RAPTOR
COMPUTING SYSTEMS

Arctic Tern ModBMC System / PCIe Development Kit

User's Guide
For OpenPOWER System Integration

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Safety Information

ELECTRICAL SAFETY

- To reduce the risk of electric shock, disconnect the power cable before relocating or servicing the system.
- When adding or removing devices to or from the system, ensure that the power cables for the devices are unplugged before the signal cables are connected. If possible, disconnect all power cables from the existing system before you add a device.
- Before connecting or removing signal cables from the motherboard, ensure that all power cables are unplugged.
- Seek professional assistance before using an adapter or extension cord. These devices could interrupt the grounding circuit.
- Make sure that your power supply is set to the correct voltage in your area. If you are not sure about the voltage of the electrical outlet you are using, contact your local power company.
- If your power supply is not functioning, do not attempt to repair it. Contact a qualified service technician or your retailer.

OPERATIONAL SAFETY

- Before installing the carrier card or connecting devices to it, carefully read any and all provided manuals for the devices in question.
- Before using the product, make sure all cables are correctly connected and the power cables are not damaged. If you find any damage, contact your dealer immediately.
- To avoid short circuits, keep paper clips, screws, staples, and other foreign metallic objects away from connectors, slots, sockets and circuitry.
- Avoid dust, humidity, and temperature extremes. Do not locate the product in any area where it may become wet or damp.
- Place the product on a stable surface at all times.
- If you encounter technical problems with the product, contact a qualified service technician or your retailer.

Notices

FEDERAL COMMUNICATIONS COMMISSION STATEMENT

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with manufacturer's instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

ENVIRONMENTAL DISPOSAL STATEMENTS

DO NOT throw the system or its components in municipal waste. This product has been designed to enable proper reuse of parts and recycling. This symbol of the crossed out wheeled bin indicates that the product (electrical and electronic equipment) should not be placed in municipal waste. Check local regulations for disposal of electronic products.

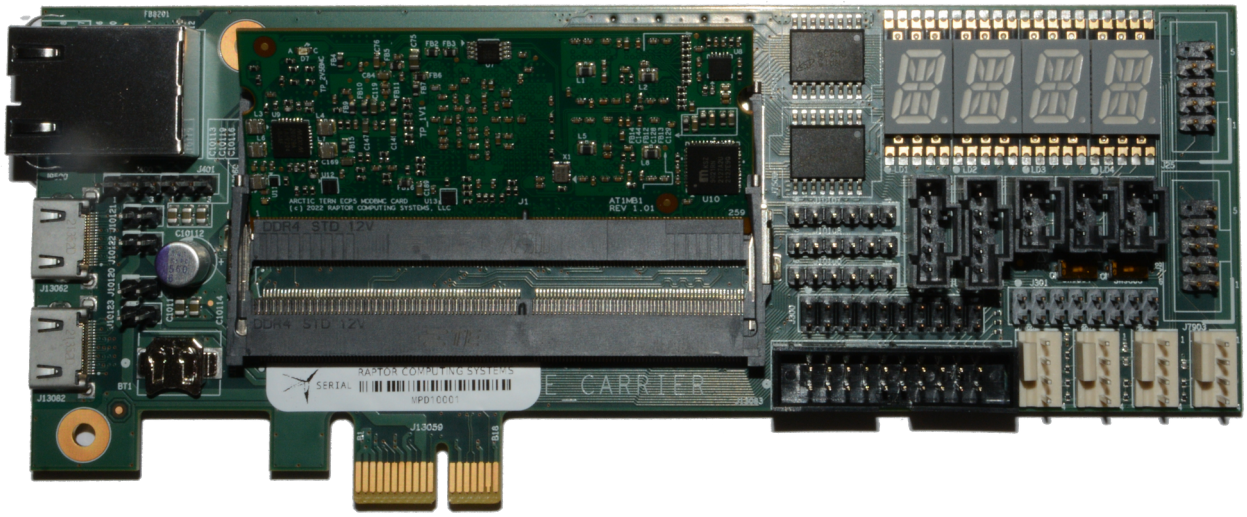
DO NOT throw the mercury-containing button cell battery in municipal waste. This symbol of the crossed out wheeled bin indicates that the battery should not be placed in municipal waste.

Module Installation and Removal

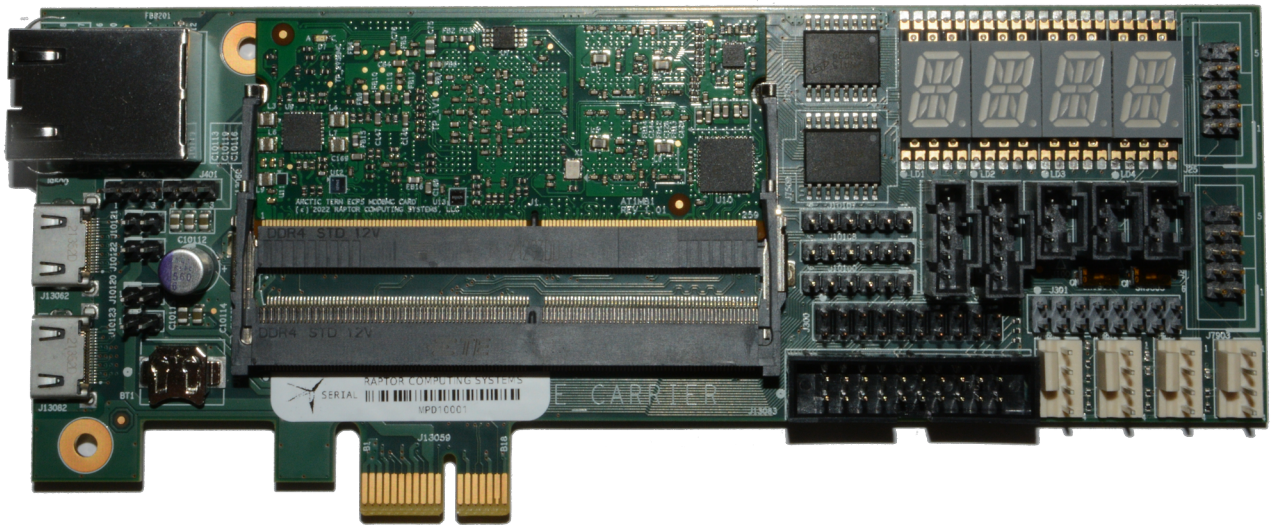
MODULE INSERTION

Modules are inserted at an angle, then rotated downward into the socket latches in the same manner as standard SODIMM memory modules. Module 1 must be installed before Module 2 (if applicable) due to mechanical interference between the two modules during the installation process.

To install, first gently insert the module at an approximate 45 degree angle to the carrier card as shown. The module must be fully inserted to the hard stop, otherwise it will not latch during the second part of the installation process.



Once inserted, carefully but firmly press the module flat toward the carrier card. Use your thumbs and press on the upper two corners of the module during this process. Installation is complete once the latches engage and the module no longer attempts to return to an angled position away from the carrier card.



