AMD Adds New High End to 29000 Family

29040's Faster Clock, 0.7-Micron Process Boost Performance by 65%

by Curtis P. Feigel

AMD has augmented its popular 29000 family with a new high-end processor, the 29040. The company claims that moving to a more advanced process allows the new processor to achieve 66.8 Dhrystone MIPS at 50 MHz but keeps the price reasonable. The device remains binary- and pin-compatible with the 29030, AMD's previous performance leader, providing customers with a new price/performance point.

The fully static 29040, built in AMD's 0.7-micron process, is an evolutionary step of the existing 29000 design. The new fabrication process lets the chip run at higher frequencies and lower supply voltages than previous versions. Although it still uses the scalar 29000-family core, the 29040 incorporates several refinements, including a 4K data cache and clock doubling that allows the external buses to run at half the processor's internal clock rate.

Architecture Remains the Same

The original 29000 processor was announced seven years ago. Since that time, the family has accumulated a total of 11 variants: the 29200 series with integrated peripherals and the 29000 series without. Table 1 shows how the new device compares with the previous nonintegrated processors.

One major variation, which actually began with the introduction of the 29030 (see MPR 5/15/91, p. 1), is the use of two external buses instead of three. Previously, 29000-family processors had brought out separate buses for address, data, and instructions. As Figure 1 shows, the 29030 and now the 29040 combine the data and instruction buses so the chips connect to external logic via conventional addresses and data buses, reducing external circuitry and simplifying the designer's task. Fewer pins also allow the device to fit into a less expensive package. The 29040 continues the 29030's programmable bus-sizing feature that lets the device access 16- or 32-bit peripherals.

The 29040 will be available in 33-, 40-, and 50-MHz speed grades, whereas 33 MHz is the maximum for the 29030. Because it is fully static, the part can run at any speed below its rated maximum. The 29040 incorporates AMD's DLL (digital-locked loop) clock circuitry with relaxed input specifications that allow duty cycles as broad as 30/70. The DLL circuit also allows the external buses to run at the processor's internal speed or at one-half that rate. Having the option to run interface logic at 25 MHz makes it significantly easier to use a 50-MHz processor.

The 29040 also has the largest caches in the family: its 8K instruction cache is matched only by that of the 29030. The 29040's 4K data cache is unique: none of the other general-purpose 29000-based chips has a data cache (although two of the 29200 series have 2K data caches). The data cache is configurable on a page basis to support write-through, write-back, or noncaching policies, and both caches are two-way set-associative. The processor implements a cache-coherency protocol to facilitate DMA or multiprocessor systems.

Further refinements to the processor include a 32 × 32 integer multiply unit that produces results in two cycles and an enhanced MMU that defines memory regions for cachability, 16- or 32-bit width, and parity checking. Additional low-power modes allow processing to be resumed quickly from the low-power state.

	29040	29000	29005	29030	29035	29050
Clock Speed (MHz)	33, 40, 50	16, 20, 25, 33	16	20, 25, 33	16	20, 25, 33, 40
Sep. Instr. Bus	no	yes	yes	no	no	yes
I Cache	8K	512 (BTC)	none	8K	4K	1K (BTC)
D Cache	4K	none	none	none	none	none
FPU	no	no	no	no	no	yes
MMU	yes	yes	no	yes	yes	yes
Supply Voltage	3.3, 5	5	5	5	5	5
Package	144 PQFP 145 PGA	169 PGA 168 PQFP	168 PQFP	145 PGA 144 PQFP	144 PQFP	169 PGA
VAX MIPS*	66.8	40.1	18.7	40.2	12.6	55.1
Price (10,000s)	$114	$42	$36	$49	$35	$140

Table 1. The long-lived 29000 family shows a broad range of prices and performance. *Based on the Dhrystone 2.1 benchmark. Performance and price figures given for processor with highest clock rate. (Source: AMD)

Competition Is Fierce

The classic battle in embedded RISC processors is between the i960 family and the 29000 family. With so much at stake, AMD is careful to make the point that the i960 benchmarks Intel quotes use SRAM-based memory systems. Such a zero-wait-state memory maximizes the performance of the processor and so describes accurately only the upper limit of its potential. But most products using these processors will be built with DRAM, and AMD maintains that benchmarking DRAM-based systems is the fairer way to show performance. According to AMD, a DRAM-based 50-MHz 29040 system enjoys a modest performance

	AMD 29040	AMD 29030	Intel i960JD	IDT R3052
Clock (MHz)	33, 40, 50	20, 25, 33	33, 40, 50	25, 33, 40
VAX MIPS*	66.8	40.1	41	35
Transistors	1,200,000	680,000	1,300,000	500,000
Die Size	119 mm^2	125 mm^2	66 mm^2	68 mm^2
Process Size	0.7 µm	0.8 µm	0.8 µm	0.8 µm
Metal Layers	3	2	3	3
Price (10,000s)	$114	$49	$57	$66

Table 2. The 29040 has a larger die area than other processors in its class, making it difficult to keep its cost low. *Based on Dhrystone 2.1 at highest clock rate. (Source: vendor data)

advantage over a 40-MHz i960CF. Clearly, the performance gap would be even wider if the Intel system used DRAM. The SRAM/DRAM issue also forms the basis for AMD's claims that the price/performance ratio for a complete 29040 system is better than that for an i960-based system: a 29040-based system could use slower DRAM than the i960 system and still maintain its performance.

