

NHD-2.8-240320AF-CSXP-FCTP

IPS TFT Liquid Crystal Display Module

NHD-	Newhaven Display
2.8-	2.8" Diagonal
240320-	240 x 320 Pixels (Portrait Mode)
AF-	Model
C-	Built-in Controller
S-	High Brightness White LED Backlight
X-	TFT
P-	IPS, Wide Temperature
FCTP-	FFC ZIF Connection Style, Capacitive Touch Panel with controller

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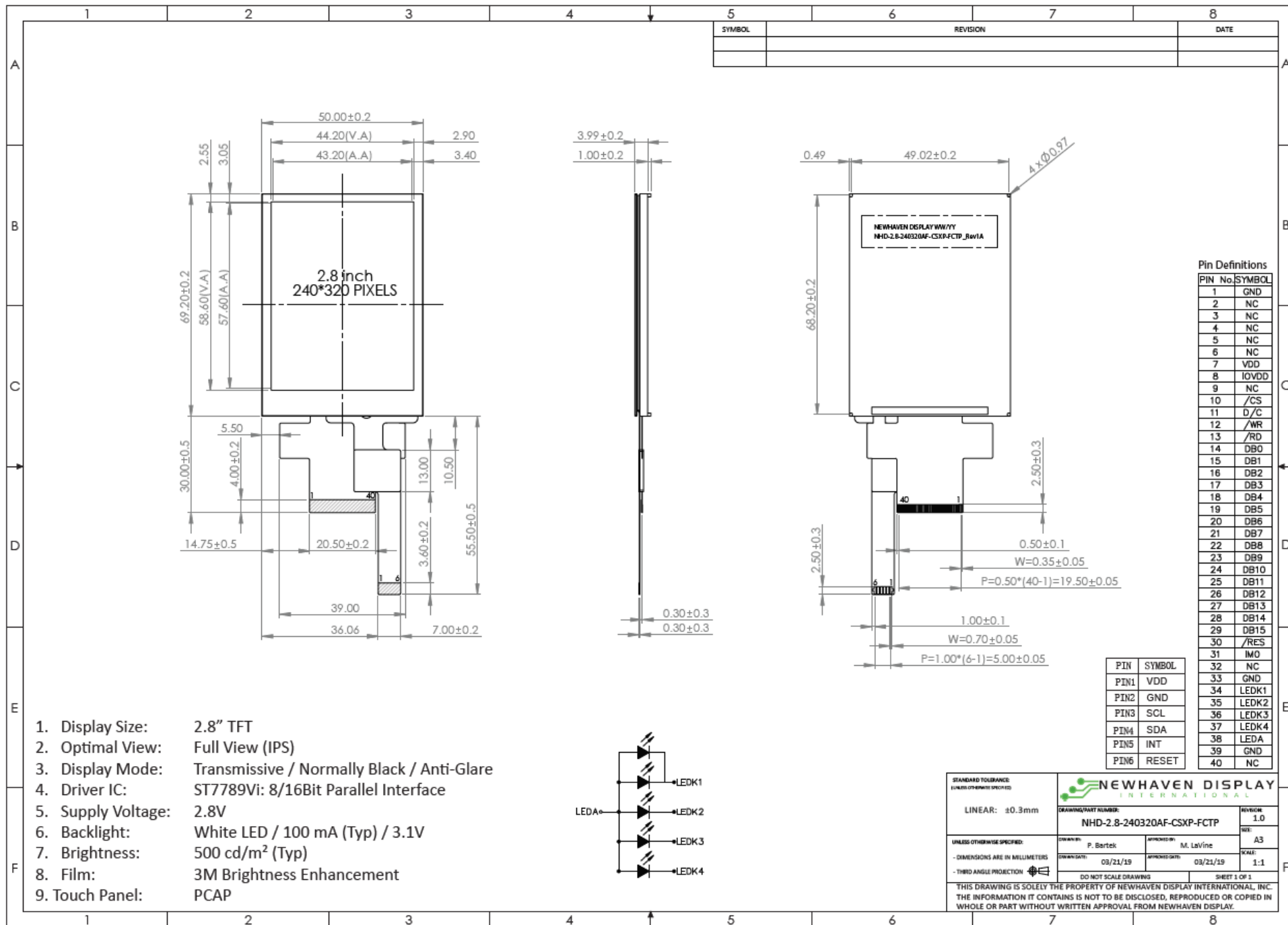
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Document Revision History

Revision	Date	Description	Changed by
-	4/9/19	Initial Release	PK
1	12/9/19	Interface information updated (8080-II)	SM
2	2/12/21	Updated FPC Tolerances On 2D Mechanical Drawing	AS
3	5/25/21	CTP Timing Characteristics Included	ZP

Functions and Features

- 240 x 320 pixels
- IPS type, full viewing angles
- High brightness LED backlight
- 3.0V power supply
- 8-bit or 16-bit Parallel MPU interface (8080-II Series)
- FFC ZIF I/O connection
- Built-in ST7789Vi controller
- 262K colors
- Capacitive touch panel with controller
 - 5-point multi-touch input
 - Gesture input
 - Zoom In/Out
 - Swipe Up/Down/Left/Right



Pin Description

TFT:

