

3.5inch 16BIT Module MRB3503 User Manual

Product Description

The product is a 3.5-inch TFT LCD module ,it has the 480x320 resolution and supports 16BIT RGB 65K color display, the internal driver IC is ILI9486 and use 16-bit parallel port communication. The module includes LCD display, resistive touch screen, SD card slot and PCB backplane. It can be directly plugged into the TFT LCD slot of STM32 series development board. It can also be used on C51 platform and supports SD card expansion function.

Product Features

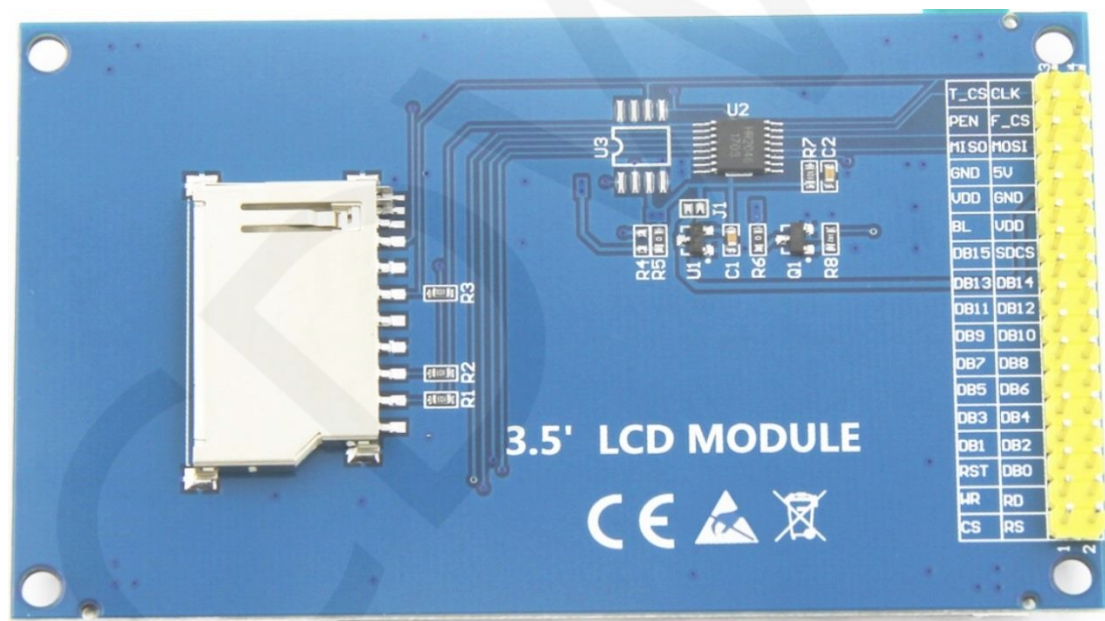
- 3.5-inch color screen, support 16BIT RGB 65K color display, display rich colors
- 320x480 resolution for clear display
- 16-bit parallel bus transmission for fast transfer speed
- Supports ALIENTEK STM32 Mini, Elite, WarShip, Explorer, and Apollo development boards direct plug-in use
- Support for touch function
- Support SD card function expansion
- Provides a rich sample program for STM32 and C51 platforms
- Military-grade process standards, long-term stable work
- Provide underlying driver technical support

Product Parameters

| Name | Description |
|---------------|---------------|
| Display Color | RGB 65K color |
| SKU | MRB3503 |
| Screen Size | 3.5(inch) |
| Screen Type | TFT |
| Driver IC | ILI9486 |

| | |
|-----------------------|--------------------------|
| Resolution | 480*320 (Pixel) |
| Module Interface | 16Bit parallel interface |
| Active Area | 48.96x73.44 (mm) |
| Touch Screen Type | Resistive touch screen |
| Touch IC | XPT2046 |
| Module PCB Size | 56.34x98.25 (mm) |
| Operating Temperature | -20℃~70℃ |
| Storage Temperature | -40℃~70℃ |
| Operating Voltage | 3.3V / 5V |
| Power Consumption | TBD |
| Product Weight | TBD |

Interface Description



Picture1. Module Pin silk screen picture

NOTE:

1. This module hardware only supports 16-bit parallel bus transmission

Important Note:

2. The following pin numbers 1~34 are the pin number of Module pin with PCB backplane of our company. If you purchase a bare screen, please refer to the

pin definition of the bare screen specification, refer to the wiring according to the signal type instead of directly Wire according to the following module pin numbers. For example: CS is 1 pin on our module. It may be x pin on different size bare screen.

3. About VCC supply voltage: If you buy a module with PCB backplane, VCC/VDD power supply can be connected to 5V or 3.3V (module has integrated ultra low dropout 5V to 3V circuit), but it is recommended to connect 3.3V, because connecting 5V will lead to circuit Increased heat generation, affecting module life; if you buy a bare screen LCD, remember to only connect 3.3V.
4. About the backlight voltage: The module with the PCB backplane has integrated triode backlight control circuit, which only needs to input the high level of the BL pin or the PWM wave to illuminate the backlight. If you are buying a bare screen, the LEDAx is connected to 3.0V-3.3V and the LEDKx is grounded.

