StarFive 赛昉科技

VisionFive Single Board Computer Software Technical Reference Manual

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Preface

About this guide and technical support information.

About this document

This document mainly describes how to compile firmware, u-boot, Linux Kernel and make file systems.

Revision History

Table 0-1 Revision History

Version	Released	Revision
V1.0	2021-12-08	The first official release.
V1.1	2022-02-17	Updated the command in step 12 in the *Method 1: Using Micro-SD Card* section.

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. Required Hardware

Make sure that the following hardware are prepared for the operation described in this manual:

- VisionFive
- Micro-SD card (16 GB or more)
- PC with Linux OS
- USB to Serial Converter
- Ethernet cable
- Power adapter
- USB Type-C cable

Note:
In this guide, Ubuntu 18.04 LTS is installed on the host PC.

2. Compiling Firmware

Alternatively, if you are interested in compiling bootloader and ddr init from source code, you can follow the guideline in this chapter.

2.1. Preparing Compilation Environment

To prepare a compilation environment, perform the following steps: **Steps:**

1. Visit this link and download the latest version of riscv64-unknown-elf-toolchain-xxx according to your operating system.
2. Unzip the downloaded toolchain by typing the following:

   ```
   tar -xzvf <Toolchain_Name>
   ```

   Tip:
   <Toolchain_Name> refers to the name of the downloaded toolchain in the previous step. For example, `riscv64-unknown-elf-toolchain-10.2.0-2020.12.8-x86_64-linux-ubuntu14.tar.gz`.

3. Open `.bashrc` file by typing the following:

   ```
   gedit ~/.bashrc
   ```

4. Add the following line, save and exit:

   ```
   export PATH=$PATH:<Unzipped_Compiler_Path>/bin
   ```

   Tip:
   <Unzipped_Compiler_Path> refers to the location of the unzipped compiler. For example, `/home/yingpeng/Downloads/riscv64-unknown-elf-toolchain-xxx/`.

   Example:

   ```
   export
    PATH=$PATH:/home/yingpeng/Downloads/riscv64-unknown-elf-toolchain-10.2.0-2020.12.8-x86_64-linux-ubuntu
   14/bin
   ```

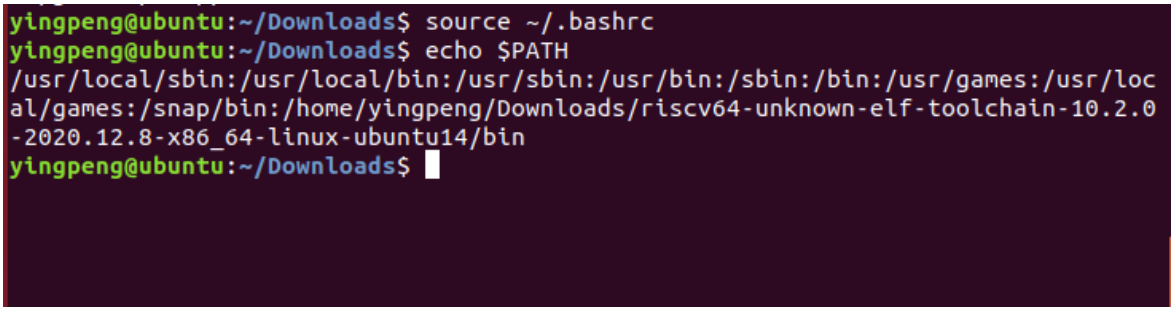
5. Type the following to make the change effective:

   ```
   source ~/.bashrc
   ```

   Command Example and Result:

   The following figure shows an example command and the result:

   Figure 2-1 Example Output

2.2. Compiling Bootloader

To compile Bootloader, perform the following steps:

1. Clone the repo from GitHub.

```
git clone https://github.com/starfive-tech/JH7100_secondBoot.git
```

2. Go into the `build` directory.

```
cd JH7100_secondBoot/build
```

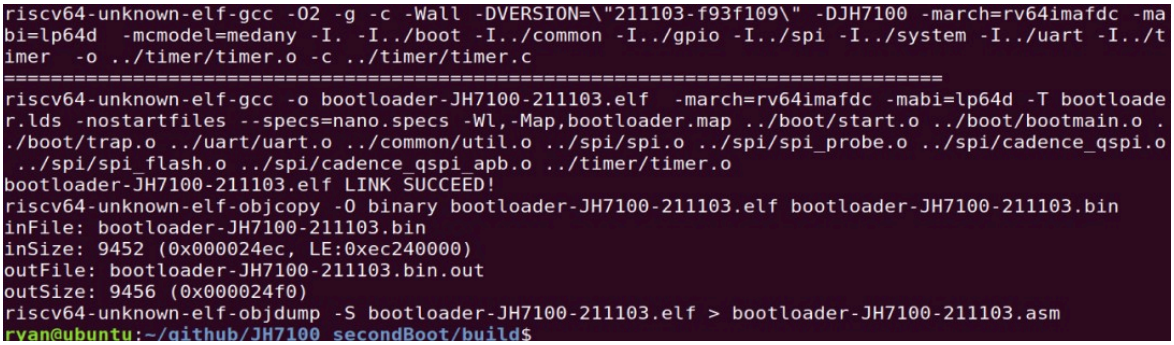
3. Compile bootloader.

```
make
```

Result:

You will see the following output if the compilation is successful.

Figure 2-2 Example Output



2.3. Compiling ddr init

To compile ddr init, perform the following:

1. Clone the repo from GitHub.

```
git clone https://github.com/starfive-tech/JH7100_ddrinit.git
```

2. Go into `build` directory.

```
cd JH7100_ddrinit/build
```

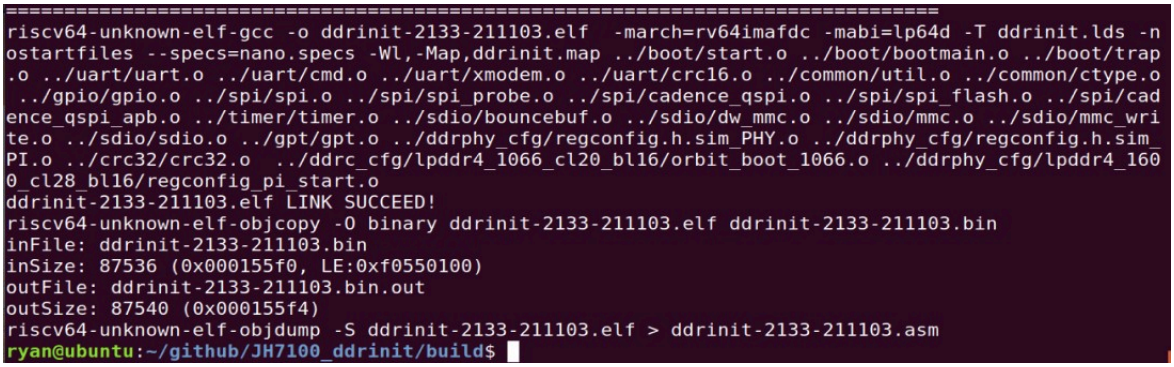
3. Compile ddr init.

```
make
```

Result:

You will see the following output if the compilation is successful.

