Overview

3.2inch 320x240 Touch LCD (D)

320×240

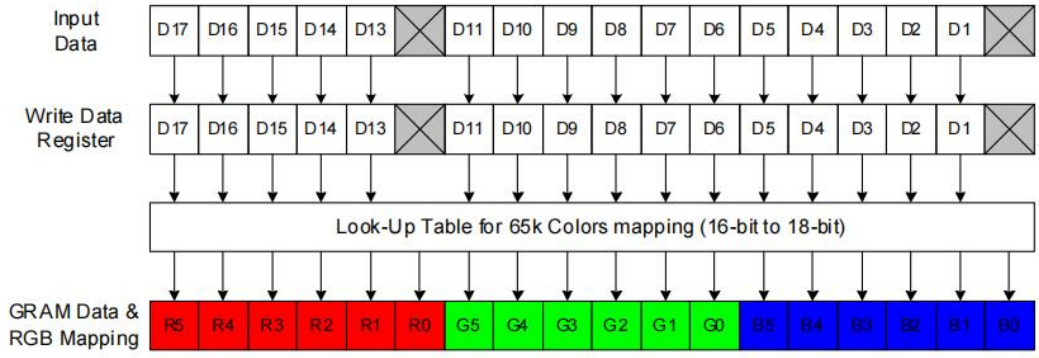
1. Hardware Resources

1.1 ILI9341

- ILI9341 is a 262144-color TFT LCD driver chip with a resolution of 240x320 (RGB) and 172820 (240 x 320x 18/8) bytes of RAM. Each pixel depth can reach 18 bits.
- ILI9341 has the following data interface modes:

1) i80-system MPU port (8-/9-/16-/18-bit bus width).
2) serial data transfer port (SPI).
3) RGB 6-/16-/18-bit port (DOTCLK, VSYNC, HSYNC, ENABLE, DB[17:0]).

The corresponding relationship between the 18-bit RGB assignment of ILI9341 and LCD GRAM in this screen is shown in the figure:



According to the above figure, ILI9341 is in the 16-bit mode and the available GRAM data are D17~D13 and D11~D1. D12 and D0 are not used. Actually, D12 and D0 of ILI9341 are not adapted in our LCD module. D17~D13 and D11~D1 of ILI9341 correspond to D15~D0 of MCU. In the 16-bit data of the MCU, the lowest 5 bits represent blue, the middle 6 bits are green, and the highest 5 bits are red. The larger the value, the darker the color.

8080 16-bit Interface Sequence Introduction

- For more details about the register, please refer to ILI9341.pdf.
- Here we only introduce the sequence requirements for reading and writing.

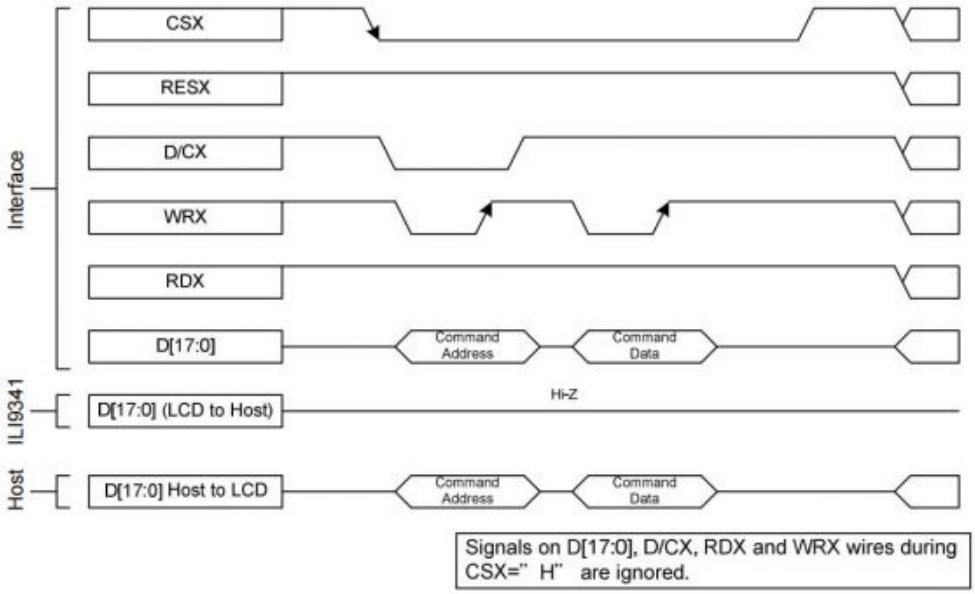
The 8080 interface is designed by Intel. It is a parallel, asynchronous, half-duplex communication protocol. It is used for external expansion of RAM and ROM and is

