



SiFive Freedom U500 VC707 FPGA Getting Started Guide

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August 1, 2016

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Release Information

Version	Date	Changes
0.1	July 11, 2016	First Release
0.2	Aug 01, 2016	Updated Configuration Memory File (MCS) link to static.dev.sifive.com

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Chapter 1

Required Hardware

The Freedom U500 VC707 FPGA Dev Kit requires the following hardware to be purchased:

1.1 Xilinx Virtex-7 FPGA VC707 Evaluation Kit

The VC707 is a standard Xilinx prototyping board. It can be purchased from Xilinx or AVNET

<http://www.xilinx.com/products/boards-and-kits/ek-v7-vc707-g.html>

<http://products.avnet.com/shop/en/ema/development-kits/3074457345626227804>

1.2 16GB SDHC Card

The SDHC Card should conform to SD specification 2.00 or later. SiFive has tested with several SDHC cards from SanDisk, PNY and Kingston, for instance SanDisk 16GB Micro SDHC Memory Card + SD Adapter

<https://www.sandisk.com/home/memory-cards/microsd-cards/sandisk-microsd>

1.3 HiTechGlobal X8 PCI Express Gen1/2/3 FMC Module (Vita57.1)

A daughter board for the VC707 which bonds out FPGA transceivers to a PCIe slot and provides PCIe REFCLK. This board can be purchased directly from HiTechGlobal

http://hitechglobal.com/FMCModules/FMC_PCIExpress.htm

The supporting “12V/7A Wall Power Supply” can optionally also be ordered

https://hitechglobal.us/index.php?route=product/product&path=25&product_id=55

One standard PC jumper should also be purchased.

1.4 Optional Max Expansion uCube3 PCIe switch

A Max Expansion “uCube3” PCIe switch can be added to extend the number of PCIe slots from 1 to 5.

<http://maxexpansion.com/desktop/mCUBE3-expansion-enclosure>

This can be purchased directly from MaxExpansion.

1.5 Supported PCIe Endpoint cards

The following PCIe cards have been tested in system

1.5.1 NIC

Intel “EXPI9301CTBLK Pro/1000 CT PCI-E 1x” NIC

<http://www.intel.com/content/www/us/en/ethernet-products/gigabit-server-adapters/gigabit-ct-desktop-adapter.html>

Realtek based PCIe NIC for instance, ST Lab “PCIe Gigabit Ethernet 1-Port Card N-313”

<http://www.st-lab.com/assign.asp?keyid=bu16>

1.5.2 USB

xHCI PCIe-USB3 NEC based controller, Bytec “BT-PEU310 PCIe NEC Chipset USB 3.0 3 Ports Card”

<http://byteccusa.com/index.php/i-o-card/pci-e/bt-peu310-html.html>

Chapter 2

Board Setup

Perform the following setup steps on delivery of hardware.

2.1 Set VC707 boot mode

Set VC707 SW11 to "11010" as shown in Figure 2.1

SW11[2:0] enables power-on FPGA configuration from the onboard Master BPI flash.

SW11[4:3]="11" ensures the Freedom U500 VC707 FPGA Dev Board boot bitstream goes into slot 3 in the BPI flash memory and does not overwrite the Xilinx BIST configuration at slot 0.

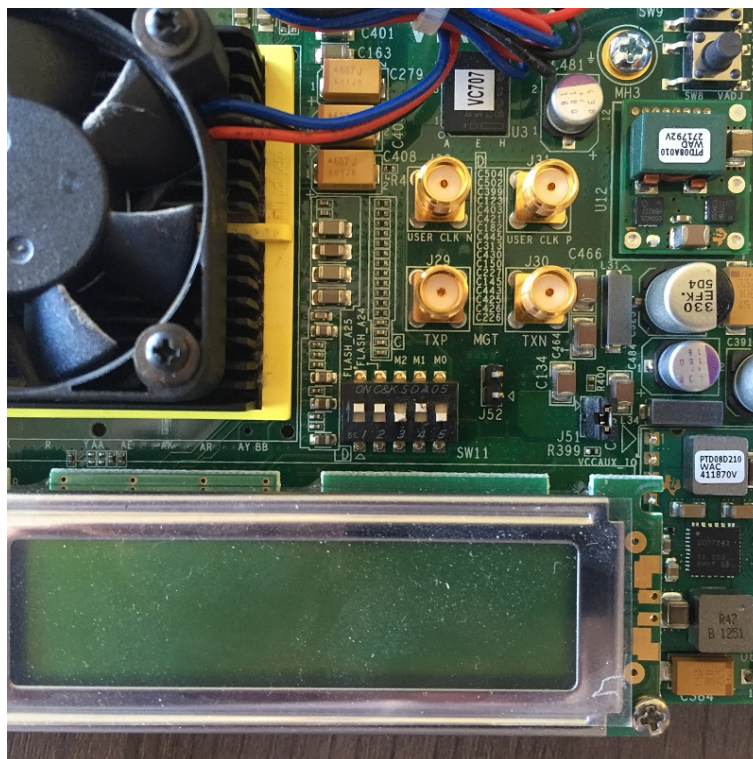


Figure 2.1: VC707 Configuration/Boot SW11 settings

2.2 Setup PCIe Root FMC card

Connect the HiTechGlobal “X8 PCI Express Gen1/2/3 FMC Module (Vita57.1)” to VV707 FMC1 Port

Jumper TDI Pin JP4 to TDO JP3 with a jumper block or wire as shown in Figure 2.2. This ensures correct JTAG connectivity across the FMC module.

