



Corporate Backgrounder

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Summary:

Enhanced Memory Systems is a leading specialty DRAM company. Enhanced Memory began shipping its first low-latency EDRAM products in 1992. In November 1996, the company announced its new 133-MHz enhanced synchronous DRAM (ESDRAM). The ESDRAM became an official JEDEC SDRAM Superset standard and was sampled in 1998. The PC133 HSDRAM products continue the Enhanced Memory Systems tradition of supplying the highest-performance plug-compatible memory upgrade products.

As a fabless DRAM company, Enhanced Memory Systems has manufacturing agreements with top semiconductor companies, including Infineon Technologies' who recently purchased 20% of EMS in exchange for its advanced memory technology and wafer capacity. EMS is pursuing other strategic partnerships to advance its EDRAM, ESDRAM, and HSDRAM technology in the marketplace.

Management Team:
Manager

Craig W. Rhodine, Vice President and General

Luann Hanson, CPA, Vice President of Finance and CFO

David Bondurant, Vice President of Marketing

Craig Taylor, Director of Worldwide Sales

Kenneth J. Mobley, Director of Design

David Fisch, Director of Engineering

Michael Peters, Director of Applications Engineering

About Enhanced Memory Systems

Enhanced Memory Systems, Inc. (EMS) offers an extensive line of high performance DRAM memory products which offer speed, density, power, and cost-effectiveness. EMS, a subsidiary of Ramtron International Corporation (NASDAQ: RMTR), pioneered the specialty DRAM industry in January 1992 with the introduction of Enhanced DRAM (EDRAM®), the world's first specialty DRAM product. EDRAM was the first product combining fast DRAM and SRAM row register cache on one chip, minimizing DRAM latency and increasing system bandwidth.

EMS now offers two additional memory product lines: Enhanced SDRAM (ESDRAM) and High-speed SDRAM (HSDRAM). A third product line, Enhanced SRAM (ESRAM), is currently in development. The unique features offered by all EMS memory products position the company as a leader in SRAM replacement memory. Top companies in the fields of communications, RAID disk controller, embedded computer, DSP, PC systems, and 3-D graphics use EMS products. Customers have included such leaders as Cisco Systems, Lucent Technologies, Motorola, Bay Networks, Fore Systems, Cabletron, 3Com, Madge Networks, Memorex-Telex.

Industry Background

According to a recent Dataquest report, low-latency DRAM has evolved from a novelty to reality. With increased need by telecommunications companies for lower power, higher capacity and speed, the SRAM market is being threatened by faster DRAM offerings. The key questions:

1. What new technologies will replace today's SRAM and when will it happen?
2. Will DRAM replace SRAM?

The answers: SRAMs are already being replaced with DRAMs in some applications. In the future, more of those SRAMs, in increasingly fast applications, will be threatened. DRAMs will convert to low-latency types, first in graphics applications, and eventually in main memory applications. In addition, SRAMs on ASICs are prime candidates for replacement with low-latency DRAMs.¹

To that end, EMS offers products with SRAM speed and DRAM density, power, and cost-effectiveness, making EMS the pioneer in SRAM replacement. The company's visionary stance in the memory market has helped EMS to remain one of the few profitable memory manufacturers during the recent downturns in worldwide memory pricing.

Strategic Partners and Standardization Efforts

¹ From "Defining the Market for Low-Latency DRAM", Dataquest, May 2000

EMS is a fabless semiconductor manufacturer. That means that EMS develops patented, high performance products that are manufactured by leading DRAM wafer, packaging and test subcontractors worldwide. To that end, EMS seeks strategic partnerships with leading semiconductor manufacturers to use our intellectual property (IP) in embedded DRAM or SRAM cell libraries or by co-developing memory products.

Currently, EMS has established strategic partnerships with several such companies including Infineon Technologies, Cypress Semiconductor, IBM Microelectronics and NEC.

- EMS and Infineon: With a 20 percent stake in EMS, the agreement with Infineon (formerly Siemens Semiconductors) provides EMS with access to Infineon's advanced DRAM process technology, DRAM designs, and manufacturing capacity in return for their equity investment.
- EMS and Cypress: EMS and Cypress are developing semiconductor memory products geared toward the network communications market.
- EMS and IBM: EMS provides an intellectual property license to IBM for its proprietary Enhanced DRAM technology. IBM is the manufacturing source of EMS 4Mb EDRAM products.
- EMS and NEC: EMS provides an intellectual property license to NEC for its virtual channel SDRAM (VC-SDRAM) products.

In addition to seeking partnerships, EMS is working to standardize its memory architectures for commodity PC main memory and SRAM applications. Currently, the EMS director of Applications Engineering holds an elected position heading up the SRAM committee for JEDEC, the semiconductor standardization body of the Electronic Industries Alliance (EIA).

Product Offerings

EMS offers four main specialty memory products to address the wide-ranging needs of today's high performance applications.