The 29040, it appears, comes just in time: without it, AMD would be in a tough position. Intel's new J-series processors both increase the performance and reduce the cost of that line *(see **080802.PDF**)*. Table 2 shows the price and performance figures for the new i960JD that result in a ratio of about $1.39/MIPS. Calculating the same ratio for the 40-MHz 29040 yields $1.57/MIPS, comparable to the Intel part. The 29040, however, offers a pin-compatible growth path to higher performance than does the 960JD.

Another interesting comparison is between the 29040 and AMD's own 29030. At 44 MIPS and $72, the 33-MHz 29040 has comparable performance, but it is priced about 50% more than the 29030. The 29040's data cache will deliver significantly better performance than the 29030 on many real applications.

Embedded PowerPC processors may also contend for a slice of the market. Motorola's PPC 505 and IBM's 403GA will offer performance in the 40–45 MIPS range *(see **080601.PDF**)*. In addition, the 505 has an FPU, and the 403 contains numerous peripherals. The MPR Cost Model *(see **071004.PDF**)* predicts a manufacturing cost of about $15–$20 for the PowerPC devices and $50 for the 29040, which has a relatively large die size of 119 mm^2. Production of the embedded PowerPC processors is further away, however, and the 29040, being a refinement of an existing design, is far more likely to hit production on schedule and be stable when it does.

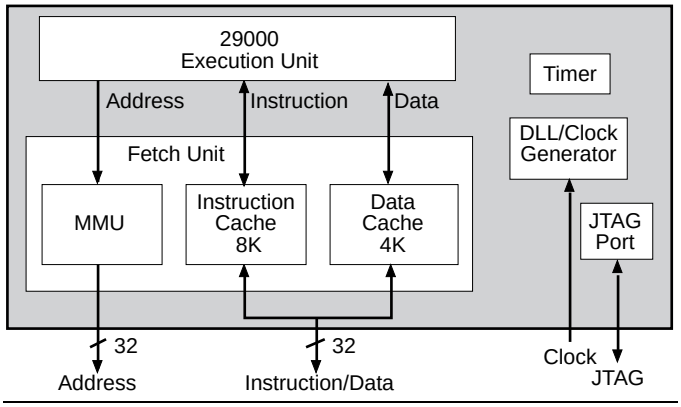

Figure 1. Internally, AMD's 29040 processor maintains separate buses for data and instructions, but they are combined before they go off the chip, allowing the chip to use a less expensive package.

Price & Availability

Samples of AMD's 29040 are promised for 3Q94, with production volumes in 1Q95. Pricing for the 33/16-MHz part is $72, the 40/20-MHz part is $84, while the 50/25-MHz part is priced at $114 (in 10,000-unit quantities). For further information, contact AMD at 800.292.9263 or 512.602.5651; fax 512.462.6985.

Market Looks at More Than Performance

For now, AMD's 29040 is the high end of the 29000 line, but the company plans to unveil a new processor at this fall's Microprocessor Forum that will compete against the fastest embedded RISC chips, including the R4200 and Intel's forthcoming P110. But performance isn't necessarily what wins this game. The important factors in the embedded market are cost, development tools, and the business relationship between chip maker and buyer. The 29000 family has an established base of software and of designers who are familiar with the architecture. The 29040 is the natural incremental advancement of the family that keeps AMD in the ballpark. ♦

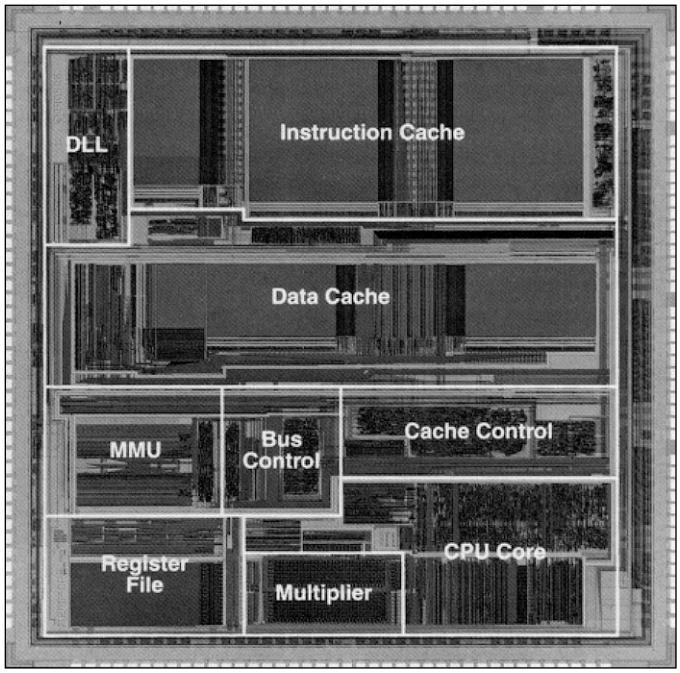

Figure 2. AMD's 29040 fits 1.2 million transistors on a 10.9 × 10.9-mm die using a 0.7-micron three-layer-metal process.

