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RISC-V core out-clocks Apple, SiFive; available as IP

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Micro Magic Inc. (Sunnyvale, Calif.) has functioning silicon of its 5GHz-capable 64bit RISC-V processor and is offering the design as intellectual property.

The Micro Magic processor out-clocks the Apple A14 bionic, the processor at the heart of the iPhone 12 and one of the first processors on 5nm silicon. It also goes faster than a quad-core U84 CPU that SiFive states can operate at up to 2.6GHz clock frequency when implemented in a 7nm process.

Micro Magic has a history that goes back to Sun Microsystems and beyond (see EDA company claims world's fastest 64bit RISC-V core). It is reportedly one of Silicon Valley's well-kept secrets and a go-to resource for design teams trying to remove bottlenecks in their datapath designs.

Andy Huang, an independent contractor who supports Micro Magic for marketing and business development functions, contacted eeNews Europe and demonstrated the processor running EEMBC CoreMark benchmarks over a Facetime connection. Huang was founder and CEO of ACAD Corp., the developer of the Finesim simulator, one of the first and fastest of parallel SPICE simulators. ACAD was acquired by Magma Design Automation in 2006 before Magma itself was acquired by Synopsys in 2012.

Huang declined to say which foundry had manufactured silicon for Micro Magic or in what manufacturing process it had been implemented. Huang said the that processor is made in a FinFET process and was manufactured using a multiproject wafer (MPW) run. He also said that Micro Magic had evaluated FinFET silicon libraries from three leading foundries – TSMC, Samsung and Globalfoundries – and intended to make the high-speed RISC-V design compatible with multiple sources of manufacture.

This compatibility is important for the chosen business model of the company. Although it has had samples of its RISC-V processor made, these are intended as a proof of capability. The company intends to go to market by providing the core for license as intellectual property, Huang said.

Up until now Micro Magic has mainly operated as an EDA tools licensor and design services provider. Huang said that the Micro Magic is sometimes contracted to consult on designs for leading processor companies, including Intel and Qualcomm. According to Micro Magic's Linkedin entry the company specializes in datapath optimization and high-speed memory design.

It remains unclear how close to the leading-edge of silicon manufacturing Micro Magic has been able to go with its own design. TSMC does offer MPW runs down to 7nm. Globalfoundries offers a FinFET process at 12nm and Samsung offers 14/11nm, 10/8nm and 7/5nm. It seems most likely that Micro Magic would have chosen something at 10nm or above for reasons of cost and cross-foundry comparability. But even if this "calling card" design is at 7nm, its 5GHz clock frequency far outperforms the Apple's A14 on 5nm and SiFive's U84 on 7nm.

The A14 is a six-core ARM-architecture processor manufactured in 5nm FinFET process from TSMC, that clocks at up to 3.1GHz and consumes at maximum about 6W. It should be noted that in its design Apple is optimizing for power consumption rather than clock frequency. The U84 is a quad-core RISC-V processor.

For the purposes of benchmarking, the Micro Magic RISC-V was mounted via a daughter card on an Odroid board. Odroid is similar to Raspberry Pi and creates a suitable environment in which to monitor the RISC-V as it runs CoreMark benchmarks. It was chosen because it has variable voltage power supply, Huang said.

At 0.8V the processor clocked at 4.3GHz and achieved 11,111 CoreMarks. The power consumption including cache memories is just 200mW, Huang said.

At 1.1V the processor clocked at 5.14GHz and achieved 13,333 CoreMarks.

Finally Huang did a run at 0.6V and the processor clocked at 3.157GHz and achieved 8,461 CoreMarks.

There are as yet no RISC-V processors listed in the EEMBC CoreMark table of submitted benchmarks. SiFive claims its U74 single-core instantiation of a 64bit RISC-V application processor achieves 5.1CoreMarks/MHz.

Some ARM processors can achieve 5 CoreMarks/MHz/Core while Micro Magic has achieved from 2.58 to 2.69 CoreMarks/MHz/Core. What remains harder to determine is whether Micro Magic has a CoreMarks/watt advantage over ARM or RISC-V competitors.

Huang said Micro Magic is not quoting power consumption at the extremes as these figures can vary widely by foundry and by particular process variant. It should also be born in mind that the ARM-based Apple A14 has six CPU cores; two ‘Firestorm’ cores and four ‘Icestorm’ cores.

Huang declined to point to any “secret sauce” that Micro Magic had used to achieve its design performance. Clearly expertise in datapath optimization and high-speed memory design are useful. “We use our own EDA tools and keep things simple. There are no additional instructions. We don’t do anything exotic in the ALU pipeline. We don’t do out-of-order processing.”

One of the conventional methods, apart from advances in manufacturing, used to speed up the clock frequency is to chop the pipeline up into more stages. Each stage contains less logic circuitry and can run faster but comes with the compromise that more partially completed operations may have to stall or be thrown away under various conditions.

So how deep is Micro Magic’s RISC-V ALU? Huang said: “We keep the pipeline as shallow as possible.”

Another possibility is that Micro Magic have some special way of improving SRAM access either through faster SRAMs themselves or multiple banks of cache memory that can overlap with instruction calls. Huang refused to be drawn. “Everything has to be part of the standard cell library; NAND gates, MUX, flip-flops,” he said.

Huang declined to comment when asked if Micro Magic would consider porting its design to a fully-depleted silicon-on-insulator (FDSOI) process or going to lower voltages with a near-threshold voltage style of design.