Set the power switch on the FMC module towards the VC707. This sets the FMC to be powered by the VC707.

Alternatively, if you intend to directly connect the FMC module to a high power load PCIe endpoint card, connect the FMC module external 12 volts power supply to J3. Then set the power switch on the FMC module away from the VC707 to select the external power source.

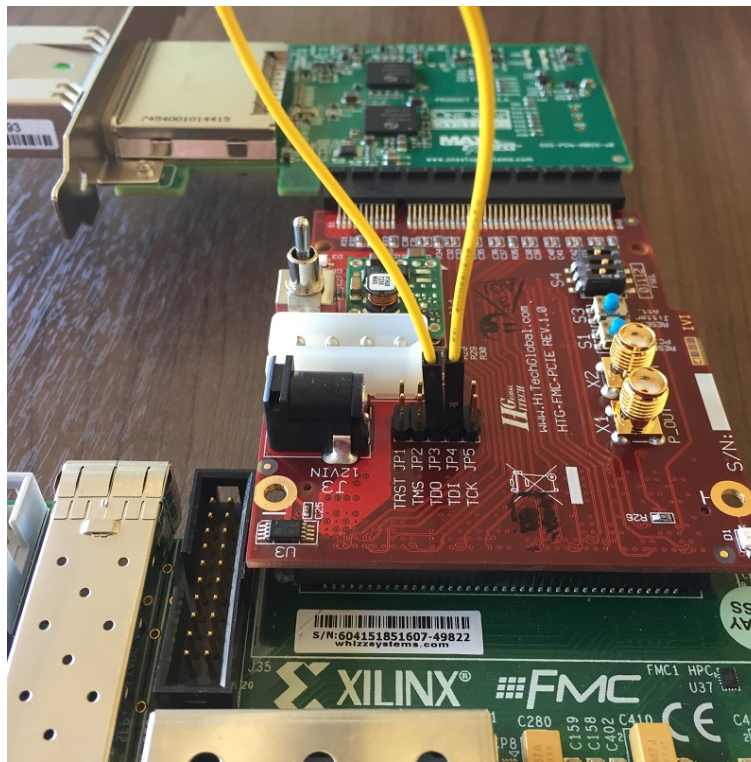


Figure 2.2: HiTechGlobal PCIe FMC Installation

After removing the Kapton tape, set the FMC Module FSEL jumpers to “101”, as shown in Figure 2.3. This programs the clock generator for the correct 100MHz PCIe REFCLK operation frequency.

2.3 Connect PCIe Switch (Optional) and PCIe Endpoint cards

Connect the Max Expansion “uCube3” desktop expansion cable to the FMC PCIe slot, as shown in Figure 2.4. Connect xHCI PCIe-USB3 PCIe card and NIC PCIe card within the uCube3.

Alternatively install one of the tested PCIe cards listed in Chapter 1 directly in the FMC PCIe slot.

If a network card is installed, it should be connected to a network with DHCP.

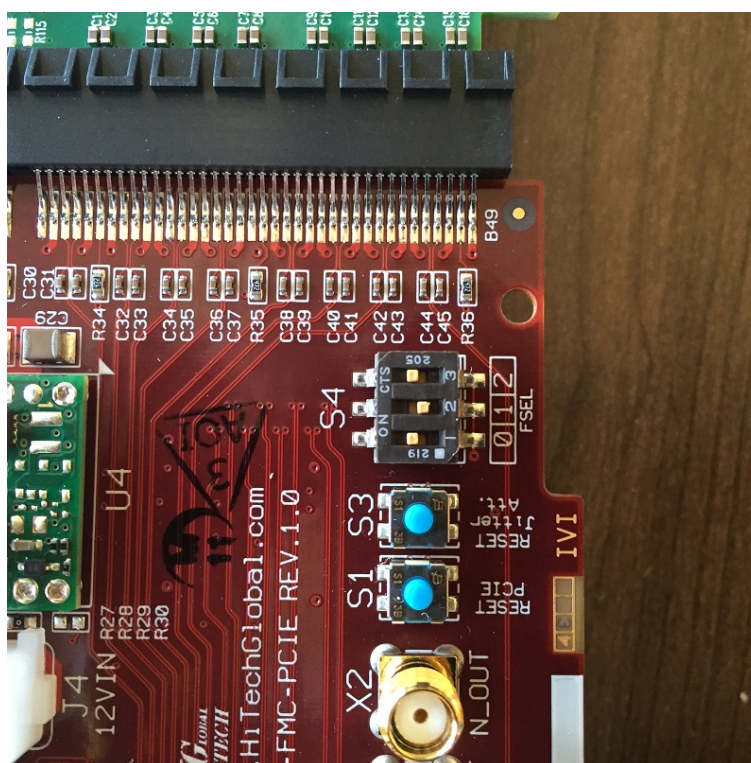


Figure 2.3: HiTechGlobal PCIe FMC FSEL jumper settings

2.4 Install SDCard for Linux boot

Following instructions from Chapter 4, prepare a SDHC Card with Linux boot image. Install SDHC Card in the VC707 SD Card slot shown in Figure 2.5.

2.5 VC707 power and UART

Connect the VC707 power adapter, supplied with the board.

Connect the USB Type-A to Type mini-B USB cable, supplied with the VC707 kit, between VC707 connector J17 and the host machine. This provides Linux terminal input/output for the Coreplex.