| Number | Module Pin | Pin Description |
|--------|------------|--|
| 1 | CS | LCD reset control pin(low level enable) |
| 2 | RS | LCD register / data selection control pin (high level: register, low level: data) |
| 3 | WR | LCD write control pin |
| 4 | RD | LCD read control pin |
| 5 | RST | LCD reset control pin(low level reset) |
| 6 | DB0 | LCD data bus low 8-bit pin |
| 7 | DB1 | |
| 8 | DB2 | |
| 9 | DB3 | |
| 10 | DB4 | |
| 11 | DB5 | |
| 12 | DB6 | |
| 13 | DB7 | |
| 14 | DB8 | LCD data bus high 8-bit pin |

| | | |
|----|------|--|
| 15 | DB9 | |
| 16 | DB10 | |
| 17 | DB11 | |
| 18 | DB12 | |
| 19 | DB13 | |
| 20 | DB14 | |
| 21 | DB15 | |
| 22 | SDCS | SD card selection control pin (used when using the SD card expansion function, this test program is not used) |
| 23 | BL | LCD backlight control pin(High level light) |
| 24 | VDD | Module power positive pin (module has integrated voltage regulator IC, so the power supply can be connected to 5V or 3.3V) |
| 25 | VDD | |
| 26 | GND | |
| 27 | GND | Module power ground pin |
| 28 | 5V | LCD backlight power positive pin (default shared onboard backlight power supply, this pin can not be connected) |
| 29 | MISO | Touch screen SPI bus data input pin |
| 30 | MOSI | Touch screen SPI bus data output pin |
| 31 | PEN | Touch screen interrupt detection pin (Low level when a touch occurs) |
| 32 | F_CS | Flash chip select control pin (used when using the Flash extension function, this test program is not used) |
| 33 | T_CS | Touch screen IC chip select control pin(Low level enable) |
| 34 | CLK | Touch screen SPI bus clock control pin |

Hardware Configuration

The LCD module hardware circuit comprises five parts: an LCD display control circuit, a power control circuit, an SD card control circuit, a touch screen control circuit and a backlight control circuit.

LCD display control circuit for controlling the pins of the LCD, including control pins and data transfer pins.

Power control circuit for stabilizing the supply voltage and selecting the external supply voltage

SD card control circuit is used for SD card function expansion, controlling SD card identification, reading and writing.

The resistive touch screen sampling circuit is used for detecting a touch event, performing AD conversion on the touch data, and transmitting touch coordinate values.

A backlight control circuit is used to control the brightness of the backlight.

working principle

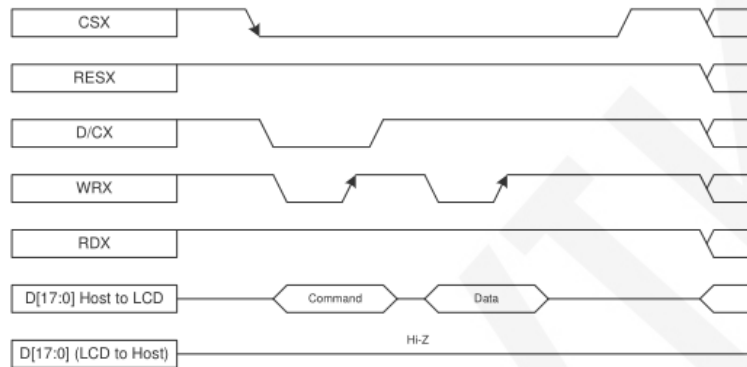
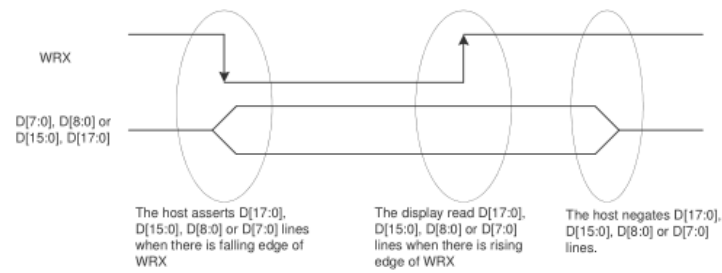
1. Introduction to ITI9486 Controller

The ITI9486 controller supports a maximum resolution of 320*480 and has a 345600-byte GRAM. It also supports 8-bit, 9-bit, 16-bit, and 18-bit parallel port data buses. It also supports 3-wire and 4-wire SPI serial ports. Since the supported resolution is relatively large and the amount of data transmitted is large, the parallel port transmission is adopted, and the transmission speed is fast. ITI9486 also supports 65K, 262K RGB color display, display color is very rich, while supporting rotating display and scroll display and video playback, display in a variety of ways.

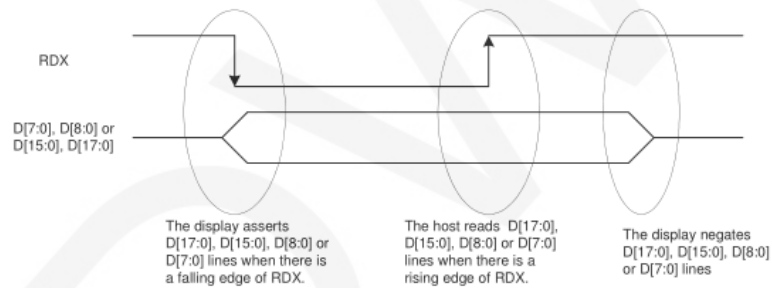
The ITI9486 controller uses 16bit (RGB565) to control a pixel display, so it can display up to 65K colors per pixel. The pixel address setting is performed in the order of rows and columns, and the incrementing and decreasing direction is determined by the scanning mode. The ITI9486 display method is performed by setting the address and then setting the color value.

2. Introduction to parallel port communication

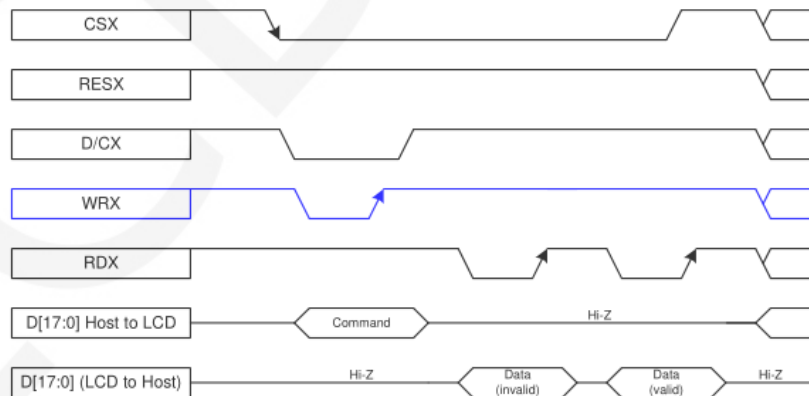
The parallel port communication write mode timing is as shown below:



The timing of the parallel port communication read mode is shown in the figure below:



Note: RDX is an unsynchronized signal (It can be stopped).



