# SiFive HiFive Unleashed Getting Started Guide

# v1p1

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## Proprietary Notice



## Release Information

| Version | Date | Changes |
|---|---|---|
| v1p1 | April 06, 2018 | • Updated introduction<br>• Added component diagrams<br>• Added links to schematics and design files<br>• Added firmware update instructions<br>• Added software development flow |
| v1p0 | March 09, 2018 | • Initial release |

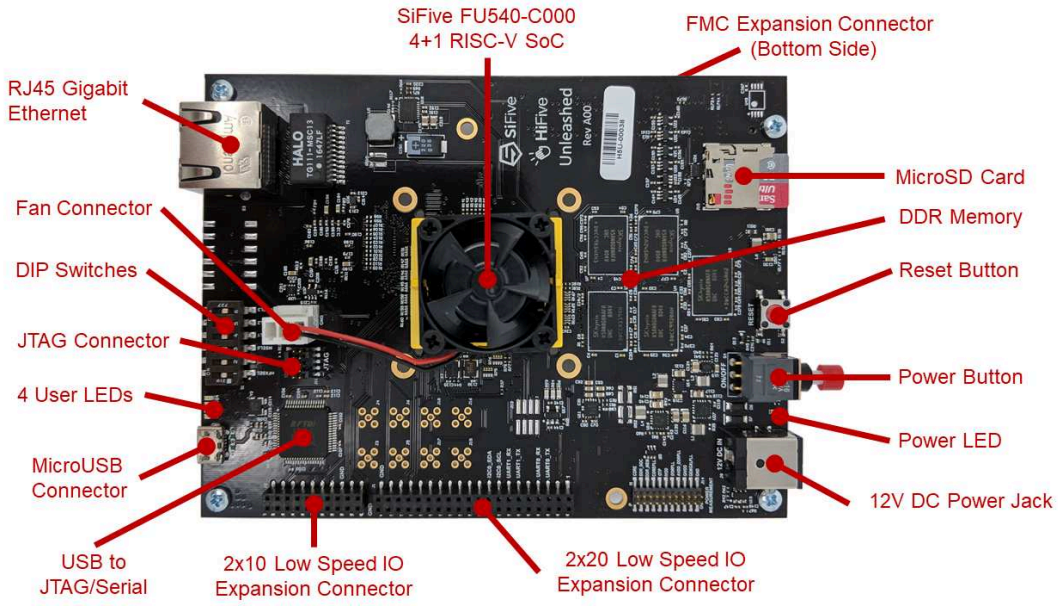
# Contents

# Chapter 1

# Introduction

HiFive Unleashed is a Linux development platform for SiFive's Freedom U540 SoC, the world's first 4+1 64-bit multi-core Linux-capable RISC-V SoC. The HiFive Unleashed has 8GB DDR4, 32MB QuadSPI Flash, a Gigabit Ethernet port, and a MicroSD card slot for more external storage. Additionally, the HiFive Unleashed supports adding new features, such as PCI Express (PCIe), through the FMC connector and low-speed I/O expansion connectors.

## 1.1 HiFive Unleashed Components




## 1.2 HiFive Unleashed Schematics

Schematics and design files for HiFive Unleashed are available at:
https://www.sifive.com/products/hifive-unleashed

# Chapter 2

# Required Hardware

Using the HiFive Unleashed Development Kit requires the following hardware:

**HiFive Unleashed Development Kit**

SiFive's HiFive Unleashed development kit is based around SiFive's FU540-C000 SoC. It can be purchased from Crowd Supply:

http://www.crowdsupply.com/sifive/hifive-unleashed

**USB A to Micro-B Cable**

Any standard USB Type A Male to Micro-B Male cable can be used to interface with the HiFive Unleashed.

http://store.digilentinc.com/usb-a-to-micro-b-cable

**12V DC Power Wall Adapter**

The HiFive Unleashed Development Kit requires an external 12V, 2A power supply. When not powering directly from the FMC expansion module, a 12V DC Wall Adapter with a 5.5 outer diameter, 2.5 mm center-positive barrel plug, must be plugged into DC power jack on the HiFive Unleashed. If powering directly from the FMC expansion module, then unplug the 12V DC power wall adapter from the development kit. Power should not be supplied from 2 different external sources.

# Chapter 3

# Optional Hardware

### Ethernet Cable

HiFive Unleashed Development Kit has an RJ45 Ethernet port that enables the FU540-C000 to connect to an 10/100/1000 Base-T network.

### FMC Expansion Carrier Card

Additional functionality can be added to the HiFive Unleashed Development Kit through the FMC connector. The FMC expansion carrier card typically has an FPGA to enable third-party developers to add new logic to the development kit.

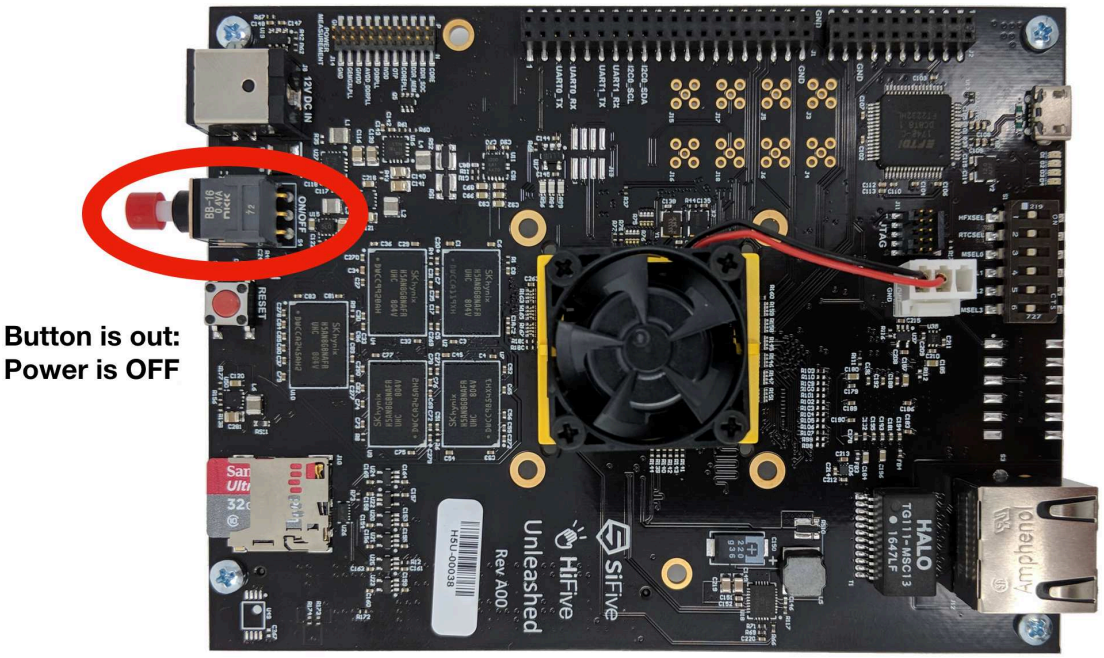
The HiFive Unleashed Development Kit can be directly powered from the FMC expansion carrier card. When powering from the FMC expansion carrier card, do not plug in the 12V DC adapter into the HiFive Unleashed.