MODULE REMOVAL

Modules must be removed in the reverse order to installation. Module 2 must be removed before Module 1 due to mechanical interference between the two modules during the removal process.

To remove, gently spread the two black plastic socket latches on either side of the module until the module “pops” up and sits at an angle to the carrier card. Once the module is at an angle to the carrier card, grasp the module by the two short edges and gently but firmly pull the module directly away from the socket until it releases from the carrier card.

CAUTION: Attempting to over-rotate or otherwise mechanically force the module away from the carrier card can result in damage to the socket and/or module. **Damage caused by improper installation or removal is not covered under warranty.**

Headers and Connectors

PIN NUMBERING CONVENTIONS

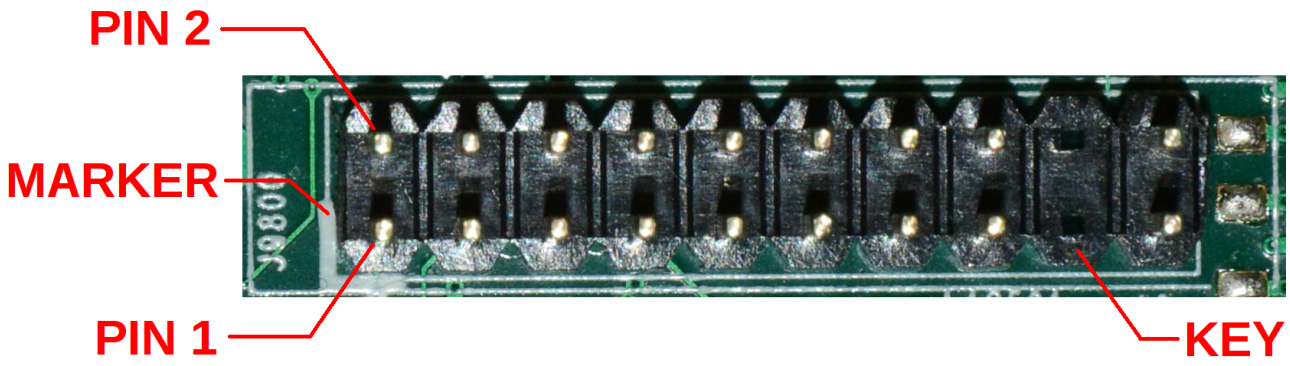


Illustration 1: Dual Row Header with Annotated Pins, Marker, and Key

All headers on the AT1PEC1 follow a standard layout, with pin 1 being denoted with a white silkscreen marking. Dual row headers follow the numbering convention shown above, where all even pins are on one side of the header and all odd pins are on the other. Single row headers use a monotonically increasing pin number, starting from pin 1. Key pins are not physically present, but are still counted as pins in the numbering scheme.

Hardware Setup and Installation

INTRODUCTION

The objective of this guide will be to install an Arctic Tern PCIe Carrier into a Raptor Computing Systems Talos II system, with the goal of replacing all functionality originally provided by the on-board proprietary ASpeed BMC ASIC. The Kestrel HDL and software stack from Raptor Engineering will be used to provide BMC functionality on the Arctic Tern hardware in this guide.

CAUTION It is important to note that as of this guide's release soft BMCs are a relatively new development, and that the leading Kestrel BMC stack for resource constrained FPGA environments is under continuous development. As a result, while the underlying Talos II system will IPL more or less reliably as of this writing, some features are not yet enabled, for example full Redfish support and VGA graphics output. Future releases of the Kestrel stack are expected to enable these features on the existing Arctic Tern and Talos II / Blackbird hardware; if specific features are critical for your application Raptor Engineering does offer paid development and consulting services that would allow Kestrel to meet your specific requirements in a cost effective manner. Please contact us at sales@raptorcs.com for a referral if you wish to pursue active development of a specific Kestrel feature set.

