2.8inch 16BIT Module MRB2802 User Manual

Product Description

The product is a 2.8-inch TFT LCD module ,it has the 400x240 resolution and supports 16BIT RGB 65K color display, the internal driver IC is R61509V . Its hardware supports 8-bit and 16-bit parallel port data bus mode switching, the default use 16-bit parallel port data bus mode. The module includes LCD display, SD card slot and PCB backplane. It can be Insert directly the STM32 series development board and supports SD card expansion.

Product Features

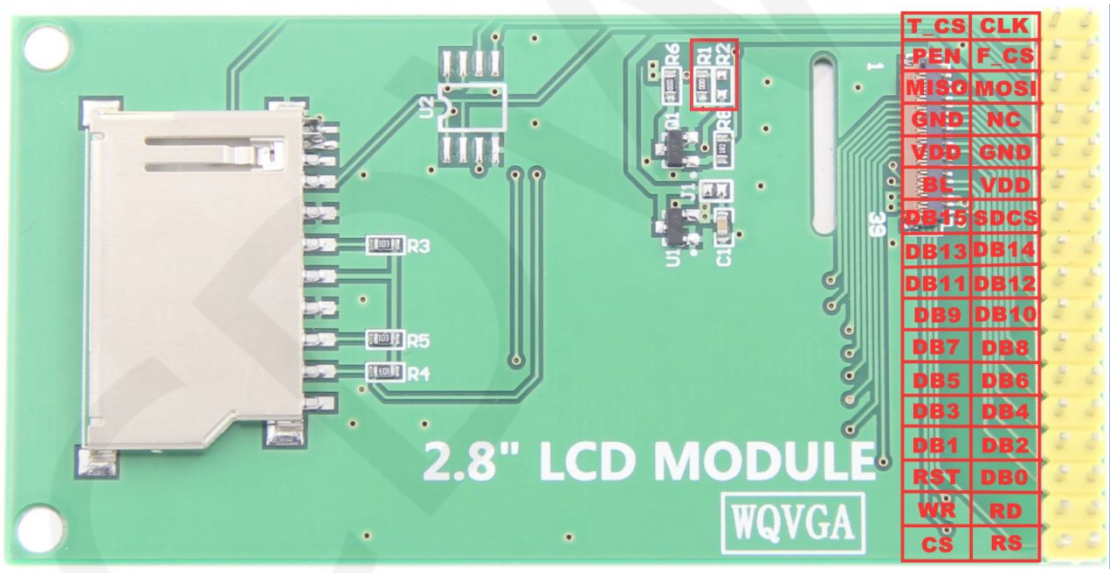
- 2.8-inch color screen, support 16BIT RGB 65K color display, display rich colors
- 240x400 resolution for clear display
- Support 8-bit and 16-bit parallel data bus mode switching, default 16-bit parallel bus transmission, fast transmission speed
- Supports ALIENTEK STM32 Mini, Elite, WarShip, Explorer, and Apollo development boards direct plug-in use
- 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	MRB2802
Screen Size	2.8(inch)
Screen Type	TFT
Driver IC	R61509V

Resolution	240*400 (Pixel)
Module Interface	8bit or 16Bit parallel interface
Active Area	36.72x61.20 (mm)
Touch Screen Type	No Touch Screen
Touch IC	No Touch IC
Module PCB Size	43.64x85.74 (mm)
Operating Temperature	-30℃~70℃
Storage Temperature	-20℃~70℃
Operating Voltage	3.3V / 5V
Power Consumption	TBD
Product Weight	TBD

Interface Description



Picture1. Module Pin silk screen picture

Note:

1. **The module hardware supports 8-bit and 16-bit parallel port data bus mode switching (as shown by the red box in Picture 1 above), as follows:**

   A. **Solder R1 with 0Ω resistor or short circuit directly, and disconnect R2: select 16-bit data bus mode (default), use DB0~DB15 data pin**

