1995 DISK/TREND® REPORT

REMOVABLE
DATA
STORAGE

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REMOVABLE DATA STORAGE

September, 1995

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FOREWORD

There is a renewed wave of competition between new generations of products being introduced this year by companies in several of the product groups included in this report. Capacities have increased, prices have dropped, and broad new markets are being addressed. Never before have so many data storage products using different technologies been aimed at the same markets.

We hope that by compiling such a diverse set of product groups into a single market study we will make it easier for you to find the information you need on the products, the manufacturers and the markets. This is only the second year for the DISK/TREND Report on removable data storage, and the report has been expanded by adding the information on low capacity flexible disk drives which previously was published in a separate report.

The DISK/TREND Report is now in its 19th year and has published annual studies on the disk drive industry during that entire period, longer than any other company. Annual reports on rigid disk drives have been published since 1977, and reports on optical disk drives were added in 1986 and on disk drive arrays in 1993. Availability of our extensive files on the industry and our data base management system was essential in organizing and presenting the data for this report on removable data storage.

We are always willing to help you at any time by providing additional information on the industry which we may have available. Your suggestions for improvements in the DISK/TREND Report are always welcome and are sincerely appreciated.

James N. Porter

Robert H. Katzive

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INTRODUCTION

A year old...and growing. Last year was the first edition of the DISK/TREND Report on removable data storage, and this year we have added an additional product group to the report. For 18 years we published a separate market study each year on flexible disk drives, but this year we decided to simplify our lives by integrating that report into the new DISK/TREND Report on removable data storage. Logically, it belongs in this report anyway.

This change means that the only place in which DISK/TREND data on low capacity flexible disk drives, high capacity flexible disk drives and PCMCIA flash cards is published is in this report on removable data storage. The product section on rigid disk cartridge drives is the same as the equivalent section which will appear in the DISK/TREND Report on rigid disk drives. The section on PCMCIA rigid disk drives has been extracted from the broader data base which will be used in the report on rigid disk drives. In a similar way, the product section on small optical disk drives has been extracted from the DISK/TREND Report on optical disk drives, with the same data, but organized into tables unique to this report.

Due to the need to address the individual product technologies, markets and applications of each of the six product sections in this report, you will find some differences in the way data is organized in each section, including different product capacity groups and the inclusion of some of DISK/TREND's standard table formats in some sections, but not in others. Naturally, the product specifications for each type of product are different from each other, but the same as the formats used in other DISK/TREND Reports, except for PCMCIA flash cards. Regular users of DISK/TREND Reports will find that the report's organization is familiar and that the summary tables in each product section adhere to our standard format, to make possible combined sales revenue and unit shipment tables in the general summary section.

Selling prices reported at level of first public sale. If the DISK/TREND Report is new to you, please note the definitions used for the relative price differences for captive, PCM/Reseller and OEM/Integrator sales, which is important in interpreting DISK/TREND revenue statistics. As in all DISK/TREND Reports, we report revenues for the sale of individual products at the level of the first public sale, at the estimated net transaction price, whether the sale occurs at the captive, PCM/Reseller or OEM/Integrator level -- to accurately record the value of the business to the original seller.

DISK/TREND ON DISK. The statistical and specification tables are available on floppy disks, as a separately purchased option to buyers of this report. For easy reference, instructions are included in the last section of this report.

SUMMARY: REMOVABLE DATA STORAGE

Industry size

With the addition of low capacity flexible disk drives to this edition of the DISK/TREND Report on removable data storage, total 1994 sales revenues for all of the products included in the report rose to $2.9 billion. While most of the product groups are expected to experience significant revenue increases in future years, the overall total for 1998 is projected to increase to only $3.1 billion, due to a pattern of declining revenues for low capacity flexible disk drives.

The only feature shared by all of the data storage products covered in this report is removability, but many of them are now vying for the same market opportunities, despite utilization of different technologies or recording materials. Intense rivalries are now developing among the manufacturers of rigid disk cartridge drives, high capacity flexible disk drives and small optical disk drives, as they each covet the growing markets for graphics and printing production, multimedia content preparation, backup of personal computer hard disks, downloading of Internet files, and a variety of other applications. Although unit shipments for the three product groups were barely over 1 million drives in 1994, a collective total exceeding 6 million drives is forecasted for 1998.

On the other hand, there is negligible competition between the other three product groups, with different application patterns dictated by distinctive combinations of product features and price levels. Low capacity flexible disk drives typically offer only 1.44 megabytes per drive, but today's OEM average unit price of $24 keeps the 3.5" floppy drive a continuing part of the personal computer. PCMCIA rigid disk drives provide a unique combination of data storage capacity and performance in a standardized small package, but prices which are relatively high compared to 2.5" fixed disk drives have restricted usage to specialized applications. Shipments of PCMCIA flash cards are growing in numerous specialized and mobile applications requiring capacities below 25 megabytes, but flash price per megabyte levels are several times those of most disk drives, preventing penetration of markets requiring higher capacities.

Noncaptive shipments predominate in these product groups, and some have no manufacturers shipping captive products. Only low capacity flexible disk drives have large captive shipments, with 2.4 million drives projected for 1998.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

REMOVABLE DATA STORAGE

REVENUE SUMMARY

	REMOVABLE DATA STORAGE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1994 Revenues		Forecast 1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	5.1	17.1	--	--	1.1	1.6	1.9	3.1	2.7	4.3
PCM/Reseller	127.1	195.2	172.6	254.6	270.7	397.4	315.0	465.6	334.3	503.3
OEM/Integrator	60.3	94.8	93.6	150.7	177.9	254.4	215.3	316.3	242.3	361.1
TOTAL U.S. REVENUES	192.5	307.1	266.2	405.3	449.7	653.4	532.2	785.0	579.3	868.7
Non-U.S. Manufacturers										
Captive	6.4	218.6	2.9	106.6	3.6	170.6	4.2	171.7	8.5	178.2
PCM/Reseller	298.4	657.1	267.6	621.8	240.2	569.8	234.8	548.6	241.0	573.1
OEM/Integrator	703.7	1,726.8	596.4	1,564.6	564.3	1,507.1	548.5	1,471.9	552.5	1,486.8
TOTAL NON-U.S. REVENUES	1,008.5	2,602.5	866.9	2,293.0	808.1	2,247.5	787.5	2,192.2	802.0	2,238.1
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,201.0	2,909.6	1,133.1	2,698.3	1,257.8	2,900.9	1,319.7	2,977.2	1,381.3	3,106.8

Marketing channels

The overall shares for each marketing channel will see little change during the five year span covered by this report, with the noncaptive channels remaining dominant. The PCM/Reseller channel held 29.3% of 1994 sales revenues, and is expected to grow to 34.6% of the 1998 total. OEM/Integrator revenues were 62.6% of 1994 revenues, declining to a projected 59.5% in 1998. Captive revenues are expected to be only 5.9% of the 1998 total. It should be noted, however, that some of the individual product groups have distribution patterns which differ significantly from the overall averages.

77.7% of low capacity flexible disk drive shipments were sold to OEMs in 1994 and the OEM share is expected to grow to 81.5% in 1998. OEM sales also dominate in the two PCMCIA card data storage groups, but modest changes are expected. 84.4% of 1994 PCMCIA rigid disk drive unit shipments went to OEMs, but the 1994 share is forecasted to decline to 74.2% in 1998, as distribution gradually increases for notebook computer aftermarket sales. The same phenomenon will also affect sales of PCMCIA flash cards, as aftermarket shipments through distribution channels squeeze OEM sales in 1994 from 70.6% of the total, to 65.3% in 1998.

OEM shipments are much less important to the other three product groups, but all will be affected by rapidly growing sales for emerging markets for several types of removable disk drives. The biggest growth is forecasted for high capacity flexible disk drives. Floppy drives in the 100+ megabyte range will create a market in 1998 more than six times larger than in 1994, with PCM/Reseller shipments holding 71.4% of the 1998 projected total. PCM/Reseller shipments are expected to capture 78.8% of the 1998 rigid disk cartridge drive total, despite strong growth for OEM shipments. Small optical disk drives are currently sold mostly through PCM/Reseller channels, and the 1998 total for that channel is forecasted to decline only slightly, to 72.4%.

The price used for each product in the DISK/TREND Report is the estimated selling price at the first time it is sold to a nonaffiliated buyer, at captive end user, PCM/Reseller or OEM/Integrator levels. In general, you can expect that prices used in the DISK/TREND Report are equivalent to the level that the company which manufactures each completed data storage product uses in its financial statements.

TABLE 2

CONSOLIDATED WORLDWIDE REVENUES
REMOVABLE DATA STORAGE
MARKET CLASS REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1994 Revenues		Forecast 1995		Forecast 1996		Forecast 1997		Forecast 1998	
	$M	%	$M	%	$M	%	$M	%	$M	%
U.S. Manufacturers										
Captive	17.1	.5%	--	--	1.6	--	3.1	.1%	4.3	.1%
	+180.3%		-100.0%		--		+93.8%		+38.7%	
PCM/Reseller	195.2	6.7%	254.6	9.4%	397.4	13.6%	465.6	15.6%	503.3	16.1%
	+5.7%		+30.4%		+56.1%		+17.2%		+8.1%	
OEM/Integrator	94.8	3.2%	150.7	5.5%	254.4	8.7%	316.3	10.6%	361.1	11.6%
	+83.4%		+59.0%		+68.8%		+24.3%		+14.2%	
Total U.S. Manufacturers	307.1	10.4%	405.3	14.9%	653.4	22.3%	785.0	26.3%	868.7	27.8%
	+26.7%		+32.0%		+61.2%		+20.1%		+10.7%	
Non-U.S. Manufacturers										
Captive	218.6	7.5%	106.6	3.9%	170.6	5.8%	171.7	5.7%	178.2	5.7%
	-34.4%		-51.2%		+60.0%		+.6%		+3.8%	
PCM/Reseller	657.1	22.5%	621.8	23.0%	569.8	19.6%	548.6	18.4%	573.1	18.4%
	+17.8%		-5.4%		-8.4%		-3.7%		+4.5%	
OEM/Integrator	1,726.8	59.6%	1,564.6	58.2%	1,507.1	52.3%	1,471.9	49.6%	1,486.8	48.1%
	-6.9%		-9.4%		-3.7%		-2.3%		+1.0%	
Total Non-U.S. Manufacturers	2,602.5	89.6%	2,293.0	85.1%	2,247.5	77.7%	2,192.2	73.7%	2,238.1	72.2%
	-5.2%		-11.9%		-2.0%		-2.5%		+2.1%	
Worldwide Recap										
Captive	235.7	8.1%	106.6	4.0%	172.2	5.9%	174.8	5.9%	182.5	5.9%
	-30.5%		-54.8%		+61.5%		+1.5%		+4.4%	
PCM/Reseller	852.3	29.3%	876.4	32.5%	967.2	33.3%	1,014.2	34.1%	1,076.4	34.6%
	+14.8%		+2.8%		+10.4%		+4.9%		+6.1%	
OEM/Integrator	1,821.6	62.6%	1,715.3	63.5%	1,761.5	60.8%	1,788.2	60.0%	1,847.9	59.5%
	-4.4%		-5.8%		+2.7%		+1.5%		+3.3%	
Total All Manufacturers	2,909.6	100.0%	2,698.3	100.0%	2,900.9	100.0%	2,977.2	100.0%	3,106.8	100.0%
	-2.6%		-7.3%		+7.5%		+2.6%		+4.4%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Product groups

The major change in organization of this year's DISK/TREND Report on removable data storage has been the addition of low capacity flexible disk drives, a product group which had been included in a separate report in previous years. Floppy drives are among the most widely used data storage devices, with 75.5 million drives shipped in 1994. 1998 total shipments are forecasted to grow to 92.9 million drives, as product mix changes continue. By 1998, the last of the 8" floppy drives will finally be gone, after a 24 year product life. Shipments of 5.25" floppy drives will be down to an insignificant level, and 3.5" floppy drives will hold 99.8% of total unit shipments.

High capacity flexible disk drives are seeing a resurgence in shipments, as the Iomega Zip drive and other promised products are stimulating new demand by offering 100 megabytes or more at retail drive prices less than $200. The new drives appear to be capable of broadening the markets for high capacity floppy drives from the traditional specialized business applications to a variety of consumer applications. The result is expected to be explosive growth from 1994's 203,500 drives to 3.4 million drives in 1998.

Rigid disk cartridge drives are also expected to exploit new consumer markets for low cost 3.5" drives being offered as competition for the 100+ megabyte floppy drives. The consumer applications supplement established specialized markets, which are also growing, as "prepress" and graphics applications continue to demand more storage capacity. SyQuest's 5.25" drives have achieved staying power as the prepress interchange standard, and are expected to remain in production though 1998, although in declining numbers, as higher capacity 3.5" drives assume shipment leadership. The new SyQuest 1.8" drive, a PCMCIA Type III drive using a disk cartridge which can be removed from the removable drive, plus the new Avatar 2.5" drive, together create additional potential areas of growth. Total shipments for the product group are forecasted to climb from 468,400 units in 1994 to almost 2 million drives in 1998.

Total shipments of small optical disk drives are expected to share in the surge of growth for removable disk drives offering midrange capacities, with 1994's 482,800 units projected to increase to just over 1 million drives in 1998. Manufacturers of small optical disk drives have been held to sales levels lower than most planned in recent years, due to aggressive price competition from both magnetic fixed disk and cartridge disk drives, combined with rapidly increasing magnetic disk drive capacities. Many optical disk drive manufacturers now plan 3.5" drives in the 600 megabyte range, with more aggressive pricing.

Two groups of storage devices included in this report are packaged only in the form of PC Cards: PCMCIA flash cards and PCMCIA rigid disk drives. However, even though both types of products utilize the same type of packaging, there is negligible competition between the two groups, due to very little overlap in capacities offered and sharply different price levels.

491,900 PCMCIA flash cards were shipped in 1994 for a diverse set of applications, ranging from mobile computers to industrial equipment, and the 1998 total is projected at 2.8 million cards. Most of the 1994 shipments were flash cards with less than 10 megabytes capacity and, although average flash card capacities are expected to increase, 56.2% of 1998 unit shipments are still expected to have less than 10 megabytes capacity, while shipments in the 10-25 megabyte range will grow to 32.4% of the 1998 total.

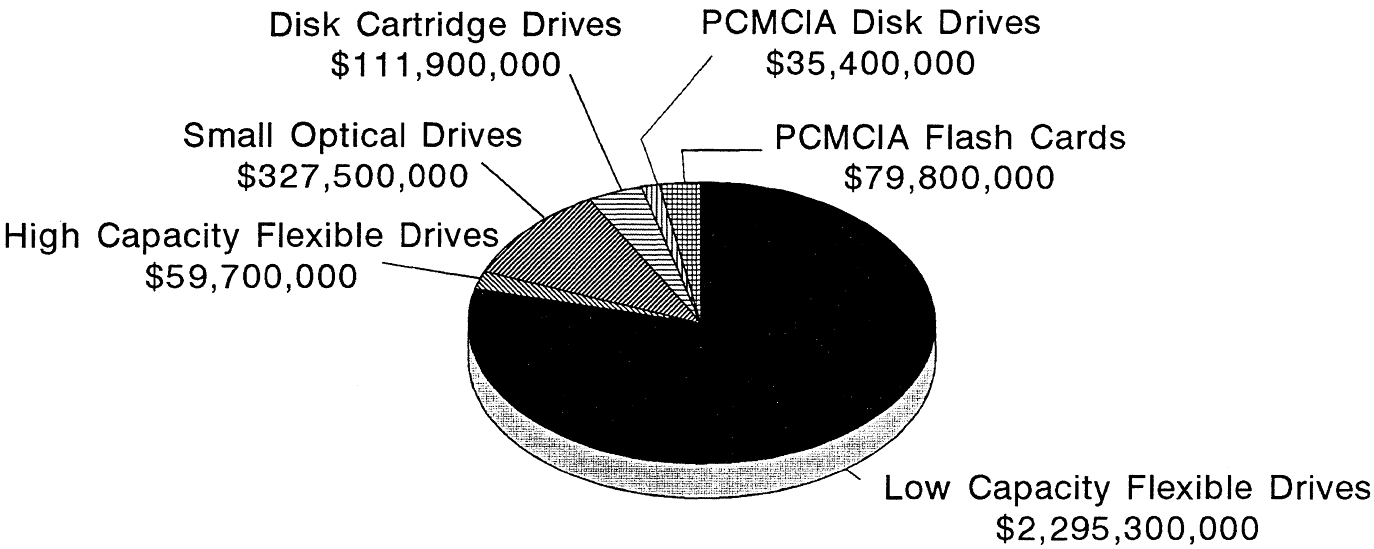
Flash cards offer thinner PCMCIA packaging than rigid disk drives, fast performance and tolerance of physical shock and hostile environments, but relatively high prices will limit the available market through 1998 to card capacities lower than offered by most PCMCIA rigid disk drives. The projected 1998 average OEM/Integrator price per megabyte for all types of PCMCIA flash cards with over 100 megabyte capacity is $7.10, not as low as previously expected, while the equivalent 1998 price for PC Card rigid disk drives with 200-300 megabytes capacity (lower drive capacities will be out of production) is forecasted at 33 cents.

PCMCIA rigid disk drives are shipping at lower levels than previously expected, due to slowness in the computer industry's movement to the smaller and lighter weight subnotebook computers, with a tendency to use 1.8" rigid disk drives, and the fact that the eagerly anticipated PDA and personal communicator markets turned out to be nonevents. Despite lower expectations, shipments of PC Card drives are nevertheless growing, with 1994's shipments of 156,100 drives projected to climb to 990,000 drives in 1998. Capacities for PC Card drives are also moving up, with 300-500 megabyte drives expected to provide leadership in 1998, and drives over 500 megabytes growing rapidly.

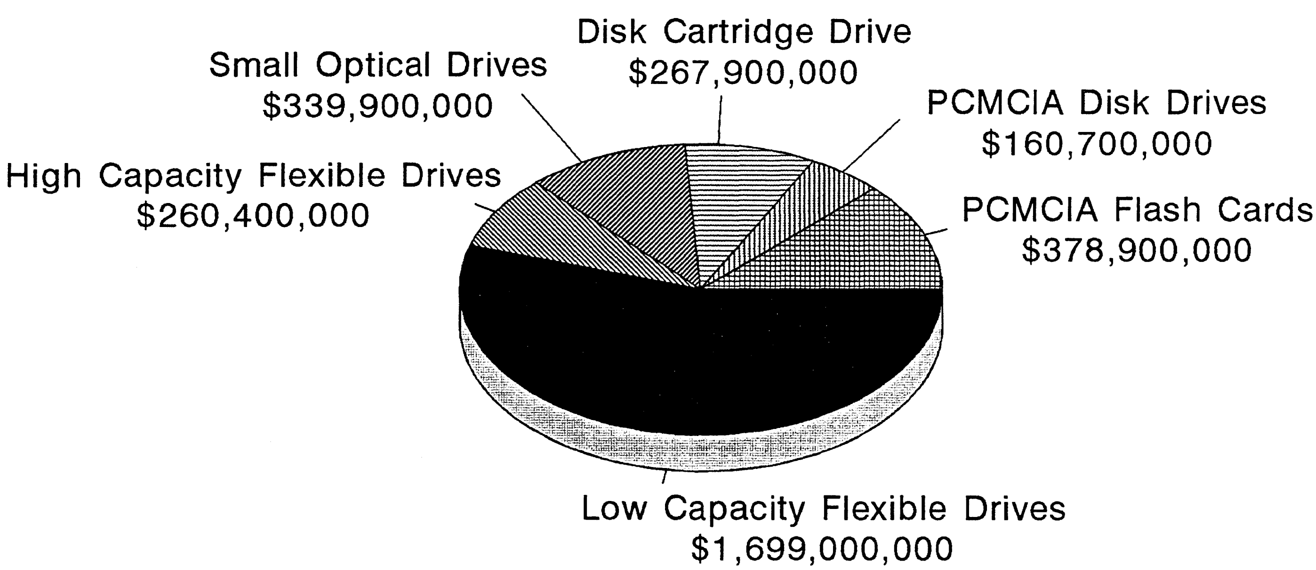
Figure 1

CHANGING PRODUCT MIX

Worldwide Removable Data Storage Revenue



1994



1998

TABLE 3

CONSOLIDATED WORLDWIDE REVENUES
REMOVABLE DATA STORAGE
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1994		Forecast							
ALL MANUFACTURERS	Revenues		1995		1996		1997		1998	
	$M	%	$M	%	$M	%	$M	%	$M	%
PCMCIA FLASH CARDS	79.8	2.7%	137.1	5.1%	229.3	7.9%	308.7	10.4%	378.9	12.2%
	+76.2%		+71.8%		+67.3%		+34.6%		+22.7%	
PCMCIA RIGID DISK DRIVES	35.4	1.2%	71.5	2.6%	130.5	4.5%	144.9	4.9%	160.7	5.2%
	+63.1%		+102.0%		+82.5%		+11.0%		+10.9%	
RIGID DISK CARTRIDGE DRIVES	111.9	3.8%	162.3	6.0%	250.8	8.6%	270.5	9.1%	267.9	8.6%
	+29.5%		+45.0%		+54.5%		+7.9%		-1.0%	
SMALL OPTICAL DISK DRIVES	327.5	11.3%	290.3	10.8%	298.8	10.3%	320.1	10.8%	339.9	10.9%
	+62.0%		-11.4%		+2.9%		+7.1%		+6.2%	
HIGH CAPACITY FLEXIBLE	59.7	2.1%	82.2	3.0%	141.5	4.8%	205.2	6.8%	260.4	8.4%
DISK DRIVES	-26.2%		+37.7%		+72.1%		+45.0%		+26.9%	
LOW CAPACITY FLEXIBLE	2,295.3	78.9%	1,954.9	72.5%	1,850.0	63.9%	1,727.8	58.0%	1,699.0	54.7%
DISK DRIVES	-10.0%		-14.8%		-5.4%		-6.6%		-1.7%	
Total Worldwide Revenue	2,909.6	100.0%	2,698.3	100.0%	2,900.9	100.0%	2,977.2	100.0%	3,106.8	100.0%
	-2.6%		-7.3%		+7.5%		+2.6%		+4.4%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Figure 2

UNIT SHIPMENT SUMMARY

Worldwide Shipments in Millions of Units

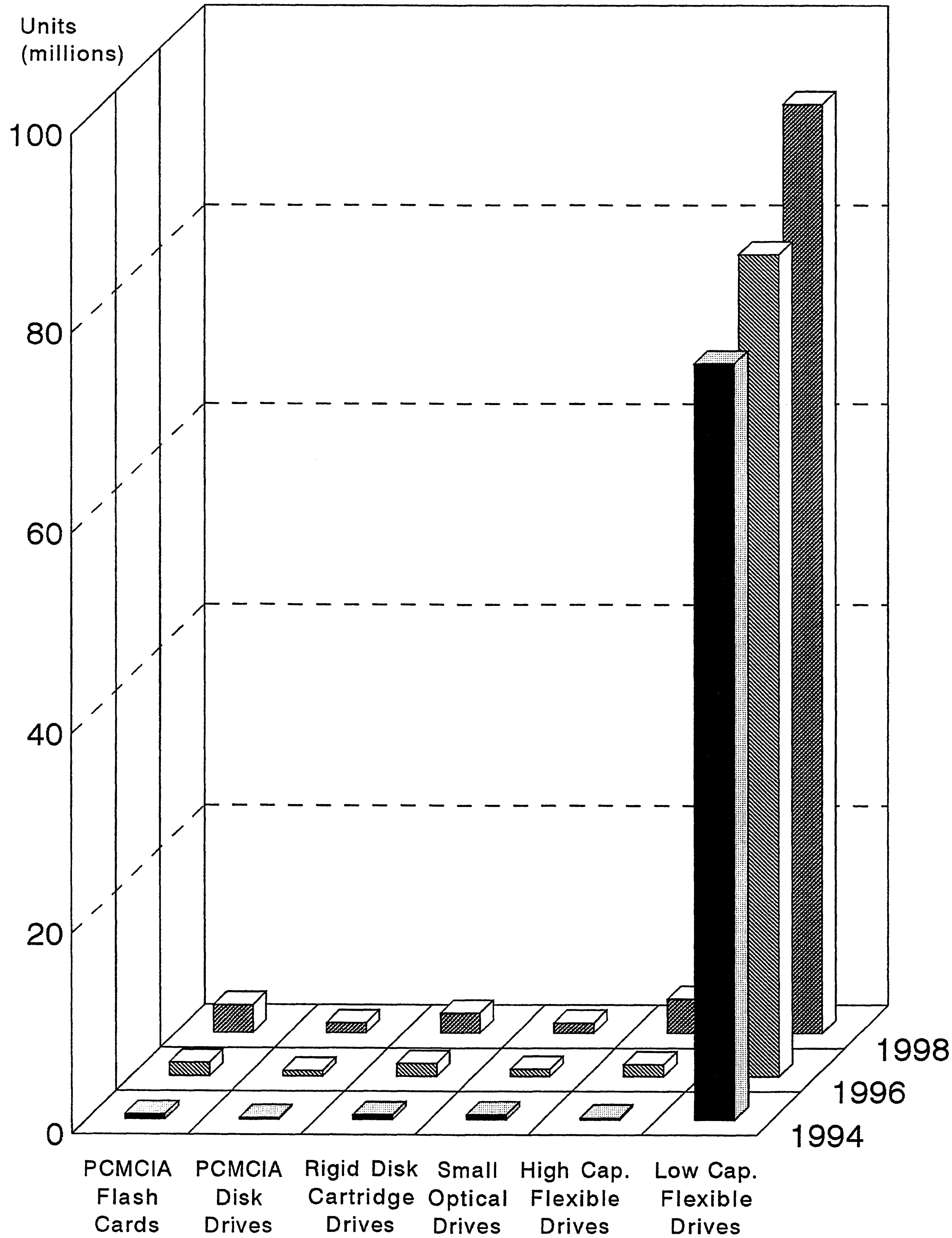


TABLE 4

CONSOLIDATED WORLDWIDE SHIPMENTS
REMOVABLE DATA STORAGE
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS IN THOUSANDS	1994 Shipments		Forecast 1995		Forecast 1996		Forecast 1997		Forecast 1998	
	Units	%	Units	%	Units	%	Units	%	Units	%
PCMCIA FLASH CARDS	491.9	.6%	835.4	1.0%	1,347.5	1.5%	1,965.3	2.1%	2,780.5	2.7%
	+98.5%		+69.8%		+61.3%		+45.8%		+41.5%	
PCMCIA RIGID DISK DRIVES	156.1	.2%	319.0	.4%	570.0	.7%	785.0	.8%	990.0	1.0%
	+66.2		+104.4%		+78.7%		+37.7%		+26.1%	
RIGID DISK CARTRIDGE DRIVES	468.4	.6%	742.0	.9%	1,300.0	1.5%	1,680.0	1.8%	1,985.0	1.9%
	+25.0%		+58.4%		+75.2%		+29.2%		+18.2%	
SMALL OPTICAL DISK DRIVES	482.8	.6%	596.8	.7%	728.5	.8%	882.0	.9%	1,007.5	1.0%
	+90.2%		+23.6%		+22.1%		+21.1%		+14.2%	
HIGH CAPACITY FLEXIBLE	203.5	.2%	475.0	.6%	1,205.0	1.3%	2,235.0	2.4%	3,430.0	3.3%
DISK DRIVES	-2.9%		+133.4%		+153.7%		+85.5%		+53.5%	
LOW CAPACITY FLEXIBLE	75,514.0	97.8%	78,204.0	96.4%	82,178.0	94.2%	87,138.0	92.0%	92,930.0	90.1%
DISK DRIVES	+14.6%		+3.6%		+5.1%		+6.0%		+6.6%	
Total Worldwide Shipments	77,316.7	100.0%	81,172.2	100.0%	87,329.0	100.0%	94,685.3	100.0%	103,123.0	100.0%
	+15.3%		+5.0%		+7.6%		+8.4%		+8.9%	
% U.S. Manufacturers	1.5%		2.4%		4.3%		6.0%		7.4%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Noncaptive market

Sales of removable data storage products are primarily generated by noncaptive shipments, which are defined in the DISK/TREND Report as any public sale of a product, except a sale of an internally manufactured product by a computer system manufacturer primarily for use with their own systems. The report classifies noncaptive shipments as PCM/Reseller (sales by "plug compatible manufacturers" or through distributing organizations, subsystem producers, retail chains, mail order firms and individual retail dealers) or OEM/Integrator (products sold by the original producer to system manufacturers, system integrators or value-added resellers, to be included in complete systems).

Captive revenues for removable data storage products are expected to drop in 1995 to half of the 1994 level, primarily due to product mix changes in the low capacity flexible disk drive product group. In the 1996-1998 period, captive revenues are forecasted to increase slightly, but at the end of the period will command only 5.9% of the total for all removable data storage products.

All PCMCIA flash card sales were noncaptive in recent years, and despite the expected start of captive shipments by IBM and several Japanese companies in future years, 98% of unit shipments are expected to remain noncaptive in 1998. More than 70% of 1994 sales revenues and unit shipments were OEM/Integrator sales. Although the proportion of PCM/Reseller shipments will increase slightly, about 65% of both sales revenues and unit shipments will still move through OEM channels in 1998, as the system manufacturers producing the numerous specialized devices using PC flash cards will control distribution to most of their customer base. PCM/Reseller shipments will largely be driven by applications such as notebook computers, PDAs, personal communicators and similar nonspecialized devices, the users of which may be efficiently reached through normal electronic product distribution channels. Clearly, PCM/Reseller sales for these applications would grow much more rapidly than forecasted if broader markets could be developed for more useful systems.

The ratio of 1994 PCMCIA rigid disk drive sales through the OEM/Integrator channel was even higher, with 83.3% of revenues and 84.4% of unit shipments. Like the PCMCIA flash card product group, PC Card rigid disk drives are expected to continue to find the majority of their customers in specialized applications, with system manufacturers making the buying decisions. As a result, the OEM channel is now expected to remain the major market for PC card drives, with the PCM/Reseller channel growing in share, but not as much as previously expected, when the outlook for PDAs, subnotebook computers and personal communicators was expected to be stronger during the next few years. OEM/Integrator shipments are projected at 74.2% of 1998 total shipments for the product group.

For many years, rigid disk cartridge drives have been sold primarily in the PCM/Reseller channel, through a variety of storage subsystem vendors who combine drives with enclosures, cables and software appropriate for specific target system markets. SyQuest, the shipment leader in the group, has concentrated on resellers with extensive Macintosh storage add-on product lines, but in recent years has also pursued several strategies designed to increase penetration of the IBM compatible PC market. The SyQuest 1995 introduction of the EZ 135 megabyte 3.5" drive, designed to compete with the Iomega Zip floppy drive, is expected to generate a significant amount of additional business for this product group. Most of the growth will be through the PCM/Reseller channel, primarily through distributors, into retail stores and through mail order firms. Overall, 78.8% of 1998 unit shipments are expected to be PCM/Reseller sales.

PCM/Reseller shipments have traditionally dominated the high capacity flexible disk drive product group, with Iomega's Bernoulli drives providing shipment leadership. Distribution sales still dominate the product group, but the product mix is changing rapidly to 3.5" drives. 21 megabyte 3.5" floptical drives started the change during last few years, and the rapid growth expected for the low-cost 3.5" Iomega Zip 100 megabyte drive, and others expected to be introduced, has reaffirmed the importance of PCM/Reseller sales channels for this product group. 71.4% of high capacity flexible disk drive unit shipments are projected to be in the PCM/Reseller channel.

75.9% of the noncaptive unit shipments of small optical disk drives were sold in the PCM/Reseller channel in 1994, and that total is expected to decline slightly to 72.4% in 1998. These drives tend to follow a sales pattern similar to that of the rigid disk cartridge drives, in that system manufacturers frequently regard them as nonstandard products, priced at a level above the drives they consider to be industry standard. Sales resistance by system manufacturers confines the market opportunity to aftermarket add-on storage requirements, predominantly in applications for which removable disks provide a functional advantage.

TABLE 5

NONCAPTIVE WORLDWIDE REVENUES
REMOVABLE DATA STORAGE
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1994		Forecast							
ALL MANUFACTURERS	Revenues		1995		1996		1997		1998	
	$M	%	$M	%	$M	%	$M	%	$M	%
PCMCIA FLASH CARDS	79.8 +76.2%	3.0%	136.3 +70.8%	5.3%	226.1 +65.9%	8.3%	303.8 +34.4%	10.8%	371.7 +22.4%	12.7%
PCMCIA RIGID DISK DRIVES	35.4 +83.4%	1.3%	71.5 +102.0%	2.8%	130.5 +82.5%	4.8%	144.9 +11.0%	5.2%	160.7 +10.9%	5.5%
RIGID DISK CARTRIDGE DRIVES	111.9 +29.5%	4.2%	162.3 +45.0%	6.3%	250.8 +54.5%	9.3%	270.5 +7.9%	9.8%	267.9 -1.0%	9.3%
SMALL OPTICAL DISK DRIVES	303.6 +66.3%	11.4%	287.3 -5.4%	11.1%	295.6 +2.9%	10.8%	316.9 +7.2%	11.3%	336.5 +6.2%	11.5%
HIGH CAPACITY FLEXIBLE DISK DRIVES	59.7 -26.2%	2.1%	82.2 +37.7%	3.1%	141.5 +72.1%	5.1%	200.0 +41.3%	7.0%	246.4 +23.2%	8.3%
LOW CAPACITY FLEXIBLE DISK DRIVES	2,083.5 -6.7%	78.0%	1,852.1 -11.1%	71.4%	1,684.2 -9.1%	61.7%	1,566.3 -7.0%	55.9%	1,541.1 -1.6%	52.7%
Total Worldwide Revenues	2,673.9 +1.0%	100.0%	2,591.7 -3.1%	100.0%	2,728.7 +5.3%	100.0%	2,802.4 +2.7%	100.0%	2,924.3 +4.3%	100.0%

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

TABLE 6

NONCAPTIVE WORLDWIDE SHIPMENTS
REMOVABLE DATA STORAGE
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

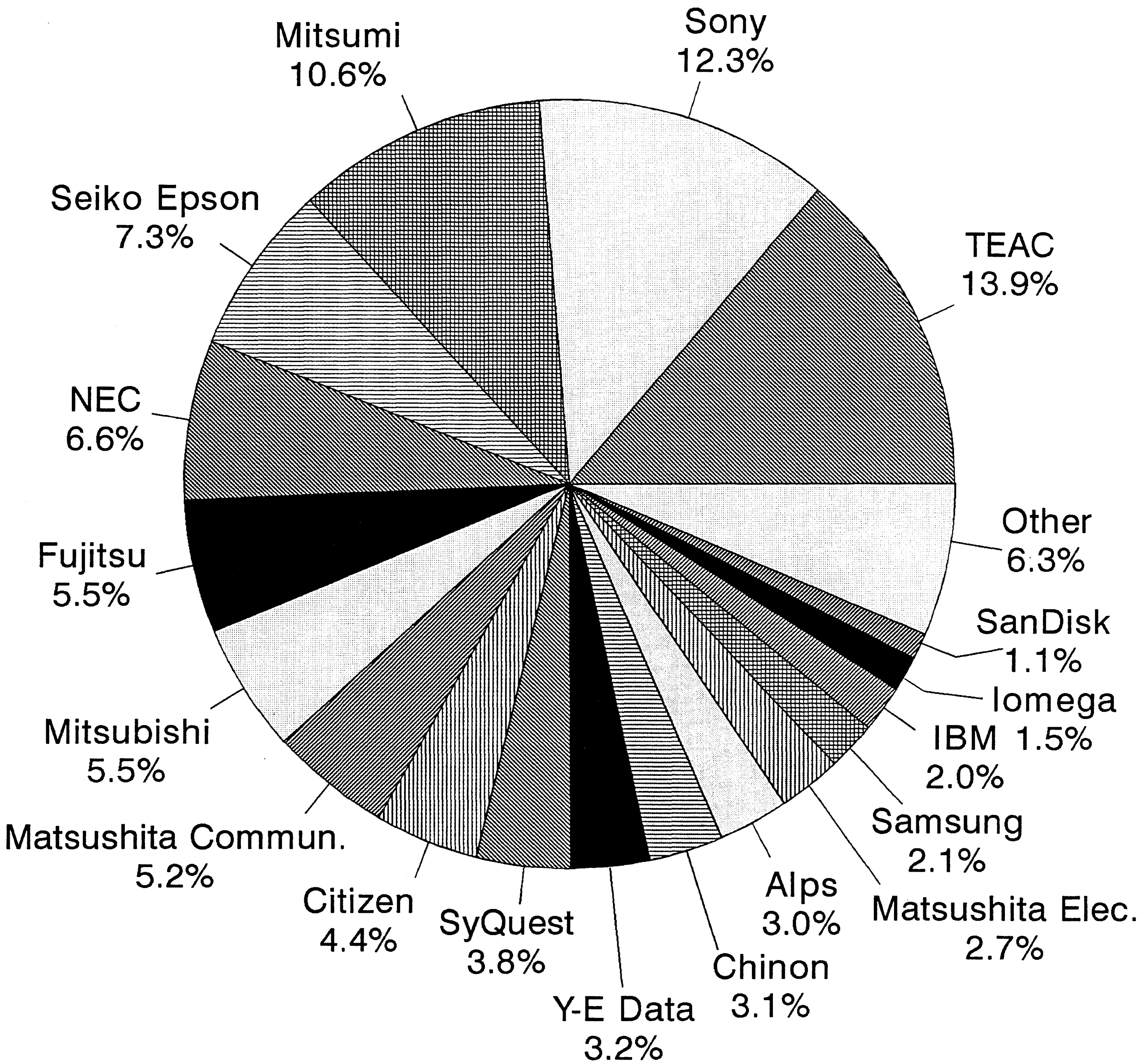
UNIT SHIPMENTS IN THOUSANDS	1994 Shipments Units	1994 Shipments %	Forecast 1995 Units	1995 %	1996 Units	1996 %	1997 Units	1997 %	1998 Units	1998 %
PCMCIA FLASH CARDS	491.9	.7%	815.4	1.0%	1,312.8	1.5%	1,920.3	2.1%	2,724.4	2.7%
	+98.5%		+65.8%		+61.0%		+46.3%		+41.9%	
PCMCIA RIGID DISK DRIVES	156.1	.2%	319.0	.4%	570.0	.7%	785.0	.8%	990.0	1.0%
	+72.2%		+104.4%		+78.7%		+37.3%		+26.1%	
RIGID DISK CARTRIDGE DRIVES	468.4	.6%	742.0	.9%	1,300.0	1.5%	1,680.0	1.8%	1,985.0	2.0%
	+25.0%		+58.4%		+75.2%		+29.2%		+18.2%	
SMALL OPTICAL DISK DRIVES	466.9	.6%	593.8	.7%	725.0	.9%	878.0	.9%	1,003.0	1.0%
	+92.5%		+27.2%		+22.1%		+21.1%		+14.2%	
HIGH CAPACITY FLEXIBLE	203.5	.2%	475.0	.5%	1,205.0	1.3%	2,215.0	2.3%	3,365.0	3.2%
DISK DRIVES	-2.9%		+133.4%		+153.7%		+83.8%		+51.9%	
LOW CAPACITY FLEXIBLE	73,366.0	97.7%	77,084.0	96.5%	80,277.0	94.1%	85,040.0	92.1%	90,535.0	90.1%
DISK DRIVES	+16.3%		+5.1%		+4.1%		+5.9%		+6.5%	
Total Worldwide Shipments	75,152.8	100.0%	80,029.2	100.0%	85,389.8	100.0%	92,518.3	100.0%	100,602.4	100.0%
	+17.0%		+6.5%		+6.7%		+8.3%		+8.7%	
% U.S. Manufacturers	1.5%		2.5%		4.4%		6.1%		7.6%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Figure 3

1994 ESTIMATED MARKET SHARE

Removable Data Storage Worldwide Revenue



1994 Revenue: $2,909,600,000

TABLE 7

1994 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL REMOVABLE DATA STORAGE
(Value of non-U.S. currencies estimated at average 1994 rates)

	CAPTIVE		PCM/RESELLER		OEM/INTEGRATOR		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
IBM	17.1	7.3	23.7	2.8	16.8	.9	57.6	2.0
Integral Peripherals	--	--	--	--	12.9	.7	12.9	.4
Intel	--	--	9.8	1.1	10.1	.6	19.9	.7
Iomega	--	--	40.2	4.7	2.0	.1	42.2	1.5
Maxtor	--	--	4.1	.5	11.2	.6	15.3	.5
SanDisk	--	--	3.1	.4	28.1	1.5	31.2	1.1
SyQuest Technology	--	--	109.7	12.9	1.3	.1	111.0	3.8
Other U.S.	--	--	4.6	.5	12.4	.7	17.0	.6
U.S. Total	17.1	7.3	195.2	22.9	94.8	5.2	307.1	10.6
NON-U.S. MANUFACTURERS								
Alps Electric	--	--	8.3	1.0	79.6	4.4	87.9	3.0
Canon	--	--	--	--	29.9	1.6	29.9	1.0
Chinon	--	--	20.2	2.4	68.6	3.8	88.8	3.1
Citizen	--	--	.8	.1	126.0	6.9	126.8	4.4
Fujitsu	--	--	147.4	17.3	13.9	.8	161.3	5.5
Insite Peripherals	--	--	7.3	.9	10.0	.5	17.3	.6
Matsushita Communication Indust.	--	--	72.8	8.5	78.7	4.3	151.5	5.2
Matsushita Electric Industrial	--	--	14.0	1.6	64.0	3.5	78.0	2.7
Mitsubishi Electric	1.2	.5	--	--	157.6	8.7	158.8	5.5
Mitsumi Electric	--	--	24.8	2.9	284.8	15.6	309.6	10.6
NEC	146.9	62.3	33.1	3.9	13.0	.7	193.0	6.6
Olympus Optical	--	--	19.8	2.3	1.1	.1	20.9	.7
Samsung Electronic	32.9	14.0	14.1	1.7	14.0	.8	61.0	2.1
Seiko Epson	30.8	13.1	78.0	9.2	104.1	5.7	212.9	7.3
Sony	--	--	96.6	11.3	260.8	14.3	357.4	12.3
TEAC	--	--	64.5	7.6	339.3	18.6	403.8	13.9
Y-E Data	--	--	26.2	3.1	66.5	3.7	92.7	3.2
Other Non-U.S.	6.8	2.9	29.2	3.4	14.9	.8	50.9	1.7
Non-U.S. Total	218.6	92.7	657.1	77.1	1,726.8	94.8	2,602.5	89.4
WORLDWIDE TOTAL	235.7	100.0	852.3	100.0	1,821.6	100.0	2,909.6	100.0

Note: The DISK/TREND estimates of revenue for each manufacturer include net sales of removable data storage products only and do not represent total revenues for individual companies

Codes:

PI = PC Card I　　C = Captive
PII = PC Card II　　P = PCM
PIII = PC Card III　　O = OEM
1 = 1.8"
2 = 2.5"
3 = 3.5"
5 = 5.25"
8 = 8"
FD = Flash disk
FM = Flash memory

TABLE 8

CURRENT PRODUCT LINES
MANUFACTURERS OF REMOVABLE DATA STORAGE

DISK/TREND PRODUCT GROUP		40/41/42/43	2/3/4	1	11	14	13
		PCMCIA Flash Cards	PCMCIA Disk Drives	Rigid Disk Cartridge Drives	Small Optical Disk Drives	High Capacity Flexible Disk Drives	Low Capacity Flexible Disk Drives
U.S. Manufacturers (18)	Type						
ActionTec	O,P	FM					
Advanced Micro Devices	O	FM					
AMP	P	FM					
Avatar Systems	O			2			
Centennial Technologies	O,P	FM					
Cirrus Logic	O	FD					
IBM Microelectronics	C,O,P	FD,FM					
Integral Peripherals	O,P		PIII				
Intel	O,P	FD,FM					
Iomega	O,P			3		3,5	
Maxtor	O,P	FM					
MOST	O,P				3		
Mountain Optech	O				3		
New Media	O,P	FM					
SanDisk	O,P	FD					
Smart Modular Technologies	O,P	FM					
Swan Instruments	O,P					3	
SyQuest Technology	O,P			1,3,5			
Asian Manufacturers (30)							
Alps Electric	O,P						3
Canon Electronics	O,P						3
Carry Computer	O,P	FM					
Chinon	O,P				3		3,5
Citizen Watch	O,P						3
Fuji Photo Film	O,P	FD,FM					
Fujitsu	C,O,P	FM			3		
Hitachi	O,P	FM					
Insite Peripherals	O,P					3	
Kingmax	O,P	FD,FM					
LaserByte	O,P				3		
Matsushita Communication Ind.	O,P						3,5
Matsushita Electric Ind.	O,P	FM			3		
Matsushita Electronic Comp.	O,P						3
Matsushita-Kotobuki Electron.	O					3	
Meiko	O,P	FM					
Mitsubishi Electric	O,P	FM					3,5
Mitsumi Electric	O,P						3,5
NEC	C,O				3		3,5,8
Olympus Optical	O,P				3		
Ricoh	O				3		
Safronic	O,P						3,5
Samsung Electronics	O,P						3,5
Seiko Epson	O,P	FD,FM	PIII		3		3,5
Sharp	O,P	FM					
Sony	O,P				2,3		3
TEAC	O				3		3,5
Toshiba	O,P	FD,FM					
Transcend	O,P	FM					
Y-E Data	O,P						3,5,8
European/Middle East Manufacturers (4)							
Calluna Technology	O		PIII				
M-Systems	O	FM					
Nomai	O,P			3			
SCM Microsystems	O	FM					

TECHNICAL REVIEW

This section briefly reviews the status and significant technology trends for removable data storage in the following areas:

* PCMCIA flash cards
* PCMCIA rigid disk drives
* Rigid disk cartridge drives
* Small optical disk drives
* High capacity flexible disk drives
* Low capacity flexible disk drives

Flash card technology

The development of flash memory dates back to work done by Toshiba in 1984, although U.S. firms have done the most to commercialize the technology. Flash memory is nonvolatile and rewritable, making it suitable for use in removable or power-off environments. The manufacturing technology involved is essentially CMOS technology, which permits flash memory manufacturers to take advantage of improvements in semiconductor manufacturing processes. There are several flash cell architectures, NOR, NAND, and EEPROM, which differ largely in erasable block sizes, power demand and access times, but otherwise have similar characteristics as viewed from outside the chip. The majority of PCMCIA flash chips are manufactured using NOR architecture for producibility reasons.

Because of their low power drain, immunity to shock and vibration, and fast read access time, flash cards are well suited for providing mass storage for portable systems, but their relatively high cost per megabyte in most cases limits their use to applications where only a few megabytes or less of storage are needed. Military or severe environment applications are often an exception, because cost is subordinate to function in these cases. An example of such an application is Raymond Engineering's flash disk array, a RAID configuration using SanDisk flash disk modules instead of disk drives.

Notebook computers, subnotebook computers, pen-based computers, and PDAs (Personal Digital Assistants) have created demand for removable mass storage, much of which can be satisfied by flash cards. Some noncomputer applications, such as storage for cameras, also have fueled increased demand. In addition to providing primary or secondary storage for small systems, flash cards can also be used to transfer data between systems, both mobile and desktop.

In order to provide for card interchangeability between systems, a set of standards has been developed by PCMCIA (Personal Computer Memory Card Industry Association) and JEIDA (Japan Electronic Industry Development Association) that defines a package and 68 pin interface for removable memory, I/O device and other functional cards suitable for use with portable computing systems. Release 1 of the PCMCIA specification covered memory cards (including flash cards), but strong industry demand resulted in the formulation of Release 2, which also covers peripheral devices. Release 2.1 specified Card Services and Socket Services software support requirements for the interface. Release 3, formally the PC Card Standard, was announced in late 1994 and defines support required for multifunction cards, a 32 bit bus architecture (CardBus), and dual 3.3 volt/5 volt power. Both PCMCIA and JEIDA now encourage usage of the phrase "PC Card" in place of "PCMCIA card". PC Card flash memory and PC Card flash disks (which emulate a disk drive) are becoming major applications for flash memory. Some important aspects of this usage are reviewed below.

* Chip density and card capacity: Because a PC Card can only carry a limited number of chips, the capacity of the chip, or chip density, is a major factor in establishing card capacity and cost per megabyte. Current designs use 1 megabit chips, 4 megabit chips, and 16 megabit chips in PC Card flash cards, and the 16 megabit chips are becoming mainstream elements. The use of 64 megabit chips is anticipated in the next few years. SanDisk and NEC have a joint development program to create a 256 megabit chip, planned for 1997, which is intended to bypass the 64 megabit step and achieve an advantageous cost per megabit position relative to other chip densities. In mid-1994, Intel announced it was developing multiple bit per cell chip designs that also are intended to result in major improvements in chip density within a few years.

* Flash disk versus flash memory: Some flash cards are designed to emulate a disk drive when plugged in and are equipped with a PCMCIA-ATA interface, which is similar to the ATA interface used in personal computers. Such memory cards, which are designated as "flash disk"

cards operate as if they were an IDE drive, and their organization can be described in terms of disk drive equivalent heads, sectors and data cylinders. SanDisk is the most significant supplier of flash disk cards.

Most flash memory, however, does not look like a disk drive to the system, although with the use of software "flash file systems" they can be presented to the host operating system as virtual disk drives. When installed as flash memory (sometimes called "linear flash"), flash cards can act as an extension to the host system's memory, permitting software stored on the card to execute directly from the card (XIP, or execute in place capability) without having to be loaded from card to host memory first.

* Performance: Because there are no moving parts, average access time for reads on flash cards can be very short compared to rigid disk drives. However, writes are inefficient (an entire block of data must be erased and then rewritten with any required changes). Accordingly, flash memory writes can take considerably longer than with a rigid drive because of the considerable amount of data management required. A memory that has been "put to sleep" for power conservation reasons may take a millisecond or two to become fully functional, but after that access times are measured in hundreds of nanoseconds.

* Power requirements: Because the primary application for flash cards is in portable equipment, minimization of power requirements is critical. Earlier flash card designs required multiple voltages (usually +12 volts and +5 volts) to operate, but more recent designs require only 5 volt power. 3.3 volt or dual 3.3 volt/5 volt operation is starting to appear. Some cards manage power internally, reducing power when the memory is inactive, although this results in short delays upon reactivating the memory card as well as creating compatibility problems in some systems.

* Packaging: The PC Card standards define a set of standard packages of various thickness but with the same width and length. PC Card Type I cards are 3.3 millimeters thick, PC Card Type II cards are 5 millimeters thick, and PC Card Type III cards are 10.5 millimeters thick. All cards are 54 millimeters wide and 85.6 millimeters long. An additional thicker "Type IV" package has been suggested by JEIDA (Japan Electronic Industries Development Association), but has not been approved by PCMCIA.

* Interface: The electrical and mechanical interface for PC Card flash cards is defined, and has evolved to accommodate a wider 32 bit PCI-like data bus, often called "CardBus". The software interface between the card and the host system has also been standardized, though sufficient ambiguities remain to prevent universal interchange between all cards and all systems. The actual physical interface between card and host is implemented in a socket contained in a "card drive", sometimes called a card reader/writer. Older card drives were configured to operate with PCMCIA Release 1

specifications, which are not compatible with PCMCIA Release 2 specifications. Consequently, the older card readers must be replaced or reconfigured (if possible) to use any PC Card cards other than memory cards.

There are many industrial applications for flash memory cards that do not require the full complement of features specified by the PC Card standard. Some card manufacturers are producing lower cost cards that conform to PC Card standards in terms of mechanical and electrical specifications, but with all but the simplest internal logic removed. AMP's FlashLite series is typical of such cards.

* Longevity: One of the limitations of flash memory is a limitation of the number of times a memory cell can be rewritten before its ability to permanently store the data accurately degrades. Most flash cards are currently specified to have at least 100,000 cycle capability, although cards with 10,000 write cycles to 1,000,000 cycles are advertised. Improvements in materials and manufacturing processes are expected to gradually improve this characteristic. In many applications, write cycle limits are not a significant problem, either because the memory does not need to be rewritten often or because wear leveling software is used to rotate write operations across the entire memory on the card, preventing any one cell or block of cells from having an abnormally large number of writes and wearing out early. Since the cycle life of the memory cells statistically follows a bell curve, it is also possible to extend card usability by flagging the memory locations that fail early and removing them from use, thereby extending the usable life of the card at the cost of a small decrease in capacity.

* Compatibility: Differences between voltage and current levels supplied by host sockets and what the memory cards expect can cause interchange incompatibility. Even though PC Card memory may adhere to physical and electrical standards, differences between the way host systems communicate with the cards cause interchange problems. Furthermore, products conforming to PCMCIA Release 2 or the PC Card standard will not operate in host systems configured to support PCMCIA Release 1. PCMCIA has attempted to resolve such difficulties by defining several layers of software executed by the host (Card Services and Socket Services) and by defining a Card Information Structure (CIS), a method for the card to report to the host what type of card it is and how its information is organized. The host computer can then determine how to attach the card's information structure to the host operating environment.

  Newer computers usually have PC Card support software preinstalled as part of the BIOS or operating system, and any operating system drivers required will be capable of operating with PC Card flash cards. The major computer and card suppliers are cooperating to eliminate potential incompatibility problems.

* Insertion integrity: Cards conforming to the PC Card standard must be designed to be removable and insertable with power on and the system running. They must also withstand a considerable number of physical insertions. Most cards are specified to withstand at least 10,000 insertion/removal cycles.

* Competing technologies: Other semiconductor technologies compete with flash memory. PC Card models using SRAM with a backup battery to provide nonvolatility are sold by many of the same firms that supply flash cards, but are being displaced by flash technology in applications where fast writes are not required. ROM or EEPROM based cards compete if read-only or write-once characteristics are acceptable. And in the future, ferroelectric memory, which is also inherently nonvolatile and is less restrictive in the number of write/erase cycles allowed, may be a significant competitor as ferroelectric chips reach 4 megabit densities and above.

PCMCIA rigid disk drive technology

Version 2.1 of the PCMCIA specification covers peripheral devices, including rigid disk drives mounted in PC Cards. Because of the limitations imposed by card size, these are all currently 1.8" diameter drives. Although several companies have produced PC Card disk drives during the last few years, Calluna and Integral Peripherals are currently the only disk drive manufacturers currently active in the market for PC Card rigid disk drives. Much of the commentary in the preceding section concerning PC Card related issues applies as much to rigid disk drive PC Cards as it does to flash cards. Areas of difference are reviewed below, as well as those issues unique to rigid disk drive technology.

Rigid disk drives packaged in PC Card format are well suited for providing primary or secondary storage for full function mobile computers, because of the higher capacities available. Computer users who wish to take their full suite of applications on the road with them will find the 170 megabyte to 340 megabyte capacities of drives now in production to be adequate, though not generous. More capacity is needed, especially for multimedia and graphics applications. Some improvement can be obtained indirectly by using data compression, which can expand drive capacity by a factor of two for an average application and user file mix.

