深圳市拓普微科技开发有限公司
SHENZHEN TOPWAY TECHNOLOGY CO., LTD.

LMT050DNCFWL-NAC

LCD Module User Manual

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Date: 2018-07-27	Date:	Date:

Rev.	Descriptions	Release Date
0.1	Preliminary new release	2018-04-17
0.2	Update section 2.1, 3 and 4.1	2018-04-21
0.3	Update section 2, 4 and add CTP Function Characteristics	2018-07-27

Table of Content

1. General Specification

Screen Size(Diagonal) :	5.0 inch
Resolution :	480 x 800
Signal Interface :	24bit parallel interface
Color Depth :	16.7M color
Pixel Pitch :	0.135 x 0.135 (mm)
Pixel Configuration :	RGB Stripe
Display Mode :	Transmissive / normal white
Surface Treatment :	Glare
Viewing Direction :	9H (*1) (gray scale inverse) 3H (*2)
Outline Dimension :	90.09 x 259.28 x 10.2 (mm) (exclude FPC, see attached drawing for details)
Active Area :	64.8 x 108 (mm)
Operating Temperature :	-20 ~ +70°C
Storage Temperature :	-30 ~ +80°C

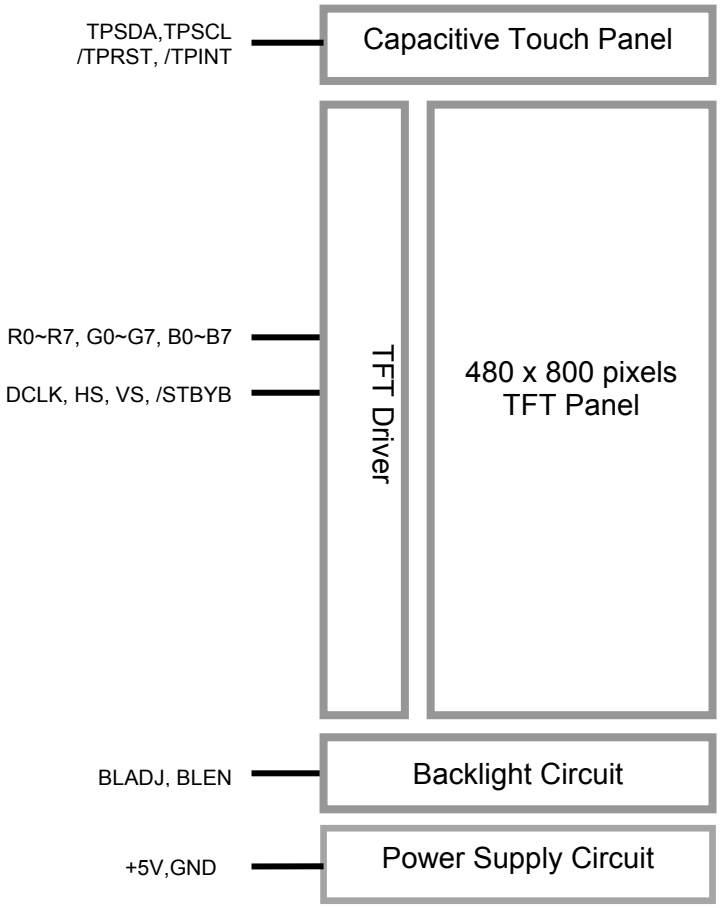
Note:

*1. For saturated color display content (eg. pure-red, pure-green, pure-blue, or pure-colors-combinations).

*2. For “color scales” display content.

*3. Color tone may slightly change by Temperature and Driving Condition.

1.1 Block Diagram



2. Terminal Functions

2.1 K1 TFT Driver Terminal

Pin No.	Pin Name	I/O	Descriptions
1	5V	Power	5V power supply
:	:		
5	5V		
6	GND	Power	0V power supply
:	:		
10	GND		
11	BLADJ	Input	Backlight brightness PWM signal (active low)
12	BLEN	Input	Backlight enable signal (active high)
13	NC(MODE)	NC	No Connection
14	NC(DE)	NC	No Connection
15	VS	Input	Vertical sync signal
16	HS	Input	Horizontal sync signal
17	B7	Input	Blue data line
:	:		
24	B0		
25	G7	Input	Green data line
:	:		
32	G0		
33	R7	Input	Red data line
:	:		
40	R0		
41	GND	Power	Ground, 0V
42	DCLK	Input	Pixel clock
43	GND	Power	Ground, 0V
44	/STBYB	Input	STBYB signal (pull hi for normal operation)
45	GND	Power	Ground, 0V
46	/TPRST	Input	Reset signal, active low reset
47	/TPINT	Output	Interrupt signal, active low interrupt
48	TPSDA	I/O	I^2C data (*1)
49	TPSCL	Input	I^2C clock (*1)
50	GND	Power	Ground

Note:
*1. With internal resister(4.7k) pull up.