# Chapter 4

# Board Setup

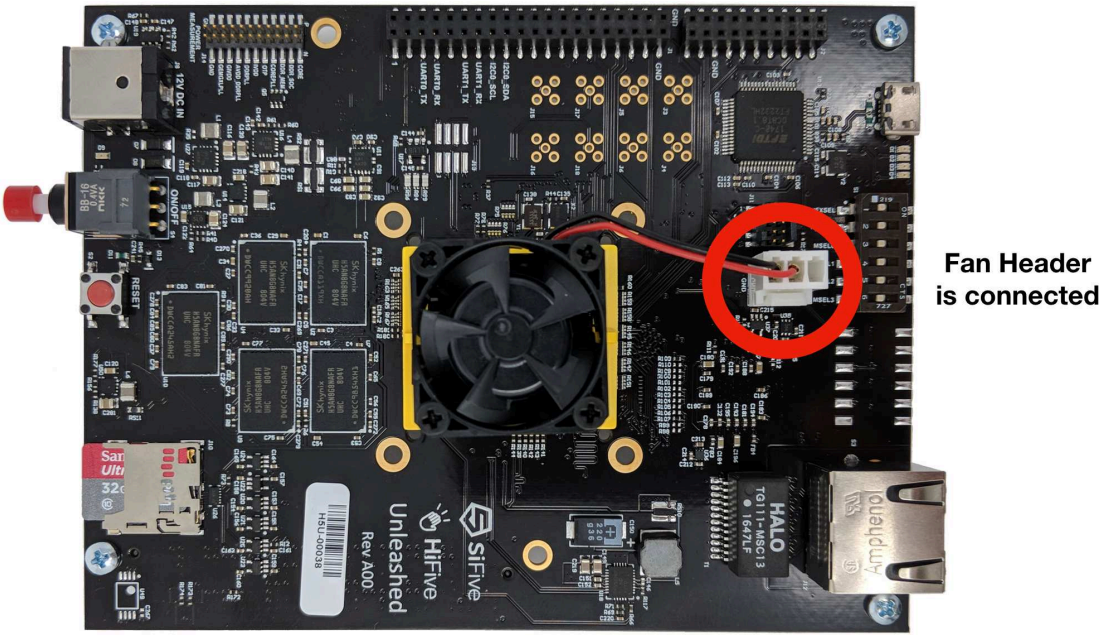
To prepare the board for use, follow these steps:

- Unplug the HiFive Unleashed and switch the power off (red button sticking out). The board is still powered even when the switch is off, so handle with care whenever power is applied.



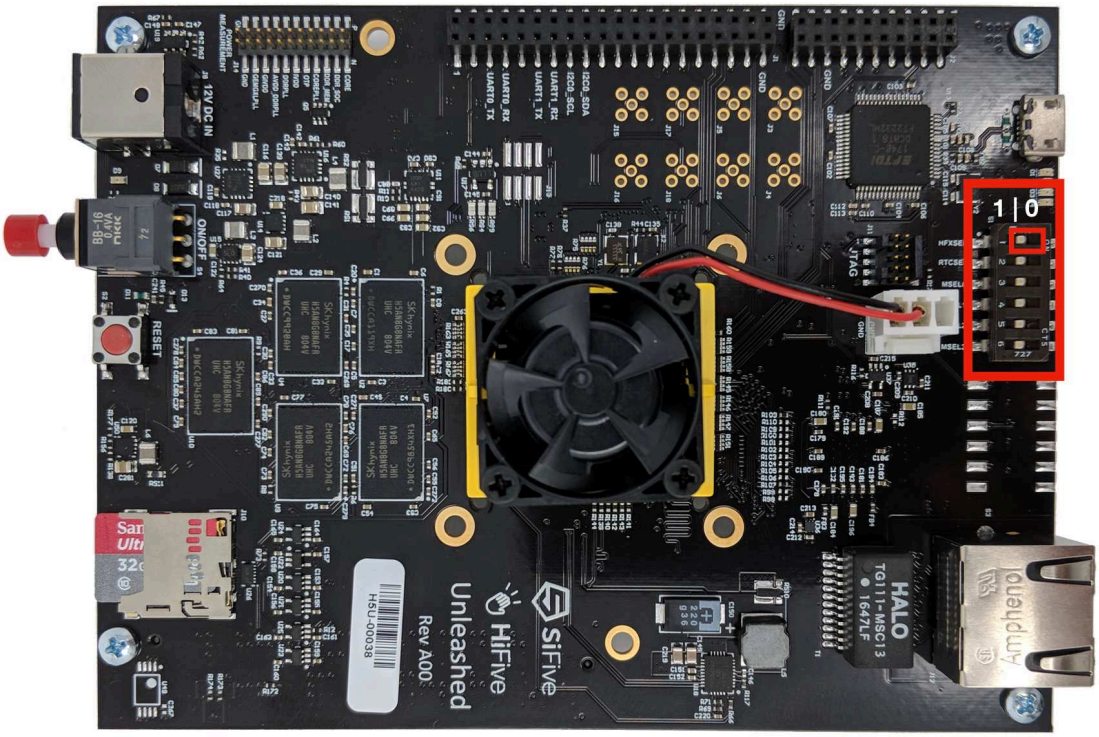
 

- Ensure the fan is plugged in.