* Areal Density: The most significant aspect of rigid disk drive technology is the trend line of areal density (TPI x BPI) increase. The rigid disk drive

industry is currently increasing recording density at an average rate of 60% annually, and this rate is expected to be maintained through this decade. It is this inexorable improvement that will keep the cost per megabyte of rigid disk storage well below the cost of flash memory during the remainder of the decade. The highest areal density announced for a 1.8" drive as of mid-1995 was about 630 megabits per square inch (Integral's 340 megabyte drive), while the industry average was in the 380 megabits per square inch range, a conservative level allowing for rapid improvements.

High areal densities are being obtained by using thin film heads and media, coupled with reduced flying height. PRML data channels have been incorporated in 1.8" drives shipping during 1995. Magnetoresistive heads and, later, heads employing giant magnetoresistance effects will eventually be employed in PC Card drives to extend areal density.

* Packaging: All current rigid disk PC Card drives employ standard Type III PC Card form factors today. A drive in the Type II form factor was announced by Maxtor, but was never shipped before Maxtor withdrew from the PC Card drive market. The major pacing element in establishment of volume production for PC Card Type II disk drives will be availability of adequate quantities of critical new components, such as motors, disks, head assemblies and semiconductors. The small area available in the card for electronics also dictates increased use of higher density semiconductor elements and innovative packaging techniques.

* Power requirements: Rigid drives require more power than semiconductor memories when operating, so power reduction and on-board power management are critical functions and likely to remain so.

* Interface: The PCMCIA-ATA disk drives conform to PCMCIA Release 2 physical specifications and use the PCMCIA 68 pin connector rather than the standard ATA 40 pin connector. The PCMCIA-ATA card also supports extended I/O addressing, necessary for removable drives, and supplies CIS data to the host on request. PCMCIA-ATA drives can support either 8 bit or 16 bit data transfers, as compared to the ATA 8 bit transfer only. Host resident drivers for ATA drives must be revised to account for the removability of the PCMCIA-ATA drives and other features. Such drivers are labeled as "PCMCIA-aware".

* Shock resistance: Because they have moving parts, PC Card rigid disk drives are more vulnerable to mechanical disturbances than their all-electronic counterparts. However, considerable insensitivity to the effects of operating shock has been obtained by incorporating piezoelectric shock sensors into the drive and halting writing operations when an excessive shock is detected, eliminating the possibility of off track or adjacent track writing that can cause unrecoverable errors. Dynamic head loading, used

by Integral Peripherals, helps reduce nonoperating shock damage because the heads are parked off the disk when the drive isn't operating. When removed from the host system, a card mounted drive is much more susceptible to shock damage, so nonoperating shock damage elimination is critical for PC Card rigid disk drives.

* Performance: Today's 1.8" drives have average access times in the 18 to 30 millisecond range, substantially inferior to flash memory cards. Startup time is in the 1-2 second range, also slow compared to flash memory. Media data transfer rates are in the 3 to 5 megabytes per second range, with burst rates at 10 megabytes per second. Media data transfer rates will probably increase as linear densities increase.

* Electronics: Drive servos are shifting to use of digital signal processing in servo tracking subsystems as TPI increases put more strain on tracking tolerances. Channel electronics are becoming more complex in order to accommodate the higher data transfer rates associated with higher linear density. While these improvements assist performance and help improve capacity, they also add cost and power consumption, both undesirable for portable systems.

* Motors: It is necessary for drive motor designers to be very creative to accommodate the ever decreasing drive heights. The rate at which the drive producers can introduce PC Card Type II form factor drives is a function of the availability of the very thin spindle motors required. Actuator designs are also being stressed for the same reason, and for some very thin drives, maintaining the expected performance levels will be a challenge.

Rigid disk cartridge drive technology

Disk cartridge drives are currently available in 5.25", 3.5", 2.5" and 1.8" form factors. The SyQuest 1.8" drive, which utilizes a removable disk, actually fits in a PC Card compatible mounting. Both the drive card and the 80 megabyte disk cartridge are removable, which makes it the industry's only removable drive with removable media.

All of the factors that apply to rigid disk drives in general pertain to cartridge drives, but the need to accommodate removable cartridges makes it difficult to match the areal densities achieved by drives with sealed head/disk assemblies. Disk cartridge drives must also be designed to deal with dust and airborne chemical pollutants to a degree not required of sealed HDA designs.

Driven by competition from optical disk drives and high capacity flexible disk drives, and able to draw upon basic improvements in magnetic drive technology, rigid disk cartridge drive technology has improved dramatically in the past few years. 5.25" disk cartridge drives currently are available from SyQuest with capacities up to 200 megabytes, but industry direction has shifted to smaller form factors, with 270 megabytes now available on 3.5" cartridge media and 80 megabytes available on 1.8" disks, both from SyQuest. Higher capacities, including a 1.3 gigabyte drive discussed by SyQuest and a 1 gigabyte drive from Iomega are expected to become available by 1996. By then, Avatar is expected to be producing 2.5" drives with at least 170 megabytes capacity. Disk cartridge drives will be able to take advantage of the heads, disks, motors and semiconductors developed for the much larger market provided by fixed disk drives. The special operating environment of removable disk cartridge drives will require improved filtration systems and cartridge protection systems to eliminate airborne pollutants, all attainable refinements of existing technologies.

The primary applications for disk cartridge drives have been data interchange associated with graphics and desktop publishing, plus secure system data storage, where they will compete with PC Card rigid drives, small optical drives, high capacity flexible drives, and, in nongraphics applications, with flash memory as flash capacity increases. Compared to the competition, rigid disk cartridge drives can offer cost advantages, and frequently provide more capacity and convenience of use. The major technology challenge for disk cartridge drives, as always, is to improve reliability, a difficult assignment due to the lack of a completely closed head/disk assembly. Disk cartridge drive reliability is currently regarded as adequate by most users, but it will be necessary to continue to improve, as competition increases from other data storage products.

Small optical disk drive technology

Small form factor optical disk drives offer cartridge removability in the same way as magnetic cartridge disk drives, and compete against both rigid and flexible magnetic cartridge disk drives, largely in the same desktop application niches. However, their larger size and power needs have kept them from playing a significant role in portable system applications. 3.5" and 2.5" optical disk drives are currently on the market, manufactured by a number of Japanese and a few

American companies. 1.8" optical drives have not yet appeared, although Fujitsu has discussed the possibility of such a future drive.

Optical disk drives and media demonstrate high areal density exceeding 350 megabits per square inch for these small form factor drives, but can address only one side of the disk because only one head is present in the drive. As a result, on-line capacity compares unfavorably with the on-line capacity available from rigid magnetic fixed or cartridge drives of equivalent media size. On the other hand, optical drives do not require the microinch range head-to-disk spacings required by rigid drives and are less subject to head crash or stiction events. Perhaps the greatest obstacle that optical drives must overcome is their high price relative to competing disk technologies, a problem created primarily by the relatively low shipments of drives in this class. Optical drives also suffer in comparison with other removable storage technologies in terms of power requirements, packaging and, sometimes, performance.

Optical drives in 5.25" and larger formats are frequently used in optical libraries (jukeboxes), enabling data stored on multiple disks to be accessed under system control. Because of the small capacities of 3.5" drives, there has been little industry interest in using them in libraries, but 3.5" drives with 600+ megabyte capacities anticipated in 1995 are expected to encourage library use. At present, only one library containing 3.5" drives is available; it holds 22 disks.

Nearly all of the present generation of 3.5" optical drives offers 230 megabytes or 128 megabytes on single sided media. By using a proprietary recording format, one firm, MOST, has been able to market 3.5" drives with over 360 megabytes capacity. The next generation of 3.5" drives, probably available in late 1995 in quantity, is expected to provide 640 megabytes or greater through the use of improved recording techniques and shorter wavelength lasers. Rigid cartridge disk drives offer serious competition to optical drives in many situations. SyQuest's 3.5" 270 megabyte removable drive competes strongly with 3.5" 230 and 128 megabyte optical drives in capacity, price and performance.

While 3.5" optical drives have improved performance to the point where they can provide sub-30 millisecond average seek time, future PC Card magnetic drives already offer sub-20 millisecond average seek times on drives of roughly equivalent capacity.

2.5" drives are the result of developments by Sony, which created the format originally as a consumer oriented audio recording product. A number of other companies have taken Sony licenses for the technology. In its current form, the 2.5" drive offers 140 megabytes of data on single sided magneto-optic media. Because the recording format is borrowed from CD-ROM technology, performance is limited. Although the road map is clear for capacity improvements in 3.5" drives, the situation regarding 2.5" drive capacity improvements is murky. The rate of progress may depend upon improvements in CD-ROM technology and upon the success of the audio format drive, which may reduce the costs of the computer version and induce manufacturers to invest in improvements.

All 3.5" and 2.5" optical disk drives currently being manufactured use magneto-optic (MO) media, although Toshiba, Matsushita and others are considering the introduction of 3.5" drives employing phase change media, which uses a different recording technology and is incompatible with MO media. Most drives using MO media cannot directly overwrite previously recorded data. Old data must be erased during one revolution of the disk, which can then record data on the next pass. As a result, the best of the MO drives have read performance approaching that of a magnetic drive, but much inferior write performance. Drives using phase change technology can overwrite data directly, but are subject to a limitation on the number of write/erase cycles that can be performed on a specific location. Direct overwrite on MO media is theoretically possible, but currently is available only in the 2.5" Sony drive and some 5.25" drives.

The fundamental technology driving improvements in all of optical drives is the technology of the semiconductor lasers used in the optical recording head. Current lasers operate at 780 nanometer (infrared) wavelengths. The spot size the laser makes on the disk is a function of the laser wavelength, and a halving of the wavelength would result in a 4x increase in capacity, with proportionate increases at lesser wavelength improvements. The prospects for blue light (400 nanometer) lasers are improving, although the frequency doubling solutions expected to be available in the next few years are costly in both power and money. However, red lasers (680 nanometers) are expected to appear in the next generation of optical drives, affording a 40% improvement in density.

Additional improvements in capacity are likely to be obtained from a shift from bit edge encoding to pulse width modulation, improved servo techniques, and the use of unconventional optical elements to increase areal density. Higher laser power will enable higher rotation rates and faster data transfer rates.

High capacity flexible disk drive technology

Flexible disk drives in this group utilize a variety of technology variations to provide capacities above those offered by standard floppy drives, including Iomega's 5.25" Bernoulli principle drives, the Iomega 3.5" "Zip" drive, and the 3.5" "floptical drives" initially introduced by Insite and now manufactured by Matsushita-Kotobuki Electronics. Because of the relatively high prices of these drives, compared to standard floppy drives, they must compete with rigid magnetic disk drives, optical disk drives and tape drives, for specialized markets which need recording devices with removable media. It has been a difficult competitive environment, however, with rapidly dropping prices for the alternative products.

Originally introduced in an 8" diameter format, the Iomega Bernoulli Box transitioned to a 5.25" format and is currently available in capacities up to 230 megabytes. Performance is competitive, with average seek times in the 20-25 millisecond range. The performance of most high capacity 3.5" drives in this group is inferior to that of the Bernoulli drives, but better than that of standard 1.44 or 2.88 megabyte floppy drives. Several design approaches have been used to create high capacity 3.5" flexible drives, most of which have not been compatible with each other, although frequently providing backward compatibility with 1.44 megabyte drives. They are reviewed briefly below:

* <u>Rigid drive technology</u>: The Iomega "Zip" drive borrows head and semiconductor technology from the rigid drive industry, obtaining design simplicity, low parts count and reduced costs as a result of being able to use components already being produced in volume for the rigid drive industry. How Iomega's success is judged is likely to cause other competitors to adopt a similar philosophy in future high capacity drive design efforts.

* <u>Optical tracking</u>: Developed by Insite Peripherals, the original 20 megabyte drives used optical tracking to provide 1,245 TPI and 1,7 RLL coding to reach almost 24,000 BPI. The barium ferrite media is packaged in a standard 3.5" floppy disk shell. To provide a tracking servo signal, the media is laser branded with a pattern of concentric rings. A multisensor pickup device receives reflected light and generates appropriate tracking data. As currently manufactured, track density of the floptical drives is 1,245 TPI, but improved optics and tighter track spacing can increase the

capacity available several times. A second generation floptical drive with 120 megabyte capacity is expected to be formally announced in late 1995 and become available by 1996. The new drive will be backward compatible with standard 3.5" floppies, with Compaq Computer as a customer, production of media by 3M, and manufacturing of the drives by Matsushita-Kotobuki Electronics.

Unfortunately for the original 20 megabyte floptical drive program, it entered the market, after several delays, at a time when rigid drive capacities were rapidly expanding, and it was inefficient in its planned role as a backup or data transfer device. Although it was produced in Japan for Insite, and later for Iomega under license, by efficient manufacturers, its production cost was too high (and the yen too strong) for it to present an attractive cost/capacity/performance trade-off for mainstream applications. While the second generation 120 megabyte floptical drive is expected to be cost reduced and to retain backward compatibility with 1.44 megabyte floppy drives, it will be severely challenged by the SyQuest and Iomega drives previously discussed.

* Metal powder media: Using metal powder media and conventional recording techniques, several Japanese firms, including NEC, Matsushita Communication Industrial and Y-E Data introduced 3.5" floppy drives from time to time with capacities up to 20 megabytes (NEC introduced a 10 megabyte version in 1990), but all have been withdrawn from the market due to limited acceptance. With the increasing availability of 100+ mega byte flexible drives, other firms are unlikely to offer similar drives. JEIDA sponsored a standards program for this type of drive, but none of the participating companies, except NEC, entered the market. Proponents of the metal powder approach have long claimed that it can support floppy drive capacities of 100 megabytes or more using standard form factor flexible disks. The Iomega "Zip" drive does achieve its 100 megabyte capacity with metal powder media.

* Embedded servo: In 1990, Brier Technology introduced a 20 megabyte floppy drive that used an "embedded servo", a magnetically written servo track co-located with the data track but using a lower frequency than that of the recorded data signals. A track density of 777 TPI was obtained. A frequency sensitive detector scheme was used to provide tracking signals to the head positioner. The barium ferrite disks used had to be preformatted at the factory before use. Brier was unable to win broad acceptance for the drive, which went out of production in 1992. The firm announced, but never made, a 40 megabyte drive.

* Other methods: Various firms have examined the possibility of increasing the capacity of standard floppy drive media by a judicious choice of coding, modulation scheme or compression without changing the fundamental file structure of the drive. While such methods can produce higher

capacities, it is at least questionable if the benefits warrant the industry-wide standardization effort required to gain acceptance for any given method or combination of methods until several producers have endorsed them by actually incorporating them into drives.

Low capacity flexible disk drive technology

1995 has seen little significant change in low capacity floppy drive technology. Notebook computers use large numbers of half inch high 3.5" drives, but one inch high 3.5" drives are still the standard for desktop computers. 2.88 megabyte 3.5" drives, once standard on many IBM PS/2 personal computers, are now only an option on IBM's newer personal computers, and have generated limited market response outside of IBM. The most significant technical development efforts are now aimed at high capacity drives.

While low capacity floppy drive development has slowed, other technologies attempting to compete with floppy drives as a universal distribution medium remain too costly, too slow, or are not standardized for universal data interchange. Flexible disk drives have succeeded because they offer low cost, recordability, random access, interchange standards and media removability. The CD-ROM drives now growing in usage for software distribution are limited to the distribution role, due to the lack of recording capability. A critical problem for competitors is that any alternate technology must offer significant improvements at a competitive price, and the OEM price for 3.5" floppy drives approaches $20 for large quantities.

Ever-smaller form factors, higher capacities, more effective designs, the need to read existing libraries of disks, and lower cost manufacturing methods have sustained floppy drive cost-effectiveness against competitive data storage technologies. Consequently, alternate technologies find only limited success in breaking into floppies' established markets, although some displacement of floppy drives is occurring in notebook and hand-held computers where there is insufficient space or power for floppy drives.

Developments in low capacity floppy technology seem limited to a few areas:

* <u>Form factor</u>: The 1/2 inch high 3.5" floppy drives now in production permit designers of notebook computers to reduce weight and system package size, and to match the heights of new 2.5" and 1.8" rigid disk drives. The

nominal 1/2 inch high profile floppy drives now offered in formats from 11 to 12.7 millimeters in height are widely used in notebook computers and have also found usage in subsystems which combine a 3.5" drive with a 5.25" drive in a single unit designed to be used in a 1.625" high slot in desktop systems.

Drives ranging from 15 to 19 millimeter height are currently offered as "3/4 inch" drives. After initial enthusiasm, the computer industry's reaction to 3/4 inch floppy drives cooled off, with recent growth in shipments going to one inch high drives -- or to 1/2 inch high drives when necessary due to packaging requirements. It currently appears that one inch high drives will remain the desktop computer standard.

Floppy disk drives have evolved from 8" disk drives through 5.25" disk drives to 3.5" disk drives, but the prospects for further diameter shrinkage in the low capacity category seem unlikely. Attempts to reduce diameter to 2.5" or less go back to the late eighties and a few drives were actually introduced, but the computer industry has not found it economically attractive to go through one more stage of diameter shrinkage.

* Media: The polyester substrate used with flexible disks suffers from limitations in its dimensional stability which derive from the manufacturing process used. As a result, today's mainstream floppy drive products using open loop head positioning systems for low cost are limited to 48 TPI with 8" drives, 96 TPI with 5.25" drives, and 135 TPI with 3.5" drives. The relatively small tonnage of polyester required for diskettes did not inspire plastics manufacturers to invest heavily in research targeted at dimensional stability improvements until the last few years, when the quantities became too large to ignore. However, the magnetic recording industry has been actively developing several methods of increasing track recording density with active servo tracking.

Some substrate materials do offer high stability and resistance to environmental degradation, but are very expensive relative to polyester films and are unlikely to be widely adopted.

DEFINITIONS

Many basic terms have varying meanings within the computer industry, depending upon the role of the person speaking. In this report, such terms are used in the way most disk drive or flash card manufacturers use them.

Market classification

Market class is used here, arbitrarily, to differentiate captive, PCM/Reseller and OEM/Integrator disk drive and flash card marketing activities.

Captive: Disk drives or flash cards manufactured internally or by a subsidiary of a system manufacturer, and sold or leased primarily for use with systems offered by the manufacturer. Note that the term is used to describe the products, not the manufacturer; drives and cards sold to PCM/Reseller or OEM/Integrator market classes are classified accordingly. Most DISK/TREND statistics separate data between IBM captive and "other captive", but the term still pertains to the products involved, not the manufacturer.

Examples:

* Flash cards sold with a computer by IBM or Fujitsu to computer system end users are considered captive, if internally manufactured.
* Optical disk drives manufactured and sold by Matsushita Electric with a computer system to an end user are considered captive.

Noncaptive: Any public sale or lease by any flash card or disk drive manufacturer, except sales or leases of internally manufactured products by computer system manufacturers primarily for use with their own systems. Both OEM/Integrator and PCM/Reseller shipments are included in the noncaptive sales channel.

Examples:

* Optical drive shipments by Fujitsu are noncaptive, except for drives sold with systems made by the parent company or other subsidiaries.
* Shipments made by Maxtor, SyQuest Technology, SanDisk or Seagate Technology are noncaptive.

PCM/Reseller: Disk drives and flash cards sold or leased by "plug compatible manufacturers" or their distributing organizations directly to end users for use with systems sold by another manufacturer. Also includes drives and cards sold in the "aftermarket" -- shipments by drive/card manufacturers to subsystem producers, distributors, retail chains, mail-order firms and individual dealers. It includes drives to be connected to systems of all types, including personal computers, minicomputers and mainframes, or products sold as add-on devices by distributors and dealers.

Examples:
* Rigid disk cartridge drives such as those of SyQuest Technology.

* Intel flash cards sold through industrial distributors.

OEM/Integrator: Drives and cards sold by the original producer to system manufacturers which resell them as part of complete computer systems. Also includes sales to system integrators or value-added resellers which combine finished system components and software to provide complete systems for specific applications. Sales by a disk drive/flash card manufacturer to a second drive/card manufacturer for resale are included only in shipment totals for the originating manufacturer, except when products are produced on a contract manufacturing basis with a design supplied by the disk drive/flash card manufacturer which finally sells the product to a third party.

Examples:
* Drives produced by Integral Peripherals or Maxtor for sale to system manufacturers.

* PCMCIA flash cards sold by Advanced Micro Devices directly to system manufacturers.

Geographic classification

Geographic analysis is based upon U.S. and non-U.S. regions. Together, these two regions comprise the worldwide market.

U.S. vs. Worldwide SHIPMENTS: Shipments are classified U.S. or worldwide depending on the country in which the headquarters of the purchasing company is located.

Examples:
* An OEM shipment by a U.S. drive or card manufacturer to a European system manufacturer is included in worldwide totals, even if the product is integrated into a system within the U.S.

* An OEM shipment by a Japanese drive manufacturer to a U.S. based system manufacturer is included in U.S. totals, even if the drive/card is integrated into a system in Taiwan, regardless of the final destination of systems in which the storage devices are used.

U.S. vs. Non-U.S. MANUFACTURERS: Manufacturers are classified U.S. or non-U.S., depending on the location of the firm's headquarters, regardless of the location of individual manufacturing plants. Subsidiary corporations are classified according to the geographical location of their parent organization's headquarters.

Example:

* IBM is considered a U.S. manufacturer, even though the company manufactures many of its data storage devices in non-U.S locations.

* LaserByte is considered a non-U.S. manufacturer because it is a Hyundai subsidiary, even though it is located in the U.S.

Units of measurement

Spindles: The basic unit in counting disk drives. One spindle or spindle disk assembly consists of the disk drive mechanism required to utilize a single disk or disk stack. All DISK/TREND disk drive unit totals are counted in spindles. Flash cards are counted in single card units.

Revenue: Based on sales of disk drives and flash cards alone, as normally sold by individual manufacturers. Controllers sold as separate units are not included in disk drive revenue, nor are spare parts or service. When individual storage device models include integral control functions, such as may be required for the first drive on a string of drives, the actual value of the complete unit is used. Sale prices are estimated public sale transaction prices, whether at captive end user, PCM/Reseller or OEM/Integrator levels. All prices are in 1995 constant dollars.

Forecasts: Expected shipments and revenues for current or announced products in new production. Evolutionary improvements within existing disk drive formats are included, but completely new configurations or technologies are not included.

Examples:

* Enhancements such as double density versions of existing single density configurations and revised encoding schemes are anticipated in DISK/TREND forecasts.

* Innovations such as nonstandard size disks or new physical configurations may require establishment of new DISK/TREND product groups.

Application classification

Shipments of disk drives and flash cards are classified by the following computer applications:

Very high performance: Disk drives attached directly to the system or to a terminal associated with a supercomputer or a high end imaging system.

Mainframe systems: Disk drives attached to the processor or to a terminal associated with a mainframe.

Network/mini/multiuser computers: Drives and flash cards used with smaller general purpose processors typically serving multiple users, including network file servers. Examples: IBM System AS/400, Compaq SystemPro, Hewlett-Packard 3000.

Personal computers: Attached to a general purpose microcomputer normally for a single user. Examples: IBM personal computers, Toshiba Satellite series, Apple Macintosh, Compaq and other general purpose home and office desktop or notebook computers.

Workstations: Single user high end workstations used for engineering, graphics, medical, military, publishing and other applications, plus specific office applications such as word processing, electronic mail or document storage. Specialized hardware is normally used. Examples: Canon Canofile, Hitachi HITFILE.

Consumer, game and hobby systems: Systems sold primarily to consumers for nonbusiness applications.

Other applications: Personal digital assistants, instrumentation, specialized industrial and telecommunications equipment, data loggers and any other application not included above.

PCMCIA FLASH CARDS

1995 DISK/TREND REPORT

PCMCIA FLASH CARDS

Coverage

Examples of PCMCIA flash cards in this group include:

Flash disk cards, less than 10 megabytes

Cirrus Logic	CL-FD0004
IBM	17JSSFP3MB, 17JSSFP5MB
Intel	iFD005P2SA
Kingmax Technology	JV20
Seiko Epson	ATA202SD11/01, ATA502SD11/01
SanDisk	SDIAT-20, SDP5A-5
Toshiba	THGSS160031AA

Flash memory cards, less than 10 megabytes

ActionTec Electronics	FH002M-BN, FH008M-BN
Advanced Micro Devices	AMC002CFLKA, AMC008DFLKA
AMP	Flash 12, FlashLite
Carry Computer	2MB
Centennial Technologies	FL256-15-11131-01
Fuji Photo Film	RD3001-8
Fujitsu	MB98A8084X, MB98A8133X
Intel	iMC004FLSP, iMC004FLSA
Kingmax Technology	JN2, JN8
M-Systems	FlashCard-1M, FlashCard-8M
Matsushita Electric Industrial	BN256HFRE, BN-04MHFRE
Maxtor	Flash Card 1, Flash Card 8
Meiko	MIC 256 F/A, MIC-8M F/A
Mitsubishi Electric	MF8257-G1EATXX, MF81M1-GCDAT
New Media	NMC00101, NMC00126
Seiko Epson	HWB257ESX0/40, HWB801S8X0/40
SCM Microsystems	FC004MB2
Sharp	Zaurus
Smart Modular Technologies	SM9FL512KP3, SM9FL4MP35V
Transcend	Flash 2 MB
Toshiba	THGMM080081AA

Flash disk cards, 10 - 25 megabytes

Cirrus Logic	CL-FD0020
IBM	17JSSFP10MB, 17JSSFP20MB
Intel	iFD010P2SA
Seiko Epson	ATA112SD11/01, ATA212SD11/01
SanDisk	SD-20, SDP5-10
Toshiba	THGSS160101AA

Flash memory cards, 10 - 25 megabytes

ActionTec Electronics	FH010M-BN, FH016M-BN

Flash memory cards, 10 - 25 megabytes (continued)

Advanced Micro Devices	AMC010CFLKA
AMP	797263-5
Carry Computer	16MB
Centennial Technologies	FL16M-20
Fuji Photo Film	RD3001-16
Fujitsu	MB98A8143X
Intel	iMC020FLSP, iMC010FLSA
Kingmax Technology	JN12, JN14
M-Systems	FlashCard-10M, FlashCard-20M
Maxtor	Flash Card 10, Flash Card 20
Matsushita Electric Industrial	BN-16MHF3CE
Mitsubishi Electric	MF810M-G7DATXX, MF820M-G7DATXX
Seiko Epson	HWB111S8X0/80, HWB161S8X0/80
SCM Microsystems	FC020MB2
Smart Modular Technologies	SM9FL16MP3
Transcend	Flash 16 MB
Toshiba	THGMM080241AA

Flash disk cards, 25 - 100 megabytes

IBM	17JSSFP30MB, 17JSSFP40MB
SanDisk	SDP5A-40
Seiko Epson	ATA412SD12/02
Toshiba	THGSS160302AA

Flash memory cards, 25 - 100 megabytes

Fujitsu	MB98A81573
Intel	iMC040FLSP
M-Systems	FlashCard-40M

Flash disk cards, more than 100 megabytes

SanDisk	SDPS-110, SDPS175

The memory cards discussed in this section are all PCMCIA flash cards organized as either flash disks, which inherently emulate a disk drive, or flash memory (sometimes called linear flash) which requires additional software to provide disk drive emulation. Flash memory can also provide XIP (execution in place) capability, permitting programs to execute from the card as if they were in the host system memory.

PCMCIA flash cards are ideal mass storage for situations where only a few megabytes of capacity are needed and relatively high price per megabyte is acceptable, and in applications where shock, vibration, humidity, dust and corrosive vapors would preclude the use of disk drives.

Market status

Flash card shipments grew 98.5% to 491,900 units in 1994, while revenues reached $79.8 million, a 76.2% gain. Shipment growth was again limited by a very weak market for PDA (personal digital assistant) class equipment, relatively few portable computers with PC Card slots, lingering compatibility problems, and a preference for nonremovable flash cards in many industrial applications. For 1994, 81.9% of card shipments (402,500 units) were in the under 10 megabyte category, while 17.3% (84,900 units) fell into the 10 to 25 megabyte category. Only 4,500 of the units shipped in 1994 exceeded 25 megabytes, but this is 20 times 1993 shipments. 1994 revenues followed the same pattern, with $44.6 million (55.9%) captured by flash cards under 10 megabytes, and $31.2 million (39.1%) by cards between 10 and 25 megabytes. Cards over 25 megabytes garnered $4.0 million for a 5% share. Compared to 1993, a significant share of shipments has shifted from the lowest capacity range to higher capacities.

U.S. manufacturers remain the leading producers of PCMCIA flash cards, with 77.6% of total worldwide unit shipments provided by the U.S. firms, but Asian firms are increasing their share. The leading 1994 producers were Intel, SanDisk, Kingmax Technology, AMP and Seiko Epson.

Over 80% of flash cards shipped in 1994 with capacities below 10 megabytes were flash memory cards, with flash disk cards accounting for the remainder. However, with 10-25 megabyte cards, flash disk holds over 72% of unit shipments. Nearly 78% of the flash cards over 25 megabytes that shipped in 1994 were flash disk. The material overhead associated with flash disks makes them less attractive at low capacities than flash memory. The relative performance and management advantages of flash disks are advantageous at high capacities.

Over 70% of 1994 flash card unit shipments were made through the OEM/Integrator channel, with the PCM/Reseller channel accounting for the rest. There were no 1994 captive shipments, although some flash cards will be shipped on a captive basis in future years.

For flash cards under 10 megabytes, price per megabyte averaged approximately $31 to $42 per megabyte in 1994, depending upon the distribution channel used and whether the card was flash disk or flash memory. In the 10-25 megabyte class, price per megabyte ranged from about $26 to $33 per megabyte. Price per megabyte for flash disk was lower than for flash memory in the under 10 megabyte product class because the flash disk cards in this class had a higher average capacity than did the flash memory cards. The situation was different in the 10-25 megabyte category, with flash memory exhibiting a lower cost per megabyte in the OEM channel, but a higher relative cost in the reseller channel due to low reseller shipments of flash memory in this product group.

In 1994, the typical flash memory card had 2 or 4 megabytes of capacity, while the typical flash disk card had 4-5 megabytes. The average capacities in each product group have increased each year, but most flash cards sold are still 2 or 4 megabyte cards. The smaller capacity cards (under 10 megabytes) tend to be used in horizontal applications (PDAs, organizers, industrial equipment, etc.), while the higher capacity designs are more likely to be used in vertical applications in service industries such as real estate, finance and insurance. Some companies are providing cards with a simplified feature set, but otherwise conforming to PCMCIA physical, electrical and environmental specifications, in order to reduce cost by eliminating features required by PCs, but not needed for industrial applications. The AMP FlashLite series is an example. Low capacity cards are most likely to be flash memory, as the higher costs of flash disk cards tend to make them poor competitors at the low end of the market.

Application platforms for PCMCIA flash memory cards tend towards non-personal computer environments, leaning heavily toward industrial equipment, telecommunications products, field survey equipment, data loggers, navigation devices and instrumentation. The more visible PDAs and mobile computers are a minor, yet growing market opportunity. The cards in the higher capacity categories are more likely to be used in mobile general purpose computers and as devices for data transfer between mobile and desktop computers. Higher capacity cards are most frequently configured as flash disk.

Marketing trends

In 1995, shipments of PCMCIA flash cards are expected to grow another 69.8%, to 835,400 units, while revenues climb 71.8% to $137.1 million. However, the expected explosion in demand does not seem to be happening, at least partly because many industrial customers are opting for less expensive nonremovable cards that are not PC Card compliant, or are only partially compliant. The PDA boom seems as far away as ever, with only nominal growth currently under way. As a result, shipments will grow at a moderate rate to exceed 2.7 million units in 1998, while revenues are expected to reach nearly $379 million. Initial shipments of flash cards with capacities exceeding 100 megabytes are beginning in 1995.

Flash cards with capacities under 10 megabytes are expected to account for 56.2% of unit shipments in 1998, about 1.6 million units. Cards in the 10 to 25 megabyte category are projected to capture 32.4% (about 900,000 units), while the 25 to 100 megabyte category will obtain a 10.4% share, or about 290,000 units. The more than 100 megabyte category is expected to garner a 1% share in 1998 due to its relatively high unit cost.

Flash memory card shipments will continue to predominate over flash disk shipments in the under 10 megabyte category throughout the forecast period. However, flash disk will be the dominant product type in the higher capacity categories, primarily because of its role as auxiliary storage and data transfer vehicle for mobile general purpose computers.

Captive shipments, beginning in 1995, are expected to remain a relatively small part of the distribution mix, accounting for only 2% of 1998's 2.78 million shipments. And weak PDA sales will inhibit the PCM/Reseller channel from overtaking the OEM/Integrator channel, as aftermarket sales will suffer from the less than anticipated number of mobile systems in use.

1998 OEM prices for flash cards in the less than 10 megabyte category are expected to decline to the $13/megabyte range, and to the $3/megabyte to $7/megabyte range for flash cards with capacities above 100 megabytes (approximately equivalent to twelve times the expected OEM price per megabyte of a 200 megabyte PCMCIA rigid disk drive at that time).

Technical trends

The most visible product trends anticipated for PCMCIA flash cards involve improvements in capacity, performance and cost per megabyte. Changes in packaging are restricted by PC Card standard dimensions, but in applications where interchange between differing brands of equipment is not required, alternative packaging is being used.

Capacity: Capacity is primarily a function of chip density. A shift from 8 megabit chips to 16 megabit chips is well under way, with both 32 megabit and 64 megabit chip availability anticipated within the forecast period. Some firms have set 1997 as a goal for introduction of 256 megabit chips. SanDisk has begun shipping flash disks with over 100 megabyte capacities, and several companies have indicated their intention to introduce 32 megabit chips into flash memory cards during 1995. Multilevel flash memory, where each cell can store 2 or more bits, is still in the early stages of development, and while not explicitly assumed to be available during the forecast period, could produce significant reductions in cost per bit for flash memory.

Performance: Performance gains are expected from a wider data transfer bus between the flash card and the host system, plus some gains from improved device geometries. However, some techniques that promise to increase capacity, such as multibit storage per memory cell, appear to have associated performance penalties. Performance of flash memory cards in some applications may be limited by a property of flash file software systems that causes a lengthening of the average seek time after a large number of data rewrites, a characteristic that is avoided in flash disk cards.

Compatibility: Interchange compatibility for PC Card flash memory is still an issue, but is expected to become less significant in the future as the PC Card standard is expanded and clarified and older equipment is retired and replaced. Future systems are also expected to embed drivers for flash memory card support within the BIOS of the host system, providing additional standardization of the interface between card and host system. PC Card flash models capable of operating with multiple voltages will also help eliminate compatibility problems. The industry appears to be on the verge of moving to cards capable of operating with either 5 volt or 3.3 volt power.

Power reduction: Intelligent flash card controllers are capable of reducing card power consumption by putting the card into a sleep mode when data is not being transferred. Certain technologies also appear to be inherently less power intensive, and will probably be preferred for mobile computing applications, even at a slight cost premium.

Competing Products: Where small capacities are adequate or use in a hostile environment is necessary, flash memory technology is only weakly challenged by other storage products. SRAM is more expensive and needs a backup battery, DRAM is nonvolatile and becoming less price competitive, and ferroelectric memory is still several product generations away from becoming an effective competitor. Small disk drives remain the primary competition to flash cards, for their low cost per megabyte and rapidly increasing capacities are unlikely to be matched by flash memory in any form until after the end of the decade, except for capacities under 100 megabytes, an area already abandoned by rigid drives.

Forecasting assumptions

1. Captive shipments of PCMCIA flash cards will begin in 1995.
2. Shipments of PCMCIA flash cards using 32 megabit chips will begin in late 1995.
3. During the forecast period, no technological breakthroughs are anticipated that will drastically alter the ability of flash memory to compete against other products. Multilevel flash memory is not anticipated within the forecast period.

TABLE 9

CONSOLIDATED WORLDWIDE REVENUES

PCMCIA FLASH CARDS

REVENUE SUMMARY

	FLASH MEMORY CARD REVENUES, BY SHIPMENT DESTINATION (M$)									
	1994 Revenues		Forecast 1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	--	--	1.1	1.6	1.9	3.1	2.7	4.3
PCM/Reseller	13.3	18.0	23.5	36.3	38.9	60.7	47.2	73.9	54.1	86.1
OEM/Integrator	32.3	50.5	46.9	75.1	68.5	108.8	87.0	142.5	95.3	157.5
TOTAL U.S. REVENUES	45.6	68.5	70.4	111.4	108.5	171.1	136.1	219.5	152.1	247.9
Non-U.S. Manufacturers										
Captive	--	--	.2	.8	.5	1.6	.6	1.8	1.3	2.9
PCM/Reseller	2.8	3.5	4.8	6.4	11.5	17.4	15.0	23.4	21.8	40.0
OEM/Integrator	3.5	7.8	9.9	18.5	21.9	39.2	35.5	64.0	48.8	88.1
TOTAL NON-U.S. REVENUES	6.3	11.3	14.9	25.7	33.9	58.2	51.1	89.2	71.9	131.0
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	51.9	79.8	85.3	137.1	142.4	229.3	187.2	308.7	224.0	378.9

TABLE 10

CONSOLIDATED WORLDWIDE SHIPMENTS

PCMCIA FLASH CARDS

SHIPMENT SUMMARY

	FLASH MEMORY CARD SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1994 Shipments		Forecast							
			1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	--	--	4.0	6.0	7.3	11.6	10.5	17.1
PCM/Reseller	87.3	113.6	149.7	217.3	244.7	370.4	329.2	500.7	446.0	674.4
OEM/Integrator	185.6	267.8	269.4	402.7	381.0	594.4	536.5	852.6	716.5	1,130.2
TOTAL U.S. SHIPMENTS	272.9	381.4	419.1	620.0	629.7	970.8	873.0	1,364.9	1,173.0	1,821.7
Non-U.S. Manufacturers										
Captive	--	--	5.0	20.0	8.3	28.7	10.6	33.4	13.5	39.0
PCM/Reseller	23.2	31.1	36.8	49.5	62.9	90.9	78.5	120.1	124.2	233.1
OEM/Integrator	37.2	79.4	76.0	145.9	138.8	257.1	237.4	446.9	365.1	686.7
TOTAL NON-U.S. SHIPMENTS	60.4	110.5	117.8	215.4	210.0	376.7	326.5	600.4	502.8	958.8
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	333.3	491.9	536.9	835.4	839.7	1,347.5	1,199.5	1,965.3	1,675.8	2,780.5

TABLE 11

CONSOLIDATED WORLDWIDE REVENUES
PCMCIA FLASH CARDS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES ALL MANUFACTURERS	1994 Revenues $M	1994 Revenues %	Forecast 1995 $M	1995 %	1996 $M	1996 %	1997 $M	1997 %	1998 $M	1998 %
PCMCIA FLASH CARDS	44.6	55.9%	59.0	43.0%	79.8	34.8%	93.9	30.4%	104.1	27.5%
Less than 10 Megabytes	+30.0%		+32.3%		+35.3%		+17.7%		+10.9%	
PCMCIA FLASH CARDS	31.2	39.1%	60.4	44.1%	99.0	43.2%	134.8	43.7%	162.8	43.0%
10 - 25 Megabytes	+188.9%		+93.6%		+63.9%		+36.2%		+20.8%	
PCMCIA FLASH CARDS	4.0	5.0%	16.7	12.2%	45.6	19.9%	66.3	21.5%	83.5	22.0%
25 - 100 Megabytes	--		+317.5%		+173.1%		+45.4%		+25.9%	
PCMCIA FLASH CARDS	--	--	1.0	.7%	4.9	2.1%	13.7	4.4%	28.5	7.5%
More than 100 Megabytes	--		--		+390.0%		+179.6%		+108.0%	
Total Worldwide Revenue	79.8	100.0%	137.1	100.0%	229.3	100.0%	308.7	100.0%	378.9	100.0%
	+76.2%		+71.8%		+67.3%		+34.6%		+22.7%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

TABLE 12

CONSOLIDATED WORLDWIDE SHIPMENTS
PCMCIA FLASH CARDS
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS IN THOUSANDS	1994 Shipments Units	1994 Shipments %	Forecast 1995 Units	1995 %	1996 Units	1996 %	1997 Units	1997 %	1998 Units	1998 %
PCMCIA FLASH CARDS	402.5	81.9%	610.3	73.1%	863.0	64.0%	1,165.9	59.3%	1,563.0	56.2%
Less than 10 Megabytes	+85.8%		+51.6%		+41.4%		+35.1%		+34.1%	
PCMCIA FLASH CARDS	84.9	17.3%	201.8	24.2%	393.8	29.2%	614.2	31.3%	900.1	32.4%
10 - 25 Megabytes	+173.9%		+137.7%		+95.1%		+56.0%		+46.5%	
PCMCIA FLASH CARDS	4.5	.8%	22.8	2.7%	87.4	6.5%	174.6	8.9%	290.2	10.4%
25 - 100 Megabytes	--		+406.7%		+283.3%		+99.8%		+66.2%	
PCMCIA FLASH CARDS	--	--	.5	--	3.3	.2%	10.6	.5%	27.2	1.0%
More than 100 Megabytes	--		--		+560.0%		+221.2%		+156.6%	
Total Worldwide Shipments	491.9	100.0%	835.4	100.0%	1,347.5	100.0%	1,965.3	100.0%	2,780.5	100.0%
	+98.5%		+69.8%		+61.3%		+45.8%		+41.5%	
% U.S. Manufacturers	77.5%		74.2%		72.0%		69.4%		65.5%	
Total Capacity (Terabytes)	2.4		5.6		12.2		21.8		39.0	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

TABLE 13

PCMCIA FLASH CARDS, LESS THAN 10 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY PRODUCT TYPE

	1994 Shipments		Forecast 1995		1996		1997		1998	
	F. Disk	F. Mem.	F. Disk	F. Mem.	F. Disk	F. Mem.	F. Disk	F. Mem.	F. Disk	F. Mem.
U.S. MANUFACTURERS										
Captive	--	--	--	--	--	3.0	--	5.0	--	7.0
PCM/Reseller	8.2	88.9	23.9	136.4	38.4	202.1	50.9	256.5	53.7	346.9
OEM/Integrator	69.1	131.8	83.6	174.1	103.6	216.5	116.8	293.4	114.7	385.9
TOTAL U.S. SHIPMENTS	77.3	220.7	107.5	310.5	142.0	421.6	167.7	554.9	168.4	739.8
NON-U.S. MANUFACTURERS										
Captive	--	--	--	20.0	--	28.0	--	32.0	--	36.0
PCM/Reseller	--	29.3	2.0	40.3	8.0	57.7	7.8	64.4	14.8	106.2
OEM/Integrator	--	75.2	8.0	122.0	16.0	189.7	17.3	321.8	20.8	477.0
TOTAL NON-U.S. SHIPMENTS	--	104.5	10.0	182.3	24.0	275.4	25.1	418.2	35.6	619.2
WORLDWIDE RECAP										
Captive	--	--	--	20.0	--	31.0	--	37.0	--	43.0
	--	--	--	--	--	+55.0%	--	+19.4%	--	+16.2%
PCM/Reseller	8.2	118.2	25.9	176.7	46.4	259.8	58.7	320.9	68.5	453.1
	+39.0%	+85.3%	+215.9%	+49.5%	+79.2%	+47.0%	+26.5%	+23.5%	+16.7%	+41.2%
OEM/Integrator	69.1	207.0	91.6	296.1	119.6	406.2	134.1	615.2	135.5	862.9
	+166.8%	+71.1%	+32.6%	+43.0%	+30.6%	+37.2%	+12.1%	+51.5%	+1.0%	+40.3%
Total Shipments	77.3	325.2	117.5	492.8	166.0	697.0	192.8	973.1	204.0	1,359.0
	+143.1%	+76.0%	+52.0%	+51.5%	+41.3%	+41.4%	+16.1%	+39.6%	+5.8%	+39.7%
ANNUAL SHARE, BY TYPE	19.2%	80.8%	19.3%	80.7%	19.2%	80.8%	16.5%	83.5%	13.1%	86.9%
TOTAL CAPACITY (Terabytes)	.3	.7	.5	1.3	.8	2.7	1.1	3.8	1.5	6.6

TABLE 14

PCMCIA FLASH CARDS, LESS THAN 10 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

PRODUCT TYPE	1994	Forecast 1995	1996	1997	1998
Captive					
Flash disk	--	--	--	--	--
Flash memory	--	42.00	27.28	21.33	16.66
Captive Average	--	42.00	27.28	21.33	16.66
PCM/Reseller					
Flash disk	34.71	24.83	20.51	15.52	10.67
Flash memory	42.41	34.61	24.08	20.80	13.46
PCM/Reseller Average	41.52	32.59	23.43	19.69	12.95
OEM/Integrator					
Flash disk	31.19	22.96	19.83	14.79	10.09
Flash memory	41.17	32.98	22.85	20.03	13.10
OEM/Integrator Average	37.05	29.40	22.04	18.78	12.53

Note: Price per megabyte calculations represent estimated total sales revenues for each product type divided by the total yearly shipped capacity of all cards of that type.

TABLE 15

PCMCIA FLASH CARDS, 10 - 25 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1994 Shipments		Forecast 1995		Forecast 1996		Forecast 1997		Forecast 1998	
	F. Disk	F. Mem.	F. Disk	F. Mem.	F. Disk	F. Mem.	F. Disk	F. Mem.	F. Disk	F. Mem.
U.S. MANUFACTURERS										
Captive	--	--	--	--	2.7	--	6.1	--	9.2	--
PCM/Reseller	8.2	7.5	32.1	19.8	59.6	53.0	81.0	84.0	102.6	111.0
OEM/Integrator	53.2	10.0	116.1	13.0	211.0	18.0	318.0	36.0	448.0	54.0
TOTAL U.S. SHIPMENTS	61.4	17.5	148.2	32.8	273.3	71.0	405.1	120.0	559.8	165.0
NON-U.S. MANUFACTURERS										
Captive	--	--	--	--	.5	--	1.1	--	2.3	--
PCM/Reseller	--	1.8	.4	6.1	4.0	10.0	8.0	16.0	16.0	49.0
OEM/Integrator	--	4.2	2.0	12.3	12.0	23.0	28.0	36.0	48.0	60.0
TOTAL NON-U.S. SHIPMENTS	--	6.0	2.4	18.4	16.5	33.0	37.1	52.0	66.3	109.0
WORLDWIDE RECAP										
Captive	--	--	--	--	3.2	--	7.2	--	11.5	--
	--	--	--	--	--	--	+125.0%	--	+59.7%	--
PCM/Reseller	8.2	9.3	32.5	25.9	63.6	63.0	89.0	100.0	118.6	160.0
	+46.4%	+132.5%	+296.3%	+178.5%	+95.7%	+143.2%	+39.9%	+58.7%	+33.3%	+60.0%
OEM/Integrator	53.2	14.2	118.1	25.3	223.0	41.0	346.0	72.0	496.0	114.0
	+297.0%	+77.5%	+122.0%	+78.2%	+88.8%	+62.1%	+55.2%	+75.6%	+43.4%	+58.3%
Total Shipments	61.4	23.5	150.6	51.2	289.8	104.0	442.2	172.0	626.1	274.0
	+223.2%	+95.8%	+145.3%	+117.9%	+92.4%	+103.1%	+52.6%	+65.4%	+41.6%	+59.3%
ANNUAL SHARE, BY TYPE	72.4%	27.6%	74.7%	25.3%	73.7%	26.3%	72.1%	27.9%	69.7%	30.3%
TOTAL CAPACITY (Terabytes)	.8	.2	2.1	.6	4.3	1.1	7.5	2.2	12.5	4.1

TABLE 16

PCMCIA FLASH CARDS, 10 - 25 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

PRODUCT TYPE	1994	Forecast 1995	1996	1997	1998
Captive					
Flash disk	--	--	26.93	20.38	18.00
Flash memory	--	--	--	--	--
Captive Average	--	--	26.93	20.38	18.00
PCM/Reseller					
Flash disk	30.99	21.87	18.65	14.21	9.84
Flash memory	33.22	22.92	20.32	15.01	11.12
PCM/Reseller Average	32.08	22.30	19.35	14.58	10.49
OEM/Integrator					
Flash disk	27.82	20.87	16.77	13.07	9.14
Flash memory	25.75	24.54	21.16	15.00	10.35
OEM/Integrator Average	27.44	21.43	17.29	13.33	9.32

Note: Price per megabyte calculations represent estimated total sales revenues for each product type divided by the total yearly shipped capacity of all cards of that type.

TABLE 17

PCMCIA FLASH CARDS, 25 - 100 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1994 Shipments		Forecast 1995		Forecast 1996		Forecast 1997		Forecast 1998	
	F. Disk	F. Mem.	F. Disk	F. Mem.	F. Disk	F. Mem.	F. Disk	F. Mem.	F. Disk	F. Mem.
U.S. MANUFACTURERS										
Captive	--	--	--	--	.3	--	.5	--	.7	--
PCM/Reseller	.4	.4	2.6	2.4	7.0	9.5	11.1	14.4	28.2	24.8
OEM/Integrator	3.1	.6	13.1	2.4	32.4	11.7	59.8	24.6	75.2	42.0
TOTAL U.S. SHIPMENTS	3.5	1.0	15.7	4.8	39.7	21.2	71.4	39.0	104.1	66.8
NON-U.S. MANUFACTURERS										
Captive	--	--	--	--	.2	--	.3	--	.5	--
PCM/Reseller	--	--	.4	.3	8.4	2.2	17.0	5.3	30.9	12.5
OEM/Integrator	--	--	1.2	.4	12.0	3.7	29.4	12.2	51.3	24.1
TOTAL NON-U.S. SHIPMENTS	--	--	1.6	.7	20.6	5.9	46.7	17.5	82.7	36.6
WORLDWIDE RECAP										
Captive	--	--	--	--	.5	--	.8	--	1.2	--
	--	--	--	--	--	--	+60.0%	--	+50.0%	--
PCM/Reseller	.4	.4	3.0	2.7	15.4	11.7	28.1	19.7	59.1	37.3
	--	+100.0%	+650.0%	+575.0%	+413.3%	+333.3%	+82.5%	+68.4%	+110.3%	+89.3%
OEM/Integrator	3.1	.6	14.3	2.8	44.4	15.4	89.2	36.8	126.5	66.1
	--	--	+361.3%	+366.7%	+210.5%	+450.0%	+100.9%	+139.0%	+41.8%	+79.6%
Total Shipments	3.5	1.0	17.3	5.5	60.3	27.1	118.1	56.5	186.8	103.4
	--	+400.0%	+394.3%	+450.0%	+248.6%	+392.7%	+95.9%	+108.5%	+58.2%	+83.0%
ANNUAL SHARE, BY TYPE	77.9%	22.1%	76.0%	24.0%	69.1%	30.9%	67.7%	32.3%	64.5%	35.5%
TOTAL CAPACITY (Terabytes)	.1	--	.6	.2	1.9	.9	3.7	2.0	6.7	3.5

TABLE 18

PCMCIA FLASH CARDS, 25 - 100 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

PRODUCT TYPE	1994	Forecast 1995	Forecast 1996	Forecast 1997	Forecast 1998
Captive					
Flash disk	--	--	23.77	18.75	14.09
Flash memory	--	--	--	--	--
Captive Average	--	--	23.77	18.75	14.09
PCM/Reseller					
Flash disk	28.28	21.94	17.21	13.00	9.04
Flash memory	21.25	18.04	14.90	9.46	8.04
PCM/Reseller Average	24.53	19.96	16.17	11.43	8.69
OEM/Integrator					
Flash disk	25.10	19.99	16.50	12.18	8.28
Flash memory	20.00	17.85	14.00	9.07	6.79
OEM/Integrator Average	24.20	19.62	15.84	11.19	7.77

Note: Price per megabyte calculations represent estimated total sales revenues for each product type divided by the total yearly shipped capacity of all cards of that type.

TABLE 19

PCMCIA FLASH CARDS, MORE THAN 100 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1994 Shipments All Dia.	Forecast --1995-- Fl.Mem.	-1996- Fl. Disk	-1996- Fl.Mem.	-1997- Fl. Disk	-1997- Fl.Mem.	-1998- Fl. Disk	-1998- Fl.Mem.
U.S. MANUFACTURERS								
Captive	--	--	--	--	--	--	.2	--
PCM/Reseller	--	.1	.6	.2	2.5	.3	6.5	.7
OEM/Integrator	--	.4	1.0	.2	3.7	.3	9.5	.9
TOTAL U.S. SHIPMENTS	--	.5	1.6	.4	6.2	.6	16.2	1.6
NON-U.S. MANUFACTURERS								
Captive	--	--	--	--	--	--	.2	--
PCM/Reseller	--	--	.4	.2	1.2	.4	2.8	.9
OEM/Integrator	--	--	.5	.2	1.8	.4	4.6	.9
TOTAL NON-U.S. SHIPMENTS	--	--	.9	.4	3.0	.8	7.6	1.8
WORLDWIDE RECAP								
Captive	--	--	--	--	--	--	.4	--
	--	--	--	--	--	--	--	--
PCM/Reseller	--	.1	1.0	.4	3.7	.7	9.3	1.6
	--	--	--	+300.0%	+270.0%	+75.0%	+151.4%	+128.6%
OEM/Integrator	--	.4	1.5	.4	5.5	.7	14.1	1.8
	--	--	--	--	+266.7%	+75.0%	+156.4%	+157.1%
Total Shipments	--	.5	2.5	.8	9.2	1.4	23.8	3.4
	--	--	--	+60.0%	+268.0%	+75.0%	+158.7%	+142.9%
ANNUAL SHARE, BY TYPE	--	100.0%	75.9%	24.1%	86.9%	13.1%	87.6%	12.4%
TOTAL CAPACITY (Terabytes)	--	--	.2	--	1.2	.1	3.5	.3

TABLE 20

PCMCIA FLASH CARDS, MORE THAN 100 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

PRODUCT TYPE	1994	1995 (Forecast)	1996 (Forecast)	1997 (Forecast)	1998 (Forecast)
Captive					
Flash disk	--	--	--	--	12.69
Flash memory	--	--	--	--	--
Captive Average	--	--	--	--	12.69
PCM/Reseller					
Flash disk	--	--	14.72	10.89	7.54
Flash memory	--	--	9.50	5.71	3.63
PCM/Reseller Average	--	--	13.33	10.20	7.10
OEM/Integrator					
Flash disk	--	--	13.93	10.38	7.44
Flash memory	--	--	9.75	5.51	3.54
OEM/Integrator Average	--	--	13.12	9.93	7.10

Note: Price per megabyte calculations represent estimated total sales revenues for each product type divided by the total yearly shipped capacity of all cards of that type.

