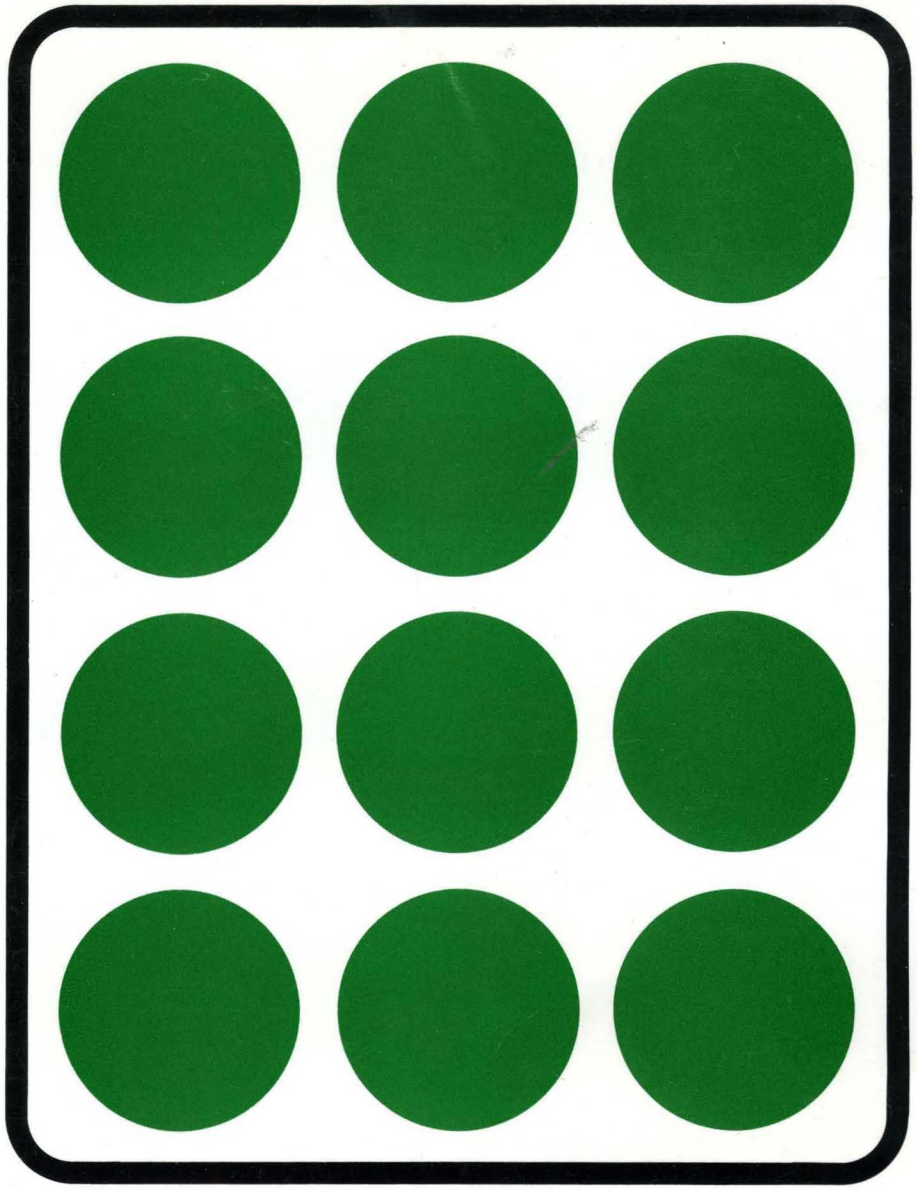
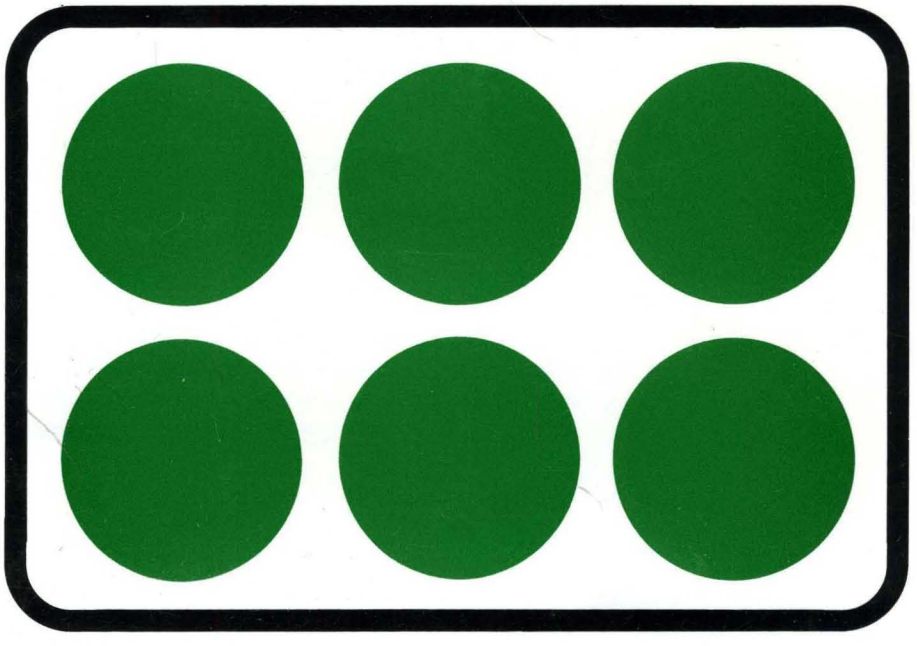


1994 DISK/TREND® REPORT



REMOVABLE DATA STORAGE

1994 DISK/TREND® REPORT

REMOVABLE DATA STORAGE

September, 1994

DISK/TREND, Inc.
1925 Landings Drive
Mountain View, California 94043

Telephone: 415-961-6209
Facsimile: 415-969-2560

FOREWORD

This is the first edition of the DISK/TREND Report on removable data storage, which becomes the fifth report in our annual series of detailed market studies. Although some of the material is also being used in our other reports, most of it has been completely reorganized, in order to provide the first comprehensive market study on removable random access storage devices for low-end applications. The section on PCMCIA flash cards will appear only in this report.

To varying degrees, there is competition between each of the separate types of removable data storage products included in this report, despite the fact that each is a different type of recording device. We hope that this report will make comparisons easier, by assuming a market orientation, and by assembling information on all five product groups in one place.

The DISK/TREND Report is now in its 18th year and has published annual studies on rigid disk drives and flexible disk drives during that entire period, longer than any other firm. Annual 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

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF FIGURES

INTRODUCTION

Something borrowed...something new. The DISK/TREND Report on removable data storage is a new report, organized to bring together for the first time in a single market study most of the major random access data storage products now competing for low-end removable storage markets. DISK/TREND already covers several of these products in other reports, and much of that material has been extracted for this report. The sections on rigid disk cartridge drives and on high capacity flexible disk drives are the same as the equivalent sections which will appear in other DISK/TREND Reports. The sections on PCMCIA rigid disk drives and small optical disk drives have been extracted from other DISK/TREND Reports, with the same data, but organized into tables unique to this report. The section on PCMCIA flash cards is included only in this report, and represents the first time DISK/TREND has covered this product area.

Due to the need to address the individual product technologies, markets and applications of each of the five 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.

What's the selling price? 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

The removable data storage products included in this report produced only $429.3 million in sales revenues during 1993, but a surge in growth is expected for some of the product groups included, and the revenue total for 1997 is forecasted to rise to almost $2.7 billion.

The two newest removable data storage product groups produced the smallest revenue totals in 1993, but are expected to become the largest groups in 1997. PCMCIA rigid disk drives were the smallest product group with 3.4% of 1993 sales revenues, a total of only $14.5 million, but are projected to become the largest group in 1997 with almost $1.1 billion in revenues, 40% of the total. PCMCIA flash cards held 10.6% of 1993 total revenues, $45.3 million, but the flash card total for 1997 is forecasted at $937.6 million, providing a 34.9% share for the group. The big boost for PCMCIA rigid disk drives will come from increasing usage with notebook computers, especially those in the subnotebook weight class, and PCMCIA flash cards will find growth markets in mobile computing of all types, plus the wide range of specialized applications in which the cards are already used.

Small optical disk drives were the largest product group in 1993 with sales revenues of $202.1 million, 47.1% of the overall total. Although unit shipments of the 3.5" magneto-optical drives, which provided all of the 1993 revenue total, were actually less than 1993 shipments of magnetic rigid disk cartridge drives, the higher average unit prices for optical drives produced a larger revenue total. Sales of small optical disk drives are expected to increase, due to increasingly more competitive pricing and the availability of higher disk capacities, but forecasted 1997 sales revenue of $365 million will provide only 13.6% of the overall total for removable data storage products.

The transition from 5.25" drives to smaller form factors at lower prices will hold down the 1997 revenue share for both rigid disk cartridge drives and high capacity flexible disk drives. Rigid disk cartridge drives are expected to produce $223.7 million in 1997 revenues, 8.3% of the total, but the high capacity flexible disk drive group is forecasted at $86.5 million, only 3.2% of overall revenues, due to significantly lower average prices.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

REMOVABLE DATA STORAGE

REVENUE SUMMARY

	REMOVABLE DATA STORAGE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993 Revenues		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	19.7	26.7	88.2	131.9	167.6	260.3
Other U.S. Captive	3.2	6.1	4.0	13.3	4.5	20.4	4.8	25.5	5.9	31.4
TOTAL U.S. CAPTIVE	3.2	6.1	4.0	13.3	24.2	47.1	93.0	157.4	173.5	291.7
PCM/Reseller	121.1	182.5	158.0	229.6	291.9	412.6	486.8	705.4	763.9	1,152.4
OEM/Integrator	32.1	46.7	104.2	145.1	225.7	295.9	325.1	448.1	406.3	596.6
TOTAL U.S. NONCAPTIVE	153.2	229.2	262.2	374.7	517.6	708.5	811.9	1,153.5	1,170.2	1,749.0
TOTAL U.S. REVENUES	156.4	235.3	266.2	388.0	541.8	755.6	904.9	1,310.9	1,343.7	2,040.7
Non-U.S. Manufacturers										
Captive	--	15.8	--	18.4	--	25.9	17.3	69.7	40.5	132.4
PCM/Reseller	45.6	111.0	45.6	120.3	58.1	155.2	91.2	221.4	148.3	335.3
OEM/Integrator	16.4	67.2	22.2	67.4	46.3	101.8	68.9	136.6	91.4	176.3
TOTAL NON-U.S. REVENUES	62.0	194.0	67.8	206.1	104.4	282.9	177.4	427.7	280.2	644.0
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	218.4	429.3	334.0	594.1	646.2	1,038.5	1,082.3	1,738.6	1,623.9	2,684.7

Marketing channels

Even though there is considerable overlap in the markets addressed by the heterogeneous group of removable data storage products included in this report, each type of product has developed a specific pattern of marketing channels, with contrasting growth trends expected for some groups.

Two groups with similar expected marketing channel trends are PCMCIA flash cards and PCMCIA rigid disk drives. OEM/Integrator shipments predominated in both groups in 1993, as notebook computer and specialized system manufacturers pioneered new applications for PCMCIA cards, and made direct purchases of most of the flash cards and rigid disk drives in PCMCIA form.

But as the population of notebook computers with PCMCIA slots grows dramatically during the next few years, distribution through resellers of all kinds for additional and upgraded data storage capacity will become a much larger factor. The PCM/Reseller channel is projected to provide 63.2% of 1997 PCMCIA flash card unit shipments and 42.5% of PCMCIA rigid disk drive shipments.

The PCM/Reseller channel is forecasted to provide 85.6% of rigid disk cartridge drive 1997 worldwide unit shipments and 68.3% of the small optical disk drive total. However, unit shipments of high capacity flexible disk drives are expected to transition from 79.8% PCM/Reseller in 1993 to 52.3% OEM/Integrator in 1997, as adoptions by several system manufacturers occur.

An understanding of the relative price levels of captive, PCM/Reseller and OEM/Integrator drives and/or cards is important in interpreting DISK/TREND revenue statistics, to avoid an exaggerated impression of the share of the industry's total unit shipments held by captive products. Captive data storage products, which are normally sold with systems made by the same manufacturer, normally carry end user prices significantly higher than noncaptive PCM/Reseller or OEM/Integrator products.

The price used for each product is the estimated value 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	1993 Revenues $M	1993 Revenues %	1994 $M	1994 %	1995 $M	1995 %	1996 $M	1996 %	1997 $M	1997 %
U.S. Manufacturers										
IBM Captive	--	--	--	--	26.7	2.5%	131.9	7.5%	260.3	9.6%
	--		--		--		+394.0%		+97.3%	
Other U.S. Captive	6.1	1.4%	13.3	2.2%	20.4	1.9%	25.5	1.4%	31.4	1.1%
	+96.8%		+118.0%		+53.4%		+25.0%		+23.1%	
PCM/Reseller	182.5	42.5%	229.6	38.6%	412.6	39.7%	705.4	40.5%	1,152.4	42.9%
	+27.9%		+25.8%		+79.7%		+71.0%		+63.4%	
OEM/Integrator	46.7	10.8%	145.1	24.4%	295.9	28.4%	448.1	25.7%	596.6	22.2%
	+586.8%		+210.7%		+103.9%		+51.4%		+33.1%	
Total U.S. Manufacturers	235.3	54.7%	388.0	65.2%	755.6	72.5%	1,310.9	75.1%	2,040.7	75.8%
	+54.2%		+64.9%		+94.7%		+73.5%		+55.7%	
Non-U.S. Manufacturers										
Captive	15.8	3.6%	18.4	3.0%	25.9	2.4%	69.7	4.0%	132.4	4.9%
	-48.5%		+16.5%		+40.8%		+169.1%		+90.0%	
PCM/Reseller	111.0	25.8%	120.3	20.2%	155.2	14.9%	221.4	12.7%	335.3	12.4%
	+57.7%		+8.4%		+29.0%		+42.7%		+51.4%	
OEM/Integrator	67.2	15.9%	67.4	11.6%	101.8	10.2%	136.6	8.2%	176.3	6.9%
	-12.7%		+.3%		+51.0%		+34.2%		+29.1%	
Total Non-U.S. Manufacturers	194.0	45.3%	206.1	34.8%	282.9	27.5%	427.7	24.9%	644.0	24.2%
	+8.9%		+6.2%		+37.3%		+51.2%		+50.6%	
Worldwide Recap										
Captive	21.9	5.1%	31.7	5.3%	73.0	7.0%	227.1	13.1%	424.1	15.8%
	-35.2%		+44.7%		+130.3%		+211.1%		+86.7%	
PCM/Reseller	293.5	68.4%	349.9	58.9%	567.8	54.7%	926.8	53.3%	1,487.7	55.4%
	+37.7%		+19.2%		+62.3%		+63.2%		+60.5%	
OEM/Integrator	113.9	26.5%	212.5	35.8%	397.7	38.3%	584.7	33.6%	772.9	28.8%
	+35.9%		+86.6%		+87.2%		+47.0%		+32.2%	
Total All Manufacturers	429.3	100.0%	594.1	100.0%	1,038.5	100.0%	1,738.6	100.0%	2,684.7	100.0%
	+29.8%		+38.4%		+74.8%		+67.4%		+54.4%	

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

Product groups

By 1997, 78.6% of the overall unit shipments for removable data storage products included in this report will be held by the two groups of storage devices in the form of PCMCIA cards: PCMCIA flash cards and PCMCIA rigid disk drives. However, even though both types of products utilize the same type of packaging, there will probably be very little competition between the two groups, due to very little overlap in capacities offered and sharply different price levels.

