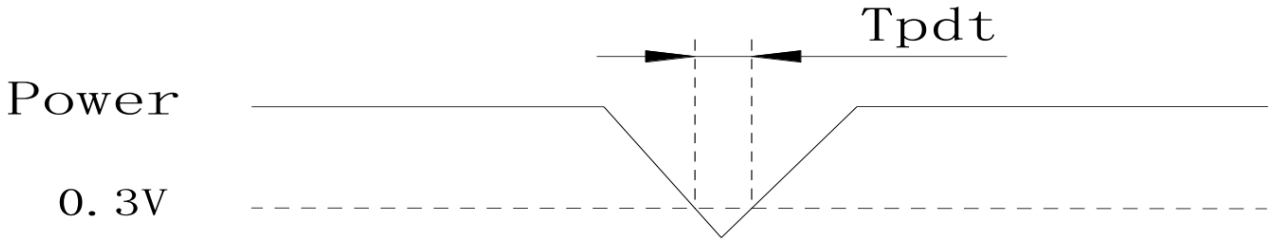

| Parameter | Min | Max | Unit |
|---|---|---|---|
| SCL Frequency | 0 | 400 | KHz |
| Bus free time between a STOP & START condition | 1.3 | - | µs |
| Hold time Repeated START condition | 0.6 | - | µs |
| Data Setup Time | 100 | - | ns |
| Setup time for a repeated START condition | 0.6 | - | µs |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



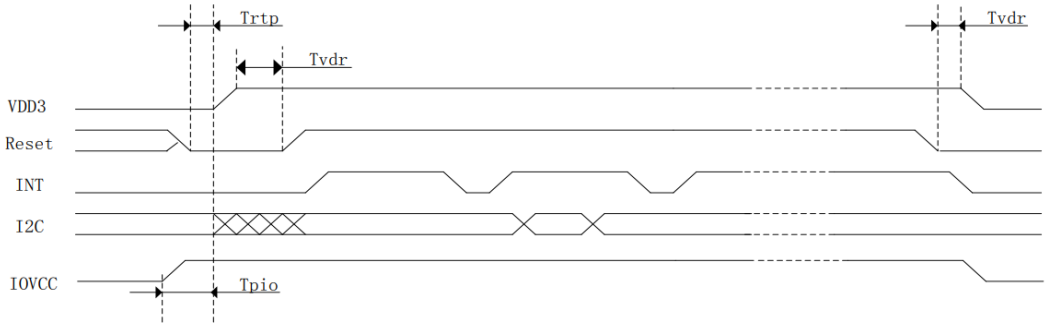
**Power ON/Reset Sequence**



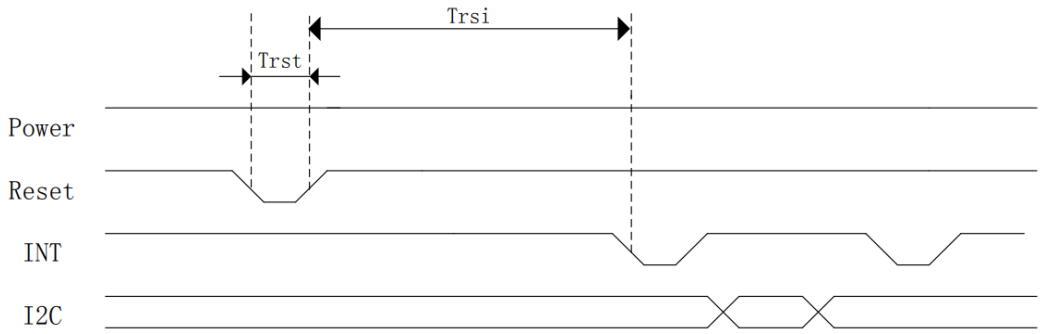

*Power On Time*




*Power Cycle Requirement*



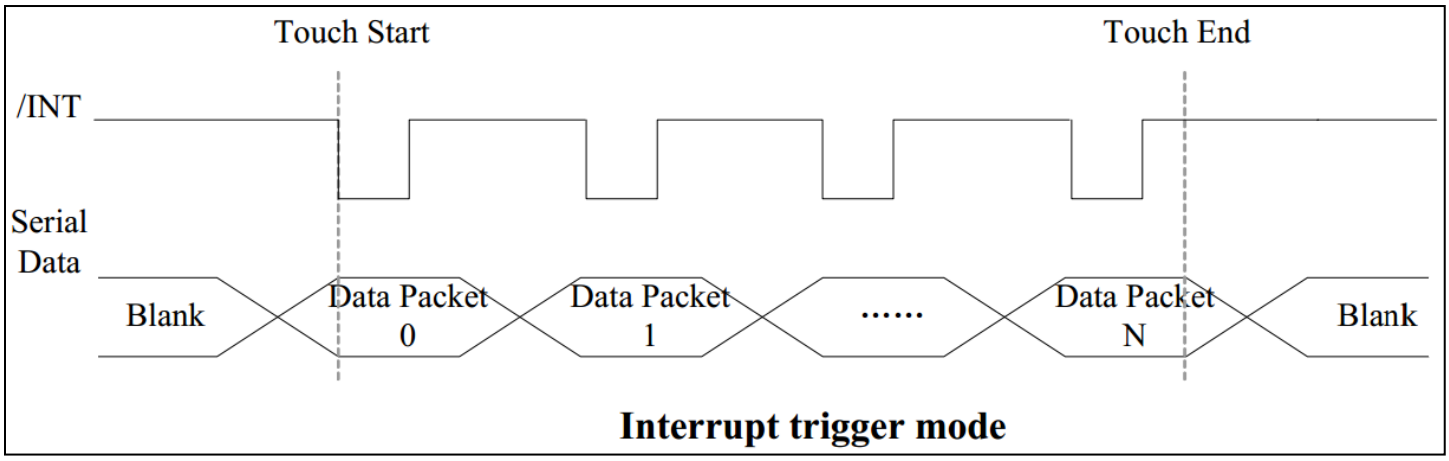
*Power ON Sequence*




*Reset sequence*

| Parameter | Description | Min | Max | Unit |
|---|---|---|---|---|
| Tris | Rise time from 0.1$V_{DD}$ to 0.9$V_{DD}$ | - | 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, 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.<br>For 100 cycles | |
| Vibration test | Endurance test applying vibration to simulate transportation and use. | 10Hz-55Hz, 1.5mm amplitude.<br>10min in each of 3 directions<br>X,Y,Z | 3 |
| Static electricity test | Endurance test applying electric static discharge. | Air discharge: ±8kV 10 Times<br>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.