VisionFive 2 40-Pin GPIO Header User Guide

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PROPRIETARY NOTICE

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Preface

About this guide and technical support information.

About this document

This document is intended to:

- introduce the 40-pin header.
- provide instructions to configure and debug GPIO, I2C, SPI, PWM, and UART.
- provide peripheral examples to use the 40-pin GPIO header.

Revision History

Table 0-1 Revision History

Version	Released	Revision
1.0	2022/12/21	The first official release.
1.1	2022/12/27	Updated GitHub Repository *(on page 11)*.
1.2	2023/03/15	Updated steps in: • Method 1: Directly Replacing DTB File *(on page 12)* • Method 2: Adding Startup Item *(on page 13)*
1.3	2023/03/31	Updated figure in Hardware Setup *(on page 28)*.

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. Overview

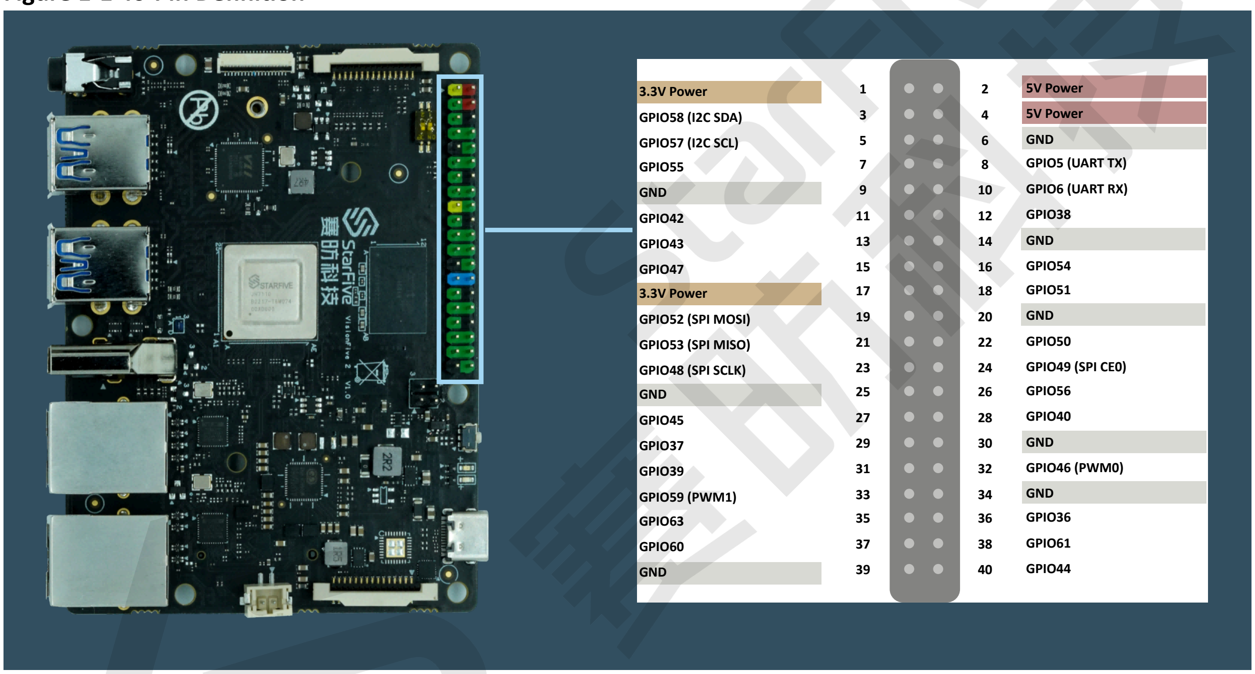
The 40-pin header allows VisionFive 2 single board computers to interface with a variety of external components, which enables developers to create their projects. This document is intended to:

- introduce the 40-pin header as described in this chapter.
- provide instructions to configure and debug GPIO, I2C, SPI, PWM, and UART, as described in GPIO Operations *(on page 15)*, I2C Operations *(on page 16)*, SPI Operations *(on page 20)*, PWM Operations *(on page 25)*, and UART Operations *(on page 27)* chapters.
- provide peripheral examples to use the 40-pin header, as described in the Peripheral Examples *(on page 33)* chapter.

1.1. 40-Pin Header Definition

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

Figure 1-1 40-Pin Definition



2. GPIO Pinout

The following table describes the GPIO pinout, the map, and the explanation of what each pin can do.

Table 2-1 GPIO Assignments

Sys	dts	GPIO Num	Pin Name	Pin Num	Pin Num	Pin Name	GPIO Num	dts	Sys
		N/A	+3.3V	1	2	+5V	N/A		
i2c-0	i2c0	58	GPIO58 (I2C SDA)	3	4	+5V	N/A		
i2c-0	i2c0	57	GPIO57 (I2C SCL)	5	6	GND	N/A		
55		55	GPIO55	7	8	GPIO5 (UART TX)	5	uart0	ttyS0
		N/A	GND	9	10	GPIO6 (UART RX)	6	uart0	ttyS0
42		42	GPIO42	11	12	GPIO38	38		38
43		43	GPIO43	13	14	GND	N/A		
47		47	GPIO47	15	16	GPIO54	54		54
		N/A	+3.3V	17	18	GPIO51	51		51
spidev1.0	spi0	52	GPIO52 (SPI MOSI)	19	20	GND	N/A		
spidev1.0	spi0	53	GPIO53 (SPI MISO)	21	22	GPIO50	50		50
spidev1.0	spi0	48	GPIO48 (SPI SCLK)	23	24	GPIO49 (SPI CE0)	49	spi0	spidev1.0
		N/A	GND	25	26	GPIO56	56		56
45		45	GPIO45	27	28	GPIO40	40		40
37		37	GPIO37	29	30	GND	N/A		
39		39	GPIO39	31	32	GPIO46 (PWM0)	49		pwm0
pwm1		59	GPIO59 (PWM1)	33	34	GND	N/A		
63		63	GPIO63	35	36	GPIO36	36		36
60		60	GPIO60	37	38	GPIO61	61		61
		N/A	GND	39	40	GPIO44	44		44

Note:

- The *dts* column shows the name of the node in the DTSI file (`jh7110-visionfive-v2.dtsi`). You can find the associated node by simply searching the name.
- The *Sys* column shows the pin number used when exporting the GPIO pin under the `/sys/class/gpio`.

3. Preparation

Before configuring and debugging the GPIOs, you need to prepare the follows:

3.1. Preparing Hardware

The following table describes hardware items to be prepared if you want to configure, debug, and test this 40-pin header by following this guide:

Table 3-1 Hardware Preparation

Type	M/O*	Item	Notes
General	M	VisionFive 2 single board computer	-
General	M	• 32 GB (or more) micro-SD card • micro-SD card reader • Computer (Windows/macOS/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.
GPIO	O	An oscilloscope	The oscilloscope is used to verify the GPIO voltage.
I2C	O	• Sense Hat (B) • Dupont Line	-
SPI	O	• ADXL345 Module • Dupont Line	-
PWM	O	An oscilloscope	The oscilloscope is used to measure the corresponding pin and check the PWM period and duty cycle.
SPI LCD	O	• 2.4inch LCD Module • Dupont Line	-
UART	O	• GNSS HAT • Dupont Line	This is a GNSS HAT based on MAX-7Q, which supports positioning systems including GPS, GLONASS, QZSS, and SBAS. It features accurate and fast positioning with minor drifting, low power consumption, outstanding ability for anti-spoofing and anti-jamming, and so on. For detailed specifications, refer to MAX-7Q GNSS HAT.

3.2. Preparing Software

Before configuring the 40-pin header, the Debian OS needs to be flashed into the Micro-SD card, and the DTB files need to be compiled and replaced. The following procedures are provided:

3.2.1. GitHub Repository

The following table describes the GitHub Repository addresses:

Note:
Make sure you have switched to the corresponding branch.

Table 3-2 GitHub Repository Addresses

Type	Repository	Branch
Linux	Linux	JH7110_VisionFive2_devel
DTS Files under Linux Repository	• jh7110.dtsi • jh7110-visionfive-v2.dts • jh7110-visionfive-v2.dtsi	-
Uboot	Uboot	JH7110_VisionFive2_devel
OpenSBI	OpenSBI	master
Debian	Debian	-

3.2.2. Flashing Debian OS to a Micro-SD Card

Two methods are provided to flash images. One is for Mac/Linux, the other is for Windows. For detailed instructions on flashing Debian OS to a Micro-SD card, refer to *Flashing OS to a Micro-SD Card* section in *VisionFive 2 Single Board Computer Quick Start Guide*.

3.2.3. Generating DTB

To compile the device tree sources (.dtsi files) into device tree blobs (.dtb files) using the device tree compiler (DTC), execute the following command under the root directory of Linux:

```
make <Configuration_File> ARCH=riscv CROSS_COMPILE=riscv64-linux-gnu-
make CROSS_COMPILE=riscv64-linux-gnu- ARCH=riscv dtbs
```

Tip:

To install **crossbuild-essential-riscv64** package, execute the following command:

```
sudo apt-get install crossbuild-essential-riscv64
```

Tip:

<Configuration_File>: Both `starfive_jh7110_defconfig` and `starfive_visionfive2_defconfig` are applicable.