also used for LCD interface later.

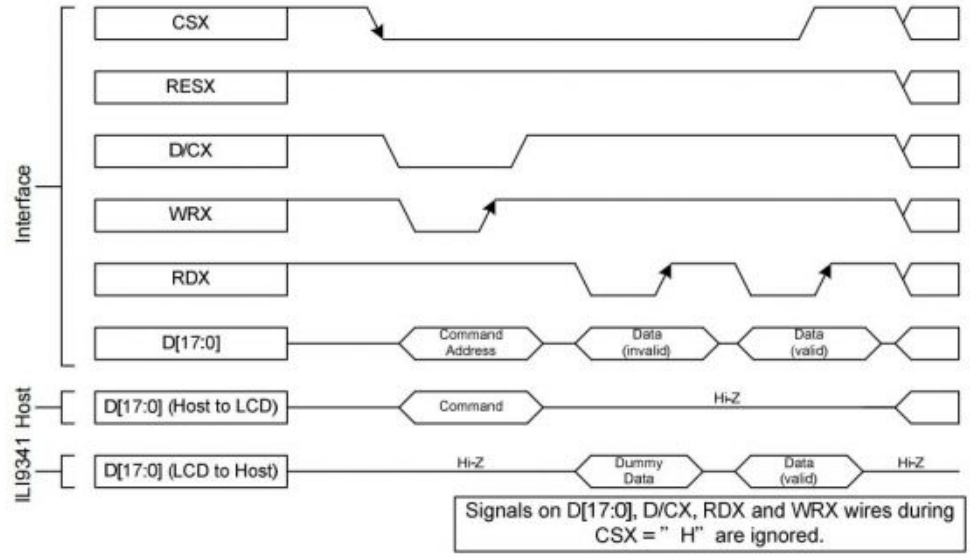
- Four control cables

```
RD: Write enable (write information to register)
WR: read enable (read information from the register)
DC(RS): data/command (1 for reading and writing data, 0 for reading and writing
commands)
CS: chip select
```

- The sequence diagram for writing commands or data is as follows:



- The sequence diagram for reading information is as follows:



1.2 XPT2046

- The XPT2046 is a 4-wire resistive touchscreen controller with a successive approximation A/D converter with 12-bit resolution and a conversion rate of 125KHZ.

- The XPT2046 supports low-voltage I/O interfaces from 1.5V to 5.25V.
- The XPT2046 can detect the touched position on the screen by performing two A/D conversions, in addition to measuring the pressure applied on the touch screen. The built-in 2.5V reference voltage can be used as an auxiliary input, temperature measurement, and battery monitoring. The voltage range of battery monitoring can be from 0V to 5V.
- The XPT2046 has a temperature sensor integrated on-chip. Under typical operating conditions of 2.7V, with the reference voltage off, the power consumption can be less than 0.75mW. The XPT2046 is available in tiny packages: TSSOP-16, QFN-16, and VFBGA-48. The working temperature range is -40℃ ~ +85℃. Fully compatible with ADS7846, TSC2046, and AK4182A.