B. Solder R2 with 0Ω resistor or short circuit directly, and disconnect R1: select 8-bit data bus mode, use DB8~DB15 data pin

Important Note:

1. **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.**
2. **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.**
3. **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(If 8-bit mode is selected, the lower 8-bit data pins are not used)
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	Module power ground pin
27	GND	
28	NC	Undefined, reserved
29	F_CS	Flash chip select control pin (used when using the Flash extension function, this test program is not used)
The following are the touch screen wiring pins. This module does not have a touch screen, so no wiring is required		
30	MISO	Touch screen SPI bus data input pin
31	MOSI	Touch screen SPI bus data output pin
32	PEN	Touch screen interrupt detection pin (Low level when a touch occurs)
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 four parts: an LCD display control circuit , an SD card interface circuit, a data bus mode switching circuit and a backlight control circuit.
LCD display control circuit for controlling the pins of the LCD, including control pins and data transfer pins.
SD card control circuit is used for SD card function expansion, controlling SD card identification, reading and writing.
Data bus mode switching circuit for switching 8-bit or 16-bit parallel port data bus mode switching.
Backlight control circuit for controlling backlight brightness and power supply selection.

working principle

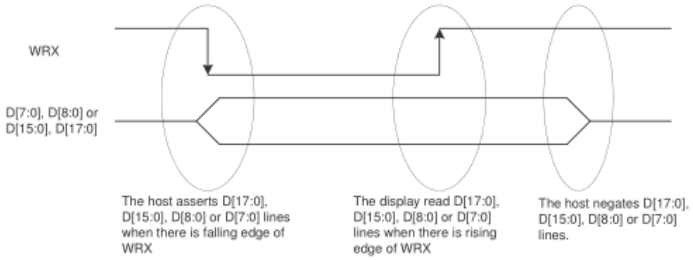
1. Introduction to R61509V Controller

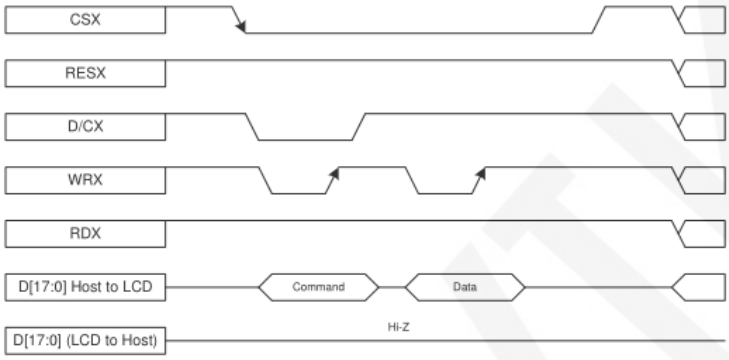
The R61509V controller supports a maximum resolution of 240*400 and has a 233280-byte GRAM. It also supports 8-bit, 9-bit, 16-bit, and 18-bit parallel port data buses. It also supports 3-wire and 4-wire SPI serial ports. Since the supported resolution is relatively large and the amount of data transmitted is large, the parallel port transmission is adopted, and the transmission speed is fast. R61509V 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 R61509V 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 R61509V display method is performed by setting the address and then setting the color value.

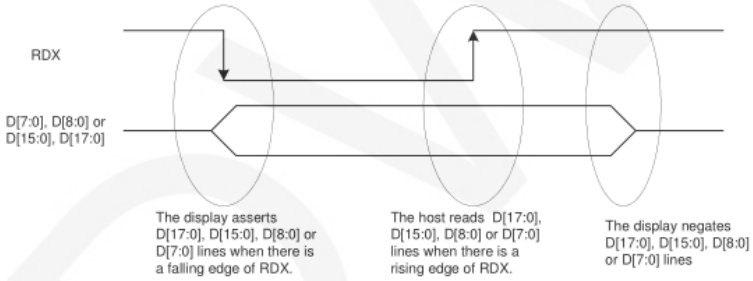
2. Introduction to parallel port communication