Pin No.	Symbol	External Connection	Function Description
1	GND	Power Supply	Ground
2 - 6	NC	-	No Connect
7	V _{DD}	Power Supply	Supply Voltage for LCD (2.8V)
8	IOV _{DD}	Power Supply	Supply Voltage for Logic (Tie to V _{DD})
9	NC	-	No Connect
10	/CS	MPU	Active LOW Chip Select signal (can tie to GND)
11	D/C	MPU	Data / Command selection: '1' = Data ; '0' = Command
12	/WR	MPU	Active LOW Write signal
13	/RD	MPU	Active LOW Read signal
14 - 29	DB0 – DB15	MPU	Bi-directional data bus, 8-bit:DB8-DB15, 16-bit: DB0-DB15
30	/RES	MPU	Active LOW Reset signal
31	IM0	MPU	IM0=0: 16-bit (8080-II) IM0=1: 8-bit (8080-II)
32	NC	-	No Connect
33	GND	Power Supply	Ground
34 - 37	LED-K1 – LED-K4	Power Supply	Backlight Cathode (Ground)
38	LED-A	Power Supply	Backlight Anode (100mA @ 3.1V)
39	GND	Power Supply	Ground
40	NC	-	No Connect

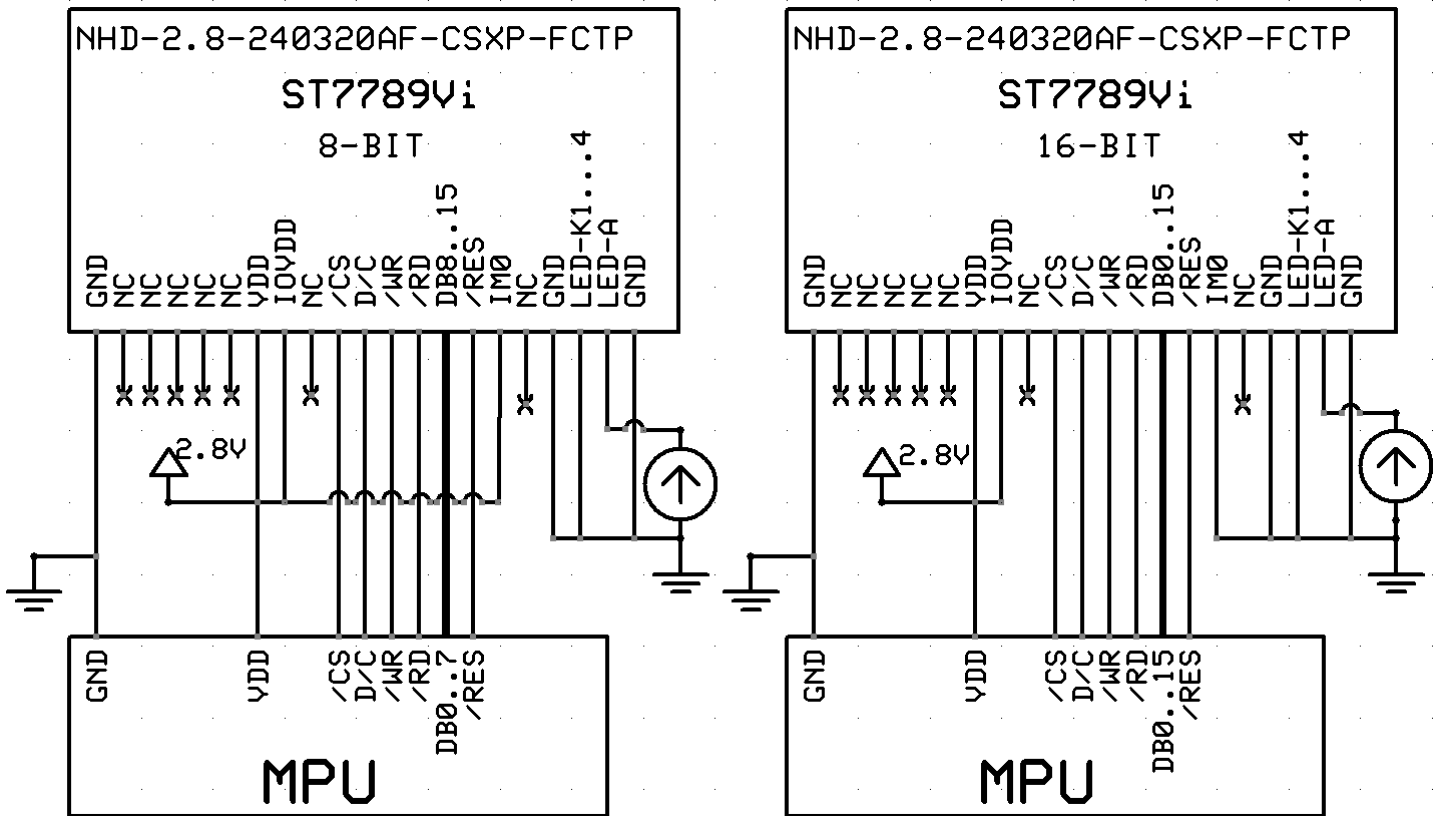
Recommended LCD connector: 40-pin, 0.5mm pitch FFC connector **Molex P/N:** 54132-4062 or similar

Capacitive Touch Panel:

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 pull-up resistor)
4	SDA	MPU	Serial I2C Data (Requires 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

Wiring Diagram



Electrical Characteristics

TFT:

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}	-	2.6	2.8	3.3	V
Supply Voltage for Logic	IOV _{DD}	-	1.65	1.8	3.3	V
Supply Current	I _{DD}	V _{DD} = 2.8	3	9	15	mA
“H” Level input	V _{IH}	-	0.7 * V _{DD}	-	V _{DD}	V
“L” Level input	V _{IL}	-	GND	-	0.3 * V _{DD}	V
“H” Level output	V _{OH}	-	0.8 * V _{DD}	-	V _{DD}	V
“L” Level output	V _{OL}	-	GND	-	0.2 * V _{DD}	V
Backlight Supply Current	I _{LED}	-	80	100	125	mA
Backlight Supply Voltage	V _{LED}	I _{LED} = 100 mA	2.8	3.1	3.4	V
Backlight Lifetime*	-	I _{LED} = 100mA T _{OP} = 25°C	20,000	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	3.3	V
Supply Current – Operating	I _{DD}	V _{DD} = 3.3V	5.75	11.50	23	mA
Supply Current – Sleep	I _{DD}	V _{DD} = 3.3V	25	50	100	μA
“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	-	80	-	°
	Bottom	φY-		-	80	-	°
	Left	θX-		-	80	-	°
	Right	θX-		-	80	-	°
Contrast Ratio		CR	-	600	800	-	-
Luminance		L _V	I _{LED} = 100 mA	410	500	-	cd/m ²
Response Time		T _R + T _F	T _{OP} = 25°C	-	30	40	Ms
Chromaticity	Red	X _R	-	0.590	0.630	0.670	-
		Y _R	-	0.296	0.336	0.376	-
	Green	X _G	-	0.267	0.607	0.347	-
		Y _G	-	0.563	0.603	0.643	-
	Blue	X _B	-	0.107	0.147	0.187	-
		Y _G	-	0.012	0.052	0.092	-
	White	X _W	-	0.249	0.289	0.329	-
		Y _W	-	0.270	0.310	0.350	-

Capacitive Touch Panel Material Characteristics:

Property	Requirement	Unit
IC	FT5426	-
ITO Glass thickness	0.55	mm
Surface Hardness	≥6	H
Light transmission	85%	-
Operating Humidity	20~90	RH
Storage Humidity	20~90	RH

Controller Information

TFT Display:

Built-in ST7789Vi controller.

Please download specification at <http://www.newhavendisplay.com/appnotes/datasheets/LCDs/ST7789V.pdf>

Capacitive Touch Panel:

Built-in FT5426 controller.

Please download specification at <https://www.newhavendisplay.com/appnotes/datasheets/touchpanel/FT5x26.pdf>

Please download app notes at [FT5x26 App Notes](#)

TFT Table of Commands

Please download specification at <http://www.newhavendisplay.com/appnotes/datasheets/LCDs/ST7789V.pdf>

Capacitive Touch Panel Registers

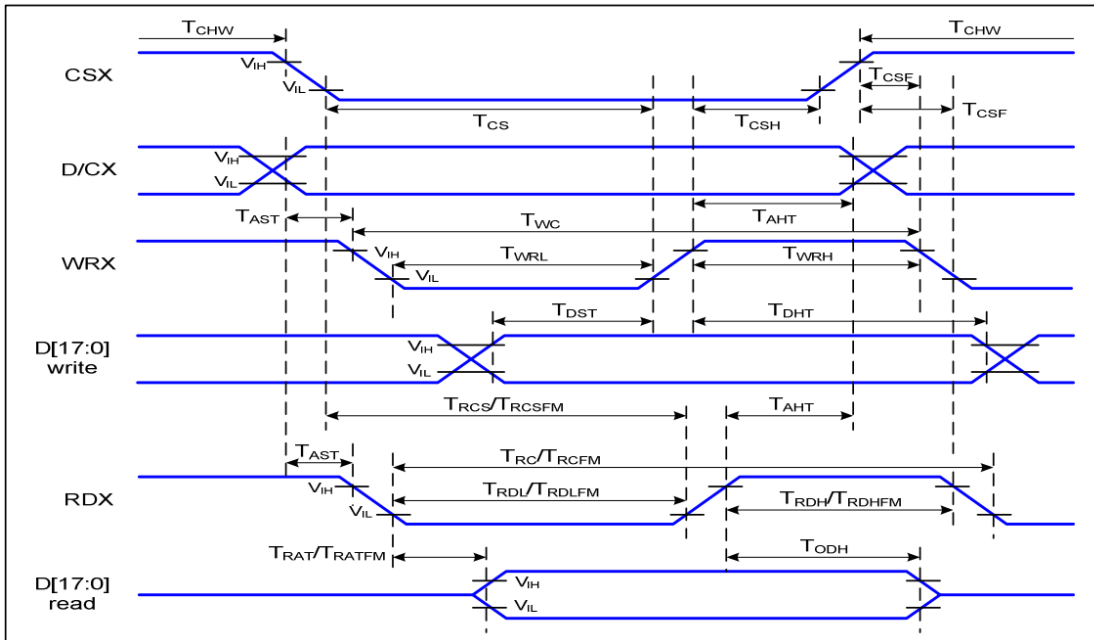
Register No.	Access	Register Name	Bits	Value	Description
01h	RO	Gesture ID	[7:0]	10 18h 1Ch 14h 48h 49h 00	Swipe Up Swipe Down Swipe Left Swipe Right Zoom Out Zoom In No gesture
02h	RO	Touch Points	[7:0]	0-5h	0: No touch detected A: 5 touch points detected
03h	RO	TOUCH1_Event_Flag	[7:6]	0 1 2 3	Put Down 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

