7inch Capacitive Touch LCD

User Manual

Chinese website: www.waveshare.net
English website: www.wvshare.com
Data download: www.waveshare.net/wiki

Contents

1. Overview

7inch Capacitive Touch LCD module is a 7 inch TFT-LCD with no LCD controller included. It adopts AT070TN92 as its LCD screen and FT5206GE1 (FT5x06 series ICs) as capacitive touch control chip, supporting multi-touch of up to 5 points. AT070TN92 can provide 800*480 pixel resolution with 24 bit pixel depth.

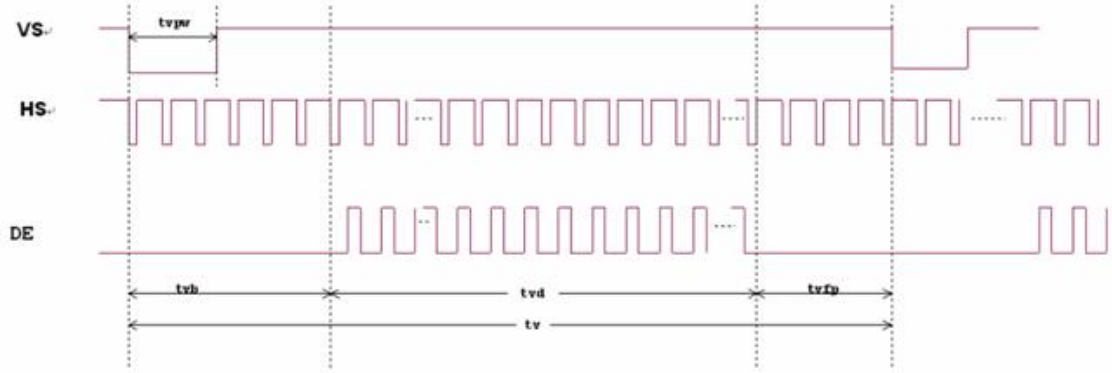
1.1 AT070TN92

Here are the basic parameters of AT070TN92.

Module Type	TFT
Interfaces	24-bit parallel RGA data input
Backlight	LED
Display area(mm)	154.08(W)×85.92(H)
Dot pitch (mm)	0.0642(W)×0.1790(H)
Aspect ratio	8:5
Resolution	800*480 (Pixel)
Scan frequency	60Hz
Display colors	16.7M

When applying AT070TN92, a MCU with LCD controller is required, since the LCD controller is not included in this LCD. Here is the basic sequence of AT070TN92:

Data Input Format



Pin descriptions:

Symbol	Description
HS	Horizontal sync signal, which indicates the starting to scan a new line
VS	Vertical sync signal, which indicates the starting to scan a new frame. One frame refers to one picture shown in the LCD
DCLK	LCD clock
R0-R7	Red pallet data line
G0-G7	Green pallet data line
B0-B7	Blue pallet data line
DE	Input data enable control

Here are the meanings of symbols in the sequence diagram:

Item	Symbol	Values			Unit	Remark
		Min.	Typ.	Max.		
Horizontal Display Area	thd	-	800	-	DCLK	
DCLK Frequency	fclk	26.4	33.3	46.8	MHz	
One Horizontal Line	th	862	1056	1200	DCLK	
HS pulse width	thpw	1	-	40	DCLK	
HS Blanking	thb	46	46	46	DCLK	
HS Front Porch	thfp	16	210	354	DCLK	

Item	Symbol	Values			Unit	Remark
		Min.	Typ.	Max.		
Vertical Display Area	tvd	-	480	-	TH	
VS period time	tv	510	525	650	TH	
VS pulse width	tvpw	1	-	20	TH	
VS Blanking	tvb	23	23	23	TH	
VS Front Porch	tvfp	7	22	147	TH	

Remarks:

(1) Unit: CLK=1/f_{CLK}, it is the duration for scanning a pixel; H=th, it is the duration for scanning a line.