CSX is a chip select signal for enabling and disabling parallel port communication, active low

RESX is an external reset signal, active low

D/CX is the data or command selection signal, 1-write data or command parameters,
0-write command

WRX is a write data control signal

RDX is a read data control signal

D[X:0] is a parallel port data bit, which has four types: 8-bit, 9-bit, 16-bit, and 18-bit.

When performing a write operation, on the basis of the reset, first set the data or command selection signal, then pull the chip select signal low, then input the content to be written from the host, and then pull the write data control signal low. When pulled high, data is written to the LCD control IC on the rising edge of the write control signal. Finally, the chip select signal is pulled high and a data write operation is completed.

When entering the read operation, on the basis of the reset, first pull the chip select signal low, then pull the data or command select signal high, then pull the read data control signal low, and then read the data from the LCD control IC. And then The read data control signal is pulled high, and the data is read out on the rising edge of the read data control signal. Finally, the chip select signal is pulled high, and a data read operation is completed.

Instructions for use

1. STM32 instructions

Wiring instructions:

See the interface description for pin assignments.

Note:

1. This module can be directly inserted into the TFTLCD slot of the punctual atom development board, no manual wiring is required.
2. The following internal plug-in pins of the corresponding MCU refer to the MCU pins directly connected to the TFTLCD slot inside the development board, only for reference.

MiniSTM32 development board TFTLCD socket in-line instructions

| Number | Module Pin | Corresponding TFTLCD socket pin | Corresponding to STM32F103RCT6 microcontroller internal connection pin |
|--------|------------|---------------------------------|--|
| 1 | CS | CS | PC9 |
| 2 | RS | RS | PC8 |
| 3 | WR | WR | PC7 |
| 4 | RD | RD | PC6 |
| 5 | RST | RST | PC4 |
| 6 | DB0 | D0 | PB0 |
| 7 | DB1 | D1 | PB1 |
| 8 | DB2 | D2 | PB2 |
| 9 | DB3 | D3 | PB3 |
| 10 | DB4 | D4 | PB4 |
| 11 | DB5 | D5 | PB5 |
| 12 | DB6 | D6 | PB6 |
| 13 | DB7 | D7 | PB7 |
| 14 | DB8 | D8 | PB8 |
| 15 | DB9 | D9 | PB9 |
| 16 | DB10 | D10 | PB10 |
| 17 | DB11 | D11 | PB11 |
| 18 | DB12 | D12 | PB12 |
| 19 | DB13 | D13 | PB13 |
| 20 | DB14 | D14 | PB14 |
| 21 | DB15 | D15 | PB15 |
| 22 | SDCS | Not used | GND |
| 23 | BL | BL | PC10 |
| 24 | VDD | 3.3 | 3.3V |
| 25 | VDD | 3.3 | 3.3V |
| 26 | GND | GND | GND |
| 27 | GND | GND | GND |
| 28 | 5V | Not used | 5V |
| 29 | MISO | MISO | PC2 |

| | | | |
|----|-------------|----------|------|
| 30 | MOSI | MOSI | PC3 |
| 31 | PEN | PEN | PC1 |
| 32 | F_CS | Not used | NC |
| 33 | T_CS | TCS | PC13 |
| 34 | CLK | CLK | PC0 |

Elite STM32 development board TFTLCD socket in-line instructions

| Number | Module Pin | Corresponding TFTLCD socket pin | Corresponding to STM32F103ZET6 microcontroller internal connection pin |
|--------|-------------|---------------------------------|--|
| 1 | CS | CS | PG12 |
| 2 | RS | RS | PG0 |
| 3 | WR | WR | PD5 |
| 4 | RD | RD | PD4 |
| 5 | RST | RST | reset pin |
| 6 | DB0 | D0 | PD14 |
| 7 | DB1 | D1 | PD15 |
| 8 | DB2 | D2 | PD0 |
| 9 | DB3 | D3 | PD1 |
| 10 | DB4 | D4 | PE7 |
| 11 | DB5 | D5 | PE8 |
| 12 | DB6 | D6 | PE9 |
| 13 | DB7 | D7 | PE10 |
| 14 | DB8 | D8 | PE11 |
| 15 | DB9 | D9 | PE12 |
| 16 | DB10 | D10 | PE13 |
| 17 | DB11 | D11 | PE14 |
| 18 | DB12 | D12 | PE15 |
| 19 | DB13 | D13 | PD8 |
| 20 | DB14 | D14 | PD9 |
| 21 | DB15 | D15 | PD10 |
| 22 | SDCS | Not used | GND |
| 23 | BL | BL | PB0 |

| | | | |
|----|------|----------|------|
| 24 | VDD | VDD | 3.3V |
| 25 | VDD | VDD | 3.3V |
| 26 | GND | GND | GND |
| 27 | GND | GND | GND |
| 28 | 5V | Not used | 5V |
| 29 | MISO | MISO | PB2 |
| 30 | MOSI | MOSI | PF9 |
| 31 | PEN | PEN | PF10 |
| 32 | F_CS | Not used | NC |
| 33 | T_CS | TCS | PF11 |
| 34 | CLK | CLK | PB1 |