3. Absolute Maximum Ratings

Items	Symbol	Min.	Max.	Unit	Condition
Power Voltage	V_{5V}	-0.3	+6	V	GND = 0V
Operating Temperature	T_{OP}	-20	+70	℃	No Condensation
Storage Temperature	T_{ST}	-30	+80	℃	No Condensation

Cautions:
Any Stresses exceeding the Absolute Maximum Ratings may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

4. Electrical Characteristics

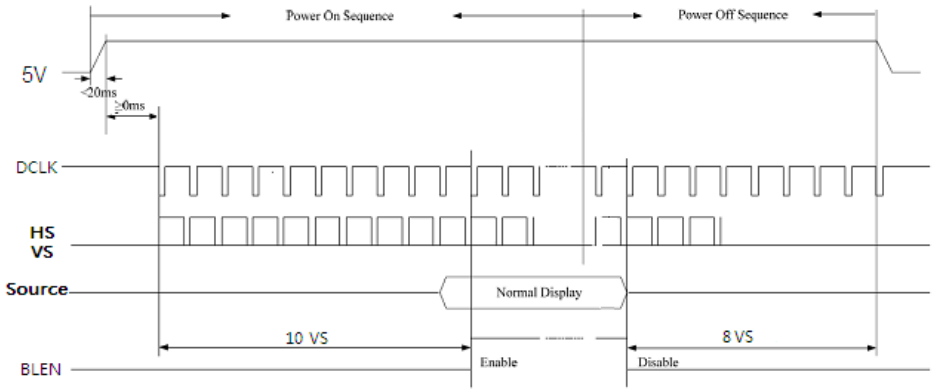
4.1 DC Characteristics

GND=0V, V_{5V} =5.0V, T_{OP} =25℃

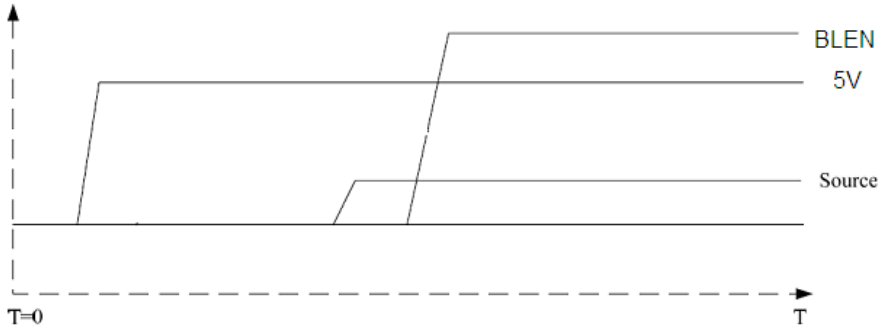
Items	Symbol	MIN.	TYP.	MAX.	Unit	Applicable Pin
Power Voltage	V_{5V}	4.5	5.0	5.5	V	5V
Operating Current (*1)	I_{5V}	-	260	400	mA	
Input High Voltage	V_{IH}	3.0	-	3.3	V	Input pins
Input Low Voltage	V_{IL}	0	-	0.3	V	Input pins
Output Signal High Voltage	V_{oH}	3.0	-	3.6	V	
Output Signal Low Voltage	V_{oL}	0	-	0.6	V	

Note.
*1. For different LCM, the value may have a bit of difference.
*2. To test the current dissipation, use “all Black Pattern”.