Total 1997 shipments of PCMCIA flash cards are forecasted at 4.9 million cards, 41.8% of the overall total for all removable data storage products. Most of the 1993 shipments were flash cards with less than 10 megabytes capacity and, although average flash card capacities are expected to increase, 64.3% of 1997 unit shipments are forecasted to have less than 10 megabytes capacity.

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 1997 to card capacities lower than offered by most PCMCIA rigid disk drives. The projected 1997 average OEM/Integrator price per megabyte for PCMCIA flash cards with over 100 megabyte capacity is $5.98, while the equivalent 1997 price for PCMCIA rigid disk drives with 100-200 megabytes capacity is forecasted at $1.00.

In the capacity ranges below 100 megabytes, the majority of flash cards are organized as "flash memory", permitting simpler architecture and the ability to execute programs directly from the card. Flash memory cards predominate in many noncomputer applications, including a wide range of industrial and telecommunication equipment, plus the newer personal digital assistants and other mobile systems. "Flash disks", which emulate disk drives, are more widely used in a higher range of flash card capacities and are expected to be used with increasing frequency with notebook computers for data interchange -- but generally at lower capacities than PCMCIA rigid disk drives, due to price differences.

PCMCIA rigid disk drives are expected to provide 36.8% of the 1997 unit shipment total, with 4.3 million drives, a striking comparison with the 47,900 drives shipped in 1993. Critical to these sales increases will be the continually increasing capacities offered, the 1995 availability of drives in the 5 millimeter

high PCMCIA Type II format, and continued reduction in price. PCMCIA rigid disk drives in the 100-200 megabyte range have assumed leadership in current shipments, but the lead is expected to pass to the 200-300 megabyte capacity range in 1996. PCMCIA Type II drives are expected in the 100-200 megabyte range in 1995, with initial capacities limited by the availability of only a single disk, but with increased capacities available during the forecast period.

Rigid disk cartridge drives, with 1997 unit shipments projected at 932,400 drives, will undergo major changes in product mix. SyQuest's 5.25" drives have achieved staying power as the "prepress" interchange standard, and are expected to stay in production though 1997, although in declining numbers, as higher capacity 3.5" drives assume shipment leadership. However, the new SyQuest 1.8" drive, a PCMCIA Type III drive using a disk cartridge which can be removed from the removable drive, is forecasted to take one third of 1997 unit shipments for the product group.

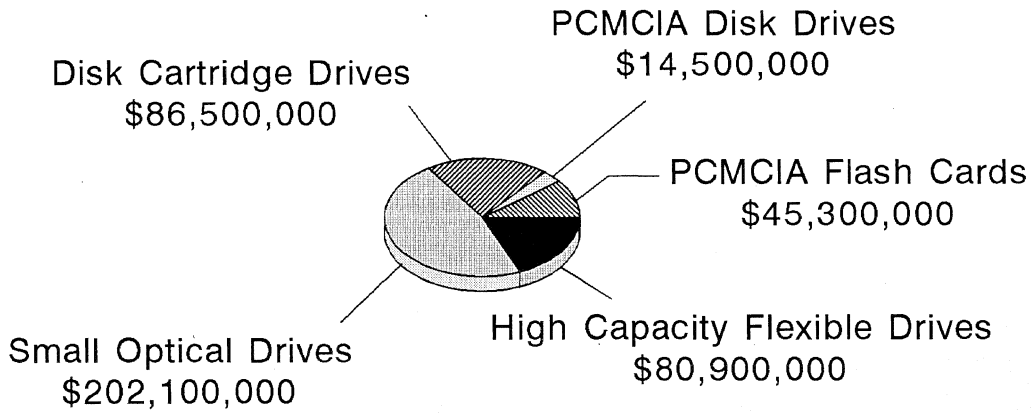
Small optical disk drives are expected to increase shipments at roughly the same rate as rigid disk cartridge drives, following modest 1994 growth, and providing 1997 shipments of 932,400 drives. Manufacturers of small optical disk drives have been held to sales levels lower than most planned, due to 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, in an attempt to be more competitive.

High capacity flexible disk drives have experienced difficult times in the last year, with saturating markets for older products, price resistance to newer 3.5" drives, and changing company managements, ownership and manufacturing arrangements. Stability has apparently been reestablished in 1994, and shipments are forecasted to grow to 600,000 drives in 1997. Based on expected growth for 3.5" drives, including a larger share of OEM adoptions than in the past, the 1997 share of total high capacity flexible disk drive shipments for 3.5" is projected at 86.9%.

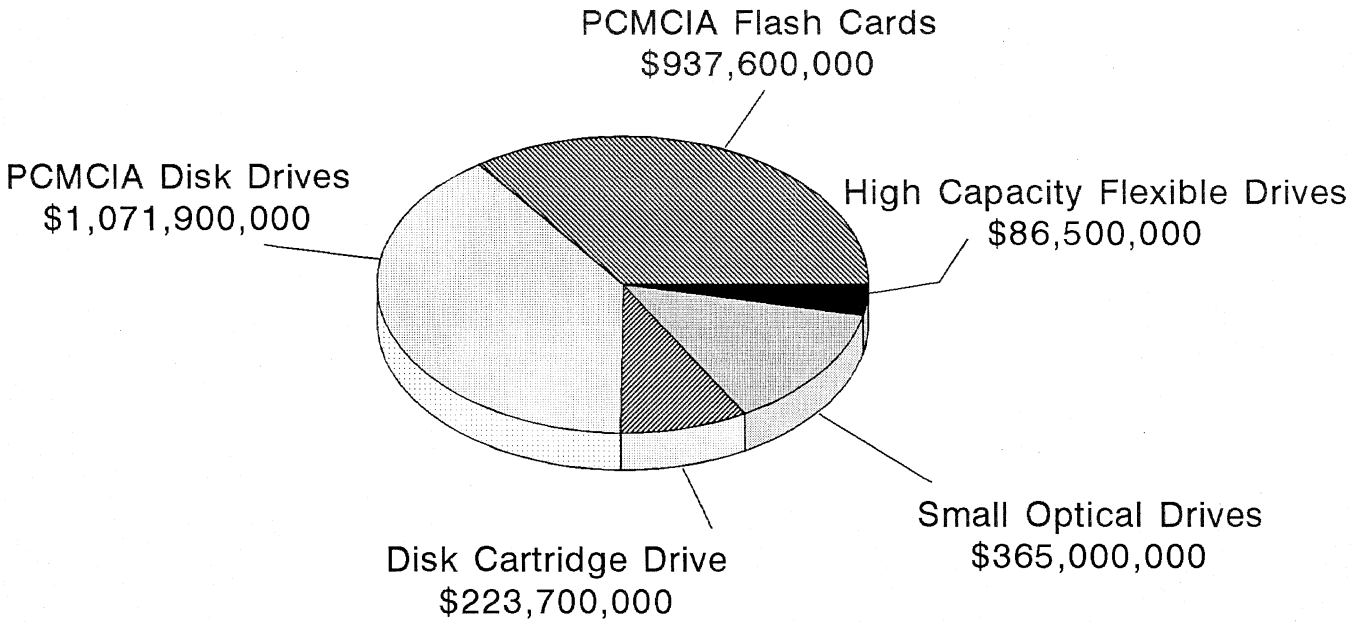
Figure 1

CHANGING PRODUCT MIX

Worldwide Removable Data Storage Revenue



1993



1997

TABLE 3

CONSOLIDATED WORLDWIDE REVENUES
REMOVABLE DATA STORAGE
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1993		Forecast							
ALL MANUFACTURERS	Revenues		1994		1995		1996		1997	
	$M	%	$M	%	$M	%	$M	%	$M	%
PCMCIA FLASH CARDS	45.3	10.6%	85.2	14.3%	220.5	21.3%	481.0	27.7%	937.6	34.9%
	--		+88.1%		+158.8%		+118.1%		+94.9%	
PCMCIA RIGID DISK DRIVES	14.5	3.4%	98.4	16.7%	333.3	32.1%	688.2	39.6%	1,071.9	40.0%
	--		+578.6%		+238.7%		+106.5%		+55.8%	
RIGID DISK CARTRIDGE DRIVES	86.5	20.1%	132.7	22.3%	173.8	16.7%	216.4	12.4%	223.7	8.3%
	+5.2%		+53.4%		+31.0%		+24.5%		+3.4%	
SMALL OPTICAL DISK DRIVES	202.1	47.1%	202.7	34.1%	222.1	21.4%	259.5	14.9%	365.0	13.6%
	+13.8%		+.3%		+9.6%		+16.8%		+40.7%	
HIGH CAPACITY FLEXIBLE DISK DRIVES	80.9	18.8%	75.1	12.6%	88.8	8.5%	93.5	5.4%	86.5	3.2%
	+14.3%		-7.2%		+18.2%		+5.3%		-7.5%	
Total Worldwide Revenue	429.3	100.0%	594.1	100.0%	1,038.5	100.0%	1,738.6	100.0%	2,684.7	100.0%
	+29.8%		+38.4%		+74.8%		+67.4%		+54.4%	

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

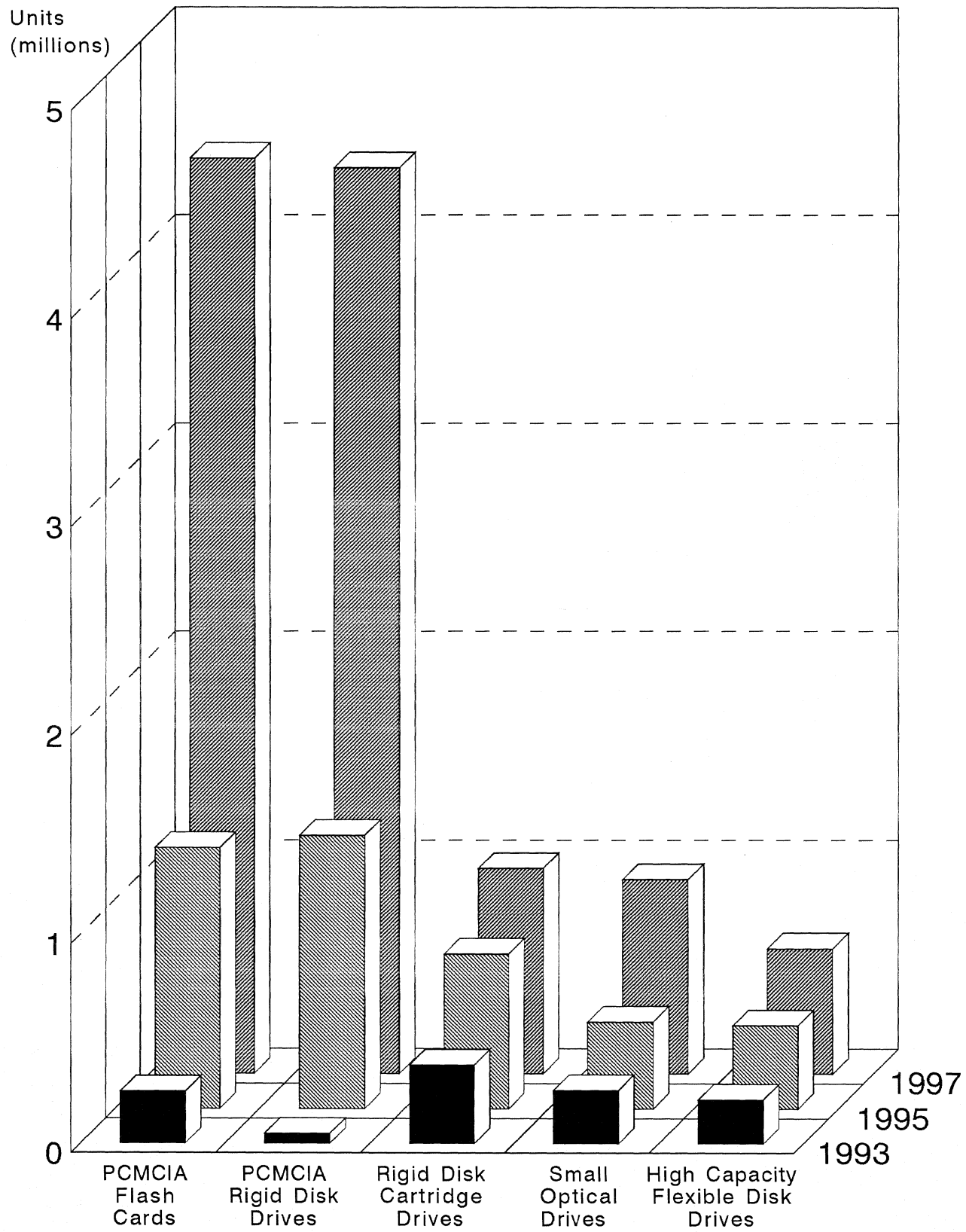


TABLE 4

CONSOLIDATED WORLDWIDE SHIPMENTS
REMOVABLE DATA STORAGE
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS IN THOUSANDS	1993 Shipments Units	1993 Shipments %	1994 Forecast Units	1994 Forecast %	1995 Forecast Units	1995 Forecast %	1996 Forecast Units	1996 Forecast %	1997 Forecast Units	1997 Forecast %
PCMCIA FLASH CARDS	247.8	21.8%	450.7	23.5%	1,250.0	30.4%	2,630.0	35.9%	4,930.0	41.8%
	--		+81.9%		+177.3%		+110.4%		+87.5%	
PCMCIA RIGID DISK DRIVES	47.9	4.2%	360.6	18.7%	1,310.0	31.9%	2,685.0	36.8%	4,345.0	36.8%
	--		+652.8%		+263.3%		+105.0%		+61.8%	
RIGID DISK CARTRIDGE DRIVES	375.0	33.1%	552.4	28.8%	740.0	18.0%	905.0	12.4%	985.0	8.4%
	+18.0%		+47.3%		+34.0%		+22.3%		+8.8%	
SMALL OPTICAL DISK DRIVES	253.9	22.4%	312.3	16.3%	415.5	10.1%	572.7	7.8%	932.4	7.9%
	+53.4%		+23.0%		+33.0%		+37.8%		+62.8%	
HIGH CAPACITY FLEXIBLE DISK DRIVES	209.6	18.5%	243.6	12.7%	399.0	9.6%	525.0	7.1%	600.0	5.1%
	+56.3%		+16.2%		+63.8%		+31.6%		+14.3%	
Total Worldwide Shipments	1,134.2	100.0%	1,919.6	100.0%	4,114.5	100.0%	7,317.7	100.0%	11,792.4	100.0%
	+83.6%		+69.2%		+114.3%		+77.9%		+61.1%	
% U.S. Manufacturers	69.2%		75.6%		77.5%		77.8%		78.0%	

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

Noncaptive market

Although captive revenues for removable data storage products are expected to increase from $21.9 million in 1993 to $424.1 million in 1997, noncaptive sales revenues will still predominate, with 84.2% of the 1997 total. The projected noncaptive 1997 total of 10.7 million units of all removable data storage products in this report will produce sales revenues of $2.3 billion. The PCM/Reseller channel will provide 55.4% of all sales revenues in 1997, and 65.8% of noncaptive revenues for the year.

