StarFive 赛昉科技

Using VisionFive SPI to Support LCD Display

with Python

Application Note

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Legal Statements

Important legal notice before reading this documentation.

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Contact Us

Address: Room 502, Building 2, No. 61 Shengxia Rd., China (Shanghai) Pilot Free Trade Zone, Shanghai, 201203, China

Website: http://www.starfivetech.com

Email: sales@starfivetech.com(sales) , support@starfivetech.com(support)

Preface

About this guide and technical support information.

About this document

This application note provides steps to use VisionFive's SPI to make a 2.4inch LCD display with specified pictures.

Revision History

Table 0-1 Revision History

Version	Released	Revision
V1.1	2022/07/29	Added "cd" in the codeblock `cd /usr/local/lib64/python3.9/site-packages` to make it a complete command.

Notes and notices

The following notes and notices might appear in this guide:

- **Tip:**
  Suggests how to apply the information in a topic or step.

- **Note:**
  Explains a special case or expands on an important point.

- **Important:**
  Points out critical information concerning a topic or step.

- **CAUTION:**
  Indicates that an action or step can cause loss of data, security problems, or performance issues.

- **Warning:**
  Indicates that an action or step can result in physical harm or cause damage to hardware.

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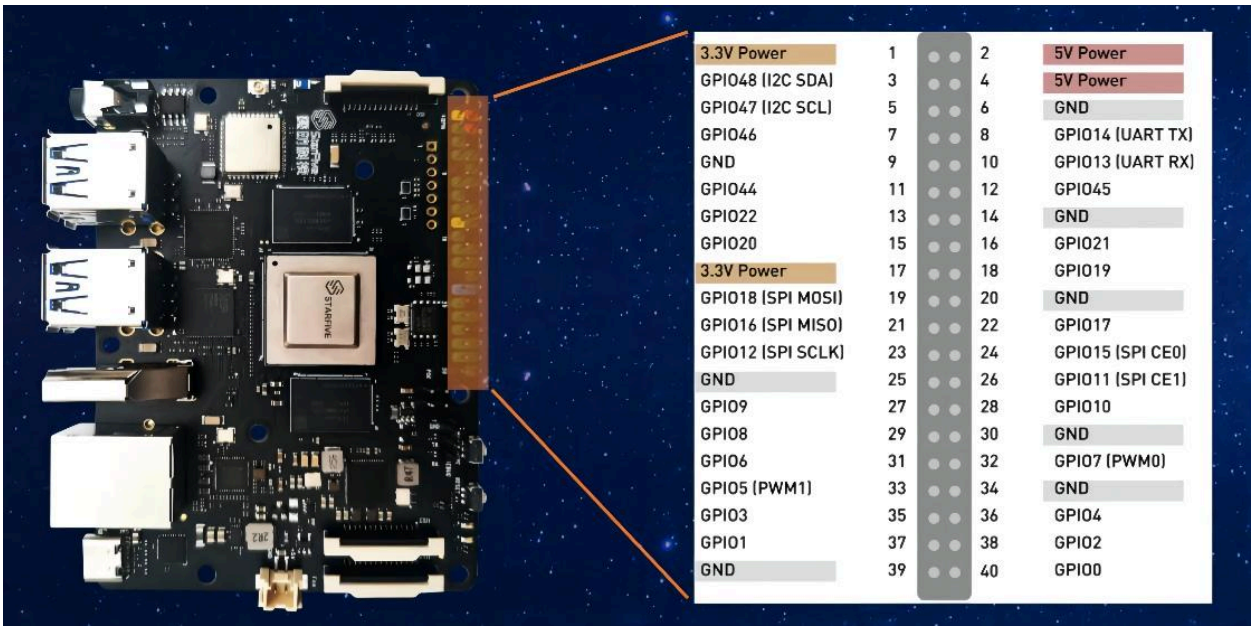
1. Introduction

This application note provides steps to use VisionFive's SPI to make a 2.4inch LCD display with specified pictures.