(2) This table is referenced from AT070TN92.pdf

From the table above, we can see that:

The clock of this LCD is come from an external clock source with the frequency of 26.4-46.8MHz. Notices that thfp+thb=46 and tvfp+tvb=23.

From the figure above, we can learn that:

The total time for scanning a line is: th = thp + thb + thd + thf; in the period of thd, when a clock plus comes, a pixel data will be transmitted via the parallel data interface. And there are 800 pixels each line for this LCD, so thd=800;

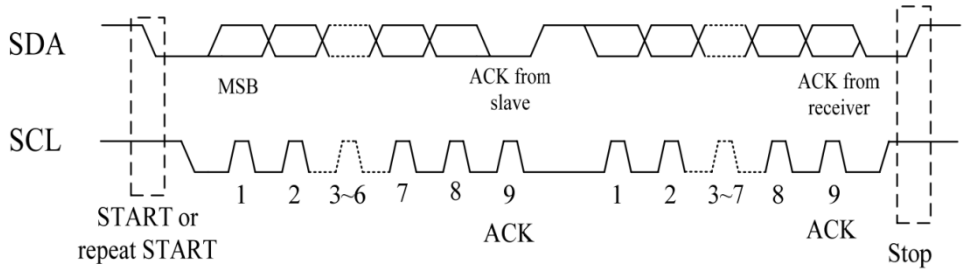
The duration for scanning a frame is: tv = tvp + tvb + tvd + tvf； Hsync can be regarded as the clock of vertical signals. A clock cycle of Hsync refers to the duration for LCD displaying a line. When a falling edge comes in Hsync, a new line will be displayed in the LCD. However, the actual data transmission only occurs in the period of tvd. And the LCD will display the new line in this case merely. There are 480 lines for this LCD, so tvd = 480. Other parameters can be modified as required, according to the specifications listed in the tables above.

1.2 FT5X06

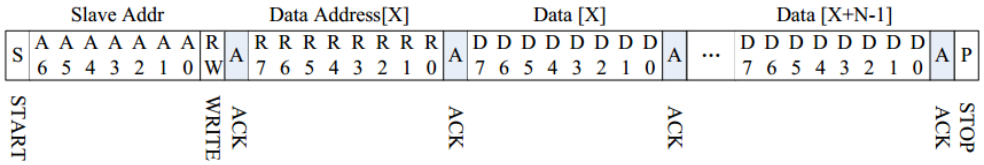
- Optional interface: I2C/SPI (This module only has I2C interface);
- Working voltage: 2.8V-3.6V;
- Built-in 8051 based MCU with 32KB Program Memory, 6KB Data Memory and 256B Internal Data Space;
- Working temperature range: -40℃-85℃;
- Supports multi-touch of up to 5 points.

I2C Read/Write Timing of FT5X06

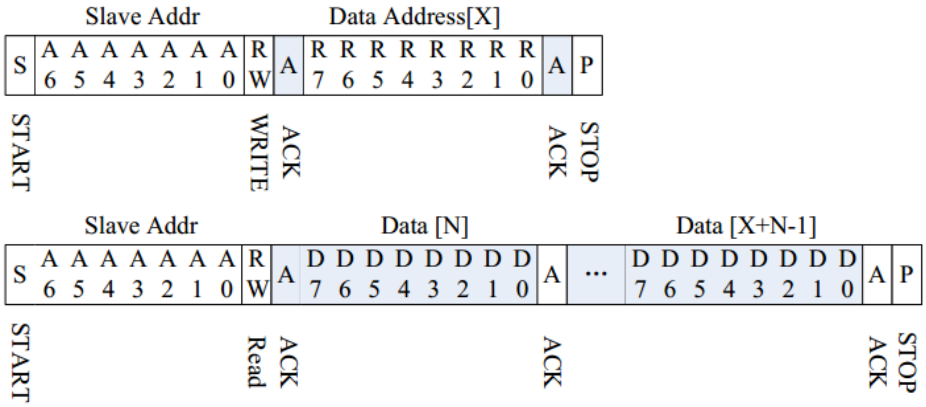
The figures below show the I2C read/write timing of FT5X06.