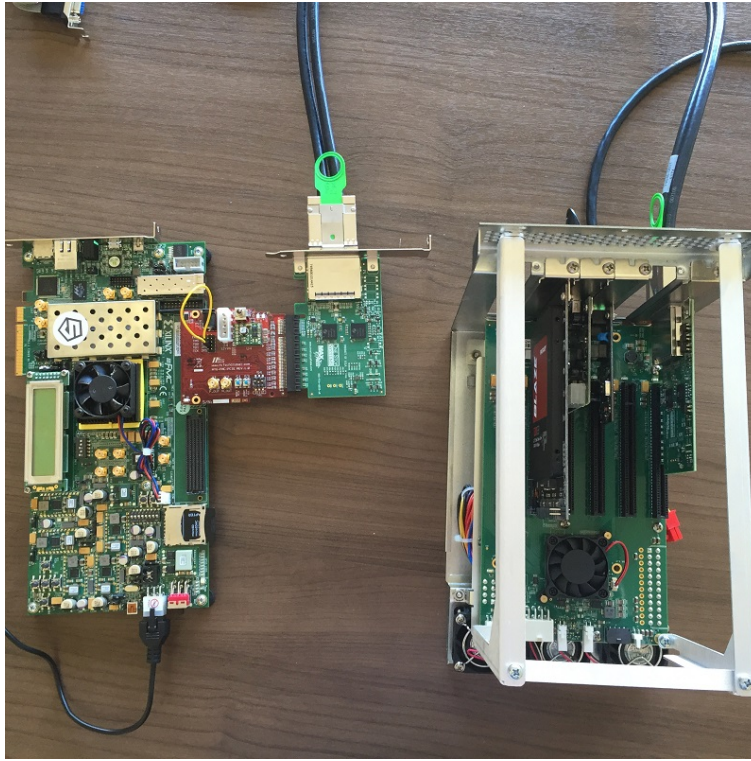


Figure 2.4: Connected Max Expansion “uCube” PCIe switch and USB+NIC PCIe endpoint cards



Figure 2.5: VC707 SD Card Slot

Chapter 3

Freedom U500 VC707 FPGA bitstream

The Xilinx Virtex-7 XCVX485T FPGA configures on power-on from an on-board BPI linear flash chip.

The Freedom U500 VC707 FPGA BPI linear flash programming file for can be downloaded from:

<https://static.dev.sifive.com/freedom-u500-vc707-mcs-0-1.zip>

Xilinx Vivado Design Suite is used for flash programming. A single node-locked license of Vivado 2016.1 is included with VC707 purchase from Xilinx. Alternatively, Vivado Lab Edition 2016.1 is available free of charge from Xilinx.

To program the flash with Vivado :

1. Launch Vivado
2. Open Hardware Manager, open target board
3. Right click on the FPGA device and select “Add Configuration Memory Device”
4. Select

Part	mt28gu01gaax1e-bpi-x16
Manufacturer	Micron
Alias	28f00ag18f
Family	g18
Type	bpi
Density	1024
Width	x16

5. Click OK to “Do you want to program the configuration memory device now ?”
6. Add freedom-u500-vc707-0-1.mcs and freedom-u500-vc707-0-1.prm
7. Select RS Pins = 25:24
8. Select OK

Programming will take approximately five minutes.

Chapter 4

Software Development Flow

After the FPGA is powered and configured from BPI linear flash, the Coreplex boots Linux+root filesystem from the SD Card.

The Freedom U500 Software Development Kit provides everything required to compile and customize this SD Card image - GCC 6.1.0 cross compilation toolchain, Linux 4.6.2 kernel and buildroot managed root filesystem.

To clone the Freedom U500 SDK git repository :

```
git clone --recursive https://github.com/sifive/freedom-u-sdk.git
```

To prepare a complete SD card image :

```
cd freedom-u-sdk; make
```

To load the compiled image to the SD card :

```
dd if=work/bbl.bin of=/dev/your-sd-card bs=1M
```

To reconfigure the linux kernel, for instance to add driver support for new PCIe cards :

```
make linux-menuconfig
```

To reconfigure buildroot and add additional packages :

```
make buildroot-menuconfig
```

To recompile after reconfiguration :

```
touch linux && make  
touch buildroot && make
```


Chapter 5

Linux Boot and Run

Using a program such as Minicom or Screen on Linux, or Teraterm on Windows, open a terminal connection from the host computer to the Freedom U500 VC707 FPGA Dev Board. Set the following parameters

Speed	115200
Parity	None
Data bits	8
Stop bits	1
Hardware Flow	None

If present, plug in the Max Expansion uCube3 PCIe switch and power on the VC707 board.

Linux will proceed to boot with tty output and keyboard input over the terminal connection. Log in with root password *sifive*.

The terminal log at the end of this Chapter demonstrates a session comprising Linux boot, login and program execution with attached PCIe switch and NIC, USB and Sata controller PCIe cards.

In summary, during boot :

1. The kernel image is loaded from SDCard by the bootloader, displaying the SiFive logo
2. PCIe probing occurs. Many devices are enumerated and BARs are reserved for PCIe switch, Ethernet, USB and Sata Controller PCIe cards.
3. The USB xHCI Host Controller driver identifies and takes ownership of PCIe device 0000:04:0.0, a BT-PEU310 PCIe NEC Chipset USB 3.0 3 Ports Card and two USB hubs are enumerated. Later in the boot log, xHCI identifies a connected SanDisk Ultra USB Mass Storage Device (USB flash drive)
4. The SATA aHCI driver identifies and takes ownership of PCIe device 0000:05:0.0, a MARVELL VIRTUALL PCIe controller card. 8 Sata channels are enumerated and a Patriot Blaze SSD hard drive is identified.