1.1. 40-Pin Header Definition

The following figure shows the location of the 40-pin header. The VisionFive board is taken as an example:

Figure 1-1 40-Pin Definition



2. Preparation

Before executing the demo program, make sure you prepare the following:

2.1. Preparing Hardware

Prepare the following hardware items before running the demo code:

Table 2-1 Hardware Preparation

Type	M/O*	Item	Notes
General	M	StarFive single board computer	The following boards are applicable: • StarLight • VisionFive
General	M	• 16 GB (or more) micro-SD card • micro-SD card reader • Computer (Windows/MAC/Linux) • USB to serial converter (3.3 V I/O) • Ethernet cable • Power adapter (5 V / 3 A) • USB Type-C Cable	These items are used for flashing Fedora OS into a micro-SD card.
SPI LCD		• 2.4inch LCD Module • Dupont Line	-

Note:
*: M: Mandatory, O: Optional

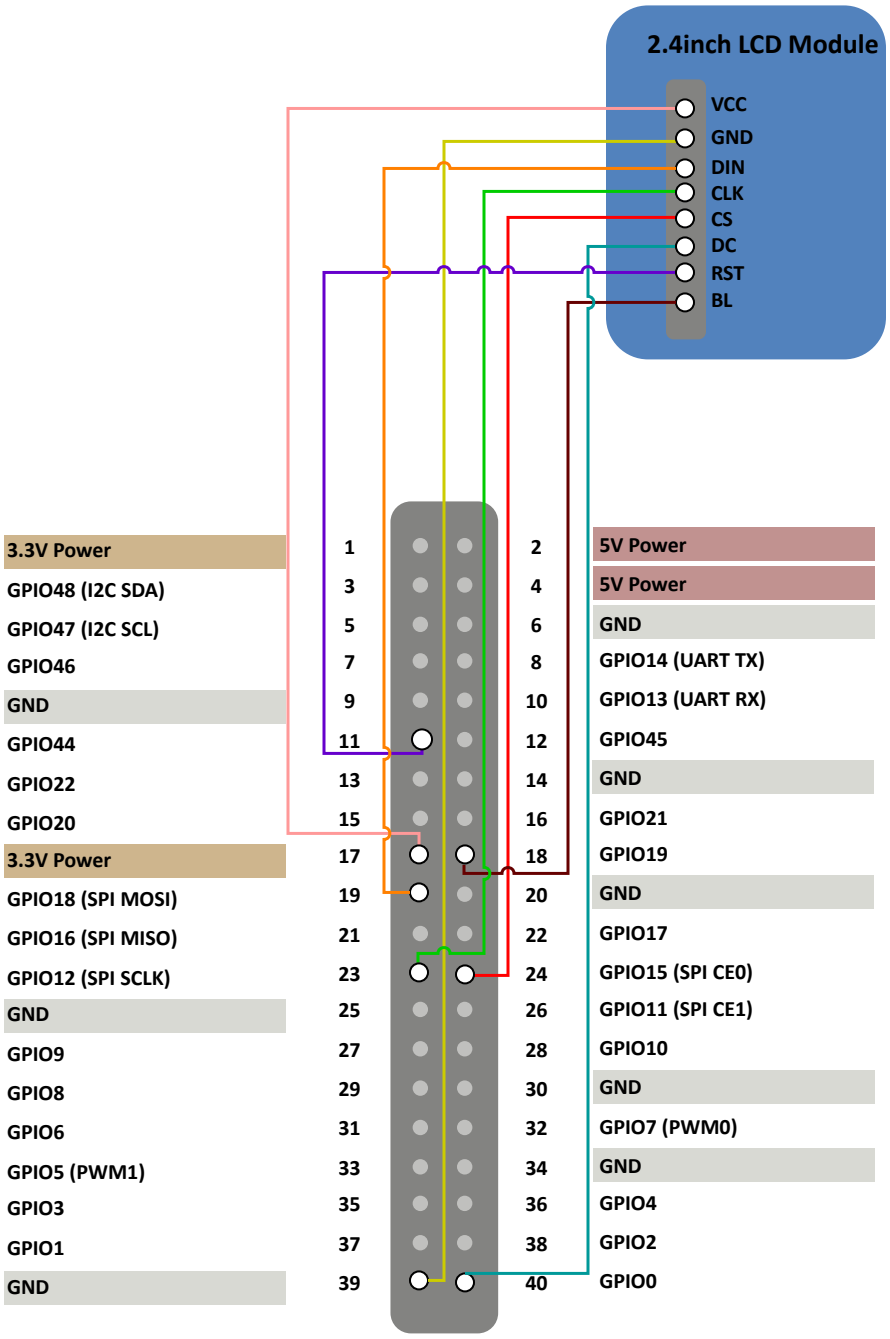
2.1.1. Hardware Setup

The following table and figure describe how to connect LCD to the 40-pin header:

Table 2-2 Connect the 2.4inch LCD to the 40-Pin Header

2.4inch LCD Module	40-Pin GPIO Header	
	Pin Number	Pin Name
VCC	17	3.3V Power
GND	39	GND
DIN	19	GPIO18 (SPI MOSI)
CLK	23	GPIO12 (SPI SCLK)
CS	24	GPIO15 (SPI CE0)
DC	40	GPIO0
RST	11	GPIO44
BL	18	GPIO19

Figure 2-1 Connect the 2.4inch LCD to the 40-Pin Header



2.2. Preparing Software

Make sure the following procedures are performed:

1. Flash Fedora OS into a Micro-SD card as described in the *Flashing Fedora OS to a Micro-SD Card* section in the *VisionFive Single Board Computer Quick Start Guide*.
2. Log into the Fedora and make sure VisionFive is connected to the Internet. For detailed instructions, refer to the *Using SSH over Ethernet* or *Using a USB to Serial Converter* section in the *VisionFive Single Board Computer Quick Start Guide*.
3. Execute the `pip` command on VisionFive Fedora to install the `VisionFive.gpio` package:

   ```
   sudo pip install VisionFive.gpio
   ```