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
20h	RO	TOUCH5_Misc	[3:0]	00-0Fh	Touch Area
80h	RW	ID_G_MC_THGROUP	[7:0]	00-FFh	Mutual-Capacitive touch Threshold / 4 Default: 4Bh
81h	RW	ID_G_MC_THPEAK	[7:0]	00-FFh	Mutual-Capacitive Peak Threshold / 4 Default: 46h
85h	RW	ID_G_THDIFF	[7:0]	00-FFh	Points Filtering Range Threshold / 16 Default: A0
86h	RW	ID_G_CTRL	[1:0]	0-1	Allowed to switch to monitor mode or not (1: Allowed, 0: Not Allowed)
88h	RW	ID_G_PERIODACTIVE	[3:0]	3h-Eh	Period of Active Status
89h	RW	ID_G_PERIODMONITOR	[7:0]	1Eh-FFh	Timer to enter “idle” while in Monitor (ms)
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: 2h
A3h	RO	ID_G_CHIPER_HIGH	[7:0]	00-FFh	Chip Vendor ID Default: 54h
A4h	RW	ID_G_MODE	[0]	0 1	INT Trigger Mode INT Polling Mode

Register No.	Access	Register Name	Bits	Value	Description
A5h	RW	ID_G_PMODE	[1:0]	0 1 3	Active Monitor Sleep
A6h	RO	ID_G_FIRMID	[7:0]	00-FFh	Firmware ID Number Default: 2
A8h	RO	ID_G_VENODRID	[7:0]	00-FFh	CTPM Vendor's Chip ID Default: 79h
C0h	RW	ID_G_GLOVE_MODE_EN	[0]	0 1	Glove Mode Switch Disable Glove Mode Switch Enable
C1h	RW	ID_G_COVER_MODE_EN	[0]	0 1	Cover Mode Switch Disable Cover Mode Switch Enable

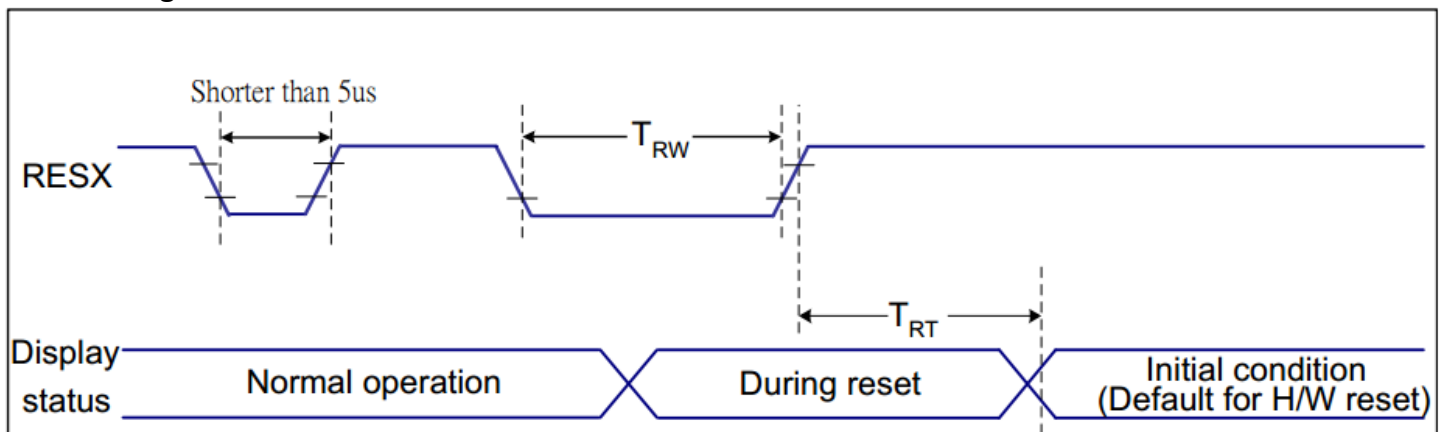
Timing Characteristics – TFT Display

Parallel 18/16/9/8-bit Interface Timing Characteristics (8080-II system)