Figure 2-3 Example Output



Tip:

Refer to *Appendix B: Updating Firmware and u-boot* section in VisionFive Single Board Computer Quick Start Guide to flash bootloader and ddr init.

3. Making General System

This chapter describes how to make general system.

It contains the following sections:

3.1. Compiling U-boot and Kernel

This chapter describes how to compile the u-boot and kernel.

It contains the following sections:

3.1.1. Set Up Compilation Environment

You can follow the steps below to set up your own cross-compile.

1. Install the `riscv64-linux-gnu-gcc` compiler from Ubuntu packages.

   ```
   sudo apt update
   sudo apt upgrade
   sudo apt install gcc-riscv64-linux-gnu
   ```

2. Check the version of the `riscv64-linux-gnu-gcc`.

   ```
   riscv64-linux-gnu-gcc -v
   ```

   The output will be as follows:

   Result:

   Figure 3-1 Example Output

   ```
   ryan@ubuntu:~$ riscv64-linux-gnu-gcc -v
   Using built-in specs.
   COLLECT_GCC=riscv64-linux-gnu-gcc
   COLLECT_LTO_WRAPPER=/usr/lib/gcc-cross/riscv64-linux-gnu/7/lto-wrapper
   Target: riscv64-linux-gnu
   Configured with: ../src/configure -v --with-pkgversion='Ubuntu 7.5.0-3ubuntu1~18.04' --with-
   bugurl=file:///usr/share/doc/gcc-7/README.Bugs --enable-languages=c,c++,d,fortran,objc,obj-c
   ++ --prefix=/usr --with-gcc-major-version-only --program-suffix=-7 --enable-shared --enable-
   linker-build-id --libexecdir=/usr/lib --without-included-gettext --enable-threads=posix --li
   bdir=/usr/lib --enable-nls --with-sysroot=/ --enable-clocale=gnu --enable-libstdcxx-debug --
   enable-libstdcxx-time=yes --with-default-libstdcxx-abi=new --enable-gnu-unique-object --disa
   ble-libitm --disable-libsanitizer --disable-libquadmath --disable-libquadmath-support --enab
   le-plugin --with-system-zlib --enable-multiarch --disable-werror --disable-multilib --with-a
   rch=rv64imafdc --with-abi=lp64d --enable-checking=release --build=x86_64-linux-gnu --host=x8
   6_64-linux-gnu --target=riscv64-linux-gnu --program-prefix=riscv64-linux-gnu- --includedir=/
   usr/riscv64-linux-gnu/include
   Thread model: posix
   gcc version 7.5.0 (Ubuntu 7.5.0-3ubuntu1~18.04)
   ```

3.1.2. Compiling the u-boot

Follow the steps below to compile the u-boot for VisionFive.

1. Locate to your desired directory to store the u-boot files. For example, the home directory.
   Example:

```
cd ~ # home directory
```

2. Download the source code for u-boot compilation.

```
git clone https://github.com/starfive-tech/u-boot
```

3. Switch to the code branch by executing the following command:

```
cd u-boot
git checkout -b JH7100_upstream origin/JH7100_upstream
git pull
```

4. Type the following to compile u-boot under the u-boot directory.

```
make <Configuration_File> ARCH=riscv CROSS_COMPILE=riscv64-linux-gnu-
make u-boot.bin u-boot.dtb ARCH=riscv CROSS_COMPILE=riscv64-linux-gnu-
```

Tip:

Configuration_File:

- For VisionFive, the file is `starfive_jh7100_visionfive_smode_defconfig`.
- For Starlight, the file is `starfive_jh7100_starlight_smode_defconfig`.

Result:

There will be these 2 files generated after compilation inside the `u-boot` directory: `u-boot.bin` and `u-boot.dtb`.

```
-rwxrwxr-x   1 ryan ryan 7224016 Nov  9 18:14 u-boot
-rw-rw-r--   1 ryan ryan  921147 Nov  9 18:14 u-boot.bin
-rw-rw-r--   1 ryan ryan      47 Nov  9 18:14 .u-boot.bin.cmd
-rw-rw-r--   1 ryan ryan   15585 Nov  9 18:14 u-boot.cfg
-rw-rw-r--   1 ryan ryan     953 Nov  9 18:14 .u-boot.cmd
-rw-rw-r--   1 ryan ryan   41643 Nov  9 18:14 u-boot.dtb
-rw-rw-r--   1 ryan ryan  921147 Nov  9 18:14 u-boot-dtb.bin
```

Figure - Example Output

Tip:

Both `u-boot.dtb` and `u-boot.bin` will be used later for OpenSBI compilation.

3.1.3. Compiling OpenSBI

OpenSBI stands for Open-source Supervisor Binary Interface and it is an open-source implementation of the RISC-V Supervisor Binary Interface. It is a RISC-V specific runtime service provider and it is typically used in boot stage following ROM and LOADER. A typical boot flow is as follows:

Figure 3-2 Typical Boot Flow

Follow the steps below to compile OpenSBI for VisionFive.