4.2 Power ON/OFF Sequence

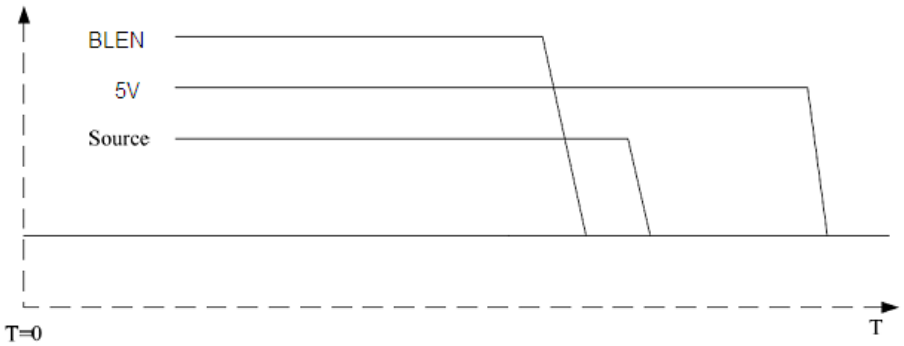


Power On/Off Sequence



5V → Display on → Source → BLEN

Power On Sequence



Display off → BLEN → Source → 5V

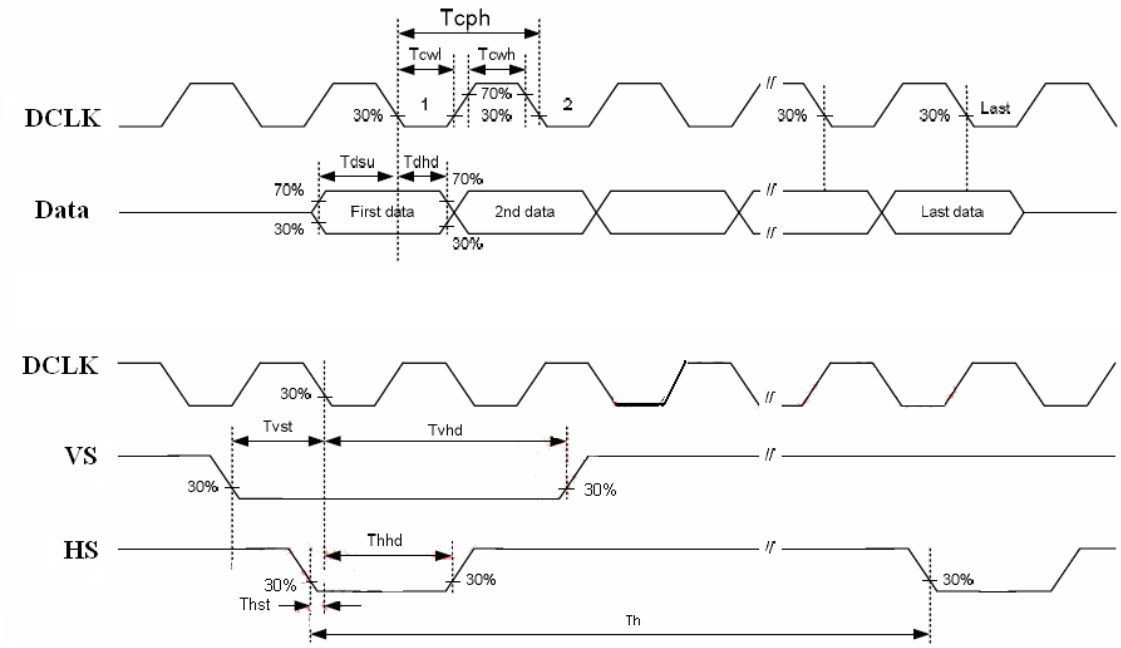
Power OFF Sequence

5. AC Characteristics

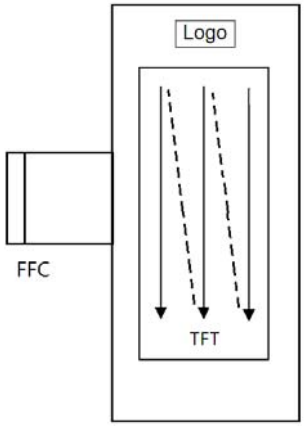
5.1 AC Timing

GND=0V, V_{5V} =5.0V, T_{OP} =25℃

Item	Symbol	MIN.	TYP.	MAX.	Unit	Remark
HS setup time	Thst	8	-	-	ns	
HS hold time	Thhd	8	-	-	ns	
VS setup time	Tvst	8	-	-	ns	
VS hold time	Tvhd	8	-	-	ns	
Data setup time	Tdsu	8	-	-	ns	
Data hole time	Tdhd	8	-	-	ns	
DE setup time	Tesu	8	-	-	ns	
DCLK cycle time	Tcph	20	-	-	ns	
DCLK pulse duty	Tcwh	40	50	60	%	