BMC DEVELOPMENT KIT CONTENTS

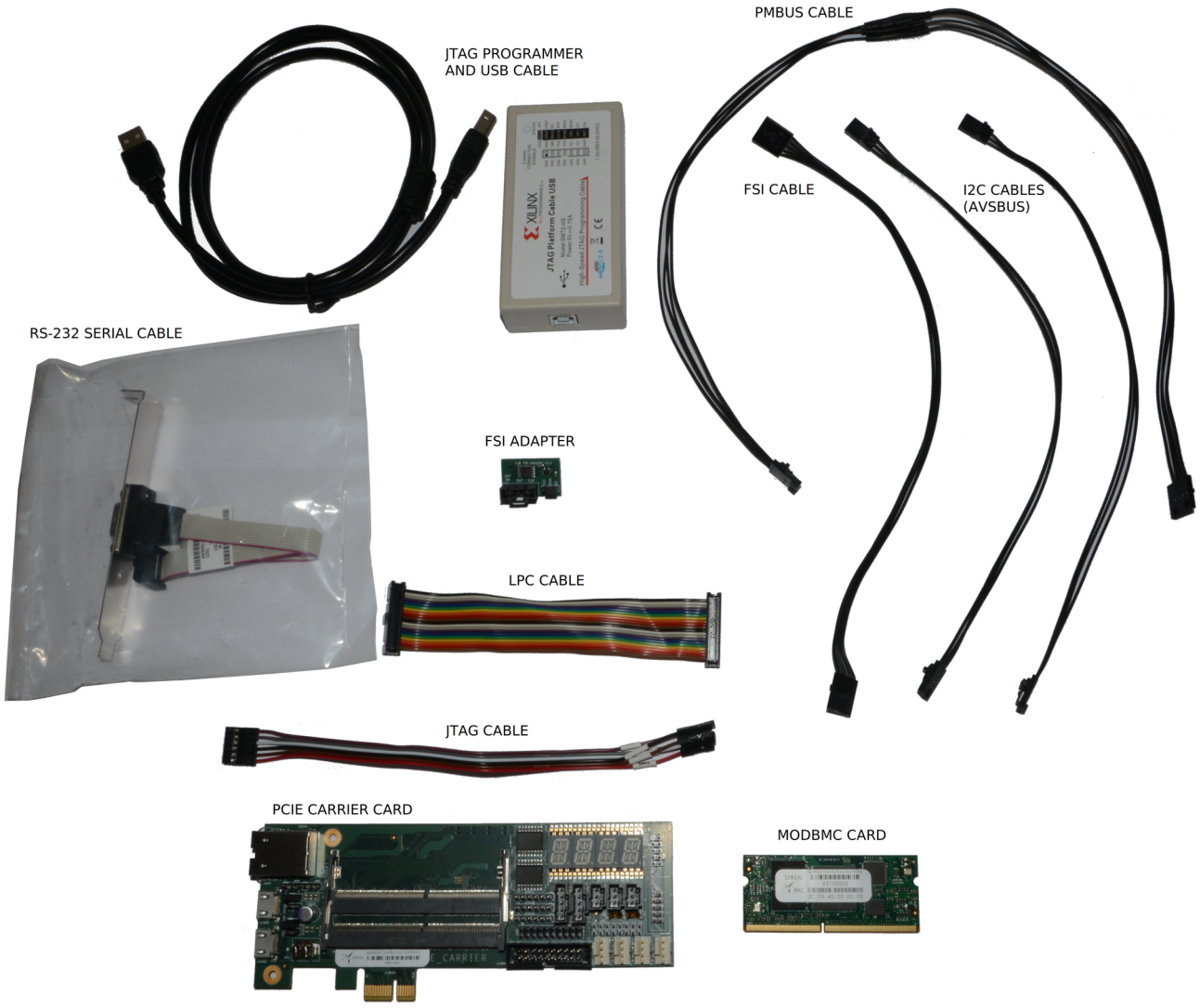


Figure 1: BMC Development Kit Contents

This guide will assume you either have a Raptor Computing Systems Arctic Tern BMC Development Kit or compatible set of components available. Please see Figure 1 for the kit contents. You will also need a standard serial cable and, if your PC does not have an on-board RS-232 serial port, a USB to RS-232 serial converter will be required.

This guide will also assume that your host PC is running Debian Linux. Raptor Computing Systems recommends Debian 11 running on an OpenPOWER system such as our Talos II or Blackbird machines, as most Kestrel development takes place with that specific hardware and software combination. While Fedora, Gentoo, and other distributions with ppc64el versions should work with minor modifications, we will not generally be able to assist with issues experienced on non-OpenPOWER hardware outside of an active support contract.

SYSTEM OVERVIEW

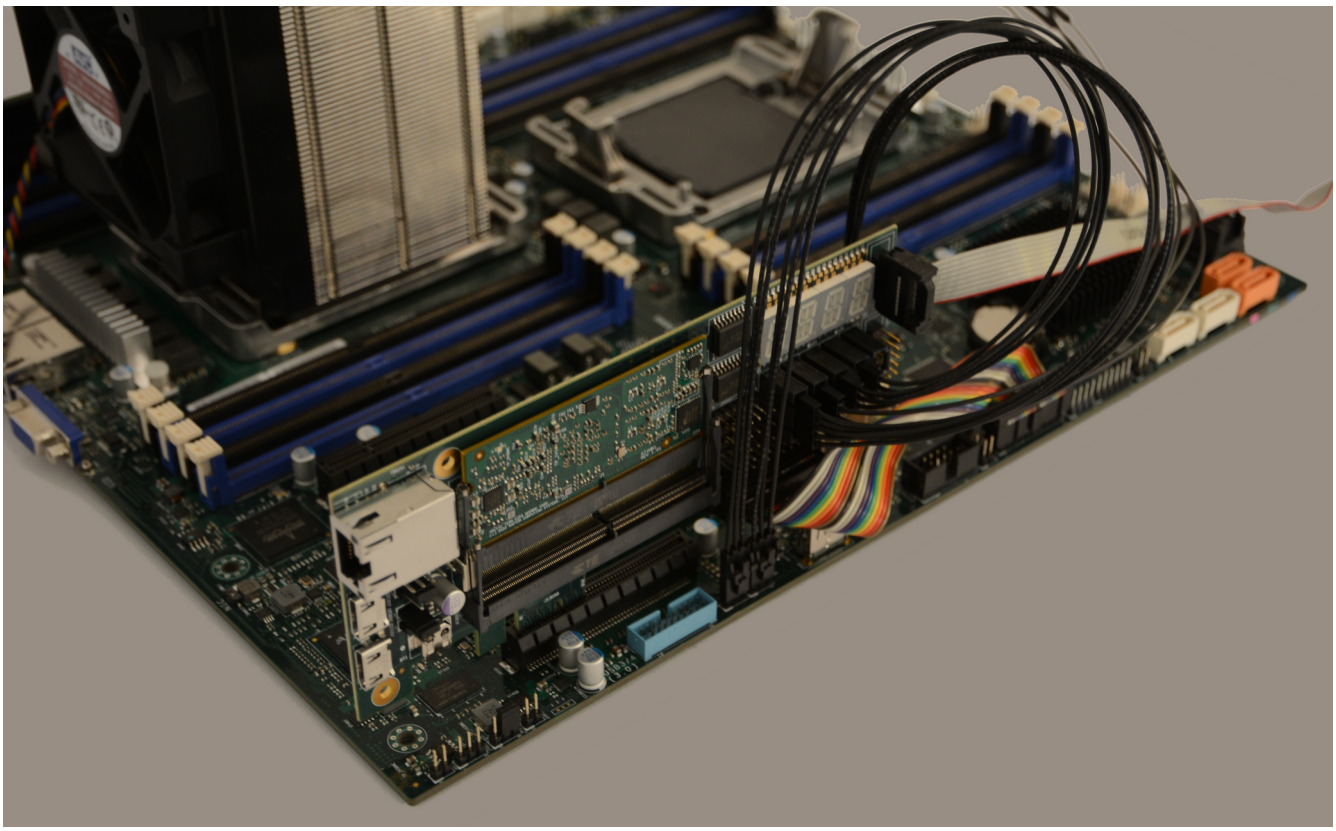


Figure 2: Arctic Tern BMC Kit installed in Talos II system

During the setup process, you will be installing the Arctic Tern BMC kit into a Talos II system, and connecting the various busses required to allow the Arctic Tern to completely take over all critical system functions from the on-board ASpeed BMC ASIC. This will require cables to be installed for LPC, FSI, PMBus, and AVSBus, in addition to the PCIe card itself.

NOTE While it is possible to use the Arctic Tern as a BMC without installation into a PCIe slot, it will be unable to function as a VGA controller or USB host device; in that case, you would need to use a discrete GPU or the ASpeed VGA display block to enable graphics output. You will also need to provide +3.3V standby power; on Raptor Computing Systems POWER9 products this power rail is available on the LPC TPM connector and will be automatically used when the Arctic Tern card is attached to the LPC bus. If the Arctic Tern card is not intended to fully replace the ASpeed BMC, i.e. if the LPC bus cable is not attached, then provisions for external power will need to be made when not installed in a PCIe slot.

ARCTIC TERN MODULE INSTALLATION

The Arctic Tern BMC Development Kit comes with a single Arctic Tern ECP5 FPGA module. Follow the instructions in the "Module Installation and Removal" section to install the module into the primary slot on the PCIe carrier card.

JTAG SETUP

The Arctic Tern PCIe carrier provides two JTAG headers, one for each module. Any OpenOCD compatible JTAG adapter can be used to program the Arctic Tern module, however FTDI based adapters are preferred as they allow the use of the `ecpprog` tool to interact with the on-board Flash memory of the Arctic Tern module. Raptor Computing Systems provides a generic Digilent HS2 compatible adapter with OpenOCD support in the BMC development kit, but any similar adapter should function correctly with the Arctic Tern system.

The primary module JTAG interface is available on J10107, and the secondary module JTAG interface is availale on J10108. In a single module system, only the primary module is installed, therefore the JTAG adapter should be connected to J10107.