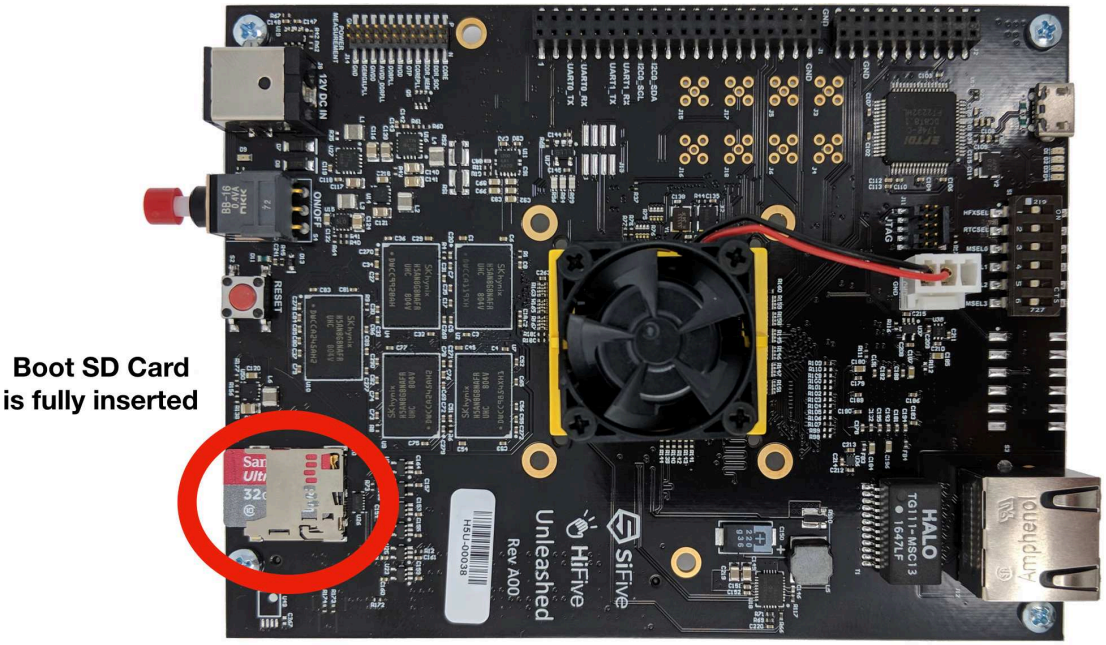

- Set all pins in the DIP-switch block to the LEFT. The ON position=0; therefore, this sets MSEL to mode 1111. See the boot modes table in next section for more information on MSEL.

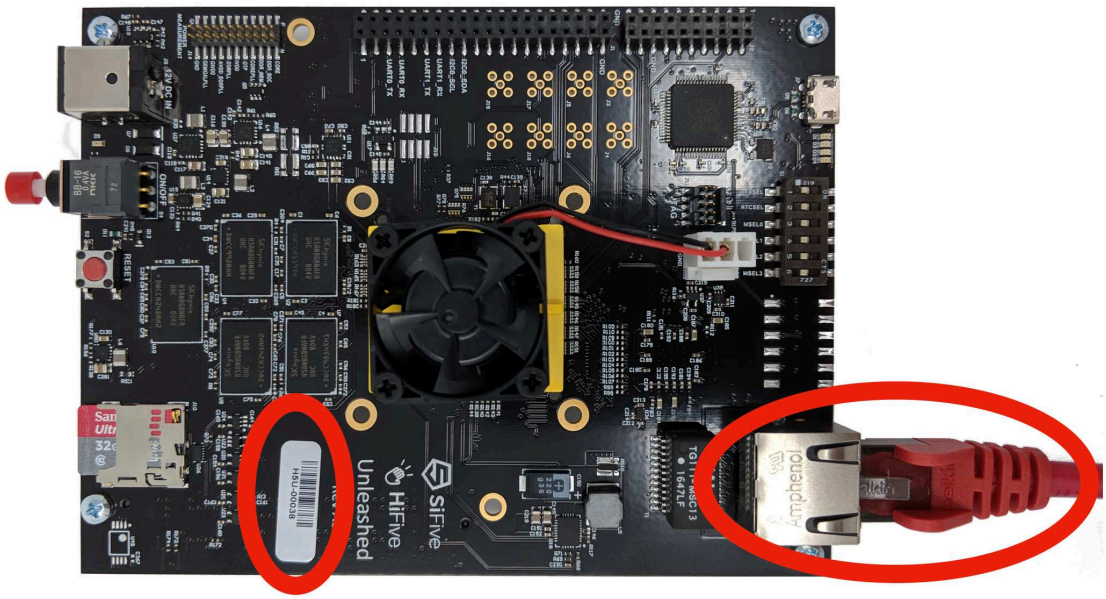


- Insert an SD-card programmed with bbl+linux. The github repository `sifive/freedom-u-sdk` produces an image suitable for writing to a partition with GUID type `2E54B353-1271-4842-806F-E436D6AF6985`.