5. The Realtek NIC driver identifies and takes ownership of PCIe device 0000:03:00.0, a ST Lab "PCIe Gigabit Ethernet 1-Port Card N-313". It brings up eth0. An IP address is acquired through DHCP and Dropbear sshd is started.

Then after login we :

1. Dump the system information string with `uname -a` : identifying Linux 4.6.2 running on RISC-V
2. Scan the PCIe bus with `lspci`, correctly identifying 6 PLC PCIe bridges via the PCIe switch, Realtek Ethernet card, Renesas USB controller, Marvell SATA controller and ATI video card (unused)
3. Scan the USB bus with `lsusb`, correctly identifying two busses, the second of which has a root and endpoint (USB Mass storage device)
4. Dump the interrupt and IRQ tables
5. Ping google with the network card
6. SSH to localhost
7. Mount the EXT2 formatted USB Mass Storage Device which has been pre-loaded with native RISC-V gnu compilation tools from <https://github.com/riscv/riscv-poky>
8. Cat the contents of a "Hello World" `hello.c` file to the `tty`.
9. Compile the `hello.c` file with `riscv64-GCC` and run it.

The full terminal log is shown on the next page.

```
INIT
CMD0
CMD8
ACMD41
CMD58
CMD16
CMD18
LOADING
BOOT
```

SIFIVE, INC.

[illegible]

```

SiFive RISC-V Coreplex
[ 0.000000] Linux version 4.6.2-ga9474b8 (gcc version 6.1.0 (GCC) ) #11 Sat Jul 9 19:12:05 PDT 2016
[ 0.000000] bootconsole [early0] enabled
[ 0.000000] Available physical memory: 248MB
[ 0.000000] Initial ramdisk at: 0xffffffff800192c0 (2519117 bytes)
[ 0.000000] Zone ranges:
[ 0.000000]   Normal   [mem 0x0000000080800000-0x000000008fffffff]
[ 0.000000] Movable zone start for each node
[ 0.000000] Early memory node ranges
[ 0.000000]   node 0: [mem 0x0000000080800000-0x000000008fffffff]
[ 0.000000] Initmem setup node 0 [mem 0x0000000080800000-0x000000008fffffff]
[ 0.000000] Built 1 zonelists in Zone order, mobility grouping on.  Total pages: 62620
[ 0.000000] Kernel command line: earlyprintk
[ 0.000000] PID hash table entries: 1024 (order: 1, 8192 bytes)
[ 0.000000] Dentry cache hash table entries: 32768 (order: 6, 262144 bytes)
[ 0.000000] Inode-cache hash table entries: 16384 (order: 5, 131072 bytes)
[ 0.000000] Sorting __ex_table...
[ 0.000000] Memory: 243356K/253952K available (3063K kernel code, 156K rwdata, 644K rodata,
2564K init, 234K bss, 10596K reserved, 0K cma-reserved)
[ 0.000000] SLUB: HWalign=64, Order=0-3, MinObjects=0, CPUs=1, Nodes=1
[ 0.000000] NR_IRQS:0 nr_irqs:0 0
[ 0.000000] clocksource: riscv_clocksource: mask: 0xffffffff max_cycles: 0xffffffff,
max_idle_ns: 1911260446275 ns
[ 0.000000] Calibrating delay loop (skipped), value calculated using timer frequency.. 2.00
BogoMIPS (lpj=10000)
[ 0.000000] pid_max: default: 32768 minimum: 301
[ 0.010000] Mount-cache hash table entries: 512 (order: 0, 4096 bytes)

