AMD K5 Volume Slips into 1996

Compaq to Get 0.5-Micron Chips in Fall—Others Wait for 0.35-Micron

by Michael Slater

AMD has revealed a two-to-four-month delay in putting the K5 into production, slipping the first deliveries from the third quarter of this year to the fourth. Furthermore, customers other than Compaq won't get production quantities until 1996. The upside is that AMD will have more capacity for high-performance 486 processors, so the company doesn't expect to see a hit in its bottom line. Nevertheless, the delay could enhance the positions of Cyrix and NexGen, and design wins for AMD will be harder to come by if the delays stretch out.

AMD CEO Jerry Sanders said that the K5 is performing well and has successfully run Windows, Windows NT, and OS/2, but that AMD's development partner (Compaq) believes that more extensive compatibility testing is needed—especially given the "heightened expectations on the part of the user" that resulted from the Pentium FDIV debacle.

Sanders conceded that AMD "underestimated the time and effort needed to validate the part" and said that one or two silicon revisions beyond those initially planned are now included in the schedule. As we have noted *(see **0815ED.PDF**)*, a 12-month interval from tapeout to volume production is to be expected, and it now appears that this is just about where AMD will end up.

The Rev. C chips, which the company originally hoped to put into production, are due out of the fab as we go to press, but the company now plans to wait for Rev. E for volume production. AMD declines to describe the bugs in the current version of the chip, other than to say that there are no "show stoppers."

When the 0.5-micron version of the K5 goes into production this fall, the chips will be offered as samples to support customer evaluation and prototyping. Production quantities of the 0.5-micron version will be shipped only to Compaq, however. Because of the delay in getting the 0.5-micron part into production, the 0.35-micron process will be ready very soon thereafter, with limited volumes available from AMD's Submicron Development Center (SDC) late this year and volume production from the company's new Fab 25 starting in 1Q96. As a result, AMD has decided to wait for the 0.35-micron chips before making production quantities available to companies other than Compaq.

K5 Sampling to Key Customers

Sanders said that current K5 samples are running at "greater than 75 MHz." He said no effort has gone into speed tuning and that he is confident the K5 will hit its 100-MHz target in the 0.5-micron process. In the 0.35-micron process, the company expects to deliver 133-MHz parts early on and higher frequencies later in the year. AMD expects to ship more than five million K5s in 1996, but 1995 volumes will be well below the 500,000 to 1,000,000 originally projected.

Along with the announcement of the delay, AMD disclosed the die size of the K5: 251 mm^2 (390K $mils^2$) in 0.5 micron and 161 mm^2 (250K $mils^2$) in 0.35 micron. Figure 1 shows a die photo of the 0.5-micron version.

It is to be expected that a device with a million more transistors would be larger than Pentium, but this transistor-count difference doesn't account for the large spread between the K5 and Pentium die sizes. The 0.35-micron K5 is about the same size as Intel's first 0.5-micron P54C design, which the company recently shrank by 10% to 148 mm^2. (Intel calls this process 0.6 micron, but we use the drawn gate length to allow a fairer comparison with other vendors' processes.)

When Intel has optimized its 0.35-micron Pentium *(see **090402.PDF**)*, we expect its die size to be about 90 mm^2—only 56% of the size of 0.35-micron K5. Intel's

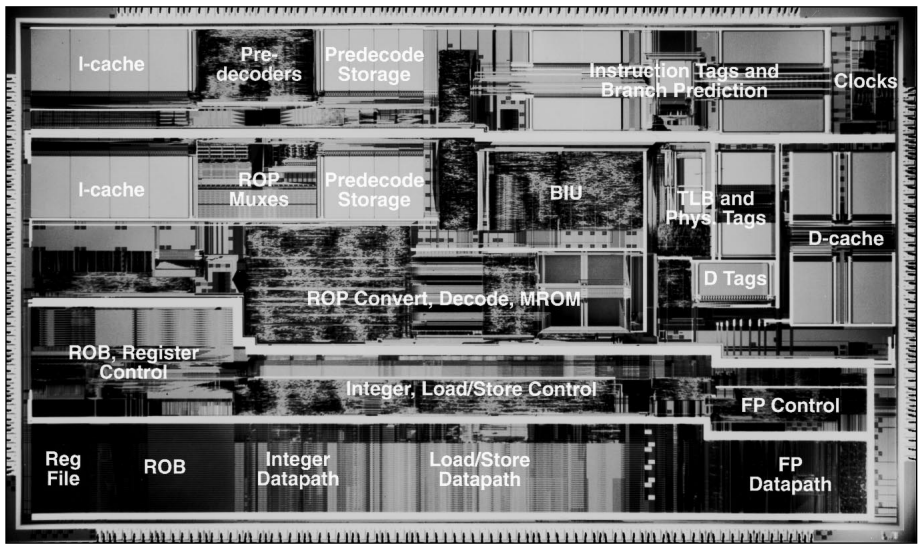

Figure 1. AMD's K5 incorporates 4.3 million transistors on a 251-mm^2 die using a 0.5-micron three-layer-metal CMOS process.

fourth layer of metal, combined with greater efforts put into compaction, yields smaller die sizes, increasing Intel's competitive advantage should a price war break out.