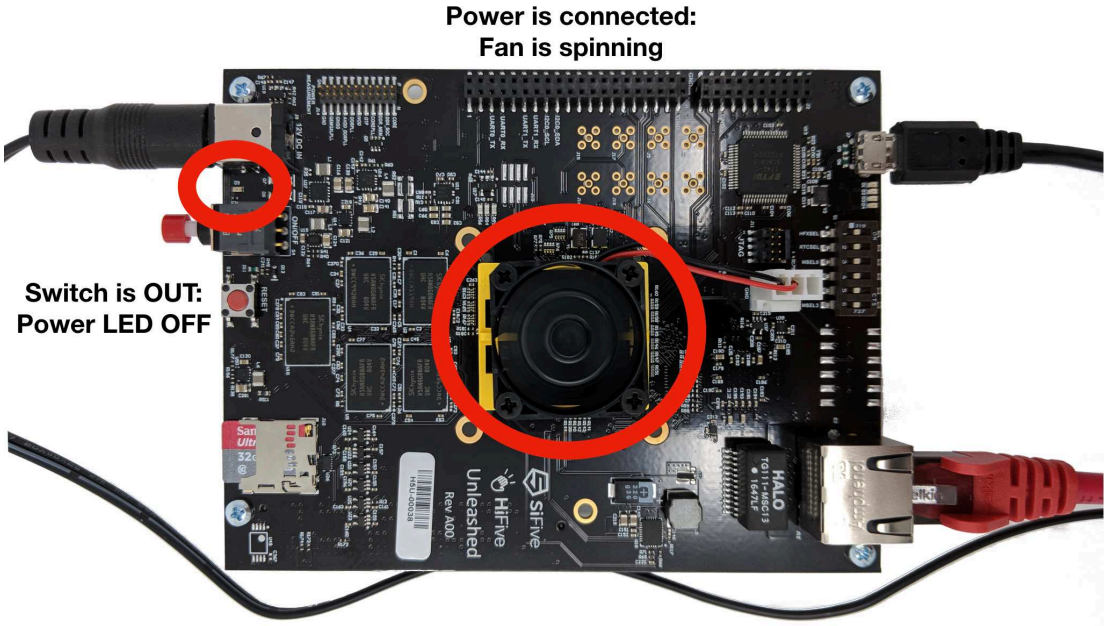

- If available, connect the board to a network switch. The board will run DHCP on boot and start an ssh server. The MAC address is `70:b3:d5:92:fX:XX`, where `X:XX` is replaced by the board number converted to hexadecimal. For example, if the board is `H5U-00063`, then the last digits of the MAC address are `0:3f`.



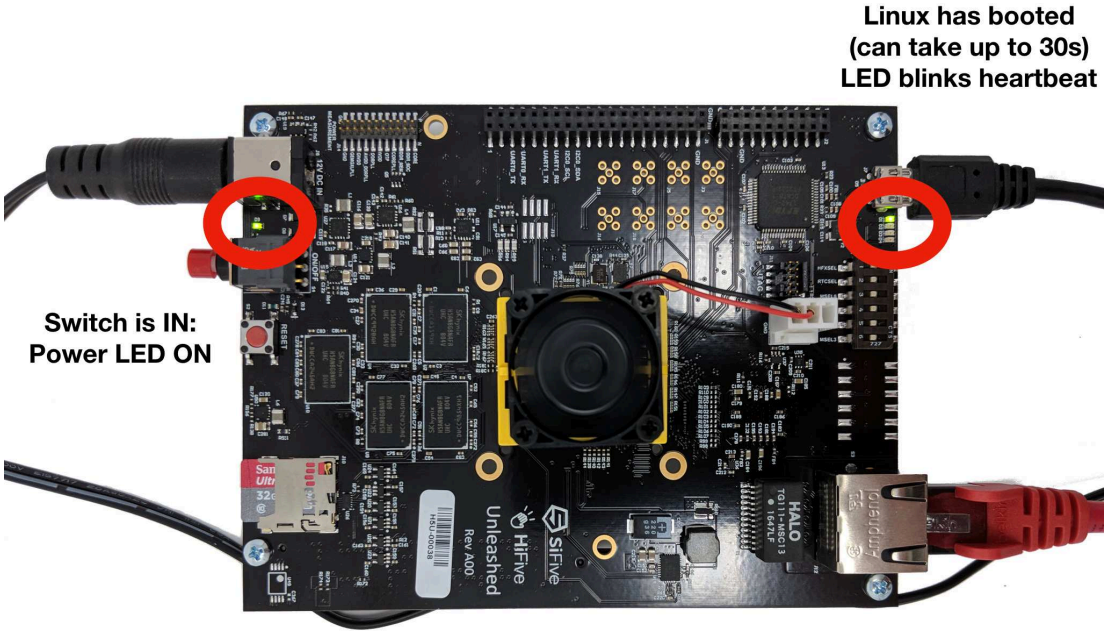

**H5U-00038**
**38 = 0x26**

- If available, connect the board via USB to a developer machine. The USB connector has two serial interfaces. The first contains the linux console running at `115200Hz`. The second provides JTAG suitable for use with openocd.
- Plug in the HiFive Unleashed; the fan should begin to spin.




- Turn on the HiFive Unleashed; after 30s a LED should begin to regularly blink a heartbeat.



# Chapter 5

# Boot and Run

Follow the steps from the previous section to power on the board. Once the heartbeat LED is pulsing regularly, you can connect to the board.

There are two ways to connect to the HiFive Unleashed: ssh and serial. The serial interface is slower and cannot receive files, so ssh is recommended.

## 5.1 Connecting with ssh

On power-on, the default `freedom-u-sdk` image obtains an IP address from DHCP and starts an ssh server. The MAC address of the board is `70:b3:d5:92:fX:XX`, where `X:XX` is replaced by the board number converted to hexadecimal. Ask your network administrator which IP address your board has obtained. Add the following to your `.ssh/config`, filling in the IP address:

```
Host hifiveu
        HostName                xxx.yyy.zzz.aaa
        User                    root
        StrictHostKeyChecking   no
        UserKnownHostsFile      /dev/null
```

To connect, run `ssh hifiveu`. The password is `sifive`.

## 5.2 Connecting with USB console

With a USB cable connected to the HiFive Unleashed, you can access the console. The console both shows the linux boot process and can be used to log in to the device.

From Mac OS, run: `sudo screen /dev/tty.usbserial-*01 115200`

From Linux, run: `sudo screen /dev/serial/by-path/*-port0 115200`

Hit enter a few times to see the login prompt. Username `root`, password `sifive`.

To quit screen, hit `Control-a`, `\`, `y`. If you do not quit properly, you can end up with multiple screens running at the same time. This manifests as lost characters both sent and received.

## 5.3 Knobs on the HiFive Unleashed

SD cards formatted by the `freedom-u-sdk` contains a second partition which can be used for persistent storage. You can access this storage by executing `mount /dev/mmcblk0p2 /mnt`. However, the linux mmc_spi driver is extremely slow, so this should not be used for large files.