Use the labels on the JTAG cable to attach each flying lead to its corresponding pin on the JTAG adapter as shown in Figure 3. Once complete, you may set the JTAG adapter and cable aside for the rest of the wiring process; its single pre-wired connector will be attached to the Arctic Tern board at the end of this guide.

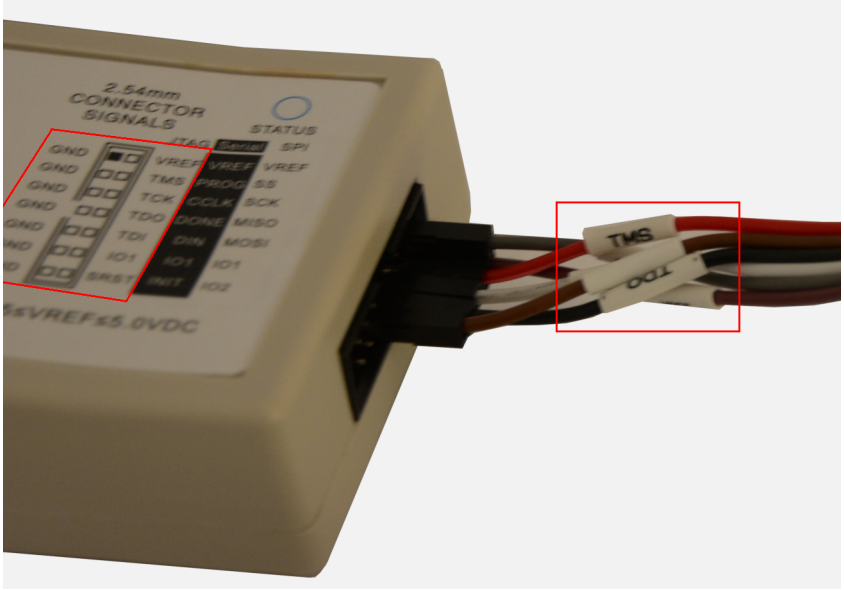


Figure 3: JTAG Adapter Wiring

NOTE While it is possible to chain both modules onto the same JTAG bus in a two-module system, much of the existing software assumes one FPGA per adapter. As a result, Raptor recommends one JTAG adapter per module unless you have the ability to modify the OpenOCD configuration files and source code of utilities such as `ecpprog` to enable the second target on the bus.

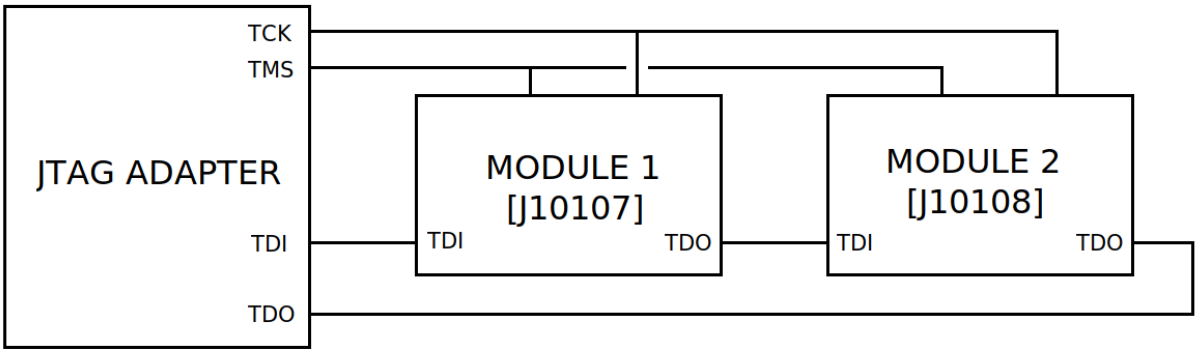


Figure 4: JTAG Bus Chaining Example

If bus chaining is desired, a custom wiring harness will need to be constructed to connect the TMS and TCK lines in parallel, and the TDO / TDI lines in series as shown in Figure 4.

CARRIER CARD

Attach each of the provided cables to the carrier card as shown in Figure 5.