1. Locate to your desired directory to store the OpenSBI files. For example, the home directory.

```
cd ~ # home directory
```

2. Download the source code for OpenSBI compilation.

```
git clone https://github.com/riscv/opensbi.git
```

3. Inside `opensbi` directory, type the following to compile openSBI.

```
cd opensbi
make ARCH=riscv CROSS_COMPILE=riscv64-linux-gnu- PLATFORM=generic
 FW_PAYLOAD_PATH={U-BOOT_PATH}/u-boot.bin FW_FDT_PATH={U-BOOT_PATH}/u-boot.dtb
```

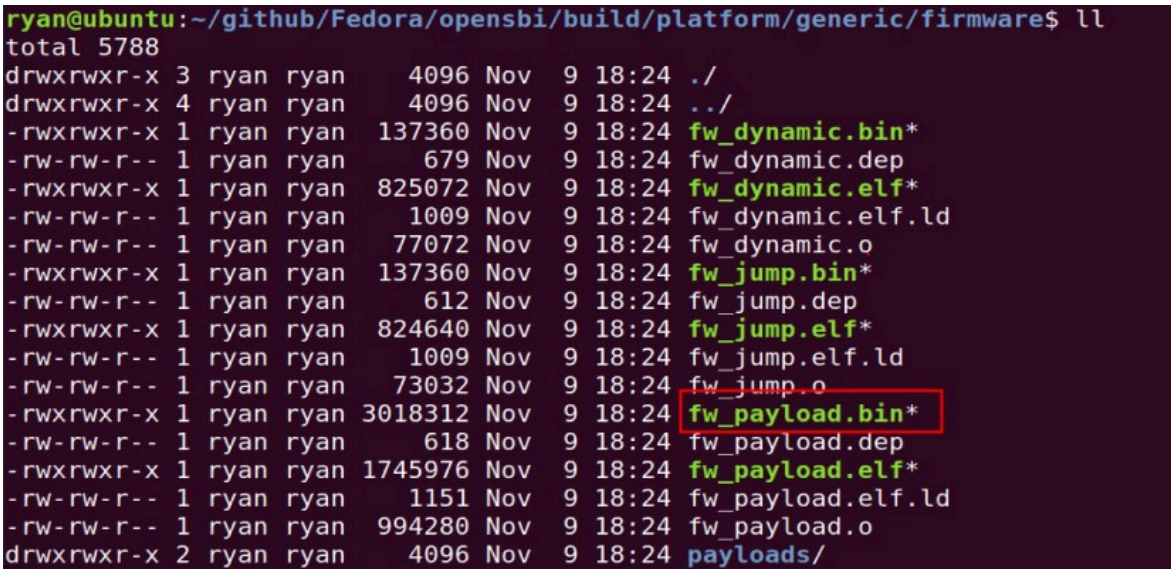
Tip:

Modify the *{U-BOOT_PATH}* to the path of u-boot from before.

Result:

After compilation, the file fw_payload.bin will be generated in the directory `opensbi/build/platform/generic/firmware` and the size is larger than 2M.

Figure 3-3 Example Output



4. Navigate to the directory containing `fw_payload.bin`.

```
cd opensbi/build/platform/generic/firmware
```

5. Copy the file `fw_payload.bin` to a different location.

```
cp fw_payload.bin ~/Desktop/payload/
```

6. Navigate to the location where fw_payload.bin is copied and execute the following to install an image conversion tool.

```
cd ~/Desktop/payload/
sudo apt install subversion
svn export https://github.com/starfive-tech/freelight-u-sdk.git/branches/starfive/fsz.sh
```

Tip:

Here is the source code.

7. Change the user rights of the tool.

```
chmod 777 fsz.sh
```

8. Convert the file from `fw_payload.bin` to `fw_payload.bin.out`.

```
./fsz.sh fw_payload.bin fw_payload.bin.out
```

Figure -

Figure 3-4 Example Output

```
ryan@ubuntu:~/Desktop/payload$ ./fsz.sh fw_payload.bin fw_payload.bin.out
inFile: fw_payload.bin
inSize: 3018312 (0x002e0e48, LE:0x480e2e00)
outFile: fw_payload.bin.out
outSize: 3018316 (0x002e0e4c)
```

Tip:

You will see a new file named `fw_payload.bin.out` generated. Refer to Appendix B: Updating Firmware and u-boot section in VisionFive Single Board Computer Quick Start Guide to flash u-boot.

3.2. Compiling Linux Kernel

Follow the following steps to compile Linux Kernel for VisionFive.

1. Locate to your desired directory to store the Linux Kernel files. For example, the home directory.

   Example:

   ```
   cd ~ # home directory
   ```

2. Download the source code for Linux Kernel.

   ```
   git clone https://github.com/starfive-tech/linux
   ```

3. Type the following to set the default configuration settings for compiling Linux Kernel.

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

4. Type the following to set additional configuration settings for compiling Linux Kernel.

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

5. Compile the Linux Kernel.

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

   Note:
   Here you need to change the *-jx* value according to the number of cores in your CPU. If your CPU has 8 cores, change this to `-j8`. This process will take some time and therefore please wait patiently.

   Result:

   The kernel image will be generated inside the directory `linux/arch/riscv/boot` as `Image.gz`.

Figure 3-5 Example Output

```
yingpeng@ubuntu:~/Desktop/github/linux/arch/riscv/boot$ ll
total 17628
drwxrwxr-x  3 yingpeng yingpeng     4096 Nov 22 16:18 ./
drwxrwxr-x 11 yingpeng yingpeng     4096 Nov 22 16:15 ../
drwxrwxr-x  6 yingpeng yingpeng     4096 Nov 18 18:52 dts/
-rw-rw-r--  1 yingpeng yingpeng       83 Nov 18 18:52 .gitignore
-rwxrwxr-x  1 yingpeng yingpeng 19723776 Nov 22 16:18 Image*
-rw-rw-r--  1 yingpeng yingpeng      151 Nov 22 16:18 .Image.cmd
-rw-rw-r--  1 yingpeng yingpeng  6353268 Nov 22 16:18 Image.gz
-rw-rw-r--  1 yingpeng yingpeng      101 Nov 22 16:18 .Image.gz.cmd
-rw-rw-r--  1 yingpeng yingpeng     1561 Nov 18 18:52 install.sh
-rw-rw-r--  1 yingpeng yingpeng      206 Nov 18 18:52 loader.lds.S
-rw-rw-r--  1 yingpeng yingpeng      143 Nov 18 18:52 loader.S
-rw-rw-r--  1 yingpeng yingpeng     1612 Nov 18 18:52 Makefile
```

The dtb files will be generated inside the directory `linux/arch/riscv/boot/dts/starfive`

Figure 3-6 Generated dtb Files

```
yingpeng@ubuntu:~/Desktop/github/linux/arch/riscv/boot/dts/starfive$ ls
jh7100-beaglev-starlight-a1.dtb  jh7100.dtsi
jh7100-beaglev-starlight-a1.dts  jh7100-starfive-visionfive-v1.dtb
jh7100-beaglev-starlight.dtb     jh7100-starfive-visionfive-v1.dts
jh7100-beaglev-starlight.dts     Makefile
jh7100-common.dtsi
```

The `Image.gz` and `.dtb` files will be used later in this guide when we try to move rootfs, dtb and kernel to VisionFive. Different boards use different dtb files, and for the detailed information, refer to the *dtb Files* table in StarFive 40-Pin GPIO Header User Guide.

