

Product Design for
the 21st Century

INNOVATION

NOR and NAND: Intel Offers Both



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“Intel is committed to nonvolatile memory technology and products in all its forms — NOR, NAND and the phase-change memory chips that we’re now prototyping.”

Intel nonvolatile memory technology leadership enables it to take advantage of the different flash memory capabilities in its innovations:

- NOR is found in wireless and embedded applications. Intel offers NOR products from 32Mb density at the low end to 1Gb density for multimedia cell phones. In keeping with its NOR leadership role, the company is transitioning its cellular memory products from 130nm and 90nm process technology to 65nm process technology next year.
- On the NAND front, Intel has also assumed a leadership role. Intel's Robson NAND disk-cache accelerator is designed to sit between the CPU and the hard drive, enabling the CPU to access this flash memory rather than the hard disk drive, which will speed booting and data access performance.
- PCM (phase change memory) technology, meanwhile, is being pioneered by Intel as the eventual replacement for today's flash memory products when these reach the limits of their scalability.

Meeting Flash Memory Needs Today and Tomorrow

Long committed to leadership in flash memory, Intel is meeting the needs of the flash memory market with technology and product leadership, dedicated supply and a range of NOR and NAND flash memory offerings.

NOR remains the nonvolatile memory technology of choice for the majority of embedded and wireless applications, thanks to NOR's architectural flexibility and long-term advantages over NAND:

- NOR offers the lowest floor cost;
- NOR's execute-in-place (XiP) handset designs offer the greatest platform flexibility compared to store-and-download (SnD) and NAND-only designs for original equipment manufacturers (OEMs) as they evolve new generations of their phone platform designs.
- More than 95 percent of today's cellular handsets include NOR flash memory, and most of these utilize only NOR.

to cover the lower-density value (32Mb-256Mb) cellular segments.

In the embedded applications sector, meanwhile, Intel provides several flash memory products in a range of densities and packages — including the Intel StrataFlash® Embedded Memory (P30/P33) and a serial peripheral interface (SPI) product, the Intel® Serial Flash Memory (S33).

Intel is also committed to NAND flash memory via its IM Flash Technologies (IMFT) venture with Micron and is now shipping 2Gb to 16Gb NAND products. Rapid capital investment in IMFT is driving quick ramp-up and the addition of new fabrication plants. Here, too, the future is bright.

Intel recently sampled their 50nm 4Gb NAND part. Semiconductor Insights' lead memory analyst, Geoff MacGillivray, says: "Our preliminary analysis has confirmed a 50nm gate length in the wordline pitch. This is the most advanced flash part we've seen, and it is impressive that IMFT is on such a fast ramp to the next lithography process technology."

Intel's Robson NAND flash disk-cache accelerator will be incorporated into the next generation of the Centrino platform to deliver key benefits, including faster boot time, platform power savings, faster application load and system benchmark gains.

What the future holds
As flash memory technology scales, it will need to support a range of application-specific solutions, including data storage (MP3, USB, cards), handsets with both code execution and data storage requirements, and disk caches.

Intel is committed to doing it all. What's more, Intel is looking beyond flash memory to the next non-volatile memory technology — phase change memory (PCM) — which will scale beyond NOR and NAND. Intel is collaborating with STMicroelectronics and Ovonyx, and has successfully developed 90nm PCM technology.

When it's time to leap ahead in nonvolatile memory, it's time to turn to Intel.

Different Solutions for Different Market Segment Needs

	Lowest Floor Cost	NOR	NAND	HDD	Lowest \$/MB
Market Segments		<ul style="list-style-type: none"> • Mobile Handset • Embedded (CE, PC, Industrial) 	<ul style="list-style-type: none"> • Removable Data • Consumer Data • Disk/Cache 	<ul style="list-style-type: none"> • PC • Digital Video Recorder • Mass Storage 	
Characteristics		<ul style="list-style-type: none"> • Long NVM product lifecycles required • Value points prioritized • Diverse needs 	<ul style="list-style-type: none"> • Rapid NAND product lifecycles • Technology changes abstracted • Focus on cost/GB 	<ul style="list-style-type: none"> • Focus on GB per platter • Performance plateau 	

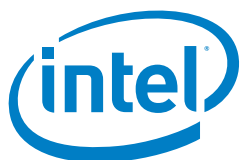
That's why Intel's leadership in the nearly \$9 billion NOR market continues. Intel's technology leadership and dedicated capacity — including factories exclusively committed to NOR production — support a range of products for both the cellular and embedded applications.

In the cellular sector, Intel plans three litho generations of compatible Intel StrataFlash® Cellular Memory (M18) designs: First, a 90-nanometer (nm) flash memory device, 512Mb generation; then the industry's first 65nm, monolithic 1Gb flash memory device; and finally, an anticipated 45nm, 1Gb-2Gb design. In addition, Intel offers cost-effective products

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