1.8inch LCD Module USER MANUAL

OVERVIEW

This product is 1.8inch resistive screen module with resolution 128x160. It has internal controller and uses SPI interface for communication. It has already basic functions: setting the point size, the line thickness, drawing circle, rectangle, and displaying English characters.

We provide Raspberry Pi, STM32 and Arduino routines for this product.

FEATURES

Display type:	TFT
Interface:	SPI
Driver:	ST7735S
Colors:	256K
Resolution:	128 x 160 (Pixel)
Product size:	56.5 x 34(mm)
Display size:	35.4(W) x 28.03(H)(mm)
Pixel size:	0.219(W) x 0.219(H)(MM)
Operating temperature:	-30°C ~ 85°C

INTERFACE DESCRIPTION

Marking	Description
3V3	3.3V power
GND	ground
DIN	SPI data input
CLK	SPI clock
CS	chip select
DC	data/command
RST	reset
BL	back light

PROGRAM ANALYSIS

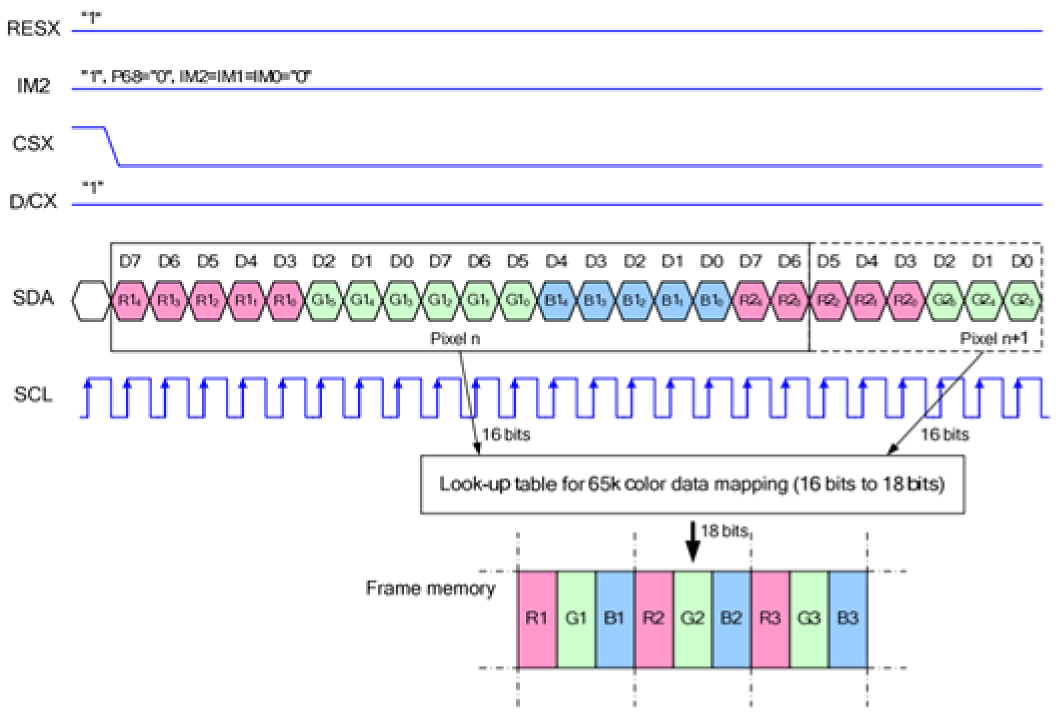
1. Working principles:

   ST7735S is 132 x 162 pixels LCD panel, but the product is 128 x 160 pixels LCD display. In the display there are two processes: the horizontal direction scanning – from the 2nd pixel, the vertical direction scanning – from the 1st pixel. So, you can see that positions of pixels in RAM correspond to their actual positions while displaying.

   The LCD supports 12-bit, 16-bit and 18-bit per pixel input formats. They correspond to RGB444, RGB565 and RGB666 color formats. This routine uses the RGB565 color format, which is commonly used.

   LCD uses 4-wired SPI communication interface, which can save a lot of GPIO ports and provides fast data transfer to LCD as well.