Report core frequency: `echo $(cat /sys/devices/platform/soc/10000000.prci/rate)`

## 5.4 HiFive Unleashed Boot

The Freedom U500 supports several boot methods. The general flow follows multiple stages:

1. ROM0 (`0x1004`): Decode MSEL and jump to the address found in `0x1100 + 8*MSEL`. For MSEL > 4, the process proceeds to the next step.
2. ROM1 (`0x1_0000`): Decode MSEL to determine which media contains the First Stage Boot Loader (FSBL). The media is expected to be formatted with a GPT partition table (even on SPI flash). The entire contents of the first partition with GUID type `5B193300-FC78-40CD-8002-E86C45580B47` are downloaded into the L2 sideband memory and execution transfers there. ROM1 contains a hard-coded DTB block passed in `a1` to the FSBL, which ignores it.
3. FSBL (`0x800_0000`): Initialize core PPLs, DDR, and Ethernet PHY. Decode MSEL to determine which media contains the Berkeley Boot Loader (BBL). The media is expected to contain a GPT-formatted partition table. The contents of the first partition with GUID type `2E54B353-1271-4842-806F-E436D6AF69851` are downloaded into DDR memory and execution transfers there. The FSBL contains an embedded DTB describing both the Freedom U500 SoC and HiFive Unleashed board. The DTB is updated with the board MAC address and DDR capacity and passed to BBL in `a1`.
4. BBL (`0x8000_0000`): Initialize the RISC-V supervisor binary interface (SBI). Jump to the embedded linux kernel payload, passing a redacted DTB in `a1`.
5. Linux (`0xffff_ffe0_0000_0000`): Initializes all devices, starts DHCP + ssh.

Both ROM1 and the FSBL find the next boot loader stage based on the MSEL setting. All possible values are enumerated below. The three SPI interfaces on the Freedom U500 SoC can be used to download media either from SPI flash (using x4 data pins or x1) or an SD card, using the SPI protocol. ROM1 downloads the FSBL at 10MHz, while the FSBL uses 50MHz for SPI and 20MHz for SD.

| MSEL | FSBL | BBL | Purpose |
|---|---|---|---|
| 0000 | - | - | loops forever waiting for debugger |
| 0001 | - | - | jump directly to 0x2000_0000 (memory-mapped SPI0) |
| 0010 | - | - | jump directly to 0x3000_0000 (memory-mapped SPI1) |
| 0011 | - | - | jump directly to 0x4000_0000 (uncached ChipLink) |
| 0100 | - | - | jump directly to 0x6000_0000 (cached ChipLink) |
| 0101 | SPI0 x1 | SPI0 x1 | - |
| 0110 | SPI0 x4 | SPI0 x4 | Rescue image from flash (preprogrammed) |
| 0111 | SPI1 x4 | SPI1 x4 | - |
| 1000 | SPI1 SD | SPI1 SD | - |
| 1001 | SPI2 x1 | SPI2 x1 | - |
| 1010 | SPI0 x4 | SPI1 SD | - |
| 1011 | SPI2 SD | SPI2 SD | Rescue image from SD card |
| 1100 | SPI1 x1 | SPI2 SD | - |
| 1101 | SPI1 x4 | SPI2 SD | - |
| 1110 | SPI0 x1 | SPI2 SD | - |
| 1111 | SPI0 x4 | SPI2 SD | Default boot mode |

**Table 1:** MSEL Boot Mode Straps

# Chapter 6

# Firmware Update

As new features are added, the HiFive Unleashed may receive periodic updates. These updates can include changes to the First Stage Boot Loader (FSBL), the Device Tree Blob (DTB), the recovery Linux kernel, or the default user kernel. To keep things simple, all of these are updated in lock-step. The newest firmware can always be found on the SiFive website.

Firmware updates for the HiFive Unleashed consist of two files:

1. `hifive-unleashed-a00-A.B-YYYY-MM-DD.gpt`, an image which should be written to the flash chip. This contains the FSBL, DTB, and recovery kernel.
2. `hifive-unleashed-a00-A.B-YYYY-MM-DD.bin`, an image which may optionally be written to the SD card. This contains the default user kernel.

To upgrade, follow these steps:

1. Switch the `MSEL` DIP switches to 0110
2. Power-on the board
3. Copy the two files to the board with scp
4. Execute: `flashcp -v hifive-unleashed-a00-A.B-YYYY-MM-DD.gpt /dev/mtd0` to upgrade the contents of the flash.
5. Optional: `cat hifive-unleashed-a00-A.B-YYYY-MM-DD.bin > /dev/mmcblk0p1; sync` to upgrade the contents of the SD card. This may be necessary if the DTB is changed in a manner incompatible with older kernels. However, this step will also destroy any customizations the user has made to the kernel.
6. Restore the `MSEL` DIP switches to 1111

# Chapter 7

# Software Development Flow

## 7.1 Supported Platforms

This document assumes you are running on a modern Linux system. It has been tested on "bare metal" Linux systems and Linux systems running as a virtual machine. The process documented here was tested using Ubuntu 16.04.4. It should also work with other Linux distributions if the equivalent prerequisite packages are installed.

## 7.2 Software Development with the Freedom Unleashed SDK

### 7.2.1 Install Prerequisite Packages

Before starting, use the `apt-get` the command to install prerequisite packages:

```
sudo apt-get install autoconf automake autotools-dev bc bison \
  build-essential curl flex gawk gdisk git gperf libgmp-dev \
  libmpc-dev libmpfr-dev libncurses-dev libssl-dev libtool \
  patchutils python screen texinfo unzip zlib1g-dev
```

### 7.2.2 Clone the freedom-u-sdk Repository

After installing the prerequisite packages, clone and initialize the freedom-u-sdk with these commands:

```
git clone https://github.com/sifive/freedom-u-sdk.git
cd freedom-u-sdk
git submodule update --init --recursive
```

Note: this command can take up to thirty minutes or one hour to complete.

### 7.2.3 Build the System

Once the repository has been cloned and its sub-modules initialized, you are ready to build the system. Simply issue a `make` command from the freedom-u-sdk directory:

```
unset RISCV
make
```

Note: this command can take several hours on a fast machine.

### 7.2.4 Copy the System to an SD Card

Assuming all prerequisite packages were installed and the freedom-u-sdk repository's sub-modules were successfully initialized, the `make` command from the previous step *should* complete with a message describing how to copy the boot image to an SD card.

Before executing this command, you will need to know the device name of your SD card. You will also need to delete Master Boot Record (MBR) partitions from the SD card and create a GUID Partition Table with no partitions defined.

Under current revisions of Ubuntu Linux, it is not uncommon for SD cards to be auto-mounted upon insertion if they contain a valid partition table and file system. You may use the `mount` command to determine if this is the case. They should be unmounted before proceeding.

For example purposes, we will assume the device name of your SD card is **`/dev/exb`**. (This is almost certainly *not* the name of an actual device; you will need to substitute the name of your actual SD card device for **`/dev/exb`** in the commands which follow.)