2. Hardware Description

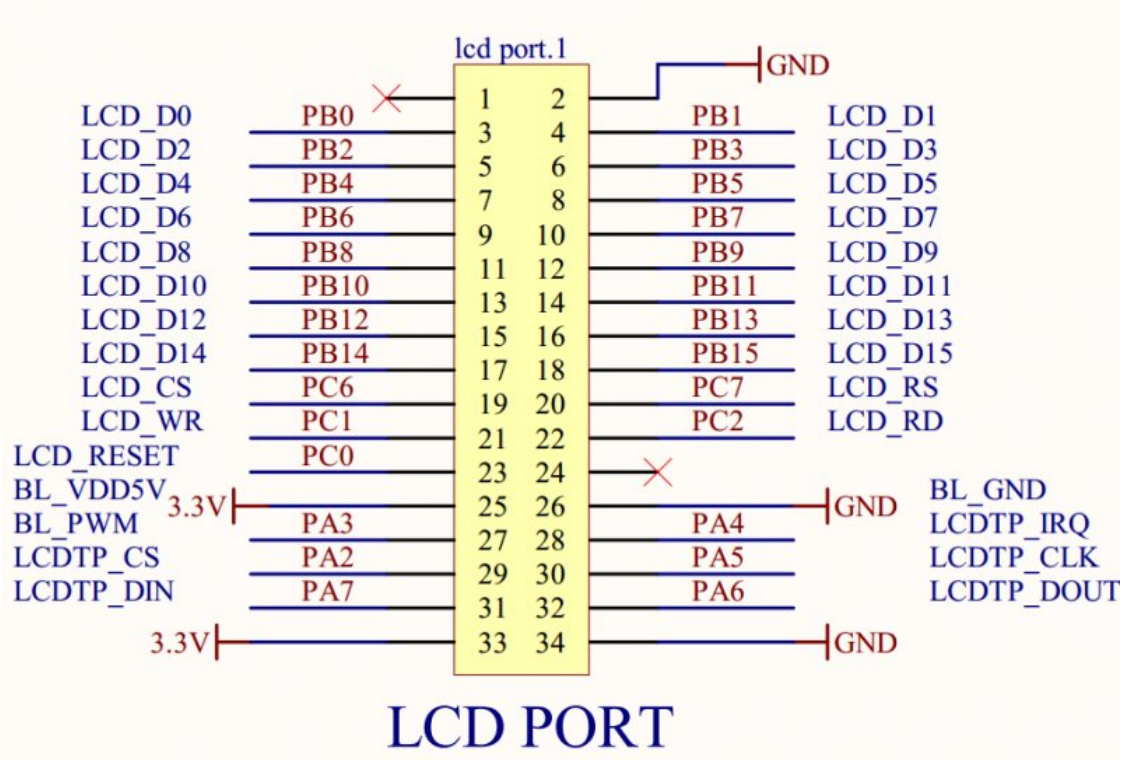
Pin No.	Symbol	Description	Function
1	5V	5V power supply	When powered from 5V supply, pin 1 & Pin 2 as power input, pin 33 & Pin 34 provide 3.3V output.
2	GND	Ground	GND
3	D0	Data cable	D0-D15
4	D1		
5	D2		
6	D3		
7	D4		
8	D5		
9	D6		
10	D7		
11	D8		
12	D9		
13	D10		
14	D11		
15	D12		
16	D13		
17	D14		
18	D15		
19	CS	LCD chip selection signal	Low active
20	RS	Command/Data Register Selection	RS = 0: Command Register RS = 1: Data Register
21	WR	Write	WR = 0, RD = 1
22	RD	Read	WR = 1, RD = 0
23	RESET	Reset the controller chip	Low active
24	NC	Not connect	Not connect
25	BLVCC	5V or 3.3V	Backlight VCC
26	BLGND	Ground	Backlight GND
27	BLCNT	Backlight brightness adjustment	Control the backlight brightness via PWM
28	TP_IRQ	Touch panel interrupt	Low level while the touch panel detects pressing
29	TP_CS	Touch panel chip select	Low active