2. Communication protocol


RESX
"1"
IM2
"1", P68="0", IM2=IM1=IM0="0"
CSX
D/CX
"1"
SDA
D7 D6 D5 D4 D3 D2 D1 D0 D7 D6 D5 D4 D3 D2 D1 D0 D7 D6 D5 D4 D3 D2 D1 D0
Pixel n
Pixel n+1
SCL
16 bits
16 bits
Look-up table for 65k color data mapping (16 bits to 18 bits)
18 bits
Frame memory
R1 G1 B1 R2 G2 B2 R3 G3 B3

Note: there is a difference from traditional SPI. Here we only need display, so sine wires come from slave to host are hidden. The detailed information please refer to datasheet at page 58

RESX: Reset. Pull-down while powering on the module. General set as 1

IM2: data communication mode pin, which define usage of SPI

CSX: chip selection control pin. If CS=0 – the chip is selected

D/CX: data/command control pin, if DC=0 – command is written, otherwise – data are written

SDA: transmitted RGB data

SCL: SPI clock

The SPI communication protocol of the data transmission uses control bits: clock phase (CPHA) and clock polarity (CPOL):

The value of CPOL determines the level when the serial synchronous clock is in idle state. CPOL=0, that its idle level is 0.

The value of CPHA determines the timing of the data bits relative to the clock pulses. CPHA=0, data is sampled at the first clock pulse edge.

The combination of these two parameters provides 4 modes of SPI data transmission. The commonly used is SPI0 mode, it is that GPOL=0 and CPHA=0.

From the figure above, SCLK begins to transfer data at the first falling edge. 8 bits data are transferred at one clock period. Use SPI0 mode, High bits transfer first, and LOW bits following.

DEMO CODE

Raspberry Pi, STM32 and Arduino programs are provided, wherein Raspberry Pi provides BCM2835, WiringPi and python programs. It implements common graphical functions as drawing dot, line, rectangle, circle, setting their sizes and line with; filling arias, and displaying English characters of 5 common fonts and other display's functions.

Following instructions are offered for you convenience

RASPBERRY

1. Hardware connection

1.8inch LCD module	Raspberry Pi
3.3V	3.3V
GND	GND
DIN	MOSI (PIN 19)
CLK	SCLK (PIN23)
CS	CE0 (PIN 24)
DC	GPIO.6 (PIN 22)
RST	GPIO.2 (PIN13)
BL	GPIO.5 (PIN18)

2. Enable SPI function of the Raspberry Pi

   sudo raspi-config

   Select: ***Advanced Options -> SPI -> yes***

   Activate SPI hardware driver.

3. Installation of libraries

   Fore detailed information about libraries installation, please refer to this page:

   https://www.waveshare.com/wiki/Libraries_Installation_for_RPi

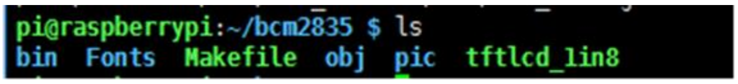
   It is description of WiringPi, bcm2835 and python libraries installation.

4. Usage

   BCM2835 and WiringPi program should be only copied into directory of Raspberry Pi ()by samba or directly copy to the SD card). The following code are compied directly to the user directory of Pi.

4.1 Usage of BCM2835

   Run **ls** command as you can see below:



```
pi@raspberrypi:~/bcm2835 $ ls
bin  Fonts  Makefile  obj  pic  tftlcd_1in8
```

bin: contains ".o" files. We don't need to change it generally

Fonts: contains 5 commonly used fonts

Pic: contains pictures used for displaying. The resolution of pictures must be 128x128, otherwise they cannot be displayed properly. And the format of pictures must be BMP.

Obj: contains object files, like main.c, LCD_Driver.c, DEV_Config.c, LCD_GUI.c and their header files.

main.c: The mian function. What need to note is that even though there are LCD_ScanDir used to control the direction of scanning, you need not to change it. Because this module is designed for Raspberry Pi, and for compatibility, we don't recommend you to change it.

DEV_Config.c: Definations of Raspberry Pi's pins and the communication mode.

LCD_Driver.c: Drive code of LCD. Need not change generally.

LCD_BMP.c: Reading and analyzing BMP files and display them

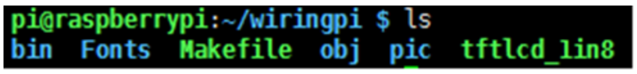
Makefile: This file contains compilation rules. If there are some changes in code, please run **make clean** to clean all the dependency file and executable files. Then execute **make** to compile the whole project and generate new executable files.

tftlcd_1in8: executable file, generated by command **make**

To run the program, you just need to run this command on terminal: **sudo ./tftlcd_1in8**

4.2 WiringPi

Input **ls** command, now you can see following:



```
pi@raspberrypi:~/wiringpi $ ls
bin  Fonts  Makefile  obj  pic  tftlcd_1in8
```

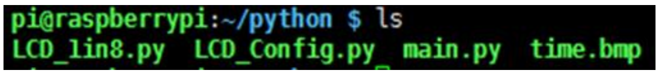
The folders is similar to BCM2835's. The only differences are that:

1. WiringPi oprates by read/write the device files of Linux OS. and the bcm2835 is library function of Raspberry Pi's CPU, it operates registers directly. Thus, if you have used bcm2835 libraries firstly, the usage of WiringPi code will be failed. In this case, you just need to reboot the system and try again.
2. Due to the first difference, they underlying configuration are different. In DEV_Config.c, use wiringpiPi and the corresponding wiringPiSPI to provide underlay interfaces.