TABLE 21

PCMCIA FLASH CARDS

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive PCMCIA Cards

	1994 Net Shipments							
	To United States Destinations				Worldwide			
	Units (000)			%	Units (000)			%
Card Manufacturers	F.Disk	F.Mem.	Total		F.Disk	F.Mem.	Total	
Intel	3.0	113.9	116.9	35.2	1.3	122.0	123.3	26.2
SanDisk	66.7	--	66.7	20.1	121.5	--	121.5	25.7
Kingmax	--	23.3	23.3	7.0	--	38.3	38.3	8.1
AMP	--	29.2	29.2	8.8	--	32.8	32.8	6.9
Seiko Epson	--	19.5	19.5	5.9	--	30.9	30.9	6.5
Other U.S.	8.8	51.5	60.3	18.1	17.0	68.2	85.2	18.0
Other Non-U.S.	--	16.3	16.3	4.9	--	40.5	40.5	8.6
TOTAL	78.5	253.7	332.2	100.0	139.8	332.7	472.5	100.0

PCMCIA RIGID DISK DRIVES

PCMCIA RIGID DISK DRIVES

Coverage

Examples of disk drives in this group include:

PCMCIA rigid disk drives, less than 100 megabytes

Calluna Technology	CT-80MC

PCMCIA rigid disk drives, 100 - 200 megabytes

Calluna Technology	CT-105MC, CT-130MC, CT-170
Integral Peripherals	8105PA, 8170PA, PocketFile 170

PCMCIA rigid disk drives, 200 - 300 megabytes

Calluna Technology	CT-260
Integral Peripherals	8260PA

PCMCIA rigid disk drives, 300 - 500 megabytes

Integral Peripherals	8340PA

The 1.8" rigid disk drives included in this section are packaged in removable card form, and all of the drives currently listed conform to the PCMCIA Type III PC Card specification, which defines allowable card dimensions and connectors. Other 1.8" disk drives which do not meet PCMCIA Type III specifications, usually because the PC Card height limitation of 10.5 millimeters is exceeded, or because they are not offered in removable card form, are included in the separate 1995 DISK/TREND Report on rigid disk drives.

The first 1.8" disk drive was shipped by Integral Peripherals in mid-1991, a 21 megabyte drive which was not designed to meet the PCMCIA standard for removable Type III cards. The earliest shipments of PCMCIA Type III rigid disk drives were made in late 1992 by Integral Peripherals. The effective start for volume production of Type III drives was in the second half of 1993 for most manufacturers, including those no longer active. Most of the drives produced to date have been used in Japanese word processors, factory data collection, dedicated application pen-based computers and other specialized applications. The expected growth in PC Card drive shipments for "personal digital assistants" and notebook computers has proven to be of minor importance so far to the growth of this product group, with the result that several of the drive manufacturers participating in the 1.8" disk drive market last year have turned their attention to other product lines, and one company, MiniStor Peripherals, has gone out of business.

The above drives have been divided into groups, depending on each drive's capacity. The statistical data on drive shipments and sales revenues has also been arranged by the same groups, which correspond to the product groups used in the DISK/TREND Report on rigid disk drives. All drives have been assigned to groups by "native" formatted capacity. Announcements of drives with native capacities over 500 megabytes are expected in 1996.

Market status

The level of sales success achieved by the manufacturers of drives in this product group is significantly below the forecasts made in previous years. The largest problem has been that the expected market with subnotebook computers has been much smaller than expected, due to the slow rate of progress computer manufacturers have experienced in reducing the size and weight of notebook computers, combined with the fact that PC Card drives have tended to offer capacities which have not kept up with the levels demanded for new notebook computers, and that PC Card drive prices are higher than 2.5" drives of equivalent capacities. The manufacturers also found a disappointingly small demand for PC Card drives for use with PDA's and portable cellular phone communicators, since the market for both types of devices turned out to be negligible compared to the industry's expectations.

However, despite the fact that the available market has been smaller than expected, shipments of 1.8" PC Card drives are definitely on a growth trend. Total unit shipments in 1994 were 156,100 drives, up 66.2%, and worldwide shipments of 319,000 units are projected for 1995, an increase of 104.4%. Worldwide sales revenues were $35.4 million in 1994, with $71.5 million forecasted for 1995, a 102.0% increase.

The strong point for shipments in this group has been the availability of drives with capacities over 100 megabytes, starting with 105 megabyte drives from four manufacturers in late 1994, supplemented by 130 and 170 megabyte models in mid-1994. Although PCMCIA Type III slots are now available on the majority of new notebook computers being offered by major system manufacturers, most system manufacturers are still relying on internally mounted 2.5" drives as the basic notebook computer disk. PC Card drives have found a major data storage role with a limited number of notebook computer models from only a few system manufacturers. Most of the current generation of PC Card drives are sold on an OEM basis to those computer system manufacturers, plus a variety of manufacturers of pen-based computers, electronic typewriters, security applications and other specialized applications.

The leader in 1994 noncaptive shipments of PC Card drives was Maxtor, which has been closing out its 1.8" drive program in 1995, after experiencing total sales significantly below its marketing plan's objective. Maxtor shipped 46.8% of the 1994 noncaptive worldwide unit shipments. Integral Peripherals held second position with 34.9% of the total.

Marketing trends

In recognition of the sales experience to date for this product group, and with the less aggressive pattern of reduction in size and weight for notebook computers which now appears likely, the DISK/TREND Report sales forecast for PC Card drives have been lowered. 990,000 PC Card drives are projected for shipment in 1998, representing an average annual increase of 47.5% during the 1996-98 period. 1998 sales revenues are forecasted at $160.7 million, an average annual increase of 34.8% during the same period. Although the product mix is expected to move up to drives with higher capacities, average prices will decline rapidly, holding down the increase in revenues.

By the end of this forecast period, PC Cards with capacities in the 300-500 megabyte range will be the leaders in shipment volume, and drives with capacities over 500 megabytes will be growing rapidly in shipments. Despite the modest size of the current notebook computer market for PC Card drives, there is an inevitable trend toward smaller and lighter weight notebook computers, as progress in screen and battery technology makes it possible. These improvements are expected to be gradual, and growth in the market for PC Card drives in this application is also expected to be gradual. It is to be expected that 1.8" drives will always be higher in cost than 2.5" drives of the same capacity, but the higher capacity PC Card drives are expected to find usage with the new generations of subnotebook computers despite somewhat higher sale prices, because they will be needed to conform to the space available in the smallest notebook computers.

The first announcement of a Type II disk drive, adhering to the PCMCIA specification for PC Cards with 5 millimeter height, was announced by Maxtor, but was never delivered. It is clear that there are many more Type II than Type III slots available on notebook computers, and that the latent sales opportunity for Type II rigid disk drives will be increasing each year, providing that disk capacities increase to appropriate levels.

Type II cards are expected to utilize only a single 1.8" disk because of size constraints, and the capacity available will be severely limited during the current period. However, the disk drive industry's areal densities are increasing very rapidly, and within a few years, it will be possible to produce Type II PC Card drives with 200 to 300 megabytes capacity. DISK/TREND Report forecasts do not differentiate between drives in the two card thicknesses, but it is clear that availability of Type II drives in the range of 100 to 300 megabytes could keep overall drive shipments in those capacity groups at a higher level than otherwise would be expected, due to a wider market and lower prices than available for Type III drives. It should be noted that it is not clear when the drive manufacturers remaining in the 1.8" field will design and ship Type II drives.

Higher shipments, wider competition and increasing drive capacities will force a continuing decline in average price per megabyte. The overall average OEM/Integrator price/megabyte has already declined sharply with the increasing sales volume, but more is easily predictable as shipments increase and capacities go up. By 1998, the best OEM price/megabyte for PC Card drives is forecasted at 33 cents.

Technical trends

The effects of the two major areas of technical change expected for this group have been included in the current forecasts and discussed above -- increasing capacity and the expected availability of rigid disk drives in the PCMCIA Type II form factor.

During the rest of this decade it is expected that the rigid disk drive industry will continue to increase areal density by about 60% per year. Critical to this rate of increase is the ability to create smoother disks, recording heads which can utilize narrower tracks, more magnetic flux reversals per linear inch, and development of semiconductors which can process much faster data transfer rates. Although major improvements must be made every year, it appears very likely that the annual 60% improvement will be achieved during the 1995-98 time frame covered by this report. By 1998, leading edge rigid disk drives will be recording data at more than 3.5 gigabits per square inch, and the drives manufactured at very high production levels, such as the typical 1998 PCMCIA disk drives in this group, will utilize areal densities above 1.5 gigabits per square inch.

Disk drive manufacturers face many interesting problems in establishing initial production of 5 millimeter high PCMCIA Type II drives, which will typically use one disk and two heads. The mechanical engineering challenges are obviously formidable. However, the biggest short-term problem will probably be to establish volume production for critical new components such as drive and head positioning motors, head assemblies and the special packaging required for semiconductors. None of the engineering problems are impossible and many have already been solved by drive manufacturers doing preliminary work on Type II drives. However, establishing high volume manufacturing capability for the new components required involves many additional suppliers, and the early growth ramp for Type II drive shipments will be difficult to predict with accuracy.

Forecasting assumptions

1. Shipments of PCMCIA rigid disk drives with native capacities in the 500 megabyte - 1 gigabyte group will start in 1997.
2. If shipments of rigid disk drives meeting the PCMCIA Type II standard, using cards 5 millimeters high, start during the 1996-98 period, the overall shipments of PC Card drives will not be significantly affected.
3. Shipments of notebook computers will continually increase, but average weight and size will gradually decrease, providing only a gradual increase in the demand for PC Card rigid disk drives.

TABLE 22

CONSOLIDATED WORLDWIDE REVENUES

PCMCIA RIGID DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1994 Revenues		Forecast							
			1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	3.5	5.2	1.7	3.2	16.6	20.2	20.8	27.2	22.1	31.9
OEM/Integrator	20.4	28.9	37.9	64.6	69.0	96.7	68.7	98.1	74.5	107.6
TOTAL U.S. REVENUES	23.9	34.1	39.6	67.8	85.6	116.9	89.5	125.3	96.6	139.5
Non-U.S. Manufacturers										
PCM/Reseller	--	.7	--	.9	2.2	3.6	4.1	6.6	5.4	8.3
OEM/Integrator	.5	.6	2.3	2.8	7.4	10.0	8.0	13.0	8.2	12.9
TOTAL NON-U.S. REVENUES	.5	1.3	2.3	3.7	9.6	13.6	12.1	19.6	13.6	21.2
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	24.4	35.4	41.9	71.5	95.2	130.5	101.6	144.9	110.2	160.7

TABLE 23

CONSOLIDATED WORLDWIDE SHIPMENTS

PCMCIA RIGID DISK DRIVES

SHIPMENT SUMMARY

	DISK DRIVE SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1994		Forecast							
	Shipments		1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	15.0	22.0	9.0	17.0	70.0	85.0	110.0	145.0	142.0	205.0
OEM/Integrator	93.5	129.5	164.0	286.0	303.0	425.0	375.0	535.0	450.0	655.0
TOTAL U.S. SHIPMENTS	108.5	151.5	173.0	303.0	373.0	510.0	485.0	680.0	592.0	860.0
Non-U.S. Manufacturers										
PCM/Reseller	--	2.3	--	4.0	9.0	15.0	22.0	35.0	32.0	50.0
OEM/Integrator	2.0	2.3	10.0	12.0	33.0	45.0	43.0	70.0	50.0	80.0
TOTAL NON-U.S. SHIPMENTS	2.0	4.6	10.0	16.0	42.0	60.0	65.0	105.0	82.0	130.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	110.5	156.1	183.0	319.0	415.0	570.0	550.0	785.0	674.0	990.0

TABLE 24

CONSOLIDATED WORLDWIDE REVENUES
PCMCIA RIGID DISK DRIVES
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES ALL MANUFACTURERS	1994 Revenues $M	1994 Revenues %	Forecast 1995 $M	Forecast 1995 %	Forecast 1996 $M	Forecast 1996 %	Forecast 1997 $M	Forecast 1997 %	Forecast 1998 $M	Forecast 1998 %
PCMCIA DISK DRIVES Less than 100 Megabytes	4.6 -77.6%	13.0%	3.2 -30.4%	4.5%	.6 -81.2%	.5%	-- -100.0%	--	-- --	--
PCMCIA DISK DRIVES 100 - 200 Megabytes	30.5 --	86.3%	34.7 +13.8%	48.5%	5.3 -84.7%	4.1%	-- -100.0%	--	-- --	--
PCMCIA DISK DRIVES 200 - 300 Megabytes	.3 --	.7%	21.6 --	30.2%	33.1 +53.2%	25.4%	36.6 +10.6%	25.3%	23.2 -36.6%	14.4%
PCMCIA DISK DRIVES 300 - 500 Megabytes	-- --	--	12.0 --	16.8%	91.5 +662.5%	70.0%	101.0 +10.4%	69.7%	89.6 -11.3%	55.8%
PCMCIA DISK DRIVES 500 Megabytes - 1 Gigabyte	-- --	--	-- --	--	-- --	--	7.3 --	5.0%	47.9 +556.2%	29.8%
Total Worldwide Revenue	35.4 +63.1%	100.0%	71.5 +102.0%	100.0%	130.5 +82.5%	100.0%	144.9 +11.0%	100.0%	160.7 +10.9%	100.0%

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

TABLE 25

CONSOLIDATED WORLDWIDE SHIPMENTS
PCMCIA RIGID DISK DRIVES
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS IN THOUSANDS	1994 Shipments		Forecast 1995		Forecast 1996		Forecast 1997		Forecast 1998	
	Units	%	Units	%	Units	%	Units	%	Units	%
PCMCIA DISK DRIVES	20.6	13.2%	20.0	6.3%	5.0	.9%	--	--	--	--
Less than 100 Megabytes	-77.2%		-2.9%		-75.0%		-100.0%		--	
PCMCIA DISK DRIVES	134.5	86.3%	169.0	53.0%	25.0	4.4%	--	--	--	--
100 - 200 Megabytes	--		+25.7%		-85.2%		-100.0%		--	
PCMCIA DISK DRIVES	1.0	.5%	90.0	28.2%	170.0	29.8%	235.0	29.9%	185.0	18.7%
200 - 300 Megabytes	--		--		+88.9%		+38.2%		-21.3%	
PCMCIA DISK DRIVES	--	--	40.0	12.5%	370.0	64.9%	520.0	66.2%	565.0	57.1%
300 - 500 Megabytes	--		--		+825.0%		+40.5%		+8.7%	
PCMCIA DISK DRIVES	--	--	--	--	--	--	30.0	3.8%	240.0	24.2%
500 Megabytes - 1 Gigabyte	--		--		--		--		+700.0%	
Total Worldwide Shipments	156.1	100.0%	319.0	100.0%	570.0	100.0%	785.0	100.0%	990.0	100.0%
	+66.2%		+104.4%		+78.7%		+37.7%		+26.1%	
% U.S. Manufacturers	97.0%		94.9%		89.4%		86.6%		86.8%	
Total Capacity (Terabytes)	19.4		73.6		173.1		269.0		417.8	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

TABLE 26

PCMCIA RIGID DISK DRIVES, LESS THAN 100 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1994 Shipments		Forecast 1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	2.0	4.0	5.0	10.0	--	--	--	--	--	--
OEM/Integrator	12.0	16.0	5.0	10.0	3.0	5.0	--	--	--	--
TOTAL U.S. SHIPMENTS	14.0	20.0	10.0	20.0	3.0	5.0	--	--	--	--
Non-U.S. Manufacturers										
PCM/Reseller	--	.3	--	--	--	--	--	--	--	--
OEM/Integrator	--	.3	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	--	.6	--	--	--	--	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	14.0	20.6	10.0	20.0	3.0	5.0	--	--	--	--
Total Capacity (Terabytes)	.8	1.1	.4	.8	.2	.4	--	--	--	--
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	54.3	111.4	64.3	131.4	67.3	136.4	67.3	136.4	67.3	136.4

TABLE 27

PCMCIA RIGID DISK DRIVES, 100 - 200 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1994 Shipments		Forecast							
			1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	13.0	18.0	4.0	7.0	--	--	--	--	--	--
OEM/Integrator	80.5	112.5	59.0	146.0	5.0	15.0	--	--	--	--
TOTAL U.S. SHIPMENTS	93.5	130.5	63.0	153.0	5.0	15.0	--	--	--	--
Non-U.S. Manufacturers										
PCM/Reseller	--	2.0	--	4.0	--	--	--	--	--	--
OEM/Integrator	2.0	2.0	10.0	12.0	8.0	10.0	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	2.0	4.0	10.0	16.0	8.0	10.0	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	103.5	147.5	103.0	229.0	13.0	25.0	--	--	--	--
Total Capacity (Terabytes)	11.5	16.2	11.4	26.6	1.9	3.7	--	--	--	--
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	97.8	138.0	170.8	307.0	183.8	332.0	183.8	332.0	183.8	332.0

TABLE 28

PCMCIA RIGID DISK DRIVES, 200 - 300 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1994 Shipments		Forecast							
			1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	--	--	--	--	25.0	30.0	40.0	55.0	45.0	65.0
OEM/Integrator	1.0	1.0	70.0	90.0	90.0	120.0	105.0	145.0	65.0	95.0
TOTAL U.S. SHIPMENTS	1.0	1.0	70.0	90.0	115.0	150.0	145.0	200.0	110.0	160.0
Non-U.S. Manufacturers										
PCM/Reseller	--	--	--	--	3.0	5.0	7.0	10.0	7.0	10.0
OEM/Integrator	--	--	--	--	10.0	15.0	15.0	25.0	10.0	15.0
TOTAL NON-U.S. SHIPMENTS	--	--	--	--	13.0	20.0	22.0	35.0	17.0	25.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	1.0	1.0	70.0	90.0	128.0	170.0	167.0	235.0	127.0	185.0
Total Capacity (Terabytes)	.3	.3	18.2	23.4	32.6	43.2	42.9	60.4	33.0	48.1
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	1.0	1.0	71.0	91.0	199.0	261.0	366.0	496.0	493.0	681.0

TABLE 29

PCMCIA RIGID DISK DRIVES, 300 - 500 MEGABYTES

UNIT SHIPMENT SUMMARY

DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)

	1994 Shipments		Forecast 1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	--	--	--	--	45.0	55.0	65.0	85.0	90.0	130.0
OEM/Integrator	--	--	30.0	40.0	205.0	285.0	255.0	370.0	230.0	355.0
TOTAL U.S. SHIPMENTS	--	--	30.0	40.0	250.0	340.0	320.0	455.0	320.0	485.0
Non-U.S. Manufacturers										
PCM/Reseller	--	--	--	--	6.0	10.0	15.0	25.0	20.0	35.0
OEM/Integrator	--	--	--	--	15.0	20.0	25.0	40.0	25.0	45.0
TOTAL NON-U.S. SHIPMENTS	--	--	--	--	21.0	30.0	40.0	65.0	45.0	80.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	--	--	30.0	40.0	271.0	370.0	360.0	520.0	365.0	565.0
Total Capacity (Terabytes)	--	--	10.2	13.6	92.1	125.8	133.2	192.4	146.0	226.0
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	--	--	30.0	40.0	301.0	410.0	661.0	930.0	1,026.0	1,495.0

TABLE 30

PCMCIA RIGID DISK DRIVES, 500 MEGABYTES - 1 GIGABYTE

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1994 Shipments		Forecast 1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	--	--	--	--	--	--	5.0	5.0	7.0	10.0
OEM/Integrator	--	--	--	--	--	--	15.0	20.0	155.0	205.0
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	20.0	25.0	162.0	215.0
Non-U.S. Manufacturers										
PCM/Reseller	--	--	--	--	--	--	--	--	5.0	5.0
OEM/Integrator	--	--	--	--	--	--	3.0	5.0	15.0	20.0
TOTAL NON-U.S. SHIPMENTS	--	--	--	--	--	--	3.0	5.0	20.0	25.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	--	--	--	--	--	--	23.0	30.0	182.0	240.0
Total Capacity (Terabytes)	--	--	--	--	--	--	12.4	16.2	108.9	143.7
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	--	--	--	--	--	--	23.0	30.0	205.0	270.0

TABLE 31

PCMCIA RIGID DISK DRIVES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

DISK DIAMETER	1994	Forecast 1995	1996	1997	1998
Captive					
100 Megabytes or less	--	--	--	--	--
100 - 200 Megabytes	--	--	--	--	--
200 - 300 Megabytes	--	--	--	--	--
300 - 500 Megabytes	--	--	--	--	--
500 Megabytes - 1 Gigabyte	--	--	--	--	--
PCM/Reseller					
100 Megabytes or less	5.12	4.25	--	--	--
100 - 200 Megabytes	1.95	1.28	--	--	--
200 - 300 Megabytes	--	--	.79	.62	.49
300 - 500 Megabytes	--	--	.75	.54	.41
500 Megabytes - 1 Gigabyte	--	--	--	.47	.37
OEM/Integrator					
100 Megabytes or less	3.87	3.25	1.50	--	--
100 - 200 Megabytes	1.86	1.30	1.43	--	--
200 - 300 Megabytes	1.15	.92	.75	.59	.47
300 - 500 Megabytes	--	.88	.72	.51	.39
500 Megabytes - 1 Gigabyte	--	--	--	.45	.33

Note: Price per megabyte calculations represent estimated total sales revenues for each product type divided by the total yearly shipped capacity of all drives of that type.

TABLE 32

PCMCIA RIGID DISK DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1994 Estimate Units (000)	1994 Estimate %	1998 Projection Units (000)	1998 Projection %
VERY HIGH PERFORMANCE Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS General purpose	--	--	--	--
NETWORKS/MINI/MULTIUSER Midrange systems and network servers	--	--	--	--
PERSONAL COMPUTERS Business and professional, single user	142.7	91.4	801.9	81.0
WORKSTATIONS Engineering and office, single user	--	--	12.9	1.3
CONSUMER, GAME AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	13.4	8.6	175.2	17.7
Total	156.1	100.0	990.0	100.0

TABLE 33

PCMCIA RIGID DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1994 Net Shipments					
	To United States Destinations			Worldwide		
	Units (000)		%	Units (000)		%
Drive Manufacturers	1.8"	Total		1.8"	Total	
Maxtor	65.0	65.0	58.8	73.0	73.0	46.8
Integral	31.5	31.5	28.5	54.5	54.5	34.9
Other U.S.	12.0	12.0	10.9	24.0	24.0	15.4
Other Non-U.S.	2.0	2.0	1.8	4.6	4.6	2.9
TOTAL	110.5	110.5	100.0	156.1	156.1	100.0

Note: "<=" indicates "less than or equal to".

RIGID DISK CARTRIDGE DRIVES

1995 DISK/TREND REPORT

RIGID DISK CARTRIDGE DRIVES

Coverage

Examples of disk drives in this group include:

5.25" disk diameter

SyQuest Technology	SQ5110, SQ5200C

3.5" disk diameter

Iomega	Jaz
Nomai	MCD-I, MCD-M
SyQuest Technology	EZ135A/S, SQ3270A/S

2.5" disk diameter

Avatar Systems	AR-2170NI

1.8" disk diameter

SyQuest Technology	SQ1080

All types of disk drives using removable media in the form of rigid disk cartridges have been included in this section, which includes data from the rigid disk cartridge drive product group in the 1995 DISK/TREND Report on rigid disk drives. During recent years 5.25" drives have provided most of the shipments in the disk cartridge drive product group. However, shipments of SyQuest's 3.5" drives have been under way since 1992, with capacities now up to 270 megabytes, and the 3.5" drives are now challenging the 5.25" form factor for shipment leadership.

In response to the Iomega initial market success with the Zip 100 megabyte high capacity 3.5" floppy drive, SyQuest announced in 1995 the "EZ" single head 3.5" rigid disk cartridge drive designed for very low cost. Iomega has announced the Jaz 3.5" rigid disk cartridge drive, promised for delivery by the end of 1995, and which will offer 1 gigabyte capacity using a two disk cartridge. SyQuest has indicated that it will announce a 3.5" drive with a capacity of 1.3 megabytes using a two disk cartridge, for delivery in 1996.

Avatar Systems' 2.5" disk cartridge drives, including models combining removable disk drives with floppy drives, have been available in limited production quantities since 1993. SyQuest also initiated a 2.5" disk cartridge drive program, with initial shipments in 1993, but has since discontinued the product. Instead, SyQuest has emphasized development of an 80 megabyte drive in a PCMCIA Type III PC Card format, which uses 1.8" disks in a cartridge which may be removed from the removable drive.

Market status

Disk cartridge drives enjoyed strong shipments in 1994, and the outlook for 1995 is even better. New SyQuest drives with increased capacity in both 5.25" and 3.5" models made the difference in 1994 shipments. Total 1994 shipments for the product group were 468,400 drives, up 25.0%, and the DISK/TREND estimate for 1995 is 742,000 drives, up another 58.4%, bolstered by high volume sales of SyQuest's new low cost "EZ" 3.5" drive. 1994 total sales revenues of $111.9 million are forecasted to jump to 162.3 million in 1995, up 45.0%

Although SyQuest's initial growth in disk cartridge drive shipments was built on the company's original 3.9" drives, the 44 megabyte 5.25" model introduced in 1987 became the dominant "prepress" interchange standard, for graphics, typography and other original material used in printing, as projects move from designers, art departments and advertising agencies to typographers and printers. But despite the active upgrading from 44 megabyte to 88 megabyte drives which was under way during 1992/93, the overall market growth for 5.25" disk cartridge drives slowed down, as customers' appetites for even higher capacities became stronger. During 1994, SyQuest responded to this demand with a 200 megabyte 5.25" drive which maintains backward media compatibility with the lower capacity models.

Overall 5.25" drive shipments declined 4.9% in 1994, but the higher capacity models are stimulating an increase in overall 5.25" drive shipments in 1995, with the total now estimated at 310,000 drives, up 11.8%. However, after several years of complete dominance by 5.25" disk cartridge drives, the product mix in the disk cartridge drive group is now starting the expected transition to smaller diameters.

For years the most aggressive competition for SyQuest's rigid disk cartridge drives was provided by optical disk drives and by the Iomega 5.25" high capacity Bernoulli floppy disk drive. Iomega's Bernoulli drives also increased in capacity over the years, now up to 230 megabytes, with the result that SyQuest and Iomega have been competing directly in both the Macintosh and IBM personal computer markets for the same graphics and desktop publishing applications. 3.5" optical disk drives have also sold into the same markets, in both the standard 128 megabyte models and the newer 230 megabyte drives available from some of the same manufacturers. However, the sales efforts for optical drives have been handicapped by high drive prices and lower performance, leaving SyQuest in a leadership role.

SyQuest's first shipments of its 105 megabyte 3.5" drives began in 1992, and the 270 megabyte drive went into production at the end of 1993, with a much stronger market response. In terms of unit shipments, the new SyQuest EZ 3.5" drive is expected to generate even stronger sales. The EZ is SyQuest's response to the excellent market reaction to the Iomega Zip 100 megabyte floppy drive. The initial EZ drive offers 135 megabytes using only one recording head, and carries an announced end user price identical to that of the Iomega Zip. Total 3.5" rigid disk cartridge drive shipments for 1995 are forecasted to reach 410,000 units, up 115.8% over the previous year.

Older 14" and 8" captive disk cartridge drive programs by Digital Equipment, Control Data and other companies have long since been phased out, accounting for the absence of captive revenues. The growth expectations of several years ago for 14" and 8" drives were largely unfulfilled, due to the arrival in the market of more cost-effective smaller drives.

The first 2.5" disk cartridge drive shipments began in 1993. SyQuest's previously announced 2.5" drive was dropped, but Avatar Systems introduced a 2.5" rigid disk cartridge drive, with capacity now up to 170 megabytes, intended for a variety of personal computer and specialized system applications. In the meantime, SyQuest's 1.8" drive in the PCMCIA Type III form factor is one of the most unusual disk drive designs to date. It uses a disk cartridge which can be removed from the drive, which, like all drives in a PCMCIA card format, is removable from the host system. The relatively low media cost will be important in applications requiring multiple media units, and may make it possible for SyQuest to gradually migrate the "prepress" disk cartridge interchange market from its 5.25" and 3.5" drives to its 1.8" drives, especially as the continuing improvements in the areal density of rigid disk drives make it possible to increase drive capacity.

SyQuest Technology captured 99.7% of the worldwide unit shipments of rigid disk cartridge drives in 1994, with 467,000 drives, the majority of which were 5.25" models. In 1994 all disk cartridge drives were shipped in noncaptive market channels.

Marketing trends

The new surge in demand for low cost 3.5" cartridge disk drives in the 100+ megabyte range, both rigid disk and floppy disk types, combined with the outlook for a new generation of high capacity 3.5" rigid disk cartridge drives in the 1+ gigabyte range, is expected to stimulate an increase in shipment levels to higher levels than experienced in the past for this product group. 1998 unit shipments are projected at almost 2 million drives, an average annual increase of 40.9% for the 1996-98 period. During the same period, sales revenues are forecasted to reach $267.9 million, but the 1998 total will actually suffer a slight decline due to falling prices and a continuing shift in product mix to lower priced 3.5" drives, as sales of 5.25" models drop off after 1996. By 1998, 5.25" drives are expected to account for only 8.1% of unit shipments, as 3.5" drives climb to 67.9%. In 1998, shipments of drives using 2.5" or smaller disks are projected at 24.0% of the worldwide total.

The PCM/Reseller sales channel will continue to dominate rigid disk cartridge drive shipments. In recent years, the personal computer aftermarket has provided most of the sales opportunity for disk cartridge drives, with the largest proportion of drives moving through independent resellers marketing disk subsystems designed as add-ons to be used with existing computers. The new battle between SyQuest's EZ rigid disk cartridge drive and Iomega's Zip high capacity floppy drive for direct aftermarket attachment to personal computers will favor sales through classic distribution sales channels. However, the majority of 2.5" and smaller drives will probably be sold to system manufacturers, the first time in many years that disk cartridge drives have had a major opportunity to achieve significant OEM sales, and some of the planned new high capacity rigid disk cartridge drives may have a similar opportunity to develop specialized OEM markets.

Technical trends

It is possible to increase density in removable disk drives. Major improvements will be significantly helped by the availability of heads, disks, semiconductors and other components developed to achieve the 60% per year increase in areal density now considered normal for the high volume manufacturers of fixed rigid disk drives. The major difference in high density recording between disk cartridge drives and fixed disk drives is the higher probability of particulate contamination in removable disk drives. At the higher areal densities already in use with fixed disk drives, heads must fly at lower altitudes, increasing the need for reduced contamination levels. But advanced disk cartridge drives will continue to take advantage of the disk drive industry's many improvements in heads, filtration systems and seals, and thin film disks will continue to be used because of improved surface durability.

The basic recording technologies now in use for products in this group will continue to predominate for years. The smaller drives now going into quantity production embody the mechanical design lessons accumulated during years of production of larger removable disk drives, and will be able to exploit the rapid advances in recording technology from other segments of the disk drive industry. The 3.5" and 2.5" disk cartridge drives now available, plus the 1.8" drives now going into production, may be expected to increase continually in capacity during the coming years, following closely the rapid improvements in areal density expected with higher capacity fixed disk drives.

Forecasting assumptions

1. Significant shipment increases of 3.5" disk cartridge drives will continue, with further increases in drive capacity available next year, with successful sales to both system manufacturers and the aftermarket.
2. Production for 5.25" disk cartridge drives will peak in 1996, to be followed with a migration of graphics and desktop publishing applications to smaller disk cartridge drives.

TABLE 34

RIGID DISK CARTRIDGE DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1994 Revenues		Forecast 1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	68.6	109.7	97.3	154.6	138.1	215.8	145.0	224.5	144.0	218.5
OEM/Integrator	1.8	2.2	5.7	7.7	27.8	35.0	35.8	46.0	37.5	49.4
TOTAL U.S. REVENUES	70.4	111.9	103.0	162.3	165.9	250.8	180.8	270.5	181.5	267.9
Non-U.S. Manufacturers										
TOTAL NON-U.S. REVENUES	--	--	--	--	--	--	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	70.4	111.9	103.0	162.3	165.9	250.8	180.8	270.5	181.5	267.9
OEM Average Price ($000)		.343		.220		.179		.146		.117

TABLE 35

RIGID DISK CARTRIDGE DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1994 Shipments		Forecast							
			1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	288.0	462.0	446.0	707.0	710.0	1,105.0	885.0	1,365.0	1,035.0	1,565.0
OEM/Integrator	5.2	6.4	26.0	35.0	155.0	195.0	245.0	315.0	320.0	420.0
TOTAL U.S. SHIPMENTS	293.2	468.4	472.0	742.0	865.0	1,300.0	1,130.0	1,680.0	1,355.0	1,985.0
Non-U.S. Manufacturers										
TOTAL NON-U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	293.2	468.4	472.0	742.0	865.0	1,300.0	1,130.0	1,680.0	1,355.0	1,985.0
Total Capacity (Terabytes)	49.4	77.6	80.9	126.9	153.4	232.9	263.9	398.1	479.5	714.0
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	2,197.8	3,530.2	2,669.8	4,272.2	3,534.8	5,572.2	4,664.8	7,252.2	6,019.8	9,237.2

TABLE 36

RIGID DISK CARTRIDGE DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1994 Revenues			Forecast 1995			Forecast 1996			Forecast 1997			Forecast 1998		
	5.25"	3.5"	<=2.5"	5.25"	3.5"	<=2.5"	5.25"	3.5"	<=2.5"	5.25"	3.5"	<=2.5"	5.25"	3.5"	<=2.5"
U.S. MANUFACTURERS															
PCM/Reseller	60.9	48.8	--	76.0	78.2	.4	74.8	130.5	10.5	54.2	155.6	14.7	24.1	175.0	19.4
OEM/Integrator	.5	1.4	.3	--	3.0	4.7	--	6.2	28.8	--	9.8	36.2	--	12.0	37.4
TOTAL U.S. REVENUES	61.4	50.2	.3	76.0	81.2	5.1	74.8	136.7	39.3	54.2	165.4	50.9	24.1	187.0	56.8
NON-U.S. MANUFACTURERS															
TOTAL NON-U.S. REVENUES	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WORLDWIDE RECAP															
PCM/Reseller	60.9	48.8	--	76.0	78.2	.4	74.8	130.5	10.5	54.2	155.6	14.7	24.1	175.0	19.4
	-.8%	+158.2%	--	+24.8%	+60.2%	--	-1.6%	+66.9%	--	-27.5%	+19.2%	+40.0%	-55.5%	+12.5%	+32.0%
OEM/Integrator	.5	1.4	.3	--	3.0	4.7	--	6.2	28.8	--	9.8	36.2	--	12.0	37.4
	-81.5%	-33.3%	--	--	+114.3%	--	--	+106.7%	+512.8%	--	+58.1%	+25.7%	--	+22.4%	+3.3%
Total Revenues	61.4	50.2	.3	76.0	81.2	5.1	74.8	136.7	39.3	54.2	165.4	50.9	24.1	187.0	56.8
	-4.2%	+139.0%	-76.9%	+23.8%	+61.8%	--	-1.6%	+68.3%	+670.6%	-27.5%	+21.0%	+29.5%	-55.5%	+13.1%	+11.6%
ANNUAL SHARE, BY DIAMETER	55.0%	44.9%	.1%	46.9%	50.0%	3.1%	29.8%	54.6%	15.6%	20.0%	61.2%	18.8%	9.0%	69.9%	21.1%

Note: "<=" indicates "less than or equal to".

TABLE 37

RIGID DISK CARTRIDGE DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1994 Shipments			Forecast 1995			1996			1997			1998		
	5.25"	3.5"	<=2.5"	5.25"	3.5"	<=2.5"	5.25"	3.5"	<=2.5"	5.25"	3.5"	<=2.5"	5.25"	3.5"	<=2.5"
U.S. MANUFACTURERS															
PCM/Reseller	277.0	185.0	--	310.0	395.0	2.0	325.0	725.0	55.0	285.0	985.0	95.0	160.0	1,250.0	155.0
OEM/Integrator	.4	5.0	1.0	--	15.0	20.0	--	35.0	160.0	--	65.0	250.0	--	95.0	325.0
TOTAL U.S. SHIPMENTS	277.4	190.0	1.0	310.0	410.0	22.0	325.0	760.0	215.0	285.0	1,050.0	345.0	160.0	1,345.0	480.0
NON-U.S. MANUFACTURERS															
TOTAL NON-U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WORLDWIDE RECAP															
PCM/Reseller	277.0	185.0	--	310.0	395.0	2.0	325.0	725.0	55.0	285.0	985.0	95.0	160.0	1,250.0	155.0
	-3.8%	+164.3%	--	+11.9%	+113.5%	--	+4.8%	+83.5%	--	-12.3%	+35.9%	+72.7%	-43.9%	+26.9%	+63.2%
OEM/Integrator	.4	5.0	1.0	--	15.0	20.0	--	35.0	160.0	--	65.0	250.0	--	95.0	325.0
	-89.5%	-37.5%	--	--	+200.0%	--	--	+133.3%	+700.0%	--	+85.7%	+56.3%	--	+46.2%	+30.0%
Total Shipments	277.4	190.0	1.0	310.0	410.0	22.0	325.0	760.0	215.0	285.0	1,050.0	345.0	160.0	1,345.0	480.0
	-4.9%	+143.6%	-80.0%	+11.8%	+115.8%	--	+4.8%	+85.4%	+877.3%	-12.3%	+38.2%	+60.5%	-43.9%	+28.1%	+39.1%
ANNUAL SHARE, BY DIAMETER	59.3%	40.6%	--	41.9%	55.3%	2.8%	25.0%	58.6%	16.4%	17.0%	62.6%	20.4%	8.1%	67.9%	24.0%
TOTAL CAPACITY (Terabytes)	29.9	47.6	.1	49.6	73.8	3.5	65.0	136.8	31.2	77.0	262.5	58.6	56.0	538.0	120.0

Note: "<=" indicates "less than or equal to".

TABLE 38

RIGID DISK CARTRIDGE DRIVES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

DISK DIAMETER	1994	Forecast 1995	1996	1997	1998
PCM/Reseller					
5.25"	2.03	1.53	1.15	.70	.42
3.5"	1.05	1.10	1.00	.63	.35
2.5" or less	--	2.20	1.31	.91	.50
PCM/Reseller Average	1.44	1.27	1.06	.66	.36
OEM/Integrator					
5.25"	--	--	--	--	--
3.5"	1.01	1.10	.97	.60	.31
2.5" or less	2.75	1.39	1.24	.85	.46
OEM/Integrator Average	1.51	1.26	1.18	.78	.41

Note: Price per megabyte calculations represent estimated total sales revenues for each product type divided by the total yearly shipped capacity of all drives of that type.

TABLE 39

RIGID DISK CARTRIDGE DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1994 Estimate Units (000)	1994 Estimate %	1998 Projection Units (000)	1998 Projection %
VERY HIGH PERFORMANCE Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS General purpose	--	--	--	--
NETWORKS/MINI/MULTIUSER Midrange systems and network servers	--	--	--	--
PERSONAL COMPUTERS Business and professional, single user	447.3	95.5	1945.3	98.0
WORKSTATIONS Engineering and office, single user	21.1	4.5	39.7	2.0
CONSUMER, GAME AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	--	--	--	--
Total	468.4	100.0	1,985.0	100.0

TABLE 40

RIGID DISK CARTRIDGE DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1994 Net Shipments									
	To United States Destinations					Worldwide				
	Units (000)				%	Units (000)				%
Drive Manufacturers	5.25"	3.5"	<=2.5"	Total		5.25"	3.5"	<=2.5"	Total	
Syquest	167.0	125.0	--	292.0	99.6	277.0	190.0	--	467.0	99.7
Other U.S.	.4	--	.8	1.2	.4	.4	--	1.0	1.4	.3
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	167.4	125.0	.8	293.2	100.0	277.4	190.0	1.0	468.4	100.0

Note: "<=" indicates "less than or equal to".

SMALL OPTICAL DISK DRIVES

SMALL OPTICAL DISK DRIVES

Coverage

Examples of optical disk drives in this group include:

2.5" disk diameter

Sony	MDH-10, MDM-111

3.5" disk diameter

Chinon	MOA 300DX
Fujitsu	M2511A, M2514B
IBM	MTA 3230
LaserByte	LB4230
Matsushita Electric Industrial	LF-3100, LF-3294
MOST	RMD 5200-S, RMD 5300-S
Mountain Optech	SE-250 R/W
NEC	PC-OD301
Olympus	230MO Plus, MOS320E
Ricoh	RO-3012E, RO-3020
Seiko Epson	OMD 6020
Sony	SMO-F-331, HS-D650
TEAC	OD-3000, OD-5000

The drives included in this group are 2.5" and 3.5" optical disk drives with removable media. At the present time, all of these drives use one sided disks and are equipped with one read/write head. All use magneto-optic (MO) recording technology, although other recording methods such as phase change technology may be used in the future.

The read/write drives discussed in this section are typically used with personal computers and workstations. Small automated libraries (jukeboxes, in industry parlance) used in departmental mass storage subsystems are usually equipped with 5.25" read/write drives, but are expected to also use 3.5" drives, as drive capacities increase above 600 megabytes in the next drive generation.

Market status

3.5" drive shipments rose 89.7% to 481,700 units in 1994. As in previous years, the majority of the 3.5" drives shipped were consumed in the Japanese domestic market. Growth was strong because of Fujitsu's aggressive pricing strategy, which has stimulated the growth of the total market while improving Fujitsu's market share. Sony began to ship its 2.5" drive in 1994, but shipped only about a thousand units.

As before, 3.5" drive shipments were helped by price incentives offered by manufacturers, and the limited usage of computer networks in Japan (3.5" disks are used as a substitute for data exchange via networks). A relatively weak SyQuest presence in Japan also helped produce atypically strong demand for 3.5" optical drives in that country. In the U.S., demand remains relatively weak as the result of severe competition from rigid cartridge drives and the heavy usage of networks, permitting data transfer by wire. OEM demand for 3.5" drives remains small, with integrators and resellers moving most of the drives shipped. The Apple Macintosh add-on market, where there is less price sensitivity, has been the strongest 3.5" market segment, but 3.5" MO drive sales have been impacted by SyQuest's 270 megabyte 3.5" removable cartridge drives, which offer higher capacity, lower prices and superior performance.

Fujitsu, Sony and Matsushita Electric were the leading 3.5" drive producers in 1994, capturing nearly 80% of the market between them. 2.5" production began in 1994 with Sony as the leading producer, due to its sponsorship of the 2.5" MiniDisc program.

1994 worldwide revenues for 3.5" drives grew 61.7% to $326.8 million, only about two thirds of the growth rate for unit shipments as a result of rapidly declining drive prices in 1994. 2.5" drive revenues were about $700,000. U.S. firms accounted for 15.4% of 1994 revenues for small optical drives. The U.S. market accounted for only 22.7% of worldwide revenues in 1994, consistent with a weak U.S. market for 3.5" drives and higher non-U.S. prices for 3.5" drives, compared to prices in the United States.

In May of 1991, Sony made a preliminary announcement of a 2.5" magneto-optic drive for the audio market, and followed with a proposed media standard for the MD-DATA, a 2.5" 140 megabyte CLV computer peripheral in mid-1993. While the Sony product requires no erase pass before writing, a feature that can be expected in other MO drives in the future, the drive's performance is much like that of a compact disk drive. The drive was further defined in early 1994, but production was delayed until the second half of the year. Because of size, power, cost, and performance constraints, the 2.5" MO drive has not been well accepted by the OEM community and it seems likely that significant product redesign will be needed to launch a successful OEM version of the drive.

Marketing trends

The magnetic disk drive industry continues to outpace the optical drive industry in terms of expanding the areal density of stored data. The inability of the optical drive industry to match the current 60% per year areal density growth rate of magnetic drives is hurting optical disk drive sales. Although 3.5" MO drives with 600+ megabyte capacities are expected to begin shipping in late 1995 and early 1996, even this improvement will barely keep 3.5" MO drives competitive. The new MO drives must compete against gigabyte magnetic cartridge drives expected from Iomega and SyQuest in the same time period, as well as the 650 megabyte PD drive from MEI and NEC. Projected modest shipment growth during the forecast period assumes a steady reduction in drive prices to match competition from competing technologies.

In 1998, annual shipments of 906,500 3.5" optical drives are anticipated. Despite the growth of the market, the 3.5" drive business has proven disappointing to some manufacturers, and some supplier restructuring is anticipated. In the same time period, 2.5" drive shipments are expected to gradually increase, assuming that Sony and other potential producers aggressively reduce costs and improve product packaging. Modest success in the aftermarket is anticipated, with shipments expected to grow to 101,000 units in 1998. Most of these units will probably be sold in the Japanese market.

When shipments of 2.5" and 3.5" drives are combined, 596,800 units are expected to ship in 1995 for the product group, growing to slightly over a million units in 1998. 3.5" drives are expected to account for 90% of shipments and 91% of revenues in 1998.

Applications

3.5" drives are used to provide project oriented storage on a single disk, and are often used in desktop publishing environments to transfer large amounts of data needed for prepress processing. They are also used for file transfer applications with video editing systems. The drives have established a role as add-on devices to Apple Macintosh systems, which are frequently used for desktop publishing. In Japan and other countries where networking is not pervasive, they have a significant role as intersystem data exchange devices. Toward the end of the forecast period, higher capacity 3.5" drives may acquire a role as a near-line storage device in optical libraries attached to file servers in small networks. As they match or exceed current CD-ROM capacity and performance, they have an opportunity to establish a role as a multipurpose device that can provide data distribution services, selective backup capability, and other secondary mass storage tasks. While 3.5" drives are unlikely to match the DVD generation of CD-ROM drives in capacity, they will probably provide superior performance compared to DVD drives, but at higher cost.

2.5" drives have been targeted as secondary storage for portable and mobile computer systems, but have not yet shown strength in any particular application. If available at a low enough price and in thin form factors, 2.5" drives may also acquire the role of a data distribution device, especially in portable systems, but no clear role for the drive in this application has yet emerged. 2.5" drives may develop usage in consumer and hobby systems and, to some extent, with personal computers if their current deficiencies in power consumption and package size are overcome.

Media with both a read-only section and a writable section, when available, can serve as a vehicle for software and data base distribution, providing that cost of the media is low. The writability feature permits timely update of a previously installed data base. Furthermore, the ability to write gives the data base publisher certain security and antipiracy options not readily available on read-only media, in that individual disks or sections of disks can be serialized or encrypted for use on a specific system or group of systems at nominal cost. However, the low market penetration of optical drives and high media costs have discouraged this application.

Technical trends

Optical drive technology is advancing. The key areas of change are reviewed below.

<u>Capacity</u>: The average capacity of small optical disk drives in this product group is expected to increase. 3.5" drive capacities are expected to exceed 600 megabytes starting in 1995 and have prospects for growth to over a gigabyte in the 1997-1998 time frame. Fujitsu and several other firms are expected to introduce backward compatible, 640 megabyte, 3.5" MO drives in late 1995. Sony has made a preliminary announcement of a 650 megabyte, 3.5" drive. Although it is not backward compatible with earlier drives, Sony claims their approach is more amenable to future capacity and performance improvements. Capacity growth for 2.5" drives is more problematic. Because a number of the drives' characteristics, such as CLV rotation speed control and file format are derived from CD-ROM technology, capacity gains may be tied to future improvements in CD-ROM capacity.

Capacity can be increased by several techniques, including improved optics and shorter laser wavelength permitting smaller spots and higher BPI and TPI, reduction of track pitch from 1.6 microns to 1.4 microns (about a 40% improvement), the adoption of pulse width modulation (100% improvement), zoned recording (about 33% improvement), land and groove recording (50-100% improvement), and variable track pitch (about 40-50% improvement). Changes in encoding methods might also modestly improve capacity.

It is unlikely that all of these possibilities will be implemented on any one drive in the near term, but some are expected to be standard features of drives announced in 1995. Some capacity improvement techniques, such as zoned recording, are used on optical drives currently in production. Increased capacity will expand the applications for 3.5" drives, enabling them to move into some niches currently occupied by 5.25" optical drives and to better compete with magnetic cartridge drives.

<u>Multifunctionality</u>: Multifunctionality can be achieved on magneto-optic media by designating some portion of the media as write-once or read-only, or by marking the media with a code that designates it as rewritable or write-once media. The media coding technique has been embodied in

ISO draft standard 11560. While this type of multifunctionality is currently used with 5.25" drives, the anticipated 600+ megabyte 3.5" drives are expected to have this capability, extending 3.5" drive utility to some archiving applications.

Performance: The optical drives in this group won't provide the average access times and data transfer rates of magnetic disk drives or flash memory, especially when writing data. While performance is expected to improve, it is not expected to match that of rigid drives within the forecast period, even if the direct overwrite problem is resolved. 26-28 millisecond average seek times and 7.1 millisecond average latency represent the best performance of 1995 production drives.

The current generation of magneto-optical drives have an additional latency for writing operations caused by the need to erase each sector before writing. This lack of overwrite capability requires that an additional complete rotation be performed before the drive is ready to write in the selected sector. Several techniques have been proposed to eliminate the need for an erase pass, and it is likely that future generations of MO drives will not require a separate erase pass. But the overwrite solution will come at the expense of performance or of additional complexity in the drive, media or both, so there will be a trade-off of performance for cost, as in the case of the Sony MD-DATA drive.

Progress has been made in rewritable phase change, which doesn't require a separate erase pass. Toshiba has stated its interest in a 600+ megabyte per side phase change 3.5" drive, and Matsushita also has a development program in this area. Phase change technology permits the interchange of write-once and erasable media on a single drive, and may permit simpler drive designs than for MO drives. Efforts to create specific standards for phase change media are in progress.

Data transfer rate: Specified internal drive maximum data transfer rates are in the 2 megabyte per second range for 3.5" drives, and are expected to increase to the 5 megabyte per second range as bit density and spin rate increase. The average data transfer rate will be lower, since bit density varies from track to track. 2.5" MO drives currently offer 150 kilobyte per second transfer rates, which may improve over the next few years.

Competing Products: The SyQuest 3.5" 270 megabyte cartridge drive is already strong competition for 3.5", 230 megabyte MO drives, and priced substantially under current prices for 3.5" MO drives. The Iomega Zip drive, although it offers only 100 megabytes, also competes by virtue of its under $200 list price. The 640 megabyte 3.5" MO drive must already compete against expectations for the SyQuest and Iomega gigabyte class magnetic cartridge drives, as well as the PD drive and, in the future, even the CD-E drives expected to become available next year.

While tape drives do not offer the performance of optical disk drives, especially when reading data, they do offer inexpensive offline storage. Newer small cartridge drives using the 400 megabyte "Travan" format developed by 3M can compete against 3.5" MO drives where save/restore and data transfer are primary applications.

Multigigabyte 5.25" and 3.5" magnetic drives from Seagate, Micropolis and others are also negatively impacting optical drive sales in those stand-alone applications where a removable disk drive or cartridge is not mandatory. A typical 3.5" 1 gigabyte magnetic disk drive sells for half the price of a 230 megabyte 3.5" optical disk drive, has four times the capacity and 3 times better performance.

Forecasting assumptions

1. 600+ megabyte 3.5" drives will be introduced by major producers with shipments beginning in late 1995.
2. Rewritable and write-once media will be available in adequate production quantities throughout the forecast period.
3. 2.5" drive prices will decline, and improvements will be made in form factor and power demand.
4. 3.5" drive prices will continue to decline in 1995 and thereafter as a result of improving economies of scale and competition from other technologies.

