

**Toshiba America Electronic Components, Inc.  
Flash Memory***Fact Sheet***Company Overview**

Combining quality and flexibility with design engineering expertise, TAEC brings a breadth of advanced, next-generation technologies to its OEM customers. This broad offering includes memory and Flash memory-based storage solutions, a broad range of discrete devices, displays, medical tubes, ASICs, custom SOCs, microprocessors, microcontrollers and wireless components for the computing, wireless, networking, automotive and digital consumer markets.

TAEC is an independent operating company owned by Toshiba America Inc., a subsidiary of Toshiba Corp. Toshiba is a world leader in high-technology products with more than 300 major subsidiaries and affiliates worldwide.

**Memory Business Unit Overview**

Toshiba's memory products are designed to enhance the performance of portable and handheld systems such as cellular phones, solid state data storage and consumer electronics. Whether the application calls for higher density, increased bit count, faster access or lower power consumption, Toshiba's memory components meet these performance requirements with reliability and flexibility.

To meet the performance demands of today's design engineers, Toshiba focuses on application-specific and high value-added memory products. The company's state-of-the-art, cost-effective memory devices include NAND Flash, a full line of NAND-based Flash cards, high-density NOR Flash, low-power SRAMs, Pseudo SRAMs, and Multi-Chip Packages (MCP) which integrate various memory technologies into a single package.

Toshiba has made major investments in design approaches and process technologies that enable the company to offer an industry-leading selection of memory products. Through its ongoing commitment to invest in future technologies, Toshiba will continue to provide advanced solutions to meet evolving customer needs.

*\_ more \_*

## Flash Memory Overview

As the recognized pioneer in Flash technology, Toshiba was a principal innovator of both NOR-type and NAND-type Flash technology in the 1980's. Today, as a leading developer of both NAND and NOR Flash, Toshiba understands the unique advantages associated with each architecture. By offering both types of Flash memory, Toshiba is able to meet the needs of a vast array of applications. NOR Flash applications often require fast random access for code execution in applications such as set-top boxes and mobile handsets, while high-density NAND Flash is used primarily for emerging digital consumer, solid-state storage applications and is quickly finding its way into traditional NOR applications such as mobile handsets for data storage and/or code storage as well.

NOR technology offers high-speed random access and byte programming, and is suitable for replacement of erasable programmable read only memory (EPROM) and one-time programmable (OTP) devices. In addition, it can be used for control memory such as BIOS/Firmware as well as in cellular, hard disk drive and PDA eXecute In Place (XIP) applications. NAND Flash has become the storage media of choice for solid-state storage applications because of its high-speed programming capability, high-speed erasing, large block size and low cost. The sequential nature (serial access) of NAND-based Flash memory provides notable advantages for these block-oriented data storage applications. NAND is also starting to be designed into multi-functional cellular phone applications where fast data storage and larger memory capacities are required. Because the NAND cell structure is smaller than the NOR cell structure, it provides a more cost-effective memory solution when higher densities are needed.

## Recent Advances

Toshiba's Flash development focus is on developing higher-density, lower-voltage products for data storage and portable applications. Recent advances include lower voltage solutions and new packaging options for handheld mobile electronics devices, including cellular phones and PDAs. These advances address the need for high levels of integration in today's miniaturized phones, and the ongoing demand to decrease power requirements to extend battery life. Toshiba is also addressing the ongoing industry demand for higher performance and higher density Flash solutions. Here are a few noteworthy developments:

- In March of 2000, Toshiba introduced the industry's first 64-megabit (Mb)<sup>1</sup> Read While Write (RWW) NOR Flash memory device at the 0.20 $\mu$ m process technology.
- Toshiba also introduced the company's 8Mb SRAM and 64Mb RWW NOR stacked-MCP device in March of 2000 at the 0.22 $\mu$ m process technology.
- The company introduced its 32Mb RWW NOR Flash at .20 $\mu$ m process technology in April 2000.
- In September 2000, Toshiba introduced the industry's highest density stacked NAND devices, at 512Mb and 1 gigabit (Gb)<sup>2</sup> using 0.16 $\mu$ m process technology.
- In November of 2000, Toshiba announced the availability to OEM customers of its Secure Digital memory cards ranging from 8- to 64 megabyte (MB)<sup>3</sup>.
- Toshiba added to its line-up of high-capacity NAND Flash memories by introducing its 64- and 128MB SmartMedia<sup>TM</sup> cards in November 2000.