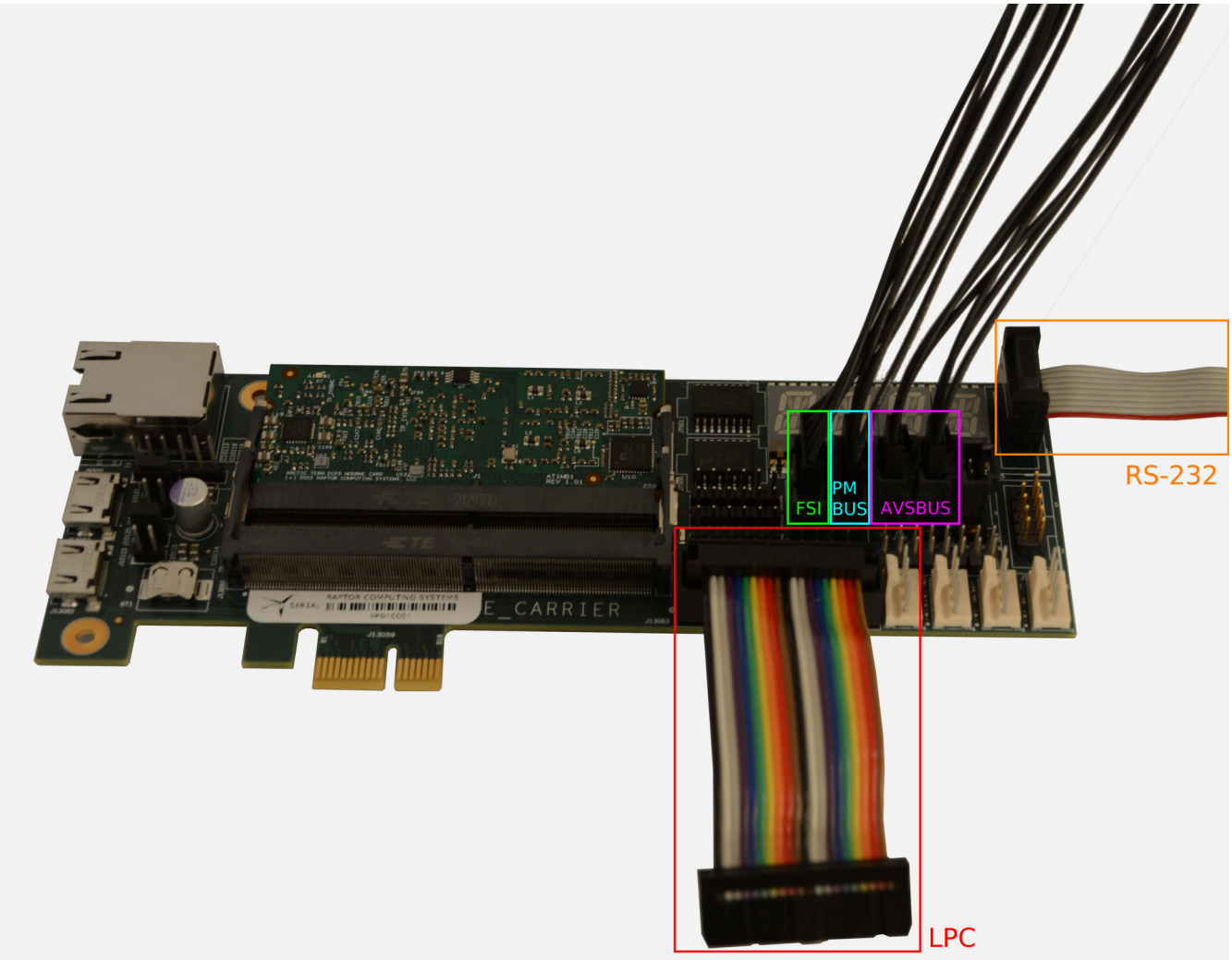


Figure 5: Carrier Card Wiring

FSI ADAPTER

Attach the end of the FSI cable to the FSI adapter as shown in Figure 6. Ensure that the MUX/EN pins are connected via a jumper cap as shown.

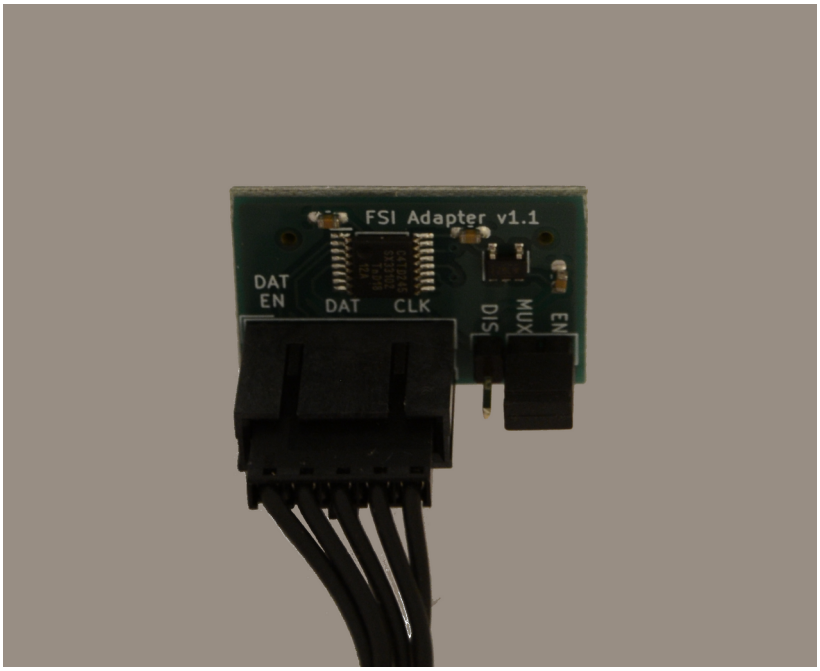


Figure 6: FSI Adapter Setup

BMC CARD INSTALLATION

- [ ] Install the Arctic Tern BMC card into the lowest PCIe slot in the system, as shown in Figure 1. This location is important; the LPC bus signal integrity is length sensitive, therefore it is critical to place the BMC card as close as possible to the TPM header on the Talos II host system. If a PCIe slot is not being used, place the card as close as practical to the TPM header on the Talos II host system and use the shortest possible LPC bus cable.

- [ ] Attach the LPC cable to the host system TPM header as shown in Figure 7. Note the short length and curl introduced into the cable; this is to maintain signal integrity as much as possible over the length of the cable run.

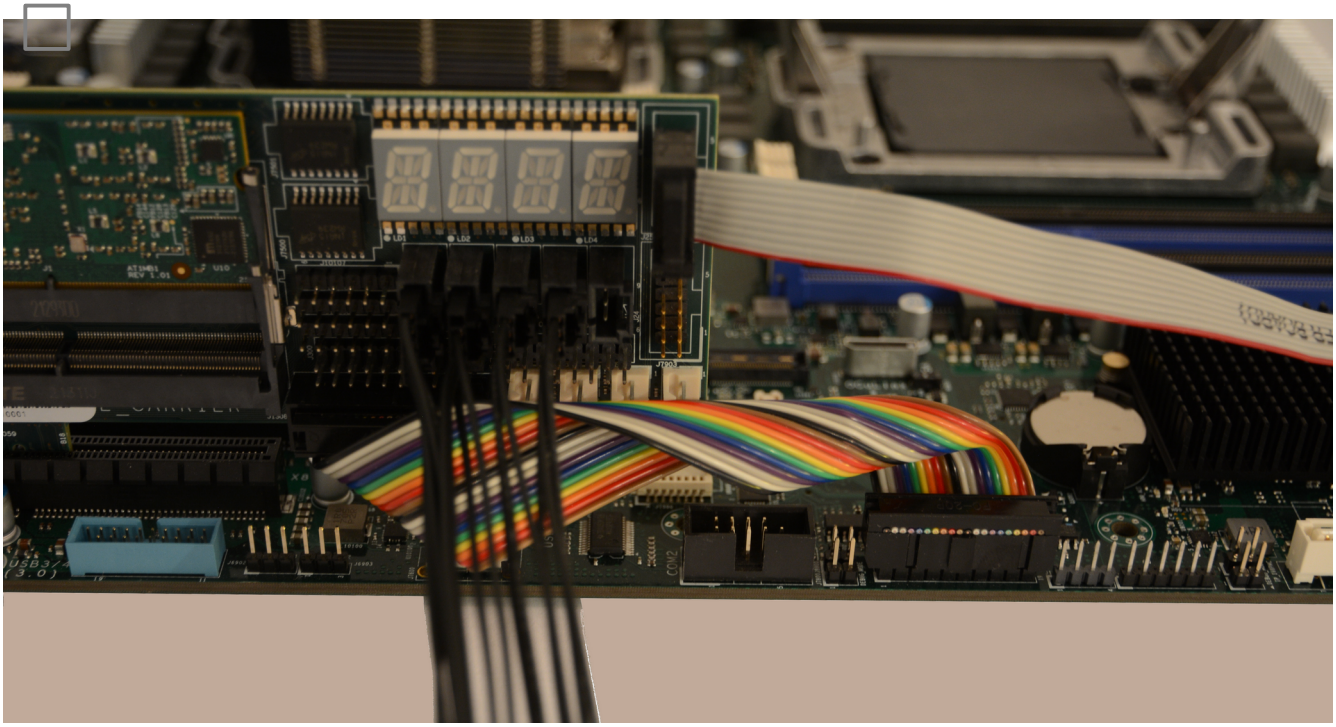


Figure 7: LPC Cable Installation

- [ ] Press the FSI adapter into the CPU debug connector on the Talos II host system using gentle vertical pressure, as shown in Figure 8.