Writes N bytes to I2C slave



Reads N bytes from I2C slave



The time parameter of I2C is listed as the table below.

Parameter	Min.	Max.	Unit
SCL clock	0	400	KHZ
STOP and START	4.7	\	us
Data setup time	250	\	ns

Registers of FT5X06

The MCU of FT5X06 can read the positions(x, y coordinates) of up to 5 points from the corresponding registers, when the working mode is configured. The following section will present the major registers of FT5X06. For other registers, please refer to *FT5X06 Data Sheet*.

Addr.	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	R/W
0x00	DEVIDE_MODE		Device Mode[2:0]							RW
0x01	GEST_ID	Gesture ID[7:0]								R
0x02	TD_STATUS					Number of touch points[3:0]				R
0x03	TOUCH1_XH	1 st Event Flag				1 st Touch X Position[11:8]				R
0x04	TOUCH1_XL	1 st Touch X Position[7:0]								R
0x05	TOUCH1_YH	1st Touch ID[3:0]				1 st Touch Y Position[11:8]				R
0x06	TOUCH1_YL	1 st Touch Y Position[7:0]								R
0x09	TOUCH2_XH	2 st Event				2 st Touch				R

		Flag		X Position[11:8]	
0x0A	TOUCH2_XL	2 st Touch X Position[7:0]			R
0x0B	TOUCH2_YH	2st Touch ID[3:0]		2 st Touch Y Position[11:8]	R
0x0C	TOUCH2_YL	2 st Touch Y Position[7:0]			R
0x0F	TOUCH3_XH	3 stEvent Flag		3 st Touch X Position[11:8]	R
0x10	TOUCH3_XL	3 st Touch X Position[7:0]			R
0x11	TOUCH3_YH	3stTouch ID[3:0]		3 st Touch Y Position[11:8]	R
0x12	TOUCH3_YL	3st Touch Y Position[7:0]			R
0x15	TOUCH4_XH	4 stEvent Flag		4st Touch X Position[11:8]	R
0x16	TOUCH4_XL	4 st Touch X Position[7:0]			R
0x17	TOUCH4_YH	4st Touch ID[3:0]		4 st Touch Y Position[11:8]	R
0x18	TOUCH4_YL	4st Touch Y Position[7:0]			R
0x1B	TOUCH5_XH	5 stEvent Flag		5 st Touch X Position[11:8]	R
0x1C	TOUCH5_XL	5 st Touch X Position[7:0]			R
0x1D	TOUCH5_YH	5st Touch ID[3:0]		5 st Touch Y Position[11:8]	R
0x1E	TOUCH5_YL	5 st Touch Y Position[7:0]			R

DEVIDE_MODE: FT5x06 mode configuration register; DEVIDE_MODE[6:4] can set three modes: Operating Mode, System Information Mode (reserved) and Testing Mode for reading raw data (reserved). Normally, Operating Mode is always set to read the positions of touch points.

GEST_ID: This register describes the gesture of valid touch.

Register	Value	Description
Gesture ID[7:0]	0x10	Move Up
	0x14	Move Left
	0x18	Move Down
	0x1C	Move Right
	0x48	Zoon Out
	0x49	Zoon In
	0x00	No Gesture

TD_STATUS: This register is the Touch Data status register.

Register	Bit	Register name	Description

	address		
TD_STATUS	3:0	Number of touch point[3:0]	How many points detected 1~5 is valid
	7:4		

TOUCHn_XH (n=1-5): This register describes the MSB of the X coordinate of the nth touch point and the corresponding flag, in which the upper two bits of the register indicate the status of the nth touch point, and the lower four bits indicate the MSB of the touch point X position.