The following is the example command:

```
make starfive_jh7110_defconfig ARCH=riscv CROSS_COMPILE=riscv64-linux-gnu-
make CROSS_COMPILE=riscv64-linux-gnu- ARCH=riscv dtbs
```

Different boards use different dtb files:

- `jh7110-visionfive-v2.dtb`: for version 1.2A and 1.3B board.
- `jh7110-visionfive-v2-ac108.dtb`: for version 1.2A and 1.3B board with ac108 codec.
- `jh7110-visionfive-v2-wm8960.dtb`: for version 1.2A and 1.3B board with wm8960 codec.

Tip:
You can refer to the silk print on the board for the version information.

3.2.4. Replacing DTB

Two methods are provided for replacing DTB files:

- Method 1: Directly Replacing DTB File *(on page 12)*
- Method 2: Adding Startup Item *(on page 13)*

3.2.4.1. Method 1: Directly Replacing DTB File

Prerequisite

Make sure you have executed the steps in Generating DTB *(on page 11)*.

Execute the following steps under the root directory of Linux to replace the DTB file:

1. Insert the micro-SD card to the PC with Ubuntu system, and execute the following command to check the SD card partition:

   ```
   sudo fdisk -l
   ```

   Example Output:

   ```
   Device       Start     End Sectors  Size Type
   /dev/sdc1     4096    8191    4096    2M unknown
   /dev/sdc2     8192   16383    8192    4M unknown
   /dev/sdc3    16384  221183  204800  100M EFI System
   /dev/sdc4   221184 4503518 4282335    2G Linux filesystem
   ```

   In this output, the `/dev/sdc3` partition is the SD card partition.

2. Mount the SD card partition under the `mnt` file path by executing:

   ```
   sudo mount /dev/sdc3 /mnt
   ```

3. Execute the following commands under the Linux root directory:

   ```
   sudo cp arch/riscv/boot/dts/starfive/<DTB_File> /mnt/dtbs/starfive
   ```

   Tip:

   Different boards use different dtb files:

   - `jh7110-visionfive-v2.dtb`: for version 1.2A and 1.3B board.
   - `jh7110-visionfive-v2-ac108.dtb`: for version 1.2A and 1.3B board with ac108 codec.
   - `jh7110-visionfive-v2-wm8960.dtb`: for version 1.2A and 1.3B board with wm8960 codec.

   Tip:
   You can refer to the silk print on the board for the version information.

   Example Command:

   ```
   sudo cp arch/riscv/boot/dts/starfive/jh7110-visionfive-v2.dtb /mnt/dtbs/starfive
   ```

4. Enter `/mnt` and modify the configuration file (`uEnv.txt`) by executing:

```
cd /mnt
sudo vim uEnv.txt
fdtfile=starfive/<DTB_File>
```

Example Command:

```
cd /mnt
sudo vim uEnv.txt
fdtfile=starfive/jh7110-visionfive-v2.dtb
```

Figure 3-1 Example

```
fdt_high=0xffffffffffffffff
initrd_high=0xffffffffffffffff
kernel_addr_r=0x44000000
kernel_comp_addr_r=0x90000000
kernel_comp_size=0x10000000
fdt_addr_r=0x48000000
ramdisk_addr_r=0x48100000
# Move distro to first boot to speed up booting
boot_targets=distro mmc0 dhcp
# Fix wrong fdtfile name
fdtfile=starfive/jh7110-visionfive-v2.dtb
# Fix missing bootcmd
bootcmd=run load_distro_uenv;run bootcmd_distro
```

5. Unmount the `/mnt` directory:

```
sudo umount /mnt
```

6. Remove the micro-SD card from PC and insert it into VisionFive 2, and power on VisionFive 2.

Note:
You can also replace the DTB file by performing the following steps:

1. Directly copy the DTB file to the `/boot/dtbs/starfive` directory under the Debian system using a USB drive or through SCP
2. Modify the configuration file `uEnv.txt`. See Step 4 *(on page 13)*.

3.2.4.2. Method 2: Adding Startup Item

Prerequisite

Make sure you have executed the steps in Generating DTB *(on page 11)*.

Perform the following steps to replace the DTB file by adding startup item:

1. Insert the micro-SD card to the PC with Ubuntu system, and execute the following command to check the SD card partition:

```
sudo fdisk -l
```

Example Output:

```
Device       Start     End Sectors  Size Type
/dev/sdc1     4096    8191    4096    2M unknown
/dev/sdc2     8192   16383    8192    4M unknown
/dev/sdc3    16384  221183  204800  100M EFI System
```

```
/dev/sdc4  221184 4503518 4282335    2G Linux filesystem
```

In this output, the `/dev/sdc3` partition is the SD card partition.

2. Mount the SD card partition under the `mnt` file path by executing:

```
sudo mount /dev/sdc3 /mnt
```

3. Execute the following commands under the Linux root directory:

```
sudo cp arch/riscv/boot/dts/starfive/<DTB_File> /mnt/dtbs/starfive
sudo umount /mnt
```

Tip:

Different boards use different dtb files:

- `jh7110-visionfive-v2.dtb`: for version 1.2A and 1.3B board.
- `jh7110-visionfive-v2-ac108.dtb`: for version 1.2A and 1.3B board with ac108 codec.
- `jh7110-visionfive-v2-wm8960.dtb`: for version 1.2A and 1.3B board with wm8960 codec.

Tip:
You can refer to the silk print on the board for the version information.

Example Command:

```
sudo cp arch/riscv/boot/dts/starfive/jh7110-visionfive-v2.dtb /mnt/dtbs/starfive
```

4. Open `extlinux.conf` by executing:

```
sudo vim /mnt/extlinux/extlinux.conf
```

5. Added the following lines, save and exit:

```
label l1
 menu label Debian GNU/Linux bookworm/sid 5.15.0-starfive (customized)
 linux /vmlinuz-5.15.0-starfive
 initrd /initrd.img-5.15.0-starfive
 fdt /dtbs/starfive/<DTB_File>
 append  root=/dev/mmcblk1p4 rw console=tty0 console=ttyS0,115200 earlycon rootwait
 stmmaceth=chain_mode:1 selinux=0

label l1r
 menu label Debian GNU/Linux bookworm/sid 5.15.0-starfive (customized)(rescue target)
 linux /vmlinuz-5.15.0-starfive
 initrd /initrd.img-5.15.0-starfive
 fdt /dtbs/starfive/<DTB_File>
 append  root=/dev/mmcblk1p4 rw console=tty0 console=ttyS0,115200 earlycon rootwait
 stmmaceth=chain_mode:1 selinux=0 single
```

6. Remove the micro-SD card from PC and insert it into VisionFive 2, and power on VisionFive 2.
7. You will see the customized menu item, for example, **Debian GNU/Linux bookworm/sid 5.15.0-starfive (customized)**, in the U-Boot startup menu. Select this item.

4. GPIO Operations

This section provides commands to configure GPIO:

4.1. Configuring GPIO

1. To configure GPIO, perform the following:

   Execute the following command to configure GPIO44:

   ```
   cd /sys/class/gpio
   echo 44 > export
   ```

2. Locate to the GPIO44 directory:

   ```
   cd gpio44
   ```

   Note:
   In this command, `44` represents the Sys number of the pin. For more information, see GPIO Pinout *(on page 9)*.

3. Configure the direction of GPIO44 as in:

   ```
   echo in > direction
   ```

4. Alternatively, configure the direction of GPIO44 as out:

   ```
   echo out > direction
   ```

5. Configure the voltage level of GPIO44 as high:

   ```
   echo 1 > value
   ```

   Tip:
   You can use an oscilloscope to check the voltage level.

6. Configure the voltage level of GPIO44 as low:

   ```
   echo 0 > value
   ```

   Tip:
   You can use an oscilloscope to check the voltage level.

7. Connect the **3.3V Power** pin with the GPIO44, and check the voltage level of GPIO44:

   ```
   cat value
   ```

8. Connect the **GND** pin with the GPIO44, and check the voltage level of GPIO44:

   ```
   cat value
   ```

5. I2C Operations

This chapter describes how to configure and debug I2C GPIO.