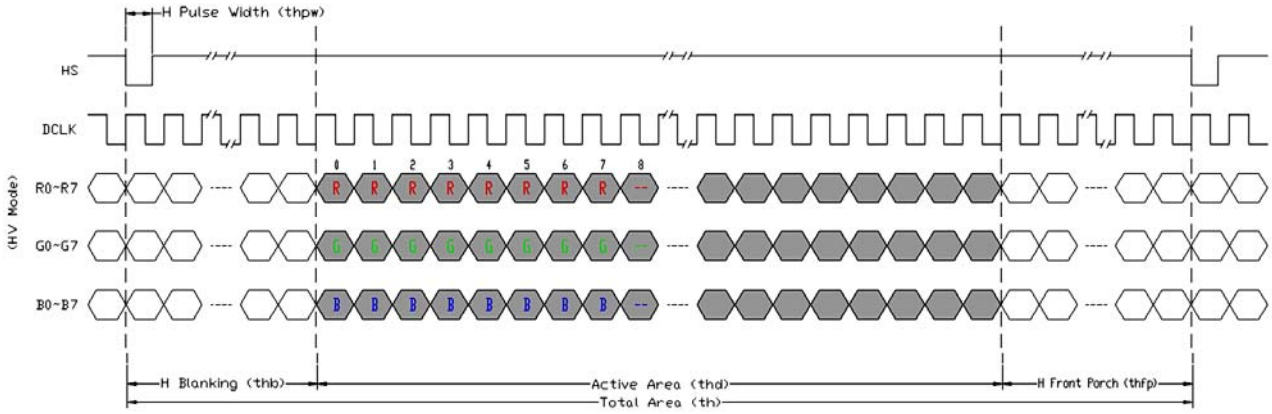
Input Clock and Data Timing Diagram



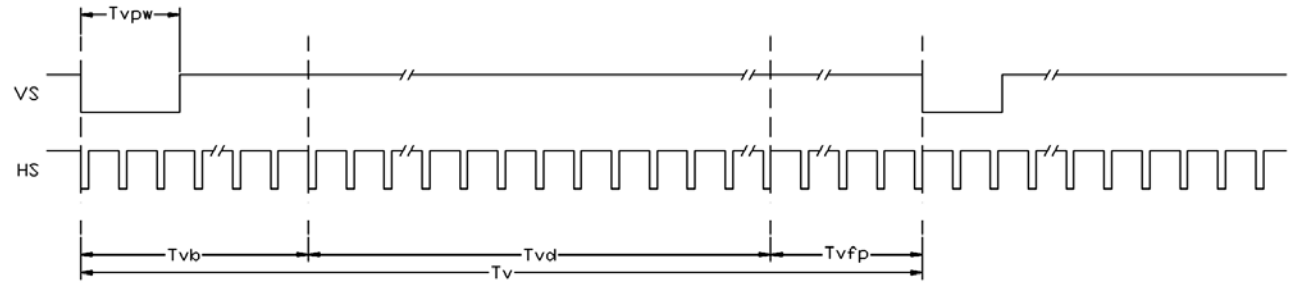
Display Driver Scanning Direction

5.2 Data Input format

Item	Symbol	MIN.	TYP.	MAX.	Unit	Remark
Horizontal Display Area	thd		800		DCLK	
DCLK Frequency	fclk	-	30	50	MHz	
One Horizontal Line	th	889	928	1143	DCLK	
HS pulse width	thpw	1	48	255	DCLK	
HS Blanking	thb		88		DCLK	
HS Front Porch	thfp	1	40	255	DCLK	
Vertical Display Area	tvd		480		TH	
VS period time	tv	513	525	767	TH	
VS pulse width	tvpw	3	3	255	TH	
VS Blanking	tvb		32		TH	
VS Front Porch	tvfp	1	13	255	TH	



Horizontal input timing diagram

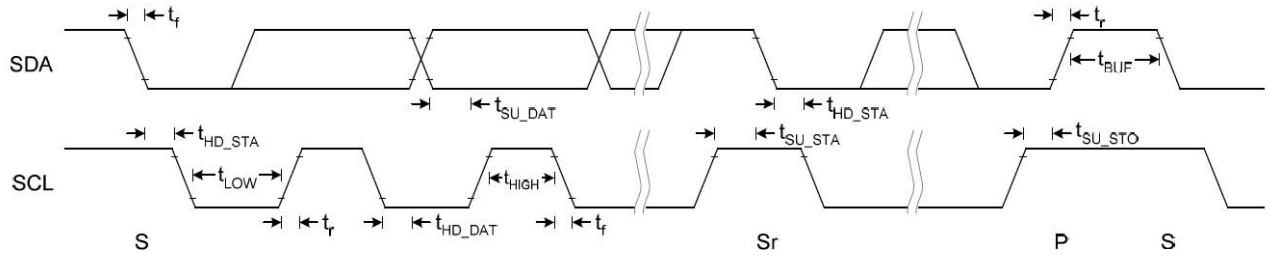


Vertical input timing diagram

5.3 I2C AC Electrical Characteristics

GND=0V, V_{5V} =5.0V, T_{OP} =25℃

Symbol	Parameter	Rating			Unit
		Min.	Typ.	Max.	
f_{SCL}	SCL clock frequency	0	-	400	kHz
t_{LOW}	Low period of the SCL clock	1.3	-	-	us
t_{HIGH}	High period of the SCL clock	0.6	-	-	us
t_f	Signal falling time	-	-	300	us
t_r	Signal rising time	-	-	300	us
t_{SU_STA}	Set up time for a repeated START condition	0.6	-	-	us
t_{HD_STA}	Hold time (repeated) START condition. After this period, the first clock pulse is generated	0.6	-	-	us
t_{SU_DAT}	Data set up time	100	-	-	us
t_{HD_DAT}	Data hold time	0	-	0.9	us
t_{SU_STO}	Set up time for STOP condition	0.6	-	-	us
t_{BUF}	Bus free time between a STOP and START condition	1.3	-	-	us