TABLE 41

SMALL OPTICAL DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1994 Revenues		Forecast 1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	5.1	17.1	--	--	--	--	--	--	--	--
PCM/Reseller	7.8	22.2	--	--	--	--	--	--	--	--
OEM/Integrator	3.9	11.1	--	--	--	--	--	--	--	--
TOTAL U.S. REVENUES	16.8	50.4	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	--	6.8	--	3.0	--	3.2	--	3.2	--	3.4
PCM/Reseller	51.1	222.2	53.5	214.7	60.0	216.8	69.3	233.1	76.5	247.9
OEM/Integrator	6.3	48.1	15.1	72.6	17.5	78.8	19.2	83.8	21.5	88.6
TOTAL NON-U.S. REVENUES	57.4	277.1	68.6	290.3	77.5	298.8	88.5	320.1	98.0	339.9
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	74.2	327.5	68.6	290.3	77.5	298.8	88.5	320.1	98.0	339.9
OEM Average Price ($000)		.587		.459		.394		.352		.323

TABLE 42

SMALL OPTICAL DISK DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1994 Shipments		Forecast							
			1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	3.4	11.4	--	--	--	--	--	--	--	--
PCM/Reseller	10.0	28.5	--	--	--	--	--	--	--	--
OEM/Integrator	6.0	17.1	--	--	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	19.4	57.0	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	--	4.5	--	3.0	--	3.5	--	4.0	--	4.5
PCM/Reseller	80.2	337.7	111.6	435.9	145.0	525.0	190.0	640.0	225.0	729.0
OEM/Integrator	11.2	83.6	33.0	157.9	44.0	200.0	54.0	238.0	66.0	274.0
TOTAL NON-U.S. SHIPMENTS	91.4	425.8	144.6	596.8	189.0	728.5	244.0	882.0	291.0	1,007.5
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	110.8	482.8	144.6	596.8	189.0	728.5	244.0	882.0	291.0	1,007.5
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	252.8	915.8	397.4	1,512.6	586.4	2,241.1	830.4	3,123.1	1,121.4	4,130.6

TABLE 43

SMALL OPTICAL DISK DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1994 Revenues		Forecast 1995		1996		1997		1998	
	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"
U.S. MANUFACTURERS										
Other U.S. Captive	17.1	--	--	--	--	--	--	--	--	--
PCM/Reseller	22.2	--	--	--	--	--	--	--	--	--
OEM/Integrator	11.1	--	--	--	--	--	--	--	--	--
TOTAL U.S. REVENUES	50.4	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS										
Captive	6.8	--	3.0	--	3.2	--	3.2	--	3.4	--
PCM/Reseller	222.2	--	213.4	1.3	209.1	7.7	214.2	18.9	225.8	22.1
OEM/Integrator	47.4	.7	66.9	5.7	70.4	8.4	74.2	9.6	78.5	10.1
TOTAL NON-U.S. REVENUES	276.4	.7	283.3	7.0	282.7	16.1	291.6	28.5	307.7	32.2
WORLDWIDE RECAP										
Captive	23.9	--	3.0	--	3.2	--	3.2	--	3.4	--
	+22.6%	--	-87.4%	--	+6.7%	--	--	--	+6.3%	--
PCM/Reseller	244.4	--	213.4	1.3	209.1	7.7	214.2	18.9	225.8	22.1
	+96.8%	--	-12.7%	--	-2.0%	+492.3%	+2.4%	+145.5%	+5.4%	+16.9%
OEM/Integrator	58.5	.7	66.9	5.7	70.4	8.4	74.2	9.6	78.5	10.1
	+.2%	--	+14.4%	+714.3%	+5.2%	+47.4%	+5.4%	+14.3%	+5.8%	+5.2%
Total Revenues	326.8	.7	283.3	7.0	282.7	16.1	291.6	28.5	307.7	32.2
	+61.7%	--	-13.3%	+900.0%	-.2%	+130.0%	+3.1%	+77.0%	+5.5%	+13.0%
ANNUAL SHARE, BY DIAMETER	99.9%	.1%	97.7%	2.3%	94.7%	5.3%	91.2%	8.8%	90.6%	9.4%

TABLE 44

SMALL OPTICAL DISK DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1994 Shipments		Forecast 1995		Forecast 1996		Forecast 1997		Forecast 1998	
	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"
U.S. MANUFACTURERS										
Other U.S. Captive	11.4	--	--	--	--	--	--	--	--	--
PCM/Reseller	28.5	--	--	--	--	--	--	--	--	--
OEM/Integrator	17.1	--	--	--	--	--	--	--	--	--
TOTAL U.S. SHIPMENTS	57.0	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS										
Captive	4.5	--	3.0	--	3.5	--	4.0	--	4.5	--
PCM/Reseller	337.7	--	434.0	1.9	510.0	15.0	595.0	45.0	664.0	65.0
OEM/Integrator	82.5	1.1	145.4	12.5	176.0	24.0	206.0	32.0	238.0	36.0
TOTAL NON-U.S. SHIPMENTS	424.7	1.1	582.4	14.4	689.5	39.0	805.0	77.0	906.5	101.0
WORLDWIDE RECAP										
Captive	15.9	--	3.0	--	3.5	--	4.0	--	4.5	--
	+39.5%	--	-81.1%	--	+16.7%	--	+14.3%	--	+12.5%	--
PCM/Reseller	366.2	--	434.0	1.9	510.0	15.0	595.0	45.0	664.0	65.0
	+134.9%	--	+18.5%	--	+17.5%	+689.5%	+16.7%	+200.0%	+11.6%	+44.4%
OEM/Integrator	99.6	1.1	145.4	12.5	176.0	24.0	206.0	32.0	238.0	36.0
	+15.0%	--	+46.0%	--	+21.0%	+92.0%	+17.0%	+33.3%	+15.5%	+12.5%
Total Shipments	481.7	1.1	582.4	14.4	689.5	39.0	805.0	77.0	906.5	101.0
	+89.7%	--	+20.9%	--	+18.4%	+170.8%	+16.8%	+97.4%	+12.6%	+31.2%
ANNUAL SHARE, BY DIAMETER	99.9%	.1%	97.7%	2.3%	94.7%	5.3%	91.4%	8.6%	90.1%	9.9%

TABLE 45

SMALL OPTICAL DISK DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1994 Estimate Units (000)	1994 Estimate %	1998 Projection Units (000)	1998 Projection %
VERY HIGH PERFORMANCE Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS General purpose	--	--	--	--
NETWORKS/MINI/MULTIUSER Midrange systems and network servers	9.2	1.9	41.3	4.1
PERSONAL COMPUTERS Business and professional, single user	417.4	86.5	548.1	54.4
WORKSTATIONS Engineering and office, single user	41.4	8.6	314.3	31.2
CONSUMER, GAME AND HOBBY COMPUTERS	8.2	1.7	83.6	8.3
OTHER APPLICATIONS	6.6	1.3	20.2	2.0
Total	482.8	100.0	1,007.5	100.0

TABLE 46

SMALL OPTICAL DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1994 Net Shipments							
	To United States Destinations				Worldwide			
	Units (000)			%	Units (000)			%
Drive Manufacturers	3.5"	2.5"	Total		3.5"	2.5"	Total	
Fujitsu	66.0	--	66.0	61.5	251.0	--	251.0	53.8
Sony	4.0	.2	4.2	3.9	60.0	1.1	61.1	13.1
Matsushita Elec. Ind.	4.0	--	4.0	3.7	59.0	--	59.0	12.6
IBM	16.0	--	16.0	14.9	45.6	--	45.6	9.8
Olympus Optical	15.0	--	15.0	14.0	38.0	--	38.0	8.1
Other U.S.	--	--	--	--	--	--	--	--
Other Non-U.S.	2.2	--	2.2	2.0	12.2	--	12.2	2.6
TOTAL	107.2	.2	107.4	100.0	465.8	1.1	466.9	100.0

HIGH CAPACITY FLEXIBLE DISK DRIVES

HIGH CAPACITY FLEXIBLE DISK DRIVES

Coverage

Examples of flexible disk drives in this group include:

5.25" Bernoulli principle drives

Iomega	Bernoulli 90, 150, 230

3.5" flexible disk drives

Insite Peripherals	I325VM
Iomega	Zip
Matsushita-Kotobuki Electronics	(Product number TBA)
Swan Instruments	UHC-3258

All types of floppy drives with capacities over 5 megabytes have been consolidated into this section. The functional and physical characteristics of these products are varied, and are individually discussed below. Unfortunately, there has been no general industry agreement on media interchange standards, and most of the high capacity floppy drives announced to date are incapable of interchanging diskettes with drives of other manufacturers, except for the downward compatibility with lower capacity standard floppy drives claimed by some manufacturers of 3.5" drives.

Iomega's Bernoulli principle drives: Iomega's existing 5.25" drives use the Bernoulli effect to control head/disk spacing. These are high performance drives, using flexible disks in a removable cartridge, and a sophisticated internal air flow system to maintain the proper position of the disk relative to the recording head. A voice coil rotary head positioning system, in conjunction with an embedded servo, provides average seek times equivalent to many rigid disk drives.

Iomega started deliveries of the original 8" 10 megabyte Alpha-10 in September, 1982, followed by other 8" models, all of which have since been discontinued. A 5 megabyte full size 5.25" drive was introduced in 1983, followed by a 21 megabyte half high model in 1986, a 44 megabyte version in 1989, a 90 megabyte model in 1991, a 150 megabyte model in 1992, and the current 230 megabyte model in late 1994.

Floptical drives: Insite Peripherals achieved quick fame in the industry by announcing its trademarked "floptical" technology, a combination of optical tracking methods with conventional magnetic recording. Floptical drives use a reflective servo pattern applied to the surface of standard 3.5" diskettes to achieve high track density. The original floptical drive introduced in 1989 had a 21 megabyte capacity in a one inch high form factor, with downward read/write compatibility for .7 and 1.44 megabyte diskettes. In 1992, Insite engaged Matsushita-Kotobuki Electronics to manufacture the drive on a contract basis, and also licensed the floptical technology to Iomega, which introduced drives compatible with Insite's in 1992, using Chinon as a contract manufacturing source. Iomega phased out of the floptical drive market in 1994, after finding a limited market for the product. In November, 1993, O.R. Computer System Pte. Ltd., a major Singapore distributor of personal computers and peripherals, acquired control of Insite Peripherals, which continues to sell floptical 21 megabyte drives produced by MKE under the Insite trade name.

In 1995, a joint program for a 120 megabyte version of the 3.5" floptical disk drive was announced by MKE, which will manufacture the drives, 3M, which will manufacture the metal powder diskettes to be used, and Compaq Computer, which will use the drives in systems not yet announced. Based on the tentative specification, the 120 megabyte drives will be backward compatible with 720 kilobyte, 1.2 megabyte and 1.44 megabyte floppies, and will conform to the standard form factor for one inch high 3.5" floppy drives. The sponsors have indicated that they will announce full details on the program late in 1995. O.R. Computer will also sell the drive, through Insite Peripherals.

Other flexible disk drives: For several years the technology required for production of higher capacity floppy drives using conventional recording techniques has been available, and numerous companies have offered floppy drives ranging in capacity from 6 to 21 megabytes, none of which were successful in the market.

A significant new entry in the 3.5" high capacity floppy drive market appeared in 1994 with the Iomega announcement of the "Zip" drive. After participating in the 21 megabyte floptical drive market and in a joint program to develop a higher capacity version of the drive, Iomega undertook its own development program with the objective to develop a 3.5" high capacity floppy with the lowest possible cost. The Zip drive dispensed with backward compatibility, but provides 100 megabyte capacity at an end user price less than $200.

Market status

1994 was a year in which sales revenues and unit shipments declined for high capacity flexible disk drives, due to weak markets for both 5.25" and 3.5" drives. Worldwide sales revenues were down 26.2% to $59.7 million and unit shipments declined 2.9% to 203,500 drives. It is a different picture, however, for 1995, as vigorous initial sales results for Iomega's Zip 3.5" floppy drive have overcome lagging shipments of 5.25" Bernoulli drives to lead the product group to a 133.4% increase in unit shipments, totaling 475,000 drives. The strong sales will produce estimated sales revenues of $82.2 million, up 37.7% over the previous year.

Iomega's Bernoulli principle drives: Iomega was founded in 1980 to manufacture 8" drives using Bernoulli technology, after the founders became discouraged with IBM's failure to utilize it. Production of the original 8" drives ended four years ago, but shipments of the firm's 5.25" Bernoulli drives continued to grow until 1993. Iomega's Bernoulli drives compete primarily with small Winchester disk drives, removable rigid disk cartridge drives, and small erasable optical disk drives, rather than with low capacity flexible disk drives available in the past, due to their capacity, performance, and pricing.

Because of the unique characteristics of its drives and lack of effective second sources, Iomega has achieved most of its sales successes through its program to sell Bernoulli Box subsystems in the personal computer add-on market with distribution through dealers. For years, Iomega's main difficulty in selling to major system manufacturers on an OEM basis has been lack of alternate sources for the company's drives. The products are unique, and system manufacturers, as always, are reluctant to take a chance on a sole-sourced disk drive of a unique design. Attempts to establish token alternate sources in Japan and the U.S. have been abortive.

5.25" Bernoulli drive shipments declined slightly in 1993 and 1994, but stayed just over the 100,000 unit level, until 1995. Despite availability of the new 230 megabyte model, unit shipments are moving down in 1995, with the total for the year projected at 90,000 drives. Despite sharp price reductions, competition from newer rigid disk cartridge drives and optical disk drives has turned the tide against the Bernoulli drives.

Other flexible disk drives: Major changes are under way in the market for high capacity 3.5" flexible disk drives. After a flat sales year in 1994, with shipments static at the 103,000 drive level, total 3.5" drive shipments are forecasted to reach 385,000 units in 1995. The new factor is the availability of 3.5" floppy drives in the 100+ megabyte range, caused initially by shipments of the Iomega Zip drive starting early in 1995, followed by the promised availability of the MKE 120 megabyte floptical drive at the end of the year.

3.5" 21 megabyte "floptical" drives became available in volume, after numerous delays, from Insite in the first half of 1992 and from Iomega late in that year. Total 3.5" drive shipments were only 25,600 units in 1992, but the combined marketing activity of Insite and Iomega boosted 1993 shipments to 103,400 drives, concentrated in PCM/Reseller markets. Contract manufacturing is now at Matsushita-Kotobuki Electronics for O.R. Computer's Insite Peripherals, the only remaining company with a marketing program for the 21 megabyte floptical drive. Although the 21 megabyte floptical drive, which has been sold primarily through distribution, found a market in a variety of specialized applications, broader sales throughout the computer industry have been held down due to price levels perceived as too high by most end users.

During most of 1995, sales momentum for 3.5" high capacity floppy drives has shifted to the Iomega Zip drive, which has attracted widespread attention in the computer industry by combining a capacity large enough to perform several useful functions with a price low enough to be attractive to a wide market. The combination of 100 megabytes capacity and an end user price less than $200 have turned out to be the right combination for many buyers. The Zip drive has received more coverage in the computer and general business press than any disk drive in years, and has generated a sales backlog of many more drives than Iomega can manufacture. Iomega has established Seiko Epson as an additional contract manufacturing source for the Zip drive, with initial production expected by the end of 1995.

Personal computers for business applications dominated shipments in 1994, with 94.5% of overall unit shipments for the product group. Workstations for engineering and office usage held 4.5% of shipments. By 1998, with shipments dominated by relatively inexpensive 3.5" drive models, personal computers are forecasted to take 98.0% of all shipments, with workstations down to 1.5%.

In 1994 Iomega held the lead in noncaptive unit shipments with 52.8% of the worldwide total, with the company's total consisting mostly of 5.25" drives. Insite Peripherals held 46.7% of the total, all 3.5" floptical drives.

Marketing trends

Total shipments of high capacity flexible disk drives of all types are projected to reach 3.4 million in 1998, an average annual increase during the 1996-98 period of 97.6%. Sales revenues for the product group are expected to climb to $260 million in 1998.

It is clear that the market response to the new generation of 3.5" high capacity floppy drives will be adequate to carry shipments for this product group to much higher levels than those achieved in previous years. Several computer industry trends have combined to create this response. The continuous increase in capacities for the fixed rigid disk drives used as the basic disk for all of today's personal computers has made many users nervous about their risks in failing to preserve their data by backing it up.

For many of these users, the high capacity floppy now provides an inexpensive alternative to buying a tape drive, and preserves the random access capability of the disk drive. Many other users now have the functional need to keep individual projects offline to free space on their system's fixed disk drive, a pattern previously available only to users of high-end personal computers or workstations, at much higher cost. The widespread usage of graphics and desktop publishing software, CD-ROM applications, games, and downloads from the Internet have inspired many additional computer users to seek affordable removable data storage devices which are suitable to keep individual projects on individual disks, ready to be loaded when needed.

High capacity 3.5" floppy drives are expected to capture a major part of the available market created by the above trends, while coexisting in a competitive marketplace alongside rigid disk cartridge drives, small optical disk drives and tape cartridge drives. During this forecast period, it is expected that the 3.5" 100 megabyte floppy drives now available and the promised 120 megabyte drives will be increased in capacity, to at least 200 megabytes, and that prices will be significantly reduced as sales increase. 21 megabyte 3.5" floptical drives are expected to be phased out in favor of higher capacity models, probably in 1996.

By 1998, the product mix for high capacity flexible disk drives will be almost entirely 3.5" models, with an estimated 99.6% of all unit shipments for the product group. Despite the backward compatibility offered by the MKE drive, the current projections forecast sales dominance for the Zip format drives, due to a significantly lower product cost made possible by a simpler design and lower parts count. Shipments of 5.25 Bernoulli drives are forecasted to drop to 15,000 units in 1998, only 0.4% of the total for that year.

The majority of sales for high capacity 3.5" floppy drives are now through the PCM/Reseller channel, as aftermarket add-ons to existing personal computers, rather than through OEM channels, as drives installed in new personal computers. Distribution channels are expected to continue to dominate sales, with end users making individual buying decisions. Because high capacity 3.5" floppy drives will continue to be priced several times higher than standard 1.44 megabyte drives, most system manufacturers will not be able to substitute them for standard floppy drives. Those system manufacturers which elect to offer high capacity floppy drives will find it necessary to treat them as options.

Technology trends

The 3.5" form factor for floppy drives in this product group is clearly destined to prevail, and the development task will be to increase capacities beyond the 100-120 megabytes now available or promised, and to achieve the design simplification required for low manufacturing cost.

The floptical optical tracking method is perhaps the most innovative approach, with obvious potential for greater capacity and low manufacturing costs. The reflective servo pattern is imprinted on the diskette as part of the media manufacturing process, and should increase the media manufacturing cost only slightly when high shipment levels are achieved. The overwhelming challenge for the engineers working with the floptical design will be to reduce the manufacturing cost of the drive, no small challenge when the requirements of the optical tracking method and backward compatibility are considered, both of which contribute to an increased parts count.

None of the interesting technical developments in this field will see wide application unless producible at low cost. This is not going to be easy, since these drives will require sophisticated head positioning systems, multifunction heads, high density encoding schemes, error correction capability, high reliability and embedded controllers. Furthermore, the media must be priced low enough to avoid buyer resistance, while still offering long life, adequate durability and easy handling. It's definitely a difficult development task, but without low costs these drives will occupy only a small market niche.

At this point, it appears that Iomega's Zip drive design has intrinsic cost advantages, when compared with the floptical design. Both types of drives will be able to utilize components designed for rigid disk drives produced at very high production volumes, and therefore available at attractive costs. And as the rigid disk drive industry continues to advance rapidly in storage capacity, high capacity floppy drives will probably benefit from being able to utilize low cost production components. But, other things being equal, it is hard to see how the floptical drives, with more internal functions to be performed, with more parts, can avoid higher manufacturing costs.

Forecasting assumptions

1. Adequate production of 3.5" high capacity floppy drives will be available in the 1996-98 period to satisfy demand, which will grow to exceed 3 million drives per year by 1998.

2. Although the higher production levels for 3.5" high capacity floppy drives projected for future years will lower the pricing differential compared to 1.44 megabyte 3.5" drives, high capacity 3.5" drives will still be priced at the OEM level 3.5 to 4 times higher than 1.44 megabyte drives in 1998, and will not be able to significantly replace them as the basic floppy drive used with most personal computers.

3. Shipments of 5.25" Bernoulli drives will continue to decline during the forecast period.

TABLE 47

HIGH CAPACITY FLEXIBLE DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1994		Forecast							
	Revenues		1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	33.9	40.1	50.1	60.5	77.1	100.7	102.0	140.0	114.1	166.8
OEM/Integrator	1.9	2.1	3.1	3.3	12.6	13.9	23.8	29.7	35.0	46.6
TOTAL U.S. REVENUES	35.8	42.2	53.2	63.8	89.7	114.6	125.8	169.7	149.1	213.4
Non-U.S. Manufacturers										
PCM/Reseller	4.8	7.3	5.0	8.3	10.1	17.1	10.4	17.6	11.0	18.2
OEM/Integrator	6.3	10.2	5.4	10.1	5.6	9.8	6.9	12.7	8.1	14.8
TOTAL NON-U.S. REVENUES	11.1	17.5	10.4	18.4	15.7	26.9	17.3	35.5	21.3	47.0
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	46.9	59.7	63.6	82.2	105.4	141.5	143.1	205.2	170.4	260.4
OEM Average Price ($000)		.193		.158		.108		.083		.067

TABLE 48

HIGH CAPACITY FLEXIBLE DISK DRIVES

UNIT SHIPMENT SUMMARY

DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)

	1994 Shipments		Forecast 1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	85.5	102.0	278.0	340.5	662.0	877.0	1,138.0	1,573.0	1,557.0	2,284.0
OEM/Integrator	5.0	5.5	19.0	19.5	133.0	148.0	317.0	397.0	571.0	761.0
TOTAL U.S. SHIPMENTS	90.5	107.5	297.0	360.0	795.0	1,025.0	1,455.0	1,970.0	2,128.0	3,045.0
Non-U.S. Manufacturers										
PCM/Reseller	25.0	38.0	30.0	50.0	65.0	110.0	80.0	135.0	100.0	165.0
OEM/Integrator	36.0	58.0	35.0	65.0	40.0	70.0	60.0	110.0	85.0	155.0
TOTAL NON-U.S. SHIPMENTS	61.0	96.0	65.0	115.0	105.0	180.0	140.0	265.0	195.0	385.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	151.5	203.5	362.0	475.0	900.0	1,205.0	1,595.0	2,235.0	2,323.0	3,430.0
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	1,036.5	1,335.4	1,398.5	1,810.4	2,298.5	3,015.4	3,893.5	5,250.4	6,216.5	8,680.4

TABLE 49

HIGH CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1994 Revenues		Forecast 1995		Forecast 1996		Forecast 1997		Forecast 1998	
	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"
U.S. MANUFACTURERS										
PCM/Reseller	38.2	1.9	29.9	30.6	19.2	81.5	9.0	131.0	3.4	163.4
OEM/Integrator	2.1	--	1.6	1.7	.9	13.0	.5	29.2	.2	46.4
TOTAL U.S. REVENUES	40.3	1.9	31.5	32.3	20.1	94.5	9.5	160.2	3.6	209.8
NON-U.S. MANUFACTURERS										
Captive	--	--	--	--	--	--	--	5.2	--	14.0
PCM/Reseller	--	7.3	--	8.3	--	17.1	--	17.6	--	18.2
OEM/Integrator	--	10.2	--	10.1	--	9.8	--	12.7	--	14.8
TOTAL NON-U.S. REVENUES	--	17.5	--	18.4	--	26.9	--	35.5	--	47.0
WORLDWIDE RECAP										
Captive	--	--	--	--	--	--	--	5.2	--	14.0
	--	--	--	--	--	--	--	--	--	+169.2%
PCM/Reseller	38.2	9.2	29.9	38.9	19.2	98.6	9.0	148.6	3.4	181.6
	-33.8%	-34.8%	-21.7%	+322.8%	-35.8%	+153.5%	-53.1%	+50.7%	-62.2%	+22.2%
OEM/Integrator	2.1	10.2	1.6	11.8	.9	22.8	.5	41.9	.2	61.2
	-4.5%	+47.8%	-23.8%	+15.7%	-43.7%	+93.2%	-44.4%	+83.8%	-60.0%	+46.1%
Total Revenues	40.3	19.4	31.5	50.7	20.1	121.4	9.5	195.7	3.6	256.8
	-32.7%	-7.6%	-21.8%	+161.3%	-36.2%	+139.4%	-52.7%	+61.2%	-62.1%	+31.2%
ANNUAL SHARE, BY DIAMETER	67.6%	32.4%	38.3%	61.7%	14.2%	85.8%	4.6%	95.4%	1.4%	98.6%

TABLE 50

HIGH CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1994 Shipments		Forecast 1995		Forecast 1996		Forecast 1997		Forecast 1998	
	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"
U.S. MANUFACTURERS										
PCM/Reseller	95.0	7.0	85.5	255.0	62.0	815.0	33.0	1,540.0	14.0	2,270.0
OEM/Integrator	5.5	--	4.5	15.0	3.0	145.0	2.0	395.0	1.0	760.0
TOTAL U.S. SHIPMENTS	100.5	7.0	90.0	270.0	65.0	960.0	35.0	1,935.0	15.0	3,030.0
NON-U.S. MANUFACTURERS										
Captive	--	--	--	--	--	--	--	20.0	--	65.0
PCM/Reseller	--	38.0	--	50.0	--	110.0	--	135.0	--	165.0
OEM/Integrator	--	58.0	--	65.0	--	70.0	--	110.0	--	155.0
TOTAL NON-U.S. SHIPMENTS	--	96.0	--	115.0	--	180.0	--	265.0	--	385.0
WORLDWIDE RECAP										
Captive	--	--	--	--	--	--	--	20.0	--	65.0
	--	--	--	--	--	--	--	--	--	+225.0%
PCM/Reseller	95.0	45.0	85.5	305.0	62.0	925.0	33.0	1,675.0	14.0	2,435.0
	-6.1%	-31.8%	-10.0%	+577.8%	-27.5%	+203.3%	-46.8%	+81.1%	-57.6%	+45.4%
OEM/Integrator	5.5	58.0	4.5	80.0	3.0	215.0	2.0	505.0	1.0	915.0
	+10.0%	+55.1%	-18.2%	+37.9%	-33.3%	+168.8%	-33.3%	+134.9%	-50.0%	+81.2%
Total Shipments	100.5	103.0	90.0	385.0	65.0	1,140.0	35.0	2,200.0	15.0	3,415.0
	-5.4%	-.4%	-10.4%	+273.8%	-27.8%	+196.1%	-46.2%	+93.0%	-57.1%	+55.2%
ANNUAL SHARE, BY DIAMETER	49.4%	50.6%	18.9%	81.1%	5.4%	94.6%	1.6%	98.4%	.4%	99.6%

TABLE 51

HIGH CAPACITY FLEXIBLE DISK DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1994 Estimate Units (000)	1994 Estimate %	1998 Projection Units (000)	1998 Projection %
VERY HIGH PERFORMANCE Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS General purpose	--	--	--	--
NETWORKS/MINI/MULTIUSER Midrange systems and network servers	--	--	--	--
PERSONAL COMPUTERS Business and professional, single user	192.3	94.5	3,361.4	98.0
WORKSTATIONS Engineering and office, single user	9.2	4.5	51.4	1.5
CONSUMER, GAME AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	2.0	1.0	17.2	.5
Total	203.5	100.0	3,430.0	100.0

TABLE 52

HIGH CAPACITY FLEXIBLE DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1994 Net Shipments							
	To United States Destinations				Worldwide			
	Units (000)			%	Units (000)			%
Drive Manufacturers	5.25"	3.5"	Total		5.25"	3.5"	Total	
Iomega	86.5	4.0	90.5	59.7	100.5	7.0	107.5	52.8
Insite Peripherals	--	60.0	60.0	39.6	--	95.0	95.0	46.7
Other U.S.	--	--	--	--	--	--	--	--
Other Non-U.S.	--	1.0	1.0	.7	--	1.0	1.0	.5
TOTAL	86.5	65.0	151.5	100.0	100.5	103.0	203.5	100.0

LOW CAPACITY FLEXIBLE DISK DRIVES

LOW CAPACITY FLEXIBLE DISK DRIVES

Coverage

Examples of low capacity flexible disk drives in this group include:

8" disk diameter

NEC	FD 1165
Y-E Data	YD-180

5.25" disk diameter: .360 megabyte

TEAC	FD-55BR

5.25" disk diameter: .7 megabyte

TEAC	FD-55FR

5.25" disk diameter: 1.2 megabytes

Chinon	FR-506
Matsushita Communication Ind.	JU-475
Mitsubishi Electric	MF504C
Mitsumi Electric	D 509V5
NEC	FD 1157D, FD 1158C
Safronic	DS-53AC
Samsung Electronics	SFD-560D
Seiko Epson	SD-780
TEAC	FD-55GFR, FD-155GF
Y-E Data	YD-380B

5.25" disk diameter: 2.4 megabytes

Y-E Data	YD-801

3.5" disk diameter: .7 megabyte

Citizen	V1DC
Matsushita Electronic Comp.	EME-213
Mitsumi Electric	D357T5
TEAC	FD-235F

3.5" disk diameter: 1.2 megabytes

Alps Electric	DF 333H
Canon	MD 3661
Citizen	OSDB, W1DB*
Matsushita Electronic Comp.	EME-262
Mitsubishi Electric	MF 504C
Mitsumi Electric	D 358P5, D358F2*
NEC	FD 1148C

3.5" disk diameter: 1.2 megabytes (continued)

TEAC	FD-235GF, FD-05GF*
Y-E Data	YD-686C

3.5" disk diameter: 1.44 megabytes

Alps Electric	DF 334H
Canon	MD 3651, MD 3641
Chinon	FG-357
Citizen	OSDA, W1DA*
Matsushita Communication Ind.	JU-257A, JU-227A*
Matsushita Electronic Comp.	EME-278
Mitsubishi Electric	MF 355F, MF 355H*
Mitsumi Electric	D 359P5, D 359F2*, D 359G*
NEC	FD 1231, FD 1239H*
Safronic	DS-34AC
Samsung Electronics	SFD-321D
Seiko Epson	SMD-1340
Sony	MPF420, MPF720*
TEAC	FD-235HF, FD-05HF*
Y-E Data	YD-701B, YD-702J*

3.5" disk diameter: 2.88 megabytes

Citizen	OSDG, OSDF
Matsushita Communication Ind.	JU-259A
Mitsubishi Electric	MF 356F
Mitsumi Electric	D352E
TEAC	FD-05JS

*12.7 millimeters height, or less

All flexible disk drives with capacities less than 5 megabytes are included in this product group. The first commercial floppy drive, used only to load micro-code for a mainframe disk drive controller, was an 8" drive shipped by IBM in 1971. However, IBM's 33FD 8" drive first shipped in 1973 established an industry de facto standard, setting off a rush of companies vying to establish floppy drive production. After a 22 year product life, two companies are still producing 8" floppy drives.

The basic standards for physical size and recording format for 5.25" floppy drives were created by Shugart Associates' 1976 introduction of the SA 400, the original minifloppy. Early growth in small microcomputer systems inspired several innovative one sided 5.25" drives, but two sided 5.25" floppy drives became a reality in 1978. The current industry recording format was established in 1982, when 1.2 megabyte two sided 5.25" drives were first shipped by Y-E Data, designed to a standard coordinated by Nippon Telephone and Telegraph. IBM's 1984 introduction of the PC AT, using Y-E Data's 1.2 megabyte drive, stampeded the market into rapid worldwide usage of the 1.2 megabyte 5.25" format, which for several years accounted for most of the industry's shipments of 5.25" floppy drives.

The only type of microfloppy currently remaining in the product group is the 3.5" format, which has evolved into the industry standard. All of the other micro-floppy formats in the 2" to 4" diameter range which were introduced during the last 11 years have been phased out.

All 3.5" drives are derived from the Sony microfloppy first shipped in 1982, with modifications to achieve logical file organization similar to the larger diskette drives which preceded it in the market. Drives with capacities of one megabyte or less use 6,250 bytes per track, the same track capacity as "double density" 5.25" diskettes, and also use 40 or 80 tracks per side to maintain file compatibility with 5.25" diskettes.

1.2 and 1.44 megabyte 3.5" drives were announced in 1985, and are intended for use with the high density media originally proposed by Sony, which operates at up to 17,434 BPI, and uses the 135 TPI standard of today's production drives. All current 1.2 and 1.44 megabyte drives claim "downward compatibility", the ability to read and write on lower capacity diskettes. 1.2 megabyte 3.5" drives are compatible with NEC drives used with personal computers in the domestic Japanese market. After the adoption of 1.44 megabyte drives by IBM in April, 1987, for the PS/2 systems, most major manufacturers of microfloppy drives added drives with the same capacity.

Most manufacturers of 3.5" drives have also made the transition from the earlier 41.3 millimeter high drives ("half high", in 5.25" drive terms) to the 25.4 millimeter (one inch) high drives pioneered by Citizen in 1984. Citizen's floppy drive packaging innovations prompted many companies to follow the firm's introduction of thinner drives in the 17-19 millimeter (3/4 inch) high range in 1989 and 15 millimeters in 1991. This trend culminated in TEAC's introduction of 12.7 millimeter (one half inch) high drives for shipment later in 1991 -- which, in turn, prompted many other drive manufacturers to join the movement to half inch high floppy drives. Citizen did not match the 12.7 millimeter height, but lowered the height on its newest models to 10.9 millimeters.

In addition to the substantial notebook computer market for thin 3.5" floppy drives, their availability has made it possible for manufacturers to offer the drives in combination packages with other products, initially with 5.25" floppy drives. In 1994, TEAC announced a 3.5" floppy/CD-ROM drive combination with 41.3 millimeter height, and 3.5" floppy/PCMCIA card slot combinations with 25.4 millimeter heights were announced by Y-E Data and Mitsumi Electric.

The 3" microfloppy format which was produced in quantity for several years has lost all of its original adherents including the last holdout, Matsushita Electronic Components, and is now out of production. 2" drives, in a data recording version of a video camera floppy, were produced during recent years by Sony, but found a limited market. Initial shipments of 2" drives with notebook computers encountered resistance from buyers who did not want to bother with interchange problems, and there were not enough applications in home computers, electronic typewriters and games to maintain growth for the 2" format. While there may eventually be a future for a 2" or smaller floppy format, most of the drive manufacturers do not appear to be interested.

Market status

The continuing growth in total low capacity flexible disk drive shipments is driven by the strong personal computer market. Worldwide total shipments were up 15.3% in 1994, for a total of 77.3 million floppy drives. The 1995 total for all types of floppy drives is estimated at 81.2 million drives, up only 5.0%, due to declining shipments of 5.25" floppy drives.

After more than a decade of high volume shipments, 5.25" floppy drives started a pattern of decline in 1993. 3.5" floppy drives passed up 5.25" drives in shipments in 1988, but 5.25" models continued in high demand for several more years, driven by the need for owners of new personal computers with 3.5" floppy drives to interchange data with older systems. However, the personal computer industry's movement to newer processors and improved software has stimulated the rapid replacement of older systems in recent years, and the percentage of personal computer buyers who need floppy drives for interchange is dropping rapidly. Worldwide unit shipments of 5.25" floppy drives declined 33.3% in 1994, and the reduction in unit shipments for 1995 is estimated at 42.9%, to 5.6 million drives, only 7.2% of the total for all floppy disk drives.

Despite the continuing overall growth in unit shipments for low capacity flexible disk drives, the pattern in sales revenues is one of continuing decline. Total 1994 sales revenues were $2.3 billion, down 10.0%, and 1995 projected revenues of $1.9 billion represent an even larger decline of 14.8%. The two reasons for the reduction in current revenue levels are the rapid drop in 5.25" floppy drive shipments now under way and the continuing downward slope of average OEM pricing for 3.5" floppy drives.

Underlying the continuing declines in average price for 3.5" floppy drives by the major Japanese floppy drive manufacturers are continuing pressure from system manufacturers for the lowest possible price, extensive product redesign for cost reduction, and the movement of most Japanese floppy drive manufacturing to offshore sites with lower costs. The average OEM price for all 3.5" floppy drives was $59 in 1988, $51 in 1989, $46 in 1990, $42 in 1991, $38 in 1992, $34 in 1993, and $27 in 1994. In 1995, a further drop in the overall OEM average unit price for 3.5" floppy drives to $24 is forecasted.

The 1.44 megabyte 3.5" models which originated in 1985 and are now offered by nearly all major floppy drive manufacturers have become the industry's major products, originally stimulated by IBM's 1987 adoption of 1.44 megabyte drives for PS/2 personal computers. The similar 1.2 megabyte drives are used mostly in Japan, primarily by NEC and with computers designed to be compatible with NEC's personal computer product line. 1994 shipments of 1.2/1.44 megabyte drives provided 97.5% of the total of all 3.5" floppy drive formats, and the 1995 share for these drives is expected to reach 99.3% of the worldwide total for low capacity flexible disk drives.

A flurry of product introductions was inspired by IBM's long expected adoption of the 2.88 megabyte microfloppy format in 1991, but the 2.88 megabyte format has proven to be a failure. Most floppy drive manufacturers had expected 2.88 megabyte drives to become an important part of the industry, but shipments peaked at only 1.6 million drives in 1993, and have declined rapidly. Even with IBM's subsequent utilization of the 2.88 megabyte format with 30 individual PS/2 models announced during 1992, the majority of system manufacturers failed to adopt it. The major negative influence holding down wider usage has been the drives' higher selling price, combined with low awareness of the drives' higher capacity among computer users.

Since personal computer system manufacturers did not notice significant demand for 2.88 megabyte floppy drives, few included them in systems, and those that offered 2.88 megabyte drives classified them as options, not standard equipment. 1994 shipments declined to 875,000 drives, only 1.3% of the overall 3.5" floppy drive total, and the 324,000 2.88 megabyte drives expected to ship in 1995 will account for only 0.4% of the worldwide total for all types of 3.5" drives.

One inch high (25.4 millimeter) 3.5" floppy drives became the dominant form factor several years ago, and have shown continuing strength in the face of competition from new drives in thinner physical formats. Intense competition has come from drives with smaller heights -- initially 19 millimeters, then 17 millimeters, 15 millimeters, then in late 1991 12.7 millimeters, and more recently down to 10.9 millimeters.

The decline during recent years in shipments of 3.5" floppy drives in the 15-19 millimeter height range is now starting to be offset by the growth in shipments for drives with heights of 12.7 millimeters or less, driven by demand for notebook computers and combination packages which combine 12.7 millimeter 3.5" and thin 5.25" floppy drives in a "half high" form factor. However, the current weakness in shipments of 15-19 millimeter high floppy drives is expected to be strong enough in 1995 to cause a 10.3% decline in total 3.5" low capacity floppy drive unit shipments.

Shipments of 3" floppy drives declined during the late 1980's and ended in 1991. The major market for these drives was the European home computer market, but newer systems with other data storage devices eventually prevailed. 3" drives never significantly penetrated the United States market, and after an early lead were overtaken in the Japan domestic market by 3.5" drives. Several drive manufacturers also experimented with 2" floppy drives, most recently available only in the Sony format. However, 2" floppy drives did not attract a wide following due to lack of interchange capability with other microfloppy formats, and 1993 was the last production year for 2" floppy drives.

Personal computer applications currently dominate unit shipments of low capacity floppy drives, utilizing 92.4% of the worldwide total in 1994. However, personal computer applications are expected to take a somewhat smaller share of 1998's total shipments, declining to 87.0%, as consumer and hobby applications increase from 1.7% in 1994 to 11.0% in 1998.

Based on strong shipments in both 3.5" and 5.25" formats, TEAC assumed leadership in 1994 noncaptive floppy drive shipments, with 13.3 million drives, 18.2 % of the worldwide total. Mitsumi Electric rose to second place with 11.85 million drives, also a combination of 3.5" and 5.25" models, 16.2% of the total. Sony held third place with 11.8 million drives, all 3.5", for 16.1%. Sony was the largest producer of noncaptive 3.5" drives in 1994.

Marketing trends

5.25" floppy drives are expected to virtually disappear by 1998, but the continuously increasing shipments of 3.5" floppy drives will maintain overall growth for the low capacity flexible disk drive product group. By 1998, total shipments are expected to reach 92.9 million drives, an average annual increase of 5.9% for the 1996-98 period. On the other hand, average unit prices will stay on a downward slope, forcing total revenues for low capacity flexible disk drives to decline to $1.7 billion, an average 4.5% annual drop for the same period.

The 1996-98 annual growth rate for 3.5" floppy drives is projected at 8.5%, a higher rate than for all low capacity floppy drives, but lower than the probable growth for personal computers, the largest application for these drives. There is no doubt that low capacity 3.5" floppy drives will still be used with a high percentage of personal computers, but there is now a variety of competitive storage devices which are expected to capture selected portions of the floppy drive market, as a result of the various capacity and performance enhancements offered by newly introduced drives, with others expected to be in the market within the coming year.

There is a trend for some notebook computers to be designed without internal floppy drives, replying on other methods of interchange, such as direct or infrared connections to networks. Although the increasing population of CD-

ROM drives in the personal computer and workstation markets will absorb a portion of the software distribution role traditionally held by floppies, CD-ROM penetration of these markets by itself is not expected to have a significant impact on shipments of floppy drives, which provide a unique low cost interchange medium. However, the high capacity 3.5" floppy drives in the 100+ megabyte range now entering the market could displace a limited number of low capacity 3.5" floppy drives. Some of the announced high capacity 3.5" floppy drives offer backward compatibility to low capacity diskettes, and when used will clearly be installed in lieu of a low capacity 3.5" floppy drive.

Noncaptive floppy drive price levels are expected to continue the long-term trend to lower levels, as the result of continuing intense competition between leading Japanese floppy drive manufacturers and the lower costs these manufacturers are achieving as they fine-tune the manufacturing facilities established during the last few years in the Philippines, Malaysia, Thailand, and China. The overall average unit OEM price for 3.5" floppy drives is forecasted to be only $20 in 1996, dropping to $16 in 1998.

The future for drives with heights less than one inch is a mixed picture. Most floppy drive manufacturers have discontinued drives in the 15-19 millimeter height range. Shipments of drives in the 10.9-12.7 millimeter height range have steadily increased, with more gains expected. However, growth in total shipments of drives less than one inch high is expected to slow in the 1996-98 period, boosting annual shipments only slightly, to 11.3 million drives in 1998.

Increased demand for 10.9-12.7 millimeter high floppy drives is driven mostly by the continuing expansion of the notebook computer market, which now employs floppies limited to this height range. However, in addition to the direct network connections now used with selected notebook computers, some others are being packaged in ever-smaller form factors, accelerating the tendency to eliminate the floppy drive in the smaller implementations, relying for interchange on network connections or on externally attached floppy drives.

The movement to smaller, lower weight notebook computers has been slow, due to the existing limitations of screens and batteries, but the expected improvements in these components will eventually make lighter weight systems feasible, strengthening the movement to eliminate the internal floppy drive from notebook computers by the end of this forecast period. The smaller market for packaging thin floppy drives in combination units with CD-ROM drives, PCMCIA card slots and other devices is not expected to provide enough momentum to sustain the current unit shipment growth rate for 3.5" floppy disk drives less than one inch high.

Perhaps the most significant limitation on wider usage of 10.9-12.7 millimeter 3.5" floppy drives is the higher typical prices for these models. 10.9-12.7 millimeter OEM drives are priced an average of $12 higher than one inch high models in 1995, and the differential is expected to remain as high as $8 in 1998. As a result of these limits on the potential market growth for thin drives, one inch high 3.5" drives are expected to remain the dominant 3.5" low capacity flexible disk drive format, with 87.8% of the 1998 market.

Despite IBM's initial surge of PS/2 systems using 2.88 megabyte drives, in the general overhaul of its personal computer product lineup which IBM undertook in 1994, the PS/2 models were dropped, and 2.88 megabyte floppy drives are now available only as options on most of the company's PC models. Other personal computer manufacturers continue to show no signs of extensive utilization of 2.88 megabyte drives in their systems.

2.88 megabyte 3.5" floppy drives are projected to provide only 0.1% of the 1997 unit shipment total for all 3.5" drives, and to disappear completely in 1998. The major problem for most system manufacturers is the price differential between 2.88 megabyte drives and 1.44 megabyte drives, the current industry standard. Due to limited demand, the price differential for 2.88 megabyte OEM floppy drives is an average of $19 more than 1.44 megabyte drives in 1995. Because of intense price competition in the personal computer industry, aggressive cost reduction programs are under way and few system manufacturers have been willing to add significantly to their product costs.

Technical trends

The highest development priority for manufacturers of low capacity 3.5" flexible disk drives in recent years has been cost reduction. Intense activity has resulted in lower costs through reduction of electronic and mechanical parts counts, and through substitution of alternate materials. However, the same level of improvement has been more difficult with 2.88 megabyte drives and with very thin drive assemblies.

The only significant potential problem for the floppy drive industry in establishing large-scale production of 2.88 megabyte drives was availability of the multifunction head required to provide downward compatibility with .7 and 1.44 megabyte drives. But with multiple head sources established, the continuing challenge is cost reduction.

The next challenges for most manufacturers of 3.5" drives were packaging problems in reducing the height of the drive to meet the demand for half inch high drives -- and hold down costs at the same time. It has been very expensive and technically difficult for most manufacturers to match competition with continually smaller drive configurations. Nevertheless, the changes have been achievable, once production of smaller motors and other key components became available. The thinner drive configurations have made possible the initial announcements in 1994 of combination packages of 3.5" floppy drive/CD-ROM drive and 3.5" floppy drive/PCMCIA card slot combinations, which will present another round of cost reduction challenges.

Many manufacturers have found it convenient to use belt drive arrangements instead of the direct drive motors common with most of today's floppy drives and preferred by the majority of system manufacturers. Several small format drives using direct drive motors have been announced, but considerable effort will probably be expended to explore various mechanical designs before an industry consensus on this point is reached.

Forecasting assumptions

1. 3.5" drives with heights less than one inch will decline to less than 13% of the 3.5" floppy shipment total for 1998, and 1.44 megabyte drives will maintain shipment dominance through 1998.

2. No major personal computer manufacturer will utilize 2.88 megabyte drives as a standard for its product lines.

3. 8" floppy drives will be out of production after 1997, and 5.25" floppy drives will constitute only 0.2% of 1998 overall shipments of low capacity flexible disk drives.

4. A positive growth rate for personal computers will continue through 1998.

5. The dollar/yen exchange rate will stay in the current range, and prices for noncaptive 3.5" drives will continue to decline at the forecasted rate.

TABLE 53

LOW CAPACITY FLEXIBLE DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1994		Forecast							
	Revenues		1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	6.4	211.8	2.7	102.8	3.1	165.8	3.6	161.5	5.0	157.9
PCM/Reseller	239.7	423.4	204.3	391.5	156.4	314.9	136.0	267.9	126.3	258.7
OEM/Integrator	687.1	1,660.1	563.7	1,460.6	511.9	1,369.3	478.9	1,298.4	465.9	1,282.4
TOTAL NON-U.S. REVENUES	933.2	2,295.3	770.7	1,954.9	671.4	1,850.0	618.5	1,727.8	597.2	1,699.0
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	933.2	2,295.3	770.7	1,954.9	671.4	1,850.0	618.5	1,727.8	597.2	1,699.0
OEM Average Price ($000)		.028		.024		.020		.018		.016

TABLE 54

LOW CAPACITY FLEXIBLE DISK DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1994		Forecast							
	Shipments		1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--
Non-U.S. Manufacturers										
Captive	60.0	2,148.0	30.0	1,120.0	40.0	1,901.0	55.0	2,098.0	90.0	2,395.0
PCM/Reseller	8,240.0	14,670.0	8,517.0	16,285.0	7,240.0	14,205.0	7,235.0	14,297.0	7,270.0	14,820.0
OEM/Integrator	24,449.0	58,696.0	23,952.0	60,799.0	25,341.0	66,072.0	26,781.0	70,743.0	28,100.0	75,715.0
TOTAL NON-U.S. SHIPMENTS	32,749.0	75,514.0	32,499.0	78,204.0	32,621.0	82,178.0	34,071.0	87,138.0	35,460.0	92,930.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	32,749.0	75,514.0	32,499.0	78,204.0	32,621.0	82,178.0	34,071.0	87,138.0	35,460.0	92,930.0
Cumulative Shipments (Units in millions)										
WORLDWIDE TOTAL	218.7	480.8	251.2	559.0	283.8	641.1	317.9	728.3	353.3	821.2

TABLE 55

LOW CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1994 Revenues			Forecast 1995			1996			1997			1998	
	8"	5.25"	3.5"	8"	5.25"	3.5"	8"	5.25"	3.5"	8"	5.25"	3.5"	5.25"	3.5"
U.S. MANUFACTURERS														
TOTAL U.S. REVENUES	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS														
Captive	2.7	11.3	197.8	1.0	4.8	97.0	--	1.9	163.9	--	.7	160.8	--	157.9
PCM/Reseller	--	115.7	307.7	--	68.5	323.0	--	47.0	267.9	--	10.0	257.9	1.9	256.8
OEM/Integrator	4.3	241.0	1,414.8	2.6	118.8	1,339.2	1.7	51.6	1,316.0	.6	15.4	1,282.4	2.8	1,279.6
TOTAL NON-U.S. REVENUES	7.0	368.0	1,920.3	3.6	192.1	1,759.2	1.7	100.5	1,747.8	.6	26.1	1,701.1	4.7	1,694.3
WORLDWIDE RECAP														
Captive	2.7	11.3	197.8	1.0	4.8	97.0	--	1.9	163.9	--	.7	160.8	--	157.9
	-20.6%	-81.2%	-22.1%	-63.0%	-57.5%	-51.0%	--	-60.4%	+69.0%	--	-63.2%	-1.9%	--	-1.8%
PCM/Reseller	--	115.7	307.7	--	68.5	323.0	--	47.0	267.9	--	10.0	257.9	1.9	256.8
	--	-22.3%	+3.4%	--	-40.8%	+5.0%	--	-31.4%	-17.1%	--	-78.7%	-3.7%	-81.0%	-.4%
OEM/Integrator	4.3	241.0	1,414.8	2.6	118.8	1,339.2	1.7	51.6	1,316.0	.6	15.4	1,282.4	2.8	1,279.6
	+10.3%	-42.9%	+3.9%	-39.5%	-50.7%	-5.3%	-34.6%	-56.6%	-1.7%	-64.7%	-70.2%	-2.6%	-81.8%	-.2%
Total Revenues	7.0	368.0	1,920.3	3.6	192.1	1,759.2	1.7	100.5	1,747.8	.6	26.1	1,701.1	4.7	1,694.3
	-6.7%	-41.7%	+.4%	-48.6%	-47.8%	-8.4%	-52.8%	-47.7%	-.6%	-64.7%	-74.0%	-2.7%	-82.0%	-.4%
ANNUAL SHARE, BY DIAMETER	.3%	16.0%	83.7%	.2%	9.8%	90.0%	.1%	5.4%	94.5%	--	1.5%	98.5%	.3%	99.7%

TABLE 56

LOW CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1994 Shipments			Forecast 1995			1996			1997			1998	
	8"	5.25"	3.5"	8"	5.25"	3.5"	8"	5.25"	3.5"	8"	5.25"	3.5"	5.25"	3.5"
U.S. MANUFACTURERS														
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NON-U.S. MANUFACTURERS														
Captive	7.0	101.0	2,040.0	3.0	47.0	1,070.0	--	21.0	1,880.0	--	8.0	2,090.0	--	2,395.0
PCM/Reseller	--	3,103.0	11,567.0	--	2,018.0	14,267.0	--	975.0	13,230.0	--	322.0	13,975.0	65.0	14,755.0
OEM/Integrator	19.0	6,610.0	52,067.0	12.0	3,540.0	57,247.0	8.0	1,634.0	64,430.0	3.0	510.0	70,230.0	95.0	75,620.0
TOTAL NON-U.S. SHIPMENTS	26.0	9,814.0	65,674.0	15.0	5,605.0	72,584.0	8.0	2,630.0	79,540.0	3.0	840.0	86,295.0	160.0	92,770.0
WORLDWIDE RECAP														
Captive	7.0	101.0	2,040.0	3.0	47.0	1,070.0	--	21.0	1,880.0	--	8.0	2,090.0	--	2,395.0
	-12.5%	-79.0%	-12.5%	-57.1%	-53.5%	-47.5%	--	-55.3%	+75.7%	--	-61.9%	+11.2%	--	+14.6%
PCM/Reseller	--	3,103.0	11,567.0	--	2,018.0	14,267.0	--	975.0	13,230.0	--	322.0	13,975.0	65.0	14,755.0
	--	-17.2%	+27.7%	--	-35.0%	+23.3%	--	-51.7%	-7.3%	--	-67.0%	+5.6%	-79.8%	+5.6%
OEM/Integrator	19.0	6,610.0	52,067.0	12.0	3,540.0	57,247.0	8.0	1,634.0	64,430.0	3.0	510.0	70,230.0	95.0	75,620.0
	+11.8%	-37.0%	+30.9%	-36.8%	-46.4%	+9.9%	-33.3%	-53.8%	+12.5%	-62.5%	-68.8%	+9.0%	-81.4%	+7.7%
Total Shipments	26.0	9,814.0	65,674.0	15.0	5,605.0	72,584.0	8.0	2,630.0	79,540.0	3.0	840.0	86,295.0	160.0	92,770.0
	--	-33.3%	+28.4%	-42.3%	-42.9%	+10.5%	-46.7%	-53.1%	+9.6%	-62.5%	-68.1%	+8.5%	-81.0%	+7.5%
ANNUAL SHARE, BY DIAMETER	--	13.0%	87.0%	--	7.2%	92.8%	--	3.2%	96.8%	--	1.0%	99.0%	.2%	99.8%

TABLE 57

LOW CAPACITY 3.5" FLEXIBLE DISK DRIVES

WORLDWIDE SHIPMENTS (000)

DRIVE HEIGHT ANALYSIS

	1994 --Shipments--		----------Forecast---------- 1995		1996		1997		1998	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	2,040.0		1,070.0		1,880.0		2,090.0		2,395.0	
Less than 1 inch	1,640.0	80.4%	850.0	79.4%	1,570.0	83.5%	1,660.0	79.4%	1,740.0	72.7%
1 inch	400.0	19.6%	220.0	20.6%	310.0	16.5%	430.0	20.6%	655.0	27.3%
Noncaptive Total	63,634.0		71,514.0		77,660.0		84,205.0		90,375.0	
Less than 1 inch	9,799.0	15.4%	9,395.0	13.1%	9,290.0	12.0%	9,570.0	11.4%	9,600.0	10.6%
1 inch	53,835.0	84.6%	62,119.0	86.9%	68,370.0	88.0%	74,635.0	88.6%	80,775.0	89.4%
Total Non-U.S.	65,674.0		72,584.0		79,540.0		86,295.0		92,770.0	
Less than 1 inch	11,439.0	17.4%	10,245.0	14.1%	10,860.0	13.7%	11,230.0	13.0%	11,340.0	12.2%
1 inch	54,235.0	82.6%	62,339.0	85.9%	68,680.0	86.3%	75,065.0	87.0%	81,430.0	87.8%
WORLDWIDE RECAP										
Total Worldwide Ship	65,674.0		72,584.0		79,540.0		86,295.0		92,770.0	
	+28.4%		+10.5%		+9.6%		+8.5%		+7.5%	
Less than 1 inch	11,439.0	17.4%	10,245.0	14.1%	10,860.0	13.7%	11,230.0	13.0%	11,340.0	12.2%
	+30.6%		-10.3%		+6.0%		+3.4%		+1.0%	
1 inch	54,235.0	82.6%	62,339.0	85.9%	68,680.0	86.3%	75,065.0	87.0%	81,430.0	87.8%
	+33.9%		+14.9%		+10.2%		+9.3%		+8.5%	

Notes: Percentage figures with plus/minus signs refer to year-to-year growth rates.

TABLE 58

LOW CAPACITY 3.5" FLEXIBLE DISK DRIVES

WORLDWIDE SHIPMENTS (000)

DRIVE CAPACITY ANALYSIS

	1994 --Shipments--		-----Forecast----- 1995		1996		1997		1998	
	Units	%	Units	%	Units	%	Units	%	Units	%
U.S. MANUFACTURERS										
Total U.S.	--		--		--		--		--	
NON-U.S. MANUFACTURERS										
Captive Total	2,040.0		1,070.0		1,880.0		2,090.0		2,395.0	
1.2/1.44 Megabytes	2,040.0	100.0%	1,070.0	100.0%	1,880.0	100.0%	2,090.0	100.0%	2,395.0	100.0%
Noncaptive Total	63,634.0		71,514.0		77,660.0		84,205.0		90,375.0	
.7 Megabyte or less	785.0	1.2%	223.0	.3%	90.0	.1%	--	--	--	--
1.2/1.44 Megabytes	61,974.0	97.4%	70,967.0	99.2%	77,380.0	99.7%	84,120.0	99.9%	90,375.0	100.0%
2.88 Megabytes	875.0	1.4%	324.0	.5%	190.0	.2%	85.0	.1%	--	--
Total Non-U.S.	65,674.0		72,584.0		79,540.0		86,295.0		92,770.0	
.7 Megabyte or less	785.0	1.2%	223.0	.3%	90.0	.1%	--	--	--	--
1.2/1.44 Megabytes	64,014.0	97.5%	72,037.0	99.3%	79,260.0	99.7%	86,210.0	99.9%	92,770.0	100.0%
2.88 Megabytes	875.0	1.3%	324.0	.4%	190.0	.2%	85.0	.1%	--	--
WORLDWIDE RECAP										
Total Worldwide Ship	65,674.0		72,584.0		79,540.0		86,295.0		92,770.0	
	+28.4%		+10.5%		+9.6%		+8.5%		+7.5%	
.7 Megabyte or less	785.0	1.2%	223.0	.3%	90.0	.1%	--	--	--	--
	-53.7%		-71.5%		-59.5%		--		--	
1.2/1.44 Megabytes	64,014.0	97.5%	72,037.0	99.3%	79,260.0	99.7%	86,210.0	99.9%	92,770.0	100.0%
	+33.9%		+12.5%		+10.0%		+8.8%		+7.6%	
2.88 Megabytes	875.0	1.3%	324.0	.4%	190.0	.2%	85.0	.1%	--	--
	-46.5%		-62.9%		-41.3%		-55.2%		--	

Notes: Percentage figures with plus/minus signs refer to year-to-year growth rates.