5.1. Configuring I2C GPIO

Perform the following procedures to configure I2C:

- Hardware Setup *(on page 16)*
- Configuring dts File *(on page 17)*

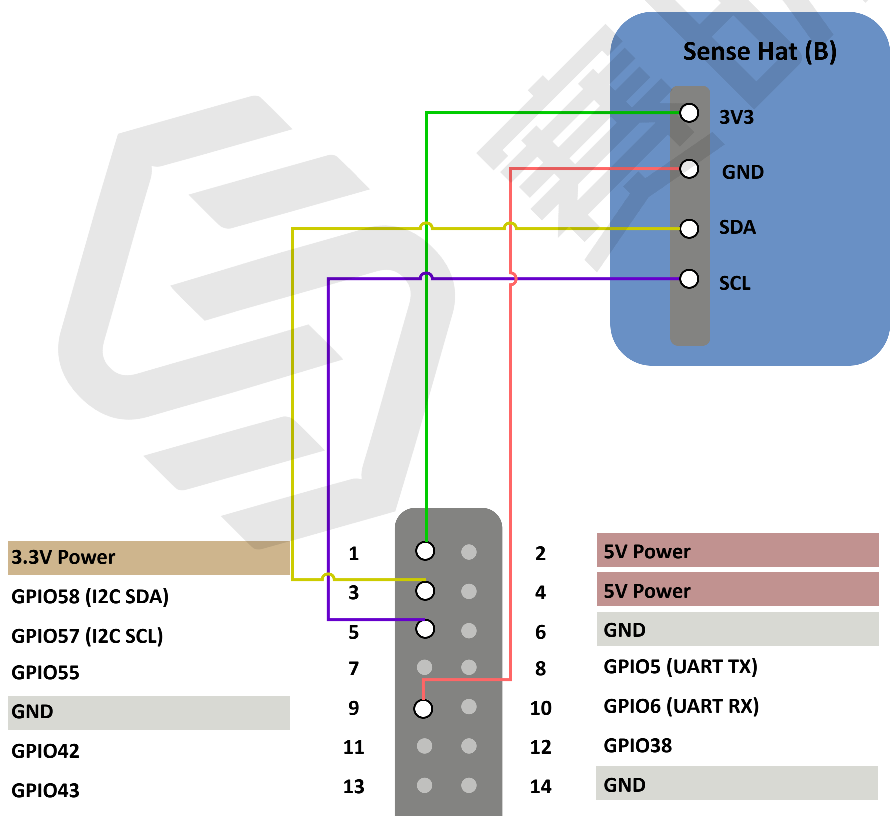
5.1.1. Hardware Setup

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

Table 5-1 Connect Sense Hat (B) to the 40-Pin Header

Sense HAT (B)	40-Pin GPIO Header	
	Pin Number	Pin Name
3V3	1	3.3V Power
GND	9	GND
SDA	3	GPIO58 (I2C SDA)
SCL	5	GPIO57 (I2C SCL)

Figure 5-1 Connect Sense Hat (B) to the 40-Pin GPIO Header



5.1.2. Configuring dts File

7 channels of I2C bus are supported: i2c0 to i2c6.

The DTSI file, `jh7110-visionfive-v2.dtsi`, is under `/linux/arch/riscv/boot/dts/starfive`.

The following is the default setting. You can configure the unoccupied GPIOs as required.

Figure 5-2 Example File Content

```
        i2c0_pins: i2c0-pins {
                i2c0-pins-scl {
                        sf,pins = <PAD_GPIO57>;
                        sf,pinmux = <PAD_GPIO57_FUNC_SEL 0>;
                        sf,pin-ioconfig = <IO(GPIO_IE(1) | (GPIO_PU(1)))>;
                        sf,pin-gpio-dout = <GPO_LOW>;
                        sf,pin-gpio-doen = <OEN_I2C0_IC_CLK_OE>;
                        sf,pin-gpio-din =  <GPI_I2C0_IC_CLK_IN_A>;
                };

                i2c0-pins-sda {
                        sf,pins = <PAD_GPIO58>;
                        sf,pinmux = <PAD_GPIO58_FUNC_SEL 0>;
                        sf,pin-ioconfig = <IO(GPIO_IE(1) | (GPIO_PU(1)))>;
                        sf,pin-gpio-dout = <GPO_LOW>;
                        sf,pin-gpio-doen = <OEN_I2C0_IC_DATA_OE>;
                        sf,pin-gpio-din =  <GPI_I2C0_IC_DATA_IN_A>;
                };
        };
```

Note:

The I2C GPIO pin number is the number indicated in the **Pin Name**. For more details about the GPIO Pin Name, see the GPIO Pinout *(on page 9)* in this document. The pin names of the I2C GPIO are listed as follows:

- GPIO58 (I2C SDA)
- GPIO57 (I2C SCL)

5.2. Debugging I2C GPIO

Perform the following steps to debug I2C:

1. Execute the following command to scan the bus:

```
i2cdetect -l
```

Result:

Figure 5-3 Example Output

```
root@starfive:~# i2cdetect -l
i2c-0   i2c             Synopsys DesignWare I2C adapter         I2C adapter
i2c-2   i2c             Synopsys DesignWare I2C adapter         I2C adapter
i2c-5   i2c             Synopsys DesignWare I2C adapter         I2C adapter
i2c-6   i2c             Synopsys DesignWare I2C adapter         I2C adapter
i2c-7   i2c             Inno HDMI                               I2C adapter
```

2. Execute the following command to detect the device:

```
i2cdetect -y -r 0
```

Tip:

0 is the I2C bus number.

Result:

Figure 5-4 Example Output

```
root@starfive:~# i2cdetect -y -r 0
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:                         -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
20: -- -- -- -- -- -- -- -- -- 29 -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: -- -- -- -- -- -- -- -- 48 -- -- -- -- -- -- --
50: -- -- -- -- -- -- -- -- -- -- -- -- 5c -- -- --
60: -- -- -- -- -- -- -- -- 68 -- -- -- -- -- -- --
70: 70 -- -- -- -- -- -- --
```

In this figure, the detected devices are `0x29`, `0x48`, `0x5c`, `0x68`, and `0x70`.

3. Execute the following command to read register content:

```
i2cget -f -y 0 0x5c 0x0f
```

Tip:

- `0`: I2C bus number
- `0x5c`: I2C device address
- `0x0f`: Memory address

Result:

Figure 5-5 Example Output

```
root@starfive:~# i2cget -f -y 0 0x5c 0x0f
0xb1
```

The register content is **0xb1** in this output.

4. Execute the following command to write register data:

```
i2cset -y 0 0x5c 0x11 0x10
```

Tip:

- `0`: I2C bus number.
- `0x5c`: I2C device address.
- `0x11`: Memory address.
- `0x10`: The content to be written in the register.

5. Execute the following to read all register values:

```
i2cdump -y 0 0x5c
```

Tip:

- `0`: I2C bus number
- `0x5c`: I2C device address

Result:

Figure 5-6 Example Output

```
root@starfive:~# i2cdump -y 0 0x5c
No size specified (using byte-data access)
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f    0123456789abcdef
00: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 b1    ...............?
10: 00 10 00 00 00 00 00 00 00 00 00 00 01 b1 68 6e    .?..........??hn
20: 00 00 00 00 00 00 00 02 71 8f 2f 00 00 00 00 00    .......?q?/.....
30: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00    ................
40: 72 e4 03 20 8a 0f 05 49 00 06 27 7b 8b 11 0b 44    r?? ???I.?'{???D
50: 42 fd 7b 0e 00 71 8f 2f 06 03 15 0a b9 04 80 c0    B?{?.q?/????????
60: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00    ................
70: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00    ................
80: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 b1    ...............?
90: 00 10 00 00 00 00 00 00 00 00 00 00 01 b1 68 6e    .?..........??hn
a0: 00 00 00 00 00 00 00 00 71 8f 2f 00 00 00 00 00    ........q?/.....
b0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00    ................
c0: 72 e4 03 20 8a 0f 05 49 00 06 27 7b 8b 11 0b 44    r?? ???I.?'{???D
d0: 42 fd 7b 0e 00 71 8f 2f 06 03 15 0a b9 04 80 c0    B?{?.q?/????????
e0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00    ................
f0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00    ................
```

6. SPI Operations

This chapter describes how to configure and debug SPI GPIO.

6.1. Configuring SPI GPIO

The DTSI file, `jh7110-visionfive-v2.dtsi`, is under `/linux/arch/riscv/boot/dts/starfive`.

7 channels of SPI bus are supported: spi0 to spi6.