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

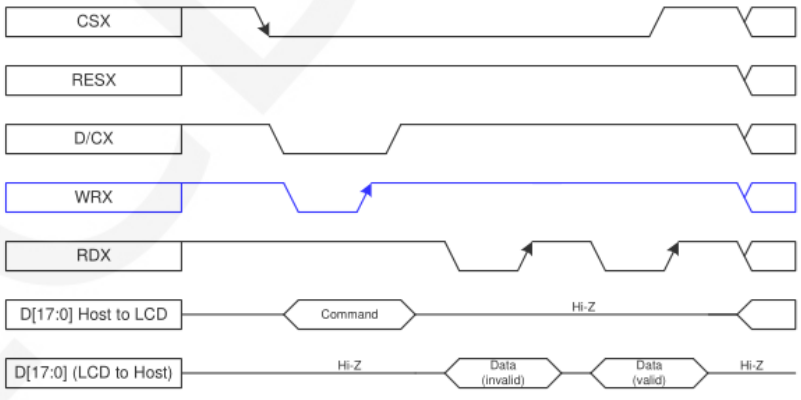




The timing of the parallel port communication read mode is shown in the figure below:



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	NC	Not used	5V
29	MISO	Not used	PC2

30	**MOSI**	Not used	PC3
31	**PEN**	Not used	PC1
32	**F_CS**	Not used	NC
33	**T_CS**	Not used	PC13
34	**CLK**	Not used	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	**NC**	Not used	5V
29	**MISO**	Not used	PB2
30	**MOSI**	Not used	PF9
31	**PEN**	Not used	PF10
32	**F_CS**	Not used	NC
33	**T_CS**	Not used	PF11
34	**CLK**	Not used	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	**NC**	Not used	5V
29	**MISO**	Not used	PF8 / PB2
30	**MOSI**	Not used	PF9
31	**PEN**	Not used	PF10
32	**F_CS**	Not used	NC
33	**T_CS**	Not used	PB2 / PF11
34	**CLK**	Not used	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	**NC**	Not used	5V
29	**MISO**	Not used	PB2
30	**MOSI**	Not used	PF11
31	**PEN**	Not used	PB1
32	**F_CS**	Not used	NC
33	**T_CS**	Not used	PC13
34	**CLK**	Not used	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