Register	Bit address	Register name	Description
TOUCHn_XH(n=1-5)	7:6	Event Flag	00b: Put down 01b: Put up 10b: Contact 11b: Reserved
	5:4		
	3:0	Touch X Position [11:8]	MSB of Touch X position in pixels

Explanations for other touch registers:

TOUCHn_XL(n=1-5): This register describes the LSB of the X coordinate of the nth touch point

TOUCHn_YH(n=1-5): This register describes the MSB of the Y coordinate of the nth touch point and the corresponding ID, in which the upper four bits of the register indicate the corresponding ID of the nth touch point, and the lower four bits indicate the MSB of the touch point Y position.

TOUCHn_YL(n=1-5): This register describes the LSB of the Y coordinate of the nth touch point

FT5x06 data reading flow

Initialize I2C;

Set the working mode of FT5x06;

If there is touch interrupt, read out the corresponding X and Y position values of the touch point(s) from relative register.

Notices: For adjacent points, the register addresses of their positions(X and Y coordinates) are not contiguous. For example, touch points A and B are two adjacent points. The position of point A will be stored in the register addresses of 0x03, 0x04, 0x05 and 0x06, and point B in 0x09, 0x0A, 0x0B and 0x0C. The addresses 0x07 and 0x08 are assigned no value.

2. Hardware description

Pin definitions of capacitive touch LCD:

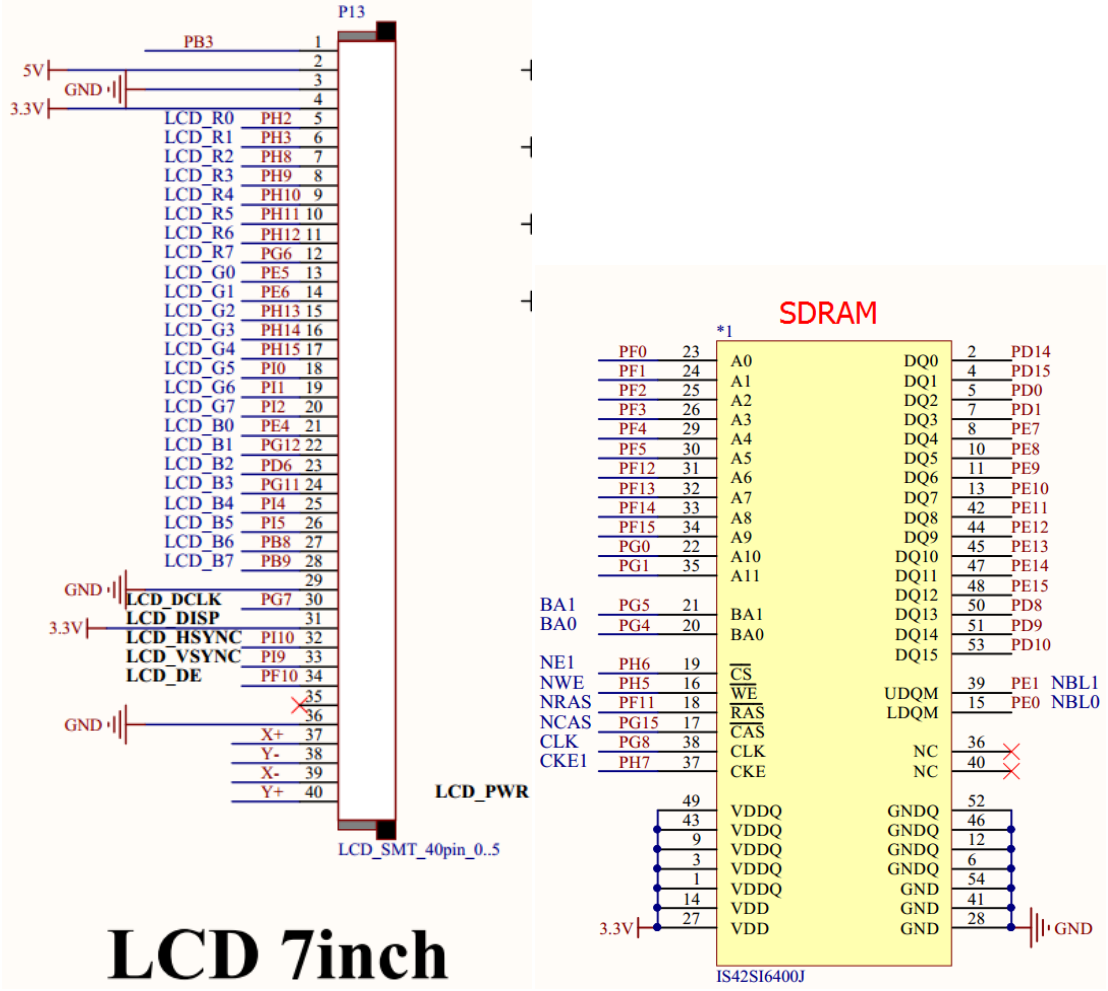
Pin No.	Symbol	Descriptions	I/O	Functions
1	CAP_INT	Interrupt pin	I	External interrupt control input pin
2	CAP_WAKE	WAKEUP pin	I	It is used to wake up external TP controller
3	I2C_SDA	I2C data pin	I/Os	I2C data transmission
4	I2C_SCL	I2C clock pin	I	I2C clock control pin