6.1.1. Modify Pins

The configured SPI GPIO number is the number indicated in the Pin Name. For more details about the GPIO Pin Name, see the GPIO Pinout *(on page 9)* in this document. You can configure the unoccupied pins. The following are the default settings in the `jh7110-visionfive-v2.dtsi`:

Figure 6-1 Modify Pins

```
	ssp0_pins: ssp0-pins {
		ssp0-pins_tx {
			sf,pins = <PAD_GPIO52>;
			sf,pinmux = <PAD_GPIO52_FUNC_SEL 0>;
			sf,pin-ioconfig = <IO(GPIO_IE(1))>;
			sf,pin-gpio-dout = <GPO_SPI0_SSPTXD>;
			sf,pin-gpio-doen = <OEN_LOW>;
		};

		ssp0-pins_rx {
			sf,pins = <PAD_GPIO53>;
			sf,pinmux = <PAD_GPIO53_FUNC_SEL 0>;
			sf,pin-ioconfig = <IO(GPIO_IE(1))>;
			sf,pin-gpio-doen = <OEN_HIGH>;
			sf,pin-gpio-din =  <GPI_SPI0_SSPRXD>;
		};

		ssp0-pins_clk {
			sf,pins = <PAD_GPIO48>;
			sf,pinmux = <PAD_GPIO48_FUNC_SEL 0>;
			sf,pin-ioconfig = <IO(GPIO_IE(1))>;
			sf,pin-gpio-dout = <GPO_SPI0_SSPCLKOUT>;
			sf,pin-gpio-doen = <OEN_LOW>;
		};

		ssp0-pins_cs {
			sf,pins = <PAD_GPIO49>;
			sf,pinmux = <PAD_GPIO49_FUNC_SEL 0>;
			sf,pin-ioconfig = <IO(GPIO_IE(1))>;
			sf,pin-gpio-dout = <GPO_SPI0_SSPFSSOUT>;
			sf,pin-gpio-doen = <OEN_LOW>;
		};
	};
```

6.2. Debugging SPI GPIO

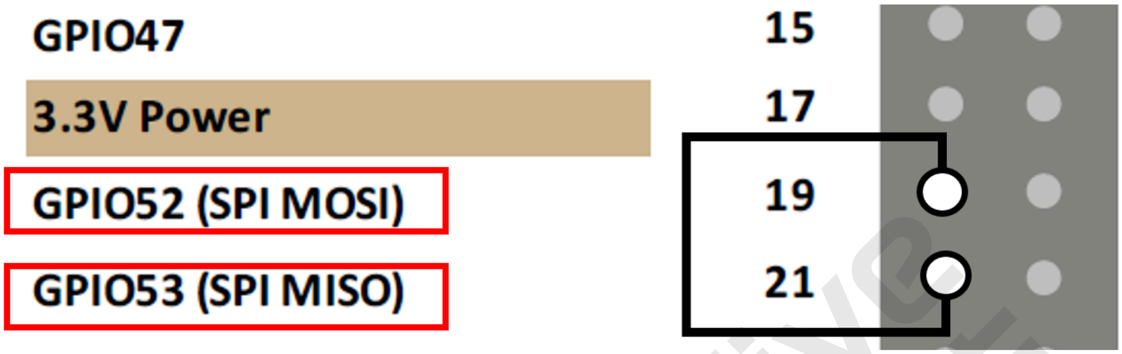
This section provides steps for loopback test and testing SPI with the ADXL345 module.

6.2.1. Loopback Test

The following steps are provided for the loopback test:

1. Wiring: Connect Pin19 with Pin 21 as the following:

   Figure 6-2 Connect Pin 19 with 21

2. Locate to the following path for the test tool, `spidev_test.c`:

   ```
   cd /linux/tools/spi
   ```

3. Execute the following command under the test tool directory:

   ```
   make CROSS_COMPILE=riscv64-linux-gnu- ARCH=riscv
   ```

   Result:

   The output file is `spidev_test` in the same directory.

4. Upload `spidev_test` to VisionFive 2, and change the execution permission by executing the following:

   ```
   chmod +x spidev_test
   ```

5. Confirm the SPI device.

   ```
   ls /dev/spidev*
   ```

   Result:

   Figure 6-3 Example Output

   ```
   root@starfive:~# ls /dev/spi*
   /dev/spidev1.0
   root@starfive:~#
   ```

   In this output, `spidev1.0` is the device name.

6. Execute the following command to perform the test:

   ```
   ./spidev_test -D /dev/spidev1.0 -v -p string_to_send
   ```

   Tip:

   `spidev1.0` is the device name got from the previous step.

   Result:

Figure 6-4 Example Output

```
root@starfive:~/spi# ./spidev_test -D  /dev/spidev1.0 -v -p string_to_send
spi mode: 0x0
bits per word: 8
max speed: 500000 Hz (500 kHz)
TX | 73 74 72 69 6E 67 5F 74 6F 5F 73 65 6E 64 __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __  |string_to_send|
RX | 73 74 72 69 6E 67 5F 74 6F 5F 73 65 6E 64 __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __  |string_to_send|
root@starfive:~/spi#
```

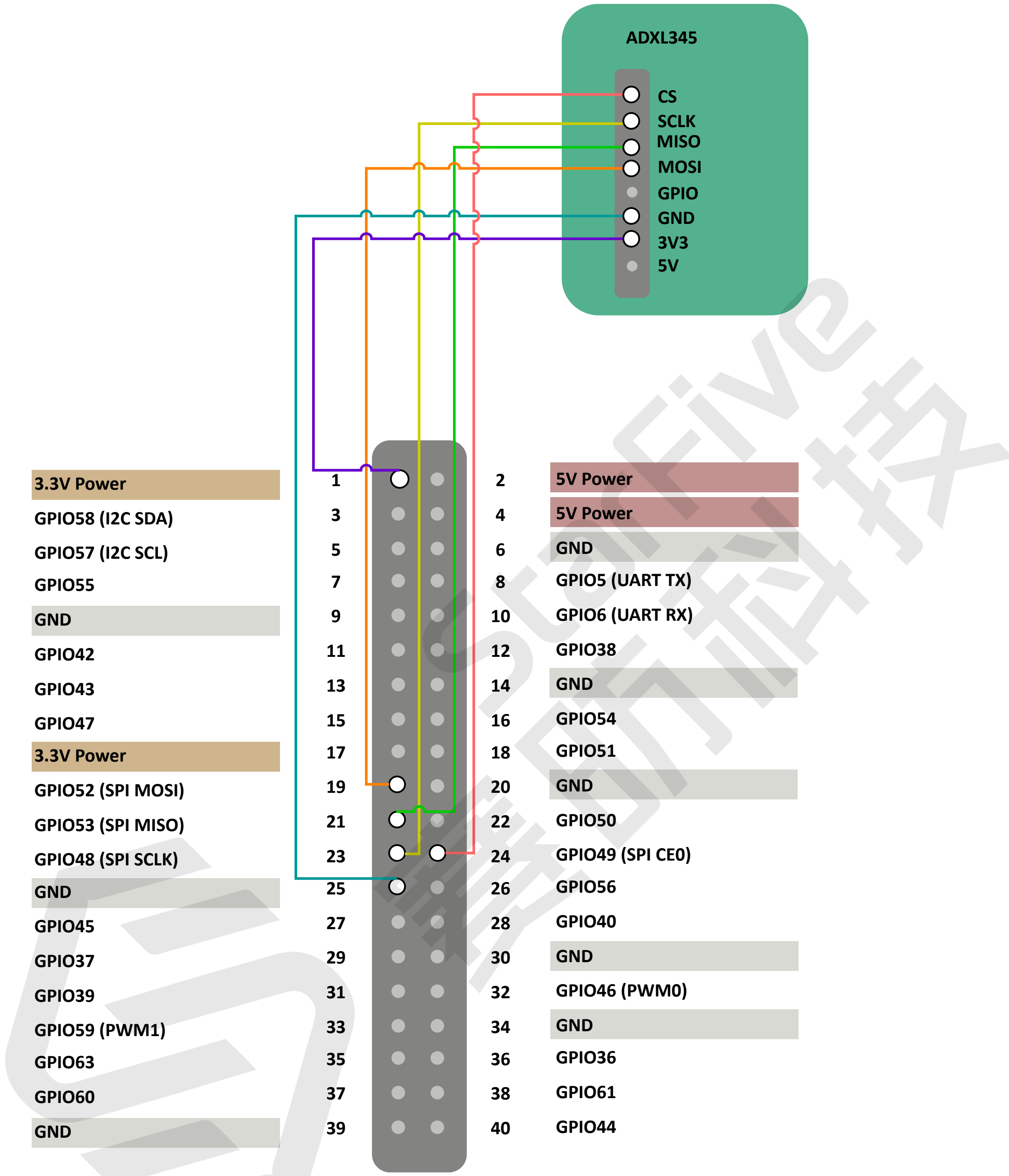
In this figure, the **TX** and **RX** output are the same, which indicates the test is successful.

6.2.2. Testing SPI with ADXL345 Module

Perform the following steps to test SPI with the ADXL345 module:

1. Connect the ADXL345 module to the 40-pin header as the following:

Figure 6-5 Connect ADXL345 Module to the Header



2. Locate to the following path for test tool, `spidev_test.c`:

```
cd /linux/tools/spi
```

3. Execute the following command under the test tool directory:

```
make CROSS_COMPILE=riscv64-linux-gnu- ARCH=riscv
```

Result:

The output file is `spidev_test` in the same directory.

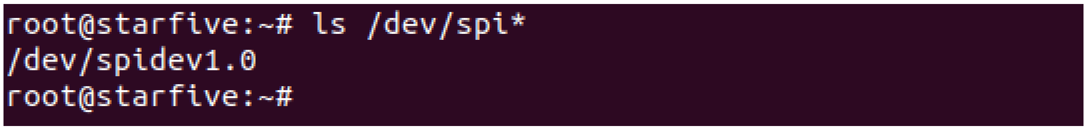
4. Upload `spidev_test` to VisionFive 2, and change the execution permission by executing the following:

```
chmod +x spidev_test
```

5. Confirm the SPI device.

```
ls /dev/spidev*
```

Figure 6-6 Example Output



In this output, `spidev1.0` is the device name.