If your SD card was auto-mounted when you inserted it, you can likely find the device name by running the `mount` command. You may also find the name of the device by running the `dmesg` command and looking for log entries with the word "mounted".

If this is the first time you have installed a freedom-u-sdk image onto an SD card, it likely still has a legacy partition table in the Master Boot Record. Before proceeding, you must delete partitions in the legacy partition table and create a new GUID Partition Table (GPT). You only need to do this once, so if you have done this before, you should skip this step.

The transcript below shows the user using the `gdisk` program to delete partitions defined in the MBR partition table and creating a GPT (GUID Partition Table). Bolded text is user input. Before proceeding to the next step, ensure that you have followed a similar procedure. The next step will fail if an existing MBR partition table remains on the SD card.

```
$ sudo gdisk /dev/exb
GPT fdisk (gdisk) version 1.0.1

Partition table scan:
  MBR: MBR only
  BSD: not present
  APM: not present
  GPT: not present
```

```
Found invalid GPT and valid MBR; converting MBR to GPT format
in memory. THIS OPERATION IS POTENTIALLY DESTRUCTIVE! Exit by
typing 'q' if you don't want to convert your MBR partitions
to GPT format!

Warning! Secondary partition table overlaps the last partition by
33 blocks!
You will need to delete this partition or resize it in another utility.

Command (? for help): p
Disk /dev/exb: 61440 sectors, 30.0 MiB
Logical sector size: 512 bytes
Disk identifier (GUID): E2725DE1-5C7D-47A4-AADB-1C87907A1E50
Partition table holds up to 128 entries
First usable sector is 34, last usable sector is 61406
Partitions will be aligned on 2048-sector boundaries
Total free space is 2014 sectors (1007.0 KiB)

Number  Start (sector)    End (sector)  Size       Code  Name
   1            2048           10239   4.0 MiB     8300  Linux filesystem
   2           10240           61439   25.0 MiB    8300  Linux filesystem

Command (? for help): d
Partition number (1-2): 2

Command (? for help): d
Using 1

Command (? for help): o
This option deletes all partitions and creates a new protective MBR.
Proceed? (Y/N): Y

Command (? for help): p
Disk /dev/exb: 61440 sectors, 30.0 MiB
Logical sector size: 512 bytes
Disk identifier (GUID): E1CE61B3-E5AD-422D-8974-A612BBEC9DE1
Partition table holds up to 128 entries
First usable sector is 34, last usable sector is 61406
Partitions will be aligned on 2048-sector boundaries
Total free space is 61373 sectors (30.0 MiB)

Number  Start (sector)    End (sector)  Size       Code  Name

Command (? for help): w

Final checks complete. About to write GPT data. THIS WILL OVERWRITE EXISTING
PARTITIONS!!

Do you want to proceed? (Y/N): Y
OK; writing new GUID partition table (GPT) to /dev/exb.
Warning: The kernel is still using the old partition table.
The new table will be used at the next reboot or after you
run partprobe(8) or kpartx(8)
The operation has completed successfully.
$
```

Once the MBR partition table and it's partitions have been deleted, you can continue with the process of writing the system to the SD card:

```
sudo make DISK=/dev/exb format-boot-loader
```

This command is known to fail with slower USB SD card devices. It *should* succeed if repeated.

The SD card should now contain a bootable linux image. Refer to previous chapters for instructions in how to boot your HiFive Unleashed board.

If you encounter difficulties while following this procedure, please visit the SiFive Developer Forums ( https://forums.sifive.com/ ). Other users may have encountered similar problems and posted usable solutions.

# Chapter 8

# Connector Pinout

## 8.1 FMC Connector

HiFive Unleashed has an VITA 57 FPGA Mezzanine Card (FMC) HPC connector (Samtec ASP-134602-01) to connect to an FPGA on an FMC carrier card (mating connector: Samtec ASP-134486-01). The communication interface between the HiFive Unleashed and the FPGA is ChipLink. The HiFive Unleashed can be powered directly from the FMC carrier card through the FMC connector.

| Pin Name | Voltage Rail | Direction | FMC Pin Number |
|---|---|---|---|
| CHIPLINK_RX_CLK | 1.8V | INPUT | G2 |
| CHIPLINK_RX_RST | 1.8V | INPUT | G37 |
| CHIPLINK_RX_SEND | 1.8V | INPUT | G36 |
| CHIPLINK_RX_DAT0 | 1.8V | INPUT | D20 |
| CHIPLINK_RX_DAT1 | 1.8V | INPUT | D21 |
| CHIPLINK_RX_DAT2 | 1.8V | INPUT | C22 |
| CHIPLINK_RX_DAT3 | 1.8V | INPUT | C23 |
| CHIPLINK_RX_DAT4 | 1.8V | INPUT | H22 |
| CHIPLINK_RX_DAT5 | 1.8V | INPUT | H23 |
| CHIPLINK_RX_DAT6 | 1.8V | INPUT | G21 |
| CHIPLINK_RX_DAT7 | 1.8V | INPUT | G22 |
| CHIPLINK_RX_DAT8 | 1.8V | INPUT | H25 |
| CHIPLINK_RX_DAT9 | 1.8V | INPUT | H26 |
| CHIPLINK_RX_DAT10 | 1.8V | INPUT | G24 |
| CHIPLINK_RX_DAT11 | 1.8V | INPUT | G25 |
| CHIPLINK_RX_DAT12 | 1.8V | INPUT | D23 |
| CHIPLINK_RX_DAT13 | 1.8V | INPUT | D24 |
| CHIPLINK_RX_DAT14 | 1.8V | INPUT | H28 |
| CHIPLINK_RX_DAT15 | 1.8V | INPUT | H29 |
| CHIPLINK_RX_DAT16 | 1.8V | INPUT | G27 |
| CHIPLINK_RX_DAT17 | 1.8V | INPUT | G28 |
| CHIPLINK_RX_DAT18 | 1.8V | INPUT | D26 |
| CHIPLINK_RX_DAT19 | 1.8V | INPUT | D27 |
| CHIPLINK_RX_DAT20 | 1.8V | INPUT | C26 |
| CHIPLINK_RX_DAT21 | 1.8V | INPUT | C27 |
| CHIPLINK_RX_DAT22 | 1.8V | INPUT | H31 |
| CHIPLINK_RX_DAT23 | 1.8V | INPUT | H32 |
| CHIPLINK_RX_DAT24 | 1.8V | INPUT | G30 |
| CHIPLINK_RX_DAT25 | 1.8V | INPUT | G31 |
| CHIPLINK_RX_DAT26 | 1.8V | INPUT | H34 |
| CHIPLINK_RX_DAT27 | 1.8V | INPUT | H35 |
| CHIPLINK_RX_DAT28 | 1.8V | INPUT | G33 |
| CHIPLINK_RX_DAT29 | 1.8V | INPUT | G34 |
| CHIPLINK_RX_DAT30 | 1.8V | INPUT | H37 |
| CHIPLINK_RX_DAT31 | 1.8V | INPUT | H38 |
| CHIPLINK_TX_CLK | 1.8V | OUTPUT | H4 |
| CHIPLINK_TX_RST | 1.8V | OUTPUT | G19 |
| CHIPLINK_TX_SEND | 1.8V | OUTPUT | G18 |
| CHIPLINK_TX_DAT0 | 1.8V | OUTPUT | G6 |
| CHIPLINK_TX_DAT1 | 1.8V | OUTPUT | G7 |
| CHIPLINK_TX_DAT2 | 1.8V | OUTPUT | D8 |
| CHIPLINK_TX_DAT3 | 1.8V | OUTPUT | D9 |

