



StarFive
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Using VisionFive 2 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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Preface

About this guide and technical support information.

About this document

This application note provides steps to use VisionFive 2's SPI to make a 2.4inch LCD display with specified pictures.

Revision History

Table 0-1 Revision History

Version	Released	Revision
1.11	2024/06/18	- Added a new step in Running Demo Code (on page 15). - Updated the Demo Source Code (on page 19).
1.1	2023/06/08	- Added a note in 40-Pin GPIO Header Definition (on page 8). - Updated the method for installing VisionFive.gpio package in Preparing Software (on page 11). - Added Resources (on page 27) and Buy Now (on page 28) chapters.
1.0	2022/11/30	The first official release.

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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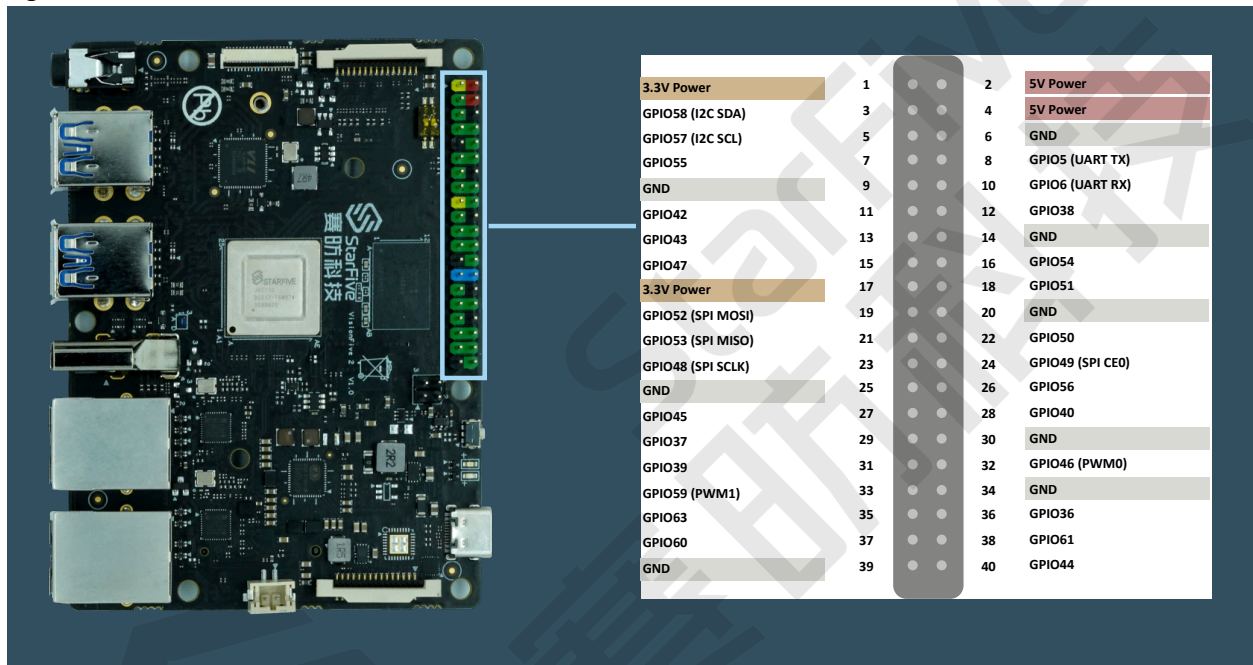
1. Introduction

This application note provides steps to use VisionFive 2's SPI to make a 2.4inch LCD display with specified pictures.

1.1. 40-Pin GPIO Header Definition

The following figure shows the location of the 40-pin header on VisionFive 2.

Figure 1-1 40-Pin GPIO Header Definition



Note:

The multiplexed pin has been initialized and cannot be used as a general GPIO.