*\_ more \_*

- Toshiba introduced its high-density 512MB CompactFlash™ removable storage card in May 2001.
- In June 2001, Toshiba introduced its 256Mb NAND device based on the 0.16µm process technology, further reducing the cost-per-megabyte for embedded storage solutions and solid-state disk drives.
- In October 2001, Toshiba introduced the company's first hard drives based on NAND Flash technology and optimized for use in industrial applications, point-of-sale (POS) terminals, automated teller machines (ATMs), factory automation systems, communications equipment as well as other emerging devices.
- Toshiba introduced its 1Gb NAND Flash memory chip based on the multi-level cell (MLC) NAND technology, co-developed by Toshiba and SanDisk Corp., in November 2001.
- In June 2002, Toshiba introduced its CompactFlash cards based on MLC technology that provides of up to 1 gigabyte (GB)<sup>4</sup> of storage space.
- In October 2002, SanDisk Corporation and Toshiba Corporation jointly announce that they will develop 90 nanometer (nm or 0.09 micron) process technology that will lead to overall increased supply and improved competitiveness of NAND Flash memory.
- In January 2003, Toshiba announced the introduction of its 256MB Secure Digital (SD) Memory Card. The new high-density offering is capable of achieving a maximum data transfer rate of 10 megabytes per second (MB/s)<sup>5</sup> and incorporates one of Toshiba's 2Gb NAND Flash memory devices.
- In March 2003, Toshiba introduced a 2Gb single-die NAND Flash memory with double the capacity of the company's present largest single-die NAND Flash memory. Toshiba also announced a 4Gb NAND Flash memory IC that stacks two of the 2Gb NAND Flash in a single package.
- In April 2003, Toshiba introduced a modified NAND Flash memory designed to simplify integration of higher density memory solutions into advanced cell phones. Called "Chip Enable Don't Care" NAND, the new memory allows inexpensive NAND Flash to be more easily combined in cell phones with other memory such as NOR, SRAM and Pseudo SRAM to provide a simpler, more affordable alternative to meet the increased memory requirements of today's feature-rich phones.
- In January 2004, Toshiba introduced a new family of high-speed SD cards, based on Single-Level Cell (SLC) NAND technology. The new cards are capable of achieving a maximum write speed of 10 megabytes (MB)/second and a sustained write speed of 5 megabytes (MB)/second. They feature a fivefold increase in data transfer rate over the company's standard SD Memory Cards and are targeted for demanding new applications in high-end portable electronics products.
- In April 2004, Toshiba Corp. announced the start of construction of 300mm NAND fab at Yokkaichi, as a joint venture with SanDisk.
- Also in April 2004, Toshiba Corp., in conjunction with TAEC, introduces its first 4Gb NAND Flash, using a 90nm process.
- TAEC completed a performance study in May 2004 that concluded that Multi-Level Cell (MLC) NAND Flash, which stores 2 bits of data per cell rather than the 1 bit per cell found in Single Level NAND Flash, provides more than sufficient performance for most consumer applications.
- At the International Solid State Circuits Conference in Feb. 2005, Toshiba and SanDisk announced a jointly-developed 8Gbit MLC NAND using a 70nm process.
- In early 2005, Toshiba developed GB NAND, which includes an SD controller and 1 to 4GB NAND Flash in an MCP package, targeted for embedded applications.

**Product Overview:****NAND Flash**

Toshiba's NAND Flash memory products are optimized for general solid-state storage, image file storage and audio. Applications include removable Flash memory cards, such as the Secure Digital (SD) Memory Card, including mini- and micro SD Cards; CompactFlash, and Memory Stick® as well embedded applications such as solid-state hard drives and devices, digital cameras, set-top boxes, industrial storage applications and an array of emerging applications which require fast and reliable storage. The company currently offers 3.3V solutions in 256Mb, 512Mb, 1Gb, 2Gb and 4Gb densities, with an aggressive roadmap for future products.

Toshiba's single-bit-per cell NAND Flash devices target high performance applications. Toshiba also offers multi-level cell NAND Flash devices for consumer type applications solutions.

**SD Memory Card**

The SD Memory Card is a revolutionary Flash memory storage device designed to meet the converging security, capacity, ergonomic and performance requirements of emerging audio, video, data and multimedia consumer electronics markets. The SD Memory Card was jointly developed by Toshiba Corporation, SanDisk Corporation and Matsushita Electric Industrial Co. Ltd.(best known for its Panasonic brand name products). The SD Memory Card includes key enhancements over existing Flash cards including cryptographic security, protection of copyrighted data, high-data transfer rate for fast copy/download and high storage capacity. Toshiba currently offers a wide selection of SD memory cards with storage capacities of 256MB, 512MB, 1GB and 2GB in the standard (blue) product family, and a higher performance (white) family of cards in 256MB, 512MB and 1GB capacities.