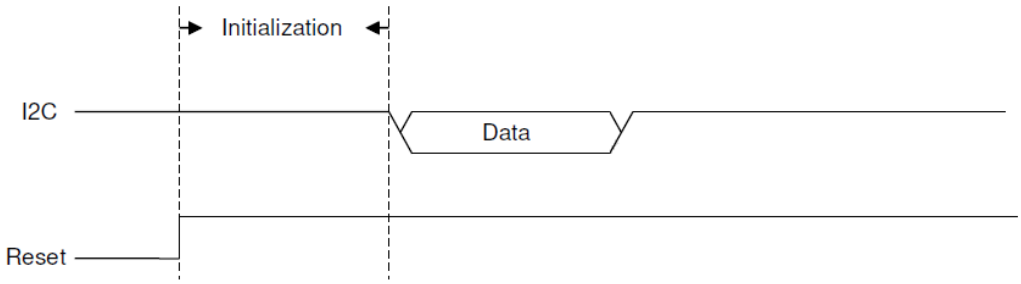


I2C Fast Mode Timing

6. CTP Function Characteristics

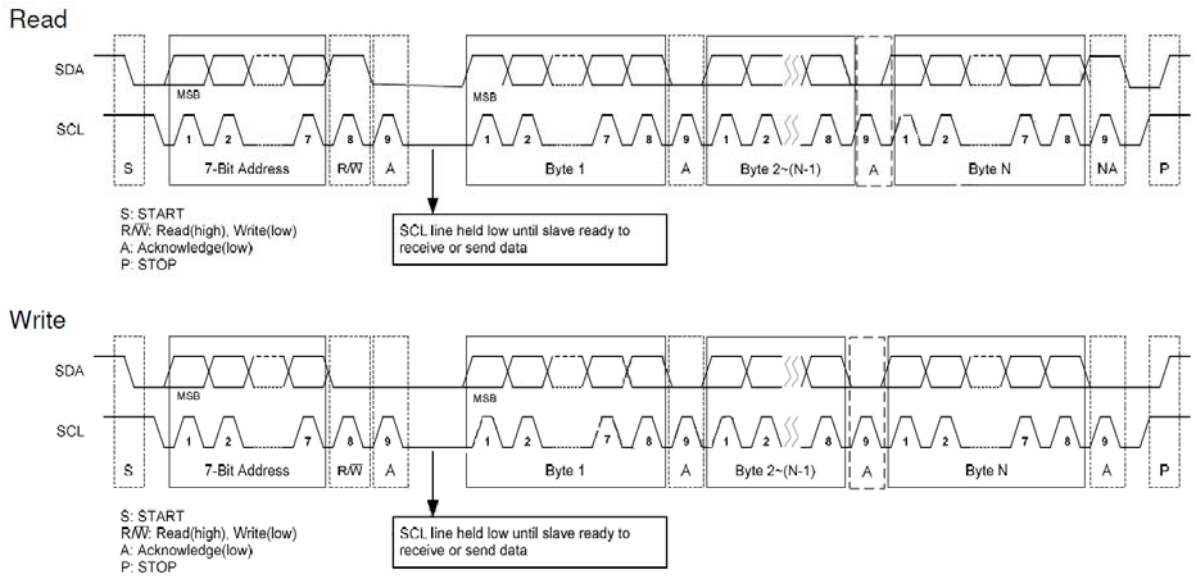
6.1 Initialization

After hardware reset, touch controller needs some time for initialization. The touch controller can be accessed via I2C interface after initialization. Initialization time is 50ms.



6.2 I2C Slave Interface

Touch IC equipped with I2C provides two wires, serial data (SDA) and serial clock (SCL), to carry transferring information at up to 400 kbit/s(Fast mode). I2C address is default to 0x55 (7-bits address). Touch IC plays the slave role in I2C transfer. Both SDA and SCL are bidirectional lines, connected to IOVDD via pull-up resistors. All transactions begin with a START (S) and can be terminated by a STOP (P). 7-bits address follows START to recognize device. Each bye is 8-bits length and followed by an acknowledge bit. A HIGH to LOW transition on the SDA line while SCL is HIGH defines a START condition. A LOW to HIGH transition on the SDA line while SCL is HIGH defines a STOP condition. The data on the SDA line must be stable during the HIGH period of the clock. The HIGH or LOW state of the data line can only change when the clock signal on the SCL line is LOW.



I2C Waveform

6.3 Register Read

For reading register value from I2C device, host has to tell I2C device the Start Register Address before reading corresponding register value.

I2C Start	I2C Header (W)	Start Reg. Addr (a)	I2C Stop	I2C Start	I2C Header (R)	Value of Reg(a)	Value of Reg(a+1)	…	Value of Reg(a+n)	I2C Stop

Register Read Format

I2C host interface protocol supports Repeated Register Read. That is, once the Start Register Address has been set by host, consequent I2C Read(R) transactions will directly read register values starting from the Start Register Address without setting address first, as shown in **Repeated Register Read.**

I2C Start	I2C Header (R)	Value of Reg(a)	Value of Reg(a+1)	…	Value of Reg(a+n)	I2C Stop	I2C Start	I2C Header (R)	Value of Reg(a)	Value of Reg(a+1)	…	Value of Reg(a+n)	I2C Stop

Repeated Register Read

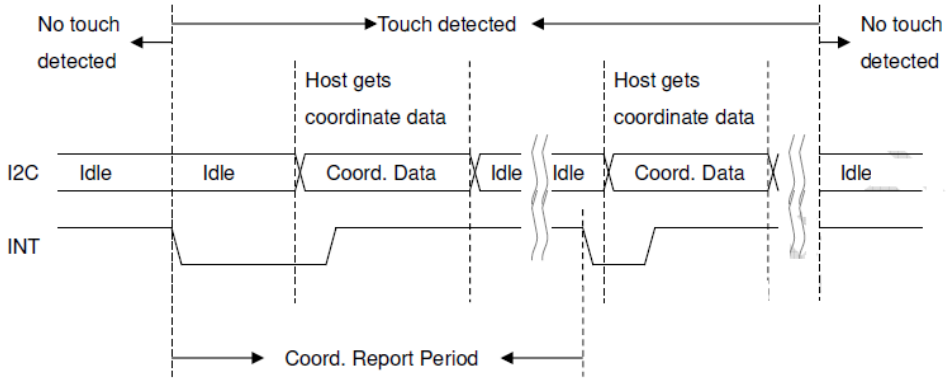
6.4 Register Write

For writing register to I2C device, host has to tell I2C device the Start Register Address in each I2C Register Write transaction. Register values to the I2C device will be written to the address starting from the Start Register Address described in Register Write I2C transaction as shown in **Register Write Format**.