2. Preparation

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

2.1. Environment Requirements

The environment requirements are as follows:

- Linux Kernel: Linux 5.15
- OS: Debian 12
- SBC: VisionFive 2
- SoC: JH-7110

2.2. Preparing Hardware

Prepare the following hardware items before running the demo code:

Table 2-1 Hardware Preparation

Type	M/O*	Item	Notes
General	M	VisionFive 2 Board	-
General	M	• 32 GB (or more) micro-SD card • Micro-SD card reader • Computer (Windows/Mac OS/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 Debian OS into a Micro-SD card.
SPI LCD		• 2.4inch LCD Module • Dupont Line	-



Note:

*: M: Mandatory, O: Optional

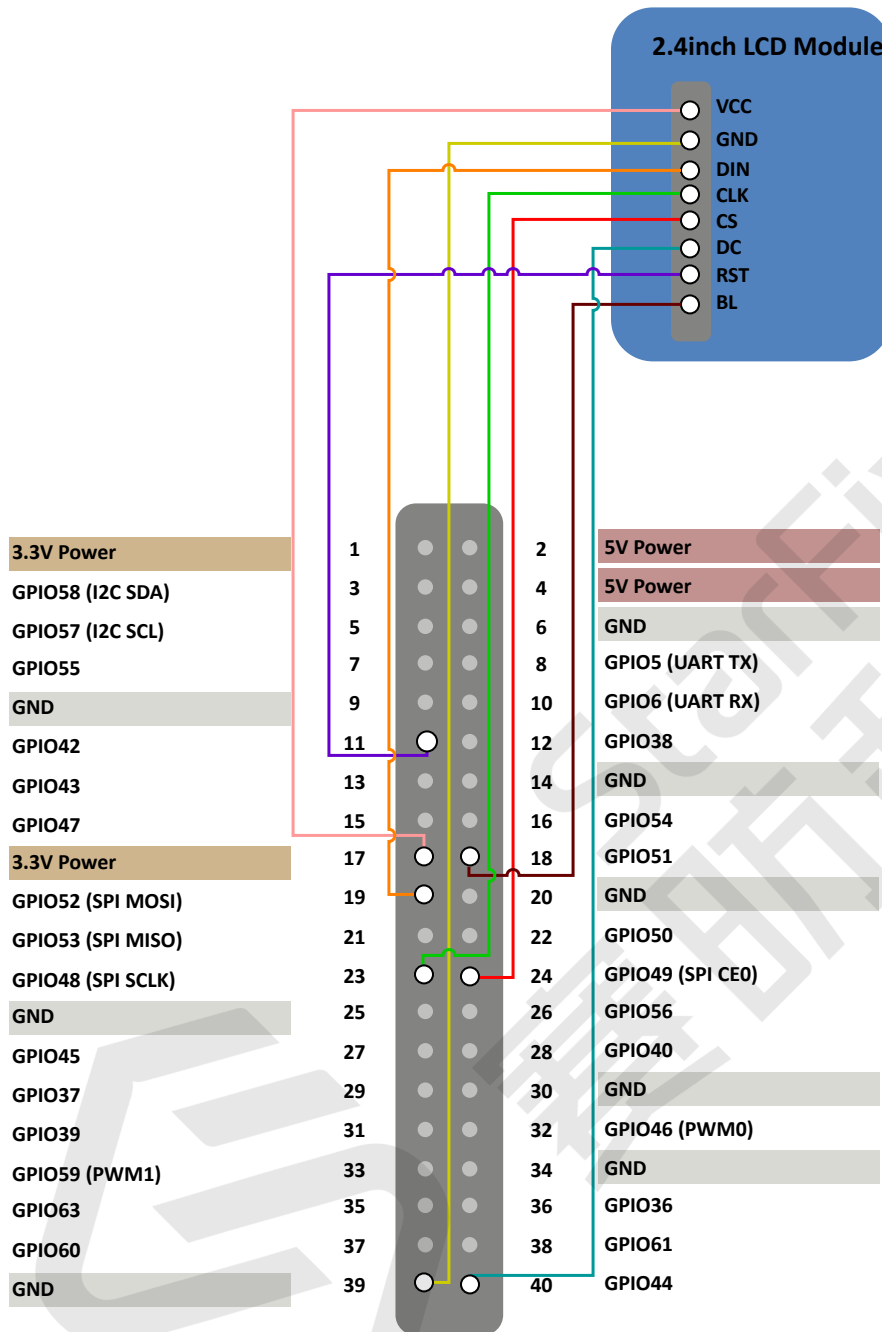
2.2.1. Hardware Setup

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	GPIO52 (SPI MOSI)
CLK	23	GPIO48 (SPI SCLK)
CS	24	GPIO49 (SPI CE0)
DC	40	GPIO44
RST	11	GPIO42
BL	18	GPIO51

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



2.3. Preparing Software

Make sure the following procedures are performed:



Note:

The python project, `VisionFive.gpio`, is applicable for VisionFive, VisionFive 2 and JH-7110 EVB.