Pin definitions of LCD:

Pin No.	Symbol	Descriptions	I/O	Functions
1	VLED-	Backlight negative polarity	O	Backlight negative polarity, connected to GND or PWM
2	VLED+	Backlight positive polarity	I	Backlight positive polarity, connected to 5V power supply
3	GND	Power ground	O	Ground
4	VCC	Power supply positive	I	Power supply, connected to 3.3V power adapter
5	R0	Data line	I	Red pallet data line
6	R1			
7	R2			
8	R3			
9	R4			
10	R5			
11	R6			
12	R7			
13	G0	Data line	I	Green pallet data line
14	G1			
15	G2			
16	G3			
17	G4			
18	G5			
19	G6			
20	G7			
21	B0	Data line	I	Blue pallet data line
22	B1			
23	B2			

24	B3			
25	B4			
26	B5			
27	B6			
28	B7			
29	GND	Ground	O	GND
30	DCLK	LCD clock	I	LCD clock signal source
31	DISP	Display on/off mode control	I	Control display on/off mode, connected to VCC
32	HSYNC	Horizontal synchronization	I	Horizontal sync signal input
33	VSYNC	Vertical synchronization	I	Vertical sync signal input
34	DE	Input data enable control	I	DE=0:SYNC mode DE=1:DE mode
35	NC			
36	GND	Ground	I	GND
37	X+	-	-	NC
38	Y-	-	-	NC
39	X-	-	-	NC
40	Y+	-	-	NC

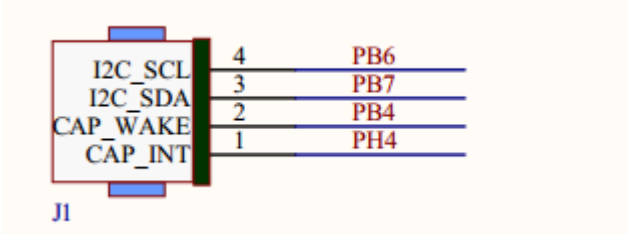
The following figures show the connection of the LCD hardware interfaces based on Open429I-C development board.



The hardware connection presented above is based on the TFT-LCD controller integrated in the STM32F429IGT6. In this application, the display is controlled by STM32F429IGT6. MCU reads/writes data from/to the capacitive touch control chip FT5X06 via I2C.

In this application, SDRAM serves as the data buffer of LCD. TFT-LCD controller reads data from SDRAM and displays what it got on LCD. The data will be refreshed by the controller all the time, so when there is any change in SDRAM, the picture displayed on the LCD will be updated immediately. Hence, you only need to configure the registers of the TFT-LCD controller, and then manage the data in SDRAM to control the display on the LCD screen. The refresh frequency depends on the LCD clock cycle.