**Table 2:** FMC Connector Pinout

| Pin Name | Voltage Rail | Direction | FMC Pin Number |
|---|---|---|---|
| CHIPLINK_TX_DAT4 | 1.8V | OUTPUT | H7 |
| CHIPLINK_TX_DAT5 | 1.8V | OUTPUT | H8 |
| CHIPLINK_TX_DAT6 | 1.8V | OUTPUT | G9 |
| CHIPLINK_TX_DAT7 | 1.8V | OUTPUT | G10 |
| CHIPLINK_TX_DAT8 | 1.8V | OUTPUT | H10 |
| CHIPLINK_TX_DAT9 | 1.8V | OUTPUT | H11 |
| CHIPLINK_TX_DAT10 | 1.8V | OUTPUT | D11 |
| CHIPLINK_TX_DAT11 | 1.8V | OUTPUT | D12 |
| CHIPLINK_TX_DAT12 | 1.8V | OUTPUT | C10 |
| CHIPLINK_TX_DAT13 | 1.8V | OUTPUT | C11 |
| CHIPLINK_TX_DAT14 | 1.8V | OUTPUT | H13 |
| CHIPLINK_TX_DAT15 | 1.8V | OUTPUT | H14 |
| CHIPLINK_TX_DAT16 | 1.8V | OUTPUT | G12 |
| CHIPLINK_TX_DAT17 | 1.8V | OUTPUT | G13 |
| CHIPLINK_TX_DAT18 | 1.8V | OUTPUT | D14 |
| CHIPLINK_TX_DAT19 | 1.8V | OUTPUT | D15 |
| CHIPLINK_TX_DAT20 | 1.8V | OUTPUT | C14 |
| CHIPLINK_TX_DAT21 | 1.8V | OUTPUT | C15 |
| CHIPLINK_TX_DAT22 | 1.8V | OUTPUT | H16 |
| CHIPLINK_TX_DAT23 | 1.8V | OUTPUT | H17 |
| CHIPLINK_TX_DAT24 | 1.8V | OUTPUT | G15 |
| CHIPLINK_TX_DAT25 | 1.8V | OUTPUT | G16 |
| CHIPLINK_TX_DAT26 | 1.8V | OUTPUT | D17 |
| CHIPLINK_TX_DAT27 | 1.8V | OUTPUT | D18 |
| CHIPLINK_TX_DAT28 | 1.8V | OUTPUT | C18 |
| CHIPLINK_TX_DAT29 | 1.8V | OUTPUT | C19 |
| CHIPLINK_TX_DAT30 | 1.8V | OUTPUT | H19 |
| CHIPLINK_TX_DAT31 | 1.8V | OUTPUT | H20 |
| RESET_N | 1.8V | Open Drain | H5 |
| VDD_DCIN | 12V | Voltage Input | C35, C37 |
| VDD_1V8 | 1.8V | Voltage Output | H1 |
| PG_M2C | Open Drain | Open Drain | F1 |
| PRSNT_M2C_L | GND | Open Drain | H2 |
| GND | GND | GND | A1, A4, A5, A8, A9, A12, A13, A16, A17, A20, A21, A24, A25, A28, A29, A32, A33, A36, A37, A40, B2, B3, B6, B7, B10, B11, B14, B15, B18, B19, B22, B23, B26, B27, B30, B31, B34, B35, B38, B39, C1, C4, C5, C8, C9, C12, C13, C16, C17, C20, C21, |

**Table 2:** FMC Connector Pinout

| Pin Name | Voltage Rail | Direction | FMC Pin Number |
|---|---|---|---|
| | | | C24, C25, C28, C29, C32, C33, C36, C38, C40, D2, D3, D6, D7, D10, D13, D16, D19, D22, D25, D28, D37, D39, E1, E4, E5, E8, E11, E14, E17, E20, E23, E26, E29, E32, E35, E38, E40, F2, F3, F6, F9, F12, F15, F18, F21, F24, F27, F30, F33, F36, F39, G1, G4, G5, G8, G11, G14, G17, G20, G23, G26, G29, G32, G35, G38, G40, H3, H6, H9, H12, H15, H18, H21, H24, H27, H30, H33, H36, H39, J1, J4, J5, J8, J11, J14, J17, J20, J23, J26, J29, J32, J35, J38, J40, K2, K3, K6, K9, K12, K15, K18, K21, K24, K27, K30, K33, K36, K39 |

**Table 2:** FMC Connector Pinout

**Pin and Signal Description**

CHIPLINK_RX_CLK: ChipLink Receive Clock from the FMC carrier card to HiFive Unleashed.

CHIPLINK_RX_RST: ChipLink Receive Reset from the FMC carrier card to HiFive Unleashed.

CHIPLINK_RX_SEND: ChipLink Receive Send strobe from the FMC carrier card to HiFive Unleashed.