All PCMCIA flash card sales are currently noncaptive, and despite the expected start of captive shipments by IBM and several Japanese companies in future years, almost 90% of unit shipments are expected to remain noncaptive in 1997. Two thirds of 1993 sales revenues and unit shipments were OEM/Integrator sales, but by 1997 more than 70% of both revenues and shipments will be derived from the PCM/Reseller channel.

Growth in PCM/Reseller shipments of PCMCIA flash cards will be driven by the product group's success in developing numerous specialized applications with a diverse group of system manufacturers, plus the general trend by computer manufacturers to add PCMCIA slots to a majority of new notebook computer models now entering the marketplace. Current flash card sales to OEMs will produce distribution sales in the future as additional cards and upgraded capacity are needed. A preponderance of PCM/Reseller sales are expected for each of the flash card capacity groups by 1997.

The ratio of 1993 PCMCIA rigid disk drive sales through the OEM/Integrator channel was even higher, with 86% of revenues and 90.3% of unit shipments. Although the PCM/Reseller channel will probably predominate in noncaptive sales for this group, it is expected to grow to slightly less than half of noncaptive sales revenues and unit shipments in 1997. Distribution sales are projected to provide more than half of the 100-200 megabyte noncaptive total for 1997, since the OEM/Integrator market will be rapidly moving up to higher capacities by then.

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 concen-

trated 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. SyQuest's newer 3.5" drives are expected to have the potential to increase OEM/Integrator sales to system manufacturers, with the result that the 96.8% share of the group's noncaptive unit shipments held by the PCM/Reseller channel in 1993 is projected to decline to 85.8% in 1997.

64.3% of the noncaptive unit shipments of small optical disk drives were sold in the PCM/Reseller channel in 1993, and that total is expected to increase to 72.1% in 1997. These drives tend to follow a distribution pattern similar to that of the magnetic 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.

The marketing channel mix for high capacity flexible disk drives is destined to change by 1997, as expected growth in sales to system manufacturers reduces the product group's dependence on distribution. 79.8% of 1993 noncaptive unit shipments were in the PCM/Reseller channel, but by 1997 shipments in this channel are projected to be only 44.2% of the noncaptive total. It should be noted, however, that in 1997 PCM/Reseller sales are expected to provide 94.5% of the remaining shipments of Iomega's 5.25" Bernoulli drives.

TABLE 5

NONCAPTIVE WORLDWIDE REVENUES
REMOVABLE DATA STORAGE
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1993		Forecast							
ALL MANUFACTURERS	Revenues		1994		1995		1996		1997	
	$M	%	$M	%	$M	%	$M	%	$M	%
PCMCIA FLASH CARDS	45.3	11.1%	85.2	15.1%	205.8	21.3%	422.8	28.1%	807.2	35.7%
	--		+88.1%		+141.5%		+105.4%		+90.9%	
PCMCIA RIGID DISK DRIVES	12.1	3.1%	96.9	17.2%	316.5	32.9%	573.6	37.9%	848.3	37.6%
	--		+700.8%		+226.6%		+81.2%		+47.9%	
RIGID DISK CARTRIDGE DRIVES	86.5	21.2%	132.7	23.6%	173.8	18.0%	216.4	14.3%	223.7	9.9%
	+5.2%		+53.4%		+31.0%		+24.5%		+3.4%	
SMALL OPTICAL DISK DRIVES	182.6	44.8%	173.5	30.9%	184.6	19.1%	212.0	14.1%	303.3	13.4%
	+26.9%		-5.0%		+6.4%		+14.8%		+43.1%	
HIGH CAPACITY FLEXIBLE DISK DRIVES	80.9	19.8%	74.1	13.2%	84.8	8.7%	86.7	5.6%	78.1	3.4%
	+14.4%		-8.4%		+14.4%		+2.2%		-9.9%	
Total Worldwide Revenues	407.4	100.0%	562.4	100.0%	965.5	100.0%	1,511.5	100.0%	2,260.6	100.0%
	+37.2%		+38.0%		+71.7%		+56.6%		+49.6%	

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

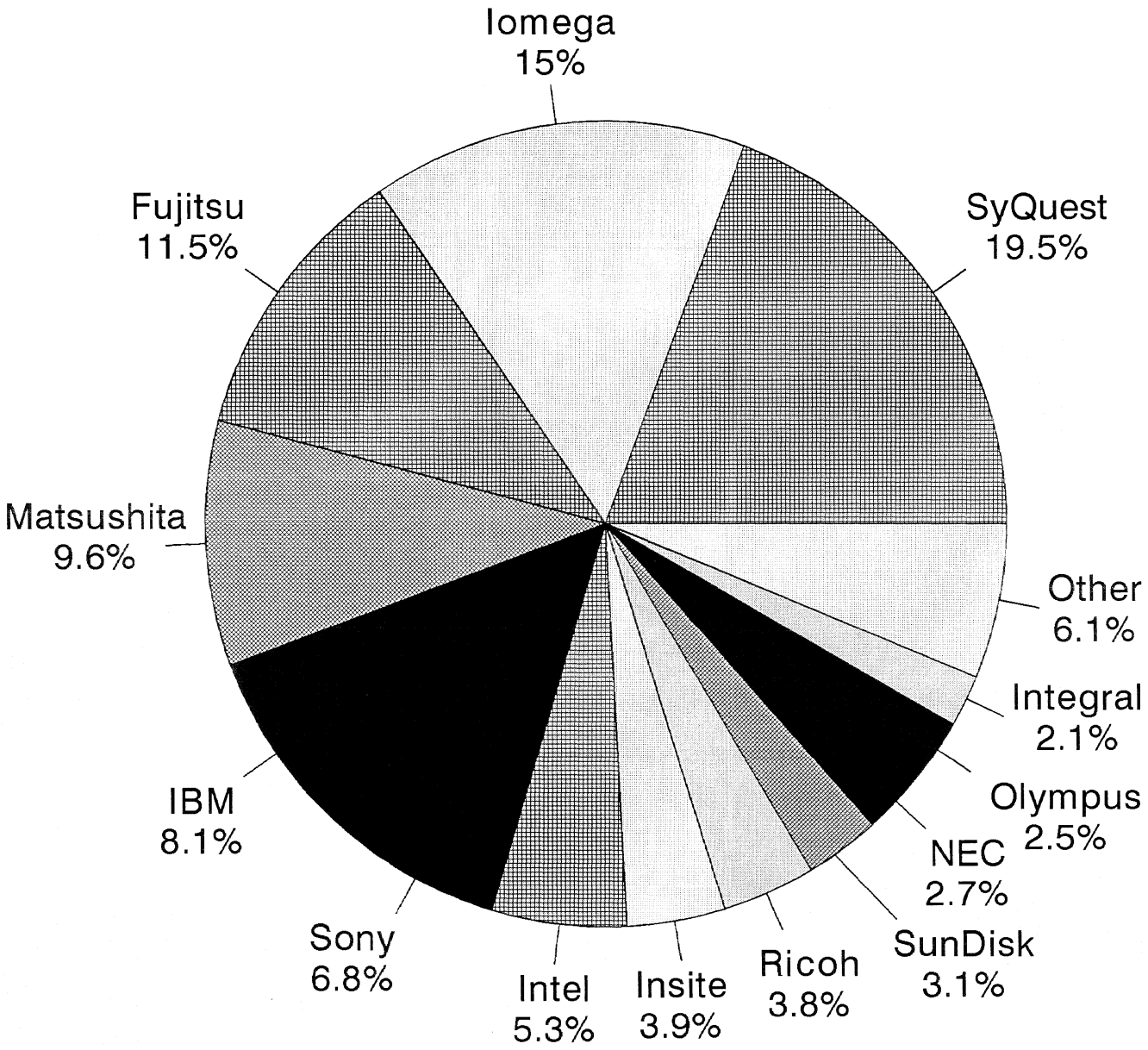
UNIT SHIPMENTS IN THOUSANDS	1993 Shipments Units	1993 Shipments %	1994 Forecast Units	1994 Forecast %	1995 Forecast Units	1995 Forecast %	1996 Forecast Units	1996 Forecast %	1997 Forecast Units	1997 Forecast %
PCMCIA FLASH CARDS	247.8	22.1%	450.7	23.8%	1,180.0	29.6%	2,367.0	35.0%	4,407.0	41.3%
	--		+81.9%		+161.8%		+100.6%		+86.2%	
PCMCIA RIGID DISK DRIVES	44.4	4.0%	358.4	18.9%	1,283.0	32.2%	2,449.0	36.2%	3,815.0	35.8%
	--		+707.2%		+258.0%		+90.9%		+55.8%	
RIGID DISK CARTRIDGE DRIVES	375.0	33.5%	552.4	29.1%	740.0	18.6%	905.0	13.4%	985.0	9.2%
	+18.0%		+47.3%		+34.0%		+22.3%		+8.8%	
SMALL OPTICAL DISK DRIVES	242.5	21.7%	294.5	15.6%	390.9	9.8%	538.4	8.0%	883.6	8.3%
	+55.8%		+21.4%		+32.7%		+37.7%		+64.1%	
HIGH CAPACITY FLEXIBLE DISK DRIVES	209.6	18.7%	241.6	12.6%	391.0	9.8%	510.0	7.4%	579.0	5.4%
	+56.4%		+15.3%		+61.8%		+30.4%		+13.5%	
Total Worldwide Shipments	1,119.3	100.0%	1,897.6	100.0%	3,984.9	100.0%	6,769.4	100.0%	10,669.6	100.0%
	+84.1%		+69.5%		+110.0%		+69.9%		+57.6%	
% U.S. Manufacturers	69.8%		76.1%		77.4%		78.2%		79.1%	

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

Figure 3

1993 ESTIMATED MARKET SHARE

Removable Data Storage Worldwide Revenue



1993 Revenue: $429,300,000

TABLE 7

1993 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL REMOVABLE DATA STORAGE
(Value of non-U.S. currencies estimated at average 1993 rates)

	CAPTIVE		PCM/RESELLER		OEM/INTEGRATOR		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
IBM	6.1	27.9	24.7	8.4	4.1	3.6	34.9	8.1
Integral Peripherals	--	--	--	--	9.1	8.0	9.1	2.1
Intel	--	--	7.6	2.6	15.0	13.2	22.6	5.3
Iomega	--	--	61.9	21.1	2.5	2.2	64.4	15.0
SunDisk	--	--	3.3	1.1	10.2	9.0	13.5	3.1
SyQuest Technology	--	--	81.5	27.8	2.2	1.9	83.7	19.5
Other U.S.	--	--	3.5	1.2	3.6	3.2	7.1	1.7
U.S. Total	6.1	27.9	182.5	62.2	46.7	41.0	235.3	54.8
NON-U.S. MANUFACTURERS								
Fujitsu	--	--	22.1	7.5	27.3	24.0	49.4	11.5
Insite Peripherals	--	--	9.9	3.4	6.7	5.9	16.6	3.9
Matsushita Electric Industrial	--	--	34.3	11.7	7.0	6.1	41.3	9.6
NEC	11.0	50.2	--	--	.4	.4	11.4	2.7
Olympus	--	--	1.4	.5	9.4	8.3	10.8	2.5
Ricoh	4.8	21.9	5.6	1.9	6.0	5.3	16.4	3.8
Sony	--	--	20.5	7.0	8.7	7.6	29.2	6.8
Other Non-U.S.	--	--	17.2	5.9	1.7	1.5	18.9	4.4
Non-U.S. Total	15.8	72.1	111.0	37.8	67.2	59.0	194.0	45.2
WORLDWIDE TOTAL	21.9	100.0	293.5	100.0	113.9	100.0	429.3	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:

P1 = PCMCIA I C = Captive
P2 = PCMCIA II P = PCM
P3 = PCMCIA III O = OEM
1 = 1.8"
2 = 2.5"
3 = 3.5"
5 = 5.25"
FD = Flash disk
FM = Flash memory

TABLE 8

CURRENT PRODUCT LINES
MANUFACTURERS OF REMOVABLE DATA STORAGE

DISK/TREND PRODUCT GROUP		40	41	42	2	3	4	1	11	16
		Flash Cards	Flash Cards	Flash Cards	PCMCIA Disk	PCMCIA Disk Drives	PCMCIA Disk Drives	Rigid Cartridge Disk	Small Optical Disk	High Capacity Flexible Disk
U.S. Manufacturers (20)	Type	<10 MB	10-25 MB	25-100 MB	<100 MB	100-200 MB	200-300 MB	Drives	Drives	Drives
Advanced Micro Devices	O	FM	FM							
AMP	P	FM								
Aura Associates	O,P				P3	P3				
Avatar Systems	O							2		
Centennial Technologies	O,P	FM								
IBM Microelectronics	C,O,P	FD,FM	FD,FM	FD					3	
Integral Peripherals	O,P				1,P3	P3				
Intel	O,P	FD,FM	FD,FM	FM						
Iomega	O,P									3,5
Maxtor	O,P	FM	FM			P3				
MFM Technology	O							5		
MiniStor Peripherals	O,P				1,P3	1,P3				
New Media	O,P	FM								
Premax Electronics	O,P	FM	FM							
Quantum	O,P	FM	FM							
Seagate Technology	O,P	FD	FD	FD	P3					
Smart Modular Technologies	O,P	FM	FM							
SunDisk	O,P	FD	FD	FD						
Swan Instruments	O,P									3
SyQuest Technology	O,P							1,3,5		
Asian Manufacturers (15)										
Chinon	O,P								3	
Fujitsu	C,O,P	FM	FM						3	
Hitachi	O,P	FM	FM			P3				
Insite Peripherals	O,P									3
LaserByte	O,P								3	
Matsushita Electric Ind.	O,P	FM							3	
Meiko	O,P	FM								
Mitsubishi Electric	O,P	FM	FM							
MOST	O,P								3	
NEC	C,O				P3	1			3	3
Olympus Optical	O,P								3	
Ricoh	O								3	
Seiko Epson	O,P	FD,FM	FD,FM	FD		P3			3	
Sony	O,P								2,3	
TEAC	O								3	
European/Middle East Manufacturers (2)										
Calluna Technology	O				P3	P3	P3			
M-Systems	O	FM	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

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 three flash cell architectures, NOR, NAND, and EEPROM, which differ largely in erasable block sizes 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 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 SunDisk flash disk modules instead of disk drives.

Notebook computers, subnotebook computers, and PDAs (Personal Digital Assistants) have created demand for removable mass storage, much of which can be satisfied by flash cards. Some unconventional 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) 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, expected in the autumn of 1994, will define support required for multifunction cards, a 32 bit bus architecture, and dual 3.3 volt/5 volt power. PCMCIA flash memory and PCMCIA 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 PCMCIA 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 PCMCIA flash cards, and the 16 megabit chips are becoming mainstream elements. The use of 64 megabit chips is anticipated in the next few years. SunDisk 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. SunDisk 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 anticipated for the next generation. Some cards also have internal power management features that reduce power when the memory isn't active, although this feature results in short delays upon reactivating the memory card as well as creating compatibility problems in some systems.