6. Execute the following to read the device ID:

```
./spidev_test -H -O -D /dev/spidev1.0 -v -p \\x80\\x00
```

7. Execute the following to read the value for multiple registers:

```
./spidev_test -H -O -D /dev/spidev1.0 -v -p \\xec\\x00\\x00\\x00\\x00\\x00\\x00
```

8. Execute the following to read:

```
./spidev_test -H -O -D /dev/spidev1.0 -v -p \\x9e\\x00
```

9. Execute the following to write:

```
./spidev_test -H -O -D /dev/spidev1.0 -v -p \\x1e\\xaa
```

10. Execute the following to read the verification:

```
./spidev_test -H -O -D /dev/spidev1.0 -v -p \\x9e\\x00
```

7. PWM Operations

This chapter describes how to configure and debug PWM GPIO:

7.1. Configuring PWM GPIO

The DTSI file, `jh7110-visionfive-v2.dtsi`, is under `/linux/arch/riscv/boot/dts/starfive`.

8 channels of PWM are supported at the most.

7.1.1. Modify Pin

The following figure shows the example file content to modify the pin:

Figure 7-1 Example File Content

```
        pwm_pins: pwm-pins {
                pwm_ch0-pins {
                        sf,pins = <PAD_GPIO46>;
                        sf,pinmux = <PAD_GPIO46_FUNC_SEL 0>;
                        sf,pin-ioconfig = <IO(GPIO_IE(1))>;
                        sf,pin-gpio-dout = <GPO_PTC0_PWM_0>;
                        sf,pin-gpio-doen = <OEN_PTC0_PWM_0_OE_N>;
                };

                pwm_ch1-pins {
                        sf,pins = <PAD_GPIO59>;
                        sf,pinmux = <PAD_GPIO59_FUNC_SEL 0>;
                        sf,pin-ioconfig = <IO(GPIO_IE(1))>;
                        sf,pin-gpio-dout = <GPO_PTC0_PWM_1>;
                        sf,pin-gpio-doen = <OEN_PTC0_PWM_1_OE_N>;
                };
        };
```

The configured PWM GPIO number is the number contained in the **Pin Name**. For more details about the GPIO Pin Name, see the GPIO Pinout *(on page 9)* in this document.

7.1.2. PWM and Pin Name Mapping

The following table describes the PWM and pin name mapping:

Table 7-1 PWM and Pin Name Mapping

PWM	GPIO (Pin Name)
PWM0	GPIO46
PWM1	GPIO59

7.2. Debugging PWM GPIO

This section describes how to debug PWM GPIO:

1. Execute the following to configure the PWM channel:

```
cd /sys/class/pwm/pwmchip0
echo 0 > export
```

2. Execute the following to configure the PWM period:

```
cd pwm0
echo 5000000 > period
```

3. Execute the following to configure the PWM duty cycle:

```
echo 1000000 > duty_cycle
```

4. Use an oscilloscope to measure the corresponding pin and check the PWM period and duty cycle.

Note:

A duty cycle is the fraction of one period in which a signal or system is active.

8. UART Operations

This chapter describes how to configure and debug UART GPIO:

8.1. Configuring UART GPIO

The DTSI file, `jh7110-visionfive-v2.dtsi`, is under `/linux/arch/riscv/boot/dts/starfive`.

6 channels of UART are supported at the most.

The configured UART GPIO number is the number contained in the **Pin Name**. For more details about the GPIO Pin Name, see the GPIO Pinout *(on page 9)* in this document.

8.1.1. Modifying dts

To modify dts file, perform the following steps:

1. Add aliases of uart1 or uart2 on the aliases node. The following is an example:

Figure 8-1 Example Configuration

```
aliases {
        spi0 = &qspi;
        gpio0 = &gpio;
        ethernet0 = &gmac0;
        ethernet1 = &gmac1;
        mmc0 = &sdio0;
        mmc1 = &sdio1;
        serial0 = &uart0;
        serial1 = &uart1;
        serial2 = &uart2;
        serial3 = &uart3;
```

2. Add uart1 or uart2 node on the dts. The following is an example:

Figure 8-2 Example Configuration

```
&uart0 {
        pinctrl-names = "default";
        pinctrl-0 = <&uart0_pins>;
        status = "okay";
};

&uart1 {
        pinctrl-names = "default";
        pinctrl-0 = <&uart1_pins>;
        status = "okay";
};

&uart2 {
        pinctrl-names = "default";
        pinctrl-0 = <&uart2_pins>;
        status = "okay";
};
```

3. Add uart1_pins or uart2_pins node on the &gpio node:

Note:

The configured UART GPIO number is the number contained in the **Pin Name**. You can configure the unoccupied pins. For more details about the GPIO Pin Name, see the GPIO Pinout *(on page 9)* in this document.

Figure 8-3 Example Configuration

```
&gpio {
        uart0_pins: uart0-pins {
                uart0-pins-tx {
                        starfive,pins = <PAD_GPIO5>;
                        starfive,pin-ioconfig = <IO(GPIO_IE(1) | GPIO_DS(3))>;
                        starfive,pin-gpio-dout = <GPO_UART0_SOUT>;
                        starfive,pin-gpio-doen = <OEN_LOW>;
                };

                uart0-pins-rx {
                        starfive,pins = <PAD_GPIO6>;
                        starfive,pinmux = <PAD_GPIO6_FUNC_SEL 0>;
                        starfive,pin-ioconfig = <IO(GPIO_IE(1) | GPIO_PU(1))>;
                        starfive,pin-gpio-doen = <OEN_HIGH>;
                        starfive,pin-gpio-din =  <GPI_UART0_SIN>;
                };
        };

        uart1_pins: uart1-pins {
                uart1-pins-tx {
                        starfive,pins = <PAD_GPIO63>;
                        starfive,pinmux = <PAD_GPIO63_FUNC_SEL 0>;
                        starfive,pin-ioconfig = <IO(GPIO_IE(1) | GPIO_DS(3))>;
                        starfive,pin-gpio-dout = <GPO_UART1_SOUT>;
                        starfive,pin-gpio-doen = <OEN_LOW>;
                };
```

8.1.1.1. UART and DEV Mapping

The following table describes the UART and DEV mapping:

Table 8-1 UART and DEV Mapping

UART	DEV
UART1	/dev/ttyS1
UART2	/dev/ttyS2

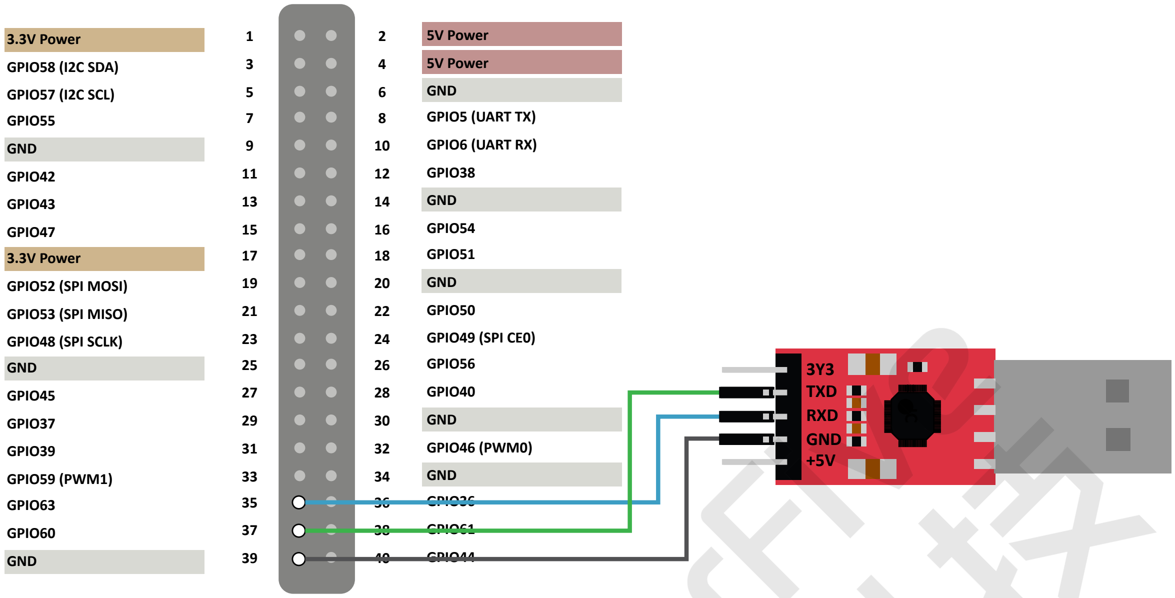
8.2. Debugging UART GPIO

8.2.1. Hardware Setup

To set up the hardware, perform the following steps:

1. Connect the jumper wires from the USB-to-Serial Converter to the 40-Pin GPIO header of the VisionFive 2 as follows.

Figure 8-4 Connect the Converter to the Header



2. Connect the other end of the USB-to-Serial Converter to your device (Windows/Mac/Linux).

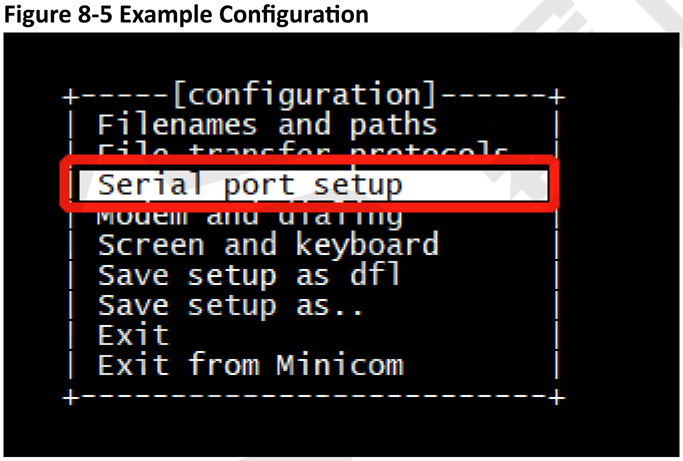
8.2.2. Debugging UART Send and Receive Functions

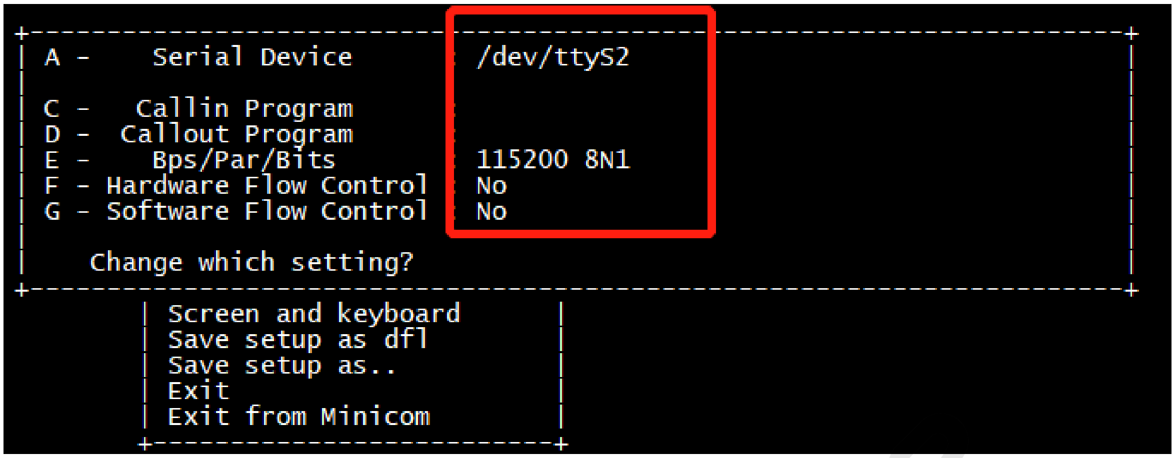
1. Configure VisionFive 2 Minicom:

```
sudo minicom -s
```

2. Select **Serial port setup**, and configure Minicom as follows:

Figure 8-5 Example Configuration

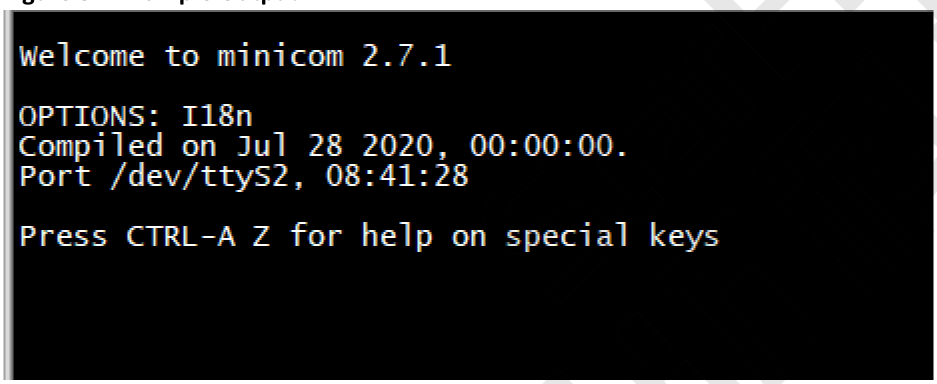




3. Start VisionFive 2 minicom by typing the following command on the PC:

```
minicom -o -D /dev/ttyS1
```

Figure 8-7 Example Output

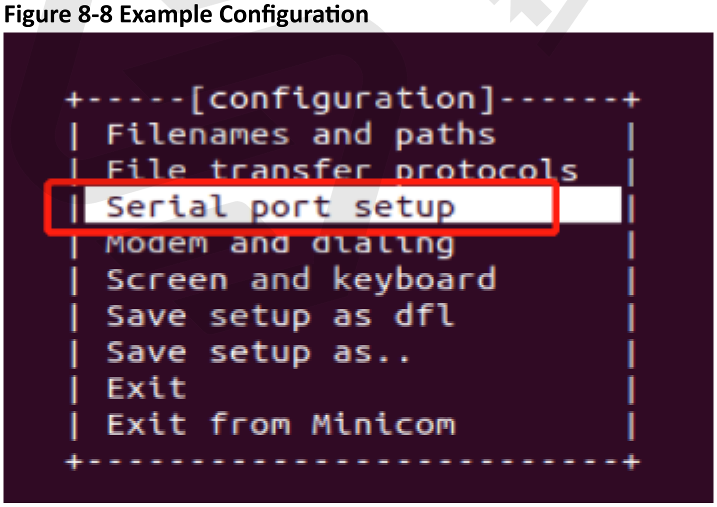


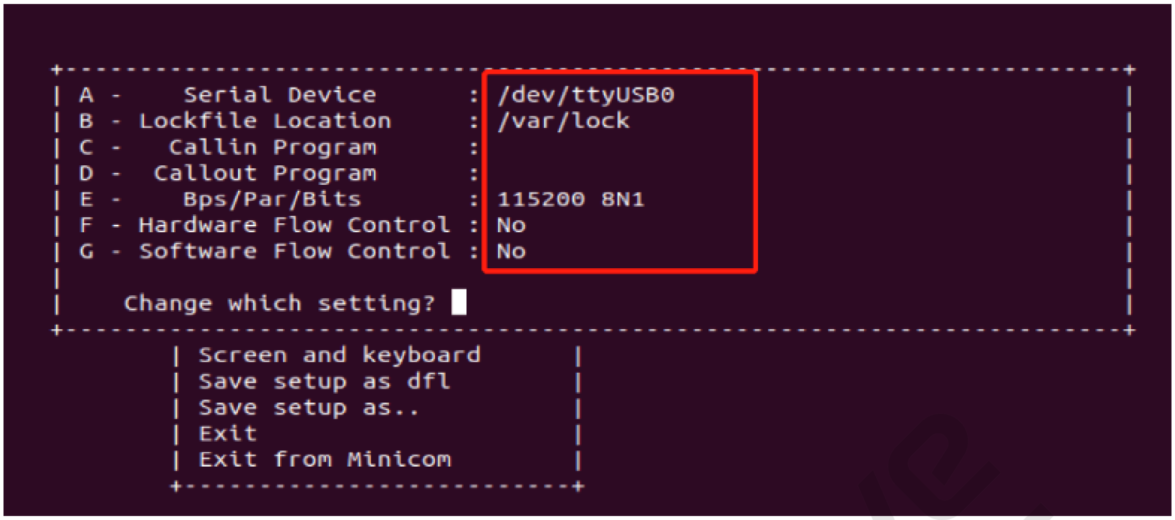
4. Configure Ubuntu minicom by typing the following:

```
sudo minicom -s
```

5. Select **Serial port setup**, and configure minicom as follows:

Figure 8-8 Example Configuration

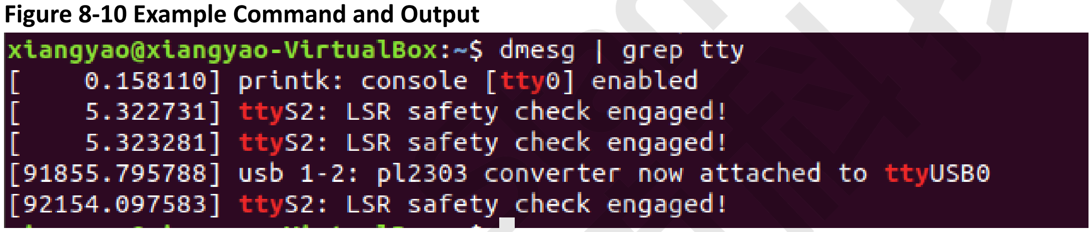




Note:

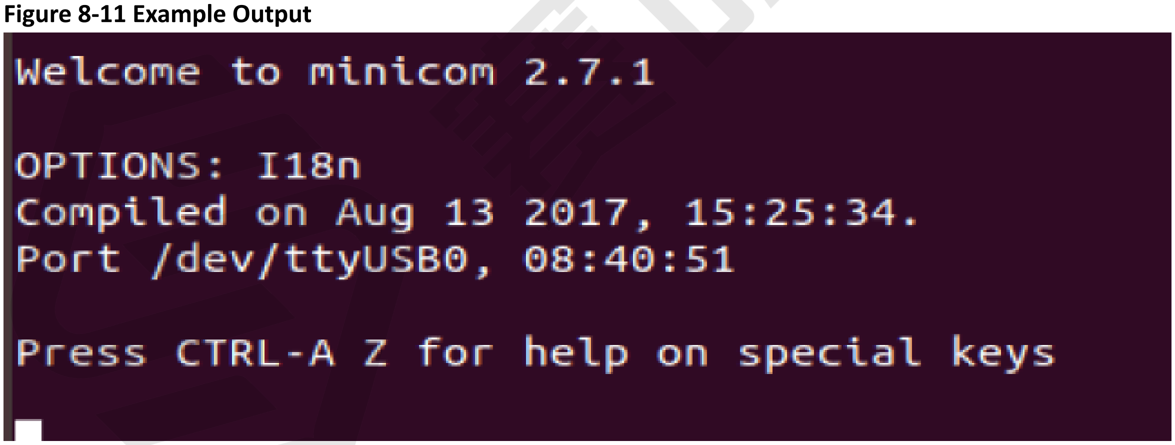
Serial Device can be detected by command `dmesg | grep tty` on Ubuntu

Figure 8-10 Example Command and Output



6. Start Ubuntu minicom, you can see as follows:

Figure 8-11 Example Output



Test UART Send:

7. To test UART send function, you can input characters, such as `hello ubuntu`, on the VisionFive 2 minicom. Then you will see the character are outputted on the Ubuntu minicom as the following:

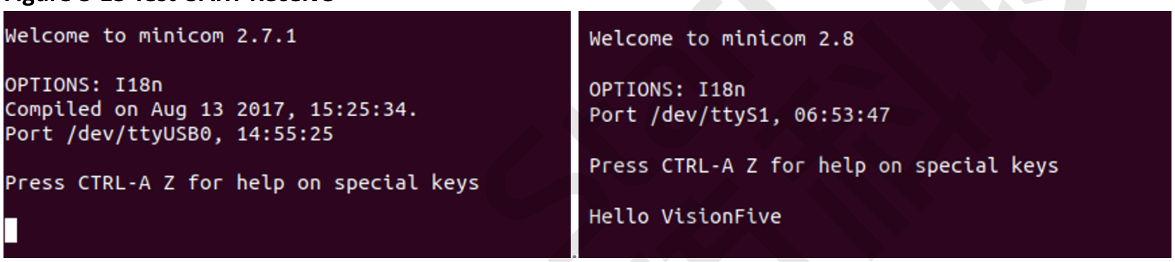
Figure 8-12 Test UART Send

- Figure on the Left: Ubuntu minicom interface
- Figure on the Right: VisionFive 2 minicom interface

Test UART Receive:

8. To test UART receive, you can input characters, such as `hello visionfive` on the Ubuntu minicom. Then you will see the characters are outputted on the VisionFive 2 minicom:

Figure 8-13 Test UART Receive



- Figure on the Left: Ubuntu minicom interface
- Figure on the Right: VisionFive 2 minicom interface

9. Peripheral Examples

In this demo, Sense Hat (B) is used. For the detailed specifications, refer to https://www.waveshare.com/wiki/Sense_HAT_(B).

Note:

The official libraries of BCM2835, Python, and wiringPi are not supported, and we use the system call instead. The examples are required to be modified.

9.1. Sense Hat (B) Example

9.1.1. Hardware Setup

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

Table 9-1 Connect Sense Hat (B) to the 40-Pin Header

Sense HAT (B)	Pin Number
3V3	1
GND	9
SDA	3
SCL	5

Figure 9-1 Connect Sense Hat (B) to the 40-Pin Header

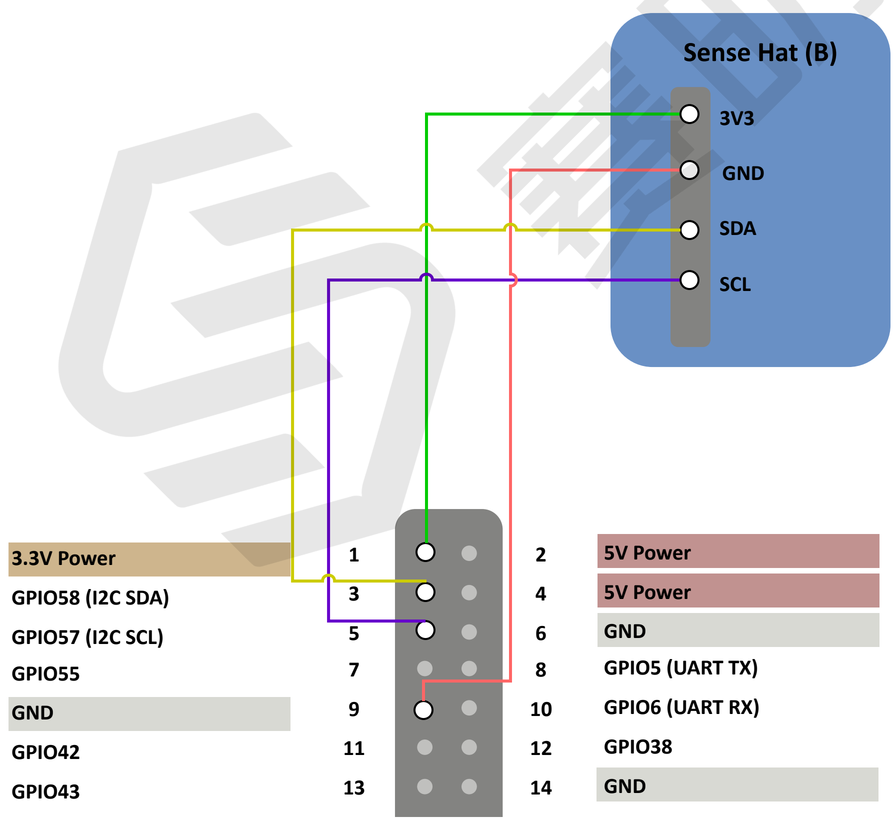
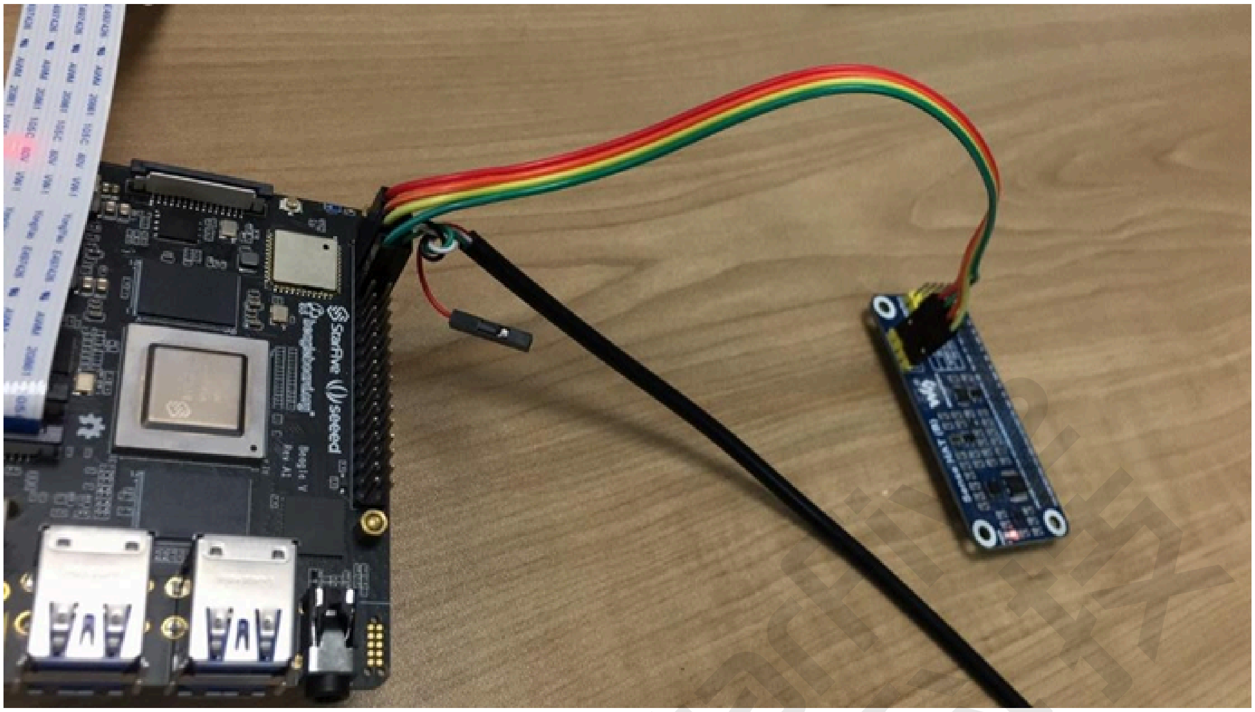


Figure 9-2 Connect Sense Hat (B) to the 40-Pin Header



9.1.2. Running Example with Sense Hat (B)

Take SHTC3 sensor as an example:

1. Download the source code from: SHTC3_dev.c
2. (Optional) Install the tool to compile. The following is an example to install:

   ```
   sudo apt-get install gcc-riscv64-linux-gnu
   ```

   Note:
   This step can be skipped if the tool has been installed.

