

Embedded Flash Drives

2008-2012

Report Number

SDS450EFD-28



Web-Feet Research, Inc.

Overview

Embedded Flash Drives (EFD) have quietly emerged in the last couple of years as the internal storage compliment to removable Flash cards. Both EFDs and cards are defined in this study as sub-systems of solid state storage ranked below solid state drives (SSD).

Embedded Flash Drives are rapidly emerging as the desired form factor for internal storage for many of the consumer and mobile electronics applications. Cell phones were one of the first applications that required large amounts of internal storage interfaced with a controller and connected seamlessly to the processor. Initially a few cell phone OEMs tried to integrate raw NAND components with their own chipset and have the host processor manage all the complexities of accessing, erasing, writing, reading, and managing the NAND memory. As new variations of NAND became available from multiple manufacturers, just managing the memory became quite an investment in engineering resources. Quickly, Flash manufacturers like M-Systems/SanDisk and Samsung realized that they could provide an integrated, turn-key internal or embedded Flash drive system or module. Though this EFD module these Flash manufacturers would provide the software/firmware, controller, interface, NAND components, and package all integrated and functioning smoothly within the EFD so that the OEMs would not have to worry about any aspect of this storage sub-system.

In the early years, EFDs were built as a small capacity and small footprint solid state-type of a hard disk drive. These early EFDs were installed in single board computers in a variety of applications like networking controllers, Point-of-Sale terminals, and other industrial controllers. EFDs evolved in complexity over time as storage functions became better understood and the use of the Flash memory gained prevalence. Once cell phone system memory was partitioned into work memory and internal storage, then EFD was developed for mobile applications. Cell phone MCP EFDs can use a combination of memories including NOR and NAND Flash, SRAM, PSRAM, and LP DRAM. As NOR was gradually eliminated from cell phone storage system architecture, then NAND-only EFD solutions became quite popular.

Various other applications have incorporated EFDs in their design, as this EFD storage module is designed to be a 'plug-n-play' storage solution. Digital camcorders, such as Hybrid Digital Camcorders, have abandoned tape and consume only Flash by storing video on EFDs and Flash cards. MP3 players are found in every electronic device form factor and Personal Media Players are morphing with these MP3 players. Both players use more internal storage EFDs than they use removable storage with Flash cards and OTP cards. GPS and Gaming have emerged as the new applications that are widely adopting EFDs. All the previously mentioned applications concentrate on media content storage, which can use multi-bit per cell NAND Flash that is low cost, high capacity and lower performance.

Analysis and Reporting Methodology

The Embedded Flash Drive: 2008-2012 study covers both the forecast for EFDs by capacity for fourteen end-use applications and then breaks out the forecast for usage of the four types of NAND Flash components: SLC, MLC, 3-bit/cell, and 4-bit/cell configured in EFDs. Each of the fourteen applications was grouped by its device use type: video, imaging, audio, and computing. Video covers digital camcorders, Portable Media Players, Digital TV, and Set Top Boxes. Imaging applications only include cell phones and digital photo albums/frames, while Audio involves just MP3 and digital radio. Computing encompasses Portable games, PDAs, GPS, Automotive, Printers, and Hybrid Flash Drives in notebooks.

This Embedded Flash Drive (EFD) Forecast for 2005-2012 provides revenue, units, Average Selling Price (ASP), and total Megabytes shipped in EFD devices. Embedded Flash Drive formats or product lines are profiled and include eMMC, eSD, eCF, eUSB, PCIe, DiskOnChip (DOC), Mobile DOC (MDOC), iNAND, Managed NAND, GB NAND, LBA NAND, mobileLBA NAND, moviNAND, OneNAND, Flex-OneNAND, All-in-OneMemory, NANDrive, and MirrorBit Eclipse. ASPs have been calculated from 2005-2012 for the major capacities of the Embedded Flash Drives; however, they are not provided separately for individual EFD form factors, since they are not forecast by each product line.

This report methodology analyzes the Embedded Flash Drive markets from two perspectives: the 'tops-down' macro-perspective and the 'bottoms-up' application-perspective. EFDs have been forecast by capacity from 2005-2012 in the above mentioned fourteen major applications. The net forecast presents the consolidated results of these individual markets for revenue, units, Average Selling Prices (ASPs), and Megabytes shipped for the overall EFD market, by EFD capacities. Also, EFD consumption of Flash components is forecast by each application market and consolidated in summary form for each type of NAND (SLC, MLC, 3-bit, and 4-bit per cell) component by density for revenue, units, ASP, and Mbits shipped. From a 'tops-down' perspective the overall Flash market trends are correlated with the EFD market shipments. Also, a new definition of Solid State Storage has been added that includes SSDs, EFDs, and Flash cards.