* Packaging: The PCMCIA standards define a set of standard packages of various thickness but with the same width and length. PCMCIA Type I cards are 3.3 millimeters thick, PCMCIA Type II cards are 5 millimeters thick, and PCMCIA 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 specifically not been approved by PCMCIA.

* Interface: The electrical and mechanical interface for PCMCIA flash cards is defined, but is also evolving in a controlled manner to accommodate a wider 32 bit PCI-like data bus. 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 PCMCIA cards other than memory 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. And even though PCMCIA cards 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 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 will have PCMCIA support software preinstalled as part of the BIOS or operating system, and any operating system drivers required will be capable of operating with PCMCIA cards. The major computer and card suppliers are cooperating to eliminate potential incompatibility problems.

* Insertion integrity: PCMCIA cards 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. PCMCIA cards 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 PCMCIA cards. Because of the limitations imposed by card size, these are 1.8" diameter drives, although smaller drives may be available in the future in PCMCIA format. Several companies, including Calluna, Integral Peripherals, MiniStor and Maxtor are currently shipping PCMCIA rigid disk drives. Much of the commentary in the preceding section concerning PCMCIA related issues applies as much to rigid disk drive PCMCIA cards as it does to flash cards. Areas of difference are reviewed below, as well as those issues unique to rigid disk drive technology.

PCMCIA rigid disk drives, because of their higher capacities, are well suited for providing primary or secondary storage for full function mobile computers. Computer users who wish to take their full suite of applications on the road with them will find the 170 megabyte capacities of today's drives adequate, though not generous. More capacity is needed, especially for multimedia 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 the capacity available in a given number of heads and disks 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-1994 was about 400 megabits per square inch (Calluna's 210 megabyte drive), while the industry average was in the 190 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. Glass media substrates are becoming more common, as their smoothness permits lower flying height. PRML data channels are expected to be incorporated in 1.8" drives shipped during 1995. Magnetoresistive heads and, later, heads employing giant magnetoresistance effects will eventually be employed in PCMCIA drives to extend areal density.

* Packaging: Rigid disk PCMCIA drives employ standard Type III PCMCIA form factors today, but several companies are expected to manufacture disk drives in single disk Type II PCMCIA packages within the next year. The major pacing element in establishment of volume production for PCMCIA 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, PCMCIA 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. The use of glass media by some drive manufacturers may also help resist slap damage to media caused by shock, as it is less likely than aluminum to deform due to a head impact event. 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 PCMCIA rigid disk drives.

* Performance: Today's 1.8" drives have average access times in the 20 to 30 millisecond range, substantially inferior to flash memory cards. Startup time from shut down is in the 1-2 second range, also slow compared to flash memory. Media data transfer rates are in the 3 to 4 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 PCMCIA 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, with the SyQuest 1.8" drive actually mounted in a PCMCIA card. 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 with capacities up to 200 megabytes. Design interest is shifting to smaller form factors, with 270 megabytes now available on 3.5" cartridge media and 80 megabytes available on 1.8"

disks. Higher capacities are predicted, and may be expected to take advantage of the 60% average annual increase in areal densities generally predicted during the rest of this decade. 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 PCMCIA 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 offer 30-40 millisecond average seek time, PCMCIA magnetic drives can offer sub-20 millisecond 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 peripheral 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.

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

The current flexible disk drives in this group are Iomega's 5.25" Bernoulli Box drives and a few remaining 3.5" drives. The 3.5" drives include the "floptical" drive

originated by Insite Peripherals, plus drives using metal powder media, currently produced only by NEC. Because of the relatively high prices of these drives, compared to standard floppy disk drives, they must compete with higher density rigid magnetic disk drives and optical disk drives, for specialized markets which need recording devices with removable media. It has been a difficult competitive environment, however, with rapidly dropping prices from all types of competitive drives.

Originally introduced in an 8" diameter format, the Iomega Bernoulli Box transitioned to a 5.25" format and is currently available in capacities ranging from 20 to 150 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 generally providing backward compatibility with 1.44 megabyte drives. They are reviewed briefly below:

* Floptical Drives: Developed by Insite Peripherals, these 20 megabyte drives use 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 manufactured, track density of the floptical drives is 1,245 TPI, but improved optics and tighter track spacing might increase the capacity available several times, especially if the inexpensive laser elements used in CD-ROM heads prove applicable. It is also possible to increase linear density by at least a factor of two, and perhaps a factor of four while retaining the barium ferrite media. With these improvements, the floptical methodology is capable of storing over 100 megabytes per disk.

  Unfortunately for the 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.

* Metal powder media: Using metal powder media and conventional recording techniques, several Japanese firms, including NEC, Matsushita

Communication Industrial and Y-E Data have introduced 3.5" floppy drives from time to time with capacities in the 20 megabyte range, but only NEC remains active in the field. (NEC introduced a 10 megabyte version in 1990.) With the failure of floptical drives to achieve high production rates, other firms may be slow to offer similar drives. JEIDA has sponsored a standards program for this type of drive, but none of the participating companies, except NEC, appears ready to enter the market. Proponents of the metal powder approach claim that it can support floppy drive capacities of 80 to 100 megabytes in future generations.

* Embedded servo: In 1990, Brier Technology introduced a high capacity floppy drive that used an "embedded servo", a magnetically written servo track collocated with the data track but using a lower frequency than that of the recorded data signals. A track density of 777 TPI was obtained, supporting a 20 megabyte capacity. 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. The firm announced a 40 megabyte drive, but never manufactured it. Brier was unable to win broad acceptance for the drive, which went out of production in 1992.

* 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 gain is large enough to warrant the industry-wide standardization effort required to gain acceptance for any given method or combination of methods.

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 Hitachi to computer system end users are considered captive, if internally manufactured.

* Optical disk drives manufactured and sold by IBM 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:

* Shipments by Fujitsu are noncaptive, except for drives sold with systems made by the parent company or other subsidiaries.

* Shipments made by Maxtor, SyQuest, SunDisk 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:

* PCMCIA rigid disk drives such as those of MiniStor Peripherals.

* 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.

* Flash cards sold by Advanced Micro Devices to system manufacturers but manufactured to AMD designs by Berg Electronics.

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.

* MOST is considered a non-U.S. manufacturer because it is a Nakamichi 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 1994 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 microcomputers: Drives and flash cards used with

smaller general purpose processors typically serving multiple users, including network file servers. Examples: IBM System AS/400, DEC 433MP, Hewlett-Packard 3000.

Personal computers: Attached to a general purpose microcomputer normally for a single user. Examples: IBM PS/2, IBM PS/1, IBM ValuePoint, Apple Macintosh, Compaq.

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

1994 DISK/TREND REPORT

PCMCIA FLASH CARDS

Coverage

Examples of PCMCIA flash cards in this group include:

Flash disk cards, less than 10 megabytes

IBM	17JSSFP3MB, 17JSSFP5MB
Intel	iFD005P2SA
Seagate Technology	ST72P5, ST75P5
Seiko Epson	ATA202SD11/01, ATA502SD11/01
SunDisk	SDP5-1, SDP5A-5

Flash memory cards, less than 10 megabytes

Advanced Micro Devices	AMC002CFLKA, AMC002BFLKA
AMP	93-1890-515-1, 797078-1
Centennial	FL256-15-11131-01
Fujitsu	MB98A8084X, MB98A8133X
Hitachi	HB286116C, HB286416C
IBM	17P01001B1DA-25, 18P0201N1DA-25
Intel	iMC004FLSP, iMC004FLSA
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
Premax Electronics	FH002M-BN, FH008M-BN
Quantum	QC01P021-01-A-A, QC04P021-01-A-A
Seiko Epson	HWB257ESX0/40, HWB801S8X0/40
Smart Modular Technologies	SM9FL512KP3, SM9FL4MP35V

Flash disk cards, 10 - 25 megabytes

IBM	17JSSFP10MB, 17JSSFP20MB
Intel	iFD010P2SA
Seagate	ST710P5
Seiko Epson	ATA112SD11/01, ATA212SD11/01
SunDisk	SD-20, SDP5-10

Flash memory cards, 10 - 25 megabytes

Advanced Micro Devices	AMC010CFLKA
Fujitsu	MB98A8143X
Hitachi	HB286516C
IBM	17P1600D1DA-25
Intel	iMC020FLSP, iMC010FLSA
M-Systems	FlashCard-10M, FlashCard-20M
Maxtor	Flash Card 10, Flash Card 20

Flash memory cards, 10 - 25 megabytes (continued)

Mitsubishi Electric	MF810M-G7DATXX, MF820M-G7DATXX
Premax Electronics	FH010M-BN, FH016M-BN
Quantum	QC10P021-01-A-A
Seiko Epson	HWB111S8X0/80, HWB161S8X0/80

Flash disk cards, 25 - 100 megabytes

IBM	17JSSFP30MB, 17JSSFP40MB
Seagate Technology	ST740P5
SunDisk	SDP5A-40

Flash memory cards, 25 - 100 megabytes

Intel	iMC040FLSP

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 also provides 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 accepted, and in applications where shock, vibration, humidity, dust and corrosive vapors would preclude the use of disk drives.

Market status

1993 flash card revenues reached $45.3 million on a volume of 247,800 cards shipped. Shipment growth was limited by a very weak market for PDA (personal digital assistant) class equipment, relatively few portable computers with PCMCIA slots, and compatibility problems. 87.5% of 1993 card shipments (216,600 units) fell into the under 10 megabyte category. 31,000 units (12.5%) were in the 10 to 25 megabyte category. Only two hundred of the units shipped in 1993 exceeded 25 megabytes. As might be expected, 1993 revenues followed the same pattern, with $34.3 million (75.7%) captured by flash cards under 10 megabytes and $10.8 million (23.8%) by cards between 10 and 25 megabytes.

U.S. manufacturers are the dominant producers of PCMCIA flash cards, with

91.5% of total worldwide unit shipments provided by the U.S. firms. The leading producers in 1993 were Intel, SunDisk and AMD.

Over 85% of flash cards shipped in 1993 with capacity less than 10 megabytes were flash memory cards, with flash disk cards accounting for the remainder. However, in the 10 to 25 megabyte category, flash disk accounts for over 61% of unit shipments. All of the small number of flash cards over 25 megabytes shipped in 1993 were flash memory.

Almost 70% of 1993 flash card unit shipments were made through the OEM/Integrator channel, with the PCM/Reseller channel accounting for the rest. There were no captive shipments in 1993, although some flash cards will be shipped on a captive basis in future years.

For flash cards under 10 megabytes, price per megabyte ranged from approximately $56 per megabyte to almost $70 per megabyte, depending upon the distribution channel used and whether the card was flash disk or flash memory. In the 10 to 25 megabyte class, price per megabyte ranged from about $24.50 to $30 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 reversed in the 10 to 25 megabyte category, with flash memory exhibiting a lower cost per megabyte.

In 1993, the typical flash memory card had 2 megabytes of capacity, while the typical flash disk card had 4-5 megabytes. In 1994, the typical capacities are expected to increase about 50%. The smaller capacity cards (under 10 megabytes) tend to be used in horizontal applications (PDAs, organizers, 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.

Application platforms for PCMCIA flash memory cards tend towards non-computer environments, leaning heavily toward industrial equipment, telecommunications products, field survey equipment, data loggers, navigation devices and instrumentation, as well as the more visible PDAs and mobile computers. 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.

Marketing trends

Shipments of PCMCIA flash cards are expected to grow 81.9% in 1994 to 450,700 units, while associated revenue growth of 88.1% to $85.2 million is anticipated. However, even stronger growth is expected in 1995 and thereafter as the result of introduction of many new mobile computers with second generation PDAs. 1997 shipments are forecasted to exceed 4.9 million units, while revenues are projected to exceed $937 million. Initial shipments of flash cards with capacities exceeding 100 megabytes are anticipated in 1995.

In 1997, flash cards with capacities under 10 megabytes are expected to account for 64.3% of unit shipments, about 3.2 million units. Cards in the 10 to 25 megabyte category will capture 23% (about 1.1 million units), while the 25 to 100 megabyte category will obtain a 5.7% share and will be outstripped by the more than 100 megabyte category, which is expected to garner a 7% share.

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 are projected to commence in 1995, but will remain a relatively small part of the distribution mix, accounting for only 10.6% of 1997's 4.9 million shipments. However, the PCM/Reseller channel will overtake and surpass the OEM/Integrator channel in 1997 as aftermarket sales are stimulated by the increasing number of mobile systems in use.

In 1997, the OEM price for flash cards in the less than 10 megabyte category is projected to decline to the $15/megabyte range, and to the $6/megabyte range for flash cards with capacities above 100 megabytes (approximately equivalent to six times the expected OEM price per megabyte of a 100 megabyte PCMCIA rigid disk drive at that time).

Technical trends

The most visible trends anticipated for PCMCIA flash cards involve improvements in capacity, performance and cost per megabyte. Changes in packaging are restricted by PCMCIA dimensions.

Capacity: Capacity is primarily a function of chip density. A shift from 8 megabit chips to 16 megabit chips is currently under way, with both 32 megabit and 64 megabit chips availability anticipated within the forecast period. Some firms have set 1997 as a goal for introduction of 256 megabit chips.

Performance: Performance gains are expected from a wider data transfer bus between card and 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 average seek time after a large number of data rewrites, a characteristic that is avoided in flash disk cards.

Compatibility: Interchange compatibility for PCMCIA flash cards is still an issue, but is expected to become less significant in the future as the PCMCIA standard is expanded and clarified. 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. PCMCIA flash cards capable of operating with multiple voltages will also help eliminate compatibility problems.

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 with capacity above 100 megabytes will begin in 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.