3.3. Updating Kernel and Modules

This chapter describes how to update kernel and modules.

It contains the following sections:

3.3.1. Obtaining OS Version (Fedora OS)

Steps:

1. Visit StarFive's official GitHub to download the latest operating system.
2. Flash the latest operating system to the Micro-SD card. For details, see *Flash Fedora OS to a Micro-SD Card* section in VisionFive Single Board Computer Quick Start Guide.

3.3.2. Adding New File

To add new file, perform the following steps:

Note:
If there is no update, no need to add the new file.

1. Compile the file under the `linux` directory with the following command:

```
make CROSS_COMPILE=riscv64-linux-gnu- ARCH=riscv INSTALL_PATH=<ROOTFS_PATH> zinstall -<jx>
```

Tip:

- *<ROOTFS_PATH>*: This is a user-defined directory where the vmliunz files will be generated.
- *<jx>*: It refers to the number of cores in your CPU. If your CPU has 8 cores, change this to -j8.

Figure -

Figure 3-7 Example Command and Output

```
yingpeng@ubuntu:~/Desktop/github/linux$ make CROSS_COMPILE=riscv64-linux-gnu- ARCH=riscv
INSTALL_PATH=~/Desktop/github/boot zinstall -j4
sh ./arch/riscv/boot/install.sh 5.16.0-rc2-visionfive-g6e924cb10a60 \
arch/riscv/boot/Image.gz System.map "/home/yingpeng/Desktop/github/boot"
yingpeng@ubuntu:~/Desktop/github/linux$
```

Result:

vmliunz files will be generated under the ROOTFS_PATH.

2. (Optional) Compile the file under the `linux` path with the following command:

```
make CROSS_COMPILE=riscv64-linux-gnu- ARCH=riscv INSTALL_MOD_PATH=<ROOTFS_PATH> modules_install -jx
```

Tip:

- If you need to add new modules, this step is required.
- *<ROOTFS_PATH>*: This is a user-defined directory where the modules will be generated.
- *-jx*: It refers to the number of cores in your CPU. If your CPU has 8 cores, change this to -j8.

Example Command and Output: Figure -

Figure 3-8 Example Command and Output

```
yingpeng@ubuntu:~/Desktop/github/linux$ make CROSS_COMPILE=riscv64-linux-gnu- ARCH=riscv
INSTALL_MOD_PATH=~/Desktop/github/boot modules_install -j4
  DEPMOD  /home/yingpeng/Desktop/github/boot/lib/modules/5.16.0-rc2-visionfive-g6e924cb10
a60
yingpeng@ubuntu:~/Desktop/github/linux$
```

The module files will be generated under the ROOTFS_PATH.

3. View the files generated under `${ROOTFS_PATH}`. The following is an example:

Figure 3-9 Example

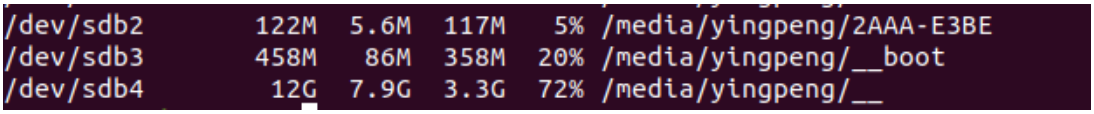
```
yingpeng@ubuntu:~/Desktop/github/boot$ ls
config-5.16.0-rc2-visionfive-g6e924cb10a60
lib
System.map-5.16.0-rc2-visionfive-g6e924cb10a60
vmlinuz-5.16.0-rc2-visionfive-g6e924cb10a60
yingpeng@ubuntu:~/Desktop/github/boot$
```

4. Add the new file:

   a. View the SD-card information.

```
df -h
```

Figure 3-10 Example SD Card Information



b. Copy the kernel file to the Micro-SD card. Please operate under the path of *${ROOTFS_PATH}*.

```
sudo cp vmlinuz-5.16.0-rc2-visionfive-g6e924cb10a60  /media/<User_Name>/__boot/ && sync
```

Note:

<User_Name> is your username, for example, yingpeng.

c. (Optional) Copy the modules file to the Micro-SD card. Please operate under the path of `${ROOTFS_PATH}`.

```
sudo cp -r lib/modules/5.16.0-rc2-visionfive-g6e924cb10a60/ /media/<User_Name>/__/lib/modules &&
 sync
```

Note:

- If you have compiled modules in the Step 2 *(on page 16)*, and you need to add these modules, this step is required.
- *<User_Name>* is your username, for example, yingpeng.

5. Perform the following step to update the `grub.cfg` file:

```
cd /media/<UserName>/__boot/
sudo gedit grub.cfg
```

Note:

<User_Name> is your username, for example, yingpeng.

6. Add the following command lines, save and exit:

```
menuentry '<Configuration_Item_Name_on_Menu>' {
linux /<Newly_Compiled_vmlinuz_file> ro root=UUID=59fcd098-2f22-441a-ba45-4f7185baf23f rhgb
 console=tty0 console=ttyS0,115200 earlycon rootwait stmmaceth=chain_mode:1 selinux=0 LANG=en_US.UTF-8
devicetree /dtbs/5.16.0-rc2+/starfive/<dtb_File_Name>
initrd /initramfs-5.16.0-rc2+.img
}
```

Tip:

In these commands:

- *<Configuration_Item_Name_on_Menu>*: The configuration name displayed on the menu. For example, `My Fedora vmlinux-5.16.0-rc2 visionfive`.
- *<Newly_Compiled_vmlinuz_file>*: The vmlinuz file name that is newly compiled in the previous steps. For example, `vmlinuz-5.16.0-rc2-visionfive-g6e924cb10a60`.
- *<dtb_File_Name>*: Different boards use different dtb files, and for the detailed information, refer to the *dtb Files* table in *StarFive 40-Pin GPIO Header User Guide*.