```

```

[ 0.010000] Mountpoint-cache hash table entries: 512 (order: 0, 4096 bytes)
[ 0.050000] devtmpfs: initialized
[ 0.060000] clocksource: jiffies: mask: 0xffffffff max_cycles: 0xffffffff, max_idle_ns: 19112604462750000 ns
[ 0.080000] NET: Registered protocol family 16
[ 0.100000] plic plic: enabling 2 IRQs
[ 0.230000] SCSI subsystem initialized
[ 0.240000] usbcore: registered new interface driver usbfs
[ 0.240000] usbcore: registered new interface driver hub
[ 0.250000] usbcore: registered new device driver usb
[ 0.250000] pps_core: LinuxPPS API ver. 1 registered
[ 0.260000] pps_core: Software ver. 5.3.6 - Copyright 2005-2007 Rodolfo Giometti <giometti@linux.it>
[ 0.260000] PTP clock support registered
[ 0.280000] clocksource: Switched to clocksource riscv_clocksource
[ 0.310000] NET: Registered protocol family 2
[ 0.330000] TCP established hash table entries: 2048 (order: 2, 16384 bytes)
[ 0.330000] TCP bind hash table entries: 2048 (order: 2, 16384 bytes)
[ 0.340000] TCP: Hash tables configured (established 2048 bind 2048)
[ 0.340000] UDP hash table entries: 256 (order: 1, 8192 bytes)
[ 0.350000] UDP-Lite hash table entries: 256 (order: 1, 8192 bytes)
[ 0.350000] NET: Registered protocol family 1
[ 4.280000] Unpacking initramfs...
[ 8.350000] console [sbi_console0] enabled
[ 8.350000] console [sbi_console0] enabled
[ 8.360000] bootconsole [early0] disabled
[ 8.360000] bootconsole [early0] disabled
[ 8.370000] futex hash table entries: 256 (order: 0, 6144 bytes)
[ 8.380000] workingset: timestamp_bits=61 max_order=16 bucket_order=0
[ 8.740000] io scheduler noop registered
[ 8.760000] io scheduler cfq registered (default)
[ 8.760000] usbcore: registered new interface driver udlfb
[ 10.070000] e1000e: Intel(R) PRO/1000 Network Driver - 3.2.6-k
[ 10.080000] e1000e: Copyright(c) 1999 - 2015 Intel Corporation.
[ 10.080000] ehci_hcd: USB 2.0 'Enhanced' Host Controller (EHCI) Driver
[ 10.090000] ehci-pci: EHCI PCI platform driver
[ 10.100000] usbcore: registered new interface driver usb-storage
[ 10.100000] usbcore: registered new interface driver usbhid
[ 10.110000] usbhid: USB HID core driver
[ 10.120000] gpio leds: loaded 4 GPIOs
[ 10.120000] xilinx-pcie-rv pcie: found; IO 0x60000000-7fffffff, CFG 0x50000000-53ffffff, BUS 1-63, IRQ 0
[ 10.140000] xilinx-pcie-rv pcie: PCIe Link is UP
[ 10.140000] xilinx-pcie-rv pcie: PCI host bridge to bus 0000:00
[ 10.140000] pci_bus 0000:00: root bus resource [mem 0x60000000-0x7fffffff]
[ 10.150000] pci_bus 0000:00: root bus resource [bus 01-3f]
[ 10.160000] pci 0000:00:00.0: bridge configuration invalid ([bus 00-00]), reconfiguring
[ 10.180000] pci 0000:01:00.0: bridge configuration invalid ([bus 00-00]), reconfiguring
[ 10.220000] pci 0000:02:00.0: bridge configuration invalid ([bus 00-00]), reconfiguring
[ 10.230000] pci 0000:02:01.0: bridge configuration invalid ([bus 00-00]), reconfiguring
[ 10.230000] pci 0000:02:02.0: bridge configuration invalid ([bus 00-00]), reconfiguring
[ 10.240000] pci 0000:02:03.0: bridge configuration invalid ([bus 00-00]), reconfiguring
[ 10.250000] pci 0000:02:04.0: bridge configuration invalid ([bus 00-00]), reconfiguring
[ 10.330000] pci 0000:00:00.0: BAR 8: assigned [mem 0x60000000-0x6effffff]
[ 10.330000] pci 0000:00:00.0: BAR 7: no space for [io size 0x4000]
[ 10.330000] pci 0000:00:00.0: BAR 7: failed to assign [io size 0x4000]
[ 10.340000] pci 0000:00:00.0: BAR 7: no space for [io size 0x3000]
[ 10.340000] pci 0000:00:00.0: BAR 7: failed to assign [io size 0x3000]
[ 10.350000] pci 0000:01:00.0: BAR 8: assigned [mem 0x60000000-0x6dffffff]
[ 10.350000] pci 0000:01:00.0: BAR 9: assigned [mem 0x6e000000-0x6e2fffff 64bit pref]
[ 10.360000] pci 0000:01:00.0: BAR 0: assigned [mem 0x6e300000-0x6e31ffff]
[ 10.360000] pci 0000:01:00.0: BAR 7: no space for [io size 0x4000]
[ 10.370000] pci 0000:01:00.0: BAR 7: failed to assign [io size 0x4000]
[ 10.370000] pci 0000:01:00.0: BAR 7: no space for [io size 0x3000]
[ 10.370000] pci 0000:01:00.0: BAR 7: failed to assign [io size 0x3000]
[ 10.380000] pci 0000:02:03.0: BAR 8: assigned [mem 0x60000000-0x6bffffff]