The program executed by command **sudo ./tftlcd_1in8** as well

4.3 Python

Input **ls** command, you can see that:



```
pi@raspberrypi:~/python $ ls
LCD_1in8.py  LCD_Config.py  main.py  time.bmp
```

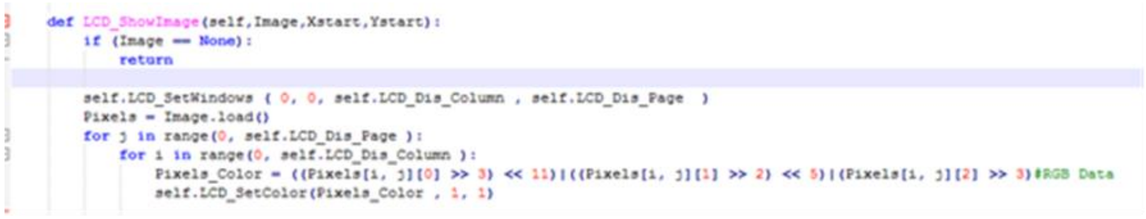
LCD_1in8.py: Driver code of LCD

LCD_Config.py: configuration of hardware underlaying interface.

Executing program: **sudo python LCD_1in8.py**

Note: Some of the OS don't have image libraries. In this case, you can run: **sudo apt-get install python-imaging** to install the image library.

Image is an image processing library of python, represents any image by an image object. Thus, we can create a blank image by **new**, its size must be same as the display size of LCD. Then draw picture by Draw library, finally, transfer the image to the LCD. Here using **Image.load()** too read RGB888 data of pixel, and convert to RGB565. Scanning every pixel then we could get the whole image for displaying. Its most important code is as below:



```
def LCD_ShowImage(self,Image,Xstart,Ystart):
    if (Image == None):
        return

    self.LCD_SetWindows ( 0, 0, self.LCD_Dis_Column , self.LCD_Dis_Page  )
    Pixels = Image.load()
    for j in range(0, self.LCD_Dis_Page ):
        for i in range(0, self.LCD_Dis_Column ):
            Pixels_Color = ((Pixels[i, j][0] >> 3) << 11)|((Pixels[i, j][1] >> 2) << 5)|(Pixels[i, j][2] >> 3)#RGB Data
            self.LCD_SetColor(Pixels_Color , 1, 1)
```

5. Auto-run

Initialize autorun in Raspberry Pi by configuring code of /etc/rc.local file:

```
sudo vim /etc/rc.local
```

Before exit0 add:

```
sudo python /home/pi/python/demo.py &
```

Important: to place the program /home/pi/python/demo.py at the same director, you can input command **pwd** to get the path. And & character is necessary at the end of command line, otherwise probable need to reinstall the system (impossible terminate the process by pressing ctrl+c, impossible to login with pi user permission).

STM32

This demo uses XNUCLEO-F103RB developing board and is based on HAT library.

1. Hardware connection

1.8inch LCD	XNUCLEO-F103RB
VCC	3V3
GND	GND
DIN	PA7
CLK	PA5
CS	PB6
DC	PA8
RST	PA9
BL	PC7

2. Expected result

Program the demo into the development Board. Firstly the screen is refreshed completely, then a solid line, dashed line, open circle, solid circle, rectangle, solid torque are drawn and English characters are shown.

ARDUINO

UNO PLUS Arduino development board is used here.

1. Hardware connection

1.8inch LCD	Arduino
3.3V	3V3

GND	GND
DIN	D11
CLK	D13
CS	D10
DC	D7
RST	D8
BL	D9

2. Due to small global memory 2Kb of UNO PLUS, the display can't work in graphical mode, but the calling method is the same. Just because there is no enough memory, this demo is not provided.

COMPATIBLE CODE PORTING

Offered demo is the commonly used programs, which are able to be ported. They can be used with two screens and the difference is only in initialization of them and their sizes.

The usage method is defined by macros. In LCD_Driver.h or in LCD.h:

#define LCD_1IN44

#define LCD_1in8.

As the name of the macros, they are used for 1.44inch and 1.8inch LCD separately. To use for one LCD, just need to comment other one.

For example:

//#define LCD_1IN44

#define LCD_1IN8

Here we use it for 1.8inch LCD, so we comment the 1.44 macro. After saving, Run **make clean** to remove dependency files, and then run **make** to generate new executable files.