Example: The following are the example commands:

```
menuentry 'My Fedora vmlinux-5.16.0-rc2 visionfive' {
linux /vmlinuz-5.16.0-rc2-visionfive-g6e924cb10a60 ro root=UUID=59fcd098-2f22-441a-ba45-4f7185baf23f
 rhgb console=tty0 console=ttyS0,115200 earlycon rootwait stmmaceth=chain_mode:1 selinux=0
 LANG=en_US.UTF-8
```

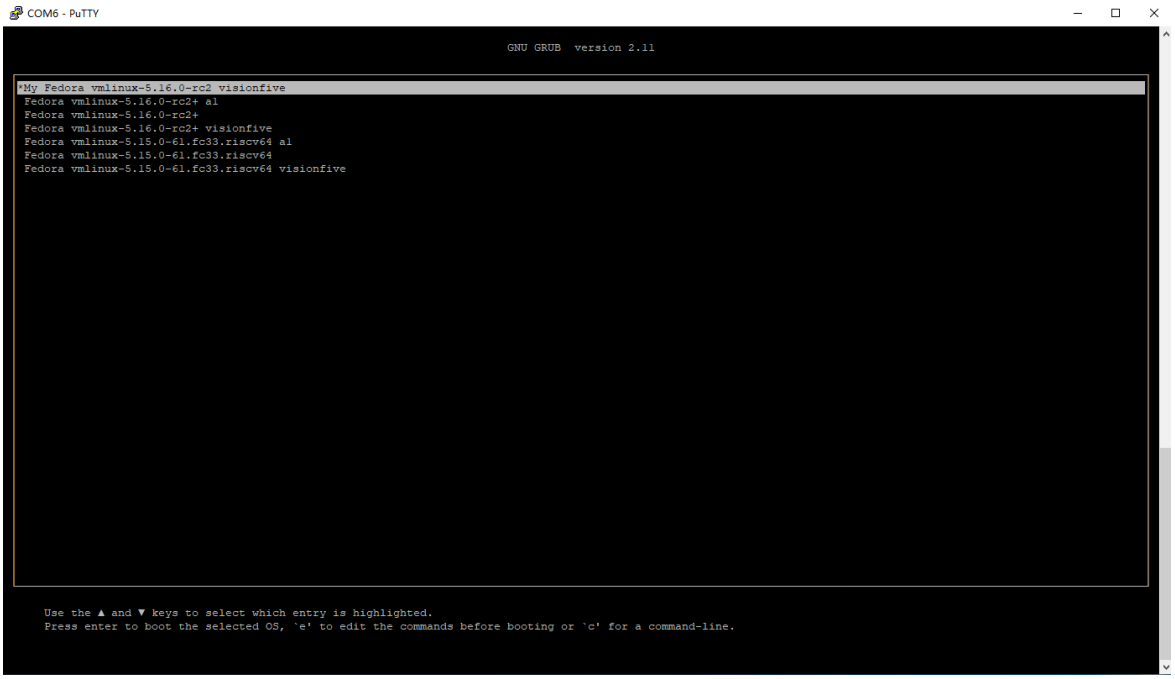
```
devicetree /dtbs/5.16.0-rc2+/starfive/jh7100-starfive-visionfive-v1.dtb
initrd /initramfs-5.16.0-rc2+.img
}
```

Verification:

The following steps are provided to verify if the configuration is successful:

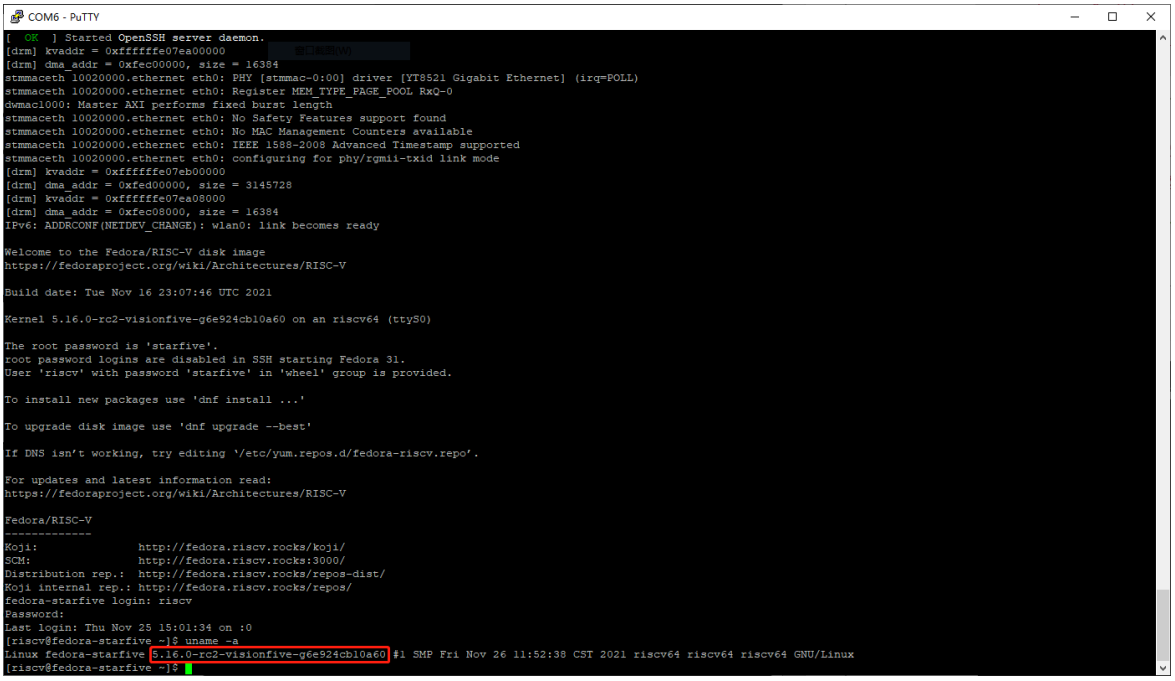
1. Pull out the card from the PC and insert it into the VisionFive board. The system will start normally after power-on.
2. You can find the defined configuration item, for example, `My Fedora vmlinux-5.16.0-rc2 visionfive`, on the menu, as shown below:

Figure 3-11 Example Interface



3. After the system starts successfully, you can see the version of the new vmlinuz file:

Figure 3-12 Example Output



4. Making Busybox System

This section describes how to make busybox system.

It contains the following sections:

4.1. Making File System

Follow the following steps to make the file system.