30	TP_SCK	Touch panel SPI clock	Connects to SPI SCK
31	TP_SI	Touch panel data input	Connects to SPI MOSI
32	TP_SO	Touch panel SPI data output	Connects to SPI MISO
33	3.3V	3.3V power supply	When powered from 3.3V supply, pin 33 & pin 34 as power input, pin 1 & pin 2 keep NC.
34	GND	Ground	

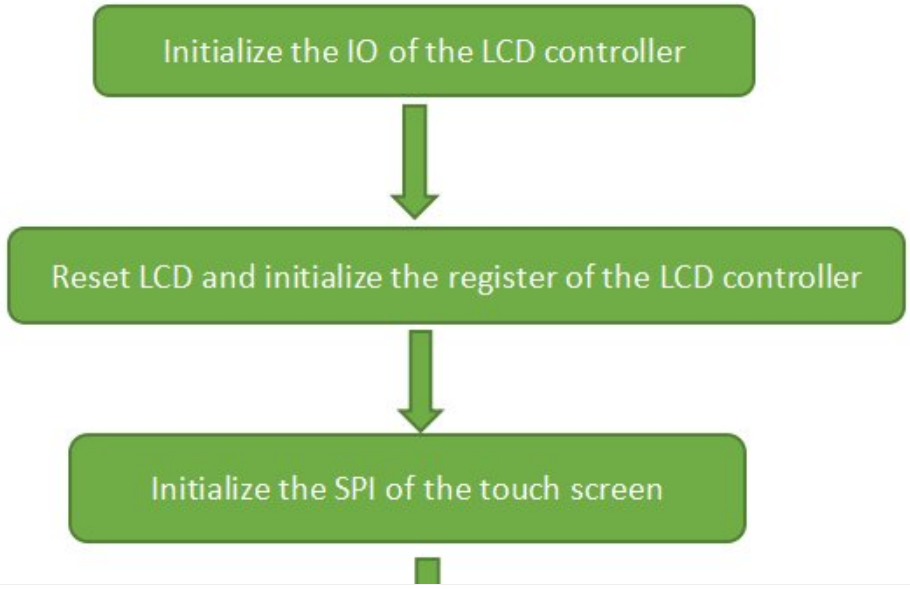
3. Sample Demo

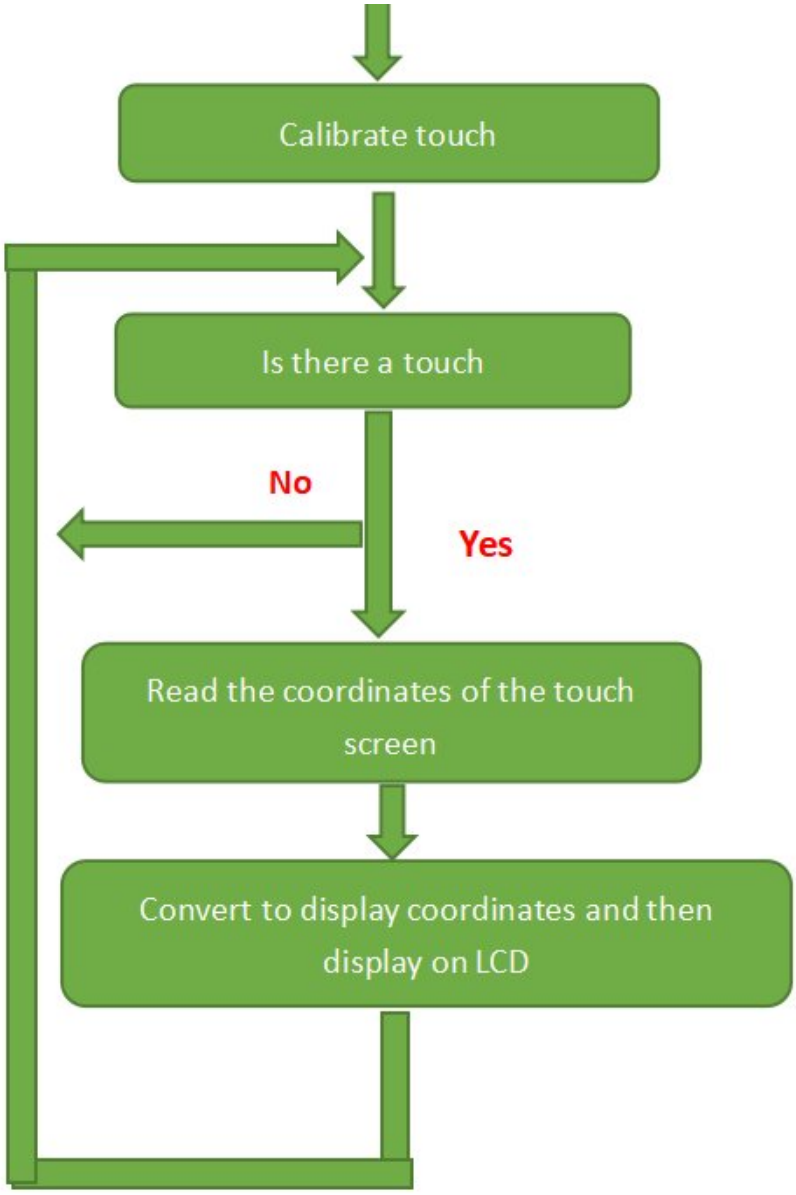
This manual uses the development board of the main control chip STM32F103RCT6 to illustrate the basic usage of this LCD. Users can also use other similar development boards for development.

3.2inch 320x240 Touch LCD (D) and STM32F103RCT6 connection interface diagram:



Procedure flow chart:





Source code analysis:

```
/*The following macro definition is for the rotation angle of the image and the
setting of the control cable*/<br />
//#define DISP_ORIENTATION                                          0
//#define DISP_ORIENTATION                                          90
//#define DISP_ORIENTATION                                          180
#define DISP_ORIENTATION                                          270

#define Set_Cs        GPIOC->BSRR = GPIO_Pin_6  //CS=1
#define Clr_Cs        GPIOC->BRR = GPIO_Pin_6           //CS=0

#define Set_Rs        GPIOC->BSRR = GPIO_Pin_7  //RS=1
#define Clr_Rs        GPIOC->BRR = GPIO_Pin_7           //RS=0

#define Set_nWr       GPIOC->BSRR = GPIO_Pin_1  //WR=1
#define Clr_nWr       GPIOC->BRR = GPIO_Pin_1           //WR=0

#define Set_nRd       GPIOC->BSRR = GPIO_Pin_2  //RD=1
#define Clr_nRd       GPIOC->BRR = GPIO_Pin_2           //RD=0
/* Write command function */
```

```
__inline void LCD_WriteIndex(uint16_t index)
{
Clr_Rs;              //RS=0
Set_nRd;             //RD=0
LCD_Delay(0);        //Delay
GPIOB->ODR = index; /*Write command */
LCD_Delay(0);        //Delay
Clr_nWr;             //WR=0
Set_nWr;             //WR=1
}
/*  */
__inline void ILI9341_LCD_WriteData(uint16_t data)
{
        Clr_Cs;                                          //CS=1
        Set_Rs;                                          //RS=1
        LCD_Delay(0);                                    //delay
        GPIOB->ODR = data;              /* GPIO_Write(GPIOB,data); */
        LCD_Delay(0);                                    //delay
        Clr_nWr;                                         //WR=0
        Set_nWr;                                         //WR=1
        Set_Cs;                                          //CS=1
}
/* Read data function */
__inline uint16_t LCD_ReadData(void)
{
uint16_t value;
Set_Rs;
Set_nWr;
Clr_nRd;
GPIOB->CRH = 0x44444444;   //Set PB0-PB15 as input
GPIOB->CRL = 0x44444444;
value = GPIOB->IDR;         //Read data
    GPIOB->CRH = 0x33333333;   //Set PB0-PB15 as output
    GPIOB->CRL = 0x33333333;
    Set_nRd;
    return value;
}
/*********************************************************************

Write data at the specified address, LCD_Reg is the address, and LCD_RegValue is
the written value.

*********************************************************************/
__inline void LCD_WriteReg(uint16_t LCD_Reg,uint16_t LCD_RegValue)
{
Clr_Cs;
LCD_WriteIndex(LCD_Reg);        //Write command; that is, the address to write d
ata into;
LCD_WriteData(LCD_RegValue);    //data writing;
Set_Cs;
}

/*********************************************************************

Read data from the specified address, LCD_Reg is the address, and the function r
```

```
