Freedom U500

Linux-capable, 1.5GHz quad-core RV64GC SoC

Jack Kang
jack@sifive.com
RISC-V Revolution!

• Lofty Goals
  • RISC-V is designed for all levels of computing system, from microcontrollers to supercomputers

• Humble Beginnings, Tremendous Progress
  • RISC-V Foundation in August 2015 – 16 member companies
  • Now: 100+ Members, Commercial Companies, Chips, IP

• SiFive continues to drive commercial development
• What’s next?
The Freedom Unleashed 500

- 250M+ Transistors
- TSMC 28nm
- High-Performance, Integrated RISC-V SoC
- U54MC RISC-V CPU Core Complex
- Latest RISC-V Specifications
- Standard Software Development Platform
Freedom U500 Base Platform Chip

~30mm² in TSMC 28nm

- 250M transistors
- 1.5 GHz+ SiFive E51/U54 CPU
  - 1x E51: 16KB L1I$ and 8KB DTIM
  - 4x U54: 32KB L1I$ and 32KB L1D$
    - ECC support
- Banked 2MB L2$
  - ECC support
- TSMC 28HPC
- FCBGA package
- Development board available in Q1 2018
Freedom U500 Block Diagram

TSMC 28nm Chip for Rapid Customization of the Freedom Unleashed Platform

- U54-MC Coreplex
  - Single- and Double-precision floating-point support
  - Banked L2$ with directory-based cache-coherence
  - Modern OS support

- ChipLink
  - Serialized Chip-to-Chip TileLink Interconnect

- GbE
- Peripherals
- DDR3/4

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SiFive U54-MC Core IP

- Features 4x U54 Cores and 1x E51 Core
- Each U54 core is a 64-bit, 1.5 GHz CPU
- U54 implements RV64GC
  - Hardware multiply/divide
  - Atomic Instructions
  - 16-bit compressed instructions
  - Single and Double Precision Floating Point with Fused Multiply Add
- U54 supports RISC-V privileged modes M, S, and U
- E51 Core is a 64-bit, 1.5GHz CPU “minion core”
  - RV64IMAC
  - RISC-V privileged modes M and U only
- Coherent, 2MB 16-way L2 subsystem
- Standard platform for Linux RISC-V development
U54MC Specifications

• Speed:
  • TSMC 28nm HPC:
    • Typical: 1.5 GHz, 0.9V, 25C
    • Fast/Fast: 2.6 GHz, 0.99V, 125C
    • Slow/Slow: 960 MHz, 0.81V, -40C
  • Standard cell, 12-track library

• Area:
  • Single U54 Core-only Area: 0.234 mm$^2$
  • Single U54 Core Complex Area: 0.538 mm$^2$
    • Includes 32KB/32KB L1 Cache

• Performance:
  • 1.7 DMIPS/MHz
  • 2.75 CoreMark/MHz

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HiFive Unleashed
The Ultimate RISC-V Linux Development Platform

- 1.5 GHz SiFive Freedom Unleashed 500 SoC
- Microsemi PolarFire FPGA
- 8 GB DDR4-2400 with ECC
- 1 Gigabit Ethernet Port
- 2 USB 2.0 Ports
- HDMI for an external display
- 2 PCIe slots for PCIe peripherals
- M.2 SSD connector
- SATA HDD connector

- Freedom SDK
- Available Q1 2018
Robust Ecosystem developing for RISC-V tools

Free, Open-Source Tools

Freedom Studio

Freedom Studio is the fastest way to get started programming your SiFive hardware. Freedom Studio is built on top of the popular Eclipse IDE and packaged with a prebuilt toolchain and example projects from the Freedom E SDK. Freedom Studio is compatible with all SiFive products including the HiFive1, the Freedom E300 Arty FPGA Dev Kit, and more.

Freedom Studio v20170616 (beta2)

- Windows
- macOS
- Linux

FREEDOM STUDIO MANUAL
Announced Commercial Debug and Tools

**UltraSoC**
- UltraSoC debug (down)
- Trace (up)
- JTAG (down)
- "Bare Metal" USB (up)

**Lauterbach**
- TRACE32® RISC-V Debugging

**Segger**
- J-Link Probe Support

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HiFive Unleashed Early Access Program

• Early Access for Open-Source Developers
  • FPGA-based prototype available now
  • Early access to HiFive Unleashed development boards

• HiFive Unleashed
  • 1.5 GHz, Quadcore U54MC RISC-V CPU Core
  • 2MB L2 Cache and DDR4 2400
  • PCIe, USB, HDMI ports

• Early Development
  • Expect some ASIC bringup headaches
  • Linux is upstream, but with no drivers
  • No distribution support
HiFive Unleashed Early Access Program

• All open-source developers are welcome!
  • Kernel hackers, maintainers of distributions, bootloader/firmware porters, build farms, etc

• The beta program spooling up now
  • We already have some FPGAs in the wild

• To get access, email info@sifive.com