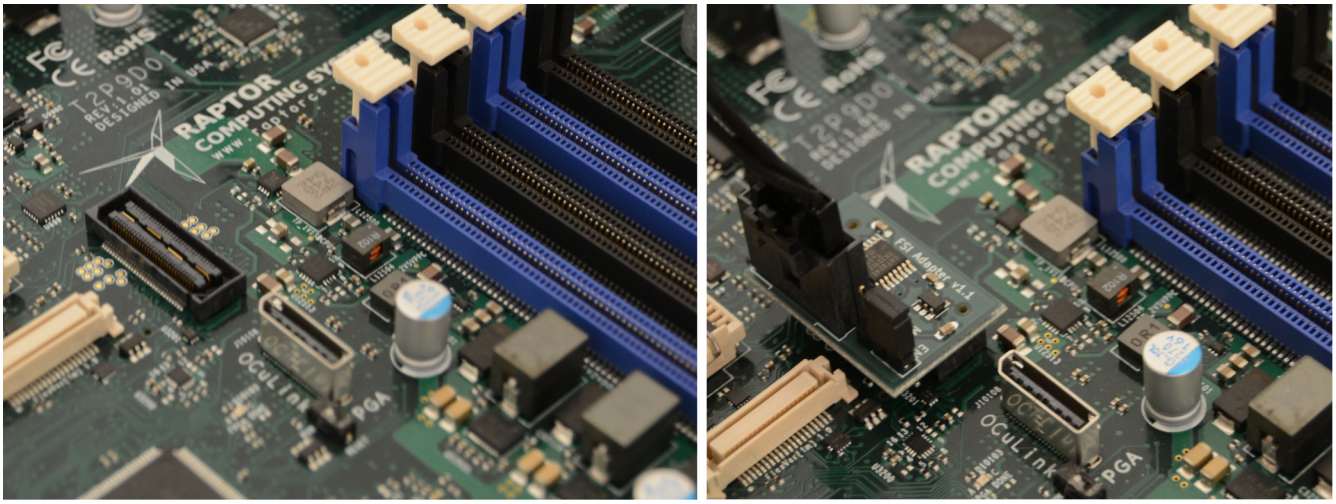


Figure 8: FSI Adapter Installation

☐ Plug the PMBus connector into the PMBus header on the Talos II host system as shown in Figure 9.

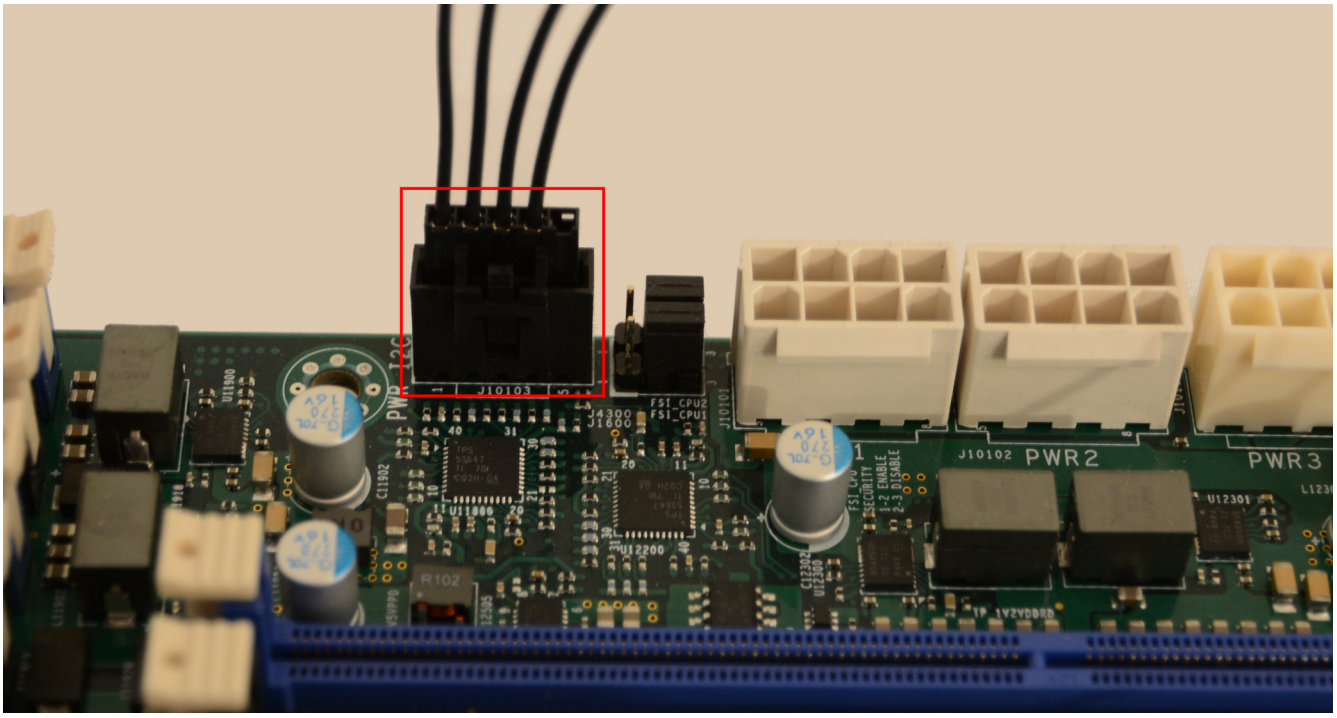


Figure 9: PMBus Cable Installation

☐ Plug the two AVSBus connectors into their respective headers on the Talos II host system as shown in Figure 10. AVSBus1 is normally provided by J100 on the BMC card, while AVSBus2 is normally provided by J101 on the BMC card. This is reconfigurable in HDL and firmware, so while the Kestrel BMC stack will be using these assignments, other BMC stacks may require different wiring.