eturns the read value.
<pre>
*********************************************************************************/
__inline uint16_t LCD_ReadReg(uint16_t LCD_Reg)
{
uint16_t LCD_RAM;
Clr_Cs;
LCD_WriteIndex(LCD_Reg);     //Write command; that is, the address of the data t
o be read;
LCD_RAM = LCD_ReadData();  //data readout;
Set_Cs;
return LCD_RAM;
}
//The above are the basic functions for reading and writing; if you want to oper
ate IO analog with the FSMC of the STM32, you can refer to LCD + TouchPanel (808
0 FSMC) demo.
/*********************************************************************************
Initialization of LCD registers, the following initialization values of the regi
sters are provided by the original LCD manufacturer and can be displayed normall
y according to the following configuration, please refer to the chip manual for
registers.
*********************************************************************************/
void LCD_Initializtion(void)
{
uint16_t DeviceCode;
LCD_Configuration();                  //Pin initialization
GPIO_PinRemapConfig(GPIO_Remap_SWJ_JTAGDisable , ENABLE);//Change the mapping of
the specified pin
GPIO_ResetBits(GPIOC, GPIO_Pin_0);   /* LCD reset*/
delay_ms(100);
GPIO_SetBits(GPIOC, GPIO_Pin_0);
GPIO_SetBits(GPIOA, GPIO_Pin_3);     /*Enable backlight */
DeviceCode = LCD_ReadReg(0x0000);    /* Read ID */
if(DeviceCode == 0 || DeviceCode == 0xffff)
{
   ILI9341_LCD_WriteReg(0XD3);
   Clr_Cs;
   DeviceCode = LCD_ReadData();
   DeviceCode = LCD_ReadData();
   DeviceCode = LCD_ReadData();
   DeviceCode <<= 8;
   DeviceCode |= LCD_ReadData();
   Set_Cs;
}
if(DeviceCode == 0x9341)
{
        LCD_Code = ILI9341;
        ILI9341_LCD_WriteReg(0x3A);
        ILI9341_LCD_WriteData(0x55);

        ILI9341_LCD_WriteReg(0xB5);
        ILI9341_LCD_WriteData(0X04);
        ILI9341_LCD_WriteData(0X04);
        ILI9341_LCD_WriteData(0X0A);
        ILI9341_LCD_WriteData(0x14);
```

```
        ILI9341_LCD_WriteReg(0x35);
        ILI9341_LCD_WriteData(0x00);

        ILI9341_LCD_WriteReg(0xCF);
        ILI9341_LCD_WriteData(0x00);
        ILI9341_LCD_WriteData(0xEA);
        ILI9341_LCD_WriteData(0XF0);

        ILI9341_LCD_WriteReg(0xED);
        ILI9341_LCD_WriteData(0x64);
        ILI9341_LCD_WriteData(0x03);
        ILI9341_LCD_WriteData(0X12);
        ILI9341_LCD_WriteData(0X81);

        ILI9341_LCD_WriteReg(0xE8);
        ILI9341_LCD_WriteData(0x85);
        ILI9341_LCD_WriteData(0x10);
        ILI9341_LCD_WriteData(0x78);

        ILI9341_LCD_WriteReg(0xCB);
        ILI9341_LCD_WriteData(0x39);
        ILI9341_LCD_WriteData(0x2C);
        ILI9341_LCD_WriteData(0x00);
        ILI9341_LCD_WriteData(0x33);
        ILI9341_LCD_WriteData(0x06);

        ILI9341_LCD_WriteReg(0xF7);