WarShip STM32 development board TFTLCD socket in-line instructions

| Number | Module Pin | Corresponding TFTLCD socket pin | Corresponding to STM32F103ZET6 microcontroller internal connection pin | |
|--------|------------|---------------------------------|--|----|
| | | | V2 | V3 |
| 1 | CS | CS | PG12 | |
| 2 | RS | RS | PG0 | |
| 3 | WR | WR | PD5 | |
| 4 | RD | RD | PD4 | |
| 5 | RST | RST | reset pin | |
| 6 | DB0 | D0 | PD14 | |
| 7 | DB1 | D1 | PD15 | |
| 8 | DB2 | D2 | PD0 | |
| 9 | DB3 | D3 | PD1 | |
| 10 | DB4 | D4 | PE7 | |
| 11 | DB5 | D5 | PE8 | |
| 12 | DB6 | D6 | PE9 | |
| 13 | DB7 | D7 | PE10 | |
| 14 | DB8 | D8 | PE11 | |
| 15 | DB9 | D9 | PE12 | |
| 16 | DB10 | D10 | PE13 | |

| | | | |
|----|-------------|----------|------|
| 17 | DB11 | D11 | PE14 |
| 18 | DB12 | D12 | PE15 |
| 19 | DB13 | D13 | PD8 |
| 20 | DB14 | D14 | PD9 |
| 21 | DB15 | D15 | PD10 |
| 22 | SDCS | Not used | GND |
| 23 | BL | BL | PB0 |
| 24 | VDD | VDD | 3.3V |
| 25 | VDD | VDD | 3.3V |
| 26 | GND | GND | GND |
| 27 | GND | GND | GND |
| 28 | 5V | Not used | 5V |
| 29 | MISO | MISO | PF8 |
| 30 | MOSI | MOSI | PF9 |
| 31 | PEN | PEN | PF10 |
| 32 | F_CS | Not used | NC |
| 33 | T_CS | TCS | PB2 |
| 34 | CLK | CLK | PB1 |

Explorer STM32F4 development board TFTLCD socket in-line instructions

| Number | Module Pin | Corresponding TFTLCD socket pin | Corresponding to STM32F407ZGT6 microcontroller internal connection pin |
|--------|------------|---------------------------------|--|
| 1 | CS | CS | PG12 |
| 2 | RS | RS | PF12 |
| 3 | WR | WR | PD5 |
| 4 | RD | RD | PD4 |
| 5 | RST | RST | reset pin |
| 6 | DB0 | D0 | PD14 |
| 7 | DB1 | D1 | PD15 |
| 8 | DB2 | D2 | PD0 |
| 9 | DB3 | D3 | PD1 |

| | | | |
|----|------|----------|------|
| 10 | DB4 | D4 | PE7 |
| 11 | DB5 | D5 | PE8 |
| 12 | DB6 | D6 | PE9 |
| 13 | DB7 | D7 | PE10 |
| 14 | DB8 | D8 | PE11 |
| 15 | DB9 | D9 | PE12 |
| 16 | DB10 | D10 | PE13 |
| 17 | DB11 | D11 | PE14 |
| 18 | DB12 | D12 | PE15 |
| 19 | DB13 | D13 | PD8 |
| 20 | DB14 | D14 | PD9 |
| 21 | DB15 | D15 | PD10 |
| 22 | SDCS | Not used | GND |
| 23 | BL | BL | PB15 |
| 24 | VDD | VDD | 3.3V |
| 25 | VDD | VDD | 3.3V |
| 26 | GND | GND | GND |
| 27 | GND | GND | GND |
| 28 | 5V | Not used | 5V |
| 29 | MISO | MISO | PB2 |
| 30 | MOSI | MOSI | PF11 |
| 31 | PEN | PEN | PB1 |
| 32 | F_CS | Not used | NC |
| 33 | T_CS | TCS | PC13 |
| 34 | CLK | CLK | PB0 |

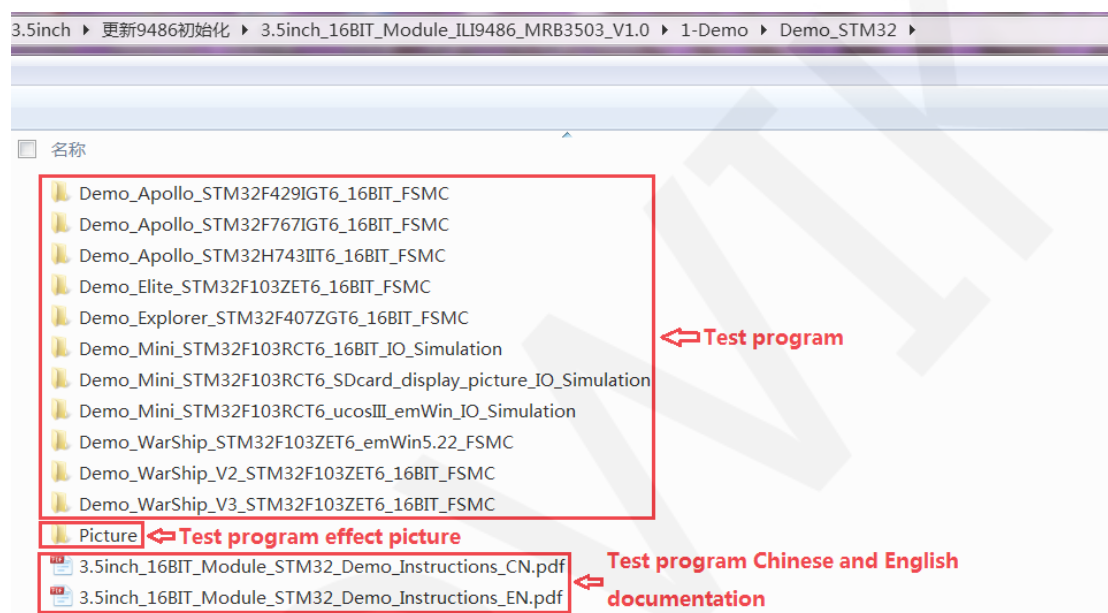
Apollo STM32F4/F7 development board TFTLCD socket in-line instructions