According to the MDR Cost Model, manufacturing cost for the K5 will be approximately $175 for the 0.5-micron version and $125 for the 0.35-micron part. Intel's Pentium cost, in contrast, we estimate will drop to about $85 when the design is fully optimized for the 0.35-micron process.

While AMD's costs will be higher, it will still be able to sell the K5 at prices comparable to Pentium and earn reasonable margins, if not Intel-like margins. AMD may have difficulty serving the lowest-speed markets profitably, since Intel has cut low-end Pentium prices exceptionally aggressively. We expect 75-MHz Pentium prices to drop below $200 in 1Q96; AMD is likely to focus on selling 100- to 133-MHz K5s as a comparable-performing alternative to 120- to 150-MHz Pentiums, which we expect to be priced from $450 to $700 in early '96.

AMD is discussing with Taiwan Semiconductor Manufacturing Company (TSMC), its primary outside foundry for 486 chips, the possibility of making 0.5-micron K5s there. Discussions are also under way about transferring AMD's 0.35-micron process to TSMC.

Upside for the 486

AMD believes that the delay in K5 production will not cut its revenue or profit for 1995 because the slip frees additional 0.5-micron wafers for 486 processors. By building high-speed 486 chips, AMD can produce more revenue per wafer from 486s than from the K5 at this level of technology. Assuming an average selling price (ASP) of $100 for its high-end 486 chips, AMD's revenue per 8" 0.5-micron wafer is about $32,000. The same wafer, however, yields far fewer K5 chips that, assuming an ASP of $400, might fetch a total of just $10,000.

In 1Q95, AMD shipped 2.3 million 486s for more than $250 million in revenue, indicating an ASP of more than $110. Sanders noted that there has been "heightened interest" in AMD's 486 chips since Intel began backing away from the 486 market *(see **0906MSB.PDF**)*. All the 486 chips so far have been produced at AMD's SDC, which is now fully outfitted for 0.5-micron production and running at capacity. AMD expects to boost production there to 2.5 million units this quarter.

Additional 486 production will come from TSMC. In the third quarter, TSMC will begin supplying AMD with 0.5-micron 486 chips, ramping up to about 500,000 per quarter sometime in 1996. AMD projects its total 486 shipments in 1995 to reach 12 million units.

Contrary to its original plan to use Fab 25 solely for the K5, AMD will now begin with 486 production there. Sanders said that Fab 25 is achieving 75% yields on 0.5-micron 486 wafers, yielding about 320 good chips from the 430 candidates on an 8" wafer, and that the majority of the chips run at 100 MHz or faster. The company has been saddled with more 66-MHz DX2 orders than it wants to ship, since most of its chips run at higher clock rates. Aggressive pricing of faster parts will remedy this imbalance and move most 486 systems to higher rates.

Fab 25 is now running about 350 8" wafer starts per week. Production runs will begin in June, with chips from the first production wafers due to hit the streets in August or September. As AMD continues to add equipment to Fab 25, it expects to ramp production to 2,500 wafer starts per week by the end of 2Q96 and 6,000–7,000 per week by the end of 1997. Just 2,500 wafers per week would produce more than 40 million 486s per year, so AMD needs the K5 to make good use of Fab 25.

Boosting 486 Speeds

Late this quarter, AMD plans to introduce enhanced 486 chips that include Intel-compatible SMM and are pin-compatible with Intel's DX4. It will also offer versions with a write-back cache. The cache size for generally available products will remain at 8K, unlike Intel's DX4, but AMD expects to make versions with 16K of cache for a few key customers.

Sources indicate that AMD expects to introduce 486 processors at 120 and 133 MHz later this year. The 120-MHz clock speed can be delivered from the 0.5-micron process, but the 133-MHz rate probably requires a shrink to 0.35 micron. AMD said that 0.35-micron 486 chips have already been made at Fab 25, but they are not yet in production. As with the 386, AMD is continuing to push the 486 to more advanced process technology and higher clock rates after Intel has ceased to invest in that product line.

486 vs. Pentium

AMD's aggressive support of the 486 will intensify the battle between 486 and a Pentium systems later this year. In Intel's view, a Pentium is needed to deliver good multimedia performance. This view is based not on today's applications, however, but on Intel's vision of future applications. The NSP approach *(see **090603.PDF**)*, for example, requires high floating-point performance to implement the signal-processing algorithms, so a 486 system falls short. For integer-oriented applications, which include almost all multimedia today (except for 3D rendering applications), a 486DX4-120 should deliver an acceptable level of performance at a lower cost than the least expensive Pentium system.

AMD will probably be able to prop up the 486 for the rest of 1995, but in 1996, the inevitable decline will begin. Fortunately, AMD should then be ready with its 0.35-micron K5, Cyrix should be ready with its 0.5-micron M1, and the Pentium-class battle will begin in earnest. ♦