TABLE 59

LOW CAPACITY FLEXIBLE DISK DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1994 Estimate Units (000)	1994 Estimate %	1998 Projection Units (000)	1998 Projection %
VERY HIGH PERFORMANCE Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS General purpose	--	--	--	--
NETWORKS/MINI/MULTIUSER Midrange systems and network servers	634.3	.8	278.8	.3
PERSONAL COMPUTERS Business and professional, single user	69,759.8	92.4	80,849.1	87.0
WORKSTATIONS Engineering and office, single user	2,862.0	3.8	1,301.0	1.4
CONSUMER, GAME AND HOBBY COMPUTERS	1,261.1	1.7	10,222.3	11.0
OTHER APPLICATIONS	996.8	1.3	278.8	.3
Total	75,514.0	100.0	92,930.0	100.0

TABLE 60

LOW CAPACITY FLEXIBLE DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1994 Net Shipments									
	To United States Destinations					Worldwide				
	Units (000)				%	Units (000)				%
Drive Manufacturers	8"	5.25"	3.5"	Total		8"	5.25"	3.5"	Total	
TEAC	--	1746.0	4672.0	6418.0	19.6	--	3463.0	9874.0	13337.0	18.2
Mitsumi Electric	--	600.0	3740.0	4340.0	13.3	--	1310.0	10540.0	11850.0	16.2
Sony	--	--	6225.0	6225.0	19.0	--	--	11800.0	11800.0	16.1
Seiko Epson	--	730.0	2210.0	2940.0	9.0	--	1470.0	4570.0	6040.0	8.2
Matsushita Comm. Ind.	--	160.0	1250.0	1410.0	4.3	--	845.0	4670.0	5515.0	7.5
Mitsubishi Electric	--	112.0	3000.0	3112.0	9.5	--	159.0	5255.0	5414.0	7.4
Citizen	--	--	977.0	977.0	3.0	--	--	3765.0	3765.0	5.1
Y-E Data	6.0	165.0	1776.0	1947.0	6.0	16.0	366.0	2936.0	3318.0	4.5
Alps Electric	--	--	1475.0	1475.0	4.5	--	--	3165.0	3165.0	4.3
Chinon	--	715.0	1392.0	2107.0	6.4	--	915.0	2143.0	3058.0	4.2
NEC	--	260.0	590.0	850.0	2.6	3.0	380.0	1240.0	1623.0	2.2
Matsushita Elec. Ind.	--	--	--	--	--	--	--	1501.0	1501.0	2.0
Other U.S.	--	--	--	--	--	--	--	--	--	--
Other Non-U.S.	--	348.0	540.0	888.0	2.8	--	805.0	2175.0	2980.0	4.1
TOTAL	6.0	4836.0	27847.0	32689.0	100.0	19.0	9713.0	63634.0	73366.0	100.0

PCMCIA FLASH CARD SPECIFICATIONS

PCMCIA FLASH CARD SPECIFICATIONS

Coverage

This product specification section of the Removable Data Storage report includes flash cards packaged in PCMCIA format, which are now in production or announced, arranged alphabetically by manufacturer.

Specifications of flash card models sold by computer system manufacturers but purchased on an OEM basis from others may be included in a few cases for clarity. Not listed in most cases are captive cards which are similar to OEM models made by the same manufacturer. In some cases, cards made by one card manufacturer and resold by another card manufacturer may be included for identification purposes.

Generic product type

The flash memory cards are categorized as "Flash disk" if organized as a disk drive, and "Flash memory" otherwise. The flash memory category is often called "Linear flash memory".

Chip density and chip count

Chip density is the number of bits contained on each of the several memory chips included in the flash card, expressed in megabits. Chip count is the number of memory chips on the card.

Chip logic

Chip logic describes the basic logical architecture of the memory chip, typically NAND or NOR. Minor variations are assigned to the basic architecture.

Chip organization

This parameter describes how the chip is addressed by its controller. In the case of flash memory, it is by word width and the number of words on the chip, e.g. 1 x 8 is 1 million 8 bit words, .512 x 16 is 512,000 16 bit words, etc. Some flash memory cards can operate in more than one mode. In the case of flash disks, three parameters are given that are equivalent to heads, sectors and cylinders on an equivalent disk drive.

Package

Package refers to the PC Card standard form factor used for the card.

Interface

This describes the interface according to the PCMCIA standard definition. Flash disk cards are designated as PCMCIA-ATA. Flash memory is designated with the PCMCIA revision level specified by each of the manufacturers. If the card does not conform to PCMCIA interface specifications, it is designated by the width of the data transfer path, (in bits, if given by the manufacturer) or as "Proprietary".

XIP

XIP (execute in place) is a capability of most flash memory cards that enables the card to appear as additional main memory to the host system.

Erasable block size

The erasable block size given is for individual chips except where noted. Card manufacturers may provide for simultaneous erasure of chips in pairs or other multiple units.

Capacity

Formatted capacities for flash disk cards have been shown in order to be consistent with the disk drive industry's trend in recent years to identify all drives by formatted capacities. Flash memory capacity is given in unformatted form, since formatting applies only when a flash memory card is used with flash file system software.

Sector endurance, spare sectors and wearout leveling

A flash memory segment or sector can be erased and rewritten a limited number of times. As specified by the manufacturer, this is a minimum specification, and most cards will exceed the specification. In order to extend the life of the memory, writes are spread across the entire memory, minimizing the accumulation of write/erase events at any one location. This is called wearout leveling, and is functionally embedded in some flash cards. Cards without this feature must have wearout leveling provided by host driver software. Flash disk cards may have spare sectors supplied to accommodate a sector failure.

Average access time

In a flash card, the time between the issuance of a read command and the transmission of data to the host system. As used in this report, it is assumed that the card is not in a powered down or sleep mode when the command is given.

Internal data read rate

The rate at which data is transferred from the card memory chips to the card control logic.

Internal data write rate

Except as noted, internal write rates given are for individual chips and assumed the chip has already been erased. Card manufacturers may provide for simultaneous writes of multiple chips.

External transfer rate

This is the maximum rate at which data can be transferred between the on-card controller and the host system.

Block erase time

Flash memory must be erased a block at a time, and must be erased before it can be written. This parameter is the time required to erase the smallest erasable block.

Accuracy

All information has been cross-checked for accuracy. However, it is anticipated that some errors may be included, since many manufacturers' published specifications do not cover all of the items listed, and numerous verbal inquiries were necessary. Your corrections will be most welcome and will be included in the next edition.

DISK/TREND product groups

In most cases the product groups used for individual flash memory cards are clear, but a few arbitrary decisions have been made. Note that all drives with capacities over 25 megabytes have been placed in the highest capacity group.

1995 DISK/TREND product groups for flash cards included in the Removable Data Storage report

Group number	Cards included
40.	PCMCIA flash cards, less than 10 megabytes
41.	PCMCIA flash cards, 10 - 25 megabytes
42.	PCMCIA flash cards, 25 - 100 megabytes
43.	PCMCIA flash cards, more than 100 megabytes

MANUFACTURER	ACTIONTEC	ACTIONTEC	ACTIONTEC	ACTIONTEC	ACTIONTEC
MODEL	FH002M-BN	FH004M-BN	FH008M-BN	FH010M-BN	FH016M-BN
DISK/TREND GROUP	40	40	40	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)					
Internal ECC	None	None	None	None	None
CAPACITY: Total capacity (Mbytes)	2	4	8	10	16
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	70 (read)	70 (read)	70 (read)	70 (read)	70 (read)
Media read rate (MB/Sec)	10	10	10	10	10
Media write rate (MB/Sec)	.85	.85	.85	.85	.85
Burst transfer rate (MB/Sec)	10 (read)	10 (read)	10 (read)	10 (read)	10 (read)
Block erase time (ms)	300	300	300	300	300
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 3.3 V 12 V option	5 V, 3.3 V 12 V option	5 V, 3.3 V 12 V option	5 V, 3.3 V 12 V option	5 V, 3.3 V 12 V option
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1994	1994
COMMENTS					

MANUFACTURER	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES
MODEL	AMC001CFLKA	AMC002CFLKA	AMC004CFLKA	AMC004DFLKA	AMC008DFLKA
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM	OEM	OEM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	4	4	4	16	16
Chip count per card	2	4	8	2	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	4 x 8	4 x 8	4 x 8	4 x 8	4 x 8
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64	64	64	64	64
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	1	2	4	4	8
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	Software	Software	Software	Software	Software
PERFORMANCE: Avg. access time (ns)	150	150	150	150	150
Media read rate (MB/Sec)	13.3	13.3	13.3	13.3	13.3
Media write rate (MB/Sec)	.125	.125	.125	.25	.25
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	1500	1500	1500	1000	1000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	5/94	5/94	5/94	7/95	7/95
COMMENTS					

MANUFACTURER	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	AMP	AMP	AMP
MODEL	AMC010CFLKA	AM020DFLKA	1-797459-1* 1-797459-2 FlashLite	1-797459-3* 1-797459-4 FlashLite	2-797132-5* 797132-1 Flash 5
DISK/TREND GROUP	41	41	40	40	40
MARKET	OEM	OEM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	4	16	1	16	1
Chip count per card	20	10	1	1	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	4 x 8	4 x 8			8x.256/16x.128
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	8 bit	8 bit	PCMCIA 2.1
XIP	Yes	Yes	No	No	No
Erasable block size (KB)	64	64	128	64	.128/.512
Internal ECC	--	--	No		--
CAPACITY:					
Total capacity (Mbytes)	10	20	.128	2	.256
SECTOR ENDURANCE: (Kcycles)	100	100	10	100	
Spare sectors	--	--	--	--	--
Wearout leveling	Software	Software	No	No	--
PERFORMANCE:					
Avg. access time (ns)	150	150	200	150	200
Media read rate (MB/Sec)	13.3	13.3			5
Media write rate (MB/Sec)	.125	.25			--
Burst transfer rate (MB/Sec)	--	--			--
Block erase time (ms)	1500	1000			--
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	5/94	7/95			1Q94
COMMENTS			*Without AMP label. Atmel chips.	*Without AMP label. AMD chips.	*Without AMP label. Atmel chips.

MANUFACTURER	AMP	AMP	AMP	AMP	AMP
MODEL	2-797132-6* 797132-2 Flash 5	2-797132-7* 797132-3 Flash 5	2-797132-8* 797132-4 Flash 5	2-797262-5* 797262-1 Flash 5C	2-797262-6* 797262-2 Flash 5C
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	1	1	1	4	4
Chip count per card	4	8	16	2	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	8x.512/16x.256	8 x 1/16 x .512	8 x 2/16 x 1	8 x 1/16 x .512	8 x 2/16 x 1
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	No	No	No
Erasable block size (KB)	.128/.512	.128/.512	.128/.512	.128/.512	.128/.512
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	.512	1	2	1	2
SECTOR ENDURANCE: (Kcycles)					
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	200	200	200	200	200
Media read rate (MB/Sec)	5	5	5	5	5
Media write rate (MB/Sec)	--	--	--	--	--
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	--	--	--	--	--
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	1Q94	1Q94	1Q94
COMMENTS	*Without AMP label. Atmel chips.	*Without AMP label. Atmel chips.	*Without AMP label. Atmel chips.	*Without AMP label. AMD chips.	*Without AMP label. AMD chips.

MANUFACTURER	AMP	AMP	AMP	AMP	AMP
MODEL	2-797262-7* 797262-3 Flash 5C	2-797262-8* 797262-4 Flash 5C	3-797078-7* 1-797078-1 Flash 12	3-797078-8* 1-797078-2 Flash 12	3-797078-9* 1-797078-3 Flash 12
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	4	4	2	2	2
Chip count per card	8	16	2	4	8
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	8 x 4/16 x 2	8 x 8/16 x 4	8 x 1/16 x .512	8 x 2/16 x 1	8x.512/16x.256
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	No	No	No
Erasable block size (KB)	.128/.512	.128/.512	8	8	8
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	4	8	.512	1	2
SECTOR ENDURANCE: (Kcycles)			10	10	10
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	200	200	200	200	200
Media read rate (MB/Sec)	5	5	5	5	5
Media write rate (MB/Sec)	--	--	.065	.065	.065
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	--	--	2000	2000	2000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	1Q94	1Q94	1Q94
COMMENTS	*Without AMP label. AMD chips.	*Without AMP label. AMD chips.	*Without AMP label. Intel chips.	*Without AMP label. Intel chips.	*Without AMP label. Intel chips.

MANUFACTURER	AMP	AMP	AMP	AMP	AMP
MODEL	3-797263-1* 797263-1 Flash 12HC	3-797263-2* 797263-2 Flash 12HC	3-797263-3* 797263-3 Flash 12HC	3-797263-4* 797263-4 Flash 12HC	3-797441-1* 2-797441-1
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	8	8	8	8	1
Chip count per card	2	4	8	10	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	16 bit
XIP					No
Erasable block size (KB)					128
Internal ECC	No	No	No	No	No
CAPACITY: Total capacity (Mbytes)	2	4	8	10	.256
SECTOR ENDURANCE: (Kcycles)					10
Spare sectors	--	--	--	--	--
Wearout leveling	No	No	No	No	No
PERFORMANCE: Avg. access time (ns)	200	200	200	200	200
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V
FIRST CUSTOMER SHIPMENT					
COMMENTS	*Without AMP label. Intel chips.	*Without AMP label. Intel chips.	*Without AMP label. Intel chips.	*Without AMP label. Intel chips.	*Without AMP label. Atmel chips.

MANUFACTURER	AMP	AMP	AMP	AMP	AMP
MODEL	3-797441-2* 2-797441-2	3-797441-3* 2-797441-3 FlashLite	3-797441-4* 2-797441-4 FlashLite	3-797441-5* 2-797441-5 FlashLite	3-797441-6* 2-797441-6 FlashLite
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	4	4	4	16	16
Chip count per card	2	1	4	2	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	16 bit	16 bit	16 bit	16 bit	16 bit
XIP	No	No	No	No	No
Erasable block size (KB)	256/512	64	64	64	64
Internal ECC	No		No	No	No
CAPACITY: Total capacity (Mbytes)	1	.256	1	4	8
SECTOR ENDURANCE: (Kcycles)	10	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	No	No	No	No	No
PERFORMANCE: Avg. access time (ns)	200	150	150	150	150
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT					
COMMENTS	*Without AMP label. Atmel chips.	*Without AMP label. AMD chips.	*Without AMP label. AMD chips.	*Without AMP label. AMD chips.	*Without AMP label. AMD chips.

MANUFACTURER	AMP	AMP	AMP	AMP	AMP
MODEL	3-797441-7* 2-797441-7 FlashLite	3-797441-8* 2-797441-8 FlashLite	3-797441-9* 2-797441-9 FlashLite	4-797078-0* 1-797078-5 Flash 12	4-797441-0* 3-797441-0 FlashLite
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	1	2	8	2	8
Chip count per card	1	1	2	16	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization				8 x 2/16 x 2	
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	16 bit	16 bit	16 bit	PCMCIA 2.1	16 bit
XIP	No	No	No	No	No
Erasable block size (KB)	128	256	64	8	64
Internal ECC	No	No	No	--	No
CAPACITY: Total capacity (Mbytes)	.256	.512	2	4	4
SECTOR ENDURANCE: (Kcycles)	100	100	100	10	100
Spare sectors	--	--	--	--	--
Wearout leveling	No	No	No	--	No
PERFORMANCE: Avg. access time (ns)	150	150	150	200	150
Media read rate (MB/Sec)				5	
Media write rate (MB/Sec)				.065	
Burst transfer rate (MB/Sec)				--	
Block erase time (ms)	2000	2000	1600	2000	1600
SIZE: (mm: H x W x D)	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3.3 x 54 x 85.6	3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS	*Without AMP label. Intel chips.	*Without AMP label. Intel chips.	*Without AMP label. Intel chips.	*Without AMP label. Intel chips.	*Without AMP label. Intel chips.

MANUFACTURER	AMP	AMP	AMP	AMP	AMP
MODEL	797459-1* 797459-6 FlashLite	797459-2* 797459-7 FlashLite	797459-3* 797459-8 FlashLite	797459-4* 797459-9 FlashLite	797459-5* 1-797459-0 FlashLite
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	4	4	1	2	8
Chip count per card	1	1	1	1	1
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	8 bit	8 bit	8 bit	8 bit	8 bit
XIP	No	No	No	No	No
Erasable block size (KB)	256/512	64	128	256	64
Internal ECC	No		No	No	No
CAPACITY: Total capacity (Mbytes)	.512	.512	.128	.256	1
SECTOR ENDURANCE: (Kcycles)	10	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	No	No	No	No	No
PERFORMANCE: Avg. access time (ns)	200	150	150	150	150
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)			2000	2000	1600
SIZE: (mm: H x W x D)	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS	*Without AMP label. Atmel chips.	*Without AMP label. AMD chips.	*Without AMP label. Intel chips.	*Without AMP label. Intel chips.	*Without AMP label. Intel chips.

MANUFACTURER	AMP	CARRY COMPUTER	CARRY COMPUTER	CARRY COMPUTER	CARRY COMPUTER
MODEL	3-797263-5* 797263-5 Flash 12HC	2MB	4MB	8MB	16MB
DISK/TREND GROUP	41	40	40	40	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	8	8	8	8	8
Chip count per card	16	2	4	8	16
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization		1 x 8	1 x 8	1 x 8	1 x 8
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP		Yes	Yes	Yes	Yes
Erasable block size (KB)		128*	128*	128*	128*
Internal ECC	No	None	None	None	None
CAPACITY: Total capacity (Mbytes)	16	2	4	8	16
SECTOR ENDURANCE: (Kcycles)		100	100	100	100
Spare sectors	--	None	None	None	None
Wearout leveling	No	--	--	--	--
PERFORMANCE: Avg. access time (ns)	200	200	200	200	200
Media read rate (MB/Sec)		5	5	5	5
Media write rate (MB/Sec)		.2*	.2*	.2*	.2*
Burst transfer rate (MB/Sec)		5	5	5	5
Block erase time (ms)		1600	1600	1600	1600
SIZE: (mm: H x W x D)	3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT		1994	1994	1994	1994
COMMENTS	*Without AMP label. Intel chips.	Intel Series 2 chips. *Chip pair.	Intel Series 2 chips. *Chip pair.	Intel Series 2 chips. *Chip pair.	Intel Series 2 chips. *Chip pair.

MANUFACTURER	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES
MODEL	FL01M-15-111-31 Series 1	FL02M-15-111-31 Series 1	FL02M-20-111-81 Series 2	FL04M-20-111-31 Series 1	FL04M-20-111-81 Series 2
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	4	8	8	8	8
Chip count per card	8	8	2	16	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	8 x 1/16 x .512	8 x 2/8 x 1		8 x 2/8 x 1	
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	Yes	No	Yes
Erasable block size (KB)					
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	1	2	2	4	4
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	150	150	150	150	150
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)	2000	2000	1600	2000	1600
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1993	1993	1994	1994	1994
COMMENTS					

MANUFACTURER	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES
MODEL	FL08M-20-111-81 Series 2	FL256-15-111-31 Series 1	FL512-15-111-31 Series 1	FL16M-20-111-81 Series 2	FL20M-20-111-81 Series 2
DISK/TREND GROUP	40	40	40	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	8	1	2	16	16
Chip count per card	8	2	4	8	10
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization		8x.256/16x.128	8x.512/16x.256		
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	No	No	Yes	Yes
Erasable block size (KB)					
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	8	.256	.512	16	20
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	150	150	150		
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)	1600	2000	2000	1600	1600
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994	1993	1993		
COMMENTS					

MANUFACTURER	CIRRUS LOGIC	CIRRUS LOGIC	CIRRUS LOGIC	CIRRUS LOGIC	CIRRUS LOGIC
MODEL	CL-FD0004	CL-FD0008	CL-FD0012	CL-FD0016	CL-FD0020
DISK/TREND GROUP	40	40	41	41	41
MARKET	OEM	OEM	OEM	OEM	OEM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)	16	16	16	16	16
Chip count per card	2	4	6	8	10
Chip logic type	NAND	NAND	NAND	NAND	NAND
Chip organization	1 x 256	1 x 256	1 x 256	1 x 256	1 x 256
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type II
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	16	16	16	16	16
Internal ECC	Yes	Yes	Yes	Yes	Yes
CAPACITY: Total capacity (Mbytes)	4	8	12	16	20
SECTOR ENDURANCE: (Kcycles)	250	250	250	250	250
Spare sectors	Yes	Yes	Yes	Yes	Yes
Wearout leveling	Yes	Yes	Yes	Yes	Yes
PERFORMANCE: Avg. access time (ns)	200	200	200	200	200
Media read rate (MB/Sec)	8	8	8	8	8
Media write rate (MB/Sec)	8	8	8	8	8
Burst transfer rate (MB/Sec)	16.6*	16.6*	16.6*	16.6*	16.6*
Block erase time (ms)	5-10	5-10	5-10	5-10	5-10
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	3Q95	3Q95	3Q95	3Q95	3Q95
COMMENTS	Samsung chips. *PIO Mode 4. *DMA Mode 3.	Samsung chips. *PIO Mode 4. *DMA Mode 3.	Samsung chips. *PIO Mode 4. *DMA Mode 3.	Samsung chips. *PIO Mode 4. *DMA Mode 3.	Samsung chips. *PIO Mode 4. *DMA Mode 3.

MANUFACTURER	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM
MODEL	RD1001-2MS	RD1001-4MS	RD1001-8MS	RD1001-8MV	RD3001-2
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)					
Chip count per card					
Chip logic type	NAND	NAND	NAND	NAND	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)	4	4	4	16	
Internal ECC					
CAPACITY:					
Total capacity (Mbytes)	2	4	8	8	2
SECTOR ENDURANCE: (Kcycles)	250	250	250	250	1000
Spare sectors					--
Wearout leveling					--
PERFORMANCE:					
Avg. access time (ns)	200	200	200	200	
Media read rate (MB/Sec)	2.2	2.2	2.2	2.7	
Media write rate (MB/Sec)	.5	.5	.5	2.7	
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1994	1995
COMMENTS					Atmel chips

MANUFACTURER	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM
MODEL	RD3001-4	RD3001-8	RD4001-1	RD4001-2	RD4001-4
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP					
Erasable block size (KB)					
Internal ECC					
CAPACITY: Total capacity (Mbytes)	4	8	1	2	4
SECTOR ENDURANCE: (Kcycles)	1000	1000	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)					
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6	3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1995	1995	1995	1995	1995
COMMENTS	Atmel chips	Atmel chips	Atmel chips	Atmel chips	Atmel chips

MANUFACTURER	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM
MODEL	RD4001-8	RD1001-10MS	RD1001-16MS	RD1001-16MV	RD1001-20MS
DISK/TREND GROUP	40	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NAND	NAND	NAND	NAND
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)		4	4	16	4
Internal ECC					
CAPACITY: Total capacity (Mbytes)	8	10	16	16	20
SECTOR ENDURANCE: (Kcycles)	100	250	250	250	250
Spare sectors	--				
Wearout leveling	--				
PERFORMANCE: Avg. access time (ns)		200	200	200	200
Media read rate (MB/Sec)		2.2	2.2	2.7	2.2
Media write rate (MB/Sec)		.5	.5	2.7	.5
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1995	1994	1994	1994	1994
COMMENTS	Atmel chips				

MANUFACTURER	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJI PHOTO FILM	FUJITSU	FUJITSU
MODEL	RD1001-24MS	RD1001-24MV	RD3001-16	MB98A8084X	MB98A8091X
DISK/TREND GROUP	41	41	41	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)				1	1
Chip count per card				2	4
Chip logic type	NAND	NAND	NOR	NOR	NOR
Chip organization				8x.256/16x.128	8x.512/16x.256
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP				No	No
Erasable block size (KB)	4	16			
Internal ECC				--	--
CAPACITY: Total capacity (Mbytes)	24	24	16	.256	.512
SECTOR ENDURANCE: (Kcycles)	250	250	1000	10	10
Spare sectors			--	--	--
Wearout leveling			--	--	--
PERFORMANCE: Avg. access time (ns)	200	200		200	250
Media read rate (MB/Sec)	2.2	2.7		5	5
Media write rate (MB/Sec)	.5	2.7		.0625	.0625
Burst transfer rate (MB/Sec)					
Block erase time (ms)				2000	2000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1994	1994	1995	4Q93	
COMMENTS			Atmel chips		

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
MODEL	MB98A8092X	MB98A8094X	MB98A8101X	MB98A8102X	MB98A8104X
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	2	1	1	2	1
Chip count per card	2	4	8	4	8
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	8x.512/16x.256	8x.512/16x.256	8 x 1/16 x .512	8 x 1/16 x .512	8 x 1/16 x .512
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	no	No	No	No	No
Erasable block size (KB)					
Internal ECC	--	--	--	--	--
CAPACITY:					
Total capacity (Mbytes)	.512	.512	1	1	1
SECTOR ENDURANCE: (Kcycles)	10	10	10	10	10
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE:					
Avg. access time (ns)	250	200	250	250	200
Media read rate (MB/Sec)	4	5	5	4	5
Media write rate (MB/Sec)	.0625	.0625	.0625	.0625	.0625
Burst transfer rate (MB/Sec)					
Block erase time (ms)	2000	2000	2000	2000	2000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT		4Q93			4Q93
COMMENTS					

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
MODEL	MB98A8111X	MB98A8112X	MB98A8113X	MB98A8114X	MB98A8122X
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	1	2	1	1	2
Chip count per card	16	16	2	16	16
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	8 x 2/16 x 1	8 x 2/16 x 1	8 x 2/16 x 1	8 x 2/16 x 1	8 x 4/16 x 2
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No			
Erasable block size (KB)					
Internal ECC	--	--	--	--	--
CAPACITY:					
Total capacity (Mbytes)	2	2	2	2	4
SECTOR ENDURANCE: (Kcycles)	10	10	10	10	10
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE:					
Avg. access time (ns)	200	250	200	200	250
Media read rate (MB/Sec)	5	4	5	5	4
Media write rate (MB/Sec)	.0625	.0625		.0625	.0625
Burst transfer rate (MB/Sec)					
Block erase time (ms)	2000	2000	2000	2000	2000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT			1Q94	4Q93	
COMMENTS					

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	IBM MICRO-ELECTRONICS
MODEL	MB98A8123X	MB98A8133X	MB98A8143X	MB98A81573	17JSSFP3MB
DISK/TREND GROUP	40	40	41	42	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Disk
Chip density (Mb)	1	1	8	16	16
Chip count per card	4	8	16	16	2
Chip logic type	NOR	NOR	NOR	NOR	NAND
Chip organization	8 x 4/16 x 2	8 x 8/16 x 4	8 x 16/16 x 8		48, 4, 32
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA-ATA
XIP			No	Yes	No
Erasable block size (KB)					4
Internal ECC	--	--	--	--	Yes
CAPACITY:					
Total capacity (Mbytes)	4	8	16	32	3
SECTOR ENDURANCE: (Kcycles)	10	10	10		250
Spare sectors	--	--	--	--	Yes
Wearout leveling	--	--	--	--	Yes
PERFORMANCE:					
Avg. access time (ns)	200	200	200		.8 ms
Media read rate (MB/Sec)	5	5	5		7/4.3*/2.5**
Media write rate (MB/Sec)	.0625	.0625	.0625		1.2/1*/.8**
Burst transfer rate (MB/Sec)					8/4*/2**
Block erase time (ms)	2000	2000	2000		6
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	1Q94	3Q95	5/94
COMMENTS				Not sold in US and Europe, except UK	Toshiba chips. *AT reduced power. **AT low power.

MANUFACTURER	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS
MODEL	17JSSFP5MB	17JSSFP10MB	17JSSFP20MB	17JSSFP30MB	17JSSFP40MB
DISK/TREND GROUP	40	41	41	42	42
MARKET	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)	16	16	16	16	16
Chip count per card	3	6	11	16	21
Chip logic type	NAND	NAND	NAND	NAND	NAND
Chip organization	80, 4, 32	160, 4, 32	320, 4, 32	464, 4, 32	624, 4, 32
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type II	PC Card Type II
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	4	4	4	4	4
Internal ECC	Yes	Yes	Yes	Yes	Yes
CAPACITY: Total capacity (Mbytes)	5	10	20	30	40
SECTOR ENDURANCE: (Kcycles)	250	250	250	250	250
Spare sectors	Yes	Yes	Yes	Yes	Yes
Wearout leveling	Yes	Yes	Yes	Yes	Yes
PERFORMANCE: Avg. access time (ns)	.8 ms	.8 ms	.8 ms	.8 ms	.8 ms
Media read rate (MB/Sec)	7/4.3*/2.5**	7/4.3*/2.5**	7/4.3*/2.5**	7/4.3*/2.5**	7/4.3*/2.5**
Media write rate (MB/Sec)	1.2/1*/.8**	1.2/1*/.8*	1.2/1*/.8**	1.2/1*/.8*	1.2/1*/.8*
Burst transfer rate (MB/Sec)	8/4*/2**	8/4*/2**	8/4*/2**	8/4*/2**	8/4*/2**
Block erase time (ms)	6	6	6	6	6
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	5/94	5/94	5/94	5/94	5/94
COMMENTS	Toshiba chips. *AT reduced power. **AT low power.	Toshiba chips. *AT reduced power. **AT low power.	Toshiba chips. *AT reduced power. **AT low power.	Toshiba chips. *AT reduced power. **AT low power.	Toshiba chips. *AT reduced power. **AT low power.

MANUFACTURER	INTEL	INTEL	INTEL	INTEL	INTEL
MODEL	iFD005P2SA Flash Drive	iMC001FLKA Series 1	iMC002FLKA Series 1	iMC002FLSA Series 2	iMC004FLKA Series 1
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	8	2	2	8	2
Chip count per card	6	4	8	2	16
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	160, 2, 32	.256 x 8	.256 x 8	1 x 8	.256 x 8
FEATURES: Package	PC Card Type II	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA 1.0	PCMCIA 1.0	PCMCIA 2.01	PCMCIA 1.0
XIP	No	Yes	Yes	Yes	Yes
Erasable block size (KB)	128*	512*	512*	128*	512*
Internal ECC	8 bits/sector	None	None	None	None
CAPACITY: Total capacity (Mbytes)	5.243	1	2	2	4
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	None	None	None	None	None
Wearout leveling	Yes	--	--	--	--
PERFORMANCE: Avg. access time (ns)	1000**	200	200	150	200
Media read rate (MB/Sec)	8	5	5	5	5
Media write rate (MB/Sec)	.27	.1250*	.1250*	.2*	.1250*
Burst transfer rate (MB/Sec)	5	5	5	5	5
Block erase time (ms)	--	2000	2000	1600	2000
SIZE: (mm: H x W x D)	5 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1Q94	1990	1990	2Q92	1990
COMMENTS	32 KB buffer. *Chip pair. **10 msec. from sleep.	*Chip pair	*Chip pair	*Chip pair	*Chip pair

MANUFACTURER	INTEL	INTEL	INTEL	INTEL	INTEL
MODEL	iMC004FLSA Series 2	iMC004FLSP Series 2+	iFD010P2SA Flash Drive	iMC010FLSA Series 2	iMC020FLSA Series 2
DISK/TREND GROUP	40	40	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Disk	Flash Memory	Flash Memory
Chip density (Mb)	8	16	8	8	8
Chip count per card	4	2	12	10	20
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	1 x 8	2 x 8	320, 2, 32	1 x 8	1 x 8
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type II	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA-ATA	PCMCIA 2.01	PCMCIA 2.01
XIP	Yes	Yes	No	Yes	Yes
Erasable block size (KB)	128*	128*	128*	128*	128*
Internal ECC	None	None	8 bits/sector	--	--
CAPACITY: Total capacity (Mbytes)	4	4	10.486	10	20
SECTOR ENDURANCE: (Kcycles)	100	1000	1000	100	100
Spare sectors	None	None	None	None	None
Wearout leveling	--	Yes	Yes	--	--
PERFORMANCE: Avg. access time (ns)	150	150	1000**	150	150
Media read rate (MB/Sec)	5	13	8	5	5
Media write rate (MB/Sec)	.2*	.85	.27	.2*	.2*
Burst transfer rate (MB/Sec)	5	10 (Read)	5	5	5
Block erase time (ms)	1600	300		1600	1600
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 or 3.3 V 12 V option	5 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	2Q92	1Q94	1Q94	2Q92	2Q92
COMMENTS	*Chip pair	*Chip pair	32 KB buffer. *Chip pair. **10 msec. from sleep.	*Chip pair	*Chip pair

MANUFACTURER	INTEL	INTEL	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
MODEL	iMC020FLSP Series 2+	iMC040FLSP Series 2+	JN2	JN4	JN6
DISK/TREND GROUP	41	42	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	16	16			
Chip count per card	10	20			
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2 x 8	4 x 8			
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	128*	128*			
Internal ECC	--	--			
CAPACITY: Total capacity (Mbytes)	20	40	2	4	6
SECTOR ENDURANCE: (Kcycles)	1000	1000	100	100	100
Spare sectors	--	--			
Wearout leveling	Yes	Yes			
PERFORMANCE: Avg. access time (ns)	150	150	250	250	250
Media read rate (MB/Sec)	13	13			
Media write rate (MB/Sec)	.85	.85			
Burst transfer rate (MB/Sec)	13 (Read)	13 (Read)			
Block erase time (ms)	300	300			
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 or 3.3 V 12 V option	5 or 3.3 V 12 V option	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	1994	1994	1994
COMMENTS	*Chip pair	*Chip pair			

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
MODEL	JN8	JP4	JP8	JV0256	JV0512
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)					
Internal ECC					
CAPACITY: Total capacity (Mbytes)	8	4	8	.256	.512
SECTOR ENDURANCE: (Kcycles)	100	1000	1000		
Spare sectors					
Wearout leveling					
PERFORMANCE: Avg. access time (ns)	250	200	200	200	200
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1994	1994
COMMENTS					

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
MODEL	JV1	JV2	JV5	JN10	JN12
DISK/TREND GROUP	40	40	40	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Disk	Flash Memory	Flash Memory
Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type II	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)					
Internal ECC					
CAPACITY: Total capacity (Mbytes)	1	2	5	10	12
SECTOR ENDURANCE: (Kcycles)				100	100
Spare sectors					
Wearout leveling					
PERFORMANCE: Avg. access time (ns)				250	250
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6		3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1994	1994
COMMENTS					

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY
MODEL	JN14	JN16	JP12	JP16	JP24
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)					
Internal ECC					
CAPACITY: Total capacity (Mbytes)	14	16	12	16	24
SECTOR ENDURANCE: (Kcycles)	100	100	1000	1000	1000
Spare sectors					
Wearout leveling					
PERFORMANCE: Avg. access time (ns)	250	250	200	200	200
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1994	1994
COMMENTS					

MANUFACTURER	KINGMAX TECHNOLOGY	KINGMAX TECHNOLOGY	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS
MODEL	JV10	JV20	FlashCard-1M	FlashCard-2M	FlashCard-4M
DISK/TREND GROUP	41	41	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM	OEM	OEM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)			8	8	8
Chip count per card			1	2	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization			1 x 8	1 x 8	1 x 8
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)			128	128	128
Internal ECC			--	--	--
CAPACITY: Total capacity (Mbytes)	10	20	1	2	4
SECTOR ENDURANCE: (Kcycles)			100	100	100
Spare sectors			--	--	--
Wearout leveling			--	--	--
PERFORMANCE: Avg. access time (ns)			150	150	150
Media read rate (MB/Sec)			12.5	12.5	12.5
Media write rate (MB/Sec)			.4	.4	.4
Burst transfer rate (MB/Sec)					
Block erase time (ms)			1600	1600	1600
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	3.3 to 5 V	3.3 to 5 V	3.3 to 5 V
FIRST CUSTOMER SHIPMENT	1994	1994			
COMMENTS					

MANUFACTURER	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	MATSUSHITA ELECTRIC INDUSTRIAL
MODEL	FlashCard-8M	FlashCard-10M	FlashCard-20M	FlashCard-40M	BN-011HFRE
DISK/TREND GROUP	40	41	41	42	40
MARKET	OEM	OEM	OEM	OEM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	8	8	8	8	1
Chip count per card	8	10	20	40	8
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	1 x 8	1 x 8	1 x 8	1 x 8	.256x8/.128x16
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	128	128	128	128	128
Internal ECC	--	--	--	22*	--
CAPACITY: Total capacity (Mbytes)	8	10	20	40	1
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	150	150	150	150	250
Media read rate (MB/Sec)	12.5	12.5	12.5	12.5	5
Media write rate (MB/Sec)	.4	.4	.4	.4	.0625
Burst transfer rate (MB/Sec)					--
Block erase time (ms)	1600	1600	1600	1600	1000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	3.3 to 5 V	3.3 to 5 V	3.3 to 5 V	3.3 to 5 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT				3Q95	1994
COMMENTS					

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL
MODEL	BN-01MHFRE	BN-021HFRE	BN-02MHF3CE	BN-02MHFRE	BN-04MHF3CE
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	2	1	8	2	8
Chip count per card	4	16	2	8	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	1 x 8/.512 x 16	.512x8/.256x16	16 x 8/8 x 16	2 x 8/1 x 16	16 x 8/8 x 16
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes		Yes	
Erasable block size (KB)	256	128	128	256	128
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	1	2	2	2	4
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	No	--	No
Wearout leveling	--	--	No	--	No
PERFORMANCE: Avg. access time (ns)	250	250	250	250	250
Media read rate (MB/Sec)	5	5		5	
Media write rate (MB/Sec)	.0625	.0625	.1	.0625	.100
Burst transfer rate (MB/Sec)	--	--		--	
Block erase time (ms)	2000	1000		2000	
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994	1994		1994	
COMMENTS					

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL
MODEL	BN-04MHFRE	BN-08MHF3CE	BN-256HFRE	BN-511HFRE	BN-512HFRE
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	2	8	1	1	2
Chip count per card	16	8	2	4	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	4 x 8/2 x 16	16 x 8/8 x 16	1 x 8/.512 x 16	2 x 8/1 x 16	.512x8/.256x16
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes		Yes	Yes	Yes
Erasable block size (KB)	256	128	128	128	256
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	4	8	.256	.512	.512
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	No	--	--	--
Wearout leveling	--	No	--	--	--
PERFORMANCE: Avg. access time (ns)	250	250	250	250	250
Media read rate (MB/Sec)	5		5	5	5
Media write rate (MB/Sec)	.0625	.100	.0625	.0625	.0625
Burst transfer rate (MB/Sec)	--		--	--	--
Block erase time (ms)	2000		1000	1000	2000
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994		1994	1994	1994
COMMENTS					

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MAXTOR	MAXTOR	MAXTOR
MODEL	BN-10MHF3CE	BN-16MHF3CE	Flash Card 1	Flash Card 2	Flash Card 4
DISK/TREND GROUP	41	41	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	8	8	8	8	8
Chip count per card	10	16	1	2	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	16 x 8/8 x 16	16 x 8/8 x 16	1 x 8	1 x 8	1 x 8
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.10	PCMCIA 2.10	PCMCIA 2.10
XIP			Yes	Yes	Yes
Erasable block size (KB)	128	128	64	128	128
Internal ECC	--	--	--	--	--
CAPACITY:					
Total capacity (Mbytes)	10	16	1	2	4
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	No	No	--	--	--
Wearout leveling	No	No	Yes	Yes	Yes
PERFORMANCE:					
Avg. access time (ns)	250	250	200	200	200
Media read rate (MB/Sec)			1.8	1.8	1.8
Media write rate (MB/Sec)	.100	.100	.03**	.055**	.11**
Burst transfer rate (MB/Sec)			1.8 (read)	1.8 (read)	1.8 (read)
Block erase time (ms)			1600	1600	1600
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT			3Q94	3Q94	3Q94
COMMENTS			*For embedded Flash File system. **Sustained write rate.	*For embedded Flash File system. **Sustained write rate.	*For embedded Flash File system. **Sustained write rate.

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MAXTOR	MAXTOR
MODEL	Flash Card 8	Flash Card 10	Flash Card 12	Flash Card 16	Flash Card 20
DISK/TREND GROUP	40	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	8	8	8	8	8
Chip count per card	8	10	12	16	20
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	1 x 8	1 x 8	1 x 8	1 x 8	1 x 8
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.10	PCMCIA 2.10	PCMCIA 2.10	PCMCIA 2.10	PCMCIA 2.10
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	128	128	128	128	128
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	8	10	12	16	20
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	Yes	Yes	Yes	Yes	Yes
PERFORMANCE: Avg. access time (ns)	200	200	200	200	200
Media read rate (MB/Sec)	1.8	1.8	1.8	1.8	1.8
Media write rate (MB/Sec)	.11**	.055**	.11**	.11**	.11**
Burst transfer rate (MB/Sec)	1.8 (read)	1.8 (read)	1.8 (Read)	1.8 (read)	1.8 (read)
Block erase time (ms)	1600	1600	1600	1600	1600
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	3Q94	3Q94	3Q94	3Q94	3Q94
COMMENTS	*For embedded Flash File system. **Sustained write rate.	*For embedded Flash file system. **Sustained write rate.	*For embedded Flash File system. **Sustained write rate.	*For embedded Flash File system. **Sustained write rate.	*For embedded Flash File system. **Sustained write rate.

MANUFACTURER	MEIKO	MEIKO	MEIKO	MEIKO	MEIKO
MODEL	MIC-1M F/A	MIC-256 F/A	MIC-2M F/A	MIC-4M F/A	MIC-512 F/A
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	4	1	4	4	1
Chip count per card	2	2	4	8	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01
XIP					
Erasable block size (KB)					
Internal ECC	None	None	None	None	None
CAPACITY: Total capacity (Mbytes)	1	.256	2	4	.512
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	None	None	None	None	None
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	200	200	200	200	200
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 54 x 85.6	3.3 54 x 85.6	3.3 54 x 85.6	3.3 54 x 85.6	3.3 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1994	1994
COMMENTS	Preliminary specification	Preliminary specification	Preliminary specification	Preliminary specification	Preliminary specification

MANUFACTURER	MEIKO	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL	MIC-8M F/A	MF81M1-G4EATXX	MF81M1-G5EATXX	MF81M1-GBDAT	MF81M1-GCDAT
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	4	1	1	1	1
Chip count per card	16	8	8	8	8
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization		1 x 8/.512 x 16	1 x 8/.512 x 16	1 x 8/.512 x 16	1 x 8/.512 x 16
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.01	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.01	PCMCIA 2.01
XIP		Yes	Yes	Yes	Yes
Erasable block size (KB)					
Internal ECC	None	--	--	--	--
CAPACITY: Total capacity (Mbytes)	8	1	1	1	1
SECTOR ENDURANCE: (Kcycles)	100	10	10	10	10
Spare sectors	None	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	200	250	250	200	200
Media read rate (MB/Sec)		4	4	5	5
Media write rate (MB/Sec)		.0625	.0625	.0625	.0625
Burst transfer rate (MB/Sec)					
Block erase time (ms)	9.5				
SIZE: (mm: H x W x D)	3.3 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994	1991			
COMMENTS	Preliminary specification	EEPROM attribute memory			EEPROM attribute memory

MANUFACTURER	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL	MF81M1-GIEATXX	MF8257-G4EATXX	MF8257-G5EATXX	MF8257-GBDAT	MF8257-GCDAT
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	1	1	1	1	1
Chip count per card	8	2	2	2	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	1 x 8/.512 x 16				
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.01	PCMCIA 2.01
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)					
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	1	.256	.256	.256	.256
SECTOR ENDURANCE: (Kcycles)	10	10			10
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	250	250	250	200	200
Media read rate (MB/Sec)	4	4	4	5	5
Media write rate (MB/Sec)	.0625	.0625	.0625	.0625	.0625
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS		EEPROM attribute memory			EEPROM attribute memory

MANUFACTURER	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL	MF8257-GIEATXX	MF82M1-G4EATXX	MF82M1-G5EATXX	MF82M1-G7DATXX	MF82M1-GBDAT
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	1	1	1	1	1
Chip count per card	2	16	16	16	16
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.01
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)					
Internal ECC	--	--	--	--	--
CAPACITY:					
Total capacity (Mbytes)	.256	2	2	2	2
SECTOR ENDURANCE: (Kcycles)	10	10	10	10	10
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE:					
Avg. access time (ns)	250	250	250	200	200
Media read rate (MB/Sec)	4	4	4	5	5
Media write rate (MB/Sec)	.0625	.0625	.0625	.0625	.0625
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT					
COMMENTS		EEPROM attribute memory		Uses Intel chips. EEPROM attribute memory.	

MANUFACTURER	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL	MF82M1-GCDAT	MF82M1-GIEATXX	MF84M1-G4EATXX	MF84M1-G5EATXX	MF84M1-G7DATXX
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	1	1			
Chip count per card	16	16			
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.01	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes		Yes
Erasable block size (KB)					
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	2	2	4	4	4
SECTOR ENDURANCE: (Kcycles)	10	10	10	10	10
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	200	250	250	250	200
Media read rate (MB/Sec)	5	4	4	4	5
Media write rate (MB/Sec)	.0625	.0625	.0625	.0625	.0625
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT			1994	1994	1994
COMMENTS	EEPROM attribute memory		EEPROM attribute memory		Uses Intel chips. EEPROM attribute memory.

MANUFACTURER	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL	MF84M1-GIEATXX	MF8513-G4EATXX	MF8513-G5EATXX	MF8513-GBDAT	MF8513-GCDAT
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	1	1	1	1	1
Chip count per card	10	4	4	4	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.01	PCMCIA 2.01
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)					
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	4	.512	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	10	10	10	10	10
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	250	250	250	200	200
Media read rate (MB/Sec)	4	4	4	5	5
Media write rate (MB/Sec)	.0625	.0625	.0625	.0625	.0625
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994				
COMMENTS		EEPROM attribute memory			

MANUFACTURER	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL	MF8513-GIEATXX	MF88M1-G7DATXX	MF91M1-98DAT	MF91M1-99DAT	MF91M5-98DAT
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	1	4	1	1	1
Chip count per card	4	16	4	4	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)					
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	.512	8	.512	.512	.512
SECTOR ENDURANCE: (Kcycles)	10	10	10	10	10
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	250	200	200	200	200
Media read rate (MB/Sec)	4	5	5	5	5
Media write rate (MB/Sec)	.0625	.0625	.0625	.0625	.0625
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT		1994			
COMMENTS		Uses Intel chips. EEPROM attribute memory.	Includes .512 KB SRAM	Includes .512 KB SRAM	Includes 1 MB SRAM

MANUFACTURER	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI	MITSUBISHI
MODEL	MF91M5-99DAT	MF92M1-98DAT	MF92M1-99DAT	MF810M-G7DATXX	MF816M-G7DATXX
DISK/TREND GROUP	40	40	40	41	41
MARKET	OEM	OEM	OEM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	1	1	1	4	4
Chip count per card	8	4	8		
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)					
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	1	.512	1	10	16
SECTOR ENDURANCE: (Kcycles)					
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)				200	200
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT				1994	1994
COMMENTS	Includes .512 KB SRAM	Includes 1 MB SRAM	Includes 1 MB SRAM	Uses Intel chips. EEPROM attribute memory.	EEPROM attribute memory

MANUFACTURER	MITSUBISHI	NEW MEDIA	NEW MEDIA	NEW MEDIA	NEW MEDIA
MODEL	MF820M-G7DATXX	NMC00101	NMC00102	NMC00103	NMC00104
DISK/TREND GROUP	41	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	4				
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP		Yes	Yes	Yes	Yes
Erasable block size (KB)					
Internal ECC	--	None	None	None	None
CAPACITY: Total capacity (Mbytes)	20	.256	.512	1	2
SECTOR ENDURANCE: (Kcycles)	10	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	200	150	150	150	150
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994	1993	1993	1993	1993
COMMENTS	Uses Intel chips. EEPROM attribute memory.				

MANUFACTURER	NEW MEDIA	NEW MEDIA	NEW MEDIA	NEW MEDIA	NEW MEDIA
MODEL	NMC00105	NMC00123	NMC00124	NMC00125	NMC00126
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes				
Erasable block size (KB)					
Internal ECC	None	None	None	None	None
CAPACITY: Total capacity (Mbytes)	4	.256	.512	1	2
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	150	150	150	150	150
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT					
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
MODEL	SDCF-2 Compact Flash	SDCF-4 Compact Flash	SDIA-2.5 FLASHDISK	SDIA-5 FLASHDISK	SDIAT-4
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)	32	32	16	16	16
Chip count per card			2	3	
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2, 16, 123	2, 32, 123	2, 32, 30	2, 32, 160	
FEATURES: Package	PC Card Typ II*	PC Card Typ II*	1.8" IDE	1.8" IDE	1.3" IDE
Interface	PCMCIA 2.1	PCMCIA 2.1	IDE	IDE	IDE
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
Internal ECC	Yes	Yes	Yes	Yes	Yes
CAPACITY: Total capacity (Mbytes)	2	4	2.6	5.2	4
SECTOR ENDURANCE: (Kcycles)	300	300	300	300	300
Spare sectors	Yes	Yes	Yes	Yes	Yes
Wearout leveling	No	No	Yes	Yes	No
PERFORMANCE: Avg. access time (ns)	1.25 ms	1.25 ms	1.25	1.25	1.25 ms
Media read rate (MB/Sec)	4	4	3	3	3
Media write rate (MB/Sec)	4	4	3	3	3
Burst transfer rate (MB/Sec)	6	6	6	6	6
Block erase time (ms)	0.75 ms	0.75 ms	0.75 ms	2	2
SIZE: (mm: H x W x D)	*5 x 54 x 85.6	*5 x 54 x 85.6	9.6 x 50.8 x 76.2	9.6 x 50.8 x 76.2	43.5 x 50.8 x 10.5
OPERATING VOLTAGE:	3.3 V, 5 V	3.3 V, 5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1995	1995	1994	1994	1995
COMMENTS	*With SDCF-01 adapter	*With SDCF-01 adapter			

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
MODEL	SDP5A-1.8 FLASHDISK	SDP5A-2.5 FLASHDISK	SDP5A-5 FLASHDISK	SDCF-10 Compact Flash	SDCF-15 Compact Flash
DISK/TREND GROUP	40	40	40	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)	16	16	16	16	16
Chip count per card	1	2	3		
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2, 32, 56	2, 32, 80	2, 32, 160	2, 32, 320	2, 32, 458
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Typ II*	PC Card Typ II*
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
Internal ECC	Yes	Yes	Yes	Yes	Yes
CAPACITY: Total capacity (Mbytes)	1.8	2.6	5.2	10.5	15.7
SECTOR ENDURANCE: (Kcycles)	300	300	300	300	300
Spare sectors	Yes	Yes	Yes	Yes	Yes
Wearout leveling	No	No	No	No	No
PERFORMANCE: Avg. access time (ns)	1.25 ms	1.25 ms	1.25 ms	1.25 ms	1.25 ms
Media read rate (MB/Sec)	3	3	3	4	4
Media write rate (MB/Sec)	3	3	3	4	4
Burst transfer rate (MB/Sec)	6	6	6	6	6
Block erase time (ms)	2	2	2		
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6	*5 x 54 x 85.6	*5 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	3.3 V, 5 V	3.3 V, 5 V
FIRST CUSTOMER SHIPMENT	1993	1993	1993	1995	1995
COMMENTS				*With SDCF-01 adapter	*With SDCF-01 adapter

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
MODEL	SDIA-10 FLASHDISK	SDIA-20 FLASHDISK	SDIAT-10	SDIAT-20	SDP5A-10 FLASHDISK
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)	16	16	16	16	16
Chip count per card	5	10			5
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2, 32, 320	2, 32, 640			2, 32, 320
FEATURES: Package	1.8" IDE	1.8" IDE	1.3" IDE	1.3" IDE	PC Card Type II
Interface	IDE	IDE	IDE	IDE	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
Internal ECC	Yes	Yes	Yes	Yes	Yes
CAPACITY: Total capacity (Mbytes)	10.4	20.9	10.4	21.4	10.4
SECTOR ENDURANCE: (Kcycles)	300	300	300	300	300
Spare sectors	Yes	Yes	Yes	Yes	Yes
Wearout leveling	No	No	No	No	No
PERFORMANCE: Avg. access time (ns)	1.25 ms	1.25 ms	1.25 ms	1.25 ms	1.25 ms
Media read rate (MB/Sec)	3	3	3	3	3
Media write rate (MB/Sec)	3	3	3	3	3
Burst transfer rate (MB/Sec)	6	6	6	6	6
Block erase time (ms)	2	2	2	2	2
SIZE: (mm: H x W x D)	9.6 x 50.8 x 76.2	9.6 x 50.8 x 76.2	43.5 x 50.8 x 10.5	43.5 x 50.8 x 10.5	5 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1994	1994	1995	1995	1993
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SANDISK
MODEL	SDP5A-20 FLASHDISK	SDIA-40 FLASHDISK	SDIA-80 FLASHDISK	SDIAT-40	SDIAT-60
DISK/TREND GROUP	41	42	42	42	42
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)	16	16	16	16	16
Chip count per card	10	20	40		
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2, 32, 640	4, 32, 640	8, 32, 640		
FEATURES: Package	PC Card Type II	1.8" IDE	1.8" IDE	1.3" IDE	1.3" IDE
Interface	PCMCIA-ATA	IDE	IDE	IDE	IDE
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
Internal ECC	Yes	Yes	Yes	Yes	Yes
CAPACITY: Total capacity (Mbytes)	20.9	41.9	83.9	42.8	62.9
SECTOR ENDURANCE: (Kcycles)	300	300	300	300	300
Spare sectors	Yes	Yes	Yes	Yes	Yes
Wearout leveling	No	No	No	No	No
PERFORMANCE: Avg. access time (ns)	1.25 ms	1.25 ms	1.25 ms	1.25 ms	1.25 ms
Media read rate (MB/Sec)	3	3	3	3	3
Media write rate (MB/Sec)	3	3	3	3	3
Burst transfer rate (MB/Sec)	6	6	6	6	6
Block erase time (ms)	2	2	2	2	2
SIZE: (mm: H x W x D)	5 x 54 x 85.6	9.6 x 50.8 x 76.2	9.6 x 50.8 x 76.2	43.5 x 50.8 x 10.5	43.5 x 50.8 x 10.5
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1993	1994	1994	1995	1995
COMMENTS					

MANUFACTURER	SANDISK	SANDISK	SANDISK	SANDISK	SCM MICROSYSTEMS
MODEL	SDP5A-40 FLASHDISK	SDP5A-80	SDP5A-110	SDP5A-175	FC001MB1
DISK/TREND GROUP	42	42	43	43	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Memory
Chip density (Mb)	16	16	16	16	
Chip count per card	20				
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	4, 32, 640	8, 32, 640	8, 32, 840	12, 32, 892	
FEATURES: Package	PC Card Type II	PC Card Typ III	PC Card Typ III	PC Card Typ III	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1
XIP	No	No	No	No	
Erasable block size (KB)	.512	.512	.512	.512	
Internal ECC	Yes	Yes	Yes	Yes	
CAPACITY: Total capacity (Mbytes)	41.9	83.9	110.1	175.4	1
SECTOR ENDURANCE: (Kcycles)	300	300	300	300	10
Spare sectors	Yes	Yes	Yes	Yes	--
Wearout leveling	No	No	No	No	--
PERFORMANCE: Avg. access time (ns)	1.25 ms	1.25 ms	1.25 ms	1.25 ms	200/250
Media read rate (MB/Sec)	3	3	3	3	
Media write rate (MB/Sec)	3	3	3	3	
Burst transfer rate (MB/Sec)	6	6	6	6	
Block erase time (ms)	2	2	2	2	2000
SIZE: (mm: H x W x D)	5 x 54 x 85.6	10 x 54 x 85.6	10 x 54 x 85.6	10 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1993	4/95	4/95	4/95	4Q94
COMMENTS					Intel chips.