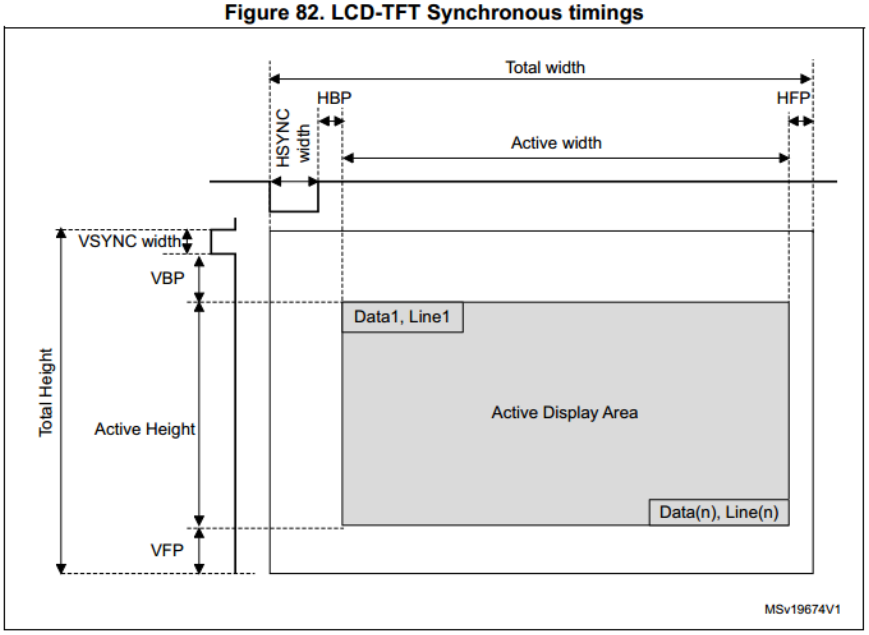
The interfaces of the capacitive touch function are shown as follow.



3. Software description

The following program is written based on the application developed with Open407I-C. The MCU of Open407I-C development board is STM32F429IGT6, which integrates a TFT-LCD controller with 800*600 pixel resolution.
The controller integrated in STM32F429IGT6 is as the figure below shows.

Figure 82. LCD-TFT Synchronous timings



HBP is for horizontal back porch and HFP is for horizontal front porch;
VBP is for vertical back porch and VFP is for vertical front porch.

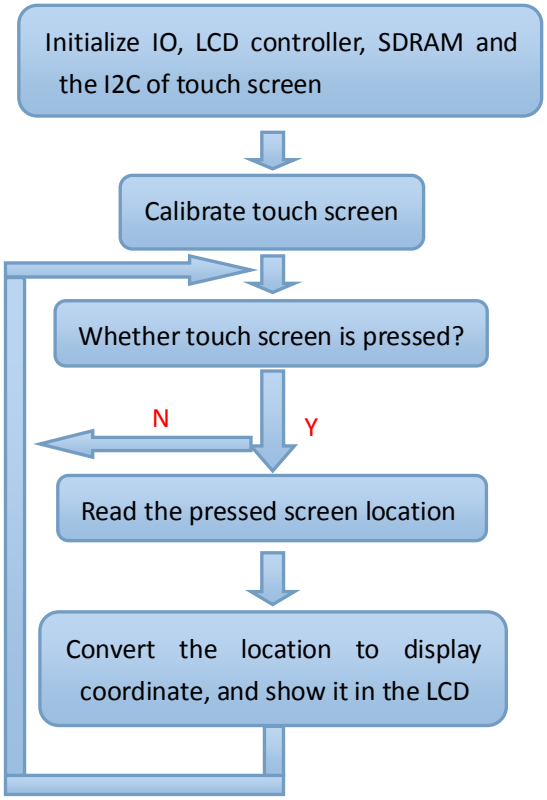
- HSYNC Width and VSYNC Height: HSYNC Width is for Horizontal Synchronization Width and VSYNC Height is Vertical Synchronization Height. They can be set by the bits HSW(LTDC_SSCR[27:16]) and VSH(LTDC_SSCR[10:0]) of LTDC_SSCR register, where HSW= HSYNC Width – 1, and VSH = VSYNC Height – 1;

