TSMC Wins 0.18-Micron Foundry Race

In a surprise move, Taiwanese semiconductor maker TSMC *(www.tsmc.com)* has announced production availability of its 0.18-micron six-layer-metal CMOS process. TSMC says that some vendors have already received sample parts from production-process lots, and volume shipments will commence next quarter. Over 40 tapeouts are scheduled for this year.

Previously thought to be behind competitors UMC and Chartered in the technology race, TSMC jumps into the lead as the first foundry to enter production with a true 0.18-micron process. Unlike some manufacturers that misleadingly claim a 0.18-micron process on the basis of a hybrid process with 0.18-micron gates but only 0.25-micron metal and transistor pitches, TSMC's process is 0.18 micron throughout.

The new process is on a par with IBM's leading 0.18-micron CMOS-7SF foundry process, which is just now entering pilot production. TSMC's process, called CL018, touts a physical gate length of 0.16 micron and a gate-oxide thickness of 32 Å, giving it 28-ps inverters at 1.8 V and at an extraordinarily low leakage (I_{off}) of 0.1 nA/µm. According to TSMC, CL018 is 30% faster and offers 65% lower power than its current 0.25-micron process.

CL018's density parameters are equally impressive: with contacted metal pitches of 0.46 (M1), 0.56 (M2–5), and 1.0 micron (M6), CL018 offers a logic density of 120,000 gates/mm^2, an increase of more than 100% over the company's current 0.25-micron process. Even though it lacks local interconnect, CL018's tiny 4.65 µm^2 SRAM cell is 15% smaller than Intel's 0.18-micron P858 cell (see MPR 1/25/99, p. 22).

Although designed as a low-cost process, CL018 uses a number of advanced features, such as low-*k* FSG intrametal dielectric, cobalt-silicided gates and diffusions, and dual gate oxides of 32 and 70 Å—the latter giving CL018 the ability to support 3.3-V I/O. The new process currently has a 5-GHz analog RF module as well as precision resistor and capacitor modules. Next year, TSMC will add embedded-DRAM and embedded-flash modules to the process.

One feature CL018 lacks compared with IBM's CMOS-7SF is copper interconnect. TSMC will remedy this shortcoming in the third quarter, when it replaces the upper two layers of aluminum with copper, improving performance by 15%. Although TSMC says it has the technology to apply copper to all layers, it finds no benefit in doing so until it can also provide a low-*k* intermetal dielectric, which it is not yet able to produce at high yield. Therefore, the company will wait for its 0.15-micron process to deploy copper in all layers.

CL018 enters production in TSMC's Fab 4 line in Hsinchu (Taiwan) and will be copied exactly to Fabs 3, 5, 6, and WaferTech. The company expects to produce 34,000 CL018 wafers this year, ramping to more than 600,000 in 2000.

The new process makes TSMC the first foundry to enter 0.18-micron production and puts it on a schedule similar to the major microprocessor vendors. Although CL018 may not have quite the performance of IBM's most aggressive CMOS-8S (see MPR 9/14/98, p. 1) or Intel's P858, it is very close, and is, in fact, denser than P858. The availability of such a state-of-the-art process—on a par with those of the traditional microprocessor vendors—could have a dramatic ramifications for fabless semiconductor companies. TSMC's advances may have helped convince National to go fabless (see MPR 5/31/99, p. 12). —*K.D.*

Pentium III Gets Faster, Cheaper

As promised, Intel has rolled out the 550-MHz Pentium III for desktop PCs, about a month after introducing that speed grade into the Xeon line (see MPR 3/29/99, p. 8). At $744, the new part pushes Intel's high-end price to a level not seen since the Pentium II-400 was introduced at $824, more than a year ago. Poised to roll out a slew of new speed grades powered by its new 0.18-micron process, Intel should be able to sustain products at this price point for the next few quarters.