| Number | Module Pin | Corresponding TFTLCD socket pin | Corresponding to STM32F429IGT6, STM32F767IGT6, STM32H743IIT6 microcontroller internal connection pin |
|--------|------------|---------------------------------|--|
| 1 | CS | CS | PD7 |

| | | | |
|----|-------------|----------|-----------|
| 2 | RS | RS | PD13 |
| 3 | WR | WR | PD5 |
| 4 | RD | RD | PD4 |
| 5 | RST | RST | reset pin |
| 6 | DB0 | D0 | PD14 |
| 7 | DB1 | D1 | PD15 |
| 8 | DB2 | D2 | PD0 |
| 9 | DB3 | D3 | PD1 |
| 10 | DB4 | D4 | PE7 |
| 11 | DB5 | D5 | PE8 |
| 12 | DB6 | D6 | PE9 |
| 13 | DB7 | D7 | PE10 |
| 14 | DB8 | D8 | PE11 |
| 15 | DB9 | D9 | PE12 |
| 16 | DB10 | D10 | PE13 |
| 17 | DB11 | D11 | PE14 |
| 18 | DB12 | D12 | PE15 |
| 19 | DB13 | D13 | PD8 |
| 20 | DB14 | D14 | PD9 |
| 21 | DB15 | D15 | PD10 |
| 22 | SDCS | Not used | GND |
| 23 | BL | BL | PB5 |
| 24 | VDD | VDD | 3.3V |
| 25 | VDD | VDD | 3.3V |
| 26 | GND | GND | GND |
| 27 | GND | GND | GND |
| 28 | 5V | Not used | 5V |
| 29 | MISO | MISO | PG3 |
| 30 | MOSI | MOSI | PI3 |
| 31 | PEN | PEN | PH7 |
| 32 | F_CS | Not used | NC |
| 33 | T_CS | TCS | PI8 |
| 34 | CLK | CLK | PH6 |

Operating Steps:

- A. Connect the LCD module(As shown in Picture 1) and the STM32 MCU according to the above wiring instructions, and power on;
- B. Select the C51 test program to be tested, as shown below:
(Test program description please refer to the test program description document in the test package)



- C. Open the selected test program project, compile and download;
detailed description of the STM32 test program compilation and download can be found in the following document:
http://www.lcdwiki.com/res/PublicFile/STM32_Keil_Use_Illustration_EN.pdf
- D. If the LCD module displays characters and graphics normally, the program runs successfully;

2. C51 instructions

Wiring instructions:

See the interface description for pin assignments.

STC12C5A60S2 microcontroller test program wiring instructions

| Number | Module Pin | Corresponding to STC12 development board wiring pin |
|--------|------------|---|
| 1 | CS | P13 |
| 2 | RS | P12 |
| 3 | WR | P11 |
| 4 | RD | P10 |
| 5 | RST | P33 |
| 6 | DB0 | P00 |
| 7 | DB1 | P01 |
| 8 | DB2 | P02 |
| 9 | DB3 | P03 |
| 10 | DB4 | P04 |
| 11 | DB5 | P05 |
| 12 | DB6 | P06 |
| 13 | DB7 | P07 |
| 14 | DB8 | P20 |
| 15 | DB9 | P21 |
| 16 | DB10 | P22 |
| 17 | DB11 | P23 |
| 18 | DB12 | P24 |
| 19 | DB13 | P25 |
| 20 | DB14 | P26 |
| 21 | DB15 | P27 |
| 22 | SDCS | No need to connect |
| 23 | BL | P32 |
| 24 | VDD | 3.3V/5V |
| 25 | VDD | 3.3V/5V |
| 26 | GND | GND |
| 27 | GND | GND |
| 28 | 5V | No need to connect |
| 29 | MISO | P35 |

| | | |
|----|------|--------------------|
| 30 | MOSI | P34 |
| 31 | PEN | P40 |
| 32 | F_CS | No need to connect |
| 33 | T_CS | P37 |
| 34 | CLK | P36 |

STC89C52RC microcontroller test program wiring instructions

| Number | Module Pin | Corresponding to STC89 development board wiring pin |
|--------|------------|---|
| 1 | CS | P13 |
| 2 | RS | P12 |
| 3 | WR | P11 |
| 4 | RD | P10 |
| 5 | RST | P14 |
| 6 | DB0 | P30 |
| 7 | DB1 | P31 |
| 8 | DB2 | P32 |
| 9 | DB3 | P33 |
| 10 | DB4 | P34 |
| 11 | DB5 | P35 |
| 12 | DB6 | P36 |
| 13 | DB7 | P37 |
| 14 | DB8 | P20 |
| 15 | DB9 | P21 |
| 16 | DB10 | P22 |
| 17 | DB11 | P23 |
| 18 | DB12 | P24 |
| 19 | DB13 | P25 |
| 20 | DB14 | P26 |
| 21 | DB15 | P27 |
| 22 | SDCS | No need to connect |
| 23 | BL | 3.3V |