1. Flash Debian OS into a Micro-SD card as described in the *Flashing Fedora OS to a Micro-SD Card* section in the [VisionFive 2 Single Board Computer Quick Start Guide](#).
2. Log into the Debian and make sure VisionFive 2 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 2 Single Board Computer Quick Start Guide](#).
3. Extend the partition on Debian as described in *Extend Partition* in the [VisionFive 2 Single Board Computer Quick Start Guide](#).
4. Execute the following command to install PIP on Debian:

```
apt-get install python3-pip
```

5. Execute the pip command on VisionFive 2 Debian to install the `VisionFive.gpio` package:

**Note:**

Due to the fact that `pypi.org` official website does not yet support uploading `whl` installation packages for the RISC-V platform, so it cannot directly execute `pip install VisionFive.gpio` command to install online.

Please follow the steps below to install the `VisionFive.gpio` package.

- a. Execute the following command to install dependent package:

```
apt install libxml2-dev libxslt-dev
python3 -m pip install requests wget bs4
```

- b. Execute the following command to run the installation script `Install_VisionFive_gpio.py`:

```
python3 Install_VisionFive_gpio.py
```

The installation script codes are as follows:

```
import requests
import wget
import sys
import os
from bs4 import BeautifulSoup

def parse_data(link_addr, class_type, key_str):
    req = requests.get(url=link_addr)
    req.encoding = "utf-8"
    html=req.text
    soup = BeautifulSoup(req.text,features="html.parser")
    package_version = soup.find(class_type,class_=key_str)
    dd = package_version.text.strip()
    data = dd.split()
    return data
```



```

def parse_link(link_addr, class_type, key_str):
    req = requests.get(url=link_addr)
    req.encoding = "utf-8"
    html=req.text
    soup = BeautifulSoup(req.text,features="html.parser")
    search_data = soup.find(class_type,class_=key_str)
    search_data_2 = search_data.find("a")
    dl_link_get = search_data_2.get("href")
    return dl_link_get

def get_dl_addr_page():
    link_address
    = "https://pypi.org/project/VisionFive.gpio/#history"
    key_str = "release__version"
    class_key = "p"
    data_get = parse_data(link_address, class_key, key_str)
    latest_version = data_get[0]

    dl_addr_page
    = "https://pypi.org/project/VisionFive.gpio/{}/#files".format(latest_version)

    return dl_addr_page

def get_dl_addr_of_latest_version(link_addr):
    key_str = "card file__card"
    class_key = "div"
    addr_get = parse_link(link_addr, class_key, key_str)

    return addr_get

def main():
    dl_addr_p = get_dl_addr_page()
    whl_dl_addr = get_dl_addr_of_latest_version(dl_addr_p)

    whl_name = whl_dl_addr.split("/")[-1]
    whl_name_suffix = os.path.splitext(whl_name)[-1]
    whl_name_prefix = os.path.splitext(whl_name)[0]
    whl_name_prefix_no_platform = whl_name_prefix[0:
len(whl_name_prefix) - 3]
    new_platform = "linux_riscv64"

    rename_whl_name
    = "{}{}{}".format(whl_name_prefix_no_platform,
new_platform, whl_name_suffix)

    wget.download(whl_dl_addr, out=rename_whl_name)

    os.system("pip install " + rename_whl_name)

```



```
os.system("rm -rf " + rename_whl_name)

if __name__ == '__main__':
    sys.exit(main())
```

3. Running Demo Code

To run the demo code, perform the following on VisionFive 2 Debian:

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

- a. Execute the following command to install dependency:

```
pip install pillow
```

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

```
pip show VisionFive.gpio
```

Result:

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



Note:

The actual output depends on how the application is installed.