```

```
[ 10.390000] pci 0000:02:00.0: BAR 9: assigned [mem 0x6e000000-0x6e0fffff 64bit pref]
[ 10.390000] pci 0000:02:01.0: BAR 8: assigned [mem 0x6c000000-0x6c2fffff]
[ 10.400000] pci 0000:02:01.0: BAR 9: assigned [mem 0x6e100000-0x6e2fffff 64bit pref]
[ 10.400000] pci 0000:02:02.0: BAR 8: assigned [mem 0x6c300000-0x6c3fffff]
[ 10.400000] pci 0000:02:00.0: BAR 7: no space for [io size 0x1000]
[ 10.410000] pci 0000:02:00.0: BAR 7: failed to assign [io size 0x1000]
[ 10.410000] pci 0000:02:01.0: BAR 7: no space for [io size 0x1000]
[ 10.420000] pci 0000:02:01.0: BAR 7: failed to assign [io size 0x1000]
[ 10.420000] pci 0000:02:02.0: BAR 7: no space for [io size 0x1000]
[ 10.420000] pci 0000:02:02.0: BAR 7: failed to assign [io size 0x1000]
[ 10.430000] pci 0000:02:03.0: BAR 7: no space for [io size 0x1000]
[ 10.430000] pci 0000:02:03.0: BAR 7: failed to assign [io size 0x1000]
[ 10.440000] pci 0000:02:00.0: BAR 7: no space for [io size 0x1000]
[ 10.440000] pci 0000:02:00.0: BAR 7: failed to assign [io size 0x1000]
[ 10.450000] pci 0000:02:02.0: BAR 7: no space for [io size 0x1000]
[ 10.450000] pci 0000:02:02.0: BAR 7: failed to assign [io size 0x1000]
[ 10.450000] pci 0000:02:03.0: BAR 7: no space for [io size 0x1000]
[ 10.460000] pci 0000:02:03.0: BAR 7: failed to assign [io size 0x1000]
[ 10.460000] pci 0000:02:01.0: BAR 7: no space for [io size 0x1000]
[ 10.470000] pci 0000:02:01.0: BAR 7: failed to assign [io size 0x1000]
[ 10.470000] pci 0000:03:00.0: BAR 4: assigned [mem 0x6e000000-0x6e003fff 64bit pref]
[ 10.480000] pci 0000:03:00.0: BAR 2: assigned [mem 0x6e004000-0x6e004fff 64bit pref]
[ 10.480000] pci 0000:03:00.0: BAR 0: no space for [io size 0x0100]
[ 10.480000] pci 0000:03:00.0: BAR 0: failed to assign [io size 0x0100]
[ 10.490000] pci 0000:02:00.0: PCI bridge to [bus 03]
[ 10.490000] pci 0000:02:00.0: bridge window [mem 0x6e000000-0x6e0fffff 64bit pref]
[ 10.500000] pci 0000:04:00.0: BAR 0: assigned [mem 0x6c000000-0x6c001fff 64bit]
[ 10.500000] pci 0000:02:01.0: PCI bridge to [bus 04]
[ 10.500000] pci 0000:02:01.0: bridge window [mem 0x6c000000-0x6c2fffff]
[ 10.510000] pci 0000:02:01.0: bridge window [mem 0x6e100000-0x6e2fffff 64bit pref]
[ 10.510000] pci 0000:05:00.0: BAR 6: assigned [mem 0x6c300000-0x6c30ffff pref]
[ 10.520000] pci 0000:05:00.0: BAR 5: assigned [mem 0x6c310000-0x6c3107ff]
[ 10.520000] pci 0000:05:00.0: BAR 4: no space for [io size 0x0020]
[ 10.530000] pci 0000:05:00.0: BAR 4: failed to assign [io size 0x0020]
[ 10.530000] pci 0000:05:00.0: BAR 0: no space for [io size 0x0008]
[ 10.530000] pci 0000:05:00.0: BAR 0: failed to assign [io size 0x0008]
[ 10.540000] pci 0000:05:00.0: BAR 2: no space for [io size 0x0008]
[ 10.540000] pci 0000:05:00.0: BAR 2: failed to assign [io size 0x0008]
[ 10.550000] pci 0000:05:00.0: BAR 1: no space for [io size 0x0004]
[ 10.550000] pci 0000:05:00.0: BAR 1: failed to assign [io size 0x0004]
[ 10.560000] pci 0000:05:00.0: BAR 3: no space for [io size 0x0004]
[ 10.560000] pci 0000:05:00.0: BAR 3: failed to assign [io size 0x0004]
[ 10.560000] pci 0000:02:02.0: PCI bridge to [bus 05]
[ 10.570000] pci 0000:02:02.0: bridge window [mem 0x6c300000-0x6c3fffff]
[ 10.570000] pci 0000:06:00.0: BAR 0: assigned [mem 0x60000000-0x607fffff pref]
[ 10.580000] pci 0000:06:00.0: BAR 6: assigned [mem 0x68000000-0x6801ffff pref]
[ 10.580000] pci 0000:06:00.0: BAR 2: assigned [mem 0x68020000-0x6802ffff]
[ 10.590000] pci 0000:06:00.1: BAR 0: assigned [mem 0x68030000-0x6803ffff]
[ 10.590000] pci 0000:06:00.0: BAR 1: no space for [io size 0x0100]
[ 10.590000] pci 0000:06:00.0: BAR 1: failed to assign [io size 0x0100]
[ 10.600000] pci 0000:02:03.0: PCI bridge to [bus 06]
[ 10.600000] pci 0000:02:03.0: bridge window [mem 0x60000000-0x6bffffff]
[ 10.610000] pci 0000:02:04.0: PCI bridge to [bus 07]
[ 10.610000] pci 0000:01:00.0: PCI bridge to [bus 02-07]
[ 10.610000] pci 0000:01:00.0: bridge window [mem 0x60000000-0x6dffffff]
[ 10.620000] pci 0000:01:00.0: bridge window [mem 0x6e000000-0x6e2fffff 64bit pref]
[ 10.620000] pci 0000:00:00.0: PCI bridge to [bus 01-07]
[ 10.620000] pci 0000:00:00.0: bridge window [mem 0x60000000-0x6effffff]
[ 10.630000] r8169 Gigabit Ethernet driver 2.3LK-NAPI loaded
[ 10.640000] pci 0000:00:00.0: enabling device (0000 -> 0002)
[ 10.640000] pci 0000:01:00.0: enabling device (0000 -> 0002)
[ 10.650000] pci 0000:02:00.0: enabling device (0000 -> 0002)
[ 10.670000] r8169 0000:03:00.0 eth0: RTL8168evl/8111evl at 0xffffffff78008000, 00:0a:cd:29:9e:45,