TABLE 9

CONSOLIDATED WORLDWIDE REVENUES

PCMCIA FLASH CARDS

REVENUE SUMMARY

	FLASH MEMORY CARD REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993 Revenues		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	10.7	14.7	23.0	33.2	42.5	67.5
TOTAL U.S. CAPTIVE	--	--	--	--	10.7	14.7	23.0	33.2	42.5	67.5
PCM/Reseller	10.6	13.1	27.1	32.9	82.7	105.4	189.4	256.7	370.7	540.0
OEM/Integrator	23.4	29.2	37.5	49.6	63.4	78.5	82.3	110.5	111.1	159.8
TOTAL U.S. NONCAPTIVE	34.0	42.3	64.6	82.5	146.1	183.9	271.7	367.2	481.8	699.8
TOTAL U.S. REVENUES	34.0	42.3	64.6	82.5	156.8	198.6	294.7	400.4	524.3	767.3
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	17.3	25.0	40.5	62.9
PCM/Reseller	1.0	1.1	.9	1.1	6.7	10.8	22.9	35.3	48.3	73.7
OEM/Integrator	1.3	1.9	1.2	1.6	6.2	11.1	12.9	20.3	19.6	33.7
TOTAL NON-U.S. REVENUES	2.3	3.0	2.1	2.7	12.9	21.9	53.1	80.6	108.4	170.3
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	36.3	45.3	66.7	85.2	169.7	220.5	347.8	481.0	632.7	937.6

TABLE 10

CONSOLIDATED WORLDWIDE SHIPMENTS

PCMCIA FLASH CARDS

SHIPMENT SUMMARY

	FLASH MEMORY CARD SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993 Shipments		Forecast							
	1994		1995		1996		1997			
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	50.0	70.0	112.0	165.0	168.0	265.0
TOTAL U.S. CAPTIVE	--	--	--	--	50.0	70.0	112.0	165.0	168.0	265.0
PCM/Reseller	56.7	71.5	128.4	159.1	400.0	506.0	975.0	1,303.0	1,946.0	2,798.0
OEM/Integrator	125.1	155.3	209.8	266.6	447.0	559.0	583.0	786.0	750.0	1,081.0
TOTAL U.S. NONCAPTIVE	181.8	226.8	338.2	425.7	847.0	1,065.0	1,558.0	2,089.0	2,696.0	3,879.0
TOTAL U.S. SHIPMENTS	181.8	226.8	338.2	425.7	897.0	1,135.0	1,670.0	2,254.0	2,864.0	4,144.0
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	63.0	98.0	158.0	258.0
PCM/Reseller	7.0	8.0	8.0	10.0	28.0	41.0	98.0	143.0	205.0	320.0
OEM/Integrator	9.0	13.0	11.0	15.0	48.0	74.0	88.0	135.0	129.0	208.0
TOTAL NON-U.S. SHIPMENTS	16.0	21.0	19.0	25.0	76.0	115.0	249.0	376.0	492.0	786.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	197.8	247.8	357.2	450.7	973.0	1,250.0	1,919.0	2,630.0	3,356.0	4,930.0

TABLE 11

CONSOLIDATED WORLDWIDE REVENUES
PCMCIA FLASH CARDS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1993		Forecast							
ALL MANUFACTURERS	Revenues		1994		1995		1996		1997	
	$M	%	$M	%	$M	%	$M	%	$M	%
FLASH CARDS	34.3	75.7%	47.1	55.3%	94.0	42.6%	174.3	36.2%	253.0	27.0%
Less than 10 Megabytes	--		+37.3%		+99.6%		+85.4%		+45.2%	
FLASH CARDS	10.8	23.8%	28.5	33.5%	76.4	34.6%	139.2	28.9%	210.1	22.4%
10 - 25 Megabytes	--		+163.9%		+168.1%		+82.2%		+50.9%	
FLASH CARDS	.2	.4%	9.6	11.2%	29.9	13.6%	81.1	16.9%	142.9	15.2%
25 - 100 Megabytes	--		--		+211.5%		+171.2%		+76.2%	
FLASH CARDS	--	--	--	--	20.2	9.2%	86.4	18.0%	331.6	35.4%
More than 100 Megabytes	--		--		--		+327.7%		+283.8%	
Total Worldwide Revenue	45.3	100.0%	85.2	100.0%	220.5	100.0%	481.0	100.0%	937.6	100.0%
	--		+88.1%		+158.8%		+118.1%		+94.9%	

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	1993		Forecast							
IN THOUSANDS	Shipments		1994		1995		1996		1997	
	Units	%	Units	%	Units	%	Units	%	Units	%
FLASH CARDS	216.6	87.5%	363.5	80.7%	935.0	74.8%	1,865.0	70.9%	3,170.0	64.3%
Less than 10 Megabytes	--		+67.8%		+157.2%		+99.5%		+70.0%	
FLASH CARDS	31.0	12.5%	75.8	16.8%	255.0	20.4%	560.0	21.3%	1,135.0	23.0%
10 - 25 Megabytes	--		+144.5%		+236.4%		+119.6%		+102.7%	
FLASH CARDS	.2	--	11.4	2.5%	45.0	3.6%	130.0	4.9%	280.0	5.7%
25 - 100 Megabytes	--		--		+294.7%		+188.9%		+115.4%	
FLASH CARDS	--	--	--	--	15.0	1.2%	75.0	2.9%	345.0	7.0%
More than 100 Megabytes	--		--		--		+400.0%		+360.0%	
Total Worldwide Shipments	247.8	100.0%	450.7	100.0%	1,250.0	100.0%	2,630.0	100.0%	4,930.0	100.0%
	--		+81.9%		+177.3%		+110.4%		+87.5%	
% U.S. Manufacturers	91.5%		94.4%		90.8%		85.7%		84.0%	
Total Capacity (Terabytes)	.9		2.6		9.8		32.0		104.9	

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 CARD TYPE

	1993 Shipments		Forecast							
			1994		1995		1996		1997	
	F.Disk	F.Mem.	F.Disk	F.Mem.	F.Disk	F.Mem.	F.Disk	F.Mem.	F.Disk	F.Mem.
U.S. MANUFACTURERS										
IBM Captive	--	--	--	--	--	50.0	--	120.0	--	170.0
PCM/Reseller	5.9	55.8	38.9	82.4	70.0	255.0	195.0	670.0	365.0	1,410.0
OEM/Integrator	25.9	108.0	69.6	147.6	155.0	315.0	185.0	450.0	160.0	610.0
TOTAL U.S. SHIPMENTS	31.8	163.8	108.5	230.0	225.0	620.0	380.0	1,240.0	525.0	2,190.0
NON-U.S. MANUFACTURERS										
Captive	--	--	--	--	--	--	--	65.0	--	160.0
PCM/Reseller	--	8.0	--	10.0	2.0	25.0	6.0	70.0	9.0	155.0
OEM/Integrator	--	13.0	--	15.0	13.0	50.0	24.0	80.0	31.0	100.0
TOTAL NON-U.S. SHIPMENTS	--	21.0	--	25.0	15.0	75.0	30.0	215.0	40.0	415.0
WORLDWIDE RECAP										
Captive	--	--	--	--	--	50.0	--	185.0	--	330.0
	--	--	--	--	--	--	--	+270.0%	--	+78.4%
PCM/Reseller	5.9	63.8	38.9	92.4	72.0	280.0	201.0	740.0	374.0	1,565.0
	--	--	+559.3%	+44.8%	+85.1%	+203.0%	+179.2%	+164.3%	+86.1%	+111.5%
OEM/Integrator	25.9	121.0	69.6	162.6	168.0	365.0	209.0	530.0	191.0	710.0
	--	--	+168.7%	+34.4%	+141.4%	+124.5%	+24.4%	+45.2%	-8.6%	+34.0%
Total Shipments	31.8	184.8	108.5	255.0	240.0	695.0	410.0	1,455.0	565.0	2,605.0
	--	--	+241.2%	+38.0%	+121.2%	+172.5%	+70.8%	+109.4%	+37.8%	+79.0%
ANNUAL SHARE, BY CARD TYPE	14.7%	85.3%	29.8%	70.2%	25.7%	74.3%	22.0%	78.0%	17.8%	82.2%
TOTAL CAPACITY (Terabytes)	.1	.3	.4	.6	.9	2.0	2.0	5.6	3.3	12.6

TABLE 14

PCMCIA FLASH CARDS LESS THAN 10 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

CARD TYPE		Forecast			
	1993	1994	1995	1996	1997
Captive					
Flash memory	--	--	39.66	29.61	19.70
PCM/Reseller					
Flash disk	62.20	47.72	35.51	25.77	18.58
Flash memory	73.64	40.09	29.48	20.81	14.75
PCM/Reseller Average	71.96	43.08	31.05	22.08	15.61
OEM/Integrator					
Flash disk	56.47	46.07	34.75	25.45	18.41
Flash memory	69.96	39.73	29.78	20.60	14.05
OEM/Integrator Average	66.15	42.21	31.70	22.22	15.11

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 15

PCMCIA FLASH CARDS 10 - 25 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY CARD TYPE

	1993 Shipments		Forecast							
			1994		1995		1996		1997	
	F.Disk	F.Mem.	F.Disk	F.Mem.	F.Disk	F.Mem.	F.Disk	F.Mem.	F.Disk	F.Mem.
U.S. MANUFACTURERS										
IBM Captive	--	--	--	--	20.0	--	35.0	--	50.0	--
PCM/Reseller	5.6	4.0	24.4	8.1	96.0	45.0	225.0	90.0	505.0	145.0
OEM/Integrator	13.4	8.0	28.2	15.1	64.0	15.0	100.0	20.0	175.0	50.0
TOTAL U.S. SHIPMENTS	19.0	12.0	52.6	23.2	180.0	60.0	360.0	110.0	730.0	195.0
NON-U.S. MANUFACTURERS										
Captive	--	--	--	--	--	--	20.0	--	55.0	--
PCM/Reseller	--	--	--	--	4.0	3.0	37.0	7.0	80.0	15.0
OEM/Integrator	--	--	--	--	6.0	2.0	23.0	3.0	55.0	5.0
TOTAL NON-U.S. SHIPMENTS	--	--	--	--	10.0	5.0	80.0	10.0	190.0	20.0
WORLDWIDE RECAP										
Captive	-- --	-- --	-- --	-- --	20.0 --	-- --	55.0 +175.0%	-- --	105.0 +90.9%	-- --
PCM/Reseller	5.6 --	4.0 --	24.4 +335.7%	8.1 +102.5%	100.0 +309.8%	48.0 +492.6%	262.0 +162.0%	97.0 +102.1%	585.0 +123.3%	160.0 +64.9%
OEM/Integrator	13.4 --	8.0 --	28.2 +110.4%	15.1 +88.8%	70.0 +148.2%	17.0 +12.6%	123.0 +75.7%	23.0 +35.3%	230.0 +87.0%	55.0 +139.1%
Total Shipments	19.0 --	12.0 --	52.6 +176.8%	23.2 +93.3%	190.0 +261.2%	65.0 +180.2%	440.0 +131.6%	120.0 +84.6%	920.0 +109.1%	215.0 +79.2%
ANNUAL SHARE, BY CARD TYPE	61.4%	38.6%	69.5%	30.5%	74.6%	25.4%	78.7%	21.3%	81.2%	18.8%
TOTAL CAPACITY (Terabytes)	.2	.1	.7	.3	2.6	.9	7.0	1.9	16.5	3.8

TABLE 16

PCMCIA FLASH CARDS 10 - 25 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

CARD TYPE		Forecast			
	1993	1994	1995	1996	1997
Captive					
Flash disk	--	--	30.92	21.32	13.59
Flash memory	--	--	--	--	--
Captive Average	--	--	30.92	21.32	13.59
PCM/Reseller					
Flash disk	30.18	30.66	22.72	16.10	10.63
Flash memory	24.58	20.99	15.73	11.33	7.63
PCM/Reseller Average	27.94	28.40	20.46	14.81	9.98
OEM/Integrator					
Flash disk	29.57	29.85	22.10	15.74	10.38
Flash memory	24.58	20.22	15.18	10.91	7.29
OEM/Integrator Average	27.79	26.56	20.75	14.98	9.79

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 17

PCMCIA FLASH CARDS 25 - 100 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY CARD TYPE

	1993 Shipments	Forecast							
		1994		1995		1996		1997	
	F.Mem.	F.Disk	F.Mem.	F.Disk	F.Mem.	F.Disk	F.Mem.	F.Disk	F.Mem.
U.S. MANUFACTURERS									
IBM Captive	--	--	--	--	--	10.0	--	25.0	--
PCM/Reseller	.2	1.3	4.0	18.0	12.0	53.0	17.0	130.0	23.0
OEM/Integrator	--	2.1	4.0	5.0	3.0	14.0	7.0	32.0	5.0
TOTAL U.S. SHIPMENTS	.2	3.4	8.0	23.0	15.0	77.0	24.0	187.0	28.0
NON-U.S. MANUFACTURERS									
Captive	--	--	--	--	--	10.0	--	26.0	--
PCM/Reseller	--	--	--	3.0	2.0	10.0	6.0	24.0	7.0
OEM/Integrator	--	--	--	2.0	--	3.0	--	8.0	--
TOTAL NON-U.S. SHIPMENTS	--	--	--	5.0	2.0	23.0	6.0	58.0	7.0
WORLDWIDE RECAP									
Captive	--	--	--	--	--	20.0	--	51.0	--
	--	--	--	--	--	--	--	+155.0%	--
PCM/Reseller	.2	1.3	4.0	21.0	14.0	63.0	23.0	154.0	30.0
	--	--	--	--	+250.0%	+200.0%	+64.3%	+144.4%	+30.4%
OEM/Integrator	--	2.1	4.0	7.0	3.0	17.0	7.0	40.0	5.0
	--	--	--	+233.3%	-25.0%	+142.9%	+133.3%	+135.3%	-28.6%
Total Shipments	.2	3.4	8.0	28.0	17.0	100.0	30.0	245.0	35.0
	--	--	--	+723.5%	+112.5%	+257.1%	+76.5%	+145.0%	+16.7%
ANNUAL SHARE, BY CARD TYPE	100.0%	29.8%	70.2%	62.3%	37.7%	77.0%	23.0%	87.6%	12.4%
TOTAL CAPACITY (Terabytes)	--	.1	.3	1.1	.6	5.0	1.5	14.7	2.1

TABLE 18

PCMCIA FLASH CARDS 25 - 100 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

DISK DIAMETER		Forecast			
	1993	1994	1995	1996	1997
Captive					
Flash disk	--	--	--	14.84	9.95
PCM/Reseller					
Flash disk	--	24.15	17.86	12.71	8.40
Flash memory	30.00	18.90	15.08	10.52	7.16
PCM/Reseller Average	30.00	20.19	16.75	12.12	8.20
OEM/Integrator					
Flash disk	--	23.84	17.67	12.51	8.26
Flash memory	--	17.95	13.65	9.96	6.75
OEM/Integrator Average	--	19.98	16.47	11.76	8.09

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 19

PCMCIA FLASH CARDS MORE THAN 100 MEGABYTES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY CARD TYPE

	1993 Shipments F.Disk	Forecast 1994 F.Disk	1995 F.Disk	1996 F.Disk	1996 F.Mem.	1997 F.Disk	1997 F.Mem.
U.S. MANUFACTURERS							
IBM Captive	--	--	--	--	--	20.0	--
PCM/Reseller	--	--	10.0	50.0	3.0	180.0	40.0
OEM/Integrator	--	--	2.0	8.0	2.0	35.0	14.0
TOTAL U.S. SHIPMENTS	--	--	12.0	58.0	5.0	235.0	54.0
NON-U.S. MANUFACTURERS							
Captive	--	--	--	3.0	--	15.0	2.0
PCM/Reseller	--	--	2.0	7.0	--	25.0	5.0
OEM/Integrator	--	--	1.0	2.0	--	5.0	4.0
TOTAL NON-U.S. SHIPMENTS	--	--	3.0	12.0	--	45.0	11.0
WORLDWIDE RECAP							
Captive	--	--	--	3.0	--	35.0	2.0
	--	--	--	--	--	--	--
PCM/Reseller	--	--	12.0	57.0	3.0	205.0	45.0
	--	--	--	+375.0%	--	+259.6%	--
OEM/Integrator	--	--	3.0	10.0	2.0	40.0	18.0
	--	--	--	+233.3%	--	+300.0%	+800.0%
Total Shipments	--	--	15.0	70.0	5.0	280.0	65.0
	--	--	--	+366.7%	--	+300.0%	--
ANNUAL SHARE, BY CARD TYPE	100.0%	100.0%	100.0%	93.4%	6.6%	81.3%	18.7%
TOTAL CAPACITY (Terabytes)	--	--	1.5	8.4	.6	42.0	9.7