Most of the volume in the PC market is at much lower price points. Acknowledging this, Intel also cut the prices of its Pentium II and Pentium III processors for the second time in five weeks (see MPR 4/19/99, p. 4), this time by as much as 35%. As the table below shows, a 450-MHz Pentium III now lists for $268, the same as a 450-MHz Pentium II. Removing the price premium for Pentium III will increase the use of that part, and further price cuts should completely eliminate Pentium II by the end of this year.

	4/11/99	5/16/99	%CHG
Pentium III Xeon-550/512K	$1,059	$931	–12%
Pentium III Xeon-500/512K	$931	$931	0%
Pentium II Xeon-450/512K	$824	$824	0%
Pentium III-550	—	$744	—
Pentium III-500	$637	$482	–24%
Pentium III-450	$411	$268	–35%
Pentium II-450	$396	$268	–32%
Pentium II-400	$234	$193	–18%
Pentium II-350	$163	$163	0%

Intel also dropped the list price of the 512K Xeon-550 from $1,059 to $931. This move obsoletes the 512K version of the Xeon-500, simplifying the Xeon line for workstation processors. Intel continues to offer the Xeon-450, which uses a Pentium II processor, for $824, but that part doesn't offer the SSE features that some workstation applications use.

The prices of Intel's server processors (Xeons with 1M and 2M of cache) stayed the same, as did the prices for Celeron and the mobile products. Most of these prices were trimmed last month and should remain in place until the next general reduction, scheduled for late July. The rapid reduction in Pentium III prices positions that part to carry most of the performance PC shipments in the second half of this year. —*L.G.*

HP Posts Fastest SPEC Results

After claiming for months that its PA-8500 is the world's fastest processor, HP finally presented the proof. The first publicly available SPEC scores for a PA-8500 system show the 440-MHz processor delivering 30.8 SPECint95 (base) and 48.7 SPECfp95 (base). These scores top the 26.0 int/47.2 fp posted by the Alpha 21264.

The results come from a new midrange server, the HP9000 N4000. These systems are upgradable (through a motherboard swap) to future IA-64 processors and start at a list price of $64,110 for a system with one 440-MHz CPU, 512M of SDRAM, and a 9G hard drive. Although the integer score is a bit better than HP's original estimate, the FP score doesn't quite reach the projected value of 50. The company expects the PA-8500 to deliver slightly better performance in a new high-end system expected later this year.

HP may not be able to hold the performance lead for long. Compaq plans to ship a 700-MHz 21264 in 3Q99 (see MPR 5/10/99, p. 4), boosting its scores by as much as 20%. HP's next sizable increase isn't due until the PA-8600 begins shipping early next year. Despite this gap, however, HP appears to be the one vendor that can keep up with Alpha in the performance race. —*L.G.*

Motorola Takes Capacitance to New Low

Having tackled resistance head on with its move to copper, Motorola is now in hot pursuit of capacitance, the other culprit in RC delay. The company has announced a breakthrough in the integration of low-*k* dielectrics with the dual-inlaid process it uses to construct copper interconnects.

Currently, most manufacturers use SiO_2 dielectric, which has a *k* of about 4.0. Although some manufactures have begun fluorine doping SiO_2 (FSG) to lower *k* to about 3.6, Motorola's new material will have a *k* as low as 2.0. Motorola will not reveal the material, but it acknowledged that it is in the family of porous inorganic materials. Published work by companies such as TI predict reductions in RC delay of up to 35% using such materials. But while previous demonstrations have been limited to one or two levels of etched aluminum wires, Motorola is claiming full multilayer dual-inlaid copper capability.

The accomplishment is impressive because low-*k* materials, especially porous oxides, have weak thermomechanical properties that make them difficult to fabricate with the chemical-mechanical polishing (CMP) technique fundamental to dual-inlaid processing. Motorola says it has now cleared this hurdle, as well as others, which has heretofore precluded use of these materials. Unfortunately, there is still work to be done in reliability testing and in integrating the materials into the production process flow, so Motorola isn't anticipating products based on the new material until 2002. AMD, Motorola's process-development partner, will also benefit from this breakthrough. —*K.D.*