- HBP and VBP can be set by the bits AHBP(LTDC_BPCR[27:16]) and AVBP(LTDC_BPCR[10:0]) of LTDC_BPCR register, where AHBP= HSYNC Width + HBP – 1, and AVBP= VSYNC Height + VBP – 1;

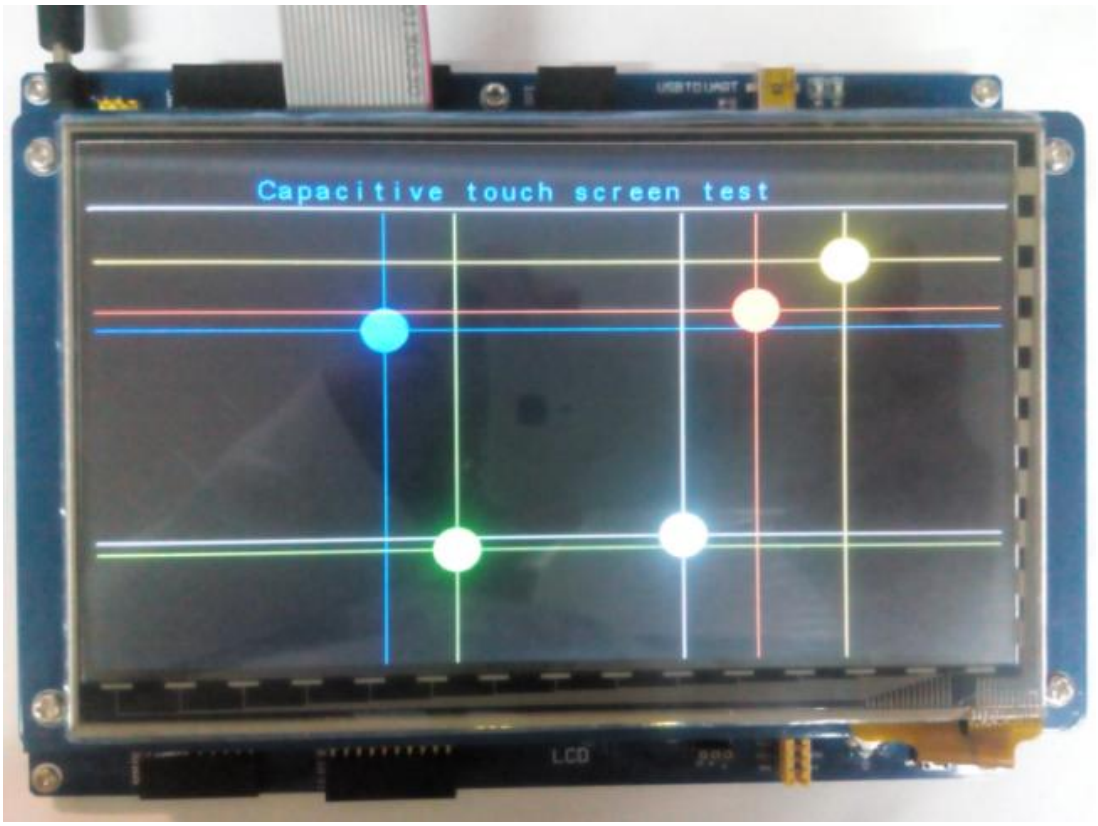
- Active Width and Active Height can be set by the bits AAW(LTDC_AWCR[27:16]) and AAH(LTDC_AWCR[10:0]) of LTDC_AWCR register, where AAW= HSYNC Width + HBP+ Active Width – 1, and AAH= VSYNC Height + VBP+ Active Height – 1;

- Total Width and Total Height can be set by the bits TOTALW(LTDC_TWCR[27:16]) and TOTALH(LTDC_TWCR[10:0]) of LTDC_TWCR register, where TOTALW= HSYNC Width + HBP+ Active Width +HFP – 1, and TOTALH= VSYNC Height + VBP+ Active Height +VFP – 1.

Program flow chart:



4. Test result



5. Dimensions