TABLE 20

PCMCIA FLASH CARDS, MORE THAN 100 MEGABYTES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

CARD TYPE		Forecast			
	1993	1994	1995	1996	1997
Captive					
Flash disk	--	--	--	12.48	8.12
PCM/Reseller					
Flash disk	--	--	13.46	9.56	6.30
Flash memory	--	--	--	9.10	6.00
PCM/Reseller Average	--	--	13.46	9.53	6.25
OEM/Integrator					
Flash disk	--	--	13.08	9.26	6.10
Flash memory	--	--	--	8.60	5.71
OEM/Integrator Average	--	--	13.08	9.15	5.98

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 21

PCMCIA FLASH CARDS

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Cards

	1993 Net Shipments							
	To United States Destinations				Worldwide			
	Units (000)			%	Units (000)			%
Card Manufacturers	F.Disk	F.Mem.	Total		F.Disk	F.Mem.	Total	
Intel	.4	109.6	109.6	55.6	.5	137.5	138.0	55.7
SunDisk	39.9	--	39.9	20.2	48.8	--	48.8	19.7
AMD	--	14.0	14.0	7.1	--	20.0	20.0	8.1
Other U.S.	--	17.9	17.9	9.0	--	19.8	19.8	8.0
Other Non-U.S.	--	16.0	16.0	8.1	--	21.0	21.0	8.5
TOTAL	40.3	157.5	197.8	100.0	49.3	198.3	247.6	100.0

PCMCIA RIGID DISK DRIVES

1994 DISK/TREND REPORT

PCMCIA RIGID DISK DRIVES

Coverage

Examples of disk drives in this group include:

PCMCIA rigid disk drives, less than 100 megabytes

Aura Associates	AU1085P-III
Calluna Technology	CT-80MC
Integral Peripherals	1841PA
MiniStor Peripherals	MiniPORT 42P, MP87P
NEC	D1632
Seagate Technology	ST7050P

PCMCIA rigid disk drives, 100 - 200 megabytes

Aura Associates	AU1170P-III
Calluna Technology	CT-105MC, CT-130MC, CT-170
Hitachi	DK120P-13
Integral Peripherals	8105PA, 8170PA, PocketFile 105
Maxtor	MobileMax 105, 131, 171
MiniStor Peripherals	MP130P3, MP170P3
NEC	D1741

PCMCIA rigid disk drives, 200 - 300 megabytes

Calluna Technology	CT-210
MiniStor Peripherals	MP260P3*

PCMCIA rigid disk drives, 300 - 500 megabytes

MiniStor Peripherals	MP340P3*

*2X capacity achieved with data compression

The 1.8" rigid disk drives included in this section are packaged in removable card form, and most of the drives conform to the PCMCIA Type III specification, which defines allowable card dimensions and connectors. A few additional drives have been included for identification purposes, although they do not meet PCMCIA Type III specifications, usually because the height limitation of 10.5 millimeters is exceeded. All of these drives, plus other 1.8" and smaller drives which are not offered in removable card form, will be included in the 1994 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 of the manufacturers now active. Most of the drives produced prior to mid-1993 were used in Japanese word processors, factory data collection and other specialized applications. With the availability starting in late 1993 of PCMCIA drives with capacities over 100 megabytes from several manufacturers, wide-scale adoption for notebook computers has commenced.

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, without data compression, except for the MiniStor drives with capacities over 200 megabytes, which carry unique model numbers. Announcements of drives with native capacities over 300 megabytes are expected for 1995 delivery.

Market status

Shipments of 1.8" rigid disk drives have remained small since the beginning of sales activity in 1991, limited by capacities too low for most notebook computers and prices too high in comparison with 2.5" drives. However, with the availability of 1.8" drives in the PCMCIA Type III form factor starting in late 1993, total shipments of PCMCIA rigid disk drives are expected to increase from 47,900 in 1993 to 360,600 in 1994. 86.6% of 1994 shipments will be drives with over 100 megabytes capacity, compared to nominal shipments in the previous year, and drives under 100 megabytes are expected to peak in 1994 with 48,500 units.

The turning 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. PCMCIA Type III slots are now available on the majority of new notebook computers being offered by most major system manufacturers. Even though most system manufacturers are still relying on internally mounted 2.5" drives as the basic notebook computer disk, PCMCIA drives are enjoying a

growing market for expanded data storage, data interchange between portable and desktop computers, security applications and specialized applications.

1993 worldwide revenues of only $14.5 million are forecasted to increase to $98.4 million in 1994, up 578%. 89% of the expected 1994 total sales revenues will be derived from OEM/Integrator drive shipments, with a strong majority of current shipments directly to system manufacturers for initial sale with notebook computers. 92.7% of worldwide revenues will be produced by companies headquartered in the United States. Because the market is young, sales through distribution channels for aftermarket upgrade and add-on drives are still a small portion of the total. Captive shipments also remain at an insignificant level in 1994.

Integral Peripherals, the disk drive manufacturer which originated the 1.8" disk format, dominated the 1993 noncaptive shipments of PCMCIA rigid disk drives, with 80.4% of the worldwide total of 44,400 units.

Marketing trends

The sharp upward growth trend established by this group in 1994 is expected to continue in the 1995-97 period, driven mostly by growing demand for PCMCIA format disk drives to be used in notebook and subnotebook computers. Shipments of 4.3 million drives are forecasted for 1997, generating sales revenues of $1.1 million.

Following the well established history of increasing average capacities already experienced with 3.5" drives for desktop personal computers and 2.5" drives for notebook computers, a similar pattern is expected for 1.8" rigid disk drives in the PCMCIA form factors. All drives in this group currently adhere to the 10.5 millimeter high Type III standard, and the range of native capacities offered is expected to increase to at least 340 megabytes by the first half of 1995, growing to over 500 megabytes by 1997. Shipments of the first 5 millimeter high Type II drives, using a single disk, are also expected for the first half of 1995, but starting with lower capacities. Early Type II drives will probably appear with capacities in the 100-120 megabyte range, but are expected to increase to over 300 megabytes by 1997.

The advent of Type II drive cards in 1995 will have an effect on the average drive capacities shipped during the next few years. It is clear that there are many more Type II than Type III slots available on notebook computers, and that the sales opportunity for Type II rigid disk drives will be increasing each year, as the typical capacities available continually increase. 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 will 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.

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 in 1994, but more is easily predictable as shipments increase and capacities go up. By 1997, the best price/megabyte is forecasted at 54 cents.

98% of 1997 unit shipments of PCMCIA rigid disk drives are expected to be used in personal computers, including desktop and portable models. By that year, there will certainly be universal availability of PCMCIA slots on subnotebook and notebook computers, but wide availability of PCMCIA slots on desktop PCs will also be a strong trend. The movement to slots on desktop systems will be driven primarily by the need of notebook computer users to interchange data with office computers, but the demand will also be driven by segments of the desktop computer market with specialized needs to interchange more data than a floppy can store, such as graphics, desktop publishing and many other specialized applications.

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 1994-97 time frame covered by this report. By 1997, leading edge rigid disk drives will be recording data at more than 2 gigabits per square inch, and the drives manufactured at very high production levels, such as the typical 1997 PCMCIA disk drives in this group, will utilize areal densities above 1 gigabit 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 most have already been solved by several of the drive manufacturers working 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 200-300 megabyte and 300-500 megabyte groups will start in 1995, and shipments of drives in the 500 megabyte - 1 gigabyte group will start in 1997.

2. Shipments of rigid disk drives meeting the PCMCIA Type II standard, using cards 5 millimeters high, will start in 1995, limited to native capacities below 200 megabytes until 1997.

3. Shipments of notebook computers will continually increase, but average weight and size will decrease, increasing the demand for PCMCIA rigid disk drives.

TABLE 22

CONSOLIDATED WORLDWIDE REVENUES

PCMCIA RIGID DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993		Forecast							
	Revenues		1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	9.0	12.0	65.2	98.7	125.1	192.8
PCM/Reseller	.7	1.3	4.3	7.2	67.4	95.1	135.6	205.3	238.9	375.9
OEM/Integrator	3.3	10.0	55.2	76.4	141.7	185.9	217.9	296.1	261.0	374.1
TOTAL U.S. REVENUES	4.0	11.3	59.5	83.6	218.1	293.0	418.7	600.1	625.0	942.8
Non-U.S. Manufacturers										
Captive	--	2.4	--	1.5	--	4.8	--	15.9	--	30.8
PCM/Reseller	--	.4	.8	2.2	6.2	14.4	16.0	32.6	23.5	46.2
OEM/Integrator	--	.4	5.0	11.1	11.1	21.1	21.2	39.6	30.6	52.1
TOTAL NON-U.S. REVENUES	--	3.2	5.8	14.8	17.3	40.3	37.2	88.1	54.1	129.1
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	4.0	14.5	65.3	98.4	235.4	333.3	455.9	688.2	679.1	1,071.9

TABLE 23

CONSOLIDATED WORLDWIDE SHIPMENTS

PCMCIA RIGID DISK DRIVES

SHIPMENT SUMMARY

	DISK DRIVE SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993 Shipments		Forecast							
			1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	15.0	20.0	138.0	210.0	300.0	470.0
PCM/Reseller	1.8	3.3	15.5	26.0	234.0	338.0	533.0	815.0	1,035.0	1,645.0
OEM/Integrator	12.8	39.0	204.5	284.5	595.0	785.0	970.0	1,319.0	1,210.0	1,735.0
TOTAL U.S. SHIPMENTS	14.6	42.3	220.0	310.5	844.0	1,143.0	1,641.0	2,344.0	2,545.0	3,850.0
Non-U.S. Manufacturers										
Captive	--	3.5	--	2.2	--	7.0	--	26.0	--	60.0
PCM/Reseller	--	1.0	3.0	8.1	26.0	60.0	65.0	135.0	100.0	200.0
OEM/Integrator	.1	1.1	18.2	39.8	52.0	100.0	95.0	180.0	137.0	235.0
TOTAL NON-U.S. SHIPMENTS	.1	5.6	21.2	50.1	78.0	167.0	160.0	341.0	237.0	495.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	14.7	47.9	241.2	360.6	922.0	1,310.0	1,801.0	2,685.0	2,782.0	4,345.0

TABLE 24

CONSOLIDATED WORLDWIDE REVENUES
PCMCIA RIGID DISK DRIVES
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES ALL MANUFACTURERS	1993 Revenues $M	 %	Forecast 1994 $M	 %	 1995 $M	 %	 1996 $M	 %	 1997 $M	 %
PCMCIA DISK DRIVES	13.3	91.8%	12.8	13.0%	7.3	2.2%	2.7	.4%	--	--
Less than 100 Megabytes	--		-3.8%		-43.0%		-63.0%		-100.0%	
PCMCIA DISK DRIVES	1.2	8.2%	85.6	87.0%	131.7	39.5%	155.3	22.6%	83.6	7.8%
100 - 200 Megabytes	--		--		+53.9%		+17.9%		-46.2%	
PCMCIA DISK DRIVES	--	--	--	--	146.2	43.9%	377.3	54.8%	430.6	40.2%
200 - 300 Megabytes	--		--		--		+158.1%		+14.1%	
PCMCIA DISK DRIVES	--	--	--	--	48.1	14.4%	152.9	22.2%	482.4	45.0%
300 - 500 Megabytes	--		--		--		+217.9%		+215.5%	
PCMCIA DISK DRIVES	--	--	--	--	--	--	--	--	75.3	7.0%
500 Megabytes - 1 GB	--		--		--		--		--	
Total Worldwide Revenue	14.5	100.0%	98.4	100.0%	333.3	100.0%	688.2	100.0%	1,071.9	100.0%
	--		+578.6%		+238.7%		+106.5%		+55.8%	

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	1993 Shipments Units	1993 Shipments %	1994 Forecast Units	1994 Forecast %	1995 Forecast Units	1995 Forecast %	1996 Forecast Units	1996 Forecast %	1997 Forecast Units	1997 Forecast %
PCMCIA DISK DRIVES Less than 100 Megabytes	44.4	92.8%	48.5	13.4%	35.0	2.7%	15.0	.6%	--	--
	--		+9.2%		-27.8%		-57.1%		-100.0%	
PCMCIA DISK DRIVES 100 - 200 Megabytes	3.5	7.2%	312.1	86.6%	660.0	50.4%	805.0	30.0%	425.0	9.8%
	--		--		+111.5%		+22.0%		-47.2%	
PCMCIA DISK DRIVES 200 - 300 Megabytes	--	--	--	--	485.0	37.0%	1,390.0	51.8%	1,950.0	44.9%
	--		--		--		+186.6%		+40.3%	
PCMCIA DISK DRIVES 300 - 500 Megabytes	--	--	--	--	130.0	9.9%	475.0	17.6%	1,760.0	40.5%
	--		--		--		+265.4%		+270.5%	
PCMCIA DISK DRIVES 500 Megabytes - 1 Gigabyte	--	--	--	--	--	--	--	--	210.0	4.8%
	--		--		--		--		--	
Total Worldwide Shipments	47.9	100.0%	360.6	100.0%	1,310.0	100.0%	2,685.0	100.0%	4,345.0	100.0%
	--		+652.8%		+263.3%		+105.0%		+61.8%	
% U.S. Manufacturers	88.3%		86.1%		87.2%		87.3%		88.6%	
Total Capacity (Terabytes)	2.5		43.5		260.1		642.7		1,367.4	

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)									
	1993		Forecast							
	Shipments		1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	1.0	2.0	2.0	4.0	4.0	8.0	3.0	5.0	--	--
OEM/Integrator	11.3	37.1	15.5	41.5	15.0	25.0	5.0	9.0	--	--
TOTAL U.S. SHIPMENTS	12.3	39.1	17.5	45.5	19.0	33.0	8.0	14.0	--	--
Non-U.S. Manufacturers										
Captive	--	3.5	--	2.2	--	2.0	--	1.0	--	--
PCM/Reseller	--	.7	--	.1	--	--	--	--	--	--
OEM/Integrator	.1	1.1	.1	.7	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	.1	5.3	.1	3.0	--	2.0	--	1.0	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	12.4	44.4	17.6	48.5	19.0	35.0	8.0	15.0	--	--
Total Capacity (Terabytes)	.5	2.2	.8	3.0	.8	1.7	.3	.6	--	--
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	12.7	44.8	30.3	93.3	49.3	128.3	57.3	143.3	57.3	143.3

TABLE 27

PCMCIA RIGID DISK DRIVES, 100 - 200 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993		Forecast							
	Shipments		1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	.8	1.3	13.5	22.0	65.0	110.0	95.0	160.0	100.0	165.0
OEM/Integrator	1.5	1.9	189.0	243.0	315.0	420.0	345.0	475.0	115.0	160.0
TOTAL U.S. SHIPMENTS	2.3	3.2	202.5	265.0	380.0	530.0	440.0	635.0	215.0	325.0
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	5.0	--	15.0	--	20.0
PCM/Reseller	--	.3	3.0	8.0	20.0	45.0	30.0	65.0	20.0	45.0
OEM/Integrator	--	--	18.1	39.1	40.0	80.0	45.0	90.0	20.0	35.0
TOTAL NON-U.S. SHIPMENTS	--	.3	21.1	47.1	60.0	130.0	75.0	170.0	40.0	100.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	2.3	3.5	223.6	312.1	440.0	660.0	515.0	805.0	255.0	425.0
Total Capacity (Terabytes)	.2	.3	29.1	40.5	65.4	97.8	82.4	128.9	43.3	72.2
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	2.3	3.5	225.9	315.6	665.9	975.6	1,180.9	1,780.6	1,435.9	2,205.6