1. Create the directory structure.

```
mkdir rootfs
cd rootfs
mkdir dev usr bin sbin lib etc proc tmp sys var root mnt
```

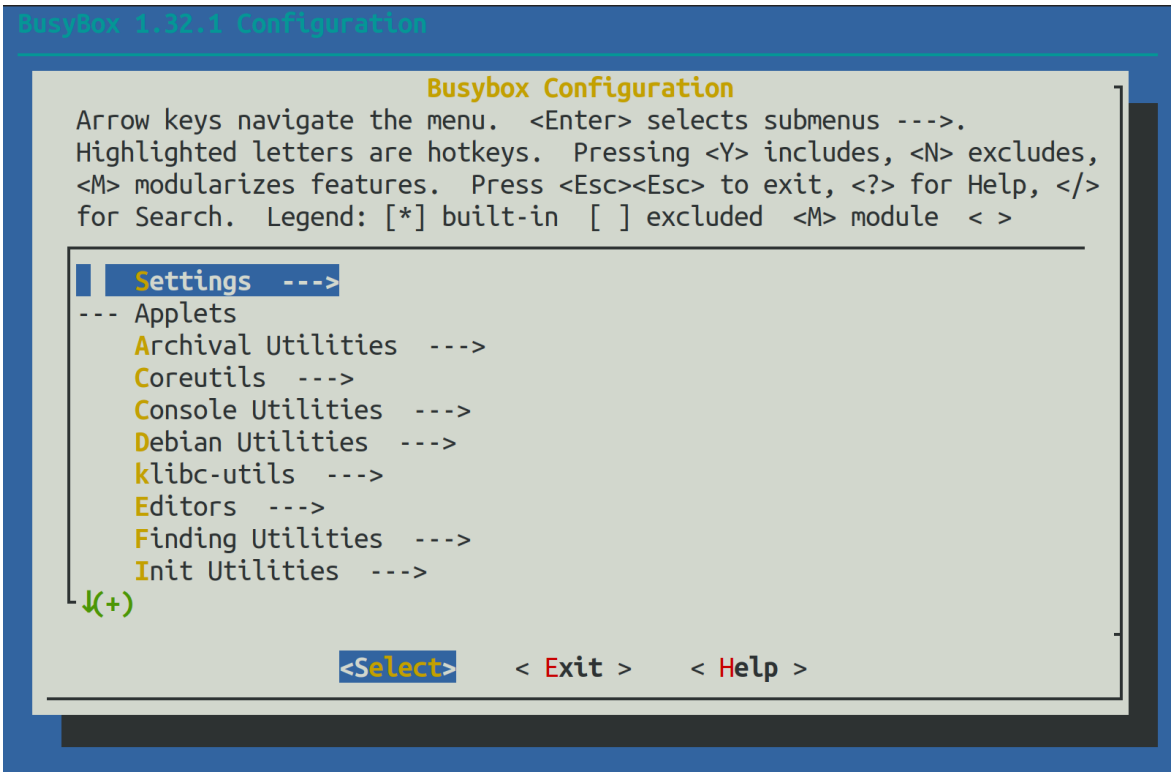
2. Download the busybox source code outside the rootfs directory.

```
git clone https://git.busybox.net/busybox
```

3. Navigate to the extracted location and enter busybox configuration.

```
cd busybox
make CROSS_COMPILE=riscv64-linux-gnu- ARCH=riscv menuconfig
```

Figure 4-1 Busybox Configuration



4. Navigate to **Settings > Build Options** and check **Build static binary (no shared libs)** by pressing **Y.**

5. Under Build Options, select cross compiler prefix and type the following to specify the compiler.

```
riscv64-linux-gnu-
```

6. Under Installation **Options > Destination** path for `make install`, change the path to the path of the rootfs file directory (this is the installation location of the compiled busybox).

Example:

```
/home/user/rootfs
```

7. Exit from the busybox configuration window and save the configuration.
8. Compile busybox.

```
make ARCH=riscv
```

9. Install busybox.

```
make install
```

10. Navigate to the rootfs/etc directory created before, create a file called inittab and open it using vim text editor.

```
cd rootfs/etc
vim inittab
```

11. Copy and paste the following content inside the `inittab` file.

```
::sysinit:/etc/init.d/rcS
::respawn:-/bin/login
::restart:/sbin/init
::ctrlaltdel:/sbin/reboot
::shutdown:/bin/umount -a -r
::shutdown:/sbin/swapoff -a
```

12. Create a file called profile inside `rootfs/etc` and open it using vim text editor.

```
vim profile
```

13. Copy and paste the following content inside the profile file.

```
# /etc/profile: system-wide .profile file for the Bourne shells
echo
#echo -n "Processing /etc/profile... "
# no-op
# Set search library path
#echo "Set search library path in /etc/profile"
export LD_LIBRARY_PATH=/lib:/usr/lib
# Set user path
#echo "Set user path in /etc/profile"
PATH=/bin:/sbin:/usr/bin:/usr/sbin
export PATH
# Set PS1
#Note: In addition to the SHELL variable, ash supports \u, \h, \W, \$, \!, \n, \w, \nnn (octal numbers
 corresponding to ASCII characters)
#And \e[xx;xxm (color effects), etc.
#Also add an extra '\' in front of it!
#echo "Set PS1 in /etc/profile"
export PS1="\\e[00;32m[$USER@\\w\\a]\\$\\e[00;34m"
#echo "Done"
```

14. Create a file called `fstab` inside `rootfs/etc` and open it using vim text editor.

```
vim fstab
```

15. Copy and paste the following content inside the `fstab` file.

```
proc /proc proc defaults 0 0
none /tmp tmpfs defaults 0 0
mdev /dev tmpfs defaults 0 0
sysfs /sys sysfs defaults 0 0
```

16. Create a file called passwd inside `rootfs/etc` and open it using vim text editor.

```
vim passwd
```

17. Copy and paste the following content inside the passwd file.

```
root:x:0:0:root:/root:/bin/sh
```

18. Create a file called group inside `rootfs/etc` and open it using vim text editor.

```
vim group
```

19. Copy and paste the following content inside the group file.

```
root:x:0:root
```

20. Create a file called shadow inside `rootfs/etc` and open it using vim text editor.

```
vim shadow
```

21. Copy and paste the following content inside the shadow file.

```
root:BAy5qvelNWKns:1:0:99999:7:::
```

22. Create a directory called `init.d` inside `rootfs/etc` and navigate inside it.

```
mkdir init.d
cd init.d
```

23. Create a file called rcS inside rootfs/etc/init.d and open it using vim text editor.

```
vim rcS
```

24. Copy and paste the following content inside the `rcS` file.

```
#! /bin/sh
#echo "----------mount all"
/bin/mount -a
#echo "----------Starting mdev......"
#/bin/echo /sbin/mdev > /proc/sys/kernel/hotplug
mdev -s
echo "*******************************************************"
echo " starfive mini RISC-V Rootfs"
echo "*******************************************************"
```

25. Navigate to the `rootfs/dev` directory created before and execute the following.

```
1 cd rootfs/dev
2 sudo mknod -m 666 console c 5 1
3 sudo mknod -m 666 null c 1 3
```

26. Create a soft link in the root directory of rootfs.

```
1 cd rootfs/
2 ln -s bin/busybox init
```

27. Modify the permissions of all files in the rootfs directory.

```
sudo chmod 777 -R *
```

28. Execute the following command in the rootfs directory to generate rootfs.cpio.gz (cpio file system package) in a different directory.