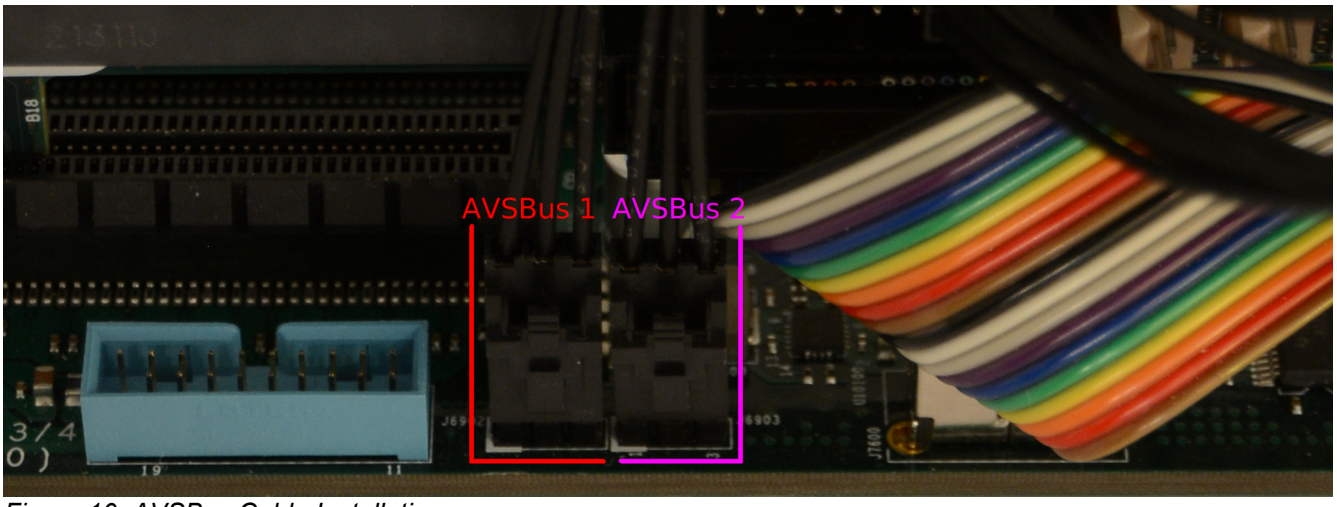


Figure 10: AVSBus Cable Installation

FINAL HARDWARE SETUP

Attach the JTAG cable to J10107, then plug the JTAG adapter and RS232 cable into the computer you will be using for either BMC development or initial provisioning of the Arctic Tern BMC system.

You may wish to connect the front panel power button and power LED of your system (if applicable) to the Arctic Tern BMC card. The Kestrel firmware stack normally uses the following pins on J300 for front panel I/O, although specific firmware variants are able to remap the GPIO pins and may require different front panel connections:

Pin	Function
6	Power button (-)
7	Power button (+)
8	Reset button (-)
9	Reset button (+)
10	Power LED (+)
20	Ground (Power LED (-))

Congratulations! Hardware setup of the Arctic Tern BMC developer kit is now complete.

DEACTIVATING THE ONBOARD ASPEED BMC

Due to internal ASIC design decisions at ASpeed, placing the BMC into reset will result in various control lines being held at logic levels that effectively block bus control using an external device. As a result, Raptor has developed a minimal program that will deactivate the BMC immediately after U-boot loads. The program initializes the ASpeed pins on the control busses to tristate mode, effectively removing the ASpeed hard ASIC from the mainboard from an electrical perspective.

Please refer to the README file for the ASpeed disable utility for full installation instructions:

https://gitlab.raptorengineering.com/kestrel-collaboration/raptor-utilities/aspeed-disable-tool/-/blob/master/README.md

NOTE: The deactivation process is fully reversible if desired, there is no risk to the hardware from installing the disable utility.

Development System Setup

DEVELOPMENT SYSTEM REQUIREMENTS AND OVERVIEW

This section of the guide will assume you already have a Debian 11 ppc64el operating system installed on an OpenPOWER machine, such as a Talos II or Blackbird machine, with the Arctic Tern JTAG adapter and serial port connected to the machine.

The steps below will then install the required toolchains, download the Kestrel source repositories, build a Kestrel FPGA bitstream and firmware image, then upload the Kestrel system to the Arctic Tern BMC card.

NOTE: It is highly recommended that the development machine be separate from the host connected to the BMC card. Due to the low level access the BMC card has to the host system, reprogramming the BMC while the host is online can cause undesired operation including a system crash. If you must use the same machine for the development system and BMC host, Raptor strongly recommends leaving the ASpeed BMC online as the main BMC until you have built a known working set of Kestrel binaries; you may need to switch between the Kestrel BMC and ASpeed BMC several times during the initial build and test process. If you have an older owner-controlled machine such as an IBM T500/T400 or older with blob-free coreboot, or a KGPE-D16 platform with blob-free coreboot, those systems could be used with `openocd` and `ecpprog` to securely program the initial Kestrel binaries while the the host system is offline.

INSTALL REQUIRED PACKAGES

As root, run:

```
apt-get install bison flex build-essential clang clang-format clang-tidy git gnat
libreadline-dev libboost-all-dev llvm lld python3-setuptools libeigen3-dev tcl-dev
```

OBTAIN TOOLING SOURCES

As root, create a folder to contain the Kestrel system level sources and change into it, then run the following commands to fetch the source trees:

```
mkdir kestrel-tooling
cd kestrel-tooling

git clone
https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-tooling/yosys

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
tooling/nextpnr

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
tooling/prjtrellis

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
tooling/ghdl
```

```
git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
tooling/ghdl-yosys-plugin

cd nextpnr
git submodule init
git submodule update
cd ../

cd prjtrellis
git submodule init
git submodule update
cd ../
```

INSTALL TOOLING

From the same folder, as root run the following commands to build and install the tooling. The -j parameter sets the number of threads to use for the build process, in the commands below 16 threads are specified which is appropriate for a single 4-core POWER9 CPU. You may want to tune the number of threads to better match your CPU core / thread count and available system RAM.

```
cd yosys
make -j 16
DESTDIR=/usr make install
cd ../

cd prjtrellis/libtrellis
cmake -DCMAKE_INSTALL_PREFIX=/usr .
make -j 16
make install
cd ../../

cd nextpnr
cmake -DARCH=ecp5 -DTRELLIS_INSTALL_PREFIX=/usr .
make -j 16
make install
cd ../

cd ghdl
./configure --prefix=/usr --with-llvm-config
make -j 16
make install
cd ../

cd ghdl-yosys-plugin
make -j 16
make install
cd ../

cd ../
```

OBTAIN UTILITY SOURCES

As root, change into the Kestrel system level sources folder, then run the following commands to fetch the source tree:

```
mkdir kestrel-utilities
cd kestrel-utilities

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-utilities/ecpprog
```

INSTALL UTILITIES

From the same folder, as root run the following commands to build and install the tooling. The -j parameter sets the number of threads to use for the build process, in the commands below 16 threads are specified which is appropriate for a single 4-core POWER9 CPU. You may want to tune the number of threads to better match your CPU core / thread count and available system RAM.

```
cd ecpprog/ecpprog

make -j 16
make install
cd ../../

cd ../
```

DOWNLOAD KESTREL SOURCE CODE

As a normal user, create a directory to hold the Kestrel sources and change into it, then run the following commands:

```
mkdir litex-repos
cd litex-repos

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/migen

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/nmigen

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/pythondata-software-compiler_rt

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/litex

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/liteeth

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/litedram

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/liteiclink

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/aquilalpc

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/opencoresi2c

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/simplepwm

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/arcticterngpio

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/simplertc

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/swiftfsi

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/tercelspi

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-litex/litex-boards

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
```

```
litex/pythondata-cpu-microwatt

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
litex/pythondata-peripheral-aquilalpc

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
litex/pythondata-peripheral-opencoresi2c

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
litex/pythondata-peripheral-simplepwm

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
litex/pythondata-peripheral-arcticterngpio

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
litex/pythondata-peripheral-simplertc

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
litex/pythondata-peripheral-swiftfsi

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
litex/pythondata-peripheral-tercelspi

cd ..
mkdir firmware
cd firmware

git clone https://gitlab.raptorengineering.com/kestrel-collaboration/kestrel-
firmware/bare-metal-firmware
cd bare-metal-firmware
git submodule init
git submodule update
cd bootrom
git checkout arctic-tern
cd ../../../litex-repos/
```