        ILI9341_LCD_WriteData(0x20);

        ILI9341_LCD_WriteReg(0xEA);
        ILI9341_LCD_WriteData(0x00);
        ILI9341_LCD_WriteData(0x00);

        ILI9341_LCD_WriteReg(0xC0);    //Power control
        ILI9341_LCD_WriteData(0x21);   //VRH[5:0]

        ILI9341_LCD_WriteReg(0xC1);    //Power control
        ILI9341_LCD_WriteData(0x10);   //SAP[2:0];BT[3:0]

        ILI9341_LCD_WriteReg(0xC5);    //VCM control
        ILI9341_LCD_WriteData(0x4F);     //3F
        ILI9341_LCD_WriteData(0x38);     //3C

        ILI9341_LCD_WriteReg(0xC7);    //VCM control2
        ILI9341_LCD_WriteData(0XB7);

        ILI9341_LCD_WriteReg(0x36);    // Memory Access Control
        if (DISP_ORIENTATION == 0)
                ILI9341_LCD_WriteData(0x08 | 0x00);
        else if (DISP_ORIENTATION == 90)
                ILI9341_LCD_WriteData(0x08 | 0xa0);
        else if(DISP_ORIENTATION == 180)
                ILI9341_LCD_WriteData(0x08 | 0xc0);
        else
```

```
                ILI9341_LCD_WriteData(0x08 | 0x60);


        ILI9341_LCD_WriteReg(0xB1);
        ILI9341_LCD_WriteData(0x00);
        ILI9341_LCD_WriteData(0x13);

        ILI9341_LCD_WriteReg(0xB6);    // Display Function Control
        ILI9341_LCD_WriteData(0x0A);
        ILI9341_LCD_WriteData(0xA2);

        ILI9341_LCD_WriteReg(0xF2);    // 3Gamma Function Disable
        ILI9341_LCD_WriteData(0x02);

        ILI9341_LCD_WriteReg(0x26);    //Gamma curve selected
        ILI9341_LCD_WriteData(0x01);

        ILI9341_LCD_WriteReg(0xE0);    //Set Gamma
        ILI9341_LCD_WriteData(0x0F);
        ILI9341_LCD_WriteData(0x27);
        ILI9341_LCD_WriteData(0x24);
        ILI9341_LCD_WriteData(0x0C);
        ILI9341_LCD_WriteData(0x10);
        ILI9341_LCD_WriteData(0x08);
        ILI9341_LCD_WriteData(0x55);
        ILI9341_LCD_WriteData(0X87);
        ILI9341_LCD_WriteData(0x45);
        ILI9341_LCD_WriteData(0x08);
        ILI9341_LCD_WriteData(0x14);
        ILI9341_LCD_WriteData(0x07);
        ILI9341_LCD_WriteData(0x13);
        ILI9341_LCD_WriteData(0x08);
        ILI9341_LCD_WriteData(0x00);

        ILI9341_LCD_WriteReg(0XE1);    //Set Gamma
        ILI9341_LCD_WriteData(0x00);
        ILI9341_LCD_WriteData(0x0F);
        ILI9341_LCD_WriteData(0x12);
        ILI9341_LCD_WriteData(0x05);
        ILI9341_LCD_WriteData(0x11);
        ILI9341_LCD_WriteData(0x06);
        ILI9341_LCD_WriteData(0x25);
        ILI9341_LCD_WriteData(0x34);
        ILI9341_LCD_WriteData(0x37);
        ILI9341_LCD_WriteData(0x01);
        ILI9341_LCD_WriteData(0x08);
        ILI9341_LCD_WriteData(0x07);
        ILI9341_LCD_WriteData(0x2B);
        ILI9341_LCD_WriteData(0x34);
        ILI9341_LCD_WriteData(0x0F);

        ILI9341_LCD_WriteReg(0x11); //Exit Sleep
        delay_ms(120);