- EDRAM® or Enhanced DRAM was first offered in 1992. EDRAM combines fast DRAM and SRAM row register cache on one chip to minimize DRAM latency and increase real bandwidth. The 4Mb EDRAM family continues to ship to leading communications, DSP, and RAID disk controller companies.
- ESDRAM or Enhanced SDRAM is compatible with today's new commodity SDRAM products while still providing significant improvements in speed and bandwidth. ESDRAM was recently named an SDRAM Superset by JEDEC, the industry standard organization, in 1998. The 16Mb and 64Mb ESDRAM product families target embedded communications, DSP, and computer applications.
- HSDRAM or High-speed SDRAM provides the highest speeds and densities available for standard SDRAM products. These products are targeted toward performance PC,

workstation and server applications as well as select communications switching applications. It is offered direct to consumers and resellers through the EMS website, www.pc133memory.com.

- ESRAM™ or Enhanced SRAM technology is being developed using advanced embedded DRAM technology from Infineon Technologies. ESRAM will achieve true SRAM speed while also offering higher density and lower power. ESRAM will be available both as standard memory components and as virtual IP in embedded DRAM cell libraries.

Technology Behind EMS Memory

EMS has a strong patent portfolio in the areas of fast DRAM core design, integrated cache architectures, and the application of these techniques to DRAM and SRAM product architectures.

The key technology is the combination of a fast 22-ns DRAM core array and multiple 10-ns integrated row register caches onto one chip. The combination of cache and DRAM on one chip provides faster initial random access speed, hidden precharge and row access latency on pipelined random accesses (page misses), and hidden refresh operations to reduce DRAM overhead. The combination of these features provides the highest sustained bandwidth available with DRAM technology. In fact, the technology provides SRAM-like speed with the benefits of DRAM cost, density, and power efficiency.

EMS uses this technology in conjunction with industry standard DRAM and SRAM interfaces to provide pin and function compatible memory products that provide performance or cost advantages over commodity products.

Management Team

Craig W. Rhodine, Vice President and General Manager

Mr. Rhodine is responsible for the overall operation of EMS. He has more than 13 years experience in the semiconductor industry. He spent the last seven within Ramtron International in the areas of engineering and operational management. Mr. Rhodine was appointed director in 1996 and named vice president a year later. Prior to Ramtron, he

worked at Texas Instruments where he was a member of the group technical staff which focused on memory product development. Mr. Rhodine holds a BSEE from the University of Wyoming.

Luann Hanson, CPA, Vice President of Finance and CFO

Ms. Hanson, who has been with EMS since its infancy, was named CFO in January 2000. She joined EMS in September 1993 as an assistant controller. She served as corporate controller from April 1995 until February 1999 when she was named vice president of Finance for EMS. As a CPA, Ms. Hanson has more than 16 years experience working in finance for a number of semiconductor companies, including United Technologies Microelectronics Center. She also has four years public accounting experience. Ms. Hanson hold a BA in accounting from the University of Northern Iowa and an MBA in finance from Regis University.

David Bondurant, Vice President of Marketing

A 28-year veteran in semiconductor marketing, Mr. Bondurant oversees all of EMS strategic and tactical marketing, applications engineering, marketing communications and public relations activities. He has worked for such companies as Control Data, Sperry-Univac, Robertshaw Controls, Honeywell, and EMS parent company, Ramtron, where he served as director of business development. He holds a BS in Physics from Northeast Missouri State and a BSEE from the University of Missouri-Rolla.

Craig Taylor, Director of Worldwide Sales

With more than 20 years in semiconductor sales, Mr. Taylor manages all sales activities for EMS. Prior to joining EMS, Mr. Taylor was director of sales for Ramtron where he was responsible for sales in the Northeastern United States and Canada. He also has experience with SGS-Thomson Microelectronics and Inmos, as well as experience as an independent sales representative.

Kenneth J. Mobley, Director of Design

Mr. Mobley heads all EMS product designs. He has been responsible as design lead for all EMS products designed to date and holds more than 10 patents. He has spent 18 years in the semiconductor industry with experience at Inmos and Texas Instruments where he was a member of the group technical staff. Mr. Mobley holds a BS in Engineering physics from the Colorado School of Mines.

David Fisch, Director of Engineering

When Mr. Fisch joined EMS in 1998 as director of engineering, he brought with him more than 15 years of industry experience in development and production. Prior to EMS, he held engineering and management positions with United Memories, Inc., National Semiconductor, Krysalis, and SGS-Thomson. Mr. Fisch holds a BS in Physics from Case Western Reserve and an MSEE from Southern Methodist University.

Michael Peters, Director of Applications Engineering

Mr. Peters comes to EMS with 18 years experience in applications engineering. He initially came to EMS as an applications engineering manager. Prior to EMS, Mr. Peters worked for Motorola's fast SRAM division. He has also held positions with nCHIP, Inc. and National Semiconductor. Mr. Peters has also published articles and applications notes on fast memory. He was a contributor to portions of "High Performance Memories" by Betty Prince. He holds a BSEE from the University of Michigan, Ann Arbor.