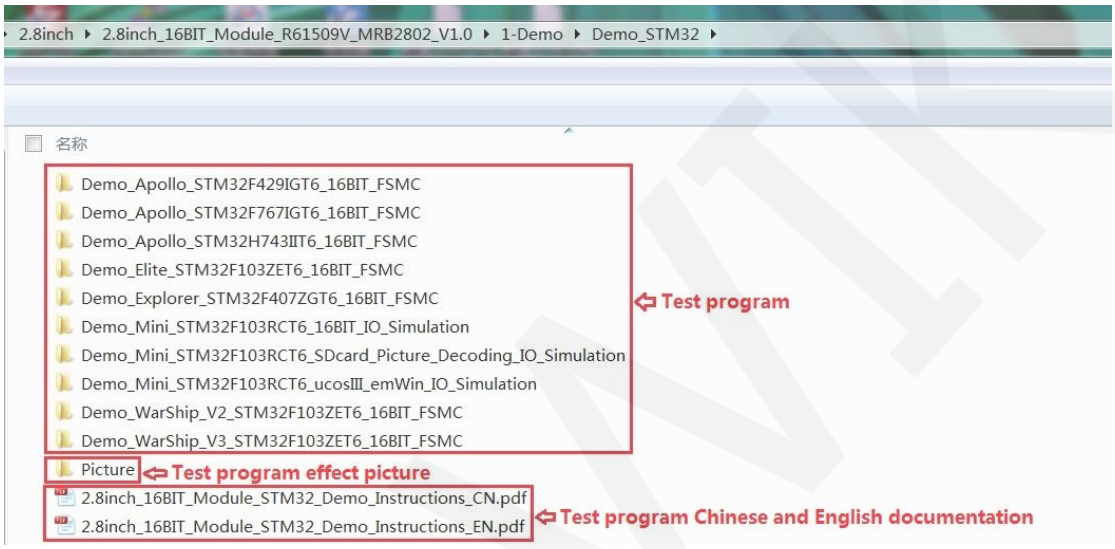
2	**RS**	RS	PD13
3	**WR**	WR	PD5
4	**RD**	RD	PD4
5	**RST**	RST	reset pin
6	**DB0**	D0	PD14
7	**DB1**	D1	PD15
8	**DB2**	D2	PD0
9	**DB3**	D3	PD1
10	**DB4**	D4	PE7
11	**DB5**	D5	PE8
12	**DB6**	D6	PE9
13	**DB7**	D7	PE10
14	**DB8**	D8	PE11
15	**DB9**	D9	PE12
16	**DB10**	D10	PE13
17	**DB11**	D11	PE14
18	**DB12**	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	**NC**	Not used	5V
29	**MISO**	Not used	PG3
30	**MOSI**	Not used	PI3
31	**PEN**	Not used	PH7
32	**F_CS**	Not used	NC
33	**T_CS**	Not used	PI8
34	**CLK**	Not used	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	**NC**	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

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	NC	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:

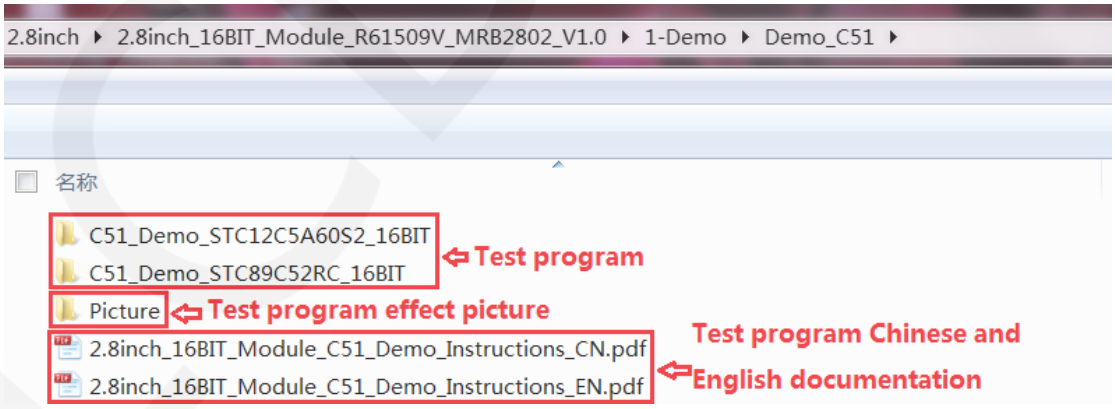
1. **Since the STC89C52RC microcontroller does not have a push-pull output function, the backlight control pin needs to be connected to a 3.3V power supply to be properly lit.**
2. **Since the STC89C52RC microcontroller's Flash capacity is too small (less than 25KB), It cannot download too large programs.**