**CompactFlash**

The CompactFlash card complements Toshiba's existing line-up of small-form factor storage solutions, offering high densities up to 4GB that can be used in a variety of applications including digital still and video cameras, audio players, PDAs, solid state disk drives and embedded storage solutions.

**USB Flash Drive**

With the increasing emphasis on convenient, transportable storage for data, digital photos, and music, Toshiba is addressing the rapidly growing USB 2.0 Flash drive market by offering USB 2.0 Flash drive subassemblies to OEMs. These subassemblies, based on MLC NAND technology are available in capacities from 256MB to 2MGB. Toshiba also offers SLC NAND USB subassemblies in capacities up to 1GB to address the high performance segment of the USB Flash drive market.

*\_ more \_*

### **NAND Multi-Level Cell Technology**

Toshiba offers an 8Gb NAND MLC Flash memory chip, the industry's highest density NAND chip using MLC technology. MLC technology allows two bits of data to be stored in one memory cell, effectively doubling memory capacity. The result is more cost-effective data storage, making the MLC NAND ideal for consumer applications such as digital cameras, cellular telephones, MP3s and PDAs, as well as streaming audio/video equipment and other emerging markets. Toshiba's 8Gb MLC NAND, co-developed by Toshiba and SanDisk Corp, is manufactured using 70 nm technology.

### **NOR Flash**

Toshiba currently offers NOR Flash in 16Mb, 32Mb, 64Mb and 128Mb densities. The devices offer low power, 1.8V and 3.3V operation with either top or bottom boot block options, and with speeds down to 65nanoseconds (ns) Toshiba's NOR Flash product line is compatible with AMD/Fujitsu's NOR Flash.

### **Multi-Chip Packages**

Toshiba can stack up to 9 layers (6 working die and 3 spacers) in various combinations of NOR, NAND, low power SRAM, Pseudo SRAM and low power SDRAM. These MCPs reduce power in mobile phones and other handheld, battery-powered devices and are available in CSP (Chip Scale Package) down to 7x10mm, which saves board space.

### **Mass Production Capabilities**

Toshiba's Flash memory production facilities include Yokkaichi Works and the Oita facility in Japan. The company's 12-inch wafer fabrication facility, Y3, at Yokkaichi went online in mid-2005.

### **Executives**

- Naohisa Sano, vice president, Memory Business Unit
- Scott Nelson, business development director, Flash Memory products
- Brian Kumagai, senior business development manager, Flash Memory products (NAND)
- Scott Beekman, business development manager, Communications Memory products (MCP, NOR, LP SRAM, PSRAM)

*\_ more \_*

### Location

Toshiba America Electronic Components, Inc., 19900 MacArthur Blvd., Suite 400, Irvine, CA 92612

### Internet Address

<http://www.chips.toshiba.com>

### Public Relations Contact

- MultiPath Communications International  
Jan Johnson (714) 633-4008 [jan@multipathcom.com](mailto:jan@multipathcom.com)

### Reader Inquiry Contact

[Tech.Question@taec.toshiba.com](mailto:Tech.Question@taec.toshiba.com)

-###-

<sup>1</sup> When used herein in relation to memory density, megabit and/or Mb means  $1,024 \times 1,024 = 1,048,576$  bits. Usable capacity may be less. For details, please refer to specifications

<sup>2</sup> When used herein in relation to memory density, gigabit and/or Gb means  $1,024 \times 1024 \times 1024 = 1,073,741,824$  bits. Usable capacity may be less.

<sup>3</sup> When used herein in relation to memory density, megabyte and/or MB means  $1,024 \times 1,024 = 1,048,576$  bytes. Usable capacity may be less. For details, please refer to specifications.

<sup>4</sup> When used herein in relation to memory density, gigabyte and/or GB means  $1,024 \times 1024 \times 1024 = 1,073,741,824$  bytes. Usable capacity may be less.

<sup>5</sup> For purposes of measuring data transfer rate in this context, megabit per second Mb/s and/or Mbps = 1,000,000 bits per second.

**SmartMedia is a trademark of Toshiba Corporation. CompactFlash is a trademark of SanDisk Corp. FCRAM (Fast Cycle RAM ) is a trademark or a registered trademark of Fujitsu Limited, Japan All others are trademarks of their respective manufacturer and may be registered in certain jurisdictions.**

FLSH 00 905

Updated 10/28/05