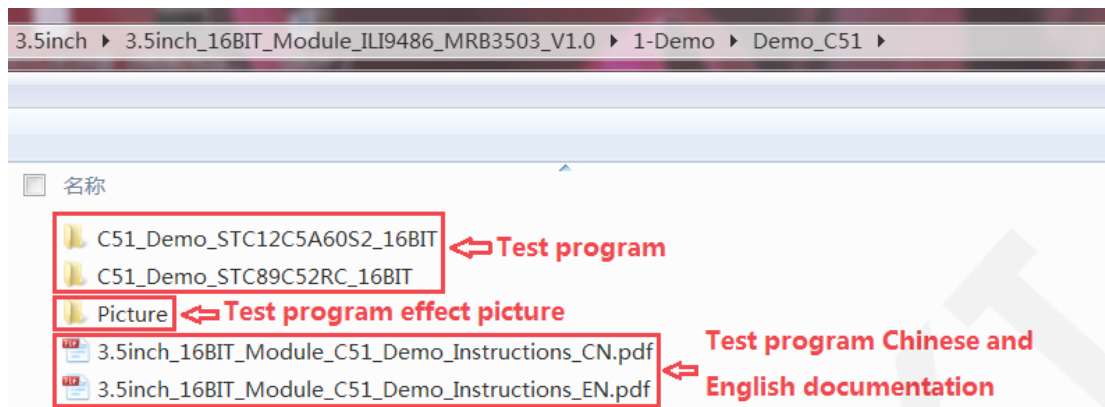
| | | |
|----|------|--------------------|
| 24 | VDD | 3.3V/5V |
| 25 | VDD | 3.3V/5V |
| 26 | GND | GND |
| 27 | GND | GND |
| 28 | 5V | No need to connect |
| 29 | MISO | No need to connect |
| 30 | MOSI | No need to connect |
| 31 | PEN | No need to connect |
| 32 | F_CS | No need to connect |
| 33 | T_CS | No need to connect |
| 34 | CLK | No need to connect |

Note:

1. Since the STC89C52RC microcontroller does not have a push-pull output function, the backlight control pin needs to be connected to a 3.3V power supply to be properly lit.
2. Since the STC89C52RC microcontroller's Flash capacity is too small (less than 25KB), the program with touch function cannot be downloaded, so the touch screen does not need wiring.

Operating Steps:

- A. Connect the LCD module (As shown in Picture 1) and the C51 MCU according to the above wiring instructions, and power on;
- B. Select the C51 test program to be tested, as shown below:
(Test program description please refer to the test program description document in the test package)



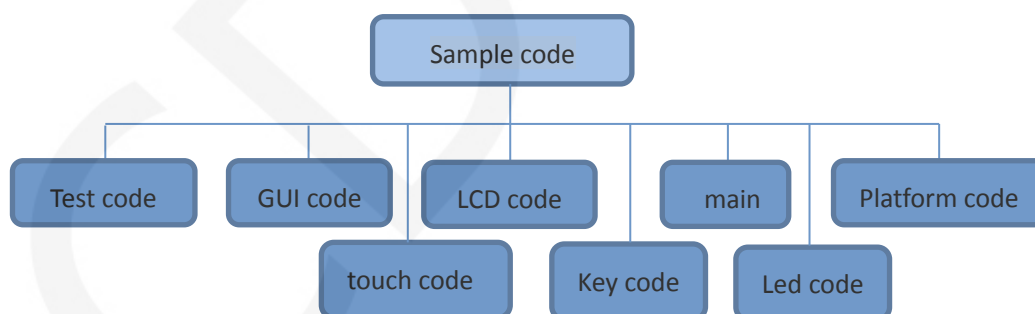
- C. Open the selected test program project, compile and download;
detailed description of the C51 test program compilation and download can be found in the following document:
http://www.lcdwiki.com/res/PublicFile/C51_Keil%26stc-isp_Use_Illustration_EN.pdf
- D. If the LCD module displays characters and graphics normally, the program runs successfully;

Software Description

1. Code Architecture

A. C51 and STM32 code architecture description

The code architecture is shown below:



The Demo API code for the main program runtime is included in the test code;
LCD initialization and related bin parallel port write data operations are included in the LCD code;
Drawing points, lines, graphics, and Chinese and English character display related operations are included in the GUI code;

The main function implements the application to run;

Platform code varies by platform;

Touch screen related operations are included in the touch code;

The key processing related code is included in the key code (the C51 platform does not have a button processing code);

The code related to the led configuration operation is included in the led code(the C51 platform does not have a led processing code);

2. GPIO definition description

A. STM32 test program GPIO definition description

The GPIO definition of the LCD screen of the STM32 test program is placed in the lcd.h file, which is defined in two ways:

- 1) STM32F103RCT6 microcontroller test program uses IO analog mode (it does not support FSMC bus)
- 2) Other STM32 MCU test programs use FSMC bus mode

STM32F103RCT6 MCU IO analog test program LCD screen GPIO definition as shown below:

```
////////////////////////////////////  
//-----LCD端口定义-----  
#define GPIO_TYPE  GPIOC //GPIO组类型  
#define LED         10    //背光控制引脚      PC10  
#define LCD_CS      9     //片选引脚          PC9  
#define LCD_RS      8     //寄存器/数据选择引脚 PC8  
#define LCD_RST     4     //复位引脚          PC4  
#define LCD_WR      7     //写引脚            PC7  
#define LCD_RD      6     //读引脚            PC6  
  
//PB0~15,作为数据线  
//注意: 如果使用8位模式数据总线, 则液晶屏的数据高8位是接到MCU的高8位总  
//举例: 如果接8位模式则本示例接线为液晶屏DB10-DB17对应接至单片机GPIOB 1  
//举例: 如果是16位模式: DB0-DB7分别接GPIOB_Pin0-GPIOB_Pin7,DB10-DB17对  
#define DATAOUT(x) GPIOB->ODR=x; //数据输出  
#define DATAIN    GPIOB->IDR;   //数据输入
```

FSMC test program lcd screen GPIO is defined as shown below (take

STM32F103ZET6 microcontroller FSMC test program as an example):

```

////////////////////////////////////
//-----LCD端口定义-----
#define LED      0      //背光控制引脚      PB0

//QDtech全系列模块采用了三极管控制背光亮灭，用户也可以接PWM调节背光亮亮度
#define LCD_LED PBout(LED) //LCD背光

//LCD地址结构体
typedef struct
{
    #if LCD_USE8BIT_MODEL
        vu8 LCD_REG;
        vu8 LCD_RAM;
    #else
        vu16 LCD_REG;
        vu16 LCD_RAM;
    #endif
} LCD_TypeDef;

//使用NOR/SRAM的 Bank1.sector4,地址位HADDR[27,26]=11 A10作为数据命令区分线
#if LCD_USE8BIT_MODEL
//使用8位模式时，STM32内部地址不需要右移一位
#define LCD_BASE ((u32)(0x6C000000 | 0x000003FF))
#else
//使用16位模式时，注意设置时STM32内部地址需要右移一位对齐！
#define LCD_BASE ((u32)(0x6C000000 | 0x000007FE))
#endif
#define LCD ((LCD_TypeDef *) LCD_BASE)