Table of Contents		6 Market Segments	19
Table of Contents	iii	6.1 Video Market Segment Characteristics	19
List of Figures	vi	6.2 Audio Market Segment Characteristics	20
List of Tables	vii	6.3 Imaging Market Segment Characteristics	20
1 Key Findings	1	6.4 Computing Market Segment Characteristics	21
2 Definition of Solid State Storage	4	7 Embedded Flash Drive Storage Markets by Application	22
3 Objectives and Methodology	6	7.1 EFD Storage Revenue by Application	23
4 A Market Perspective on Flash Storage	8	7.2 EFD Storage Units by Application	24
4.1 The Electronic Device Market	8	7.3 EFD Storage ASPs by Application	25
4.1.1 Function-based Market Segmentation	8	7.4 EFD Megabyte Shipments by Application	25
4.1.2 Device-based Market Segmentation	8	8 Embedded Flash Drive Component Shipments by Application	26
4.1.3 Use Model-based Market Segmentation	9	8.1 EFD Component Revenue by Application	28
4.1.4 Market Segmentation Summary	13	8.2 EFD Component Units by Application	30
4.2 Removable Storage Market Segmentation	13	8.3 EFD Component ASPs by Application	33
4.2.1 Segmentation by Form Factor	14	8.4 EFD Component Megabit Shipments by Application	35
4.2.2 Segmentation by Capacity	14	9 Video End-Use Application Markets	38
4.2.3 Segmentation by Performance	15	9.1.1 Digital Camcorders	38
4.2.4 Segmentation by Security Level	16	9.1.2 Televisions	42
5 A System Architecture Perspective on Flash Storage	17		
5.1 Market-Driven System Architecture Development	17		
5.2 System Architecture Impact on Flash Storage	18		

9.1.3 Personal Media Player	46	14.6 OneNAND and Flex-OneNAND	101
9.1.4 Set Top Boxes	51	14.7 moviNAND	102
10 Imaging End-Use Application Markets	55	14.8 eMMC	102
10.1.1 Cell Phones	55	14.9 Managed NAND	103
10.1.2 Photo Albums	61	14.10 LBA NAND and mobile LBA NAND	103
11 Audio End-Use Application Markets	67	14.11 GB NAND and eSD	104
11.1.1 MP3 Players	67	14.12 eUSB	104
11.1.2 Digital Radio	71	14.13 Eclipse	104
12 Computing End-Use Application Markets	75	15 EFD Revenue by Capacity	106
12.1.1 Notebooks Hybrid Flash Drive	75	15.1 EFD Revenue by Capacity	106
12.1.2 Personal Digital Assistants (PDA)	79	15.2 EFD Component Revenue by NAND Type and Capacity	107
12.1.3 Game Consoles	82	16 EFD Storage Units by Capacity	109
12.1.4 GPS	85	16.1 EFD Units by Capacity	109
12.1.5 Automotive	89	16.2 EFD Component Units by NAND Type and Capacity	110
12.1.6 Printers	92	17 EFD Storage ASP by Capacity	111
13 Embedded Flash Drive Storage Market Forecast	96	17.1 EFD ASP by Capacity	111
14 Embedded Flash Drive Form Factors	99	17.2 EFD Component ASPs by NAND Type and Capacity	112
14.1 Disk-On-Chip, DiskOnChip 2000, and MDOC	99	18 EFD Storage MB by Capacity	114
14.2 iNAND	100	18.1 EFD MB by Capacity	114
14.3 PCIe	100	18.2 EFD Component Mbits by NAND Type and Capacity	115
14.4 eCompact Flash or eCF	101	19 Appendix A: EFD Storage Detail by Density and Form Factor	117
14.5 NANDrive, All-in-OneMemory	101	19.1 EFD Storage by Density	117
		20 Appendix B: Biography	119

About Web-Feet Research

Web-Feet Research, located in Monterey, California, provides market research, analysis, and consulting services for the electronics and semiconductor industries; focusing on the non-volatile memory and storage markets with an emphasis on Flash memory, SSDs and small form factor hard drives.

The company has significant expertise and experience in the areas of communications, computers and consumer electronics applications, as well as in identification, definition, design and marketing of standard and application specific semiconductor components. In addition to the syndicated market analysis reports, our analysts and consultants have worked on a series of commissioned reports and projects for customers in the electronics and semiconductor industries: customer-specific and multi-client reports, advanced applications of existing technology reports, emerging technology economics studies, potential uses of emerging technology studies, management consulting projects.

The company draws on a vast technology and systems expertise in communications, computing, consumer and automotive, including experience in the relevant areas of the semiconductor industry: micrologic, analog/mixed signal, memories, micro power management, displays and sensors, as well as semiconductor manufacturing technologies and processes. Web-Feet Research collaborators have extensive market knowledge and marketing experience in the United States, Europe and in the Asia-Pacific region.

Web-Feet Research reports take into consideration major social, political, economic and technology changes underway and the impact these changes have on the economy, the high technology industries in general, and the electronics and semiconductor industries in particular.

The growing complexity and scope of economic developments creates a need to put the qualitative and quantitative aspects of the development trends in a broader perspective and to correlate them with the macroeconomic factors. Therefore, Web-Feet Research reports embrace and correlate both the technology and commercial aspects of the developments.