

# Motorola Buys Reverse-Engineered 68000

## *Synthesized CPU Core Runs Four Times Faster Than Original 68000 Chip*

by Jim Turley

Motorola has signed an exclusive licensing agreement for a reverse-engineered version of its own 68000 microprocessor core. The new core runs unmodified 68000 binary code an average of 4× faster than the 68000 itself, according to Motorola. Application-specific chips based on the new design should start appearing in the middle of 1998.

Motorola licensed the core from the small Japanese design firm of Excellent Design (EXD) of Yokohama. In its seven-year history, EXD had previously developed synthesizable versions of 8-bit CPU cores, a PCI interface, and video encoding and decoding circuits. The new 68000 was not entirely a clean-room design; Motorola provided some assistance in the later stages of its development.

The new core adds another weapon to the Motorola arsenal, but it also casts a shadow over ColdFire, which Motorola spent years developing for essentially the same purpose: to provide ASIC customers with better performance while maintaining some level of 68K compatibility.

### New Core Faster Than 68000, But Slightly Bigger

The new core is completely object-code-compatible with the original 68000 chip. Unless programs include software timing loops, existing binaries will run unmodified—but faster. The new core executes many 68000 instructions in a single cycle, compared with 4–24 cycles for a standard 68000 chip. The core's interface also supports single-cycle bus transactions, versus the four-cycle bus on the original Motorola part. After simulating several benchmarks, Motorola arrived at an average performance improvement of 4:1 compared with a 68000 running at the same clock frequency.

That frequency is expected to be in the 25–30-MHz range in the targeted 0.42-micron process. Because the core is synthesized, die size can vary, but Motorola characterized it as “about the same size” as a 68000 in 0.65-micron technology, or about 7 mm<sup>2</sup>. Allowing for the synthesized core's built-in BDM (background debug module) extension, which adds 15%–20% to its size, and the differences in process geometry, the new core is somewhat bulkier overall than the original handcrafted 68000. In typical ASICs, this small difference will be insignificant to manufacturing cost.

### Anyone Can Design, But Motorola Must Build

Under the terms of the agreement, Motorola retains exclusive worldwide rights to manufacture parts using the 68000-compatible core. Other ASIC customers can still license and design with EXD's core, but any resulting chips must be manufactured on Motorola fab lines. Motorola can sub-

license the core to allow other semiconductor vendors to build EXD-based chips, a move the company hinted it may make in the future. Such a deal would be interesting to a large-volume customer that wants the right to manufacture parts for internal consumption. Hewlett-Packard and Motorola made a similar deal in 1996 for ColdFire and low-end 68K chips (see MPR 8/5/96, p. 8).

### 68000 vs. ColdFire at the Low End

The new core may make positioning difficult for Motorola because it plays much the same role as ColdFire. Both CPUs are synthesized, used in custom devices, run at 25 MHz or so, and leverage customers' familiarity with the 68K dynasty. But while ColdFire bears only a passing resemblance to the 68000, the new core is totally compatible with it—a compelling attraction for customers trying to reuse existing code.

Motorola claims ColdFire is twice as fast as the new core at the same clock rate because ColdFire chips have caches, while 68000 chips (and the copycat core) do not. Attaching a cache to this new core should be trivial, however, and would eliminate ColdFire's advantage while delivering complete 68000 software compatibility at the same time.

Looking ahead, the two advantages ColdFire has are its simpler pipeline and its reworked instruction set. The former should allow Motorola to turn up clock speeds on ColdFire faster than it could for the new core. The latter gives the company room to add new instructions, as it did with ColdFire V3 (see MPR 11/17/97, p. 8). ColdFire's advantages may be fleeting: after developing a complete 68000 core, it seems possible that EXD could follow it with an '020-compatible or '040-compatible core in a short time. A shrink to 0.35-micron technology would also provide a big speed boost.

Motorola avoids comparing the new core with ColdFire, however. In the company's game plan, the first offers compatibility while the second offers performance. In the end, it looks like market positioning, not technology, will keep these two CPU designs apart. □

### Price & Availability

Motorola has not released price or schedule information for chips using the new 68000-compatible CPU core.

For more information, contact Motorola's New Media Division (Austin, Texas) at 512.895.2142. Excellent Design (Yokohama, Japan) can be reached at 81.3.5487.8383 or in Santa Clara (Calif.) at 408.970.1480, or access the Web at [www.exd.com](http://www.exd.com).