I2C Start	I2C Header(W)	Start Reg. Addr.(a)	Value to Reg(a)	Value to Reg(a+1)	…	Value to Reg(a+n)	I2C Stop

Register Write Format

6.5 I2C Electrical Waveform



6.6 Report Page Registers

Touch IC provides a register set for host to configure device attributes and retrieve information about fingers and raw data through device host interface. Host interface registers are listed below.

Reg. Addr.	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x00	Firmware Version	Version (RO)							
0x01	Status Reg.	Error Code (RO)				Device Status (RO)			
0x02	Device Control Reg.	*Reserved*	Multi-Touch Disable (RW)	Proximity Enable (RW)	*Reserved*	*Reserved*	Deep Power Down (RW)	Power Down (RW)	Reset (RW)
0x03	Timeout to Idle Reg.	Timeout to Idle (sec.) (RW)							
0x04	XY Resolution (High Byte)	*Reserved*	X_Res_H (RO)			*Reserved*	Y_Res_H (RO)		
0x05	X Resolution (Low Byte)	X_Res_L (RO)							
0x06	Y Resolution (Low Byte)	Y_Res_L (RO)							
0x07	Sensing Counter (High Byte)	Sensing_Counter_H (RO)							
0x08	Sensing Counter (Low Byte)	Sensing_Counter_L (RO)							
0x09 … 0x0B	…	*Reserved*							
0x0C	Firmware Revision 3	FW_Rev_3 (RO)							
0x0D	Firmware Revision 2	FW_Rev_2 (RO)							
0x0E	Firmware Revision 1	FW_Rev_1 (RO)							
0x0F	Firmware Revision 0	FW_Rev_0 (RO)							
0x10	Advanced Touch Info.	*Reserved*	Proximity Flag (RO)	Water Flag (RO)	*Reserved*	Gesture Type(RO)			
0x11	Keys Reg.	Keys (RO)							
0x12	XY0 Coord. (High Byte)	Valid 0 (RO)	X0_H (RO)			*Reserved*	Y0_H (RO)		
0x13	X0 Coord. (Low Byte)	X0_L (RO)							
0x14	Y0 Coord. (Low Byte)	Y0_L (RO)							
0x15	…	*Reserved.*							

Reg. Addr.	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x16	XY1 Coord. (High Byte)	Valid 1 (RO)	X1_H (RO)			*Reserved*	Y1_H (RO)		
0x17	X1 Coord. (Low Byte)	X1_L (RO)							
0x18	Y1 Coord. (Low Byte)	Y1_L (RO)							
0x19	…	*Reserved.*							
0x1A … 0x35	…	…							
0x36	XY9 Coord. (High Byte)	Valid 9 (RO)	X9_H (RO)			*Reserved*	Y9_H (RO)		
0x37	X9 Coord. (Low Byte)	X9_L (RO)							
0x38	Y9 Coord. (Low Byte)	Y9_L (RO)							
0x39	Reserved	*Reserved.*							
0x3A … 0x3E	…	*Reserved*							
0x3F	Contact Count Max.	Max Number of Contacts Support (RO)							
0x40 … 0xCA	…	*Reserved*							
0xCB	PWM0 Duty	*Reserved*	PWM0 Duty (RW)						
0xCC	PWM1 Duty	*Reserved*	PWM1 Duty (RW)						
0xCD	PWM2 Duty	*Reserved*	PWM2 Duty (RW)						
0xCE	PWM3 Duty	*Reserved*	PWM3 Duty (RW)						
0xCF	PWM Control	PWM Trigger (RW)	PWM Clock (RW)			PWM3 Enable (RW)	PWM2 Enable (RW)	PWM1 Enable (RW)	PWM0 Enable (RW)
0xD0 … 0xEF	…	*Reserved*							
0xF0	Misc. Info.	Smart Wake Up Flag (RO)	*Reserved*						
0xF1	Misc. Control	Enable Smart Wake Up (RW)	*Reserved*						
0xF2	Smart Wake Up ID	Smart Wake Up ID (RW)							
0xF3 … 0xFE	…	*Reserved*							
0xFF	Page Reg.	Page Number (RW)							

Note:
Please refer to ST1633i IC datasheet and Sitronix Touch IC Protocol for detail.