MANUFACTURER	SCM MICROSYSTEMS	SCM MICROSYSTEMS	SCM MICROSYSTEMS	SCM MICROSYSTEMS	SCM MICROSYSTEMS
MODEL	FC002MB2	FC004MB2	FC256KB	FC512KB	FC010MB2
DISK/TREND GROUP	40	40	40	40	41
MARKET	PCM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	8	8			8
Chip count per card	2	4			10
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)					
Internal ECC					
CAPACITY: Total capacity (Mbytes)	2	4	.256	.512	10
SECTOR ENDURANCE: (Kcycles)	100	100	10	10	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	170/200	170/200	200/250	200/250	170/200
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)	1500	1500	2000	2000	1500
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	4Q94	4Q94	4Q94	4Q94	1995
COMMENTS	Intel chips.	Intel chips.	Intel chips.	Intel chips.	Intel chips.

MANUFACTURER	SCM MICROSYSTEMS	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
MODEL	FC020MB2	ATA202SD11/01	ATA502SD11/01	HWB101ESX0/40	HWB201ESX0/40
DISK/TREND GROUP	41	40	40	40	40
MARKET	PCM	OEM, PCM	OEM, PCM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Disk	Flash Disk	Flash Memory	Flash Memory
Chip density (Mb)	8				
Chip count per card	20				
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type II	PC Card Type II	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.01	PCMCIA 2.01
XIP		No	No		
Erasable block size (KB)		.512	.512		
Internal ECC		Yes	Yes	--	--
CAPACITY: Total capacity (Mbytes)	20	2.6	5.2	.512	1
SECTOR ENDURANCE: (Kcycles)	100	200	200		
Spare sectors	--	Yes	Yes	--	--
Wearout leveling	--	Yes	Yes	--	--
PERFORMANCE: Avg. access time (ns)	170/200	1.25 ms	1.25 ms	200	200
Media read rate (MB/Sec)		.625	.625		
Media write rate (MB/Sec)		.075	.075		
Burst transfer rate (MB/Sec)					
Block erase time (ms)	1500				
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V	5 V		
FIRST CUSTOMER SHIPMENT	1995				
COMMENTS	Intel chips.	Made by SanDisk	Made by SanDisk		

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
MODEL	HWB201S8X0/40	HWB257ESX0/40	HWB401ESX0/40	HWB401S8X0/40	HWB513ESX0/40
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM	OEM	OEM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01
XIP					
Erasable block size (KB)					
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	1	.128	2	2	.256
SECTOR ENDURANCE: (Kcycles)					
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	200	200	200	200	200
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:					
FIRST CUSTOMER SHIPMENT					
COMMENTS					

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
MODEL	HWB801S8X0/40	Mini-2 FLASH-PACKER	Mini-4 FLASH-PACKER	SDP5-2-5 FLASH-PACKER	SDP5-5 SDP5HP-5 FLASH-PACKER
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Disk	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)		32	32		
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization		2, 16, 123	2, 32, 123		
FEATURES: Package	PC Card Type I	PC Card TypeII*	PC Card TypeII*	PC Card Type II	PC Card Type II
Interface	PCMCIA 2.01	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.0
XIP		No	No	No	No
Erasable block size (KB)		.512	.512	.512	.512
Internal ECC	--	Yes	Yes	Yes	Yes
CAPACITY: Total capacity (Mbytes)	4	2	4	2.6	5.2
SECTOR ENDURANCE: (Kcycles)		300	300	200	200
Spare sectors	--	Yes	Yes	Yes	Yes
Wearout leveling	--	Yes	Yes	Yes	Yes
PERFORMANCE: Avg. access time (ns)	200	1.25 ms	1.25 ms	1.25 ms	1.25 ms
Media read rate (MB/Sec)		.625	.625	.625	.625
Media write rate (MB/Sec)		.075	.075	.075	.075
Burst transfer rate (MB/Sec)		6	6	6	6
Block erase time (ms)		.75	.75	2	2
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	5 x 36.4 x 42.8	5 x 36.4 x 42.8	5 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:		3.3 V, 5 V	3.3 V, 5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT		1995	1995	1995	1995
COMMENTS		*Fits into Type II adapter. Sold in Japan. Made by SanDisk	*Fits into Type II adapter. Sold in Japan. Made by SanDisk	Made by SanDisk Sold in Japan.	Made by SanDisk Sold in Japan.

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
MODEL	ATA112SD11/01	ATA212SD11/01	HWB111S8X0/80	HWB161S8X0/80	Mini-10 FLASH-PACKER
DISK/TREND GROUP	41	41	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM	OEM	PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Memory	Flash Memory	Flash Disk
Chip density (Mb)					32
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					2, 32, 320
FEATURES: Package	PC Card Type II	PC Card Type II	PC Card Type I	PC Card Type I	PC Card TypeII*
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.0
XIP	No	No			No
Erasable block size (KB)					.512
Internal ECC			--	--	Yes
CAPACITY:					
Total capacity (Mbytes)	10.4	20.9	10	16	10.4
SECTOR ENDURANCE: (Kcycles)	200	200			300
Spare sectors			--	--	Yes
Wearout leveling			--	--	Yes
PERFORMANCE:					
Avg. access time (ns)	1.25 ms	1.25 ms	200	200	1.25 ms
Media read rate (MB/Sec)	.625	.625			.625
Media write rate (MB/Sec)	.075	.075			.075
Burst transfer rate (MB/Sec)					6
Block erase time (ms)					.75
SIZE: (mm: H x W x D)	5 x 54 x 85.6	5 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	5 x 36.4 x 42.8
OPERATING VOLTAGE:	5 V	5 V			3.3 V, 5 V
FIRST CUSTOMER SHIPMENT					1995
COMMENTS	Made by SanDisk	Made by SanDisk			*Fits into Type II adapter. Sold in Japan. Made by SanDisk

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
MODEL	Mini-15 FLASH-PACKER	SDP5-10 SDP5HP-10 FLASH-PACKER	SDP5-20 SDP5HP-20 FLASH-PACKER	ATA412SD12/02	SDP5-40 SDP5HP-40 FLASH-PACKER
DISK/TREND GROUP	41	41	41	42	42
MARKET	PCM	PCM	PCM	OEM, PCM	PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)	32			16	
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2, 32, 458			4, 32, 640	
FEATURES: Package	PC Card TypeII*	PC Card Type II	PC Card Type II	PC Card Type II	PC Card Type II
Interface	PCMCIA 2.0	PCMCIA 2.0	PCMCIA 2.0	PCMCIA-ATA	PCMCIA 2.0
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
Internal ECC	Yes	Yes	Yes		Yes
CAPACITY: Total capacity (Mbytes)	15.7	10.4	20.9	40	41.9
SECTOR ENDURANCE: (Kcycles)	300	200	200	200	200
Spare sectors	Yes	Yes	Yes		Yes
Wearout leveling	Yes	Yes	Yes		Yes
PERFORMANCE: Avg. access time (ns)	1.25 ms	1.25 ms	1.25 ms	1.25 ms	1.25 ms
Media read rate (MB/Sec)	.625	.625	.625	.625	.625
Media write rate (MB/Sec)	.075	.075	.075	.075	.075
Burst transfer rate (MB/Sec)	6	6	6		6
Block erase time (ms)	.75	2	2		2
SIZE: (mm: H x W x D)	5 x 36.4 x 42.8	5 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:	3.3 V, 5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1995	1995	1995	1994	1995
COMMENTS	*Fits into Type II adapter. Sold in Japan. Made by SanDisk	Made by SanDisk Sold in Japan.	Made by SanDisk Sold in Japan.	Made by SanDisk	Made by SanDisk Sold in Japan.

MANUFACTURER	SHARP	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
MODEL	ZAURUS	SM9FL1MP3 SM9FL1MP35V	SM9FL256KP3 SM9FL256KP35V	SM9FL2MP3 SM9FL2MP35V	SM9FL4MP3 SM9FL4MP35V
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	8				
Chip count per card	1				
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)	.128				
Internal ECC	--	None	None	None	None
CAPACITY: Total capacity (Mbytes)	1	1	.256	2	4
SECTOR ENDURANCE: (Kcycles)	100				
Spare sectors	--	None	None	None	None
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	200	150/200/250	150/200/250	150/200/250	150/200/250
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)	1600				
SIZE: (mm: H x W x D)	3.3 X 54 X 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1994	1992	1992	1992	1992
COMMENTS		5V is 5 volt unit	5V is 5 volt unit	5V is 5 volt unit. Secure version available.	5V is 5 volt unit. Secure version available.

MANUFACTURER	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	TOSHIBA	TOSHIBA
MODEL	SM9FL512KP3 SM9FL512KP35V	SM9FL8MP3 SM9FL8MP35V	SM9FL16MP3 SM9FL16MP35V	THGMM080021AA	THGMM080041AA
DISK/TREND GROUP	40	40	41	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)				16	16
Chip count per card				1	2
Chip logic type	NOR	NOR	NOR	NAND	NAND
Chip organization				--	--
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP				No	No
Erasable block size (KB)				4	4
Internal ECC	None	None	None	No	No
CAPACITY: Total capacity (Mbytes)	.512	8	16	2	4
SECTOR ENDURANCE: (Kcycles)				250	250
Spare sectors	None	None	None	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	150/200/250	150/200/250	150/200/250	200	200
Media read rate (MB/Sec)				3.8	3.8
Media write rate (MB/Sec)				.87	.87
Burst transfer rate (MB/Sec)					
Block erase time (ms)				6-100	6-100
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1992	1992	1992	4Q94	4Q94
COMMENTS	5V is 5 volt unit	5V is 5 volt unit	5V is 5 volt unit		

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA
MODEL	THGMM080081AA	THGSS160031AA	THGSS160051AA	THGMM080101AA	THGMM080161AA
DISK/TREND GROUP	40	40	40	41	41
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Disk	Flash Disk	Flash Memory	Flash Memory
Chip density (Mb)	16	16	16	16	16
Chip count per card	4	2	3	5	8
Chip logic type	NAND	NAND	NAND	NAND	NAND
Chip organization	--			--	--
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA 2.1	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	No	No	No
Erasable block size (KB)	4	8 x .512	8 x .512	4	4
Internal ECC	No	Yes	Yes	No	No
CAPACITY: Total capacity (Mbytes)	8	3	5	10	16
SECTOR ENDURANCE: (Kcycles)	250	250	250	250	250
Spare sectors	--	Yes	Yes	--	--
Wearout leveling	--	Yes	Yes	--	--
PERFORMANCE: Avg. access time (ns)	200	300	300	200	200
Media read rate (MB/Sec)	3.8			3.8	3.8
Media write rate (MB/Sec)	.87			.87	.87
Burst transfer rate (MB/Sec)		8	8		
Block erase time (ms)	6-100	6-100		6-100	6-100
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	4Q94	4Q94	4Q94	4Q94	4Q94
COMMENTS					

MANUFACTURER	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA	TOSHIBA
MODEL	THGMM080201AA	THGMM080241AA	THGSS160101AA	THGSS160201AA	THGSS160302AA
DISK/TREND GROUP	41	41	41	41	42
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)	16	16	16	16	16
Chip count per card	10	12	6	11	16
Chip logic type	NAND	NAND	NAND	NAND	NAND
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type II
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	4	4	8 x .512	8 x .512	8 x .512
Internal ECC	No	--	Yes	Yes	Yes
CAPACITY: Total capacity (Mbytes)	20	24	10	20	30
SECTOR ENDURANCE: (Kcycles)	250	250	250	250	250
Spare sectors	--	--	Yes	Yes	Yes
Wearout leveling	--	--	Yes	Yes	Yes
PERFORMANCE: Avg. access time (ns)	200	200	300	300	300
Media read rate (MB/Sec)	3.8	3.8			
Media write rate (MB/Sec)	.87	.87			
Burst transfer rate (MB/Sec)			8	8	8
Block erase time (ms)	6-100	6-100			
SIZE: (mm: H x W x D)	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	3.3 x 54 x 85.6	5 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	4Q94	4Q94	4Q94	4Q94	4Q94
COMMENTS					

MANUFACTURER	TOSHIBA	TRANSCEND	TRANSCEND	TRANSCEND	TRANSCEND
MODEL	THGSS160402AA	Flash 2 MB	Flash 4 MB	Flash 5 MB	Flash 8 MB
DISK/TREND GROUP	42	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	16				
Chip count per card	21				
Chip logic type	NAND				
Chip organization					
FEATURES: Package	PC Card Type II	PC Card Type I	PC Card Type I	PC Card Type I	PC Card Type I
Interface	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No				
Erasable block size (KB)	8 x .512				
Internal ECC	Yes				
CAPACITY: Total capacity (Mbytes)	40	2	4	5	8
SECTOR ENDURANCE: (Kcycles)	250				
Spare sectors	Yes				
Wearout leveling	Yes				
PERFORMANCE: Avg. access time (ns)	300				
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)	8				
Block erase time (ms)	6-100				
SIZE: (mm: H x W x D)	5 x 54 x 85.6	3.3 x 34.6 x 85.6	3.3 x 34.6 x 85.6	3.3 x 34.6 x 85.6	3.3 x 34.6 x 85.6
OPERATING VOLTAGE:	5 V				
FIRST CUSTOMER SHIPMENT	4Q94	3Q95	3Q95	3Q95	3Q95
COMMENTS					

MANUFACTURER	TRANSCEND	TRANSCEND			
MODEL	Flash 16 MB	Flash 20 MB			
DISK/TREND GROUP	41	41			
MARKET	OEM, PCM	OEM, PCM			
PRODUCT TYPE: Generic	Flash Memory	Flash Memory			
Chip density (Mb)					
Chip count per card					
Chip logic type					
Chip organization					
FEATURES: Package	PC Card Type I	PC Card Type I			
Interface	PCMCIA 2.1	PCMCIA 2.1			
XIP					
Erasable block size (KB)					
Internal ECC					
CAPACITY: Total capacity (Mbytes)	16	20			
SECTOR ENDURANCE: (Kcycles)					
Spare sectors					
Wearout leveling					
PERFORMANCE:					
Avg. access time (ns)					
Media read rate (MB/Sec)					
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)					
SIZE: (mm: H x W x D)	3.3 x 34.6 x 85.6	3.3 x 34.6 x 85.6			
OPERATING VOLTAGE:					
FIRST CUSTOMER SHIPMENT	3Q95	3Q95			
COMMENTS					

PCMCIA RIGID DISK DRIVE SPECIFICATIONS

PCMCIA RIGID DISK DRIVE SPECIFICATIONS

Coverage

This section includes removable rigid disk drives packaged in PCMCIA form factors, frequently known as "PC card" drives, intended for computer data storage which are now in new production or announced, arranged alphabetically by manufacturer. Product specifications use the same format employed in the DISK/TREND Report on rigid disk drives.

Specifications on drive models sold by computer system manufacturers, but purchased on an OEM basis from others, have been included in some cases, for identification purposes. In the case of captive disk drives manufactured by some system manufacturers, captive drives which are similar to OEM/Integrator models made by the same manufacturer are usually not listed.

Capacities

Formatted native capacity has been used to determine the appropriate DISK/TREND product group for each drive in this product group, with specific formatted capacities indicated by "F". Formatted capacities are given for captive drives and noncaptive drives with embedded controllers, such as SCSI or IDE. Capacities per track are not listed for drives with zoned recording.

Interfaces

Specific interfaces available are indicated for most drives, using references to manufacturers' own unique interfaces or to industry standards, either de facto or formalized. However, this is a rapidly changing area, so please be alert to the need to check for manufacturers' latest information if you need precise data. Most PC card drives currently available adhere to the PCMCIA-ATA interface specifications.

Average access time

All DISK/TREND specifications use the term "average access time" to describe the combination of average head positioning time and average disk rotational delay. Some in the industry have fallen into the habit of using the term average access time to describe average positioning time, or "seek" time, but this usage fails to adequately describe the time required for a disk drive to start to respond to a system request. The DISK/TREND specifications show separately the average positioning time, average rotational delay, and average access time, in order to avoid confusion.

Transfer rate

The transfer rate shown in the specifications is the rate at which data is transferred between the drive and the computer to which it is attached, in the case of drives with embedded controllers. If the manufacturer has specified more than one communication mode, such as synchronous and asynchronous, both data rates are indicated.

Accuracy

All information in this section has been cross-checked for accuracy. However, it is anticipated that some errors may be included, since many manufacturers' published specifications do not cover all of the items listed, and numerous verbal inquiries have been required.

1995 DISK/TREND product groups for PCMCIA rigid disk drives included in the Removable Data Storage report are:

Group number	Drives included
2.	PCMCIA rigid disk drives, less than 100 megabytes
3.	PCMCIA rigid disk drives, 100 - 200 megabytes
4.	PCMCIA rigid disk drives, 200 - 300 megabytes
5.	PCMCIA rigid disk drives, 300 - 500 megabytes
6.	PCMCIA rigid disk drives, 500 megabytes - 1 gigabyte

MANUFACTURER	CALLUNA TECHNOLOGY	CALLUNA TECHNOLOGY	CALLUNA TECHNOLOGY	CALLUNA TECHNOLOGY	CALLUNA TECHNOLOGY
DRIVE	CT-80MC Callunacard	CT-105MC Callunacard	CT-130MC Callunacard	CT-170MC Callunacard	CT-260MC Callunacard
DISK/TREND GROUP	2	3	3	3	4
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Disk diameter	48 mm	48 mm	48 mm	48 mm	48 mm
Recording medium	Thin Film*	Thin Film*	Thin Film*	Thin Film*	Thin Film*
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 85	F: 105	F: 130	F: 170	F: 260
Capacity per track (Bytes)	Varies by zone	Varies by zone	Varies by zone	Varies by zone	Varies by zone
Data surfaces per spindle	4	4	4	4	4
Tracks per surface	1084	1099	1256	1467	1801
Track density (TPI)	2490	2490	2840	3300	4000
Maximum linear density (BPI) (FCI)	50411 37808	62244 46683	67580 50685	73570 55178	84777 63583
Areal density (Mb/square inch)	125.5	155.0	191.9	242.8	339.1
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	4800	4800	4800	4800	4800
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	18	16	16	16	16
Average rotational delay (msec)	6.25	6.25	6.25	6.25	6.25
Average access time (msec)	24.25	22.25	22.25	22.25	22.25
Data transfer rate (MBytes/sec) Internal, min/max External	1.3/2.3 4.0	1.7/3.0 4.0	1.6/3.1 11.1 PIO Mode 3	2.0/4.0 11.1 PIO Mode 3	2.2/4.7 11.1 PIO Mode 3
SIZE: (mm) H x W x D	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6
FIRST CUSTOMER SHIPMENT	5/93	12/93	5/94	9/94	3/95
COMMENTS	PCMCIA Type III *Glass disk	PCMCIA Type III *Glass disk	PCMCIA Type III *Glass disk	PCMCIA Type III *Glass disk	PCMCIA Type III *Glass disk

MANUFACTURER	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS
DRIVE	8105PA Viper	8170PA Viper	PocketFile 105	PocketFile 170	8260PA Viper
DISK/TREND GROUP	3	3	3	3	4
MARKET	OEM	OEM	PCM	PCM	OEM
MEDIA: Disk diameter	48 mm	48 mm	48 mm	48 mm	48 mm
Recording medium	Thin Film	Thin Film*	Thin Film	Thin Film*	Thin Film*
DRIVE: Heads	MIG	Thin Film	MIG	Thin Film	Thin Film
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 105.4	F: 170.8	F: 105.4	F: 170.8	F: 260.4
Capacity per track (Bytes)	Varies by zone	Varies by zone	Varies by zone	Varies by zone	Varies by zone
Data surfaces per spindle	4	4	4	4	4
Tracks per surface	1107	1370	1107	1370	1650
Track density (TPI)	2840	3800	2840	3800	4300
Maximum linear density (BPI) (FCI)	70000 52000	84000 63000	70000 52000	84000 63000	112350 84260
Areal density (Mb/square inch)	198.8	319.2	198.8	319.2	483.1
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 PRML
Rotational speed (RPM)	4500	4500	4500	4500	4500
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	15	12	15	12	12
Average rotational delay (msec)	6.7	6.7	6.7	6.7	6.7
Average access time (msec)	21.7	18.7	21.7	18.7	18.7
Data transfer rate (MBytes/sec) Internal, min/max External	--/3.0 10.7	--/3.5 12.0	--/3.0 10.7	--/3.5 12.0	--/5.7 16.0
SIZE: (mm) H x W x D	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6
FIRST CUSTOMER SHIPMENT	11/93	3/94	1/94	3/94	3Q94
COMMENTS	PCMCIA Type III Ramp loaded heads	PCMCIA Type III Ramp loaded heads *Untextured disks	PCMCIA Type III Ramp loaded heads	PCMCIA Type III Ramp loaded heads *Untextured disks	PCMCIA Type III Ramp loaded heads *Untextured disks

MANUFACTURER	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS	SEIKO EPSON		
DRIVE	PocketFile 260	8340PA Viper	EHDD170 Hard Disk Card		
DISK/TREND GROUP	4	5	3		
MARKET	PCM	OEM	PCM		
MEDIA: Disk diameter	48 mm	48 mm	48 mm		
Recording medium	Thin Film*	Thin Film*	Thin Film*		
DRIVE: Heads	Thin Film	Thin Film	Thin Film		
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA		
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--		
REMOVABLE	F: 260.4	F: 340.6	F: 170.8		
Capacity per track (Bytes)	Varies by zone	Varies by zone	Varies by zone		
Data surfaces per spindle	4	4	4		
Tracks per surface	1650	2000	1370		
Track density (TPI)	4200	5100	3800		
Maximum linear density (BPI) (FCI)	105000 78750	123600 92700	84000 63000		
Areal density (Mb/square inch)	441.0	630.4	319.2		
Recording code	1,7 PRML	1,7 PRML	1,7 RLL		
Rotational speed (RPM)	4500	4500	4500		
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil		
Servo type	Embedded	Embedded	Embedded		
Average positioning time (msec)	12	12	12		
Average rotational delay (msec)	6.7	6.7	6.7		
Average access time (msec)	18.7	18.7	18.7		
Data transfer rate (MBytes/sec) Internal, min/max External	--/5.7 16.0	--/6.0 16.0	 12.0		
SIZE: (mm) H x W x D	10.5 x 54 x 85.6	10.5 x 54 x 85.6	10.5 x 54 x 85.6		
FIRST CUSTOMER SHIPMENT	3Q94	4Q94	3/94		
COMMENTS	PCMCIA Type III Ramp loaded heads *Untextured disks	PCMCIA Type III Ramp loaded heads *Untextured disks	PCMCIA Type III Ramp loaded heads. *Untextured disks. Mfg by Integral Peripherals		

RIGID DISK CARTRIDGE DRIVE SPECIFICATIONS

1995 DISK/TREND REPORT

RIGID DISK CARTRIDGE DRIVE SPECIFICATIONS

Coverage

This section includes removable rigid disk cartridge drives intended for computer data storage which are now in new production or announced, arranged alphabetically by manufacturer. Product specifications use the same format employed in the DISK/TREND Report on rigid disk drives.

Capacities

Formatted native capacity has been used to determine the appropriate DISK/TREND product group for each drive in this product group, with specific formatted capacities indicated by "F". Formatted capacities are given for captive drives and noncaptive drives with embedded controllers, such as SCSI or IDE. Capacities per track are listed, except for drives with zoned recording.

Average access time

All DISK/TREND specifications use the term "average access time" to describe the combination of average head positioning time and average disk rotational delay. Some in the industry have fallen into the habit of using the term average access time to describe average positioning time, or "seek" time, but this usage fails to adequately describe the time required for a disk drive to start to respond to a system request. The DISK/TREND specifications show separately the average positioning time, average rotational delay, and average access time, in order to avoid confusion.

Transfer rate

The transfer rate shown in the specifications is the rate at which data is transferred between the drive and the computer to which it is attached, in the case of drives with embedded controllers. If the manufacturer has specified more than one communication mode, such as synchronous and asynchronous, both data rates are indicated.

Interfaces

Specific interfaces available are indicated for most drives, using references to manufacturers' own unique interfaces or to industry standards, either de facto or formalized. However, this is a rapidly changing area for noncaptive drives, so please be alert to the need to check for manufacturers' latest information if you need precise data. In particular, there are many noninterchangeable forms of SCSI interfaces.

Accuracy

All information in this section has been cross-checked for accuracy. However, it is anticipated that some errors may be included, since many manufacturers' published specifications do not cover all of the items listed, and numerous verbal inquiries have been required.

1995 DISK/TREND product groups for rigid disk cartridge drives included in the Removable Data Storage report are:

Group number	Drives included
1.	Rigid disk cartridge drives

MANUFACTURER	AVATAR	AVATAR	IOMEGA	IOMEGA	NOMAI
DRIVE	AR-2170NI AR-2170NS	AR-3170FI AR-3170FS	Jaz 1GB IDE	Jaz 1GB SCSI	MCD-I
DISK/TREND GROUP	1	1	1	1	1
MARKET	OEM	OEM	OEM, PCM	OEM, PCM	OEM, PCM
MEDIA: Disk diameter	65 mm	65 mm	95 mm	95 mm	95 mm
Recording medium	Thin Film*	Thin Film*	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
Interface	SCSI-2, PC AT	SCSI-2, PC AT	IDE	SCSI-2	SCSI-2, IDE
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 170	F: 170	F: 540/1,070	F: 540/1,070	F: 540
Capacity per track (Bytes)	Varies by zone	Varies by zone	Varies by zone	Varies by zone	Varies by zone
Data surfaces per spindle	2	2	4	4	2
Tracks per surface	2404	2404	4204	4204	
Track density (TPI)	4300	4300	4301	4301	5000
Maximum linear density (BPI) (FCI)	80000 60000	80000 60000	89200 66900	89200 66900	100000
Areal density (Mb/square inch)	344.0	344.0	383.6	383.6	500.0
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	PRML
Rotational speed (RPM)	3804	3804	5400	5400	4500
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	12	12	10 RD/12 WR	10 RD/12 WR	10
Average rotational delay (msec)	8	8	5.6	5.6	6.6
Average access time (msec)	20	20	15.6/17.6	15.6/17.6	16.6
Data transfer rate (MBytes/sec) Internal, min/max External	1.5/2.8 10.0	1.5/2.8 10.0	3.5/6.7 13.3 PIO Mode 4	3.5/6.7 10.0 synch. 5.0 asynch.	4.5/8.3 10.0
SIZE: (mm) H x W x D	17.5 x 72.4 x 107.9	25.4 x 101.6 x 146	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 102 x 150
FIRST CUSTOMER SHIPMENT	6/95	6/95	1Q96	4Q95	2H95
COMMENTS	Removable data cartridge. *Glass disk.	Removable data cartridge. *Glass disk. Includes 3.5" 1.44 MB floppy drive.			

MANUFACTURER	NOMAI	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY
DRIVE	MCD-M	SQ1080	SQ3105A	SQ3105S	SQ3270A
DISK/TREND GROUP	1	1	1	1	1
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
MEDIA: Disk diameter	95 mm	48 mm	95 mm	95 mm	95 mm
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MR Thin Film	Thin Film	MIG	MIG	MIG
Interface	SCSI-2, IDE	PCMCIA-ATA	IDE	SCSI-2	IDE
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 680	F: 80	F: 110	F: 110	F: 270
Capacity per track (Bytes)	Varies by zone	Varies by zone	Varies by zone	Varies by zone	F:
Data surfaces per spindle	2	2	2	2	2
Tracks per surface		1472	2043	2043	3140
Track density (TPI)	5000	3200	2100	2100	3280
Maximum linear density (BPI) (FCI)		72000 54330	40000 30000	40000 30000	60000 45000
Areal density (Mb/square inch)		230.4	84.0	84.0	196.8
Recording code	PRML	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	4500	5400	3600	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	10	15	14.5	14.5	13.5
Average rotational delay (msec)	6.6	5.6	8.3	8.3	8.3
Average access time (msec)	16.6	20.6	22.8	22.8	21.8
Data transfer rate (MBytes/sec) Internal, min/max External	4.5/8.3 10.0	2.2/4.2 10.0	1.6/2.3 4.0	1.6/2.3 4.0 synch.	2.3/4.0 4.0
SIZE: (mm) H x W x D	25.4 x 102 x 150	10.5 x 54 x 85.6	25.4 x 101.6 x 146.1	25.4 x 101.6 x 146.1	25.4 x 101.6 x 150
FIRST CUSTOMER SHIPMENT	1996	3Q95	3Q92	3/93	4Q93
COMMENTS		PCMCIA Type III with removable data cartridge.	Removable data cartridge.	Removable data cartridge.	Removable data cartridge. Read/write compatible with 105 MB & 270 MB cartridge.

MANUFACTURER	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY
DRIVE	SQ3270S	SQ5110	SQ5200C	EZ135A	EZ135S
DISK/TREND GROUP	1	1	1	1	1
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
MEDIA: Disk diameter	95 mm	130 mm	130 mm	95 mm	95 mm
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads		Ferrite	Ferrite	MIG	MIG
Interface	SCSI-2	SCSI	SCSI-2	IDE	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 270	F: 88.8	F: 200	F: 135	F: 135
Capacity per track (Bytes)	F:	Varies by zone	Varies by zone	Varies by zone	Varies by zone
Data surfaces per spindle	2	2	2	1	1
Tracks per surface	3140	1774	2260	3140	3140
Track density (TPI)	3280	1470	1875	3280	3280
Maximum linear density (BPI) (FCI)	60000 45000	28546 19031	49820 37365	60000 45000	60000 45000
Areal density (Mb/square inch)	196.8	42.0	93.4	196.8	196.8
Recording code	1,7 RLL	2,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3600	3220	3220	3600	3600
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	13.5	20	18	13.5	13.5
Average rotational delay (msec)	8.3	9.32	9.32	8.3	8.3
Average access time (msec)	21.8	29.32	27.32	21.8	21.8
Data transfer rate (MBytes/sec) Internal, min/max External	2.3/4.0 4.0	1.4/1.8 4.0 synch. 1.25 asynch.	2.6/3.6 5.0 synch. 3.0 asynch.	2.3/4.0 4.0	2.3/4.0 4.0 synch.
SIZE: (mm) H x W x D	25.4 x 101.6 x 150	41.3 x 146.1 x 203.2	41.3 x 146.1 x 203.2	25.4 x 101.6 x 150	25.4 x 101.6 x 150
FIRST CUSTOMER SHIPMENT	2/94	2/91	2Q94	7/95	7/95
COMMENTS	Removable data cartridge.	Removable data cartridge. Read & write compatible with 44 MB & 88 MB cartridges.	Removable data cartridge. Read & write compatible with 44 MB, 88 MB & 200 MB cart.	Removable data cartridge. Internal model.	Removable data cartridge. External model.

SMALL OPTICAL DISK DRIVE SPECIFICATIONS

1995 DISK/TREND REPORT

OPTICAL DISK DRIVE SPECIFICATIONS

Coverage: This section lists 3.5" and 2.5" optical disk drives intended for computer data storage used as computer peripherals which are now announced or in new production. In a few cases, products are listed for which only preliminary announcements have been made because they are judged to be significant indicators of industry direction in the production period shown.

Recording technology: The basic type of recording technology is given. Most drives in this product group use magneto-optic recording: Other recording technologies that may be encountered include phase change and dye polymer.

Operating mode: Rewritable (erasable) drives are indicated with the technology type in parentheses if it is other than magneto-optic. Where the drive is a magneto-optic type and supports multifunctionality using MO-WORM media, the designation "Rewritable-(MF)" is used.

Interface: Specific interfaces are listed for most of the drives.

Speed control: Various abbreviations are used:

CAV = constant angular velocity.

CLV = constant linear velocity.

ZCAV = zoned constant angular velocity.
(Sometimes called MCAV = modified constant angular velocity).

Capacities: Capacities are listed as "U" for unformatted and "F" for formatted. For optical drives that can access only one side of the media, the capacity given is in terms of one side, even if the drive uses two-sided media. As optical media is preformatted, the capacity given is the formatted capacity. Track capacity in CLV drives is variable, so this parameter is given only for CAV drives.

Rotational speed: If more than one speed range exists, only the highest performance range is given.

Servo type: Optical drive servo types are noted as:

Continuous: Continuous composite servo format.
Sampled: Sampled servo format.

Positioner type: Optical disk drives have compound head positioning systems.

A coarse movement positions the head near the track to be located. A fine, or vernier, actuator then positions the head on the desired track and also maintains correct focus. Unless otherwise indicated, a vernier actuator is always present.

Average access time: The average access time is the sum of average positioning time plus rotational latency. Optical drive manufacturers are inconsistent in the use of this definition, so while the values given for these specifications are believed to be accurate, they should be accepted with caution and the drive manufacturer contacted for details.

Data transfer rate: The data transfer rate given is the rate from the disk during reading. When more than one data transfer rate is given:

If separated by a hyphen, the figures represent the drive's minimum and maximum transfer rates.

If separated by a slash, the figures represent the rates obtained when the drive operates at more than one RPM or offers more than one capacity.

Figures followed by the abbreviations "asynch." or "synch." are transfer rates between the drive and the host computer.

Accuracy: All of the information in this section has been checked for accuracy. Due to rapid changes in the industry, report users may need to make verbal inquiries of manufacturers for updates. Where data is not specified or otherwise unavailable, the abbreviation "NS" is used. Where a specification is not applicable, the abbreviation "N/A" appears.

1995 DISK/TREND optical disk product groups for the Removable Data Storage report

Group 11: Optical disk drives less than 1 gigabyte.

All optical disk drives using 3.5" and 2.5" optical disks which were included in the DISK/TREND Report on optical disk drives have been included in this report on removable data storage. Other optical disk drives are covered in the annual DISK/TREND Report on optical disk drives.

MANUFACTURER	CHINON	FUJITSU	FUJITSU	FUJITSU	FUJITSU
DRIVE	MOA300DX MOD300DX MOX300DX	M2511A DynaMO 128	M2512A DynaMO 230	M2541B DynaMO 230 Portable	MO City
DISK/TREND GROUP	11	11	11	11	11
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
MEDIA: Disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording technology	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic
DRIVE: Operating mode	Rewritable	Rewritable	Rewritable	Rewritable	Rewritable
Interface	SCSI-2	SCSI-2	SCSI-2	IDE/ATAPI	SCSI-2
Compatibility					
Speed control & zones	CAV	CAV	CAV/ZCAV	CAV/ZCAV	CAV/ZCAV
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 128	F: 128	F: 128/230	F: 128/230	F: 128/230
Capacity per track (Bytes)	F: 12800	F: 12800	F: 12800/N/A	F: 12800/N/A	F: 12800/N/A
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	10000	10000	10000/17940	10000/17940	10000/17940
Track density (TPI)	15875	15875	15875/18273	15875/18273	15875/18273
Maximum linear density (BPI)	24440	24400	24400/29296	24400/29296	24400/29296
Rotational speed (RPM)	3000	3600	3600	2700	2700
PERFORMANCE					
Positioner type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	42	30	30	50	50
Average rotational delay (msec)	10	8.3	8.3	11	11
Average access time (msec)	52	38.3	38.3	61	61
Data transfer rate (KBytes/sec)	625	1090 4000 synch.	1300-2100 5000 synch.	975-1575	975-1575
Buffer/cache size (Kbytes)	256	256	256	128	128
SIZE (mm: H x W x D)	42 x 146 x 200	25.4 x 101.6 x 146.1	25.4 x 101.6 x 146	17 x 101.6 x 140	
FIRST CUSTOMER SHIPMENT		1992	3/94	10/95	1995
COMMENTS	Internal cache	DynaMO is external subsystem	DynaMO is external subsystem	DynaMO is external subsystem Direct overwrite	Sold in Europe

MANUFACTURER	FUJITSU	LASERBYTE	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL
DRIVE	SMB230B SMB230M	LB4230	LF-3100 LF-3104	LF-3200JA	LF-3200JD
DISK/TREND GROUP	11	11	11	11	11
MARKET	OEM, PCM	OEM, PCM	OEM	OEM	OEM
MEDIA: Disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording technology	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic
DRIVE: Operating mode	Rewritable	Rewritable	Rewritable	Rewritable	Rewritable
Interface	*	SCSI, SCSI-2	SCSI-2	SCSI	SCSI
Compatibility					
Speed control & zones	CAV/ZCAV	ZCAV	CAV	ZCAV	ZCAV
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 128/230	F: 229.1	F: 128	F: 229.1	F: 229.1
Capacity per track (Bytes)	F: 12800/N/A	F: 12800	F: 12800	F: 12800*	F: 12800*
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	10000/17940	17900	10000	11510/17853*	11510/17853*
Track density (TPI)	15875/18273	18273	15875	18273	18273
Maximum linear density (BPI)	24400/29296	24300	24440	29540	29540
Rotational speed (RPM)	3600	3600	3000	3600	3600
PERFORMANCE					
Positioner type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Voice Coil	Voice Coil
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	30	40	40	35	35
Average rotational delay (msec)	8.3	8.3	10	8.3	8.3
Average access time (msec)	38.3	48.3	50	43.3	43.3
Data transfer rate (KBytes/sec)	1300-2100 5000 synch.	920-1470	906 1500 avg.	2100 5000 synch.	2100 5000 synch.
Buffer/cache size (Kbytes)		256		256	256
SIZE (mm: H x W x D)	25.4 x 101.6 x 146	25 x 101.6 x 146	41.3 x 101.6 x 146	56 x 168 x 240	56 x 168 x 240
FIRST CUSTOMER SHIPMENT	7/95	6/95	3Q91	3Q94	3Q94
COMMENTS	*230B is for DOS/V PC 230M is for Macintosh	Read only and partial read only modes	LF-3100 is external mount Sold in Japan	*Logical tracks External mount For use with Macintosh	*Logical tracks External mount. For use w/DOS, PC-9800 and Panacom systems

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MOST	MOST	MOUNTAIN OPTECH	OLYMPUS
DRIVE	LF-3294	RMD 5200-S	RMD 5300-S	SE-250 R/W SI-250 R/W ST-250 R/W	230MO Plus* 230MO Turbo
DISK/TREND GROUP	11	11	11	11	11
MARKET	OEM	OEM, PCM	OEM, PCM	OEM	OEM, PCM
MEDIA: Disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording technology	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic
DRIVE: Operating mode	Rewritable	Rewritable	Rewritable	Rewritable	Rewritable
Interface	SCSI	SCSI-1/2	SCSI-2	SCSI	SCSI-2
Compatibility					
Speed control & zones	ZCAV	CAV	CAV	ZCAV	CAV
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 229.1	F: 128/256*	F: 230*/256/384	F: 230	F: 230/128
Capacity per track (Bytes)	F: 12800*	F: 12800/**	**	F: 12800	F: 12800
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	11510/17853*	10000	12900	11510/17853*	11500
Track density (TPI)	18273	15875	18273	18273	18273
Maximum linear density (BPI)	29540	15875/39625	42900	29540	29300
Rotational speed (RPM)	3600	2400	2400	3600	4200
PERFORMANCE					
Positioner type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	35	35.2	35.2	40	28
Average rotational delay (msec)	8.3	12.5	12	8.3	7.1
Average access time (msec)	43.3	47.7	47.2	48.3	35.1
Data transfer rate (KBytes/sec)	2100 5000 synch.	512/820-1228	512/860-1500	1475 max.	1075-1720/896
Buffer/cache size (Kbytes)	256	128	256	64	1000*
SIZE (mm: H x W x D)	41.3 x 101.6 x 151.5	41.3 x 146 x 203.2	41.3 x 146 x 203.2		
FIRST CUSTOMER SHIPMENT	2Q94	2Q92	3Q94	1Q95	10/94
COMMENTS	*Logical tracks	*Zoned recording. **Varies by zone. OROM support	*Also operates with 128 MB media **Varies by format	Ruggedized *Logical tracks	*Includes cache

MANUFACTURER	OLYMPUS	RICOH	RICOH	SEIKO EPSON	SONY
DRIVE	MOS320E MOS320S MOS321E* MOS321S*	RO-3012E RS-3102E Transporter 2	RO-3020E RS-3020E	OMD 6020	HS-D650
DISK/TREND GROUP	11	11	11	11	11
MARKET	OEM	OEM	OEM, PCM	OEM	OEM
MEDIA: Disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording technology	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic
DRIVE: Operating mode	Rewritable	Rewritable	Rewritable	Rewritable	Rewritable
Interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Compatibility					
Speed control & zones	CAV/ZCAV	CAV	CAV/ZCAV	ZCAV	ZCAV
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 230/128	F: 127.4	F: 230	F: 230	F: 650
Capacity per track (Bytes)	F: 12800	F: 12740	F:	F: 12800*	F: N/A
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	11500**	10000	17940	17853*	
Track density (TPI)	18273	15875	18273	18273	21800
Maximum linear density (BPI)	29300	24440	29296	29540**	
Rotational speed (RPM)	4500	3000	3600	3600	
PERFORMANCE					
Positioner type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
Servo type	Continuous	Continuous	Continuous	Continuous	Sampled
Average positioning time (msec)	26	45	40	28	
Average rotational delay (msec)	7.1	10	8.3	8.3	
Average access time (msec)	33.1	55	48.3	36.3	
Data transfer rate (KBytes/sec)	1075-1840/896	640	5000 synch. 2500 asynch.	900-1440	2000 max.
Buffer/cache size (Kbytes)	256*	256	243	500	
SIZE (mm: H x W x D)	41.3 x 101.6 x 160	41.3 x 101.6 x 149.8	32 x 117 x 202	25.4 x 101.6 x 146	25.4 x 101 x 146
FIRST CUSTOMER SHIPMENT	2Q94	3/93	1Q95	4Q94	4Q95
COMMENTS	*1 MB optional **17900 logical tracks	RS-3012E is external version	RS-3020E is external version	*Logical tracks **2,7 RLL Code Split optics	Preliminary specification 680 nm laser

MANUFACTURER	SONY	SONY	SONY	SONY	SONY
DRIVE	MDH-10	MDM-111	MDMII-AI	RMO-S330	SMO-F331
DISK/TREND GROUP	11	11	11	11	11
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
MEDIA: Disk diameter	64 mm	64 mm	64 mm	86 mm	86 mm
Recording technology	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic	Magneto-Optic
DRIVE: Operating mode	Rd.Only,Rewrit.	Rd.Only,Rewrit.	Rd.Only,Rewrit.	Rewritable	Rewritable
Interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Compatibility	--		--		
Speed control & zones	CLV	CLV	CLV	CAV	CAV
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 140	F: 140	F: 140	F: 128	F: 128
Capacity per track (Bytes)	F: NA	F: NA	F: NA	F: 12800	F: 12800
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	10000	10000	10000	10000	10000
Track density (TPI)	15875	15875	15875	15875	15875
Maximum linear density (BPI)	39827	39827	39827	24420	24420
Rotational speed (RPM)	940-422	940-422	940-422	1800	1800
PERFORMANCE					
Positioner type	Linear, DC Motor	Linear, Stepping Motor	Linear, Stepping Motor	Linear, Voice Coil	Linear, Voice Coil
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	455	255	255	120	120
Average rotational delay (msec)	45	45	45	16.6	16.6
Average access time (msec)	500	300	300	136.6	136.6
Data transfer rate (KBytes/sec)	150 2500 asynch.	150 2500 synch.	150	375 4000 synch.	375 4000 synch.
Buffer/cache size (Kbytes)				128	128
SIZE (mm: H x W x D)	25.4 x 101.6 x 149	25.4 x 101.6 x 149	25.4 x 101.6 x 149	52.4 x 160 x 240	52.4 160 x 240
FIRST CUSTOMER SHIPMENT	3Q94	2Q94	1995	7/94	7/94
COMMENTS			For IBM ThinkPad docking station	External subsystem	

MANUFACTURER	TEAC	TEAC			
DRIVE	OD 3000	OD 5000			
DISK/TREND GROUP	11	11			
MARKET	PCM	PCM			
MEDIA: Disk diameter	86 mm	86 mm			
Recording technology	Magneto-optic	Magneto-optic			
DRIVE: Operating mode	Rewritable	Rewritable			
Interface	SCSI-2	SCSI-2			
Compatibility					
Speed control & zones	CAV	CAV			
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 128	F: 128			
Capacity per track (Bytes)	F: 12800	F: 12800			
Data surfaces per spindle	1	1			
Tracks per surface	10000	10000			
Track density (TPI)	15875	15875			
Maximum linear density (BPI)	24423	24423			
Rotational speed (RPM)	3000	3000			
PERFORMANCE					
Positioner type	Linear, Voice Coil	Linear, Voice Coil			
Servo type	Continuous	Continuous			
Average positioning time (msec)	42	42			
Average rotational delay (msec)	10	10			
Average access time (msec)	52	52			
Data transfer rate (KBytes/sec)	640	640			
Buffer/cache size (Kbytes)	128	128			
SIZE (mm: H x W x D)	41.5 x 101.6 x 146	41.5 x 101.6 x 153.5			
FIRST CUSTOMER SHIPMENT	4Q91	2Q93			
COMMENTS					

HIGH CAPACITY FLEXIBLE DISK DRIVE SPECIFICATIONS

HIGH CAPACITY
FLEXIBLE DISK DRIVE SPECIFICATIONS

Coverage

This section includes high capacity flexible disk drives intended for computer data storage, with capacities exceeding five megabytes, which are now in production or announced, arranged alphabetically by manufacturer. Product specifications use the same format employed in the separate DISK/TREND Report on flexible disk drives published in previous years.

Specifications of flexible disk drive models sold by computer system manufacturers, but purchased on an OEM basis from others, may be included in a few cases for clarity. In the case of captive flexible disk drives manufactured by some system manufacturers, captive drives which are similar to individual OEM/Integrator models made by the same system manufacturer are usually not listed.

Capacities

Formatted native capacities have been used to be consistent with the disk drive industry's trend to identify all drives by formatted capacities. Capacities are listed as "U" for unformatted or "F" for formatted. All capacities are per spindle, one individual drive. Capacities per track are listed, except for drives with zoned recording.

Average access time

DISK/TREND Reports use the term "average access time" to describe the combination of average head positioning time and average disk rotational delay. Some in the industry have fallen into the habit of using the term average access time to describe average positioning time, or "seek" time, but this usage fails to adequately describe the time required for a disk drive to start to respond to a system request. In this product group, average positioning time is given in the comments section for several drives, due to the higher performance provided by the voice coil actuators utilized. In some cases, settling time is included in the total for average positioning time.

Accuracy

All information has been cross-checked for accuracy. However, it is anticipated that some errors may be included, since many manufacturers' published specifications do not cover all of the items listed, and numerous verbal inquiries were necessary. Your corrections will be most welcome and will be included in the next edition.

1995 DISK/TREND product groups for flexible disk drives included in the Removable Data Storage report

Group number	Drives included
14.	High capacity flexible disk drives

MANUFACTURER	IOMEGA	IOMEGA	IOMEGA	IOMEGA	IOMEGA
DRIVE	Bernoulli 90	Bernoulli 150	Bernoulli 230	Zip 100 Intern. (IDE Interface)	Zip 100 Parall. (Parallel Port)
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	PCM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	3.5"	3.5"
Recording medium	Metal Powder	Metal Powder	Metal Powder	Metal Powder	Metal Powder
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 90	F: 150.9	F: 230	F: 25/100	F: 25/100
Capacity per track (Bytes)	F: 29,696	F: 35,328	F: 47,616	Varies by zone	Varies by zone
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	1516	2594	2885	1817	1817
Track density (TPI)	1605	2117	2353	2118	2118
Maximum linear density (BPI)	37961 BPI* 28470 FCI	35990 BPI* 26992 FCI	49323 BPI* 36992 FCI	46000 BPI* 34500 FCI*	46000 BPI* 34500 FCI*
Rotational speed (RPM)	2368	2368	2439	2945	2945
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil
POSITIONING: Track to track(msec)	2.4 (including settling)	2.5 (including settling)	3.7	4	4
Settling time (msec)	--	--	--	--	--
Head load time(msec)	N/A	N/A	N/A	Continuous Contact	Continuous Contact
Average rotational delay (msec)	12.7	12.7	12.3	10.1	10.1
Data transfer rate (KBytes/sec)	2500	5000 synch.** 3000 asynch.**	5000 synch.** 3000 asynch.**	--**	1400**
SIZE (mm: H x W x D)	41.3 x 146 x 203.2	41.3 x 146 x 203.2	41.3 x 146 x 202.3	41.3 x 146.1 x 189	36.9 x 134.1 x 181.6
FIRST CUSTOMER SHIPMENT	7/91	4Q92	9/94	1Q96	1Q95
COMMENTS	*1,7 RLL Code 27 msec average positioning time	*1,7 RLL Code. **SCSI. 25 msec average positioning time Downward comp. 90 MB read/write 44 MB read	*1,7 RLL Code. **SCSI. 25 msec average positioning time Downward comp. 150, 105, 90, 65, 35 MB read/write; 44 MB read	*1,8 RLL Code. **IDE. 29 msec average positioning time. 25 and 100 MB disk cartridges available.	*1,8 RLL Code. **Parallel port. 29 msec average positioning time. 25 and 100 MB disk cartridges available

MANUFACTURER	INSITE PERIPHERALS	INSITE PERIPHERALS	INSITE PERIPHERALS	INSITE PERIPHERALS	INSITE PERIPHERALS
DRIVE	E325VM	ELF-20M External Drive Subsystem	ELF-20P External Drive Subsystem	I325VM	ORI-120A
DISK/TREND GROUP	14	14	14	14	14
MARKET	OEM	PCM	PCM	OEM	OEM, PCM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	Barium Ferrite	Barium Ferrite	Barium Ferrite	Barium Ferrite	Metal Powder
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 21	F: 21	F: 21	F: 21	F: 125.8
Capacity per track (Bytes)	F: 13,824	F: 13,824	F: 13,824	F: 13,824	Varies by zone
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	753	753	753	753	1736/80
Track density (TPI)	1245	1245	1245	1245	2490/135
Maximum linear density (BPI)	23980 BPI* 17985 FCI	23980 BPI* 17985 FCI	23980 BPI* 17985 FCI	23980 BPI* 17985 FCI	44880 BPI* 33660 FCI
Rotational speed (RPM)	720	720	720	720	720
PERFORMANCE					
Actuator type	Crs:Step. Motor Fine:Voice Coil	Crs:Step. Motor Fine:Voice Coil	Crs:Step. Motor Fine:Voice Coil	Crs:Step. Motor Fine:Voice Coil	Linear, Voice Coil
POSITIONING: Track to track(msec)	1	1	1	1	10/15
Settling time (msec)	15	15	15	15	--
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	41.6	41.6	41.6	41.6	41.6
Data transfer rate (KBytes/sec)	1500	1500	1500	1500	4000
SIZE (mm: H x W x D)	25.4 x 101.6 x 149.9	35 x 131 x 203	35 x 131 x 203	25.4 x 101.6 x 149.9	25.4 x 101.6 x 150
FIRST CUSTOMER SHIPMENT	3/93	12/93	12/93	10/93	1Q96
COMMENTS	*1,7 RLL Code. 65 msec average positioning time. Optical servo track system. SCSI interface. Read/write downward comp. 800 KB/1.4 MB GEC format.	*1,7 RLL Code. 65 msec average positioning time. Macintosh SCSI interface. Read/write downward comp. 800 KB/1.4 MB GEC format.	*1,7 RLL Code. 65 msec average positioning time. Printer parallel port interface. Read/write downward comp. 720 KB/1.2 MB (NEC)/1.44 MB.	*1,7 RLL Code. 65 msec average positioning time. Optical servo track system. SCSI interface. Read/write downward comp. 720 KB/1.2 MB (NEC)/1.44 MB.	*1,7 RLL Code. 65 msec average positioning time. Optical servo track system. ATAPI interface Read/write dowward comp. 720 KB/1.2 MB (NEC/1.44 MB.

MANUFACTURER	IOMEGA	MATSUSHITA-KOTOBUKI ELECTRONICS	SWAN INSTRUMENTS		
DRIVE	Zip 100 SCSI (SCSI Interface)	TBA	UHC 3258		
DISK/TREND GROUP	14	14	14		
MARKET	PCM	OEM, PCM	OEM, PCM		
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"		
Recording medium	Metal Powder	Metal Powder	Metal Powder		
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 25/100	F: 125.8	F: 173.3 Fixed F: 88.3 Remov. F: 44.0 Remov. F: 1.44 Remov.		
Capacity per track (Bytes)	Varies by zone	Varies by zone	Varies by zone		
Data surfaces per spindle	2	2	4		
Tracks per surface	1817	1736/80	1841/937/80		
Track density (TPI)	2118	2490/135	2970/1512/135		
Maximum linear density (BPI)	46000 BPI* 34500 FCI*	44880 BPI* 33660 FCI	73200/17434		
Rotational speed (RPM)	2945	720	3600		
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil		
POSITIONING: Track to track(msec)	4	10/15	3.5		
Settling time (msec)	--	--			
Head load time(msec)	Continuous Contact	Continuous Contact			
Average rotational delay (msec)	10.1	41.7	8.3		
Data transfer rate (KBytes/sec)	4000 synch.**	4000	6000/10000		
SIZE (mm: H x W x D)	36.9 x 134.1 x 181.6	25.4 x 101.6 x 150	25.4 x 101.6 x 146.1		
FIRST CUSTOMER SHIPMENT	1Q95	4Q95	4Q95		
COMMENTS	*1,8 RLL Code. **SCSI. 29 msec average positioning time. 25 and 100 MB disk cartridges available.	Preliminary specification. *1,7 RLL Code. 65 ms average positioning time. Downward compatible 720 KB, 1.2 MB, 1.44 MB.	18 msec. average head positioning SCSI-2 or IDE interface		

LOW CAPACITY FLEXIBLE DISK DRIVE SPECIFICATIONS

LOW CAPACITY
FLEXIBLE DISK DRIVE SPECIFICATIONS

Coverage

This section includes low capacity flexible disk drives intended for computer data storage, with capacities less than five megabytes, which are now in production or announced, arranged alphabetically by manufacturer. Product specifications use the same format employed in the separate DISK/TREND Report on flexible disk drives published in previous years.