```

```

XID 0c900880 IRQ 2
[ 10.670000] r8169 0000:03:00.0 eth0: jumbo features [frames: 9200 bytes, tx checksumming: ko]
[ 10.680000] pci 0000:02:01.0: enabling device (0000 -> 0002)
[ 10.680000] pci 0000:04:00.0: enabling device (0000 -> 0002)
[ 10.690000] xhci_hcd 0000:04:00.0: xHCI Host Controller
[ 10.690000] xhci_hcd 0000:04:00.0: new USB bus registered, assigned bus number 1
[ 10.700000] xhci_hcd 0000:04:00.0: hcc params 0x014050cf hci version 0x100 quirks 0x00000090
[ 10.730000] hub 1-0:1.0: USB hub found
[ 10.730000] hub 1-0:1.0: 2 ports detected
[ 10.740000] xhci_hcd 0000:04:00.0: xHCI Host Controller
[ 10.750000] xhci_hcd 0000:04:00.0: new USB bus registered, assigned bus number 2
[ 10.760000] usb usb2: We don't know the algorithms for LPM for this host, disabling LPM.
[ 10.780000] hub 2-0:1.0: USB hub found
[ 10.780000] hub 2-0:1.0: 2 ports detected
[ 10.790000] pci 0000:02:02.0: enabling device (0000 -> 0002)
[ 10.800000] ahci 0000:05:00.0: controller can do FBS, turning on CAP_FBS
[ 10.830000] ahci 0000:05:00.0: AHCI 0001.0200 32 slots 8 ports 6 Gbps 0xff impl SATA mode
[ 10.830000] ahci 0000:05:00.0: flags: 64bit ncq fbs pio
[ 10.930000] scsi host0: ahci
[ 10.940000] scsi host1: ahci
[ 10.950000] scsi host2: ahci
[ 10.970000] scsi host3: ahci
[ 10.980000] scsi host4: ahci
[ 10.990000] scsi host5: ahci
[ 11.000000] scsi host6: ahci
[ 11.020000] scsi host7: ahci
[ 11.020000] ata1: SATA max UDMA/133 abar m2048@0x6c310000 port 0x6c310100 irq 5
[ 11.030000] ata2: SATA max UDMA/133 abar m2048@0x6c310000 port 0x6c310180 irq 5
[ 11.030000] ata3: SATA max UDMA/133 abar m2048@0x6c310000 port 0x6c310200 irq 5
[ 11.040000] ata4: SATA max UDMA/133 abar m2048@0x6c310000 port 0x6c310280 irq 5
[ 11.040000] ata5: SATA max UDMA/133 abar m2048@0x6c310000 port 0x6c310300 irq 5
[ 11.050000] ata6: SATA max UDMA/133 abar m2048@0x6c310000 port 0x6c310380 irq 5
[ 11.050000] ata7: SATA max UDMA/133 abar m2048@0x6c310000 port 0x6c310400 irq 5
[ 11.060000] ata8: SATA max UDMA/133 abar m2048@0x6c310000 port 0x6c310480 irq 5
[ 11.070000] NET: Registered protocol family 17
[ 11.200000] usb 1-1: new high-speed USB device number 2 using xhci_hcd
[ 11.410000] ata3: SATA link down (SStatus 0 SControl 300)
[ 11.410000] ata2: SATA link down (SStatus 0 SControl 300)
[ 11.410000] ata1: SATA link up 6.0 Gbps (SStatus 133 SControl 300)
[ 11.420000] ata7: SATA link down (SStatus 0 SControl 300)
[ 11.420000] ata6: SATA link down (SStatus 0 SControl 300)
[ 11.430000] ata5: SATA link down (SStatus 0 SControl 300)
[ 11.430000] ata4: SATA link down (SStatus 0 SControl 300)
[ 11.430000] ata8: SATA link up 1.5 Gbps (SStatus 113 SControl 300)
[ 11.440000] ata8.00: ATAPI: MARVELL VIRTUALL, 1.09, max UDMA/66
[ 11.450000] ata1.00: ATA-10: Patriot Blaze, S9FM02.8, max UDMA/133
[ 11.450000] ata1.00: 234441648 sectors, multi 16: LBA48 NCQ (depth 31/32), AA
[ 11.460000] ata8.00: configured for UDMA/66
[ 11.460000] ata1.00: configured for UDMA/133
[ 11.470000] scsi 0:0:0:0: Direct-Access ATA Patriot Blaze 02.8 PQ: 0 ANSI: 5
[ 11.500000] usb 2-1: new SuperSpeed USB device number 2 using xhci_hcd
[ 11.510000] sd 0:0:0:0: [sda] 234441648 512-byte logical blocks: (120 GB/112 GiB)
[ 11.520000] sd 0:0:0:0: [sda] 4096-byte physical blocks
[ 11.530000] scsi 7:0:0:0: Processor Marvell Console 1.01 PQ: 0 ANSI: 5
[ 11.560000] sd 0:0:0:0: [sda] Write Protect is off
[ 11.570000] sd 0:0:0:0: [sda] Write cache: enabled, read cache: enabled, doesn't support DPO or FUA
[ 11.600000] usb-storage 2-1:1.0: USB Mass Storage device detected
[ 11.620000] sda: sda1
[ 11.650000] scsi host8: usb-storage 2-1:1.0
[ 11.670000] sd 0:0:0:0: [sda] Attached SCSI disk
[ 11.730000] Freeing unused kernel memory: 2564K (ffffffffff80000000 - fffffffffff80281000)
[ 11.740000] This architecture does not have kernel memory protection.
Starting logging: OK

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[ 12.660000] scsi 8:0:0:0: Direct-Access      SanDisk  SanDisk Ultra    PMAP PQ: 0 ANSI: 6
[ 12.690000] sd 8:0:0:0: [sdb] 61767680 512-byte logical blocks: (31.6 GB/29.5 GiB)
[ 12.700000] sd 8:0:0:0: [sdb] Write Protect is off
[ 12.700000] sd 8:0:0:0: [sdb] Write cache: disabled, read cache: enabled, doesn't support DPO or FUA
Starting mdev...
[ 12.920000] sdb: sdb1 sdb2
[ 13.040000] sd 8:0:0:0: [sdb] Attached SCSI removable disk
modprobe: can't change directory to '/lib/modules': No such file or directory