   Alternatively, you can execute the following command:

   ```
   sudo pip3 install VisionFive.gpio
   ```

4. (Optional) If you copy the source code to the local directory under VisionFive Fedora, execute the following commands under the source code directory:

   Tip:
   The source code can be downloaded by clicking the following link: VisionFive.gpio.

   ```
   sudo yum install python-devel python3-devel
   sudo python setup.py install
   ```

   Alternatively, you can execute the following command:

   ```
   sudo python3 setup.py install
   ```

3. Running Demo Code

To run the demo code, perform the following on VisionFive Fedora:

1. Locate to the directory where the test code, `2.4inch_LCD_demo`, exists:

    a. Execute the following command to get the directory where `VisionFive.gpio` exists:

    ```
    pip show VisionFive.gpio
    ```

    Example Result:

    ```
    Location: /usr/local/lib64/python3.9/site-packages
    ```

    Note:

    The actual output depends on how the application is installed.

    b. Execute the following to enter the directory, for example, `/usr/local/lib64/python3.9/site-packages` as indicated in the previous step output:

    ```
    cd /usr/local/lib64/python3.9/site-packages
    ```

    c. Execute the following command to enter the `sample-code` directory:

    ```
    cd ./VisionFive/sample-code/
    ```

    d. Execute the following command to enter the directory where the test code, `2.4inch_LCD_demo`, exists:

    ```
    cd ./lcddemo/example/
    ```

2. Under the `sample-code` directory, execute the following command to execute the demo code:

    ```
    sudo python 2.4inch_LCD_demo
    ```

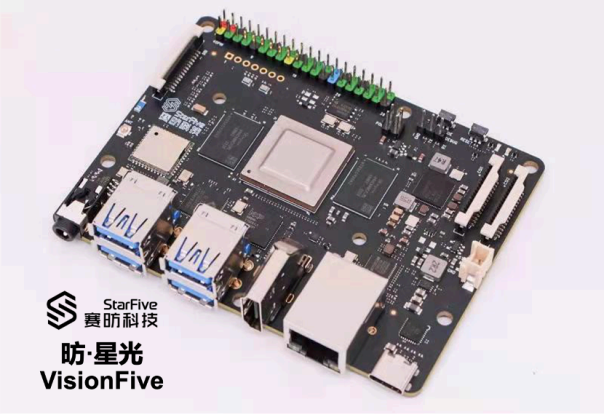
    Alternatively, you can execute the following command:

    ```
    sudo python3 2.4inch_LCD_demo
    ```

    Result:

- On the 2.4inch LCD:
  - First, the following picture with the StarFive logo will be displayed for two seconds.