Specifications of flexible disk drive models sold by computer system manufacturers, but purchased on an OEM basis from others, may be included in a few cases for clarity. In the case of captive flexible disk drives manufactured by system manufacturers, captive drives which are similar to individual OEM/Integrator models made by the same system manufacturer are usually not listed.

Capacities

Formatted native capacities have been used to be consistent with the disk drive industry's trend to identify all drives by formatted capacities. Capacities are listed as "F" for formatted. All capacities are per spindle, one individual drive. Capacities per track are listed, except for drives with zoned recording.

Accuracy

All information has been cross-checked for accuracy. However, it is anticipated that some errors may be included, since many manufacturers' published specifications do not cover all of the items listed, and numerous verbal inquiries were necessary. Your corrections will be most welcome and will be included in the next edition.

DISK/TREND product groups

. In most cases the product groups used for individual drives are clear, but a few arbitrary decisions have been made. Please note that all drives with capacities under 5 megabytes have been placed in the low capacity group, regardless of disk diameter.

1995 DISK/TREND product groups for flexible disk drives included in the Removable Data Storage report

Group number	Drives included
13.	Low capacity flexible disk drives

MANUFACTURER	ALPS ELECTRIC	ALPS ELECTRIC	ALPS ELECTRIC	CANON	CANON
DRIVE	DF 333H	DF 334H	DF 334N	MD 3641	MD 3651
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680/ 9,216	F: 4,608/9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80/77/80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184	8717/17434	8717/14184/ 17434	8717/17434	8717/17434
Rotational speed (RPM)	300/360	300	300/360/300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	100	100/83.3	100	100
Data transfer rate (KBytes/sec)	37.5/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 145	25.4 x 101.6 x 145	25.4 x 101.6 x 145	19.6 x 101.6 x 129.5	15.5 x 96 x 130
FIRST CUSTOMER SHIPMENT	5/94	5/94	5/94	4/90	1991
COMMENTS	Direct drive	Direct drive	Direct drive	Direct drive motor	

MANUFACTURER	CANON	CHINON	CHINON	CHINON	CHINON
DRIVE	MD 3661	FG-357	FG-506	FR-506	FZ-357 FZ-357I FZ-357IS
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	5.25"	5.25"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .7/1.2	F: .7/1.2	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	96	96	135
Maximum linear density (BPI)	8717/14527	8717/17434	5922/9870	5922/9870	8717/17434
Rotational speed (RPM)	360	300	300/360	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83.3	100	100/83.3	100/83.3	100
Data transfer rate (KBytes/sec)	37.5/62.5	31.25/62.5	37.5/62.5	37.5/62.5	31.25/62.5
SIZE (mm: H x W x D)	15.5 x 101.6 x 108	25.4 x 101.6 x 145	41.3 x 146 x 193	41 x 146 x 193	25.4 x 101.6 x 130
FIRST CUSTOMER SHIPMENT	5/92	1Q95	1Q95	1Q91	1Q90
COMMENTS					FZ-357I and FZ-357IS in 5.25" frame

MANUFACTURER	CITIZEN	CITIZEN	CITIZEN	CITIZEN	CITIZEN
DRIVE	OSDA	OSDB	OSDE	OSDF	OSDG
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2	F: .7/1.2/1.4	F: .7/1.4/2.88	F: .7/1.2/2.88
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/18,432	F: 4,608/18,432
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80/77	80	80/77
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/14184	8717/17434	8717/17434/ 34868	8717/14184/ 34868
Rotational speed (RPM)	300	300/360	300	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5/125	31.25/62.5/125
SIZE (mm: H x W x D)	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT	4Q87	4Q87	4Q89	4Q90	4Q90
COMMENTS					

MANUFACTURER	CITIZEN	CITIZEN	CITIZEN	CITIZEN	CITIZEN
DRIVE	V1DA V2DA V3DA	V1DB V2DB V3DB	V1DC V2DC V3DC	V1DE V2DE V3DE	W1DA
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2	F: .7	F: .7/1.2/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680	F: 4,608	F: 4,608/9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80/77/80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/14184	8717	8717/17434	8717/17434
Rotational speed (RPM)	300	300/360	300	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	15 x 96.5 x 129.5	15 x 96.5 x 129.5	15 x 96.5 x 129.5	15 x 96.5 x 129.5	10.9 x 96.5 x 116.8
FIRST CUSTOMER SHIPMENT	2Q91	2Q91	2Q91	2Q91	2Q93
COMMENTS	V3DA is 3 volt model	V3DB is 3 volt model	V3DC is 3 volt model	V3DE is 3 volt model	

MANUFACTURER	CITIZEN	CITIZEN	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL
DRIVE	W1DB	W1DE	JU-226A	JU-227A	JU-256A
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680/ 9,216	F: 4,608/9,216	F: 4,608/7,680/ 9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77/80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184	8717/17434	17434	17434	17434
Rotational speed (RPM)	300/360	300/360	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100/83.3	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	62.5	62.5	62.5
SIZE (mm: H x W x D)	10.9 x 96.5 x 116.8	10.9 x 96.5 x 116.8	12.7 x 101.6 x 106	12.7 x 101.6 x 106	25.4 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT	2Q93	2Q93	1994	1994	1994
COMMENTS					

MANUFACTURER	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA COMMUNICATION INDUSTRIAL	MATSUSHITA ELECTRONIC COMPONENTS
DRIVE	JU-257	JU-257A	JU-259A	JU-475	EME-213
DISK/TREND GROUP	13	13	13	13	13
MARKET	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	Captive,OEM,PCM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	5.25"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Barium Ferrite	Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.4	F: .7/1.4/2.88	F: .360/.7 or F: .6/1.2	F: .7
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216/ 18,432	F: 4,608/7,680	F: 4,608
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	77/80	80
Track density (TPI)	135	135	135	96	135
Maximum linear density (BPI)	8717/17434	8717/17434	8717/34868	5922/9646	8717
Rotational speed (RPM)	300	300	300	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	6
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5/125	31.25/62.5	31.25
SIZE (mm: H x W x D)	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	41.3 x 146 x 203.2	25.4 x 101.6 x 150.0
FIRST CUSTOMER SHIPMENT	1987	1987	4Q92	1983	1989
COMMENTS			SCSI interface option		

MANUFACTURER	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS
DRIVE	EME-215	EME-216	EME-219	EME-262	EME-264
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2	F: .7
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680/ 9,216	F: 4,608/7,680	F: 4,608
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14528	8717/17434	8717/14528/ 17434	8717/14528	8717
Rotational speed (RPM)	300/360	300	300/360/300	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	6
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83	100	100/83/100	83/100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5/62.5	31.25/62.5	31.25
SIZE (mm: H x W x D)	25.4 x 101.6 x 150.0	25.4 x 101.6 x 150.0	25.4 x 101.6 x 150.0	17 x 96.5 x 134.6	17 x 96.5 x 134.6
FIRST CUSTOMER SHIPMENT	1991	1991	1994	1989	1989
COMMENTS					

MANUFACTURER	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MATSUSHITA ELECTRONIC COMPONENTS	MITSUBISHI ELECTRIC CORPORATION
DRIVE	EME-272 EME-277	EME-273 EME-278	EME-276	EME-279	MF 355F
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .7	F: .7/1.2/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608	F: 4,608/7,680/ 9,216	F: 4,608/7,680 9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14528	8717/17434	8717	8717/14528/ 17434	8717/14184/ 17434
Rotational speed (RPM)	300/360	300	300	300/360/300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	12	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	83/100	100	100	100/83/100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25	31.25/62.5/62.5	31.25/62.5
SIZE (mm: H x W x D)	15 x 96 x 130	15 x 96 x 130	15 x 96 x 130	15 x 96 x 130	25.4 x 101.6 x 146
FIRST CUSTOMER SHIPMENT	1992	4/91	1992	1992	3Q93
COMMENTS					

MANUFACTURER	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUBISHI ELECTRIC CORPORATION	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	MF 355H	MF 356F	MF 504C	D 352E	D 353F2
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	5.25"	3.5"	3.5"
Recording medium	High Density Oxide Coated	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.2/ 1.4/2.88	F: .7/1.2	F: .7/1.4/2.88	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/7,680 9,216	F: 4,608/7,680/ 9,216/18,432	F: 4,608/7,680	F: 4,608/9,216 18,432	F: 4,608/7,860 9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80/77	80	80/77
Track density (TPI)	135	135	96	135	135
Maximum linear density (BPI)	8717/14184/ 17434	8717/14184/ 17434/34868	5922/9870	8717/17434/ 34868	8717/14184/ 17434
Rotational speed (RPM)	300/360	300/360	300/360	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100/83.3	100/83.3	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5/125	31.25/62.5	31.25/62.5/125	31.25/62.5
SIZE (mm: H x W x D)	12.7* x 96 x 126	25.4 x 101.6 x 146	41 x 146 x 195	25.4 x 101.6 x 125	12.7 x 96 x 130
FIRST CUSTOMER SHIPMENT	1Q94	3Q93	2Q88		
COMMENTS	*15 mm high version available with auto eject				

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	D 353P5 D 353T5	D 357T5	D 358F2	D 358P5 D 358T5	D 359F2
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7	F: .7/1.2	F: .7/1.2	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,860 9,216	F: 4,608	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	80/77	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184/ 17434	8717	8717/14184	8718/14184	8717/17434
Rotational speed (RPM)	300/360	300	300/360	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3/6	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	100/83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 150	25.4 x 101.6 x 154.9	12.7 x 96 x 130	25.4 x 101.6 x 149.9	12.7 x 96 x 130
FIRST CUSTOMER SHIPMENT		4Q88		3Q91	
COMMENTS	D353P5 is in 5.25" form factor			D 358P5 is in 5.25" form factor	

MANUFACTURER	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC	MITSUMI ELECTRIC
DRIVE	D 359F2E	D 359G	D 359P5 D 359T5	D 509V5	DP 119F2
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	5.25"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 1.4	F: .7/1.4	F: .7/1.4	F: .7/1.2	F: .7/1.4
Capacity per track (Bytes)	F: 9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/7,680	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	96	135
Maximum linear density (BPI)	17434	8717/17434	8717/17434	5922/9646	8717/17434
Rotational speed (RPM)	300	300	300	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	6	3/6	3/5	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100	100/83.3	100
Data transfer rate (KBytes/sec)	62.5	31.25/62.5	31.25/62.5	37.5/62.5	31.25/62.5
SIZE (mm: H x W x D)	19.5 x 106 x 143	12.7 x 101.6 x 101.6	25.4 x 101.6 x 154.9	41.3 x 146 x 188	25.4 x 101.6 x 170
FIRST CUSTOMER SHIPMENT	1Q95	1Q95	4Q88	4Q88	2Q95
COMMENTS	External model		D 359P5 is in 5.25" form factor		Combines FDD with slot for PCMCIA card types I, II, or III

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	FD 1138C	FD 1138D	FD 1138H FD 1148H	FD 1138T	FD 1139C
DISK/TREND GROUP	13	13	13	13	13
MARKET	Captive, OEM	Captive, OEM	OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680 9,216	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14528	8717/14528	8717/17434	8717/14528/ 17434	8717/14528
Rotational speed (RPM)	300/360	300/360	300	300/360	300/360
PERFORMANCE					
Actuator type	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100/83.3	100	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	19 x 101.6 x 127	19 x 101.6 x 127	19 x 101.6 x 127	19 x 101.6 x 127	15 x 101.6 x 101.6
FIRST CUSTOMER SHIPMENT	1Q90	2Q90	1Q90	2Q92	2/91
COMMENTS		With VFO			

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	FD 1139H	FD 1139T	FD 1148C	FD 1148H	FD 1148T
DISK/TREND GROUP	13	13	13	13	13
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/9,216	F: 4,608/7,680 9,216	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680 9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/17434	8717/14528/ 17434	8717/14528	8717/17434	8717/14528/ 17434
Rotational speed (RPM)	300	300/360	300/360	300	300/360
PERFORMANCE					
Actuator type	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor	Linear, Pulse Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100/83.3	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	15 x 101.6 x 101.6	15 x 101.6 x 101.6	19.8 x 101.6 x 130	19.8 x 101.6 x 130	19.8 x 101.6 x 130
FIRST CUSTOMER SHIPMENT	2/91				
COMMENTS					

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
DRIVE	FD 1157C	FD 1157D	FD 1158C	FD 1158D	FD 1165
DISK/TREND GROUP	13	13	13	13	13
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	8"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.2	F: .6/1.2
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,096/8,192
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	77
Track density (TPI)	96	96	96	96	48
Maximum linear density (BPI)	5922/9870	5922/9870	5922/9870	5922/9870	3408/6816
Rotational speed (RPM)	300/360	300/360	300/360	300/360	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	35	35	Continuous Contact	Continuous Contact	50
Average rotational delay (msec)	100/83.3	100/83.3	100/83.3	100/83.3	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	41.3 x 146 x 203.2	41.3 x 146 x 203.2	25.4 x 146 x 190.5	25.4 x 146 x 190.5	57.9 x 216.9 x 322.6
FIRST CUSTOMER SHIPMENT	1987	1987	2Q90	3Q90	4Q81
COMMENTS		With VFO		With VFO	

MANUFACTURER	NEC	NEC	NEC	NEC	SAFRONIC
DRIVE	FD 1177C	FD 1231	FD 1238H	FD 1239H	DS-34AC DS-35AC
DISK/TREND GROUP	13	13	13	13	13
MARKET	Captive, OEM	Captive, OEM	Captive, OEM	Captive, OEM	OEM
MEDIA: Nominal disk diameter	5.25"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .7/1.4	F: .7/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	96	135	135	135	135
Maximum linear density (BPI)	5922/9870	8717/17434	8717/17434	8717/17434	8717/17434
Rotational speed (RPM)	300/360	300	300	300	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	100	100	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	41 x 146 x 203	25.4 x 101.6 x 146	12.7 x 96 x 126	12.5 x 101.6 x 101.6	25.4 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT		2Q95	1Q95	4Q95	1989
COMMENTS					

MANUFACTURER	SAFRONIC	SAMSUNG ELECTRONICS	SAMSUNG ELECTRONICS	SEIKO EPSON	SEIKO EPSON
DRIVE	DS-53AC	SFD-321D SFD-321DT	SFD-560D SFD-560DT	DYO-211	SD-780
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	Captive, OEM	Captive, OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	3.5"	5.25"	3.5"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .360/1.2	F: .7/1.4	F: .7/1.2	F: .7/1.4	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80/77	80	80
Track density (TPI)	96	135	96	135	96
Maximum linear density (BPI)	5876/9870	8717/17434	5922/9646	8717/17434	5922/9870
Rotational speed (RPM)	300	300	300/360	300	360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	83.3	100	83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	37.5/62.5
SIZE (mm: H x W x D)	41.3 x 146 x 193	25.4 x 101.6 x 149.9	41.3 x 146 x 203.2	41.5 x 146 x 192	25.4 x 146 x 193
FIRST CUSTOMER SHIPMENT	1989	2Q89	4Q87	1Q95	3Q93
COMMENTS				Combines SMD-1340 FDD with slot for PCMCIA card Types I, II, or III	

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SONY	SONY
DRIVE	SD-880	SMD-1140	SMD-1340	MPF420	MPF520
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	Captive, OEM	Captive, OEM
MEDIA: Nominal disk diameter	3.5"/5.25"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 1.4/1.2	F: .7/1.4	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 9,216/7,680	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/7,680/ 9,216	F: 4,608/7,680/ 9,216
Data surfaces per spindle	2/2	2	2	2	2
Tracks per surface	80/80	80	80	80	80
Track density (TPI)	135/96	135	135	135	135
Maximum linear density (BPI)	17434/9646	8717/17434	8717/17434	8717/14528/ 17434	8717/14528/ 17434
Rotational speed (RPM)	300/360	300	300	300/360/300	300/360/300
PERFORMANCE					
Actuator type	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Rack & Pinion, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3/3	3	3	3	3
Settling time (msec)	15/15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100.83.3	100	100	100	100
Data transfer rate (KBytes/sec)	62.5/62.5	31.25/62.5	31.25/62.5	31.25/62.5/62.5	31.25/62.5/62.5
SIZE (mm: H x W x D)	41.5 x 146 x 193	15 x 96.5 x 116.8	25.4 x 101.6 x 146	25.4 x 101.6 x 150	25.4 x 101.6 x 145
FIRST CUSTOMER SHIPMENT	1992	10/92	1Q95		2Q94
COMMENTS	Combines 5.25" SD-780 and 3.5" SMD-1140	Also 3.3 volt version			

MANUFACTURER	SONY	TEAC	TEAC	TEAC	TEAC
DRIVE	MPF720	CF-506A	FD-04GF	FD-04HF	FD-04HG
DISK/TREND GROUP	13	13	13	13	13
MARKET	Captive, OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.4	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4
Capacity per track (Bytes)	F: 4,608/7,680/ 9,216	F: 4,608/9,216	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14528/ 17434	8717/17434	8717/14528	8717/17434	8717/17434
Rotational speed (RPM)	300/360/300	300	300/360	300	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100	100/83.3	100	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	12.7 x 96 x 130	41.3 x 146 x 203	12.7 x 101.6 x 106	12.7 x 101.6 x 106	12.7 x 101.6 x 106
FIRST CUSTOMER SHIPMENT	2Q95	1Q95	1Q95	1Q95	1Q95
COMMENTS		Combines FDD with 4X CD-ROM drive	Direct drive motor	Direct drive motor	Direct drive motor

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-05GF	FD-05HF	FD-05HG	FD-05HGS	FD-05HS
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717/14184	8717/17434	8717/17434	8717/17434	8717/17434
Rotational speed (RPM)	300/360	300	300/360	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100	100/83.3	100/83.3	100
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	12.7 x 101.6 x 129.5	12.7 x 101.6 x 129.5	12.7 x 101.6 x 129.5	25.4 x 101.6 x 144.5	25.4 x 101.6 x 144.5
FIRST CUSTOMER SHIPMENT	10/91	10/91		2Q93	2Q93
COMMENTS	Direct drive motor 101.6 mm or 96 mm width available	Direct drive motor 101.6 mm or 96 mm width available	Direct drive motor 101.6 mm or 96 mm width available	SCSI interface	SCSI interface

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-05JS	FD-05PGF	FD-05PHF	FD-05PHG	FD-155GF
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	5.25"
Recording medium	Barium Ferrite	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 1.4/2.88	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/18,432	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80/77
Track density (TPI)	135	135	135	135	96
Maximum linear density (BPI)	8717/34868	8717/14184	8717/17434	8717/17434	5922/9646
Rotational speed (RPM)	300	300/360	300	300/360	300/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100/83.3	100/83.3	100	100/83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5/125	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 144.5	15.5 x 106.2 x 146	15.5 x 106.2 x 146	15.5 x 106.2 x 146	25.4 x 146 x 191
FIRST CUSTOMER SHIPMENT	2Q93	4/92	4/92	4/92	8/91
COMMENTS	SCSI interface	External drive unit	External drive unit	External drive unit	

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-235F	FD-235GF	FD-235HF	FD-235HG	FD-235HS
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7	F: .7/1.2	F: .7/1.4	F: .7/1.2/1.4	F: .7/1.4
Capacity per track (Bytes)	F: 4,608	F: 4,608/7,680	F: 4,608/9,216	F: 4,608/9,216	F: 4,608/9,216
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80	80	80	80
Track density (TPI)	135	135	135	135	135
Maximum linear density (BPI)	8717	8717/14528	8717/17434	8717/17434	8717/17434
Rotational speed (RPM)	300	300/360	300	300/360	300
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	100	100/83.3	100	100	100
Data transfer rate (KBytes/sec)	31.25	31.25/62.5	31.25/62.5	31.25/62.5	31.25/62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 145	25.4 x 101.6 x 145	25.4 x 101.6 x 145	25.4 x 101.6 x 145	41.9 x 104.1 x 161.8
FIRST CUSTOMER SHIPMENT	2Q88	2Q88	2Q88		1990
COMMENTS					SCSI interface

MANUFACTURER	TEAC	TEAC	TEAC	TEAC	TEAC
DRIVE	FD-505	FD-55BR	FD-55FR	FD-55GFR	FD-55GR
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"/5.25"	5.25"	5.25"	5.25"	5.25"
Recording medium	High Density Oxide Coated	Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 1.4/1.2	F: .360	F: .7	F: .7/1.2	F: 1.2
Capacity per track (Bytes)	F: 9,216/7,680	F: 4,608	F: 4,608	F: 4,608/7,680	F: 7,680
Data surfaces per spindle	2/2	2	2	2	2
Tracks per surface	80/80	40	80	80/77	77
Track density (TPI)	135/96	48	96	96	96
Maximum linear density (BPI)	17434/9646	5876	5922	5922/9646	9646
Rotational speed (RPM)	300/360	300	300	300/360	360
PERFORMANCE					
Actuator type	Lead Screw, Band Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track (msec)	3/3	4/6	3	3	3
Settling time (msec)	15/15	10/15	15	15	15
Head load time (msec)	Continuous Contact	50	50	50	50
Average rotational delay (msec)	100/83.3	100	100	100/83.3	83.3
Data transfer rate (KBytes/sec)	62.5/62.5	31.25	31.25	31.25/62.5	62.5
SIZE (mm: H x W x D)	41.3 x 146 x 198	41.3 x 146 x 203.2	41.3 x 146 x 203.2	41.3 x 146 x 203.2	41.3 x 146 x 203.2
FIRST CUSTOMER SHIPMENT	1992	1987	1987	1987	1987
COMMENTS	Combines 5.25" and 3.5" floppy drives			Dual speed	

MANUFACTURER	TEAC	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	FD-55GS	2100	YD-180	YD-380B-1710B	YD-380B-1714B
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	3.5"	8"	5.25"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.4	F: .6/1.2	F: 1.2	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/9,216	F: 4,096/8,192	F: 7,680	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77	80	77	77	80/77
Track density (TPI)	96	135	48	96	96
Maximum linear density (BPI)	5922/9646	8717/17434	3408/6816	9646	5922/9646
Rotational speed (RPM)	300/360	300	360	360	300/360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	50	50	50
Average rotational delay (msec)	100/83.3	100	83.3	83.3	100/83.3
Data transfer rate (KBytes/sec)	31.25/62.5	31.25/62.5	31.25/62.5	62.5	31.25/62.5
SIZE (mm: H x W x D)	43.2 x 144.8 x 203.2	25.4 x 101.8 x 150	57.2 x 217.2 x 320	41.3 x 146 x 203.2	41.3 x 146 x 203.2
FIRST CUSTOMER SHIPMENT	1990	1Q95	9/81	4/86	4/86
COMMENTS	SCSI interface	Combines FDD with slot for PCMCIA card types I, II, or III			

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-380B-1734H	YD-380B-1734S	YD-380D-1711D	YD-685C-1505H	YD-686C
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	3.5"	3.5"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.2	F: .7/1.2
Capacity per track (Bytes)	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680	F: 4,608/7,680
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80	80/77	80	80/77	80/77
Track density (TPI)	96	96	96	135	135
Maximum linear density (BPI)	5922/9870	5922/9870	5922/9870	8717/14184	8717/14184
Rotational speed (RPM)	600/720	600/720	360	600/720	300/360
PERFORMANCE					
Actuator type	Band, Stepping Motor	Band, Stepping Motor	Band, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	50	Continuous Contact	Continuous Contact
Average rotational delay (msec)	50/41.6	50/41.6	83.3	50/41.6	100/83.3
Data transfer rate (KBytes/sec)	75/125	75/125	37.5/62.5	62.5/125	31.25/62.5
SIZE (mm: H x W x D)	41.3 x 146 x 203.2	41.3 x 146 x 203.2	41.3 x 146 x 203.2	17.3 x 101.6 x 149.9	25.4 x 101.6 x 149.9
FIRST CUSTOMER SHIPMENT	6/90	6/91	4/86	6/90	1Q87
COMMENTS	Double speed drive sold for duplicators	Double speed R/W drive sold for duplicators		Double speed drive sold for duplicators	

MANUFACTURER	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA	Y-E DATA
DRIVE	YD-701B YD-702B YD-702D	YD-701B-6030S	YD-701B-6030Q	YD-702J	YD-801 YD-802
DISK/TREND GROUP	13	13	13	13	13
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	5.25"
Recording medium	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated	High Density Oxide Coated
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: .7/1.2/1.4	F: 1.2/2.4
Capacity per track (Bytes)	F: 4,608/7,680 9,216	F: 4,608/7,680/ 9,216	F: 4,608/7,680/ 9,216	F: 4,608/7,680 9,216	F: 20,832
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	80/77/80	80/77/80	80/77/80	80/77/80	80
Track density (TPI)	135	135	135	135	96
Maximum linear density (BPI)	8717/14184/ 17434	8717/14184/ 17434	8717/14184/ 17434	8717/14184/ 17434	19740
Rotational speed (RPM)	300/360	600/720/600	1200/1440/1200	300/360/300	180/360
PERFORMANCE					
Actuator type	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Lead Screw, Stepping Motor	Band, Stepping Motor
POSITIONING: Track to track(msec)	3	3	3	3	3
Settling time (msec)	15	15	15	15	15
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	50
Average rotational delay (msec)	100	50/41.6/50	25/20.8/25	100/83.3/100	166.7
Data transfer rate (KBytes/sec)	31.25/62.5/62.5	62.5/125/125	125/250/250	31.25/62.5/62.5	62.5
SIZE (mm: H x W x D)	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	25.4 x 101.6 x 149.9	12.7 x 96 x 129.5	41.3 x 146 x 203.2
FIRST CUSTOMER SHIPMENT	1Q87	6/91	1Q95	2Q94	1Q87
COMMENTS		Double speed R/W drive sold for duplicators	Quad speed R/W drive sold for duplicators		Compatible with 1.0 and 1.6 MB formats

MANUFACTURER PROFILES

1995 DISK/TREND REPORT

U.S. Manufacturers

ACTIONTEC, INC. (Formerly Premax Electronics, Inc.)
750 North Mary Avenue
Sunnyvale, CA 94086

Founded in 1993, Premax specializes in PC Card storage and peripheral boards. The firm's manufacturing is done in Taiwan. Intel chips are used in a line of flash memory cards that range from 256 kilobytes to 16 megabytes in capacity. The company changed its name in 1995 to eliminate confusion with other organizations and as a step to establish a stronger brand image.

ADVANCED MICRO DEVICES
1 AMD Place
Sunnyvale, CA 94088

1994 total net sales: $2,134,659,000 Net income: $305,266,000

AMD, founded in 1969, is the fifth largest U.S. semiconductor manufacturer. The firm produces memories, microprocessors, programmable logic devices and other semiconductor products.

AMD's flash product line includes flash chips and PC Card flash memory cards. Card capacities from 1 to 10 megabytes are available, with the later cards requiring only five volts for operation. AMD relies upon outside contractors to assemble its flash memory cards, as the firm's primary emphasis is upon chips.

In mid-1994, AMD announced that SGS-Thomson Microelectronics would become a second source for AMD's flash chips and would work with AMD on future developments. A 1992 agreement also established Fujitsu as an AMD chip second source, and jointly funded development has resulted in the production of 16 megabit chips by both firms in 1995.

AMP INCORPORATED
Harrisburg, PA 17105

1994 total net sales: $4,027,000,000 Net income: $369,000,000

AMP is a major manufacturer of electronic hardware and the largest manufacturer of electrical and electronic connectors. The firm produces a line of flash memory cards ranging from 128 kilobytes to 16 megabytes. AMP is using Atmel, AMD and Intel chips in the flash memory cards it produces. In 1993, the firm acquired a minority interest in New Media, which includes flash memory cards in its own product line. AMP is one of the companies producing flash cards not fully compliant with the computer oriented PC Card interface specification, but suitable for use with industrial equipment.

MANUFACTURER PROFILES

All manufacturers now producing the types of removable data storage products covered by this report, or those which are expected to eventually enter the market, are listed in this section. "1994 total net sales" covers the fiscal year ending in 1994 for each firm unless noted otherwise, or for the parent company if the storage product manufacturer is a subsidiary. The fiscal year of listed firms ends on December 31, 1994, unless otherwise noted.

Manufacturers located in the United States that have majority owners headquartered in other countries are grouped in the geographical area in which the owner's home office is located.

Exchange rates

The exchange rates used in converting the financial data of non-U.S. manufacturers to dollars are given below. The average exchange rate for 1994 is used, as cited by the Federal Reserve Bulletin.

Country	Currency	Currency units/U.S. dollar
Germany	Deutschmark	1.62
Italy	Lira	1,611.5
Japan	Yen	102.2
Netherlands	Guilder	1.82
South Korea	Won	807.0
United Kingdom	Pound	.652
Taiwan	Dollar	26.5

Use caution in making year to year comparisons of revenue and income figures, as they are significantly impacted by exchange rate changes.

ATMEL CORPORATION
2125 O'Nel Drive
San Jose, CA 95131

Atmel, founded in 1984, produces a wide range of semiconductor products, including flash chips up to 4 megabits density using EEPROM architectures. The firm supplies chips to manufacturers of flash memory cards, including AMP and Fuji Photo Film, but does not manufacture cards.

AURA ASSOCIATES
2605 South Winchester Boulevard
Campbell, CA 95008

Aura Associates, founded by disk drive industry veterans in mid-1986, initially planned to develop a 2.5" drive using multiple actuators and offering very fast access time and transfer rate. An early model of the drive was demonstrated at the 1988 Fall Comdex, but was never produced. More recently, Aura designed 1.8" drives which were produced by NEC, but for which Aura also retained manufacturing and sales rights. The firm began shipments of PC Card Type III rigid disk drives in 1993, but suspended sales due to market weakness. The company is currently developing an electronic camera which will use PC Card Type III drives.

AVATAR SYSTEMS CORPORATION
1455 McCarthy Boulevard
Milpitas, CA 95035

Avatar, founded in 1991, specializes in small form factor disk cartridge drives. The company started limited production using glass disks in California with an 85 megabyte 2.5" cartridge drive sold individually and packaged with a 3.5" floppy disk drive in a one inch high combination unit, intended for portable and desktop applications. Following management changes, a 170 megabyte unit was announced in 1995, with higher capacities expected in the near future. Drive development is centered in Milpitas, with a manufacturing facility under development in Thailand.

BERG ELECTRONICS, INC.
101 Hanley Road, Suite 400
St. Louis, MO 63105

Berg Electronics, founded in the 1950's, was sold to DuPont in 1972 and resold to outside investors in 1993. An aggressive acquisition policy has driven rapid growth since Berg's reemergence as an independent entity. The firm is the third largest supplier of electronic connectors and cable assemblies, and also performs contract design and manufacturing services. Berg facilities are located in the U.S., Europe and Asia, with marketing and engineering located in Pennsylvania. The firm manufactures flash memory cards for AMD.

CATALYST SEMICONDUCTOR
2231 Calle de Luna
Santa Clara, CA 95054

Catalyst was founded in 1985 by private investors, and has become a producer of CMOS and EEPROM chips and derivative products, including flash memories. The company made a brief attempt at entering the PC Card flash memory market, but then decided to concentrate on chip manufacturing. A card market reentry remains a future possibility, but Catalyst wants to see a larger market before it tries again with the card products. The company has joint development agreements with Zilog.

CENTENNIAL TECHNOLOGIES, INC.
37 Manning Road, Suite 1
Billerica, MA 01821

Centennial was founded in 1962 as a supplier of printer fonts and font hardware modules. The firm got into the small printer font cartridge market in the mid-eighties and subsequently evolved into a supplier of PC Card memory in 1992, including flash memory, SRAM, DRAM and read-only memory.

CIRRUS LOGIC, INC.
3100 West Warren Avenue
Fremont, CA 94538

Cirrus Logic is a producer of specialized controller and interface chips and related products. The company entered the PC Card market in 1995 with a line of flash disk cards based on Samsung 16 megabit NAND logic chips. The company sells complete cards or portions thereof to OEM customers. Production began in mid-1995.

INTEGRAL PERIPHERALS
5775 Flatiron Parkway
Boulder, CO 80301

Integral Peripherals was founded in September, 1990, by engineering and management personnel who previously pioneered early 2.5" drives at PrairieTek. The company was the first to design and manufacture 1.8" disk drives. Its initial product was a 20 megabyte drive, first produced in the second half of 1991, and for which the available market was minimal. Integral had somewhat better luck with 42 and 85 megabyte drives, available in both fixed and PC Card Type III models, in production since 1992. A 105 megabyte PC Card Type III drive shipped in late 1993, a 170 megabyte version in early 1994, and a 340 megabyte model in late 1994. A higher capacity PC Card Type III drive is expected to begin production in late 1995. Integral's drives use ramp loaded heads, and are designed to high operating shock and vibration specifications, with low power requirements, in anticipation of wide usage in subnotebook computers and other portable computer applications. Integral began its high volume manufacturing in Singapore in mid-1992. In 1995, Integral completed a design project funded by Samsung for high capacity 2.5" disk drives, which will be produced by both companies.

INTEL CORPORATION
2200 Mission College Boulevard
Santa Clara, CA 95052

1994 total net sales: $11,521,000,000 Net income: $2,288,000,000

Aside from being the leading manufacturer of microprocessors, Intel manufactures flash chips, flash memory cards and flash disk cards ranging from 1 megabyte to 40 megabytes. Production of the flash memory cards began in 1993, while the flash disk cards began shipments in mid-1994. The company tends to emphasize flash memory over flash disk, and is expected to expand its flash memory offerings during 1995. Intel's flash production program was delayed due to problems at several Japanese firms used for chip production, and although the manufacturing logjam was reduced in 1994, demand still outstrips capacity. Flash chip production is now concentrated at Intel facilities in Albuquerque and with Sharp Corporation.

In mid-1994, Intel revealed a development program capable of storing multiple bits of information in a single flash memory cell. Intel hopes to be able to use the technology to produce a 128 megabyte flash chip by the year 2000.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

1994 total net sales: $64,052,000,000 Net income: $3,021,000,000

For many years IBM has been the world's premier computer company. In 1956, IBM became the first company to ship a rigid magnetic disk drive and maintained a leadership position in storage technology for much of the time between then and the present. Today, the 3.5" and 2.5" rigid disk drives made by IBM's Storage Systems Division use the most advanced heads available in any disk drive. In addition, IBM manufactures 5.25" optical disk drives. The firm had been producing 3.5" optical drives, but ceased production in 1995. IBM was the earliest manufacturer of floppy disk drives, which it no longer produces.

IBM Microelectronics Division now supplies PC Card flash disk cards, having dropped flash memory cards previously produced. The flash disk cards, which use Toshiba devices and an IBM designed controller chip, became available in 1994. The flash disk cards are manufactured by IBM in Japan, while flash memory and other PC Card peripherals are made by Celestica, an IBM subsidiary in Canada, on a contract basis for other firms.

IOMEGA CORPORATION
1821 West Iomega Way
Roy, UT 84067

1994 FDD sales: $42,200,000
1994 total net sales: $141,380,000 Net income: ($1,882,000)

Iomega, founded in 1980, was successful in establishing production capability for its unique 8" flexible disk drive, which maintained control of head/disk contact with the Bernoulli effect. The product was originally intended as an OEM drive, but Iomega had much better luck with subsystems sold in the personal computer add-on market. The original 8" subsystem for the IBM PC market provided most of the company's early revenue growth until surpassed by the 20 megabyte half high 8" drives introduced in 1985. However, half high 5.25" models in production since 1987 have largely displaced 8" drives, and Iomega discontinued 8" drives in 1991. The 5.25" product line currently includes a 90 megabyte model (1991), a 150 megabyte model (1992), and a 230 megabyte model (1994).

Attempting to broaden its product coverage, Iomega licensed the Insite Peripherals "floptical" drive and media, and selected Chinon as a manufacturing partner for the drive. Iomega's 20 megabyte "floptical" drive was introduced in 1992, but was discontinued in 1994 after only limited sales success.

The 100 megabyte "Zip" 3.5" floppy drive, which began shipments in early 1995, has found a much broader market, due to its unique combination of 100 megabyte disk capacity and less than $200 drive list price. Seiko Epson has been established as a second manufacturing source for the Zip drive. The one gigabyte "Jaz" drive, expected to ship in late 1995, marks Iomega's entry into the rigid cartridge disk drive market.

MAXTOR CORPORATION
150 River Oaks Parkway
San Jose, CA 95134

Total 1994 net sales: $906,799,000 Net income: ($82,222,000)
(FY ending 3/95)

Maxtor startled its competitors in 1982 by announcing a family of 5.25" rigid disk drives with up to 140 megabyte capacity. These drives went into production in mid-1983, later joined by 190 megabyte drives in 1984 and the industry's first 5.25" 380 megabyte drives in 1985.

A series of 3.5" drives with increasingly higher capacities was initiated in 1988, along with a 5.25" MO drive produced by Maxoptix, then a joint venture with Kubota managed by Maxtor, in which the Maxtor interest was sold to Kubota in 1994. In 1990, Maxtor acquired the Miniscribe product line and manufacturing facilities, providing the firm with a 3.5" disk drive product line from which the firm's current major product family was derived.

Starting with the departure of several key employees in 1987, a succession of management changes, combined with the numerous internal changes which followed, disrupted Maxtor's ability to continue the pioneering product development activities upon which most of the company's growth was based, causing 5.25" drives and gigabyte 3.5" drives to be discontinued. Maxtor's efforts were redirected towards 3.5" drives sold for personal computer applications, plus a line of 1.8" PC Card drives. In February, 1994, Maxtor improved its financial status when Hyundai invested in the firm, acquiring a 40% share.

Maxtor was the first major disk drive manufacturer to launch a major effort to develop products for the 1.8" drive market. Following the initial 105 megabyte PC Card Type III drive in 1993, a 131 megabyte drive was announced in April, 1994. This was followed in August, 1994, by announcement of a 171 megabyte model, also in PC Card Type III packaging. Production levels were modest, and the firm discontinued its 1.8" product line in mid-1995.

Maxtor also remarkets much of the M-Systems flash card line, including a few models made specifically for Maxtor by M-Systems. Shipments began in 1994.

MFM TECHNOLOGY, INC.
360 Merrimack Street
North Andover, MA 01845

MFM started manufacturing 5.25" disk cartridge drives in 1985 under license from DMA Systems. The firm had previously been involved in providing service for DMA drives, and offered controller development services. A 24 megabyte version of the drive was introduced in 1987, and a fixed/removable version with 24 megabytes capacity in each category was shipped in 1990, but demand diminished to the point where production was halted in the last year.

MINISTOR PERIPHERALS CORPORATION
2801 Orchard Parkway
San Jose, CA 95134

Founded in 1991 by former Maxtor executives and funded by seed money from venture capitalists, MiniStor started production of 32 and 64 megabyte 1.8" drives in late 1992. Despite management changes and a skeptical venture capital market, the firm managed to acquire the necessary resources to continue its program and establish manufacturing in Singapore. MiniStor offered 1.8" PC Card Type III drives up to 170 megabytes, plus 260 megabyte and 340 megabyte models which incorporate data compression.

In September, 1993, MiniStor and Hitachi announced agreements under which MiniStor licensed Hitachi to utilize the firm's 1.8" disk drive technology. The two companies cooperated in developing a new family of high capacity 2.5" disk drives, manufactured by Hitachi and sold by both firms.

MiniStor encountered serious financial difficulties, was unable to raise additional financing, and ceased operations in the Spring of 1995.

MOST, INC.
11205 Knott Avenue
Cypress, CA 90630

MOST was formed in 1987. The firm is engaged in the design and manufacture of 3.5" MO rewritable disk drives. Sales to the VAR/VAD distribution channel are made through Ocean Microsystems, a related organization.

Production of a 128 megabyte 3.5" drive developed by MOST and Nakamichi began in late 1990. A 256 megabyte drive using a GCR recording format was announced in 1991, with shipments beginning in 1992. A 384 megabyte drive (also capable of operating at 230, 256 and 128 megabytes) went into production in the third quarter of 1994. In early 1993, Nakamichi, MOST's parent firm, acquired the Optical Products Division of Applied Magnetics and placed it within MOST, where it continues to produce optical drive heads and mechanisms. In 1995, the firm's senior management purchased MOST from Nakamichi, along with Ocean Microsystems.

MOTOROLA, INC.
1303 East Algonquin Road
Schaumberg, IL 60196

Established in 1928, Motorola is a large diversified producer of electronic equipment and electronic components. While not currently a manufacturer of flash cards, the company is remarketing SanDisk flash disk cards through its Microprocessor and Memory Technologies Group. Motorola supplies controller chips for the cards. The company also uses AMD flash chips, but not in PC Card standard products.

MOUNTAIN OPTECH, INC.
4775 Walnut Street
Boulder, CO 80301

Mountain Optech, founded in 1985, specializes in optical disk drives for ruggedized and military applications. Its first product was a modified version of the Optotech 5.25" write-once drive, delivered in 1986. 3.5" drives were added in early 1995. The modified drives are used in harsh environments such as seismic survey, aircraft maintenance, and manned spacecraft. The mechanism and electronics have been modified for ruggedized or militarized requirements.

The firm has begun designing its own drives which will include advanced features such as digitally adaptive read/write electronics. A militarized write-once drive for use in an airborne digital mapping system was delivered in late 1990. An upgraded ISO-compatible version was first shipped in 1992, as was a ruggedized version of a currently available 5.25" magneto-optic rewritable drive.

NATIONAL SEMICONDUCTOR CORPORATION
2900 Semiconductor Drive
Santa Clara, CA 95052

1995 total net sales: $2,379,400,000 Net income: $264,000,000
(FY ending 5/28/95)

National Semiconductor is currently in production for flash memory chips but is not yet making flash memory cards. The firm is considering entering the flash memory card business, but is not likely to do so until market size increases.

NEW MEDIA CORPORATION
1 Technology, Building A
Irvine, CA 92718

New Media produces flash memory cards ranging from 256 kilobytes to 8 megabytes in capacity. AMP has a minority interest in the company, but AMP and New Media produce separate PC Card flash memory product lines.

QUANTUM CORPORATION
500 McCarthy Boulevard
Milpitas, CA 95035

1995 total net sales: $3,367,984,000 Net income: $81,591,000
(FY ending 3/31/95)

Founded in 1980, Quantum is the largest volume producer of rigid disk drives. In mid-1994, the firm agreed to purchase the storage business of Digital Equipment, and the transaction was completed in October, 1994. In mid-1993, Quantum formed an alliance with Silicon Storage Technology in preparation for its subsequent entry into the flash card market. Quantum officially introduced a line of flash cards in mid-1994 using chips obtained from Silicon Storage Technology, which worked with Quantum to design the chips and cards. 1, 2, 4 and 10 megabyte cards were offered. Quantum sold the cards through industrial distributors. The firm subsequently decided to discontinue the product line.

RAYMOND ENGINEERING
217 Smith Street
Middletown, CT 06457

Raymond Engineering is a supplier of military and aerospace electronics. The firm packages disk drives for use in hostile environments, and in 1994 announced a disk drive array using SanDisk flash drives rather than rigid disk drives. The 320 megabyte array uses 8 SanDisk's 40 megabyte flash drives. The array will operate with higher capacity storage modules as they become available in the future.

SANDISK CORPORATION (Formerly SunDisk Corporation)
3270 Jay Street
Santa Clara, CA 95054

Founded in 1988 as SunDisk, SanDisk is today the largest producer of flash disk ATA interfaced PC Card memories. Products range from 1.8 megabyte to 40 megabytes in capacity, with capacities up to 175 megabytes announced in 1995. Matsushita Electronics, NEC and LG Group produce the chips for SanDisk, which are then mounted on boards by Anam, a Korean contract manufacturer. Final card assembly is done in Thailand by still another contractor. In 1993, Seagate acquired a 25% interest in SanDisk, and for a while distributed the SanDisk cards on a nonexclusive basis, an activity which ceased in 1995. Other announced SanDisk customers include Motorola, Seiko Epson and Verbatim. In mid-1995, the company changed its name from SunDisk to SanDisk to avoid confusion with other organizations. SanDisk has entered into a number of alliances with other firms for development of suitable chips, including NEC, with which it is working on 256 megabit chips for production in 1997.

SEAGATE TECHNOLOGY
920 Disc Drive
Scotts Valley, CA 95066

1995 total net sales: $4,539,570,000 Net income: $260,082,000
(FY ending 6/30/95)

Seagate, which began shipping rigid disk drives in 1980, is the leading independent disk drive producer. In 1989, the firm acquired the Imprimis disk drive operation from Control Data, adding high capacity 3.5", 5.25" and 8" drives to its existing lower capacity products. Seagate currently manufactures 1.8", 2.5", 3.5" and 5.25" rigid drives. A 43 megabyte 1.8" PC Card Type III rigid disk drive was announced in 1993, but was subsequently dropped. The firm also produces many of its own components, including heads, media and semiconductors.

In 1993, Seagate purchased a 25% share in SanDisk, and began marketing SanDisk PC Card flash disk cards through its own distribution channels. This effort was only marginally successful and Seagate elected to drop its marketing effort in 1995, although the firm retains its interest in SanDisk.

SILICON STORAGE TECHNOLOGY
1171 Sonora Court
Sunnyvale, CA 94086

SST was founded in 1989 as a producer of nonvolatile storage components using flash memory technology. Manufacturing partners, some in Japan, Singapore and Taiwan, perform wafer fabrication, die packaging and board assembly for SST products. The flash memory designed by SST uses EEPROM technology. In mid-1993, the firm entered an alliance with Quantum, which became a marketing channel for SST's PC Card flash memory cards. However, SST continues to market components through its own distribution channels.

SMART MODULAR TECHNOLOGIES
45531 Northport Loop West, Building 3B
Fremont, CA 94538

Formed in 1988, SMT is a specialist in add-on and add-in memory card products, especially in SIMM format. The company began selling PC Card flash memory cards in 1992, with its designs based upon Intel and AMD chips.

SWAN INSTRUMENTS
3000 Olcott Street
Santa Clara, CA 95054

Swan Instruments, founded in 1984, is a producer of rigid disk drive head testing instruments and fixtures. It is also among the ranks of the few firms developing high capacity flexible disk drives, and in 1994 announced a high capacity floppy disk drive in a 3.5" form factor, with the combination of fixed and removable metal powder flexible disks. The fixed disk will store 170 megabytes, and the removable disk 88 megabytes, and the drive will also have the capability to read and write conventional 1.44 megabyte 3.5" floppy disks. The company plans to begin production in late 1995 or early 1996, with a manufacturing partner.

SYQUEST TECHNOLOGY
47071 Bayside Parkway
Fremont, CA 94538

1994 total net sales: $221,001,000 Net income: $5,405,000
(FY ending 9/30/94)

SyQuest was started in early 1982 to make rigid disk drives using 3.9" (100 mm) plated disks, in both fixed and removable disk cartridge configurations, but after several years of production 3.9" disks were displaced by industry standard sizes. The firm began shipping 5.25" disk cartridge drives with formatted capacity of 44 megabytes and embedded SCSI controllers in 1988, achieving significant success in the Macintosh add-on market, and with its 5.25" disk cartridges, eventually becoming the dominant "prepress" interchange standard for graphics and desktop publishing. In 1989, SyQuest began manufacturing operations in Singapore.

In early 1991, SyQuest began shipping an 88 megabyte 5.25" cartridge disk drive, which was the firm's major product in recent years, supplemented in 1994 with a 200 megabyte model. A 3.5" disk cartridge drive program resulted in first shipments of 105 and 270 megabyte models in 1993. The EZ135, a 135 megabyte drive marketed as a counter to the Iomega "Zip" drive, began shipping in mid-1995. SyQuest also manufactures the disk cartridges for the drives, and cartridges accounted for a majority of the firm's revenue. A unique 1.8" drive was introduced in 1995, utilizing a disk cartridge which is removable from a PC Card Type III disk drive.

Asian Manufacturers

(All fiscal years end in March, 1995, unless otherwise noted. All companies are in Japan unless otherwise noted.)

ALPS ELECTRIC CO., LTD.
1-7, Yukigaya Ohtsuka-cho
Ohta-ku, Tokyo 145
Japan

1994 FDD sales: $87,900,000
1995 total net sales: $3,910,930,000 Net income: $44,139,000

Alps Electric is a diversified manufacturer of electronic components and subassemblies for television, audio, instruments and computer applications. Printers, keyboards, mice and disk drives together account for approximately 24% of Alps' revenues. The firm's big increase in floppy drive shipments came in 1981, with a rapid buildup of shipments to Apple Computer.

In the spring of 1987, Alps became the first Japanese company to manufacture floppy drives in the U.S., with 5.25" drives made in Garden Grove, California. Alps has also manufactured floppy drives in Ireland. Alps began shipping 3.5" microfloppy drives in mid-1984. A prototype 2.5" nonremovable floppy disk drive with a 10 megabyte capacity and average seek time of 50 milliseconds was shown to prospective customers in 1991 but was not formally announced.

CANON ELECTRONICS CO., INC.
Subsidiary of Canon, Inc.
1248, Shimokagemori, Chichibu-city
Saitama, 369-18
Japan

1994 FDD sales: $29,900,000
1994 total net sales: $18,916,928,000 (FY ending 12/31/94) Net income: $303,562,000

Canon Electronics produces electronic subassemblies for Canon cameras, as well as other electronic components, including magnetic heads, and systems. Floppy disk drives represent 13% of Canon Electronics' revenues, up from 11% in 1991. One and two sided 5.25" floppy drives have been in production since 1979, originally under a BASF license for one third high drives. Canon also developed its own unique microfloppy using a 97 mm disk, but these drives were dropped, and the firm began shipments of 3.5" microfloppies in late 1984. One inch high 3.5" drives began production in mid-1986, and in 1988 Canon commenced production of 1.44 megabyte 3.5" drives. 19.5 millimeter high 3.5" drives were introduced in late 1989, followed by 15.5 millimeter high versions in 1991. Canon was one of the early producers of a half high combination drive assembly, using its one third high 5.25" drives and 15.5 millimeter high 3.5" drives.

CARRY COMPUTER ENGINEERING CO., LTD.
10 Alley 59, Lane 42, Min Chuan Road
Hsin-Tien City
Taipei
Taiwan, R.O.C.

Carry Computer provides a variety of PC Card based products, including memories, modems, network interface cards and card "drives". The flash memory cards use Intel chips and range from 2 to 16 megabytes in capacity.

CHINON INDUSTRIES INC.
1-21-17, Takashima
Suwa City, Nagano 392

1994 FDD sales: $88,800,000
1995 total net sales: $281,517,000 Net income: ($68,229,000)

Chinon is best known for its cameras and lenses, but 70% of its sales come from floppy disk drives, printers and other equipment for information systems. Eastman Kodak holds approximately 12.3% ownership through Kodak Japan. Chinon has been producing head assemblies for CD equipment and in 1988 began supplying CD-ROM drives to Atari as a custom product. A similar drive has since appeared under Chinon's own label for use with IBM and Apple personal computers and the product line has since been expanded to include double speed drives. A 128 megabyte 3.5" drive was announced in 1992 and began shipping in early 1993.

The firm introduced its flexible disk drive product line in 1984, currently consisting of half high 5.25" drives and 3.5" microfloppies. In mid-1992, Chinon established Chinon Asia Private Ltd., a Singapore based company, which manufactures flexible disk drives. Chinon and Iomega had an agreement for Chinon to manufacture the "floptical" disk drive that Iomega licensed from Insite Peripherals, and production started in the second half of 1992. Due to the limited size of the floptical market, the Chinon production program is now inactive.

CITIZEN WATCH CO., LTD.
2-1-1, Nishi-Shinjuku
Shinjuku-ku, Tokyo 160
Japan

1994 FDD sales: $126,800,000
1995 total net sales: $3,549,051,000 Net income: $33,963,000

Citizen is steadily expanding its diversification into additional products, from its basic position of strength as Japan's second largest watch manufacturer. Watches are now down to 47% of sales, machine tools hold 7% and electronic equipment the balance. In addition to printers, displays, and small computers, Citizen introduced 3.5" microfloppies in 1984, offering the first one inch high floppy drive, and began an aggressive sales program in the U.S. and Europe, aimed at the OEM market.

In 1989, Citizen again led the industry in drive packaging, this time with the first introduction of 19 millimeter high 3.5" floppy disk drives, followed in 1990 with drives only 15 millimeters high. A 20.6 megabyte (formatted) floppy drive using metal powder media was announced in late 1989, and since dropped due to weak market reaction. In late 1992 Citizen announced the thinnest 3.5" floppy drive to date, only 11 millimeters in height.

EASTERN PERIPHERALS PVT. LTD.
72, S. D. F. III
Seepz, Andheri (E)
Bombay, 400 096
India

Eastern Peripherals was originally established in 1979 to make 5.25" floppy disk drives and components for Tandon Corporation, and is owned by members of the Tandon family. With Tandon Corporation's departure from the disk drive business in 1987, Eastern Peripherals continued as an OEM floppy drive manufacturer, using models developed by Tandon, and also produces heads, stepping motors, and other electronic products.

FUJI PHOTO FILM
2-26-30 Nishi-Azabu
Minato-ku, Tokyo 108

Established in 1934, Fuji Photo Film today obtains nearly half of its revenues from computing and communications related equipment, supplies and accessories. The remainder comes from sales of photographic equipment and supplies, photofinishing equipment and imaging equipment.

The company provides media for the Iomega "Zip" drive and standard floppy disk media for conventional floppy drives. It also markets flash disk and flash memory PC Cards. The more recent and higher capacity cards use Atmel chips.

FUJITSU, LTD.
1-6-1, Marunouchi
Chiyoda-ku, Tokyo 100

1995 total net sales: $31,875,793,000 Net income: $440,509,000

Fujitsu is Japan's largest producer of computer systems and also manufactures a wide variety of other electronic equipment. Computer products represented about 68% of Fujitsu's 1994 sales. In 1992, Fujitsu became a second source supplier for AMD's flash chip product, and the two companies are currently working together on design and manufacturing of advanced flash chips. Flash memory cards were introduced in 1993.

The firm has also been active in the optical drive area, and has manufactured 8", 5.25" and 3.5" optical drives. Fujitsu is the leading supplier of 230 megabyte 3.5" optical drives and is one of the group of firms working towards development of a 640 megabyte 3.5" drive.

HITACHI, LTD.
6-2, Otemachi 2-chome
Chiyoda-ku, Tokyo 100

1995 total net sales: $74,288,317,000 Net income: $1,114,599,000

Hitachi remains Japan's largest manufacturer of electrical and electronic equipment and a major producer of computer systems. It manufactures rigid disk drives and other peripherals as well as processors. About 50% of 1994 revenues were derived from computing and electronic equipment.