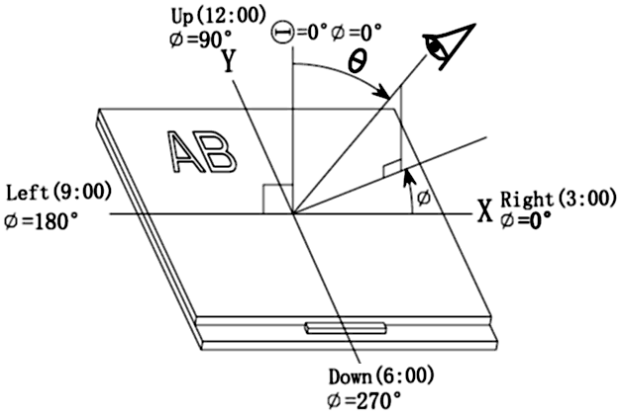
7. Optical Characteristics

Item		Symbol	Condition	MIN.	TYP.	MAX.	UNIT	Note.
Viewing angle		θ_T	(CR≥10)	60	70	-	degree	Note 2
		θ_B		60	70	-		
		θ_L		60	70	-		
		θ_R		40	50	-		
Contrast ratio		CR	θ=0°	500	600	-	-	Note 1,3
Response Time		T_{on}	25℃	-	20	30	msec	Note 1,4
		T_{off}					msec	
Chromaticlty	White	X	Backlight is on	0.260	0.310	0.360		Note 1,5
		Y		0.280	0.330	0.380		
	Red	X		0.540	0.590	0.640		
		Y		0.300	0.350	0.400		
	Green	X		0.298	0.348	0.398		
		Y		0.520	0.570	0.620		
	Blue	X		0.095	0.145	0.195		
		Y		0.060	0.110	0.160		
Luminance		L		-	200	-	cd/m^2	Note 1,6
NTSC				-	50		%	Note 5
Luminance uniformity		U		75	80	-	%	Note 1,7

Test Conditions:
1. IF= 40mA, VF=21.7V, and the ambient temperature is 25. ℃
2. The test systems refer to Note 1 and Note 2.

Note 1:
The data are measured after LEDs are turned on for 5 minutes. LCM displays full white. The brightness is the average value of 9 measured spots. Measurement equipment SR-3A (1°)
Measuring condition:
- Measuring surroundings: Dark room
- Measuring temperature: Ta=25℃.
- Adjust operating voltage to get optimum contrast at the center of the display.

Note 2:
The definition of viewing angle:
Refer to the graph below marked by θ and Φ

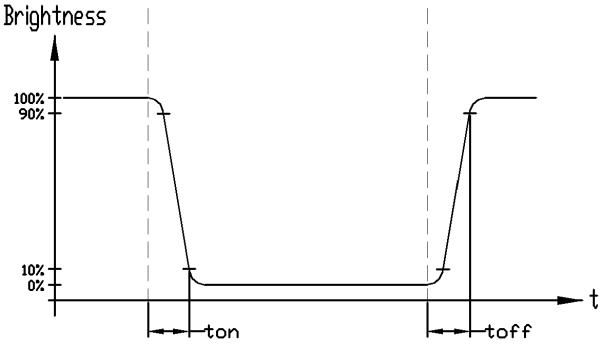


Note 3:
The definition of contrast ratio (Test LCM using SR-3A (1°)):

$$\text{Contrast Ratio(CR)} = \frac{\text{Luminance When LCD is at "White" state}}{\text{Luminance When LCD is at "Black" state}}$$

(Contrast Ratio is measured in optimum common electrode voltage)

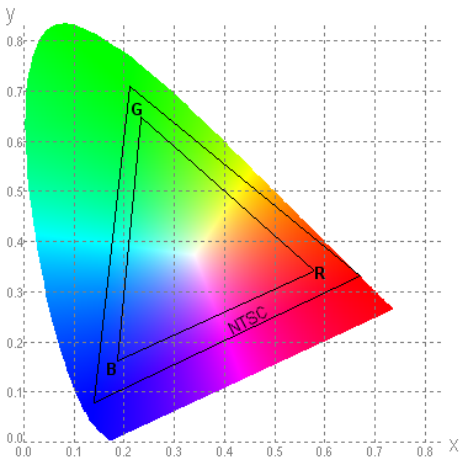
Note 4:
Definition of Response time. (Test LCD using BM-7A(2°)):
The output signals of photo detector are measured when the input signals are changed from "black" to "white"(falling time) and from "white" to "black"(rising time), respectively. The response time is defined as the time interval between the 10% and 90% of amplitudes.Refer to figure as below.



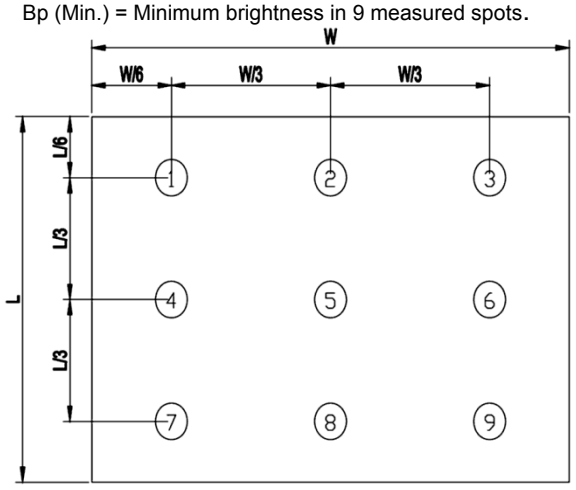
Note 5:
Definition of Color of CIE1931 Coordinate and NTSC Ratio.

Color gamut:

$$S = \frac{\text{Area of RGB triangle}}{\text{Area of NTSC triangle}} \times 100\%$$



Note 6:
The luminance uniformity is calculated by using following formula.
△ Bp = Bp (Min.) / Bp (Max.)×100 (%)
Bp (Max.) = Maximum brightness in 9 measured spots
Bp (Min.) = Minimum brightness in 9 measured spots.