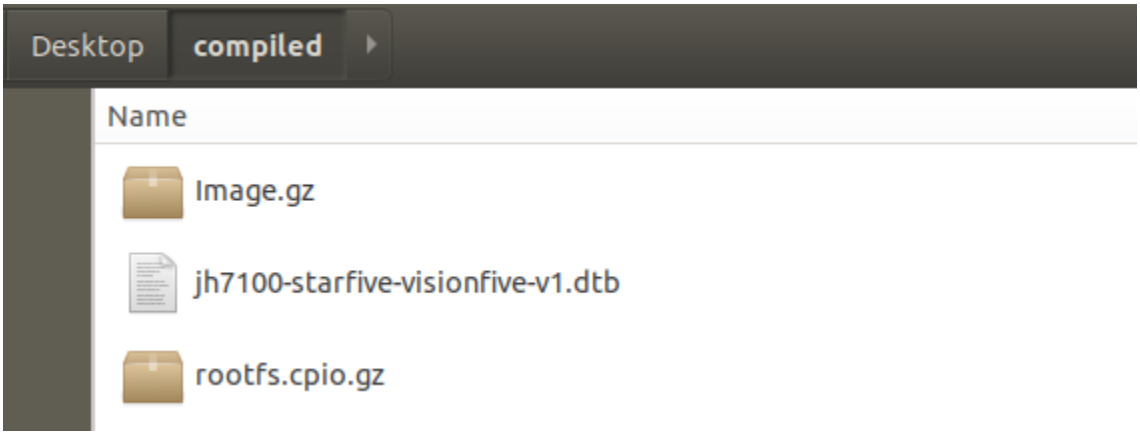
```
1 cd rootfs
2 find . | cpio -o -H newc | gzip > /home/user/Desktop/rootfs.cpio.gz
```

Note:
After you successfully run the command above, you will see a file named `rootfs.cpio.gz` on your Desktop. This directory can be any directory you want. If your CPU has 8 cores, change this to `-j8`. This process will take some time and therefore please wait patiently.

4.2. Moving Rootfs, Kernel, and dtb into VisionFive

Start by moving the previously compiled rootfs file system package, kernel and dtb images into a single directory.

Figure 4-2 Example Interface



Tip:
`<dtb_File_Name>`: Different boards use different dtb files, and for the detailed information, refer to the *dtb Files* table in StarFive 40-Pin GPIO Header User Guide.

4.2.1. Method 1: Using Micro-SD Card

1. Insert a micro-SD card to the host PC.
2. Type the following to see the location of the connected micro-SD card.

   ```
   lsblk
   ```

   For example, it's `/dev/sdb`.

   Figure 4-3 Example

   ```
   loop25    7:25   0   5.5M  1 loop /snap/notepad-plus-plus/258
   sda       8:0    0   400G  0 disk
   └─sda1    8:1    0   398G  0 part /
   sdb       8:16   1 119.1G  0 disk
   ├─sdb1    8:17   1   488M  0 part /media/ryan/__boot1
   └─sdb2    8:18   1  11.5G  0 part /media/ryan/__
   ```

3. Type the following to enter the partition configuration.

   ```
   sudo gdisk /dev/sdb
   ```

Figure 4-4 Example Output

4. Delete the original partition and then create a new partition by entering the following respectively.

```
d--->o--->n--->w--->y
```

Tip:
Press `Enter` to keep some settings to default in this configuration.

5. Format the micro-SD card and create the file system.

```
sudo mkfs.vfat /dev/sdb1
```

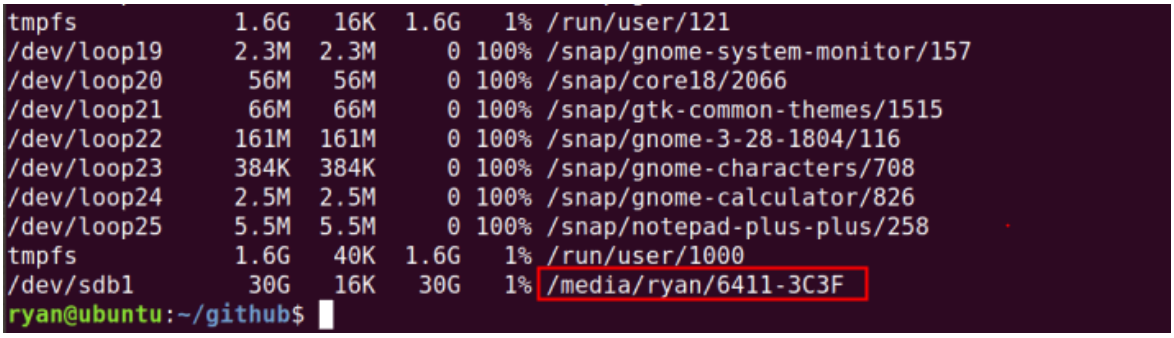
6. Remove the micro-SD card from PC and plug again to mount it.

7. Enter the following to check whether it gets mounted.

```
df -h
```

You will see an output as follows and take a note of the mount location.

Figure 4-5 Example Output



8. Navigate to the directory containing the 3 images as before.

```
cd Desktop/compiled
```

9. Copy the files to the micro-SD card by typing the following.

```
sudo cp Image.gz <Mount_Location>
sudo cp rootfs.cpio.gz <Mount_Location>
sudo cp <dtb_File_Name> <Mount_Location>
sync
```

Note:

- *<Mount_Location>*: is the mount location as shown above.
- *<dtb_File_Name>*: Different boards use different dtb files, and for the detailed information, refer to the *dtb Files* table in StarFive 40-Pin GPIO Header User Guide.