CHIPLINK_RX_DATA[31:0]: ChipLink Receive Data bus from the FMC carrier card to HiFive Unleashed.

CHIPLINK_TX_CLK: ChipLink Transmit Clock from HiFive Unleashed to the FMC carrier card.

CHIPLINK_TX_RST: ChipLink Transmit Reset from HiFive Unleashed to the FMC carrier card.

CHIPLINK_TX_SEND: ChipLink Transmit Send strobe from HiFive Unleashed to the FMC carrier card.

CHIPLINK_TX_DATA[31:0]: ChipLink Transmit Data bus from HiFive Unleashed to the FMC carrier card.

RESET_N: Bidirectional, Open Drain active-low system-level reset. Either the HiFive Unleashed or the FMC carrier card can initiate a system level reset by pulling this pin low. The pull up resistor is on the HiFive Unleashed.

VDD_DCIN: 12V voltage rail from the FMC carrier card to HiFive Unleashed.

VDD_1V8: 1.8V I/O voltage from HiFive Unleashed to the FMC carrier card.

PG_M2C: Open-drain, active high power good signal to indicate that HiFiveUnleashed has powered up correctly. The pull up resistor is on the FMC carrier card.

PRSNT_M2C_L: Active-low signal to indicate to the FMC carrier card that HiFive Unleashed is present. The pull up resistor is on the FMC carrier card.

All other pins are No Connect on the FMC connector.

## 8.2 Low Speed I/O Expansion Connectors

There are two low speed I/O expansion connectors, a 2mm pitch 2x20 and a 2mm pitch 2x10 female headers.

The 2x20 connector follows the 96Boards EE specification expansion connector pinout. All I/O voltage are at 1.8V.

| **Net Name** | **Pin Name** | **#** | **#** | **Pin Name** | **Net Name** |
|---|---|---|---|---|---|
| GND | GND | 1 | 2 | GND | GND |
| No Connect | UART0_CTS | 3 | 4 | PWR_BTN_N | PWR_BTN_N |
| UART0_TX | UART0_TXD | 5 | 6 | RST_BTN_N | RESET_N |
| UART0_RX | UART0_RXD | 7 | 8 | SPI0_SCLK | QSPI1_SCK |
| No Connect | UART0_RTS | 9 | 10 | SPI0_DIN | QSPI1_DQ1 |
| UART1_TX | UART1_TXD | 11 | 12 | SPI0_CS | QSPI1_CS0 |
| UART1_RX | UART1_RXD | 13 | 14 | SPI0_DOUT | QSPI1_DQ0 |
| I2C0_SCL | I2C0_SCL | 15 | 16 | PCM_FS | No Connect |
| I2C0_SDA | I2C0_SDA | 17 | 18 | PCM_CLK | No Connect |
| No Connect | I2C1_SCL | 19 | 20 | PCM_DO | No Connect |
| No Connect | I2C1_SDA | 21 | 22 | PCM_DI | No Connect |
| GPIO0 | GPIO-A | 23 | 24 | GPIO-B | GPIO1 |
| GPIO2 | GPIO-C | 25 | 26 | GPIO-D | GPIO3 |
| GPIO4 | GPIO-E | 27 | 28 | GPIO-F | GPIO5 |
| GPIO6 | GPIO-G | 29 | 30 | GPIO-H | GPIO7 |
| GPIO8 | GPIO-I | 31 | 32 | GPIO-J | GPIO9 |
| GPIO15 | GPIO-K | 33 | 34 | GPIO-L | No Connect |
| VDD_1V8 | +1V8 | 35 | 36 | SYS_DCIN | VDD_DCIN |
| VDD_5V0 | +5V | 37 | 38 | SYS_DCIN | VDD_DCIN |
| GND | GND | 39 | 40 | GND | GND |

**Table 3:** 2x20 Low Speed I/O Expansion Connector Pinout

The 2x10 connector has additional low speed I/Os. All I/O voltage are at 1.8V.

| Net Name | Direction | # | # | Direction | Net Name |
|---|---|---|---|---|---|
| PWM0_0 | OUTPUT | 1 | 2 | OUTPUT | PWM0_2 |
| PWM0_1 | OUTPUT | 3 | 4 | OUTPUT | PWM0_3 |
| GEMGXL_RST (Reset to Ethernet PHY) | OUTPUT | 5 | 6 | BIDIRECTIONAL | QSPI1_DQ2 |
| FASTLINK_FAIL (Output from Ethernet PHY) | OUTPUT | 7 | 8 | BIDIRECTIONAL | QSPI1_DQ3 |
| EN_VDD_SD (Enable Power to SD Card) | OUTPUT | 9 | 10 | OUTPUT | QSPI1_CS1 |
| SD_CD (SD Card Detect) | OUTPUT | 11 | 12 | OUTPUT | QSPI1_CS2 |
| (NC) | NC | 13 | 14 | OUTPUT | QSPI1_CS3 |
| PWM1_0 | OUTPUT | 15 | 16 | GND | GND |
| PWM1_1 | OUTPUT | 17 | 18 | OUTPUT | PWM1_2 |
| GND | GND | 19 | 20 | OUTPUT | PWM1_3 |

**Table 4:** 2x10 Low Speed I/O Expansion Connector Pinout

## 8.3 MicroUSB Connector

The MicroUSB connector provides a connection to UART0 and JTAG from a Host PC. If needed, drivers for the FTDI FT2232H can be found at:

http://www.ftdichip.com/FTDrivers.htm

## 8.4 MicroSD Card Connector

The MicroSD card connector enables adding more storage with an external MicroSD card. The connector is accessible from the Freedom U540 through SPI0.

## 8.5 JTAG Connector

The JTAG connector is a 1.27 mm pitch 2x5 male header (SAMTEC FTSH-105 or equivalent) that is complaint to the RISC-V External Debug Support V0.13 specification.

More information about the RISC-V External Debug can be found at:

https://www.sifive.com/documentation/risc-v/risc-v-external-debug-support

| **Pin Name** | **#** | **#** | **Pin Name** |
|---|---|---|---|
| TCK | 1 | 2 | GND |
| TDO | 3 | 4 | VCC |
| TMS | 5 | 6 | SRSTn |
| (NC) | 7 | 8 | (TRSTn/NC) |
| TDI | 9 | 10 | GND |

**Table 5:** JTAG Connector Pinout