Initializing random number generator...
[ 34.330000] random: dd urandom read with 14 bits of entropy available
done.
Starting network...
[ 35.710000] r8169 0000:03:00:0: Direct firmware load for rtl_nic/rtl8168e-3.fw failed with error -2
[ 35.710000] r8169 0000:03:00:0 eth0: unable to load firmware patch rtl_nic/rtl8168e-3.fw (-2)
[ 35.740000] r8169 0000:03:00:0 eth0: link down
[ 35.750000] r8169 0000:03:00:0 eth0: link down
udhcpc (v1.24.2) started
Sending discover...
[ 38.110000] r8169 0000:03:00:0 eth0: link up
Sending discover...
Sending select for 10.14.3.190...
Lease of 10.14.3.190 obtained, lease time 3163
deleting routers
adding dns 10.14.0.3
Starting dropbear sshd: OK

Welcome to Buildroot
buildroot login: root
Password:
# uname -a
Linux buildroot 4.6.2-ga9474b8 #11 Sat Jul 9 19:12:05 PDT 2016 riscv GNU/Linux
# lspci
00:00.0 PCI bridge: Xilinx Corporation Device 7111
01:00.0 PCI bridge: PLX Technology, Inc. PEX 8632 32-lane, 12-Port PCI Express Gen 2 (5.0 GT/s) Switch (rev bb)
02:00.0 PCI bridge: PLX Technology, Inc. PEX 8632 32-lane, 12-Port PCI Express Gen 2 (5.0 GT/s) Switch (rev bb)
02:01.0 PCI bridge: PLX Technology, Inc. PEX 8632 32-lane, 12-Port PCI Express Gen 2 (5.0 GT/s) Switch (rev bb)
02:02.0 PCI bridge: PLX Technology, Inc. PEX 8632 32-lane, 12-Port PCI Express Gen 2 (5.0 GT/s) Switch (rev bb)
02:03.0 PCI bridge: PLX Technology, Inc. PEX 8632 32-lane, 12-Port PCI Express Gen 2 (5.0 GT/s) Switch (rev bb)
02:04.0 PCI bridge: PLX Technology, Inc. PEX 8632 32-lane, 12-Port PCI Express Gen 2 (5.0 GT/s) Switch (rev bb)
03:00.0 Ethernet controller: Realtek Semiconductor Co., Ltd.
RTL8111/8168/8411 PCI Express Gigabit Ethernet Controller (rev 06)
04:00.0 USB controller: Renesas Technology Corp. uPD720202 USB 3.0 Host Controller (rev 02)
05:00.0 SATA controller: Marvell Technology Group Ltd. 88SE9230 PCIe SATA 6Gb/s Controller (rev 11)
06:00.0 VGA compatible controller: Advanced Micro Devices, Inc. [AMD/ATI] RV370 [Radeon X300]
06:00.1 Display controller: Advanced Micro Devices, Inc. [AMD/ATI] RV370 [Radeon X300 SE]
# lsusb
Bus 002 Device 002: ID 0781:5581
Bus 001 Device 001: ID 1d6b:0002
Bus 002 Device 001: ID 1d6b:0003
# cat /proc/interrupts
          CPU0
0:         151      riscv  xilinx-pcie-rv
2:          29  Xilinx PCIe MSI    0  eth0
3:          72  Xilinx PCIe MSI    1  xhci_hcd
4:           0  Xilinx PCIe MSI    2  xhci_hcd
5:          14  Xilinx PCIe MSI    3  ahci[0000:05:00.0]
# cat /proc/softirqs
          CPU0
          HI:          2
          TIMER:       15502
          NET_TX:       19
          NET_RX:       169
          BLOCK:        59

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BLOCK_IOPOLL:      0
TASKLET:           63
SCHED:             0
HRTIMER:           0
RCU:               1210

# ping google.de
PING google.de (216.58.192.3): 56 data bytes
64 bytes from 216.58.192.3: seq=0 ttl=56 time=5.526 ms
64 bytes from 216.58.192.3: seq=1 ttl=56 time=4.702 ms
64 bytes from 216.58.192.3: seq=2 ttl=56 time=3.980 ms
^C
--- google.de ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 3.980/4.736/5.526 ms
# [ 285.640000] random: nonblocking pool is initialized
# ifconfig
eth0      Link encap:Ethernet  HWaddr 00:0A:CD:29:9E:45
          inet addr:10.14.3.190  Bcast:10.14.15.255  Mask:255.255.240.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:528 errors:0 dropped:11 overruns:0 frame:0
          TX packets:8 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:45151 (44.0 KiB)  TX bytes:1167 (1.1 KiB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:65 errors:0 dropped:0 overruns:0 frame:0
          TX packets:65 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1
          RX bytes:6984 (6.8 KiB)  TX bytes:6984 (6.8 KiB)

# ssh root@10.14.3.190

Host '10.14.3.190' is not in the trusted hosts file.
(ecdsa-sha2-nistp521 fingerprint md5 48:f4:1f:34:22:db:c7:60:c6:2c:d1:4b:e2:8e:3a:e4)
Do you want to continue connecting? (y/n) y
root@10.14.3.190's password:
# ls /
bin      etc      lib      linuxrc  mnt      proc     run      sys      usr
dev      init     lib64    media    opt      root     sbin     tmp      var
# exit
# mount /dev/sdb1 /mnt
[ 372.070000] EXT2-fs (sdb1): warning: mounting unchecked fs, running e2fsck is recommended
# chroot /mnt
# cat hello.c
#include <stdio.h>
int main() {
    printf("Hello world\n");
    return 0;
}
# riscv64-poky-linux-gcc -Wall -O2 hello.c -o hello
# ./hello
Hello world
#

```