Figure 3-1 Example Output



  - Then the following two official example figures will be displayed in turn.

Figure 3-2 Example Output

- The terminal output is as the following.

```
-----------lcd demo-----------
Set SPI mode successfully
spi mode: 0x0
bits per word: 8
max speed: 40000000 Hz(40000 kHz)
2022-07-04 16:40:40
2022-07-04 16:40:41
2022-07-04 16:40:41
2022-07-04 16:40:42
2022-07-04 16:40:42
2022-07-04 16:40:43
2022-07-04 16:40:44
2022-07-04 16:40:44
2022-07-04 16:40:45
```

The output indicates:

- that the SPI mode is set successfully
- the SPI mode
- the date and time when all the above three figures are displayed

4. Demo Source Code

The Python source code of this demo is provided for reference purpose only.

`2.4inch_LCD_demo.py`:

```
'''
Please make sure the 2.4inch LCD module is connected to the correct pins.
The following table describes how to connect the 2.4inch LCD Module to the
 40-pin header.
-------------------------------------------------
__2.4inch LCD Module___Pin Number_____Pin Name
 VCC 17 3.3 V Power
 GND 39 GND
 DIN 19 SPI MOSI
 CLK 23 SPI SCLK
 CS 24 SPI CE0
 DC 40 GPIO0
 RST 11 GPIO44
 BL 18 GPIO19
-------------------------------------------------
'''

import os
import sys
import time
import logging
from PIL import Image
sys.path.append("..")

from lib import LCD2inch4_lib

'''
Demo modification and new function description:
-------------------------------------------------------------
    I. Add the clear() function to fill LCD screen with white
    II. Give a hexadecimal value of white
    III. Cycle through multiple pictures
-------------------------------------------------------------
'''

WHITE = 0xFF

def main():
    print('-----------lcd demo-------------')

    #The initialization settings of 2.4inch module.
    disp = LCD2inch4_lib.LCD_2inch4(44, 0, '/dev/spidev0.0')
```

```
    disp.lcd_init_2inch4()

    disp.lcd_clear(WHITE)
    image = Image.open('./visionfive.bmp')
    disp.lcd_ShowImage(image, 0, 0)
    time.sleep(2)

    #Add the part of displaying pictures circularly.
    while True:
        print(time.strftime("%Y-%m-%d
 %H:%M:%S",time.localtime(time.time())))

        #Rotate the picture by 90 degrees (anticlockwise).
        #To keep consistent with the display direction of other pictures.
        image = Image.open('./LCD_2inch4_parrot.bmp')
        image = image.transpose(Image.Transpose.ROTATE_90)
        disp.lcd_ShowImage(image, 0, 0)

        image = Image.open('./LCD_2inch.jpg')
        disp.lcd_ShowImage(image, 0, 0)

if __name__=="__main__":
    main()
```