- c. 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
```

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

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

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

```
cd ./lccdemo/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 purposes only.

2.4inch_LCD_demo.py:

```
#!/usr/bin/python
"""
Please make sure the 2.4inch LCD Moudle 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          GPIO44
RST                      11          GPIO42
BL                       18          GPIO51
-----
"""

import os
import sys
import time
import logging
from PIL import Image

sys.path.append("..")

import VisionFive.boardtype as board_t
from lib import LCD2inch4_lib

"""
Demo modification ans 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-----")

# Determining cpu Type: 1 means visionfive1; 2 means visionfive 2
vf_t = board_t.boardtype()
if vf_t == 1:
    SPI_DEVICE = "/dev/spidev0.0"
elif vf_t == 2:
    SPI_DEVICE = "/dev/spidev1.0"
else:
    print("This module can only be run on a VisionFive board!")
    return 0

"""The initialization settings of 2inch and 2.4inch are distinguished"""
disp = LCD2inch4_lib.LCD_2inch4(11, 40, SPI_DEVICE)
# disp.lcd_init()
disp.lcd_init_2inch4()

disp.lcd_clear(WHITE)

if vf_t == 1:
    image = Image.open("./visionfive.bmp")
elif vf_t == 2:
    image = Image.open("./visionfive2.png")
else:
    return

disp.lcd_ShowImage(image, 0, 0)
time.sleep(2)

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

        """rotate the picture 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)
        time.sleep(0.5)

        image = Image.open("./LCD_2inch.jpg")
        disp.lcd_ShowImage(image, 0, 0)
        time.sleep(0.5)

        if vf_t == 1:
            image = Image.open("./visionfive.bmp")
        elif vf_t == 2:

```

```

        image = Image.open("./visionfive2.png")
    else:
        return
    disp lcd_ShowImage(image, 0, 0)
    time.sleep(0.5)

    except KeyboardInterrupt:
        break

    print("Exit demo!")

if __name__ ==

```

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):
        gpio.setmode(gpio.BOARD)

        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(5000000, 0, 8)
        spi.setmode(400000000, 0, 8)
        gpio.setup(self.rstpin, gpio.OUT)
        gpio.setup(self.dcpin, gpio.OUT)

    def __del__(self):
        spi.freedevice()

        """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 2.4inch LCD module"""

def lcd_init_2inch4(self):
    self.lcd_reset()

    self.lcd_sendcmd(0x11) # sleep out

    self.lcd_sendcmd(0xCF) # Ppower 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) # 3Gamma 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)

"""modify the original single byte write to multi byte write"""
# for i in range(0, len(_buffer)):
#     self.lcd_spisend(_buffer[i])
self.lcd_sendnbytes(_buffer)

def lcd_ShowImage(self, Image, Xstart, Ystart):
    """Set buffer to value of Python Imaging Library image."""
    """Write display buffer to 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)
        # RGB888 >> RGB565
        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)

        """modify the original single byte write to multi byte write"""
        # for i in range(0, len(pix), 1):
        #     self.lcd_spisend(pix[i])
        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)

"""modify the original single byte write to multi byte write"""
# for i in range(0, len(pix)):
#     self lcd_spisend(pix[i])
self lcd_sendnbytes(pix)
```

5. Resources

Click on this tab to find all SBC relevant resources.

StarFive provides the following resources to guide you through an extraordinary experience on using the VisionFive 2 SBC.

- [RVspace Wiki](#)
- [Application Center](#)
- [Documentation Center](#)
- [Technical Forum](#)
- [VisionFive 2 GitHub Repository](#)
- [VisionFive 2 Debian OS Download](#)
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6. Buy Now

Click on this tab to find all the online shops and compatible accessories.

Buy SBC

Use the following page to find your nearest sales channel or the global channels for purchasing a VisionFive 2 Single Board Computer (SBC).

- [Buy VisionFive 2](#)

Buy Parts

Use the following page to find the parts that are tested as compatible with VisionFive 2.

- [Buy Accessory](#)