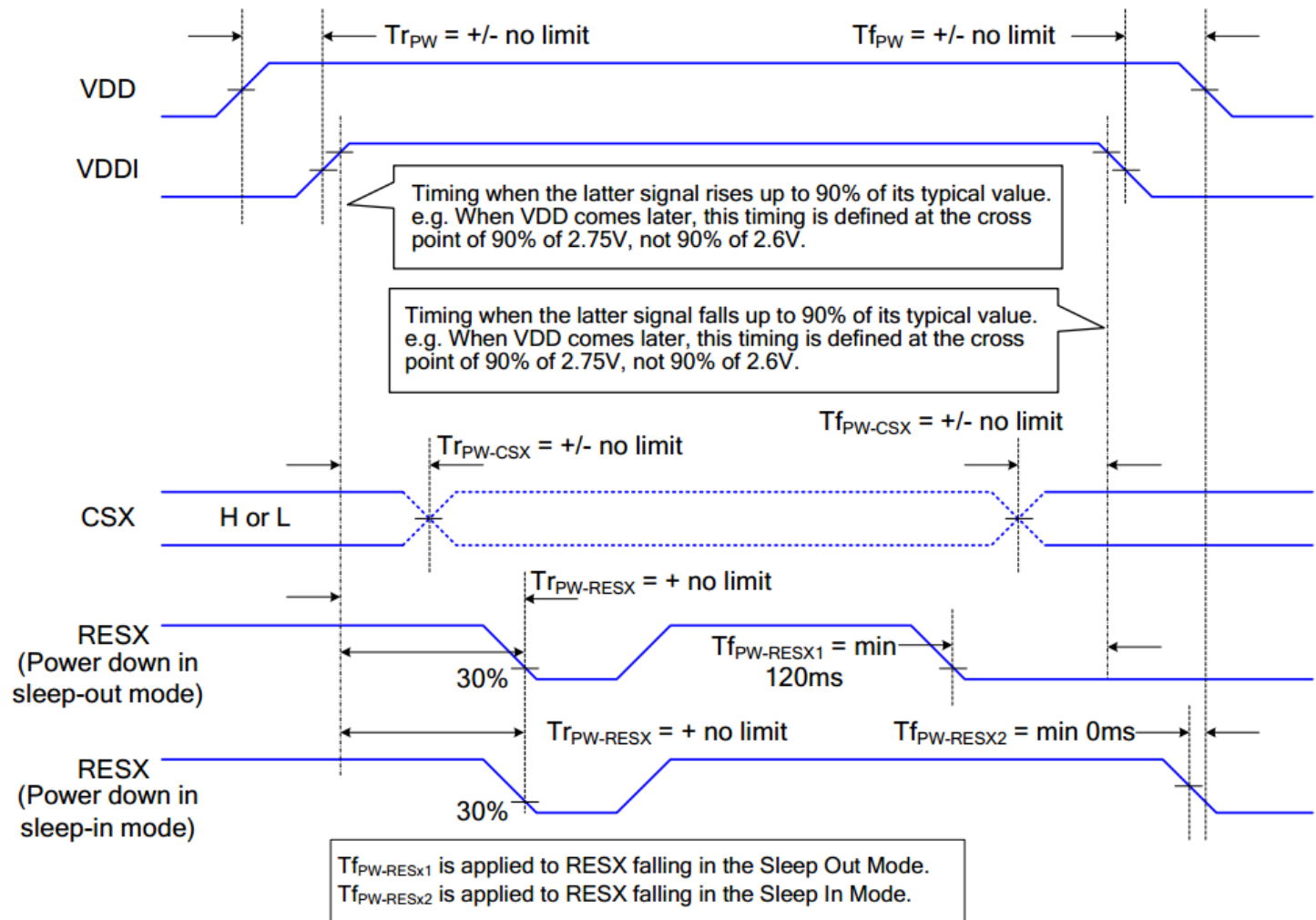
Signal	Symbol	Parameter	Min	Max	Unit	Description
D/CX	T_{AST}	Address setup time	0		ns	-
	T_{AHT}	Address hold time (Write/Read)	10		ns	
CSX	T_{CHW}	Chip select "H" pulse width	0		ns	-
	T_{CS}	Chip select setup time (Write)	15		ns	
	T_{RCS}	Chip select setup time (Read ID)	45		ns	
	T_{RCSFM}	Chip select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

Reset Timing



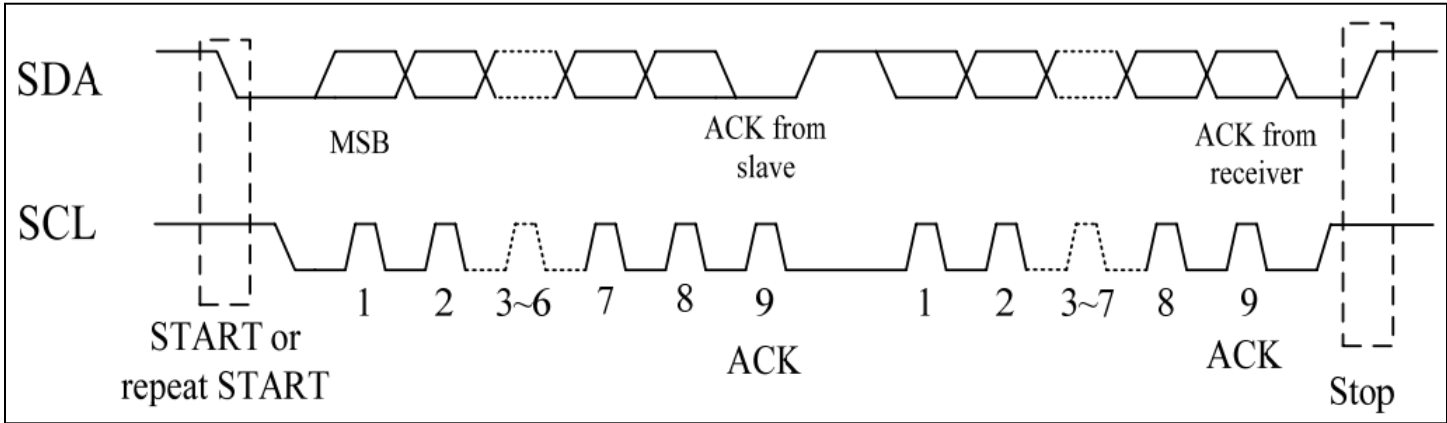
Related Pins	Symbol	Parameter	MIN	MAX	Unit
RESX	TRW	Reset pulse duration	10	-	us
	TRT	Reset cancel	-	5 (Note 1, 5)	ms
				120 (Note 1, 6, 7)	ms