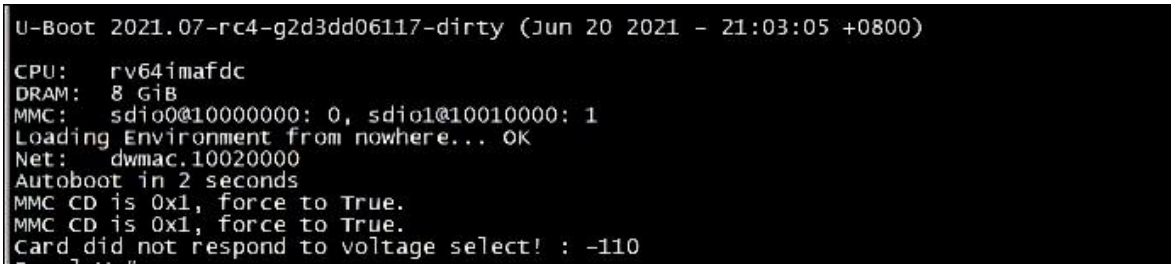
Example:

The following are the example commands:

```
sudo cp Image.gz /media/user/6411-3C3F/
sudo cp rootfs.cpio.gz /media/user/6411-3C3F/
sudo cp jh7100-starfive-visionfive-v1.dtb /media/user/6411-3C3F/
sync
```

10. Remove the micro-SD card from PC, insert into VisionFive and turn it on.
11. Open minicom while USB to Serial Adapter is connected between VisionFive and PC, and wait until the board enters **u-boot mode**. You will see the following output when it is in u-boot mode.

Figure 4-6 Example Output



12. Enter the following commands.

```
setenv kernel_comp_addr_r 0x90000000;setenv kernel_comp_size 0x10000000;setenv kernel_addr_r
 0x84000000;setenv fdt_addr_r 0x88000000;setenv ramdisk_addr_r 0x88300000
fatls mmc 0:1
fatload mmc 0:1 ${kernel_addr_r} Image.gz
fatload mmc 0:1 ${fdt_addr_r} jh7100-starfive-visionfive-v1.dtb
fatload mmc 0:1 ${ramdisk_addr_r} rootfs.cpio.gz
booti ${kernel_addr_r} ${ramdisk_addr_r}:${filesize} ${fdt_addr_r}
```

13. Log in by typing the following credentials.
    - Username: root
    - Password: starfive

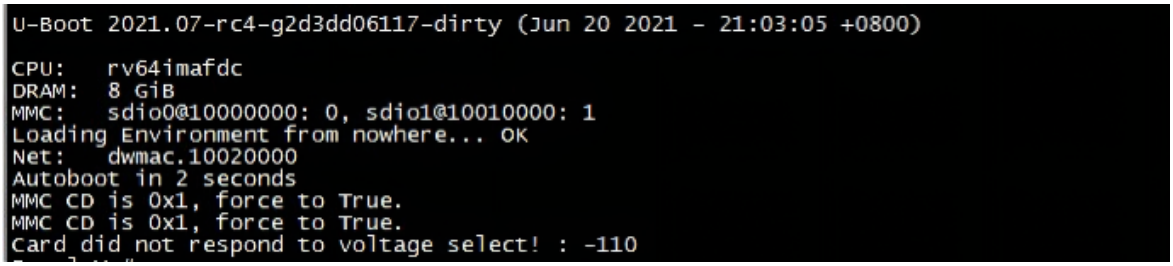
4.2.2. Method 2: Using Ethernet Cable

1. Connect an Ethernet Cable from the RJ45 port of VisionFive to a router, connect serial adapter cable and power on the board.

Note:
Make sure the host PC is also connected to the same router using Ethernet or Wi-Fi.

2. Open **minicom** and wait until the board enters **u-boot mode**. You will see the following output when it is in u-boot mode.

Figure 4-7 Example Output



3. Enter the following commands to set u-boot environment variables.

```
setenv serverip 192.168.120.12;setenv ipaddr 192.168.120.200;setenv hostname starfive;setenv netdev
 eth0;setenv kernel_comp_addr_r 0x90000000;setenv kernel_comp_size 0x10000000; setenv bootargs
 console=ttyS0,115200 earlycon=sbi root=/dev/ram0 stmmaceth=chain_mode:1 loglevel=8
```

Note:
Generally, the default IP of a router is 192.168.120.1. In this case, use the server IP as the IP assigned by the DHCP server of the router and use the VisionFive IP as 192.168.120.xxx. However, if your router IP is different (e.g.: 192.168.2.1), the server and VisionFive should follow the IP format of 192.168.2.xxx.

4. Check the connectivity by pinging the host PC from VisionFive.

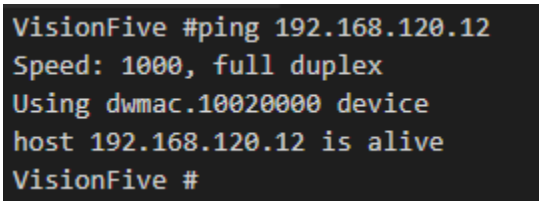
Example:

```
ping 192.168.120.12
```

Result:

If you see the following output, the host PC and VisionFive has established a communication on the same network.

Figure 4-8 Example Output



5. Install a tftp server on the Host PC.

```
sudo apt-get update
sudo apt install tftpd-hpa
```

6. Check the status of the server.

```
sudo systemctl status tftpd-hpa
```

7. Execute the following to enter the tftp server configuration.

```
sudo nano /etc/default/tftpd-hpa
```

8. Configure the tftp server as follows.

```
TFTP_USERNAME="tftp"
TFTP_DIRECTORY="/home/user/Desktop/compiled"
TFTP_ADDRESS=":69"
TFTP_OPTIONS="--secure"
```

Note:
The `TFTP_DIRECTORY` is the directory that we created before with all the 3 images (`Image.gz`, `jh7100-starfive-visionfive-v1.dtb`, `rootfs.cpio.gz`).

9. Restart the tftp server.

```
sudo systemctl restart tftpd-hpa
```

10. Type the following inside the u-boot mode of VisionFive to download the files from the tftp server of the host PC and start the kernel.

```
tftpboot ${fdt_addr_r} <dtb_File_Name>;tftpboot ${kernel_addr_r} Image.gz;tftpboot ${ramdisk_addr_r}
 rootfs.cpio.gz;booti ${kernel_addr_r} ${ramdisk_addr_r}:${filesize} ${fdt_addr_r}
```

Note:

<dtb_File_Name>: Different boards use different dtb files, and for the detailed information, refer to the *dtb Files* table in StarFive 40-Pin GPIO Header User Guide.

Example:

The following command is an example for VisionFive:

```
tftpboot ${fdt_addr_r} jh7100-starfive-visionfive-v1.dtb;tftpboot ${kernel_addr_r} Image.gz;tftpboot
 ${ramdisk_addr_r} rootfs.cpio.gz;booti ${kernel_addr_r} ${ramdisk_addr_r}:${filesize} ${fdt_addr_r}
```

11. Log in with the following credentials.
    - Username: root
    - Password: starfive