The company has been active in the flash chip market for several years, and has developed its own flash cell AND architecture, announced in 1992, which combines features of NAND and NOR architectures. In early 1994, Hitachi and Mitsubishi Electric announced they would jointly develop and market 16 megabit and 64 megabit flash memory products. Each firm will second source the other's chips. A small quantity of low capacity PCMCIA flash memory cards were made by Hitachi in 1994, but the firm's primary effort is expected to begin in late 1995 using 16 megabit or larger chips.

In September of 1993, Hitachi and MiniStor announced agreements under which Hitachi was licensed to use MiniStor's 1.8" rigid disk drive technology. The 1.8" drives, which Hitachi announced were manufactured by MiniStor, have since been discontinued.

HYUNDAI ELECTRONICS INDUSTRIES CO., LTD.
140-2, Kye-dong
Chongro-ku, Seoul
Korea

Hyundai is working on 4 megabit and 16 megabit flash memory chips for sale to other companies and possibly for use in its own line of flash memory cards. The firm also has a majority ownership in a U.S. subsidiary, LaserByte, which produces 3.5" optical drives.

INSITE PERIPHERALS, INC.
Subsidiary of O.R. Computer System Pte. LTD.
2050 Bering Drive
San Jose, CA 95131

Insite's announcement of a 20 megabyte 3.5" microfloppy, combining an optical head positioning scheme with magnetic recording, aroused widespread interest in the disk drive industry. Trademarked as the "floptical", the drive uses an LED on the head assembly to follow optically reflective servo tracks on the surface of 3.5" barium ferrite media. A one inch high version that is downward compatible with standard 3.5" .7 and 1.44 megabyte drives in both read and write modes became available in late 1991, the result of Insite's contract manufacturing arrangement with Matsushita Kotobuki Electronics. Insite has attempted to achieve mainstream status for the "floptical" through licensing of established drive and media manufacturers, with Iomega as the first announced licensee. 3M and Hitachi Maxell have been granted licenses as media producers, and have made equity investments in Insite.

Despite establishment of reliable drive and media manufacturing sources, the Insite drive's price has been several times higher than low capacity 3.5" floppy drives during a period of intense price competition in the personal computer industry, the largest market opportunity. As a result, personal computer manufacturers have been unwilling to add floptical drives as standard products, assuming the market opportunity for the drives is specialized and that the majority of their customers would be unwilling to pay a higher price for personal computers with floptical drives. So far, the available market has been confined to storage subsystems builders active in the add-on market and to OEM sales for engineering workstations.

Insite's development activities and other operations were funded by several rounds of venture capital investments, which were mostly exhausted by the second half of 1993. In late 1993, negotiations for the sale of Insite to O.R. Computer, a subsidiary of Ocean Radio Group, based in Singapore, were completed. Ocean Radio has been active for 50 years as a trading company in consumer electronics, components, computers and peripherals. With the new owner's financial backing, the manufacturing arrangement with MKE has been continued and a new emphasis on OEM sales has been established. A second generation floptical drive with 120 megabyte capacity is expected to be announced in late 1995. A technology announcement was made earlier in the year.

LASERBYTE CORPORATION
Subsidiary of Hyundai Electronics Industries Co., Ltd.
1330 Bordeaux Drive
Sunnyvale, CA 94089

LaserByte was founded in 1990 by former employees of Verbatim who had developed Verbatim's 3.5" magneto-optic drive technology. In early 1991, the founders sold a 55% share in LaserByte to Hyundai, in order to obtain development funds and technical assistance. The firm announced its first product, a 3.5", 128 megabyte MO drive in June, 1993, but actual production started with a 230 megabyte model in 1994. The drive also supports OROM and PROM media. Hyundai will provide volume manufacturing for the drive, and LaserByte will also maintain a low volume production facility.

MATSUSHITA COMMUNICATION INDUSTRIAL CO., LTD.
Subsidiary of Matsushita Electric Industrial Co., Ltd.
4-3-1 Tsunashima-Higashi
Kohoku-ku, Yokohama 223
Japan

1994 FDD sales: $151,500,000
1995 total net sales: $5,127,896,000 Net income: $66,693,000

Matsushita Communication Industrial is a member of the Matsushita Electric Industrial group, a worldwide giant in appliances and electronics. During the early growth of the floppy drive industry, MCI manufactured most of the Shugart Associates floppy drive line under license for the Japanese OEM market. MCI later added floppy drives of its own design, including half high 5.25" and 3.5" microfloppy drives. The firm made half high 5.25" drives on a contract manufacturing basis for Shugart and in 1985 acquired marketing rights in the United States, which has resulted in significant sales by the firm's U.S. Panasonic subsidiary. MCI established a joint venture in the Philippines with Precision Electronics Corporation, to manufacture floppy disk drives and other computer components, and all flexible disk drive production is now located in the Philippines.

The firm introduced a .7 megabyte 2" floppy drive that was adopted by Zenith in 1989 for use in a notebook computer but was otherwise shunned by the computer industry. After several attempts to pioneer various high capacity floppy drive configurations, most of the MCI floppy drive activity is centered on mainstream 5.25" and 3.5" floppy drives.

MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.
1006, Kadoma City
Osaka, 571

1995 total net sales: $67,985,900,000 Net income: $885,460,000

MEI's Panasonic, National, Technics, and Quasar brands are among the most widely known in the world for appliances, consumer electronics, and communications equipment. MEI is the leading manufacturer of 5.25" phase change optical disk drives and also manufactures 3.5" MO drives. The firm is considering the use of phase change technology in 3.5" drives. Matsushita-Kotobuki Electronics produces CD-ROM drives for sale by MEI. High volume production commenced in 1992, and MKE has become one of the largest producers of CD-ROM drives and mechanisms. Matsushita Electronic Components manufactures floppy drives and CD-ROM mechanisms as well.

Matsushita is a flash foundry for SanDisk, and is expanding its capabilities to design and produce flash chips and derivative products. 16 megabit chips are scheduled to start shipping in late 1994. 32 megabit and 64 megabit chip developments are planned for the future. The company is also developing ferroelectric memories, a potentially competing technology to flash memory, in order to be well positioned in the event ferroelectric technology becomes competitive.

PCMCIA flash memory cards were introduced in 1993, and are being sold by the Panasonic Battery Sales Group in the U.S. Capacities range from 256 kilobytes to 4 megabytes.

MATSUSHITA ELECTRONIC COMPONENTS CO., LTD.
Subsidiary of Matsushita Electric Industrial Co., Ltd.
1006, Kadoma, Kadoma City
Osaka 571
Japan

1994 FDD sales: $40,600,000

A member of the Matsushita Electric Industrial group, Matsushita Electronic Components Co. (MACO), is a diversified manufacturer of electro-mechanical and circuit components, plus various system and audio products. The company joined with Hitachi in attempting to establish a 3" microfloppy standard, which had widest acceptance in the European market, but was discontinued in 1991. Production of 3.5" floppy drives began in 1987.

MATSUSHITA-KOTOBUKI ELECTRONICS INDUSTRIES, LTD.
2-2-10 Kotobuki-machi
Takamatsu-shi 760

1995 total net sales: $4,388,777,000 Net income: $83,180,000

Matsushita Electric Industrial owns 57.6% of MKE, which was established in 1948. MKE is a major producer of VCRs and other consumer electronic items, some of which are sold by the Matsushita companies and some by other firms. Disk storage products include rigid disk drives made for Quantum, floptical disk drives made originally for Insite Peripherals, and CD-ROM drives. CD-ROM drive production, which commenced in 1992, has become quite large, making MKE the leading CD-ROM manufacturer. Much of MKE's CD-ROM output is marketed through Matsushita companies.

MKE will manufacture the second generation 120 megabyte floptical drive for Insite Peripherals, with production expected to commence in late 1995.

MEIKO ELECTRONICS CO., LTD.
5-14-15 Ogami, Ayase-shi
Kanagawa 252

Meiko was founded in 1975 as a manufacturer of printed circuit boards, an activity that still accounts for 70% of the firm's business. Other products include CRT screens and memory cards. Full production of flash memory PCMCIA cards was initiated in 1994, with capacities ranging from 256 kilobytes to 8 megabytes.

MITSUBISHI ELECTRIC CORPORATION
2-2-3, Marunouchi
Chiyoda-ku, Tokyo 100

1994 FDD sales: $158,800,000
1995 total net sales: $31,808,963,000 Net income: $411,888,000

Mitsubishi is most noted for heavy machinery production, but is also active in defense electronics and consumer electronics. Data and communication systems represent 34% of sales.

Mitsubishi has entered into product development alliances with several other flash memory producers, including SGS-Thomson (16 megabit chips) and Hitachi (64 megabit chips). The firm currently offers flash memory cards based upon Intel chips with capacities ranging from 256 kilobytes to 20 megabytes.

A family of half high 5.25" floppy drives was introduced in 1982, with capacities up to 1.6 megabytes. Mitsubishi also started shipping a 3.5" microfloppy drive in 1983 and introduced a 1.44 megabyte version as early as 1985. Mitsubishi became a major supplier of flexible disk drives to IBM, following the IBM introduction of PS/2 in 1987. In 1991, the firm introduced a 2.88 megabyte 3.5" drive. After several years of flexible disk drive production at Mitsubishi's Koriyama Works, Melco Manufacturing (Thailand), a joint venture for the manufacture of floppy drives was established with Kang Yong Electric Manufacturing Co. The joint venture is largely owned by Mitsubishi.

MITSUMI ELECTRIC CO., LTD.
8-8-2, Kokuryo-cho
Chofu-City, Tokyo 182
Japan

1994 FDD sales: $309,600,000
1995 total net sales: $1,932,143,000 Net income: $19,824,000
(FY ending 1/31/95)

Mitsumi is a leading manufacturer of electronic subassemblies and components, including magnetic heads. Floppy disk drives represent about 18% of sales, up from 10% in 1991. The firm established a joint venture facility with Commodore, named Newtronics, to produce 5.25" and 3.5" floppy drives, and acquired complete ownership of Newtronics in 1986. During the last few years, Mitsumi has established a pattern of high growth in floppy drive sales, the result of low cost manufacturing operations and the company's aggressive pricing policy.

In 1984, Mitsumi introduced a very low cost 2.8" drive using a special Maxell disk under the name "Quick Disk", which used a single spiral track with 64,000 kilobytes capacity. It was used primarily in low-end home systems, including games, with final shipments in 1991. One inch high 3.5" drives went into production in 1987, followed by 3/4 inch high drives in 1989. A 12.7 millimeter high 1.44 megabyte 3.5" drive was introduced in 1991. Mitsumi has established a manufacturing facility in Malaysia for floppy disk drives and began manufacturing at Cebu Mitsumi in the Philippines in early 1992.

NEC CORPORATION
5-33-1, Shiba
Minato-ku, Tokyo 108

1994 FDD sales: $193,000,000
1995 total net sales: $36,882,162,000 Net income: $345,558,000

NEC has defined its product area as communications and computers, with computer products accounting for about 49% of 1994 revenues. The firm has the largest share of the Japanese personal computer market. NEC makes a variety of data storage products, including floppy, rigid, CD-ROM and 3.5" optical disk drives.

Under an agreement with Aura Associates, NEC produced PCMCIA Type III 1.8" drives designed by Aura and also sold by Aura. In mid-1994, NEC and SanDisk announced a joint development effort aimed at producing 256 megabit flash devices by 1997. NEC has also indicated its intent to produce flash chips at the 16 megabit and 64 megabit levels.

Since 1978 the company has manufactured two sided 8" floppy disk drives, and was one of the earliest firms to offer half high 8" floppy drives, with shipments starting in late 1981. 3.5" microfloppy drives and half high 5.25" drives were introduced in 1984. The majority of NEC's floppy drive shipments have been for captive applications.

NEC was an early participant in the high capacity floppy drive market with the 1988 introduction of a 3.5" 9.4 megabyte drive for sale with its microcomputer systems. A 10 megabyte version with downward compatibility to .7 and 1.44 megabyte drives was introduced in 1990. NEC was very active on the JEIDA committee working to standardize high capacity 3.5" floppy disk drives, and announced a 21.4 megabyte drive. NEC high capacity floppy drive production was limited, and all have been dropped from the company's product line.

OLYMPUS OPTICAL CO., LTD.
22-2, Nishi-Shinjuku 1-chome
Shinjuku-ku, Tokyo

1995 total net sales: $2,466,703,000 Net income: $30,342,000

Founded in 1919, Olympus Optical company is known primarily for its cameras and optical instruments. In recent years the company has broadened its activities to include electronics and some specialty products, including optical heads for disk drives. Development of optical disk drive technology began in 1981 when Olympus and Fujitsu began a joint project that resulted in one of the first commercial write-once optical disk drives. The firm's optical electronic products include optical heads, an optical card reader compatible with the Drexler Lasercard and a 5.25" erasable optical disk drive announced in November, 1987. The disk drive, which has a capacity of 326 megabytes per side, was provided in sample quantities as of mid-1988, and Olympus mechanisms have been adopted by Ricoh and others as the basis of their own rewritable drives.

Olympus began marketing under its own brand name in 1992 when it introduced a 3.5" 128 megabyte drive. This was followed by a 230 megabyte version in early 1994. At that time the firm also announced 5.25" full height and half height MO drives. A high performance 3.5" MO drive was introduced in 1995. The company is currently expanding its marketing channels in the United States for the drives, and in early 1994 adopted the brand name "Deltis" for its externally packaged drive subsystems and related products such as optical disk libraries.

RICOH CO., LTD.
15-1, Minami-Aoyama 1-chome
Minato-ku, Tokyo 107

1995 total net sales: $9,983,327,000 Net income: $181,928,000

Copiers, photographic equipment, and sensitized papers provide most of Ricoh's revenues, but the firm also produces a growing line of data processing equipment, which accounted for 25% of 1994 revenues. Data storage products include write-once and rewritable optical disk drives.

Ricoh was Pioneer's partner in the development of an 8" write-once optical drive which Ricoh used in a document storage system, and the firm showed a prototype OEM 8" write-once drive at the 1986 NCC show. However, Ricoh has concentrated upon developing optical disk drives in the 5.25" form factor and 3.5" form factor, rather than expending further effort on an 8" product.

In 1988, a half high version of its original 5.25" write-once optical disk drive design was announced. Also in 1988, Ricoh adopted a rewritable drive mechanism supplied by Olympus on an exclusive basis, and, supplying the required electronics and packaging, began shipping a rewritable 5.25" 300 megabyte per side optical drive in the second quarter of 1989. An ISO-standard high performance 5.25" rewritable drive was introduced in 1991. A 3.5" 128 megabyte drive announced in 1991 was made for Ricoh by another Japanese firm, but Ricoh has since begun manufacturing a drive of its own design.

SAFRONIC CORPORATION
7-5-17 Nakazato
Tendo-shi, Yamagata 994
Japan

Safronic, founded in October, 1988, originally was called Digital Systems, Inc., and later adopted the name of its major distributor, Japan Peripherals Network (JPN). In 1991, the firm adopted its present name, with JPN remaining a separate organization distributing peripherals, including floppy disk drives made by Safronic. Safronic has used contract manufacturing sources for the firm's half high 5.25" drives and 1.44 megabyte 3.5" drives, and in the second half of 1993 started production in China through a contract manufacturing arrangement managed by a Hong Kong firm. Sales are mostly through distribution.

SAMSUNG ELECTRONICS
7 Soonwha-Dong
Seoul
Korea

1994 FDD sales: $61,000,000
1994 total net sales: $14,275,000,000 Net income: $1,171,000,000

Founded in 1969, Samsung Electronics is Korea's largest manufacturer of electronic products, which range from semiconductor components to telecommunications equipment and computers. About one fifth of the firm's revenues are derived from information systems and related products. The company also produces rigid, flexible and optical disk drives. An active product development center has been established in the United States.

Samsung is using Toshiba's NAND flash memory architecture in a family of 16 megabit chips, and hopes to have 32 megabit and 64 megabit chips available in 1995 and 1996, respectively. The firm does not presently manufacture flash memory cards, preferring to be a supplier to card manufacturers.

Samsung got started in floppy drive production in 1983 when Shugart Associates granted a license to manufacture and market the Shugart floppy drives in South Korea. Samsung is currently making half high 5.25" drives with capacities up to 1.2 megabytes, and production of 3.5" 1.44 megabyte one inch high drives began in 1989.

SEIKO EPSON CORPORATION
80 Hirooka
Shiojiri-shi, Nagano 399-07

1994 FDD sales: $209,100,000

Epson is a member of the privately held Suwa Seikosha/Epson group owned by members of the Hattori family, which also controls Japan's Seiko companies, known for watches and electronics. Epson is best known for its printers, but also manufactures a portable computer, displays, and floppy, optical and rigid disk drives. Seiko Epson announced a 128 megabyte 3.5" drive in 1992. However, the firm has elected to remarket certain 3.5" and 5.25" models rather than produce them internally.

The firm remarkets PCMCIA flash disk cards made by SanDisk and also manufactures flash memory cards using its own chips. The PCMCIA product line also includes a PCMCIA Type III rigid disk drive made by Integral Peripherals.

The first Epson floppy drive was a captive 5.25" one third high unit first shipped in 1982 and used with the Epson portable computer. Starting in October, 1983, Epson added an OEM floppy drive product line of 5.25" and 3.5" models, including 3.5" drives with very low power requirements. Currently, the product line includes half high 5.25" drives and 25.4, 18 and 15 millimeter high 3.5" drives.

SHARP CORPORATION
22-22 Nagaike-cho
Abeno-ku, Osaka 545

1995 total net sales: $15,827,984,000 Net income: $435,499,000

Founded in 1935, Sharp originally made mechanical pencils. Sharp is now a supplier of electrical and electronic equipment for both consumer electronics and office automation. About 49% of the company's sales are derived from computer or computer related products, including desktop and transportable personal computers.

Sharp is a Sony licensee for the MiniDisc system and could be expected to produce a computer peripheral version of the MiniDisc once Sony establishes the parameters for such a product.

In the flash memory area, Sharp has been one of Intel's foundry operations for flash memory chips.

SONY CORPORATION
6-7-35, Kitashinagawa
Shinagawa-ku, Tokyo 141

1994 FDD sales: $312,300,000
1995 total net sales: $38,976,888,000 Net income: ($2,870,411,000)

Sony is a leader in consumer electronics and has also earned a position as a leading supplier of 3.5" floppy disk drives. TV, VCR, and audio products make up about 80% of revenues. Sony is also a leading manufacturer of magneto-optic disk drives and high performance CD-ROM drives. The company is vertically integrated and supplies its own media, and is currently the largest producer of magneto-optic media.

Sony sells CD-ROM, write-once and rewritable optical drives. The write-once product line includes 12" drives with up to 3.3 gigabyte per side capacity, while the rewritable drives are 5.25", 3.5" and 2.5" MO models. Sony introduced its 3.5" 128 megabyte rewritable drive in mid-1991. The drive had a specified average seek time of 40 milliseconds and rotated at 3,000 RPM, among the faster optical drives. Sony surprised the industry when it failed to announce a 230 megabyte 3.5" drive in early 1994, but it now appears that the firm has made a strategic decision to leapfrog the competition and go directly to higher capacity drives.

Another 1991 Sony announcement concerned the MiniDisc, a 2.5" magneto-optic drive intended for use in a portable audio recorder and currently in production as an audio device. In mid-1993, Sony proposed a standard for the MD-DATA, a 140 megabyte CLV 2.5" magneto-optic drive with 150 kilobyte per second data transfer rate. A separate erase pass is not required. Sony is also looking for opportunities to apply the MD-DATA technology to other form factors.

Sony proposed to the industry a 1.44 megabyte, 3.5" diskette in 1985, which has become a de facto industry standard, with help from IBM, which adopted the standard for the PS/2 family in 1987. Also in 1987, Sony responded to the growing industry support for one inch high 3.5" drives by introducing its own model. A 2.88 megabyte 3.5" floppy disk drive was introduced in 1991. Sony pioneered the submicrofloppy field with a very high bandwidth .7 megabyte 2" floppy disk drive based upon a Mavica video camera storage device, but the data version of the 2" drive did not find a following in the computer industry.

TEAC CORPORATION
3-7-3 Naka-cho
Tokyo 180

1994 FDD sales: $403,800,000
1995 total net sales: $1,074,853,000 Net income: ($108,973,000)

TEAC is best known for its leadership position in the flexible disk drive industry, but the firm also has a development program for optical disk drives. A 3.5"

128 megabyte drive was announced in 1991, but production shipments did not begin until 1992.

Shipments of 5.25" floppy drives for the OEM market started in 1978, and in 1985 TEAC announced its line of 3.5" drives, including a 1.44 megabyte model and subsequently added one inch high models.

Rapid growth made TEAC the leader in worldwide noncaptive floppy drive revenues during the last few years. The firm joined Toshiba in 1987 in announcing 2.88 megabyte 3.5" floppy drives using barium ferrite media. 19 millimeter high 3.5" drives were introduced in 1989, and a 2.88 megabyte model was introduced in 1990. In 1991, TEAC introduced the industry's first 12.7 millimeter high 3.5" floppy disk drive, moving to the front in the race to downsize microfloppy drives. TEAC has made manufacturing and licensing arrangements with a number of firms in Japan, Korea, and other countries. Much of TEAC's current production has been moved to Malaysia. The company has also established a drive component manufacturing operation in Singapore.

TOSHIBA CORPORATION
1-1-1, Shibaura
Minato-ku, Tokyo 105

1995 total net sales: $46,876,380,000 Net income: $437,309,000

Toshiba is a major factor in consumer electric and electronic products, and also has a leading position in the office computer market in Japan. About 61% of 1994 revenues were related to data communications or computer products. Toshiba is a leading producer of 2.5" rigid disk drives, and also manufactures CD-ROM drives. The firm has also proposed a 1.3 gigabyte 3.5" phase change optical drive.

Toshiba's flash memory program dates back to the mid-1980s, although the firm was unable to capitalize financially on its early participation. In later years the company developed a high performance NAND flash architecture, and is currently supplying chips to several customers, including IBM Microelectronics and National Semiconductor. Toshiba has entered into flash memory development agreements with other firms as well, including licensee Samsung Electronics with which it is developing 64 megabit chips. Toshiba's flash memory and flash disk cards were announced in late 1994. The cards currently use 16 megabit chips.

8" floppy drives for both captive and OEM markets were produced starting in 1977. Half high two sided 5.25" drives were added in 1982, followed in the mid-1980's by microfloppy drives. High capacity barium ferrite media was developed by Toshiba for 2.88 megabyte 3.5" floppies, with production of drives and media starting in 1988. Several other firms licensed the drive and media. In recent years, Toshiba relied on contract manufacturing arrangements for its supply of floppy drives, which were sold primarily in the North American market, and discontinued the product line during the last year.

TRANSCEND INFORMATION, INC.
465 Chung Hsiao East Road, Section 6
Taipei
Taiwan, R.O.C.

Founded in 1988, Transcend is a manufacturer of controllers, printer memory, memory boards and copy protection devices. Flash memory PC Cards range from 2 megabytes to 20 megabytes in capacity.

Y-E DATA, INC.
182 Shinkoh, Iruma
Saitama, 358
Japan

1994 FDD sales: $92,700,000
1995 total net sales: $153,337,000 Net income: ($11,575,000)

Y-E Data is a spin-off of Yaskawa Electric, a diversified manufacturer of heavy electric, factory automation and data processing equipment. Data processing products are the responsibility of Y-E Data, which first manufactured 8" one sided floppy drives in 1974 under an Orbis license. Disk drives represent about two thirds of current sales. Manufacturing is currently split between Japan, China and Thailand.

Y-E Data became an early leader in the Japanese OEM markets for both 8" and 5.25" two sided drives. Y-E Data also cooperated with NTT on the standard for 1.2 megabyte 5.25" drives and has been shipping its version since early 1982. Microfloppy drives were added in 1984. Y-E Data's biggest sale of all came in 1984, with IBM's selection of the firm's 1.2 megabyte 5.25" drive for use with the PC AT. In 1986, one inch high 3.5" drives were added to the product line. A 2.88 megabyte 3.5" microfloppy drive using cobalt modified oxide media was introduced in 1988 in an unsuccessful attempt to develop an industry standard, and a 2.88 megabyte 3.5" drive using standard barium ferrite media was first shipped in 1990.

Y-E Data attempted to provide industry leadership in pioneering the market for high capacity floppy drives. A preliminary announcement of a 27.8 megabyte drive using metal particle media was made in 1989, with specifications revised in 1991. The final capacity specification became 20.8 megabytes, with initial shipments in late 1992, but the program has been discontinued, due to low demand.

In addition to its drive manufacturing activities, Y-E Data supplies drive kits to manufacturers in India, mainland China and other Asian countries.

European/Middle Eastern Manufacturers

CALLUNA TECHNOLOGY LIMITED
Blackwood Road, Eastfield
Glenrothes, Fife KY7 4NP
Scotland

Calluna Technology was founded to design and manufacture 1.8" rigid disk drives in Glenrothes. The founders are all veterans of Rodime, and many were previously with the Burroughs disk drive manufacturing facility in Glenrothes. Calluna occupied a new industrial building early in 1992 and started production of 85 megabyte drives in the PC Card Type III format in mid-1993. The PC Card drive product line has since been expanded and includes 105 megabyte and 130 megabyte drives, also currently in production. A 170 megabyte PC Card drive began shipping in September, 1994, followed by a 260 megabyte drive in early 1995. Like their predecessors, these drives are also packaged in PC Card type III format.

M-SYSTEMS FLASH DISK PIONEERS LTD.
ATIDIM Industrial Park, Building 1
Neve Sharet
Tel Aviv 61 580
Israel

Founded in 1989, M-Systems offers flash memory cards and supporting flash file system software, allowing the flash memory cards to emulate disk drives. PC bus cards from 1 to 32 megabytes are available, including an extended operating temperature series. PC Card memories with 20 megabyte capacity became available in mid-1993. In November, 1993, M-Systems and Maxtor entered a strategic partnership, allowing Maxtor to offer PC Card memories based on M-Systems flash memory technology with capacities from 1.6 to 20 megabytes.

NOMAI
188, rue de la Libertė -- B.P. 141
50 301 AVRANCHES cedex
France

Nomai was established in 1992, and developed an international business in manufacturing and marketing rigid disk cartridges compatible with SyQuest 5.25" drives. After a flurry of legal actions by SyQuest were settled, Nomai was successful in setting up extensive distribution for the disk cartridge product line. The company more recently announced the development of high capacity 3.5" rigid disk cartridge drives, which it plans to make available by the end of 1995. The basic 540 megabyte drive design was done in Scotland by Myrica (U.K.) Limited, a design firm staffed with Rodime graduates, with technology assistance from universities in the U.K. and France, and the drive will be manufactured at Havant, U.K., by Xyratex, the IBM spinoff.

N. V. PHILIPS
5600 MD Eindhoven
The Netherlands

1994 total net sales: $33,688,950,000 Net income: $1,174,033,000

The Philips organization, established in 1891 as a manufacturer of electrical equipment, has been active for many years in the development of optically based information systems. Philips' initial digital optical developments were a 12" write-once drive and the read-only device which became the CD-ROM. Philips, together with Sony, has been instrumental in establishing standards for CD and CD-ROM drives. Philips and Sony continue to innovate standards for CD-ROM, including CD-I and CD-ROM XA. Magneto-optic recording has been under development at Philips for many years, but the effort has been intermittent. Manufacturing of CD-ROM drives, CD-R drives and 3.5" MO drives (and mechanisms) is the responsibility of Philips Key Modules.

In late 1993, Philips and IBM announced a joint development venture leading to the introduction of a one inch high 3.5" MO drive by IBM that used a mechanism manufactured by Philips Key Modules Group. At that time, it was also indicated that Philips would participate in future joint developments.

SCM MICROSYSTEMS GMBH
Pettenkoferstrasse 7
D-85276 Pfaffenhofen
Germany

SCM has been active in flash memory storage products since 1990, developing a flash card host module enabling computers to accept flash cards. The firm also developed a flash filing system, much of which was incorporated into the PCMCIA standards. In November, 1994, SCM announced a line of flash memory cards.

SGS-THOMSON MICROELECTRONICS
20041 Agrate Brianza
Italy

Jointly owned by the French and Italian governments, SGS-Thomson was founded in 1987 from the merger of SGS Microelettronica and Thomson Semiconducteurs, although the origins of its component companies go as far back as 1957. The firm is a manufacturer of semiconductor components, with over half of its sales made in Europe. The firm is a second source manufacturer for AMD flash chips, but does not at the present time manufacture flash memory cards.

DISK/TREND ON DISK

1995 DISK/TREND REPORT

DISK/TREND ON DISK

Introduction

DISK/TREND ON DISK is a licensed set of floppy disks available for separate purchase that contain the statistical tables and specification tables from the annual DISK/TREND Reports. The disk files have been prepared in a format usable on IBM or IBM-compatible computers running under the MS-DOS or PC-DOS operating system. A system with a hard disk is highly recommended, but a system with two floppy disks can be used if necessary. All DISK/TREND ON DISK files contain data only -- manipulation of data is the user's responsibility. Because some of the files can be very large, system memory of 640K or more is recommended.

Two types of diskette files are supplied for each DISK/TREND disk drive report. The first type contains the statistical tables in ASCII format. File names are keyed to the table numbers in the report for easy identification. The second type contains the specification section in a Lotus 1-2-3 data base format. Multiple disks of each type are provided where the files are too numerous or too large to fit on a single floppy disk. The color of the label of the floppy disk is similar to the color used on the cover of the corresponding report for ease in identification.

Because the statistical tables are provided in ASCII format, they can be used with any spreadsheet program that can import ASCII text files. However, the specification tables have been prepared specifically in Lotus 1-2-3 format to allow them to be searchable using Lotus 1-2-3 data base commands. If you are using a spreadsheet program other than Lotus 1-2-3 that can translate Lotus WK1 formatted files to its own format, it may be able to import the specification tables without difficulty.

A file translation program, AutoImport, is available from DISK/TREND to assist in converting the data supplied to the formats of several popular spreadsheet programs. One copy of AutoImport is provided automatically at no extra charge to DISK/TREND subscribers who have purchased an original copy of DISK/TREND ON DISK but is provided only in the first year DISK/TREND ON DISK is purchased. Updates to AutoImport may be provided in following years at DISK/TREND's discretion. Extra copies of AutoImport may be purchased at any time. If you have not purchased DISK/TREND ON DISK, but would find AutoImport useful with other file translation tasks, it may be purchased independently from DISK/TREND or White Crane Systems, Inc.

IMPORTANT NOTE: Effective July, 1994, White Crane began shipping version 3.13 or higher of AutoImport. Instructions in this section are written to work with this version. If you have an older version of AutoImport, refer to instructions in previous DISK/TREND reports. You must have AutoImport 3.13 or higher to use DISK/TREND ON DISK with these instructions.

The authors of this manual assume that you are familiar with personal computers, Lotus 1-2-3 or other spreadsheets, and MS-DOS, and do not cover their operation in this manual. This manual deals specifically with how to load and use the files supplied on the floppy disks.

Note: Please read the license on the following page.

DISK/TREND ON DISK

Information License

DISK/TREND supplies diskettes containing selected information from the 1995 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1995 DISK/TREND Report volume.

YOU MAY:

1. Install and use the information on a single computer system, provided that you or the organization by which you are employed has purchased at least one copy of the DISK/TREND report volume associated with the information.

2. Make backup copies of the information for your own use. Such backup copies may be used only on the computer on which the information is installed. You must reproduce the copyright notice on any copies.

3. Reproduce the information, but not the associated programs or documentation, contained in the Product for use within internal documents distributed within the organization by which you are employed.

YOU MAY NOT:

1. Install, or allow the use of, the information on more than a single computer system.

2. Transfer the information through or within a computer network.

3. Distribute the information or any portion thereof in any form outside the organization by which you are employed or modify the information for purposes of distribution.

4. Transfer this license to another party.

AUTOIMPORT

Use of AutoImport is subject to license terms and conditions of White Crane Systems, Inc., 8255 Overview Court, Suite 100, Roswell, GA 30076.

Trademarks

IBM is a trademark of International Business Machines Corporation.
Lotus and Lotus 1-2-3 are trademarks of Lotus Development Corporation.
MS-DOS is a trademark of Microsoft Corporation.
AutoImport is a trademark of White Crane Systems, Inc.

Getting started

The first thing you should do is to make working copies of the original DISK/TREND diskettes. Place the originals in a safe location and use only the working copies for day-to-day operations. This procedure will help to protect your data from inadvertent destruction or loss due to a malfunction of the computer or its operator. We also recommend that you place a write protect tab on the working copies (after you create them) for the same reason. Use the hard disk or another floppy disk copy for day-to-day manipulations of the files.

The statistical tables are provided in ASCII text format. This allows you to use any word processor to edit the file prior to importing it into Lotus 1-2-3. Appropriate editing removes any material you don't wish to work with and allows you to add figures or text to the data tables. You may also embed the data in internal documents or reports you are preparing for use within your company.

To convert the statistical tables to a spreadsheet you may use the AutoImport utility software, which is probably quicker and easier than the typical text file import and conversion procedure provided with spreadsheet programs. One copy of AutoImport is provided automatically at no extra charge to each DISK/TREND subscriber who has purchased an original copy of DISK/TREND ON DISK and is provided in the first year DISK/TREND ON DISK is purchased. Updates to AutoImport may be provided in following years at DISK/TREND's discretion. Extra copies of AutoImport may be purchased at any time.

DISK/TREND ON DISK is normally shipped on 1.44 megabyte 3.5" diskettes, but is also available on 1.2 megabyte 5.25" diskettes if requested.

STATISTICAL TABLES

Loading and Installation

1. Place the floppy disk marked "Tables" in a floppy disk drive able to read your size disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the Lotus 1-2-3 system disk in drive A. Use the DOS 'DIR' command to examine the file directory on the "Tables" disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

   TYPE A:READ.ME (Use the appropriate drive letter if not A)

   If you wish to print the instructions, turn on your printer and type:

   TYPE A:READ.ME>PRN

2. Do this step if you have a hard disk. Log into the hard disk directory in which Lotus 1-2-3 normally stores worksheet files. Using the DOS 'COPY' command, copy all the statistical table files to the hard disk. This can be done in one step using the copy command as follows:

   COPY A:?T*.*

   Several utility files should also be copied. The command is:

   COPY A:*.PRN (if using the Lotus 1-2-3 data parsing commands)

   COPY A:MASK?2.MSK (if you are using AutoImport version 2.xx)
   COPY A:MASK?3.MSK (if you are using AutoImport version 3.xx)

   The utility files named FORMLIN?.PRN are specifically for usage with Lotus 1-2-3 data parsing if you prefer not to use AutoImport for file translation.

   Installing AutoImport V3.xx: If you have a hard disk, create a directory named AIMP (You could use other names if you prefer). Now place AutoImport disk 1 in drive A and type: COPY A:*.* and then ENTER. Follow any instructions appearing on the screen until installation is complete. To make AutoImport accessible from any directory, place C:\AIMP in your AUTOEXEC.BAT file's 'PATH' statement. See your MS-DOS instruction manual for information about this step.

   If you are using a floppy-only system, copy the AutoImport disks and use only the copies in following steps. In a floppy-only system, AutoImport disk 1 should be in drive A when AutoImport is in use for file translation.

3. If you are using AutoImport (highly recommended) for translation of files to spreadsheet format, do the translation at this point. See the following section on using AutoImport for details.

4. Now you are ready to start your spreadsheet. If you are using a two floppy system, place the DISK/TREND disk in drive B and the spreadsheet system disk in drive A. If you are using a rigid disk system, place a copy of the spreadsheet system disk in floppy drive A if required by the security provisions of your spreadsheet program. Now start your spreadsheet as usual. After obtaining the blank spreadsheet image on the screen, use the appropriate file retrieval command to select a file. For Lotus 1-2-3:

   /FR<filename>

   The file names are in the format XTYY.WK1, where: X= Type of data

   R (Rigid disk drive data)
   O (Optical disk drive data)
   A (Disk drive array data)
   V (Removable data storage data)

   YY= Table number, as shown in the appropriate report volume

   Examples:
   File RT10.WK1 is Rigid Disk Drive Report Table 10
   File OT1.WK1 is Optical Disk Drive Report Table 1
   File AT3.WK1 is Disk Drive Array Report Table 3
   File VT2.WK1 is Removable Data Storage Report Table 2

   The file selected will be loaded as a worksheet. If this is the first time the file has been loaded, you may want to create your own formulas linking the cells of the spreadsheet. See your spreadsheet reference manual for details on numerical manipulations and graphics.

If you don't use AutoImport

If you don't use AutoImport but still want to translate ASCII files to your spreadsheet format, you will have to use spreadsheet tools such as the Lotus 1-2-3 Data Parse commands. They allow the user to convert a table which has been imported in the form of a block of text to a form in which the individual numbers and labels can be manipulated as spreadsheet elements or used to prepare graphics. Let's take Lotus 1-2-3 as an example. Before proceeding, it would be useful to read the Lotus reference manual on this subject if you are not a regular user of the Data Parse commands.

The trickiest and most time-consuming part of using the Data Parse commands is setting up the format line. Several utility files have been provided on the tables disk to make this process easier. These are used with various table formats encountered in the DISK/TREND Reports and correspond with the precomputed masks provided for use with AutoImport:

o FORMLINA.PRN	Used with Table 1 and the Revenue and Unit Shipment tables found in the product group sections of all DISK/TREND reports.
o FORMLINB.PRN	Used with Table 2.
o FORMLINC.PRN	Used with Tables 3 through 6,11,12,24,25.
o FORMLIND.PRN	Used with Application tables.
o FORMLINE.PRN	Used with Drive Height and Drive Capacity tables.

There are no FORMLIN format files for disk diameter tables or market share tables, as these are variable in format. You will have to construct the format line directly, but after you have seen how it is done for the other tables, this should not be too big a job.

After you have used spreadsheet tools to translate a file, you will understand why we recommend AutoImport for this function.

Using AutoImport

Using AutoImport is a two-step process. Step one is creation of a translation mask for each format used in files to be converted. The typical DISK/TREND Report uses 5 to 7 standard mask designs (which have been precomputed and included on your Statistical Tables disk) plus additional masks that are dependent upon table content, as some table types have variable numbers of columns. You will have to create your own masks for such tables, but this can be done easily as shown below.

Step two is the translation process. Once the mask has been created, it can be used with any table matching the mask format. See the table below which relates table types to specific masks.

MASK TABLE

Mask File Name	Rigid Report	Removable Report	Optical Report	Array Report
MASKA	<-------- Table 1--------->		Tables 1,2	Table 1
	<-------------- Product Group Revenue ------------------>			
	<-------------- Product Group Shipment ----------------->			
MASKB	<-------- Table 2 -------->		Tables 3,4	Table 2
MASKC	Tables 3,4,6,9, 10,11	Tables 3 to 6, 11,12,24,25	Tables 5 to 12	Tables 3 to 7
MASKD	<-- All Product Group Application Tables ---->			N/A
MASKE	N/A	Drive height, Drive capacity	Write-Once/ Erasable Analysis	N/A
MASKH	Tables 7,8	Table 31	N/A	N/A
MASKI	<----- Product Group -----> Price/Megabyte		N/A	N/A

N/A = Not applicable to this report

* Variable format depending upon number of disk diameters in the product group.

TABLE NUMBER TO MASK CROSS-REFERENCE

Table Number	1994 Rigid Report	1995 Removable Report	1995 Optical Report	1995 Array Report
1	MASKA	MASKA	MASKA	MASKA
2	MASKB	MASKB	MASKA	MASKB
3	MASKC	MASKC	MASKB	MASKC
4	MASKC	MASKC	MASKB	MASKC
5	MASKC	MASKC	MASKC	MASKC
6	MASKC	MASKC	MASKC	MASKC
7	MASKH	--	MASKC	MASKC
8	MASKH	--	MASKC	--
9	MASKC	MASKA	MASKC	--
10	MASKC	MASKA	MASKC	MASKA
11	MASKC	MASKC	MASKC	MASKA
12	--	MASKC	MASKC	--
13	--	--	--	--
14	MASKA	MASKI	--	--
15	MASKA	--	--	--
16	--	MASKI	--	MASKA
17	--	--	MASKA	MASKA
18	MASKD	MASKI	MASKA	--
19	MASKI	--	--	--
20	--	MASKI	--	--
21	MASKA	--	MASKD	MASKD
22	MASKA	MASKA	--	--
23	--	MASKA	MASKA	MASKA
24	--	MASKC	MASKA	MASKA
25	MASKD	MASKC	--	--
26	MASKI	MASKA	--	--
27	--	MASKA	--	--
28	MASKA	MASKA	--	--
29	MASKA	MASKA	MASKE	MASKA
30	--	MASKA	MASKD	MASKA
31	--	MASKH	--	--
32	MASKD	MASKD	MASKA	--
33	MASKI	--	MASKA	--
34	--	MASKA	--	--
35	MASKA	MASKA	--	
36	MASKA	--	MASKE	
37	--	--	MASKD	
38	--	MASKI	--	
39	MASKD	MASKD	MASKA	
40	MASKI	--	MASKA	
41	--	MASKA	--	
42	MASKA	MASKA	--	
43	MASKA	--	MASKA	
44	--	--	MASKA	
45	--	MASKD	--	
46	MASKD	--	--	
47	MASKI	MASKA	MASKE	

Cross-reference (continued)

Table Number	1994 Rigid Report	1995 Removable Report	1995 Optical Report	1995 Array Report
48	--	MASKA	MASKA	
49	MASKA	--	MASKA	
50	MASKA	--	--	
51	--	MASKD	--	
52	--	--	MASKE	
53	MASKD	MASKA	MASKA	
54	MASKI	MASKA	MASKA	
55	--	--	--	
56	MASKA	--	--	
57	MASKA	MASKE	MASKE	
58	--	MASKE		
59	--	MASKD		
60	MASKD	--		
61	MASKI			
62	--			
63	MASKA			
64	MASKA			
65	--			
66	--			
67	MASKD			
68	MASKI			
69	--			
70	MASKA			
71	MASKA			
72	--			
73	--			
74	--			
75	MASKD			
76	MASKI			
77	--			

-- indicates that the format of this table is variable. Create a mask using AutoImport if a spreadsheet is needed.

Translation using precomputed masks

1. First, copy the files you wish to translate to the AIMP directory from the DISK/TREND ON DISK floppy disk. Go to the AIMP directory, insert the floppy disk in drive A and type the following commands:

   COPY A:?T*.*
   COPY A:*.MSK

   These commands copy the data files and mask files you need.

   If you are using a two floppy disk system, copy the files you want to translate to a second floppy disk along with the mask files. Make sure that no more than half of the floppy disk is filled, because you will need space for the converted files.

2. Now start AutoImport by typing AI, then the ENTER key. When the opening screen appears, select the "File" menu bar item using the mouse or just type /F. (The AutoImport menu system works just like the menus in Lotus 1-2-3.)

3. When the next screen appears (File Selection menu), use the arrow keys or the mouse to select the Mask name option, then select the name of the mask you want from the displayed list. If a standard mask is being used, see the mask table above to choose the mask file name to enter. If you used a mask previously, the system defaults to the last mask named.

4. Select Input file name option on the File Selection Menu.

   Enter the name of the file, including the extension, which will be of the form yy? where yy is the year of the report and ? is the report type as above.

   Examples: RT4.94R OT14.94O AT19.94A VT3.94V

5. Select the Output file option on the File Selection menu.

   Enter the name of the file. The file name form recommended is ?Tnn, where ? is the type of report (A, R, V, or O), T is just that, and nn is the DISK/TREND Report table number matching the file being translated. You should not enter the file name extension as the system adds it automatically for you.

   Examples: RT4 OT14 AT20 VT23

6. The default spreadsheet type to which translation is made is Lotus 1-2-3 version 2.x. If you wish to translate to a different spreadsheet format you may choose it by selecting Format from the File Selection menu and then selecting your preference from the menu of choices displayed.

7. You are ready to translate. Recheck all the file names displayed to be CERTAIN they are correct. Select "CONVERT" button using the mouse (or arrow keys and ENTER). If you are asked "Do you want to load input file *.* named in mask", answer "NO". You will see the file being translated scroll by as the translation proceeds.

8. If you want to do more translations, repeat from step 3.

9. When you are done translating, leave AutoImport by typing /Q, or use the mouse to select "Quit" on the menu bar to return to the AutoImport main menu, to leave AutoImport and return to DOS. It will save you some keystrokes if you copy your new spreadsheet files to your spreadsheet directory. If you are using a two floppy system, just remove the AutoImport disk from drive A and substitute your spreadsheet disk.

Mask Generation

1. Start AutoImport as above. When the opening screen appears, select "File" using the mouse or type /F.

2. Name the input file you will use as the template to create the mask. The file name will be of the form ?Tnn.yy?, where ? is the type of report (R, O, V or A), nn is the table number and yy is the report year.

   Example: OT10.94O, VT3.94V

   To name the file, select Input file from the File selection menu. Type the desired file name and press 'Enter'. The contents of the file will now appear on the screen.

3. Next define the header lines. These are lines that are translated to the spreadsheet as a single cell of text. Place the cursor at the top of the header area, normally at the left top of the report table. Now select "Lines" from the menu bar, then select "Header" from the pop-up window that opens. Using the down arrow key, expand the highlighted area until it extends to just above the first row of numerical data. Press 'ENTER'. If there are any footnotes at the bottom, the lines in which they appear can be treated the same way by locating the header at the left margin of the first footnote line, selecting "Lines" and "Headings" again, and extending the highlight area over the note and pressing 'ENTER'.

4. Next, locate the longest left margin label (excluding the header lines) in the table. Position the cursor so that it is at the left margin of the line containing the longest label. Select "Column" from the menu bar, then "Auto Define". This step actually creates the mask. Check to be sure all figures have been delineated properly. If not, see below.

   In a few cases, the automatic feature may be confused by a table layout and all values will not be picked for conversion. In these unusual cases, you may be able to get the overlooked values included by repeating this step on another line.

   Another unusual case can occur in which the right-hand part of a label is somehow included in a value occurring in the next column to the right. Deal with this rare case as follows:

   Place cursor in left margin of offending line. Select "Column", then "Width & move". Select the column you wish to adjust with mouse (or arrows & ENTER), and then use arrow keys to move right column margin clear of the column of values. You can also shift the entire column by depressing the CONTROL key and using the appropriate arrow key (or drag with the mouse).

5. Save the mask in a mask file. Select "File", then "Mask", then the Save Mask button, or type /FMS (File:Mask:Save). Fill in the name of the mask file when asked.

   Example: MYMASK.MSK, or just MYMASK

6. Save the output file. Type /FO (File:Output). Now enter the file name.

   Example: OT10. You don't need to enter the file extender.

7. To make more masks, repeat from step 2. To quit the mask function, type /QY (quit).

Other AutoImport Functions

AutoImport can do much more than the functions described above, which are those concerned with a basic understanding of how to create spreadsheets from DISK/TREND ON DISK files. See the separate AutoImport manual provided for details of these other functions.

SPECIFICATION TABLES

Loading

1. Place the floppy disk marked "Specifications" in a floppy disk drive able to read your size disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the spreadsheet system disk in drive A. Use the DOS "DIR" command to examine the file directory on the "Tables" disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

   TYPE A:READ.ME (Use the appropriate drive letter if not A)

   If you wish to print the instructions, turn on your printer and type:

   TYPE A:READ.ME>PRN

2. Do this step if you have a hard disk. Log into the hard disk directory in which your spreadsheet normally stores worksheet files. Using the DOS "COPY" command, copy all the specification table files to the hard disk.

   COPY A:?S*.*

3. Now you are ready to start Lotus 1-2-3 or other spreadsheet. If you are using a two floppy system, place the DISK/TREND disk in drive B and the Lotus spreadsheet system disk in drive A. If you are using a rigid disk system, place the spreadsheet system disk in floppy drive A. If your spreadsheet is not Lotus 1-2-3, you will have to translate the data from Lotus 1-2-3 to your format. Almost all spreadsheet packages of recent vintage are able to do this translation. After translation, if needed, start your spreadsheet as usual. After obtaining the blank spreadsheet image on the screen, use the spreadsheet File Retrieve command to select a file. The equivalent Lotus 1-2-3 command is:

   /FR<filename>

   The file names are in the format XSYZZ.WK1 or XSYZZ.WKS, depending upon which version of Lotus 1-2-3 you are using. X,Y, and Z are:

   X= O (Optical disk drive data)
   R (Rigid disk drive data)
   C (Cartridge rigid disk drive data)
   S (Semiconductor flash card data)

   In the case of the Removable Data Storage Report, there will be separate specification tables for Optical, Rigid, Cartridge rigid disk, High and Low capacity flexible disk drive and Semiconductor flash card data.

Y= Table number. Usually, there is only one table for each type of data, but if the specification file is so large as to need multiple disks to hold it, there may be several.

ZZ=Year of report.

Example: OS195 Optical disk drive specification table.
RS195 Rigid disk drive specification table.

Note that the specification tables load directly as a data base. You can use the data base functions of Lotus 1-2-3 to sort, count or otherwise manipulate the data for purposes of special analysis. Other spreadsheets may have similar capabilities.

Using the specification data base

Introduction: If you have not used the Lotus 1-2-3 /DATA QUERY commands, it will be helpful for you to review the sections of the Lotus 1-2-3 reference manual that pertain to their use before proceeding further.

The specification data base fits into a worksheet format of 25 to 30 columns, depending upon whether rigid, optical or floppy drives are involved, and a row count of up to 500 rows. Each row represents a specific record, and is equivalent to a single column in the Specifications section of the DISK/TREND Report. Each column represents a specific specification parameter, and is equivalent to one row of the specification table in the DISK/TREND Report.

The data base has been set up for data extraction using Lotus 1-2-3 commands. The Input, Output and Criterion ranges have been predefined, but you, the user, will have to decide how you want the extracted data manipulated and place the appropriate Lotus functions, such as @COUNT, in the appropriate cells. Some rows between the bottom of the input range and the top of the output range have been left empty so that you can do this easily. When the data base is first loaded, you will see the top of the input range, showing the first column (manufacturer name) for the first several manufacturers. Use the arrow keys to find other manufacturers or specific product specifications. If you are not using Lotus 1-2-3, use the equivalent procedure for your spreadsheet.

Operating tips

Expanding the input or output ranges: The predefined output range is of a nominal size, and a search with broad parameters may result in overflowing the output range. In such a case, merely extend the output range (add more rows) using the Lotus 1-2-3 /DQEO command. Similarly, it is possible to extend the input range to add more products, but be sure you move the output range so that there is no overlap.

Memory overflow: If you should receive a memory overflow message while manipulating the specification data, it is usually because:

- There are other "pop-up" programs resident in the memory of your computer. These should be removed.
- You have selected too large an output range. Use a smaller output range or delete some of the columns that contain data not relevant to your analysis. If you delete data, be sure that if you save your spreadsheet you use a different file name, otherwise you will overwrite the original file with the modified spreadsheet.
- If you receive a memory overflow message while loading the data base, the data base is too large for your computer's available memory. You probably will have to remove other resident programs and reload Lotus 1-2-3 and the data base. If your computer doesn't have 640K memory, you will probably get this message.

Saving time

The specification data base is large and takes significant time to recompute or perform other operations. If you are interested in drives that belong to only a few product groups, it will probably save you time in the long run if you extract only those groups you are interested in into a new worksheet and use that for the analysis. Use spreadsheet FILE EXTRACT and FILE COMBINE commands for this purpose.

Another way to save time is to use the SORT capabilities of your spreadsheet to organize the data the way you find it most useful. The most commonly done sorts are by manufacturer name and by DISK/TREND product group, but it would also be possible to sort by average seek time, first ship date, and so on.

Make sure that when you save a worksheet using the FILE SAVE command that you save it in a new file name. If you save it in the file name from which it was loaded, the original copy will be overwritten. If a file is overwritten unintentionally, it can take a long time to recreate.

If you are interested in only a subset of product groups, use the FILE EXTRACT and FILE COMBINE commands to move these records to another file and then use it for analysis. The smaller file will take less time to process.

Technical support

Just about all of your questions regarding the use of DISK/TREND ON DISK should be answered in this manual or in the Lotus 1-2-3 reference manual. However, if you need to contact us to resolve any points of confusion, report errors, or otherwise receive comfort:

Call us at: **415-961-6209**

Ask for Technical Support for DISK/TREND ON DISK.

In order to make this process efficient, when you call...

1. Tell us what is on the diskette label.

2. Have your computer up and displaying the data or operation that is the subject of your call.

3. Have this manual and the Lotus 1-2-3 reference manual handy.

If you have questions about AutoImport as it is used with DISK/TREND ON DISK, contact DISK/TREND at the number above. Questions about other functions of AutoImport should be referred to White Crane Systems.

Apple Macintosh compatibility: While DISK/TREND ON DISK has been prepared for use on IBM PC compatible computers, users have reported that they are able to translate files into Macintosh format using Apple Computer software. The specific software reported used is Apple File Exchange. Some newer Apple systems will directly read files written on IBM PC compatible systems.

Special data

The specification data base contains one category of information not present in the hard copy report. This is the country code field, representing the continental region in which the headquarters of the drive producer is located. A key is located at the top of the adjacent column to the right.

A country code field has been added in the last column of the data base.

The code explanation is:

1 = U.S. manufacturer
2 = Asian manufacturer
3 = European manufacturer
4 = South American or other manufacturer

Codes are based upon the location of the manufacturer's headquarters.

In order to make it easier to do sorting or extraction analysis on the data, the contents of certain fields have been modified and are not exactly the same as in the printed report tables. Some affected fields have been converted to purely numeric fields as described below. Where multiple values existed, the value representing the highest level of performance or capability has been retained.

First ship date has been modified so that the last two characters will always represent the year of shipment. An entry of ??93 in the criterion field for the First Ship Date column will cause all products first shipped in 1993 to be extracted.

Comments and asterisks in the affected fields have been eliminated. A '0' means that no data was available. Asterisks are retained in the comment field so that you will have an indication that one or more characteristics of the drive was referenced to a comment. Check the printed report table for details.

<u>Drive specifications</u>: The affected fields for a drive specification data base are:

Group:	Numeric conversion: You can extract a range of groups.
BPI:	Numeric conversion: You can extract a range of BPI.
TPI:	Numeric conversion: You can extract a range of TPI.
Pos_Time:	Numeric conversion: You can extract a range of seek times.

Aver_rot_del: Numeric conversion: You can extract a range of rotational latencies.

Access_time: Numeric conversion: You can extract a range of average access times.

PCMCIA flash cards: The affected fields for the flash card data base are:

Group: Numeric groups: You can extract a range of groups.

Capacity: Numeric conversion: You can extract by card capacity.

Eras_block: Numeric conversion: You can extract for the size of erase block.

Endrnce: Numeric conversion: You can extract for the maximum number of write/erase cycles specified for a chip.

Avg_access: Numeric conversion: You can extract for a range of average read access times.