Power ON/OFF Sequence

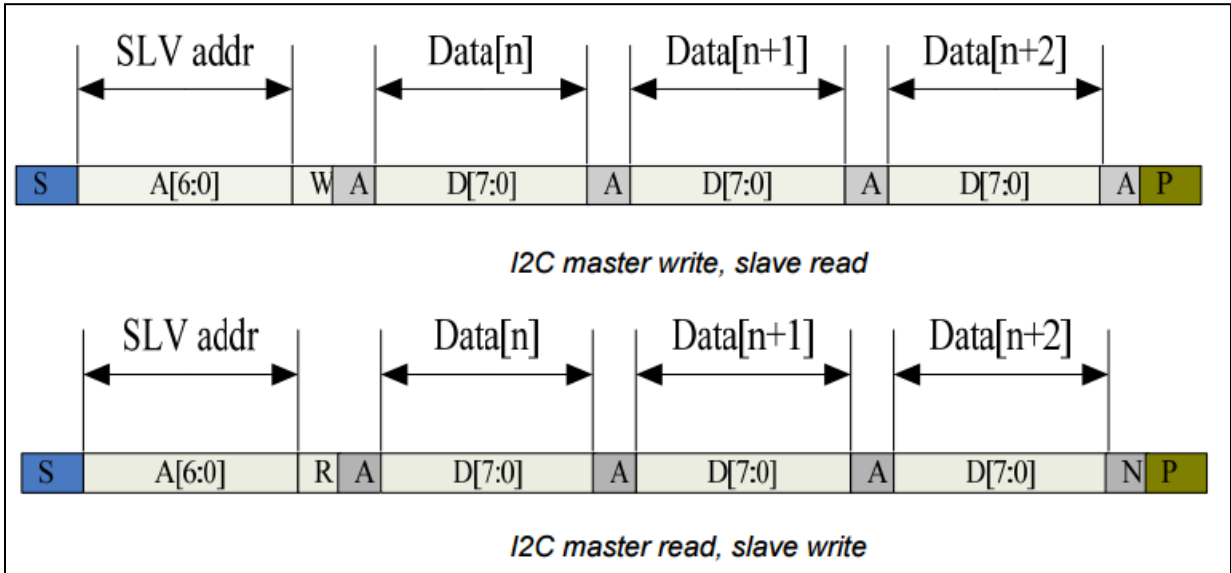


Timing Characteristics – Capacitive Touch Panel

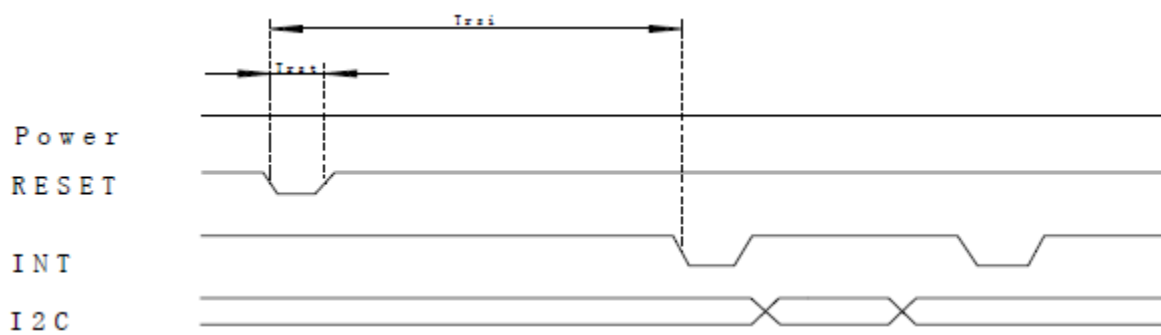
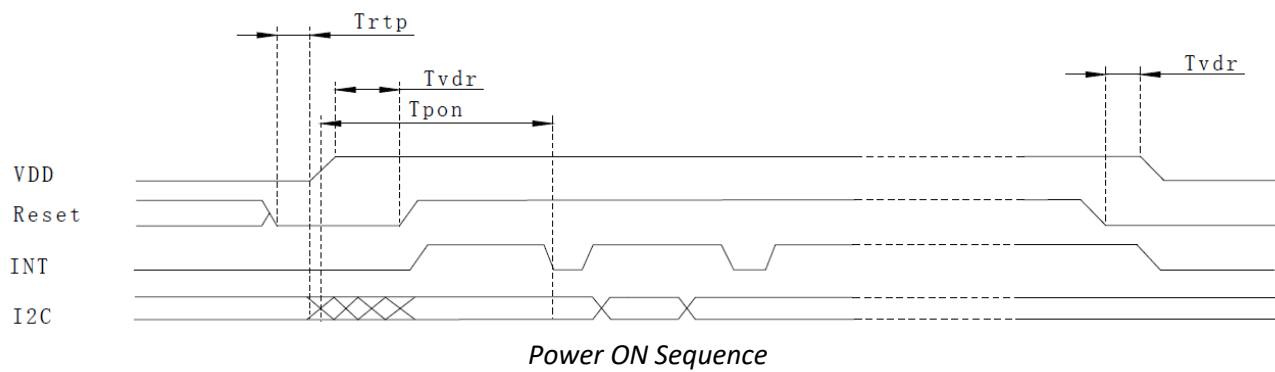
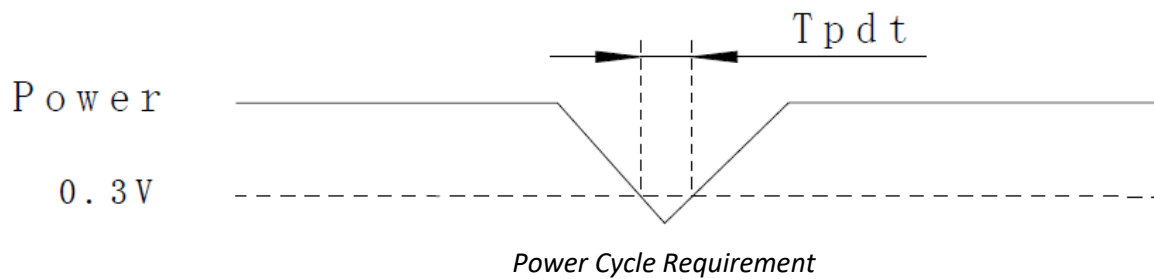
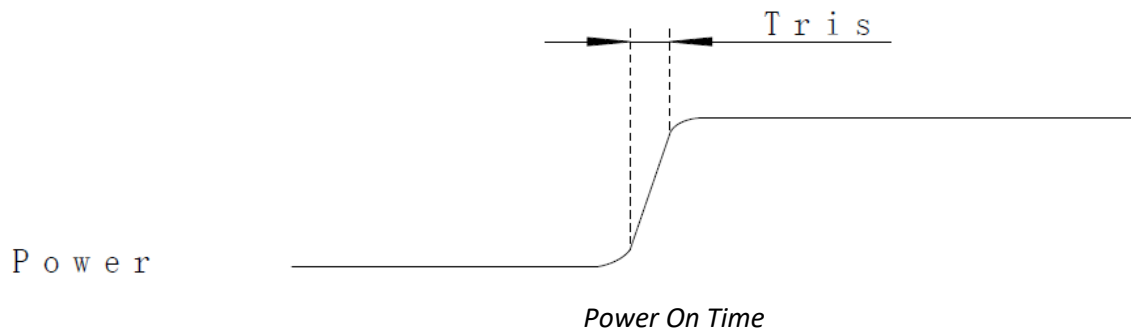
Data Transfer Format