TABLE 28

PCMCIA RIGID DISK DRIVES, 200 - 300 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993		Forecast							
	Shipments		1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	15.0	20.0	130.0	200.0	210.0	340.0
PCM/Reseller	--	--	--	--	125.0	170.0	310.0	475.0	425.0	710.0
OEM/Integrator	--	--	--	--	200.0	260.0	450.0	600.0	510.0	730.0
TOTAL U.S. SHIPMENTS	--	--	--	--	340.0	450.0	890.0	1,275.0	1,145.0	1,780.0
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	10.0	--	25.0
PCM/Reseller	--	--	--	--	6.0	15.0	20.0	45.0	30.0	65.0
OEM/Integrator	--	--	--	--	12.0	20.0	33.0	60.0	45.0	80.0
TOTAL NON-U.S. SHIPMENTS	--	--	--	--	18.0	35.0	53.0	115.0	75.0	170.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	--	--	--	--	358.0	485.0	943.0	1,390.0	1,220.0	1,950.0
Total Capacity (Terabytes)	--	--	--	--	85.9	116.4	226.3	333.6	292.8	468.0
Cumulative Shipments (Units in thousands)										
IBM	--	--	--	--	15.0	20.0	145.0	220.0	355.0	560.0
Non-IBM	--	--	--	--	343.0	465.0	1,156.0	1,655.0	2,166.0	3,265.0
WORLDWIDE TOTAL	--	--	--	--	358.0	485.0	1,301.0	1,875.0	2,521.0	3,825.0

TABLE 29

PCMCIA RIGID DISK DRIVES, 300 - 500 MEGABYTES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993 Shipments		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	8.0	10.0	65.0	100.0
PCM/Reseller	--	--	--	--	40.0	50.0	125.0	175.0	455.0	700.0
OEM/Integrator	--	--	--	--	65.0	80.0	170.0	235.0	515.0	760.0
TOTAL U.S. SHIPMENTS	--	--	--	--	105.0	130.0	303.0	420.0	1,035.0	1,560.0
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	15.0
PCM/Reseller	--	--	--	--	--	--	15.0	25.0	45.0	80.0
OEM/Integrator	--	--	--	--	--	--	17.0	30.0	60.0	105.0
TOTAL NON-U.S. SHIPMENTS	--	--	--	--	--	--	32.0	55.0	105.0	200.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	--	--	--	--	105.0	130.0	335.0	475.0	1,140.0	1,760.0
Total Capacity (Terabytes)	--	--	--	--	35.7	44.2	126.6	179.5	461.8	711.7
Cumulative Shipments (Units in thousands)										
IBM	--	--	--	--	--	--	8.0	10.0	73.0	110.0
Non-IBM	--	--	--	--	105.0	130.0	432.0	595.0	1,507.0	2,255.0
WORLDWIDE TOTAL	--	--	--	--	105.0	130.0	440.0	605.0	1,580.0	2,365.0

TABLE 30

PCMCIA RIGID DISK DRIVES, 500 MEGABYTES - 1 GIGABYTE

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993 Shipments		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
IBM Captive	--	--	--	--	--	--	--	--	25.0	30.0
PCM/Reseller	--	--	--	--	--	--	--	--	55.0	70.0
OEM/Integrator	--	--	--	--	--	--	--	--	70.0	85.0
TOTAL U.S. SHIPMENTS	--	--	--	--	--	--	--	--	150.0	185.0
Non-U.S. Manufacturers										
PCM/Reseller	--	--	--	--	--	--	--	--	5.0	10.0
OEM/Integrator	--	--	--	--	--	--	--	--	12.0	15.0
TOTAL NON-U.S. SHIPMENTS	--	--	--	--	--	--	--	--	17.0	25.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	--	--	--	--	--	--	--	--	167.0	210.0
Total Capacity (Terabytes)	--	--	--	--	--	--	--	--	91.8	115.5
Cumulative Shipments (Units in thousands)										
IBM	--	--	--	--	--	--	--	--	25.0	30.0
Non-IBM	--	--	--	--	--	--	--	--	142.0	180.0
WORLDWIDE TOTAL	--	--	--	--	--	--	--	--	167.0	210.0

TABLE 31

PCMCIA RIGID DISK DRIVES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

DISK CAPACITY	1993	Forecast 1994	1995	1996	1997
Captive					
100 Megabytes or less	8.16	7.70	7.64	7.05	--
100 - 200 Megabytes	--	--	4.11	3.82	3.52
200 - 300 Megabytes	--	--	2.50	1.93	1.51
300 - 500 Megabytes	--	--	--	1.97	1.49
500 Megabytes - 1 Gigabyte	--	--	--	--	1.23
PCM/Reseller					
100 Megabytes or less	6.63	4.75	4.52	4.04	--
100 - 200 Megabytes	3.98	2.16	1.43	1.22	1.07
200 - 300 Megabytes	--	--	1.25	1.02	.81
300 - 500 Megabytes	--	--	1.13	.86	.64
500 Megabytes - 1 Gigabyte	--	--	--	--	.57
OEM/Integrator					
100 Megabytes or less	5.19	3.93	3.60	3.33	--
100 - 200 Megabytes	2.97	2.10	1.28	1.12	1.00
200 - 300 Megabytes	--	--	1.16	.96	.75
300 - 500 Megabytes	--	--	1.05	.80	.61
500 Megabytes - 1 Gigabyte	--	--	--	--	.54

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	1993 Estimate Units (000)	1993 Estimate %	1997 Projection Units (000)	1997 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	46.1	96.2	4,258.1	98.0
WORKSTATIONS				
Engineering and office, single user	--	--	21.7	.5
CONSUMER, GAME AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	1.8	3.8	65.2	1.5
Total	47.9	100.0	4,345.0	100.0

TABLE 33

PCMCIA RIGID DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1993 Net Shipments					
	To United States Destinations			Worldwide		
	Units (000)		%	Units (000)		%
Drive Manufacturers	1.8"	Total		1.8"	Total	
Integral	11.6	11.6	78.9	35.7	35.7	80.4
Other U.S.	3.0	3.0	20.4	6.6	6.6	14.9
Other Non-U.S.	.1	.1	.7	2.1	2.1	4.7
TOTAL	14.7	14.7	100.0	44.4	44.4	100.0

RIGID DISK CARTRIDGE DRIVES

1994 DISK/TREND REPORT

RIGID DISK CARTRIDGE DRIVES

Coverage

Examples of disk drives in this group include:

5.25" disk diameter	
MFM Technology	11/11, 5/5
SyQuest Technology	SQ555, SQ5110, SQ5200C
3.5" disk diameter	
SyQuest Technology	SQ3105A/S, SQ3270A/S
2.5" disk diameter	
Avatar Systems	ASR-2085N, ASR-3085N
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 1994 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, and the 3.5" drives are now challenging the 5.25" form factor for shipment leadership.

Avatar Systems' 2.5" disk cartridge drives, including models combining removable disk drives with floppy drives or with fixed disk drives, went into production in 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 card format, which uses 1.8" disks in a cartridge which may be removed from the removable drive.

Market status

Shipments of disk cartridge drives grew only 18% in 1993, a relatively small increase for this product group, but a strong resurgence in shipment growth is

projected for 1994. 552,400 disk cartridge drives are forecasted for 1994, up 47.3%, and 1994 sales revenues are estimated at $132.7 million, an increase of 53.3%. New SyQuest drives with increased capacity in both 5.25" and 3.5" models have made the difference in 1994 shipments and revenues.

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, and a slight increase in overall 5.25" drive shipments is now expected for 1994. 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.

The most aggressive competition for SyQuest's rigid disk cartridge drives is provided by manufacturers of optical disk drives and by Iomega, maker of the high capacity Bernoulli floppy disk drive. Iomega's 44 megabyte 5.25" drive was supplemented in 1991 with a 90 megabyte model and in 1992 with a new 150 megabyte model, with the result that SyQuest and Iomega are 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. The 105 megabyte model captured 20.8% of 1993 total unit shipments for the product group, but the market response to the 270 megabyte model has been even stronger. 1994 shipments of 3.5" disk drives are expected to provide over 39%

of the overall disk cartridge drive unit shipment total for the year. In addition to extensive shipments through PCM/Reseller channels for usage as add-on drives with Macintosh and IBM compatible personal computers, the 3.5" drives are also expected to capture significant OEM sales to system manufacturers -- a market in which 5.25" disk cartridge drives had only a minor role in recent years.

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 an 85 megabyte 2.5" rigid disk cartridge drive 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. This drive has an interesting potential future market, since the removable disk cartridge will have a much lower cost than a complete drive unit. 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 98.9% of the worldwide unit shipments of disk cartridge drives in 1993, with 371,000 drives. In 1993 all disk cartridge drives were shipped in noncaptive market channels.

Marketing trends

Based on the surge in demand now under way for SyQuest's 270 megabyte 3.5" drives, it is expected that growth for 3.5" drives will continue and they will take over shipment leadership in this product group in 1995. Through 1997, SyQuest's 3.5" drives are expected to be locked in a continuing contest with

Iomega's Bernoulli drives and various 3.5" magneto-optical drives for dominance in the graphics and "prepress" interchange markets. Increased storage capacities for 3.5" MO drives are expected next year, with two different camps predicting drives in the mid-600 megabyte range, and further increases in Bernoulli drive capacity are expected. However, it is to be expected that SyQuest will benefit from the rigid disk drive components being developed to maintain the 60% per year increases in areal density now expected in rigid disk drive technology, and availability of these components will probably enable SyQuest to equal or better the currently planned capacity improvements envisioned for optical disk drives.

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. Given the earlier background of technical difficulties, shaky financial status of some manufacturers, lack of media interchange standards and excellent competition from fixed disk drives, it is easy to understand why a majority of the computer industry's system manufacturers are no longer using disk cartridge drives.

However, the availability of the new smaller drives may erode some of the current dominance of the aftermarket distribution channel for disk drives in this product group. SyQuest's 3.5" drives and the Avatar Systems 2.5" model have an interesting opportunity in OEM markets -- the first time in the last ten years that disk cartridge drives have had this opportunity. Both drives' smaller sizes are consistent with the industry's current physical formats, and with many end users already sold on the use of removable media for selected applications, the time for renewed growth of OEM shipments for disk cartridge drives may have arrived. DISK/TREND data indicates that 97.2% of all disk cartridge drive 1993 unit shipments were sold through PCM/Reseller channels, but forecasts a drop to 85.8% in 1997, with the balance sold to OEM/Integrators.

SyQuest's 1.8" "removable/removable" drive may have even greater potential, in both PCM/Reseller and OEM/Integrator channels. The PCMCIA standards for removable devices in the card format is clearly destined for very wide usage in the computer industry, for desktop personal computers, notebook and subnotebook computers and for a variety of mobile computing devices intended for indi-

vidual use. Since it is not yet clear which applications will survive the market introduction phase, forecasting the specific usage patterns for the storage devices which will be available is still very speculative. However, it is now obvious that there will be innumerable PCMCIA slots offered with new notebook and desktop PCs -- and this market alone will provide a major sales opportunity for 1.8" drives offering the added feature of removable media.

Technical trends

It is possible to increase density in removable 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, but will be able to take advantage of the rapid design advancements in recent years in recording heads, disks, head positioning and electronic components originally intended for fixed disk drives. 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 1994, 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)									
	1993 Revenues		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	46.8	81.6	74.7	123.0	96.9	152.5	122.2	188.6	122.6	190.2
OEM/Integrator	2.5	3.0	7.1	9.7	16.0	21.3	18.7	27.8	22.5	33.5
TOTAL U.S. REVENUES	49.3	84.6	81.8	132.7	112.9	173.8	140.9	216.4	145.1	223.7
Non-U.S. Manufacturers										
OEM/Integrator	.3	1.9	--	--	--	--	--	--	--	--
TOTAL NON-U.S. REVENUES	.3	1.9	--	--	--	--	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	49.6	86.5	81.8	132.7	112.9	173.8	140.9	216.4	145.1	223.7
OEM Average Price ($000)		.408		.299		.264		.252		.239

TABLE 35

RIGID DISK CARTRIDGE DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993		Forecast							
	Shipments		1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	205.0	363.0	308.0	520.0	410.0	659.6	505.0	795.0	535.0	845.0
OEM/Integrator	7.0	9.0	23.4	32.4	60.4	80.4	75.0	110.0	95.0	140.0
TOTAL U.S. SHIPMENTS	212.0	372.0	331.4	552.4	470.4	740.0	580.0	905.0	630.0	985.0
Non-U.S. Manufacturers										
OEM/Integrator	.5	3.0	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	.5	3.0	--	--	--	--	--	--	--	--
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	212.5	375.0	331.4	552.4	470.4	740.0	580.0	905.0	630.0	985.0
Total Capacity (Terabytes)	19.5	33.0	56.7	90.1	95.9	148.2	154.7	236.6	205.3	315.1
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	1,093.1	1,519.8	1,424.5	2,072.2	1,894.9	2,812.2	2,474.9	3,717.2	3,104.9	4,702.2

TABLE 36

RIGID DISK CARTRIDGE DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1993 Revenues			Forecast 1994			1995			1996			1997		
	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	61.4	18.9	1.3	63.6	56.6	2.8	56.0	84.8	11.7	39.4	113.5	35.7	23.7	115.7	50.8
OEM/Integrator	.8	2.1	.1	.5	6.4	2.8	.5	10.6	10.2	--	16.3	11.5	--	19.5	14.0
TOTAL U.S. REVENUES	62.2	21.0	1.4	64.1	63.0	5.6	56.5	95.4	21.9	39.4	129.8	47.2	23.7	135.2	64.8
NON-U.S. MANUFACTURERS															
OEM/Integrator	1.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. REVENUES	1.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WORLDWIDE RECAP															
PCM/Reseller	61.4	18.9	1.3	63.6	56.6	2.8	56.0	84.8	11.7	39.4	113.5	35.7	23.7	115.7	50.8
	-21.0%	--	--	+3.6%	+199.5%	+115.4%	-11.9%	+49.8%	+317.9%	-29.6%	+33.8%	+205.1%	-39.8%	+1.9%	+42.3%
OEM/Integrator	2.7	2.1	.1	.5	6.4	2.8	.5	10.6	10.2	--	16.3	11.5	--	19.5	14.0
	-35.7%	+950.0%	--	-81.5%	+204.8%	--	--	+65.6%	+264.3%	--	+53.8%	+12.7%	--	+19.6%	+21.7%
Total Revenues	64.1	21.0	1.4	64.1	63.0	5.6	56.5	95.4	21.9	39.4	129.8	47.2	23.7	135.2	64.8
	-21.7%	--	--	--	+200.0%	+300.0%	-11.9%	+51.4%	+291.1%	-30.3%	+36.1%	+115.5%	-39.8%	+4.2%	+37.3%
ANNUAL SHARE, BY DIAMETER	74.2%	24.3%	1.5%	48.4%	47.5%	4.1%	32.5%	55.0%	12.5%	18.2%	60.1%	21.7%	10.6%	60.5%	28.9%