        ILI9341_LCD_WriteReg(0x29); //Display on
}
```

```
delay_ms(50);
}
/*****************************************************************************
Set the positions X, and Y of the display window;
*****************************************************************************/
void LCD_Address_Set(u16 x1,u16 y1,u16 x2,u16 y2)
{
        ILI9341_LCD_WriteReg(0x2a);//Column address setting
        ILI9341_LCD_WriteData(x1>>8);
        ILI9341_LCD_WriteData(x1&0xff);
        ILI9341_LCD_WriteData(x2>>8);
        ILI9341_LCD_WriteData(x2&0xff);

        ILI9341_LCD_WriteReg(0x2b);//Line address setting
        ILI9341_LCD_WriteData(y1>>8);
        ILI9341_LCD_WriteData(y1&0xff);
        ILI9341_LCD_WriteData(y2>>8);
        ILI9341_LCD_WriteData(y2&0xff);

        ILI9341_LCD_WriteReg(0x2c);//Write in memory
}

static void LCD_SetCursor( uint16_t Xpos, uint16_t Ypos )
{
        uint16_t temp;
        #if (DISP_ORIENTATION == 0)
        #elif (DISP_ORIENTATION == 90)
        temp = Xpos;
        Xpos =Ypos;
        Ypos = MAX_X - 1 - temp;
        #elif (DISP_ORIENTATION == 180)
        Xpos = MAX_X - 1 - Xpos;
        Ypos = MAX_Y - 1 - Ypos;
        #elif (DISP_ORIENTATION == 270)
        temp = Ypos;
        Ypos = Xpos;
        Xpos = MAX_Y - 1 - temp;
        #endif

        ILI9341_LCD_WriteReg(0x2a);     //Column address setting
        ILI9341_LCD_WriteData(Xpos>>8);
        ILI9341_LCD_WriteData(Xpos&0xff);

        ILI9341_LCD_WriteReg(0x2b);     //Line address setting
        ILI9341_LCD_WriteData(Ypos>>8);
        ILI9341_LCD_WriteData(Ypos&0xff);
}
/*****************************************************************************
Clearing screen function to make the whole screen display a certain color,
*****************************************************************************/
void LCD_Clear(uint16_t Color)
{
uint32_t index=0;

LCD_Address_Set(0,0,MAX_X-1,MAX_Y-1);//Set the display range
```

```
for( index = 0; index < MAX_X * MAX_Y; index++ )
{
   ILI9341_LCD_WriteData(Color);
}

}

int main(void)
{
//Delay and initialization system
  LCD_Initializtion();      //LCD initialization
//LCD initialization
  LCD_Clear(Red);        //Clear the screen to red
//You can write a function to calibrate the screen.
  /* Infinite loop */
  while (1)
  {
//You can write a function to display the coordinates of the touch point on the
LCD.
  }
}
```

Resources

Documentation

- Schematic diagram
- Dimensions

Demo

- Sample demo

Datasheet

- ILI9325
- XPT2046

FAQ

Question: If I use STM32F407VET6, how to drive the screen?

Answer:

Different main control programs are different, STM32F407VET6) can use the following program： Open407V-C_3.2inch 320x240 Touch LCD (D)

Support

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