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

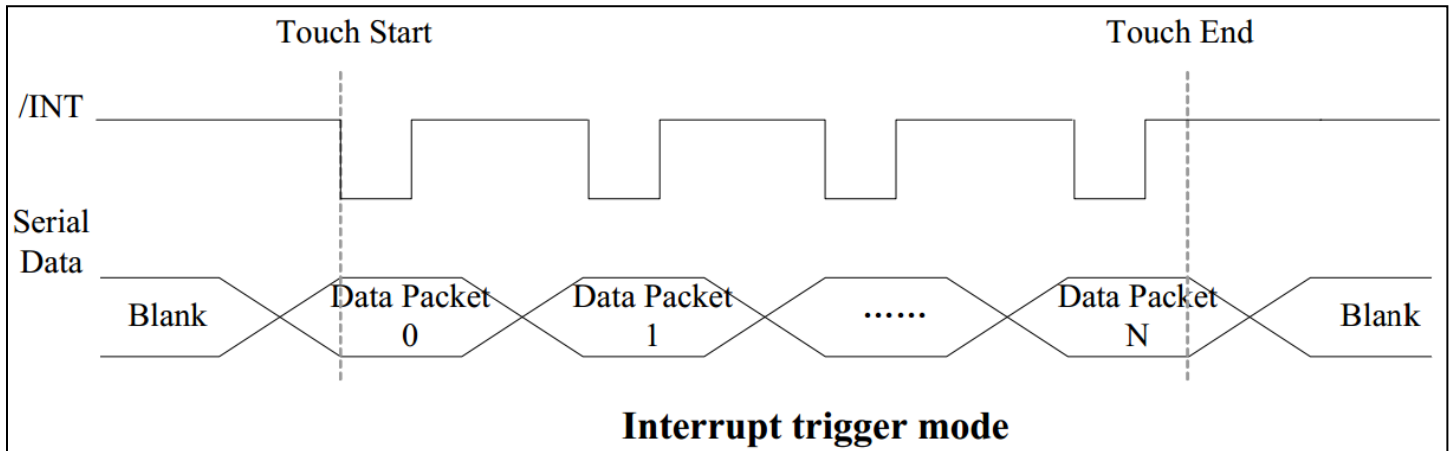


Power ON/Reset Sequence



Parameter	Description	Min	Max	Unit
T_{ris}	Rise time from $0.1V_{DD}$ to $0.9V_{DD}$	-	5	ms
T_{pdt}	Time of the voltage of supply being below 0.3V	5	-	ms
T_{rtp}	Time of resetting to be low before powering on	100	-	μs
T_{pon}	Time to start reporting after power on	-	200	ms
T_{vdr}^*	Reset time after applying V_{DD}	1	-	ms
T_{rsi}	Time to start reporting after reset	-	200	ms
T_{rst}^*	Reset Time	1	-	ms