3. Execute the following to compile:

   ```
   riscv64-linux-gnu-gcc SHTC3_dev.c -o shtc3
   ```

   Result:

   The output file is `shtc3` in the same directory.

4. Copy the executable code from the shtc3 file to the board, and change the execution permission by executing the following command:

   ```
   chmod +x shtc3
   ```

5. Execute the following command to run:

   ```
   ./shtc3
   ```

   Result:

   The following output indicates the execution is successful:

   ```
   root@starfive:~# ./shtc3

   SHTC3 Sensor Test Program ...
   Fopen : /dev/i2c-0
   ```

```
Temperature =  52.20°C , Humidity =  55.32%
Temperature =  23.81°C , Humidity =  55.29%
Temperature =  23.79°C , Humidity =  55.30%
Temperature =  23.82°C , Humidity =  55.29%
Temperature =  23.81°C , Humidity =  55.29%
Temperature =  23.82°C , Humidity =  55.30%
```

9.2. 2.4inch LCD Module Example

A 2.4inch LCD Module is used in this example. For the detailed specifications, refer to the following: https://www.waveshare.com/wiki/2.4inch_LCD_Module.

Note:
The official examples are required to be modified for this demo.

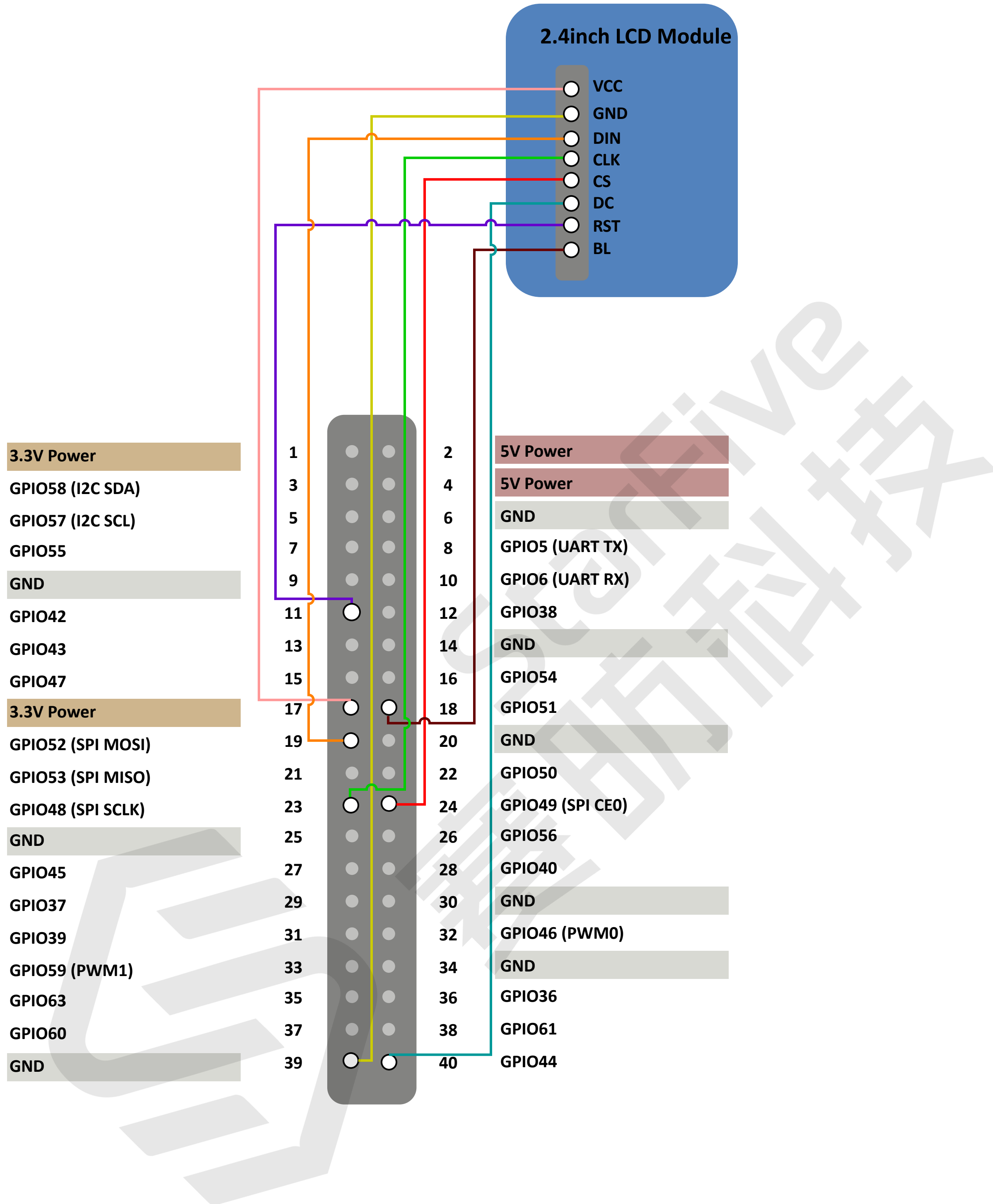
9.2.1. Hardware Setup

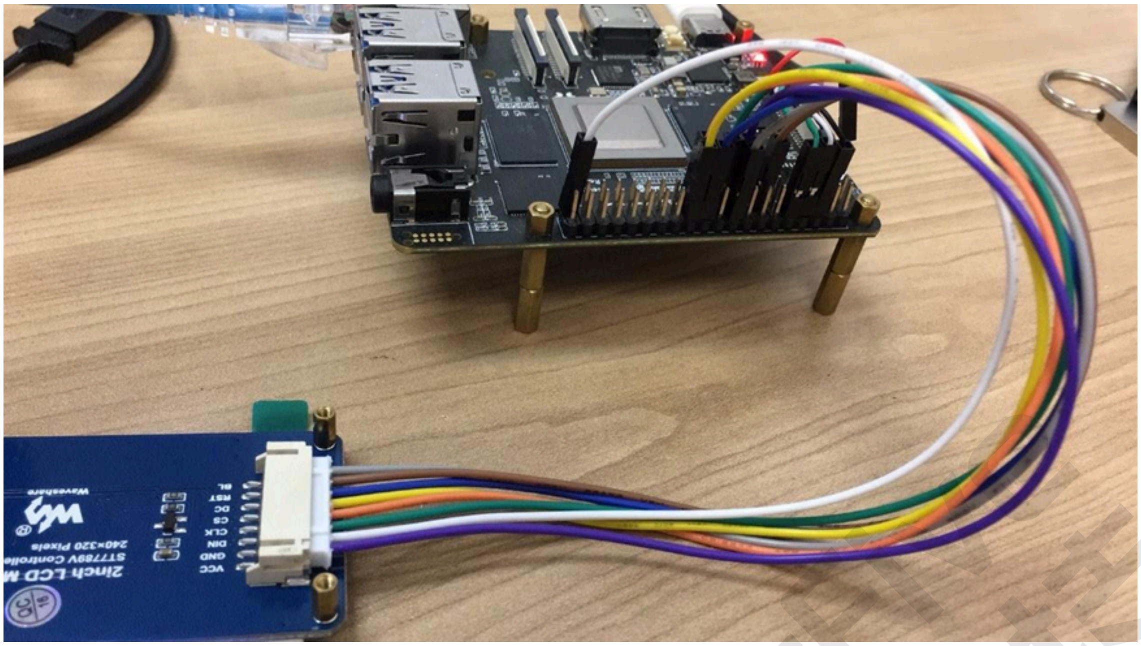
The following table and figure describe how to connect the 2.4inch LCD module with the 40-pin header:

Table 9-2 Connect 2.4inch LCD with 40-pin Header

2.4inch LCD Module	Pin Number
VCC	17
GND	39
DIN	19
CLK	23
CS	24
DC	40
RST	11
BL	18

Figure 9-3 Connect 2.4inch LCD with 40-Pin Header





9.2.2. Executing Example

Perform the following steps to execute the example:

1. Download the source code from LCD Demo.
2. Execute the following command to copy the code to the board. For example, VisionFive 2.

   ```
   tar -xvf LCD_Demo.tar.gz
   cd visionfive2/
   ./main 2.4
   ```

   Result:

   The following two figures will be displayed in turn. One is the photo of VisionFive 2, the other is the official example figure.

   Figure 9-5 Example Output