INSTALL KESTREL PACKAGES

From the Kestrel directory created in the previous step, run the following command as a normal user:

```
for d in */; do cd $d; python3 setup.py develop --user; cd ../; done
```

BUILD THE KESTREL HDL

As a normal user, run the following command. Note this process will take a long time, especially during the place and route phase.

```
cd litex-boards/litex_boards/targets

./rcs_arctic_tern_bmc_card.py --device=LFE5UM --cpu-type=microwatt --cpu-
variant=standard+ghdl+irq --with-ethernet --with-video --sys-clk-freq=50e6 --build
--nextpnr-seed 1
```

NOTE: You may select either the Microwatt CPU as shown above, or if you would prefer you can use the LibreSoC CPU after installing its Python data files by passing the `libresoc` parameter in place of `microwatt`; both POWER-compliant soft CPUs are supported by the Kestrel stack.

BUILD THE KESTREL FIRMWARE

For simplicity, the bare metal firmware will be used in the build example below. The bare metal firmware is the simplest firmware stack capable of booting a POWER9 host system, but does not use a threaded operating system kernel or enable networking features. It is ideal for desktop class systems that do not need remote management capabilities, as it is also provides the fastest system IPL time of the various Kestrel firmware options.

First, change directory up into the firmware source tree:

```
cd ../../../../firmware/bare-metal-firmware
```

Copy the built gateware and software into the bare metal firmware boot ROM directory:

```
cp -Rp
../../litex-repos/litex-boards/litex_boards/targets/build/rcs_arctic_tern_bmc_card
/* bootrom/fpga/release/
```

The firmware source tree needs to be configured for the Arctic Tern platform. Open main.c for editing, then change `PLATFORM_VERSA_ECP5` to `0` and `PLATFORM_ARCTIC_TERN` to `1`. Save the file and exit.

TIP: If you would prefer to trade off a small amount of host IPL time for a nearly instant-on BMC at wall power application, change the `WITH_DRAM` define in the `main.c` file to `0` instead of `1`. This will disable caching of the host firmware from SPI Flash into BMC RAM, which normally adds around 15 seconds at initial BMC start. This caching process constitutes the main source of BMC startup delay in most Kestrel firmware variants.

Finally, build the firmware image using the following commands, again as normal user:

```
mkdir build
cd build
cmake ..
make
cd ../../../
```

Upload Kestrel to the BMC Card

In this step you will need to have two simultaneous terminal sessions open, one to interact with the BMC card over serial, and one to issue programming commands. These two sessions will be referred to as Session 1 and Session 2. Both sessions need to start in the Kestrel source directory that was created in the Download Kestrel step. When complete, the Kestrel system will be running from RAM; programming the firmware into the on-board Flash memory will be shown in a different step.

In Session 1, start the LiteX terminal with firmware upload capability. If the BMC card is connected to serial device other than `/dev/ttyUSB0`, update the command below to match the device to which the BMC card is connected:

```
python3 litex-repos/litex/litex/tools/litex_term.py --speed 115200 /dev/ttyUSB0 --
kernel litex-repos/firmware/bare-metal-firmware/build/firmware.bin
```

In Session 2, program the FPGA bitstream over JTAG:

```
openocd --log_output openocd.log -f
"litex-repos/litex-boards/litex_boards/prog/openocd_rcs_arctic_tern_bmc_card_xc2c6
4a.cfg" -c "transport select jtag; init; svf
litex-repos/litex-boards/litex_boards/targets/build/rcs_arctic_tern_bmc_card/
gateware/rcs_arctic_tern_bmc_card.svf; exit"
```

Within a 2-3 seconds, you should see the Kestrel system initializing in Session 1. At this point it is a good idea to ensure that you can IPL the host using the interactive serial console; if so, you can proceed to the Flash programming step.

WRITE THE KESTREL STACK TO FLASH ROM

The bare metal stack is small enough to fit on the single Flash device present on the Arctic Tern FPGA module; the external BMC firmware Flash device on the carrier card does not need to be used in this particular case. This greatly simplifies the Flash programming process, since it allows the ecpprog tool to be used to write both the FPGA bitstream and the built Kestrel firmware image. For this guide, the bare metal firmware will be placed at an offset of 4MB from the start of the Flash device, thus allowing up to a 4MB FPGA bitstream to be located at the start of the Flash device.

First, the bootloader needs to be reconfigured to boot from a specified location in Flash ROM.

Change directory into the LiteX boards repository:

```
cd litex-repos/litex-boards/litex_boards/targets
```

Open the `rcs_arctic_tern_bmc_card.py` file for editing, then change `production_mode = False` to `production_mode = True`. Adjust the firmware location by changing `flash_boot_adr =`

`soc.mem_map["bmcspiflash"]` to `flash_boot_adr = soc.mem_map["fpgaspiflash"] + 0x400000`. Save the file and exit.

Rebuild the bootloader and update the bitstream:

```
./rcs_arctic_tern_bmc_card.py --device=LFE5UM --cpu-type=microwatt --cpu-
variant=standard+ghdl+irq --with-ethernet --with-video –load
cd ../../../
```

Write the bitstream and firmware to Flash:

```
ecpprog
litex-boards/litex_boards/targets/build/rcs_arctic_tern_bmc_card/gateware/
rcs_arctic_tern_bmc_card.bit

ecpprog -o 4M litex-repos/firmware/bare-metal-firmware/build/firmware.bin
```

Reset the BMC card by removing power and reapplying power. After reset, the BMC card should automatically load the bitstream and firmware from the on-board Flash memory.

WRITE THE HOST PNOR IMAGE TO FLASH ROM

One final step remains before your Arctic Tern BMC card is able to IPL the host system. The host PNOR Flash device needs to be programmed with the host system firmware image; since the current Kestrel bare metal firmware does not include networking support, this process requires an external SPI programmer and SOIC-16 Pomona clip. While other versions of the Kestrel firmware stack, including the existing Zephyr RTOS based variant, are able to receive the firmware image over Ethernet and program the PNOR directly, their build process is complex and outside the scope of this document.

The host PNOR device is located at reference designator J7501; programming is similar to an external recovery of the main PNOR device on the host system mainboard and proceeds in the same overall fashion. Ensure the Pomona clip is attached to the Flash device and that standby power is connected, i.e. the Arctic Tern BMC card is powered up, then write the image using the external programmer. Disconnect the Pomona clip when done.

Congratulations, you have successfully installed the Arctic Tern BMC card with Kestrel into your OpenPOWER host machine!

Support

GETTING HELP

If you require assistance operating your Arctic Tern system, you may contact Raptor Computing Systems technical support directly at support@raptorcs.com. Alternatively, we also have a Wiki and other support resources available online at https://www.raptorcs.com; the information you require may already be available on one of these resources.