```

The GPIO definition related to the STM32 touch screen is placed in the touch.h file as shown below (take the STM32F103RCT6 microcontroller IO simulation test program as an example):

```

//与触摸屏芯片连接引脚
//与触摸屏芯片连接引脚
#define PEN    PCin(1)      //PC1   INT
#define DOUT   PCin(2)      //PC2   MISO      PC2--PB14
#define TDIN   PCout(3)     //PC3   MOSI      PC3--PB15
#define TCLK   PCout(0)     //PC0   SCLK      PC0--PB13
#define TCS    PCout(13)    //PC13  CS

```

B. C51 test program GPIO definition description

C51 test program lcd screen GPIO definition is placed in the lcd.h file, as shown below (Taking the STC12C5A60S2 microcontroller test program as an example):

```
//IO连接
#define LCD_DataPortH P2 //高8位数据口,8位模式下只使用高8位
#define LCD_DataPortL P0 //低8位数据口,8位模式下低8位可以不接线
sbit LCD_RS = P1^2; //数据/命令切换
sbit LCD_WR = P1^1; //写控制
sbit LCD_RD = P1^0; //读控制
sbit LCD_CS = P1^3; //片选
sbit LCD_RESET = P3^3; //复位
sbit LCD_BL=P3^2; //背光控制, 如果不需要控制, 接3.3v
```

Parallel pin definition needs to select the whole set of GPIO port groups, such as P0, P2, etc., so that when transferring data, the operation is convenient. Other pins can be defined as any free GPIO.

The touch screen related GPIO definition is placed in the touch.h file, as shown below (take the STC12C5A60S2 microcontroller test program as an example):

```
//IO连接
sfr P4 = 0xC0;
sbit DCLK = P3^6;
sbit TCS = P3^7;
sbit DIN = P3^4;
sbit DOUT = P3^5;
sbit Penirq = P4^0; //检测触摸屏响应信号
```

The GPIO definition of the touch screen can be modified and can be defined as any other free GPIO.

If the microcontroller does not have a P4 GPIO group, penirq can be defined as other GPIOs.

3. Parallel port communication code implementation

A. STM32 test program parallel port communication code implementation

The STM32 test program parallel port communication code is placed in the LCD.c file, which is implemented in two ways:

- 1) STM32F103RCT6 microcontroller test program uses IO analog mode (it does not support FSMC bus)
- 2) Other STM32 MCU test programs use FSMC bus mode

The IO simulation test program is implemented as shown below:

```

void LCD_write(u16 VAL)
{
    LCD_CS_CLR;
    DATAOUT(VAL);
    LCD_WR_CLR;
    LCD_WR_SET;
    LCD_CS_SET;
}

u16 LCD_read(void)
{
    u16 data;
    LCD_CS_CLR;
    LCD_RD_CLR;
    delay_us(1); //延时1us
    data = DATAIN;
    LCD_RD_SET;
    LCD_CS_SET;
    return data;
}

```

The FSMC test program is implemented as shown below:

```

u16 LCD_read(void)
{
    vu16 data; //防止被优化
    data=LCD->LCD_RAM;
    return data;
}

/*****
 * @name      :void LCD_WR_REG(u16 data)
 * @date      :2018-08-09
 * @function   :Write an 16-bit command to the LCD screen
 * @parameters :data:Command value to be written
 * @retvalue   :None
 *****/
void LCD_WR_REG(u16 data)
{
    LCD->LCD_REG=data; //写入要写的寄存器序号
}

/*****
 * @name      :void LCD_WR_DATA(u16 data)
 * @date      :2018-08-09
 * @function   :Write an 16-bit data to the LCD screen
 * @parameters :data:data value to be written
 * @retvalue   :None
 *****/
void LCD_WR_DATA(u16 data)
{
    LCD->LCD_RAM=data; //写入要写的的数据
}

```

Both 8- and 16-bit command writes and 8- and 16-bit data writes and reads are implemented.

B. C51 test program parallel port communication code implementation

The relevant code is implemented in the LCD.c file as shown below:

```
void LCD_write(u8 HVAL,u8 LVAL)
{
    LCD_CS = 0;
    LCD_WR = 0;
    LCD_DataPortH = HVAL;
    LCD_DataPortL = LVAL;
    LCD_WR = 1;
    LCD_CS = 1;
}

u16 LCD_read(void)
{
    u16 d;
    LCD_CS = 0;
    LCD_RD = 0;
    delay_us(1); //delay 1 us
    d = LCD_DataPortH;
    d = (d<<8) | LCD_DataPortL;
    LCD_RD = 1;
    LCD_CS = 1;
    return d;
}
```