Note 7:
Measured the luminance of white state at center point

8. Precautions of using LCD Modules

Mounting

- Mounting must use holes arranged in four corners or four sides.
- The mounting structure so provide even force on to LCD module. Uneven force (ex. Twisted stress) should not applied to the module. And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
- It is suggested to attach a transparent protective plate to the surface in order to protect the polarizer. It should have sufficient strength in order to the resist external force.
- The housing should adopt radiation structure to satisfy the temperature specification.
- Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
- Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. Never rub with dust clothes with chemical treatment. Do not touch the surface of polarizer for bare hand or greasy cloth.(Some cosmetics deteriorate the polarizer.)
- When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzine. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
- Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer

Operating

- The spike noise causes the mis-operation of circuits. It should be within the ±200mV level (Over and under shoot voltage)
- Response time depends on the temperature.(In lower temperature, it becomes longer.)
- Brightness depends on the temperature. (In lower temperature, it becomes lower.) And in lower temperature, response time(required time that brightness is stable after turned on) becomes longer.
- Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
- When fixed patterns are displayed for a long time, remnant image is likely to occur.
- Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference

Electrostatic Discharge Control

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

Strong Light Exposure

Strong light exposure causes degradation of polarizer and color filter.

Storage

When storing modules as spares for a long time, the following precautions are necessary.

- Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
- The polarizer surface should not come in contact with any other object. It is recommended that they be stored in the container in which they were shipped.

Protection Film

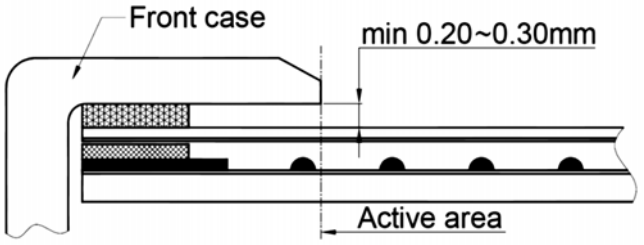
- When the protection film is peeled off, static electricity is generated between the film and polarizer. This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
- The protection film is attached to the polarizer with a small amount of glue. If some stress is applied to rub the protection film against the polarizer during the time you peel off the film, the glue is apt tore main on the polarizer. Please carefully peel off the protection film without rubbing it against the polarizer.
- When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the polarizer after the protection film is peeled off.
- You can remove the glue easily. When the glue remains on the polarizer surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.

Transportation

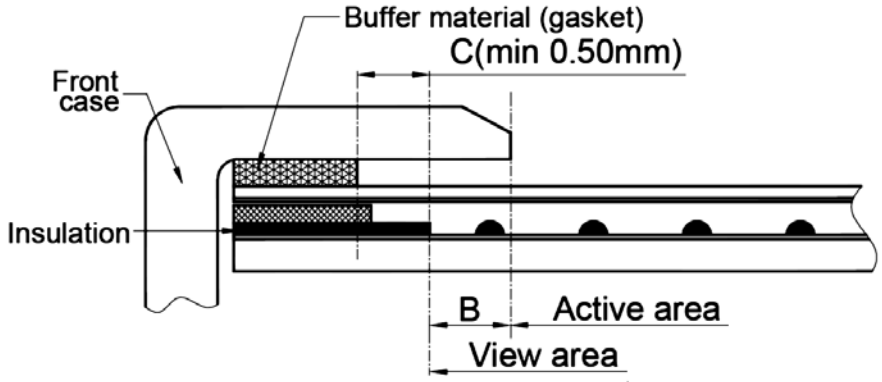
The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.

附录：Touch panel Design Precautions

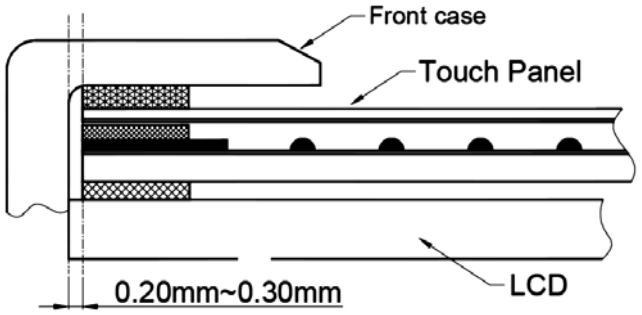
1. It should prevent front case touching the touch panel Active Area (A.A.) to prevent abnormal touch.
   It should left gab (e.g. 0.2~0.3mm) in between.



2. Outer case design should take care about the area outside the A.A.
   Those areas contain circuit wires which is having different thickness. Touching those areas could deform the ITO film. As a result case the ITO cold be damaged and shorten its lifetime.
   It is suggested to protect those areas with gasket (between the front case and the touch panel).
   The suggested figures are B≥0.50mm; C≥0.50mm。



3. The front case side wall should keep space (e.g. 0.2 ~ 0.3mm) from the touch panel.



4. In general design,
   touch panel V.A. should be bigger than the LCD V.A.
   and touch panel A.A. should be bigger than the LCD A.A.