LCD2inch4_lib.py:

```
import os
import sys
import time
import logging
import VisionFive.spi as spi
import VisionFive.gpio as gpio
import numpy as np
from PIL import Image,ImageDraw,ImageFont

class LCD_2inch4():
    width  = 240
    height = 320
    def __init__(self, rst_pin, dc_pin, dev):
        self.rstpin = rst_pin
        self.dcpin  = dc_pin
        self.spidev  = dev
        spi.getdev(self.spidev)

        #Reset the maximum clock frequency of communication.
        #The display speed of the picture is positively correlated with the
 clock frequency.
        spi.setmode(40000000, 0, 8)
        gpio.setup(self.rstpin, gpio.OUT)
        gpio.setup(self.dcpin, gpio.OUT)
```

```
    def __del__(self):
        spi.freedev()

    #Add a short delay for each change of electrical level.
    def lcd_reset(self):
        gpio.output(self.rstpin, gpio.HIGH)
        time.sleep(0.01)
        gpio.output(self.rstpin, gpio.LOW)
        time.sleep(0.01)
        gpio.output(self.rstpin, gpio.HIGH)
        time.sleep(0.01)

    def lcd_spisend(self, data):
        spi.transfer(data)

    def lcd_sendcmd(self, cmd):
        gpio.output(self.dcpin, gpio.LOW)
        spi.transfer(cmd)

    def lcd_senddata(self,data):
        gpio.output(self.dcpin, gpio.HIGH)
        spi.transfer(data)


    #Write multiple bytes.
    def lcd_sendnbytes(self, data):
        gpio.output(self.dcpin, gpio.HIGH)
        spi.write(data)

    #Common registers' initialization of the 2.4inch LCD module.
    def lcd_init_2inch4(self):
        self.lcd_reset()

        self.lcd_sendcmd(0x11) #Sleep out.

        self.lcd_sendcmd(0xCF) #Power Control B.
        self.lcd_senddata(0x00)
        self.lcd_senddata(0xC1)
        self.lcd_senddata(0x30)

        self.lcd_sendcmd(0xED) #Power on sequence control.
        self.lcd_senddata(0x64)
        self.lcd_senddata(0x03)
        self.lcd_senddata(0x12)
        self.lcd_senddata(0x81)

        self.lcd_sendcmd(0xE8) #Driver Timing Control A.
        self.lcd_senddata(0x85)
        self.lcd_senddata(0x00)
```

```
        self.lcd_senddata(0x79)

        self.lcd_sendcmd(0xCB) #Power Control A.
        self.lcd_senddata(0x39)
        self.lcd_senddata(0x2C)
        self.lcd_senddata(0x00)
        self.lcd_senddata(0x34)
        self.lcd_senddata(0x02)

        self.lcd_sendcmd(0xF7) #Pump ratio control.
        self.lcd_senddata(0x20)

        self.lcd_sendcmd(0xEA) #Driver Timing Control B.
        self.lcd_senddata(0x00)
        self.lcd_senddata(0x00)

        self.lcd_sendcmd(0xC0) #Power Control 1.
        self.lcd_senddata(0x1D) #VRH[5:0]

        self.lcd_sendcmd(0xC1) #Power Control 2.
        self.lcd_senddata(0x12) #SAP[2:0], BT[3:0].

        self.lcd_sendcmd(0xC5) #VCOM Control 1.
        self.lcd_senddata(0x33)
        self.lcd_senddata(0x3F)

        self.lcd_sendcmd(0xC7) #VCOM Control 2.
        self.lcd_senddata(0x92)

        self.lcd_sendcmd(0x3A) #COLMOD: Pixel Format Set.
        self.lcd_senddata(0x55)

        self.lcd_sendcmd(0x36) #Memory Access Control.
        self.lcd_senddata(0x08)

        self.lcd_sendcmd(0xB1) #Frame rate control(in normal mode/full
 colors).
        self.lcd_senddata(0x00)
        self.lcd_senddata(0x12)

        self.lcd_sendcmd(0xB6) #Display function control.
        self.lcd_senddata(0x0A)
        self.lcd_senddata(0xA2)

        self.lcd_sendcmd(0x44) #Set_Tear_Scanline
        self.lcd_senddata(0x02);

        self.lcd_sendcmd(0xF2) #Gamma Function Disable
        self.lcd_senddata(0x00)
```

```