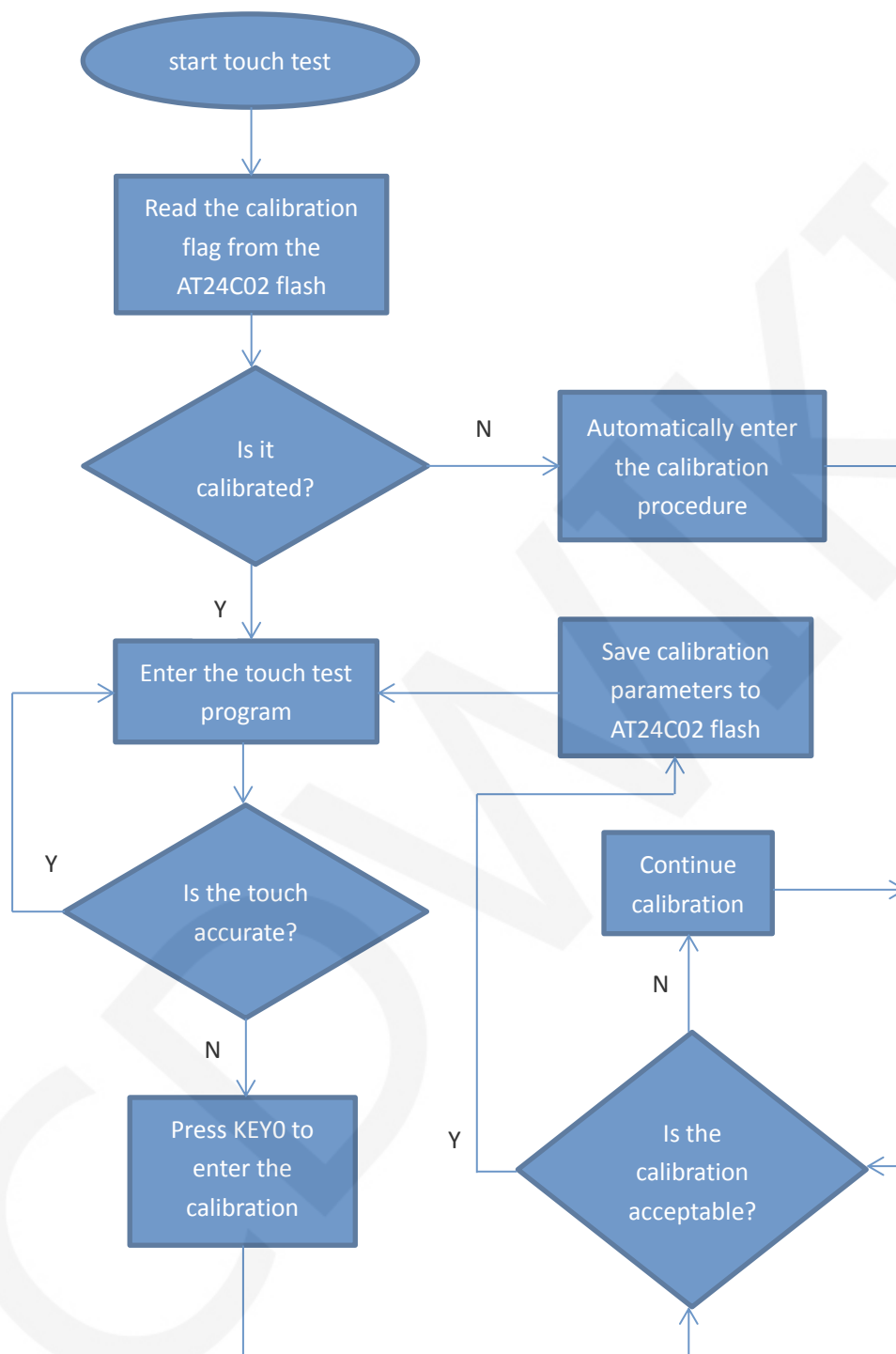
Implemented 8-bit and 16-bit commands and 8-bit and 16-bit data write and read.

4. touch screen calibration instructions

A. STM32 test program touch screen calibration instructions

The STM32 touch screen calibration program automatically recognizes whether calibration is required or manually enters calibration by pressing a button.

It is included in the touch screen test item. The calibration mark and calibration parameters are saved in the AT24C02 flash. If necessary, read from the flash. The calibration process is as shown below:



B. C51 test program touch screen calibration instructions

The C51 touch screen calibration needs to execute the Touch_Adjust test item (only available in the STC12C5A60S2 test program), as shown below:

```
//循环进行各项测试
while(1)
{
    main_test();      //测试主界面
    Test_Color();     //简单刷屏填充测试
    Test_FillRec();   //GUI矩形绘图测试
    Test_Circle();    //GUI画圆测试
    Test_Triangle();  //GUI三角形填充测试
    English_Font_test();//英文字体示例测试
    Chinese_Font_test();//中文字体示例测试
    Pic_test();       //图片显示示例测试
    Rotate_Test();
    //不使用触摸或者模块本身不带触摸，请屏蔽下面触摸屏测试
    Touch_Test();     //触摸屏手写测试
    //需要触摸校准时，请将触摸手写测试屏蔽，将下面触摸校准测试项打开
    // Touch_Adjust(); //触摸校准
}
```

After the touch calibration is passed, you need to save the calibration parameters displayed on the screen in the touch.c file, as shown below:

```
/**因触摸屏批次不同等原因，默认的校准参数值可能会引起触摸
u16 vx=11738,vy=7736; //比例因子，此值除以1000之后表示多少
u16 chx=3905,chy=246; //默认像素点坐标为0时的AD起始值
/**因触摸屏批次不同等原因，默认的校准参数值可能会引起触摸
```

Common software

This set of test examples requires the display of Chinese and English, symbols and pictures, so the modulo software is used. There are two types of modulo software: Image2Lcd and PCtoLCD2002. Here is only the setting of the modulo software for the test program.

The **PCtoLCD2002** modulo software settings are as follows:

Dot matrix format select **Dark code**

the modulo mode select **the progressive mode**

Take the model to choose **the direction (high position first)**

Output number system selects **hexadecimal number**

Custom format selection **C51 format**

The specific setting method is as follows:

http://www.lcdwiki.com/Chinese_and_English_display_modulo_settings

Image2Lcd modulo software settings are shown below:



The Image2Lcd software needs to be set to horizontal, left to right, top to bottom, and low position to the front scan mode.