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

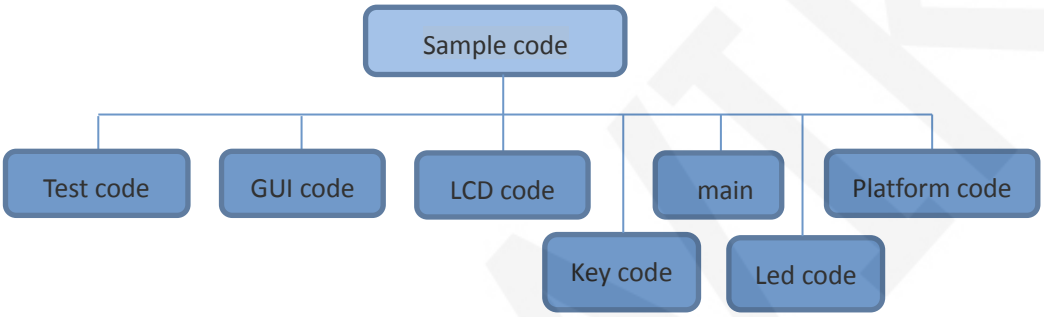
E. If the LCD module displays characters and graphics normally, the program runs successfully;

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;

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_
//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调节背光亮度
#define LCD_LED PBout(LED) //LCD背光
//如果使用官方库函数定义下列底层，速度将会下降到14帧每秒，建议采用我司推荐方法
//以下IO定义直接操作寄存器，快速IO操作，刷屏速率可以达到28帧每秒！

//LCD地址结构体
typedef struct
{
  vu16 LCD_REG;
  vu16 LCD_RAM;
} 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
//注意设置时STM32内部会右移一位对其!
#define LCD_BASE        ((u32)(0x6C000000 | 0x000007FE))
#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;
#if LCD_USE8BIT_MODEL
  return (data>>8);
#else
  return data;
#endif
}

/*****************************************************************************
 * @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)
{
#if LCD_USE8BIT_MODEL
  LCD->LCD_REG=(data<<8); //写入要写的寄存器序号
#else
  LCD->LCD_REG=data; //写入要写的寄存器序号
#endif
}

/*****************************************************************************
 * @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)
{
#if LCD_USE8BIT_MODEL
  LCD->LCD_RAM=(data<<8);//写入要写的数据
#else
  LCD->LCD_RAM=data; //写入要写的数据
#endif
}
```

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.

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)

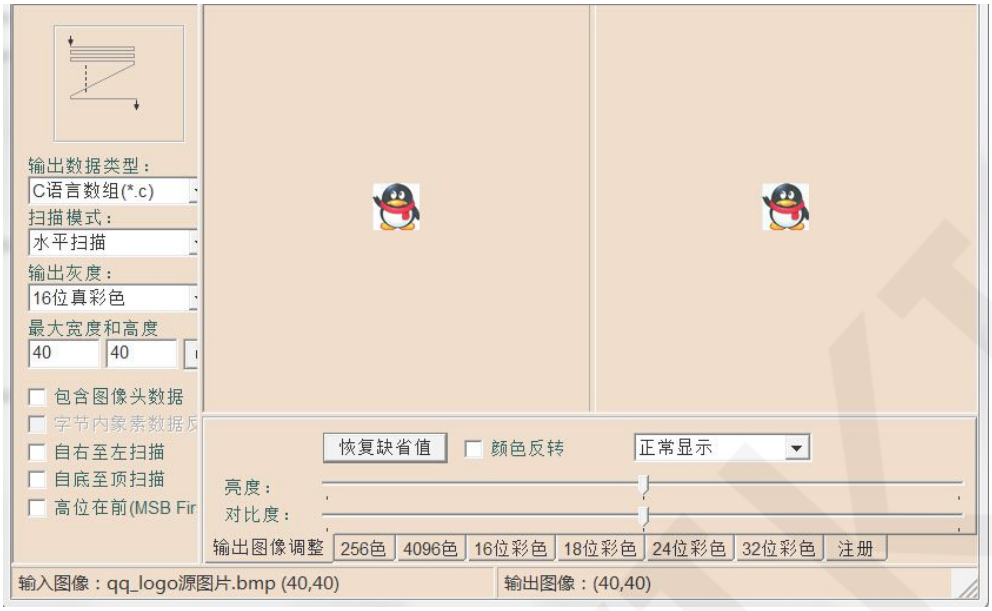
Output number system selects hexadecimal number

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.