*If Reset is tied to V_{CC} 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 TFT_28_7789_Write_Command(unsigned int command)
{
    GPIO_ResetBits(GPIOC, CS1);
    GPIO_ResetBits(GPIOC, RS);
    GPIO_SetBits(GPIOC, nRD);
    GPIO_ResetBits(GPIOC, nWR);
    GPIO_Write(GPIOB, command);
    TFT_delay(10);
    GPIO_SetBits(GPIOC, nWR);
    TFT_delay(1);
}
/*****/
void TFT_28_7789_Write_Data(unsigned int data1)
{
    GPIO_Write(GPIOB, data1);
    GPIO_SetBits(GPIOC, RS);
    GPIO_ResetBits(GPIOC, nWR);
    TFT_delay(1);
    GPIO_SetBits(GPIOC, nWR);
}
/*****/
void TFT_28_7789_Init(void)
{
    int n;
    GPIO_ResetBits(GPIOC, CS1);
    GPIO_SetBits(GPIOC, nRD);
    GPIO_ResetBits(GPIOC, nWR);
    GPIO_WriteBit(GPIOC, RES, Bit_RESET);
    TFT_delay(100);
    GPIO_WriteBit(GPIOC, RES, Bit_SET);
    TFT_delay(100);
    TFT_28_7789_Write_Command(0x0011); //exit SLEEP mode
    TFT_delay(100);

    TFT_28_7789_Write_Command(0x0036);
    TFT_28_7789_Write_Data(0x0080); //MADCTL: memory data access control
    TFT_28_7789_Write_Command(0x003A);
    TFT_28_7789_Write_Data(0x0066); //COLMOD: Interface Pixel format
    TFT_28_7789_Write_Command(0x0021); //INVON: Display Inversion ON (setting for IPS)
    TFT_28_7789_Write_Command(0x00B2);
    TFT_28_7789_Write_Data(0x000C);
    TFT_28_7789_Write_Data(0x0C);
    TFT_28_7789_Write_Data(0x00);
    TFT_28_7789_Write_Data(0x33);
    TFT_28_7789_Write_Data(0x33); //PORCTRK: Porch setting
    TFT_28_7789_Write_Command(0x00B7);
    TFT_28_7789_Write_Data(0x0035); //GCTRL: Gate Control
    TFT_28_7789_Write_Command(0x00BB);
    TFT_28_7789_Write_Data(0x002B); //VCOMS: VCOM setting
    TFT_28_7789_Write_Command(0x00C0);
    TFT_28_7789_Write_Data(0x002C); //LCMCTRL: LCM Control
    TFT_28_7789_Write_Command(0x00C2);
    TFT_28_7789_Write_Data(0x0001);
    TFT_28_7789_Write_Data(0xFF); //VDVVRHEN: VDV and VRH Command Enable
    TFT_28_7789_Write_Command(0x00C3);
    TFT_28_7789_Write_Data(0x0011); //VRHS: VRH Set

```

```

TFT_28_7789_Write_Command(0x00C4);
TFT_28_7789_Write_Data(0x0020); //VDVS: VDV Set
TFT_28_7789_Write_Command(0x00C6);
TFT_28_7789_Write_Data(0x000F); //FRCTRL2: Frame Rate control in normal mode
TFT_28_7789_Write_Command(0x00D0);
TFT_28_7789_Write_Data(0x00A4);
TFT_28_7789_Write_Data(0xA1); //PWCTRL1: Power Control 1
TFT_28_7789_Write_Command(0x00E0);
TFT_28_7789_Write_Data(0x00D0);
TFT_28_7789_Write_Data(0x0000);
TFT_28_7789_Write_Data(0x0005);
TFT_28_7789_Write_Data(0x000E);
TFT_28_7789_Write_Data(0x0015);
TFT_28_7789_Write_Data(0x000D);
TFT_28_7789_Write_Data(0x0037);
TFT_28_7789_Write_Data(0x0043);
TFT_28_7789_Write_Data(0x0047);
TFT_28_7789_Write_Data(0x0009);
TFT_28_7789_Write_Data(0x0015);
TFT_28_7789_Write_Data(0x0012);
TFT_28_7789_Write_Data(0x0016);
TFT_28_7789_Write_Data(0x0019); //PVGAMCTRL: Positive Voltage Gamma control
TFT_28_7789_Write_Command(0x00E1);
TFT_28_7789_Write_Data(0x00D0);
TFT_28_7789_Write_Data(0x0000);
TFT_28_7789_Write_Data(0x0005);
TFT_28_7789_Write_Data(0x000D);
TFT_28_7789_Write_Data(0x000C);
TFT_28_7789_Write_Data(0x0006);
TFT_28_7789_Write_Data(0x002D);
TFT_28_7789_Write_Data(0x0044);
TFT_28_7789_Write_Data(0x0040);
TFT_28_7789_Write_Data(0x000E);
TFT_28_7789_Write_Data(0x001C);
TFT_28_7789_Write_Data(0x0018);
TFT_28_7789_Write_Data(0x0016);
TFT_28_7789_Write_Data(0x0019); //NVGAMCTRL: Negative Voltage Gamma control
TFT_28_7789_Write_Command(0x002A);
TFT_28_7789_Write_Data(0x0000);
TFT_28_7789_Write_Data(0x0000);
TFT_28_7789_Write_Data(0x0000);
TFT_28_7789_Write_Data(0x00EF); //X address set
TFT_28_7789_Write_Command(0x002B);
TFT_28_7789_Write_Data(0x0000);
TFT_28_7789_Write_Data(0x0000);
TFT_28_7789_Write_Data(0x0001);
TFT_28_7789_Write_Data(0x003F); //Y address set

TFT_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 Storage	Endurance test applying the electric stress (voltage & current) and the high thermal with high humidity stress for a long time.	+50°C, 90-95% RH, 120hrs	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. For 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.	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.

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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