

LEXRA INTRODUCES LX4189 CORE

Deeper Pipeline Enables Higher Clock Speeds

By Tom R. Halfhill {5/8/00-06}

Lexra has introduced its fifth MIPS-like embedded-processor core, the LX4189. It's very similar to the 32-bit LX4180 core rolled out a year ago, except that it has an additional pipeline stage to reach higher clock frequencies. Lexra says the LX4189 is better suited for

next-generation 0.15-micron fabrication processes.

While the older LX4180 has a conventional MIPS five-stage pipeline, the new LX4189 adds an extra stage at the front of the pipe for accessing instruction memory. Besides shortening a critical path and boosting clock speeds, the deeper pipeline also makes it easier for ASIC designers to work with the synthesizable model of the core, because clock timings are less critical.

According to Lexra, the LX4189's worst-case clock frequency in a typical 0.15-micron process is 266MHz, and the core will occupy only 1mm² of die area—without using full-custom circuit designs. In comparison, MIPS Technologies specifies a worst-case clock frequency of 200MHz and a nominal frequency of 280MHz for a comparable MIPS32 4K-series core in a larger 0.18-micron process, with the core occupying 1.4mm². If the MIPS and Lexra cores were fabricated in the same process, they would probably run neck and neck, even though the MIPS32 4K core has a shorter five-stage pipeline.

Lexra's new core supports the MIPS-16 compressed-code format (see [MPR 10/28/96-10](#), "LSI's TinyRISC Core Shrinks Code Size"), while the MIPS32 4K core does not. On the other hand, Lexra doesn't natively support the patented unaligned load and store instructions in the MIPS instruction set. Lexra is currently fighting a patent-infringement lawsuit filed last year by MIPS over this issue (see [MPR 12/6/99-03](#), "MIPS vs. Lexra: Definitely Not Aligned").

The LX4189 fits into Lexra's product line just below the LX4280 and LX5280, which have six- or seven-stage superscalar pipelines. The LX5280 also has Lexra's Radiax DSP extensions (see [MPR 8/23/99-05](#), "Lexra Adds DSP Extensions"). In contrast, the LX4189 is a uniscalar design without

Feature	Lexra LX4189	Lexra LX4180	Lexra LX4080	Lexra LX4280	Lexra LX5280	MIPS MIPS32 4K	MIPS MIPS64 5K
Architecture	MIPS-I*	MIPS-I*	MIPS-I*	MIPS-I*	MIPS-I*	MIPS32	MIPS64
Microarchitecture	Uniscalar	Uniscalar	Uniscalar	Superscalar	Superscalar	Uniscalar	Uniscalar
CPU Width	32 bits	32 bits	32 bits	32 bits	32 bits	32 bits	64 bits
Hard/Soft Macro?	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
DSP Extensions?	No	No	No	No	Yes	No	No
Pipeline Depth	6 stages	5 stages	5 stages	6 stages	7 stages	5 stages	6 stages
MIPS-16?	Yes	Yes	No	Yes	Yes	No	No
Hardware MAC?	Optional	Optional	No	Optional	Yes	Optional	Yes
MPR Article Introduction	-----	1/25/99	2/16/98	8/2/99	8/23/99	5/31/99	10/25/99
	2Q00	1Q99	1Q98	4Q99	4Q99	2Q99	1Q00

Table 1. Lexra's LX4189 is essentially a "stretch" version of the LX4180 with a deeper pipeline. A 16-bit multiply-accumulate unit is optional. *Lexra cores are mostly compatible with the MIPS-I instruction-set architecture but don't support the unaligned load and store instructions.

Radiax, like the LX4180 on which it's based. Table 1 summarizes the features of the soft cores from Lexra and MIPS.

Lexra supplies its cores in RTL formats and as "SmoothCores," the company's term for optimized hard macros. Foundry partners are TSMC, UMC, and IBM. Unlike most core vendors, Lexra isn't secretive about its pricing—a single-project license for the LX4189 soft core costs \$350,000, plus royalties. The company has cut the price of a similar license for the LX4180, its most popular core, to \$179,000.

The introduction of the LX4189 should reassure potential customers that the MIPS lawsuit hasn't stopped Lexra in its tracks. Indeed, Lexra plans to introduce more new cores this year, including Monadnock, a RISC core designed for multiprocessor chips that could process packets at OC-192 data rates. MIPS isn't static, either—it plans to introduce a superscalar MIPS64 20Kc core that executes 1,000 Dhrystone mips. (Both cores will be revealed at Embedded Processor Forum in June.) Still, a timely settlement of the MIPS-Lexra lawsuit would clear the air for customers of both companies. ♦

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