        self.lcd_sendcmd(0x26) #Gamma curve selected.
        self.lcd_senddata(0x01)

        self.lcd_sendcmd(0xE0) #Set Gamma.
        self.lcd_senddata(0x0F)
        self.lcd_senddata(0x22)
        self.lcd_senddata(0x1C)
        self.lcd_senddata(0x1B)
        self.lcd_senddata(0x08)
        self.lcd_senddata(0x0F)
        self.lcd_senddata(0x48)
        self.lcd_senddata(0xB8)
        self.lcd_senddata(0x34)
        self.lcd_senddata(0x05)
        self.lcd_senddata(0x0C)
        self.lcd_senddata(0x09)
        self.lcd_senddata(0x0F)
        self.lcd_senddata(0x07)
        self.lcd_senddata(0x00)

        self.lcd_sendcmd(0XE1); #Set Gamma.
        self.lcd_senddata(0x00)
        self.lcd_senddata(0x23)
        self.lcd_senddata(0x24)
        self.lcd_senddata(0x07)
        self.lcd_senddata(0x10)
        self.lcd_senddata(0x07)
        self.lcd_senddata(0x38)
        self.lcd_senddata(0x47)
        self.lcd_senddata(0x4B)
        self.lcd_senddata(0x0A)
        self.lcd_senddata(0x13)
        self.lcd_senddata(0x06)
        self.lcd_senddata(0x30)
        self.lcd_senddata(0x38)
        self.lcd_senddata(0x0F)
        self.lcd_sendcmd(0x29) #Display On.

    def lcd_setPos(self, Xstart, Ystart, Xend, Yend):

        self.lcd_sendcmd(0x2a)
        self.lcd_senddata(Xstart >>8)
        self.lcd_senddata(Xstart & 0xff)
        self.lcd_senddata((Xend - 1) >> 8)
        self.lcd_senddata((Xend - 1) & 0xff)
        self.lcd_sendcmd(0x2b)
        self.lcd_senddata(Ystart >>8)
        self.lcd_senddata(Ystart & 0xff)
        self.lcd_senddata((Yend - 1) >> 8)
        self.lcd_senddata((Yend - 1) & 0xff)
```

```
        self.lcd_sendcmd(0x2C)

    def lcd_clear(self, color):

        #Clear contents of image buffer.
        _buffer = [color]*(self.width * self.height *2)

        self.lcd_setPos(0, 0, self.width, self.height)
        gpio.output(self.dcpin, gpio.HIGH)

        #Multi-byte-write.
        self.lcd_sendnbytes(_buffer)

    def lcd_ShowImage(self, Image, Xstart, Ystart):
        #Set buffer to the value of the Python Imaging Library image.
        #Write display buffer to the physical display.
        imwidth, imheight = Image.size

        if imwidth == self.height and imheight == self.width:
            img = np.asarray(Image)
            pix = np.zeros((self.width, self.height,2), dtype = np.uint8)
            pix[...,[0]] =
np.add(np.bitwise_and(img[...,[0]],0xF8),np.right_shift(img[...,[1]],5))
            pix[...,[1]] =
np.add(np.bitwise_and(np.left_shift(img[...,[1]],3),0xE0),
np.right_shift(img[...,[2]],3))
            pix = pix.flatten().tolist()

            self.lcd_sendcmd(0x36) #Define read/write scanning direction of
frame memory.
            self.lcd_senddata(0x78)
            self.lcd_setPos(0, 0, self.height, self.width)

            gpio.output(self.dcpin, gpio.HIGH)

            #Multi-byte-write.
            self.lcd_sendnbytes(pix)
        else :
            img = np.asarray(Image)
            pix = np.zeros((imheight, imwidth, 2), dtype = np.uint8)

            pix[...,[0]] =
np.add(np.bitwise_and(img[...,[0]],0xF8),np.right_shift(img[...,[1]],5))
            pix[...,[1]] =
np.add(np.bitwise_and(np.left_shift(img[...,[1]],3),0xE0),
np.right_shift(img[...,[2]],3))

            pix = pix.flatten().tolist()

            self.lcd_sendcmd(0x36)
```

```
            self.lcd_senddata(0x08)
            self.lcd_setPos(0, 0, self.width, self.height)

            gpio.output(self.dcpin, gpio.HIGH)
            #Multi-byte-write.
            self.lcd_sendnbytes(pix)
```