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

TABLE 37

RIGID DISK CARTRIDGE DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1993 Shipments			Forecast 1994			1995			1996			1997		
	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	288.0	70.0	5.0	315.0	195.0	10.0	294.6	320.0	45.0	220.0	420.0	155.0	140.0	445.0	260.0
OEM/Integrator	.8	8.0	.2	.4	22.0	10.0	.4	40.0	40.0	--	60.0	50.0	--	75.0	65.0
TOTAL U.S. SHIPMENTS	288.8	78.0	5.2	315.4	217.0	20.0	295.0	360.0	85.0	220.0	480.0	205.0	140.0	520.0	325.0
NON-U.S. MANUFACTURERS															
OEM/Integrator	3.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	3.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WORLDWIDE RECAP															
PCM/Reseller	288.0	70.0	5.0	315.0	195.0	10.0	294.6	320.0	45.0	220.0	420.0	155.0	140.0	445.0	260.0
	-7.4%	--	--	+9.4%	+178.6%	+100.0%	-6.5%	+64.1%	+350.0%	-25.3%	+31.3%	+244.4%	-36.4%	+6.0%	+67.7%
OEM/Integrator	3.8	8.0	.2	.4	22.0	10.0	.4	40.0	40.0	--	60.0	50.0	--	75.0	65.0
	-35.6%	+900.0%	--	-89.5%	+175.0%	--	--	+81.8%	+300.0%	--	+50.0%	+25.0%	--	+25.0%	+30.0%
Total Shipments	291.8	78.0	5.2	315.4	217.0	20.0	295.0	360.0	85.0	220.0	480.0	205.0	140.0	520.0	325.0
	-7.9%	--	--	+8.1%	+178.2%	+284.6%	-6.5%	+65.9%	+325.0%	-25.4%	+33.3%	+141.2%	-36.4%	+8.3%	+58.5%
ANNUAL SHARE, BY DIAMETER	77.9%	20.8%	1.3%	57.2%	39.3%	3.5%	40.0%	48.6%	11.4%	24.3%	53.1%	22.6%	14.2%	52.9%	32.9%
TOTAL CAPACITY (Terabytes)	21.1	11.7	.2	34.0	54.4	1.7	44.2	97.2	6.8	44.0	168.0	24.6	35.0	218.4	61.8

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

TABLE 38

RIGID DISK CARTRIDGE DRIVES

WORLDWIDE PRICE PER MEGABYTE ($/MB)

DISK DIAMETER	1993	Forecast 1994	1995	1996	1997
PCM/Reseller					
5.25"	2.92	1.87	1.26	.89	.67
3.5"	1.80	1.15	.98	.77	.61
2.5" or less	6.25	3.43	3.25	1.91	.97
PCM/Reseller Average	2.57	1.47	1.13	.89	.69
OEM/Integrator					
5.25"	--	--	--	--	--
3.5"	1.80	1.13	.98	.77	.61
2.5" or less	--	3.05	3.18	1.91	1.43
OEM/Integrator Average	3.80	1.48	1.52	1.02	.81

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	1993 Estimate Units (000)	1993 Estimate %	1997 Projection Units (000)	1997 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	354.3	94.5	955.5	97.0
WORKSTATIONS				
Engineering and office, single user	20.7	5.5	29.5	3.0
CONSUMER, GAME AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	--	--	--	--
Total	375.0	100.0	985.0	100.0

TABLE 40

RIGID DISK CARTRIDGE DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1993 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	150.0	56.0	5.0	211.0	99.3	288.0	78.0	5.0	371.0	98.9
Other U.S.	.8	--	.2	1.0	.5	.8	--	.2	1.0	.3
Other Non-U.S.	.5	--	--	.5	.2	3.0	--	--	3.0	.8
TOTAL	151.3	56.0	5.2	212.5	100.0	291.8	78.0	5.2	375.0	100.0

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

SMALL OPTICAL DISK DRIVES

1994 DISK/TREND REPORT

SMALL OPTICAL DISK DRIVES

Coverage

Examples of optical disk drives in this group include:

2.5" disk diameter

Sony	MDM-111

3.5" disk diameter

Chinon	MO 300
Fujitsu	M2511A, M2512A
IBM	MD 3125B
LaserByte	LB3230
Matsushita Electric Industrial	LF-3100, LF-3294
MOST	RMD 5200-S, RMD 5300-S
Mountain Optech	SE-250, SI-250
NEC	PC-OD301
Olympus	MOS300E, MOS320E
Ricoh	RO-3012E
Seiko Epson	OMD 5010
Sony	SMO-E301, RMO-S310
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 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 level mass storage subsystems are usually equipped with 5.25" read/write drives, but are expected to use 3.5" drives as well as drive capacities increase in future generations.

Market status

1993 was a moderate growth year for 3.5" drives as shipments rose 53% to 253,900 units, but shipments of 2.5" drives were deferred to 1994. Almost all of the growth was in 3.5" drives shipped in the Japanese domestic market. The growth figure is misleading, however, because many suppliers cleaned out their

inventories of 3.5" 128 megabyte drives late in the year in anticipation of new 230 megabyte models.

3.5" drive shipments were helped by price incentives offered by manufacturers, and the lack of 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. Demand for 3.5" drives in the U.S. is weak as the result of severe competition from rigid cartridge drives and the almost universal prevalence 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 the 3.5" MO drive is being challenged by SyQuest's new family of 270 megabyte 3.5" removable cartridge drives which are available with higher capacity, lower prices and superior performance.

Fujitsu, Matsushita Electric and Sony were the leading 3.5" drive producers in 1993. 2.5" production is expected to begin in late 1994 with Sony as the leading producer due to its sponsorship of the 2.5" MiniDisc program.

1993 worldwide revenues grew only 13.8% to $202.1 million, a fraction of the unit shipment growth rate as a result of rapidly declining unit prices in 1993. U.S. firms accounted for 16.2% of 1993 revenues. The U.S. market accounted for only 32% of worldwide revenues in 1993, 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.

Marketing trends

The inability of the optical drive industry to match the current 60% per year areal density growth rate of the magnetic drive industry has hurt optical disk drive sales, and 3.5" drive unit shipments in 1994 and early 1995 are expected to grow only moderately. Even this limited growth forecast assumes a steady reduction in drive prices to match competition from removable magnetic cartridge drives such as SyQuest's 270 megabyte model. As 230 megabyte 3.5" drives are now readily available, significant shipments of 128 megabyte models will be restricted to models that are priced considerably below 230 megabyte pricing levels.

With the introduction of high capacity 3.5" drives with capacities in excess of 600 megabytes expected in 1995, the growth rate is forecasted to improve in following years. 1997 annual shipments of 734,400 units are anticipated. If 3.5" optical disk drives with capacities exceeding 600 megabytes, using standardized, competitively priced media are introduced at attractive drive prices ($350 or less), there is an opportunity for 3.5" drives to improve upon the projected shipment forecast.

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 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. Modest success in the aftermarket is anticipated, with shipments expected to grow to 198,000 units in 1997. Most of these units will probably be sold in the Japanese market.

When shipments of 2.5" and 3.5" drives are combined, 312,300 units are expected to ship in 1994 for the product group, growing to 932,400 units in 1997. 3.5" drives are expected to account for 78.9% of shipments and 89.3% of revenues in 1997.

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 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 CD-ROM capacities, also in the 600 megabyte range, 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.

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 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, although it is proving difficult for the industry to match the 60% per year growth rate in areal density exhibited by the rigid drive industry. The key areas of change are reviewed below.

Capacity: 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 1997. 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 they are expected to be standard features of some drives by 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.

Multifunctionality: 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.

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 and other types of rewritable recording that don't require a separate erase pass, even though these technologies are behind magneto-optical in development. Toshiba has stated its interest in a 600+ megabyte 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 are expected to improve over the next few years.

Competing Products: Strong competition for the 3.5" 128 megabyte and 230 megabyte optical drives is coming from the SyQuest 3.5" 270 megabyte cartridge drive. The OEM price, in the $300 range, is substantially under current prices for 3.5" MO drives, although 3.5" drives soon to be announced are expected to compete more strongly in price. Performance of the SyQuest drive is currently superior to that of MO drives now in production.

Multigigabyte 5.25" and 3.5" magnetic drives from Seagate, Micropolis and others are 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 the same price as a 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 1995.
2. Rewritable and write-once media will be available in adequate production quantities throughout the forecast period.
3. 2.5" drives will be shipped in the last half of 1994.
4. 3.5" drive prices will continue to decline rapidly in 1994 and more slowly thereafter.

TABLE 41

SMALL OPTICAL DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993 Revenues		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	3.2	6.1	4.0	13.3	4.5	20.4	4.8	25.5	5.9	31.4
PCM/Reseller	12.1	24.6	7.6	15.0	8.9	17.6	10.7	20.8	12.9	24.6
OEM/Integrator	.7	2.1	2.3	6.9	2.6	7.8	4.8	12.0	10.8	28.0
TOTAL U.S. REVENUES	16.0	32.8	13.9	35.2	16.0	45.8	20.3	58.3	29.6	84.0
Non-U.S. Manufacturers										
Captive	--	13.4	--	15.9	--	17.1	--	22.0	--	30.3
PCM/Reseller	38.3	99.6	36.9	105.6	33.2	112.0	38.0	132.0	62.2	193.7
OEM/Integrator	10.3	56.3	10.4	46.0	10.8	47.2	10.8	47.2	14.2	57.0
TOTAL NON-U.S. REVENUES	48.6	169.3	47.3	167.5	44.0	176.3	48.8	201.2	76.4	281.0
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	64.6	202.1	61.2	202.7	60.0	222.1	69.1	259.5	106.0	365.0
OEM Average Price ($000)		.674		.591		.470		.400		.344

TABLE 42

SMALL OPTICAL DISK DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993 Shipments		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	1.9	3.6	2.5	8.3	3.0	13.6	3.7	19.6	5.4	28.6
PCM/Reseller	8.1	16.4	11.5	22.7	16.1	31.9	21.3	41.4	28.7	54.6
OEM/Integrator	1.0	3.0	4.0	12.0	5.0	15.0	10.0	25.0	25.0	65.0
TOTAL U.S. SHIPMENTS	11.0	23.0	18.0	43.0	24.1	60.5	35.0	86.0	59.1	148.2
Non-U.S. Manufacturers										
Captive	--	7.8	--	9.5	--	11.0	--	14.7	--	20.2
PCM/Reseller	52.0	139.5	62.8	182.3	71.0	242.0	98.0	349.0	183.0	582.0
OEM/Integrator	15.5	83.6	18.1	77.5	24.0	102.0	29.0	123.0	47.0	182.0
TOTAL NON-U.S. SHIPMENTS	67.5	230.9	80.9	269.3	95.0	355.0	127.0	486.7	230.0	784.2
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	78.5	253.9	98.9	312.3	119.1	415.5	162.0	572.7	289.1	932.4
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	142.0	433.0	240.9	745.3	360.0	1,160.8	522.0	1,733.5	811.1	2,665.9

TABLE 43

SMALL OPTICAL DISK DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1993 Revenues	Forecast							
		1994		1995		1996		1997	
	3.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"
U.S. MANUFACTURERS									
Captive	6.1	13.3	--	20.4	--	25.5	--	31.4	--
PCM/Reseller	24.6	15.0	--	17.6	--	20.8	--	24.6	--
OEM/Integrator	2.1	6.9	--	7.8	--	12.0	--	28.0	--
TOTAL U.S. REVENUES	32.8	35.2	--	45.8	--	58.3	--	84.0	--
NON-U.S. MANUFACTURERS									
Captive	13.4	15.9	--	17.1	--	22.0	--	30.3	--
PCM/Reseller	99.6	97.9	7.7	93.1	18.9	103.4	28.6	163.1	30.6
OEM/Integrator	56.3	45.3	.7	41.5	5.7	40.7	6.5	48.0	9.0
TOTAL NON-U.S. REVENUES	169.3	159.1	8.4	151.7	24.6	166.1	35.1	241.4	39.6
WORLDWIDE RECAP									
Captive	19.5 -42.1%	29.2 +49.7%	-- --	37.5 +28.4%	-- --	47.5 +26.7%	-- --	61.7 +29.9%	-- --
PCM/Reseller	124.2 +84.3%	112.9 -9.1%	7.7 --	110.7 -1.9%	18.9 +145.5%	124.2 +12.2%	28.6 +51.3%	187.7 +51.1%	30.6 +7.0%
OEM/Integrator	58.4 -23.7%	52.2 -10.6%	.7 --	49.3 -5.6%	5.7 +714.3%	52.7 +6.9%	6.5 +14.0%	76.0 +44.2%	9.0 +38.5%
Total Revenues	202.1 +13.8%	194.3 -3.9%	8.4 --	197.5 +1.6%	24.6 +192.9%	224.4 +13.6%	35.1 +42.7%	325.4 +45.0%	39.6 +12.8%
ANNUAL SHARE, BY DIAMETER	100.0%	96.0%	4.0%	89.0%	11.0%	86.6%	13.4%	89.3%	10.7%

TABLE 44

SMALL OPTICAL DISK DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1993 Shipments	Forecast							
		1994		1995		1996		1997	
	3.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"	3.5"	2.5"
U.S. MANUFACTURERS									
Captive	3.6	8.3	--	13.6	--	19.6	--	28.6	--
PCM/Reseller	16.4	22.7	--	31.9	--	41.4	--	54.6	--
OEM/Integrator	3.0	12.0	--	15.0	--	25.0	--	65.0	--
TOTAL U.S. SHIPMENTS	23.0	43.0	--	60.5	--	86.0	--	148.2	--
NON-U.S. MANUFACTURERS									
Captive	7.8	9.5	--	11.0	--	14.7	--	20.2	--
PCM/Reseller	139.5	160.3	22.0	179.0	63.0	235.0	114.0	429.0	153.0
OEM/Integrator	83.6	75.2	2.3	83.0	19.0	97.0	26.0	137.0	45.0
TOTAL NON-U.S. SHIPMENTS	230.9	245.0	24.3	273.0	82.0	346.7	140.0	586.2	198.0
WORLDWIDE RECAP									
Captive	11.4	17.8	--	24.6	--	34.3	--	48.8	--
	+15.2%	+56.1%	--	+38.2%	--	+39.4%	--	+42.3%	--
PCM/Reseller	155.9	183.0	22.0	210.9	63.0	276.4	114.0	483.6	153.0
	+124.3%	+17.4%	--	+15.2%	+186.4%	+31.1%	+81.0%	+75.0%	+34.2%
OEM/Integrator	86.6	87.2	2.3	98.0	19.0	122.0	26.0	202.0	45.0
	+.6%	+.7%	--	+12.4%	+726.1%	+24.5%	+36.8%	+65.6%	+73.1%
Total Shipments	253.9	288.0	24.3	333.5	82.0	432.7	140.0	734.4	198.0
	+53.4%	+13.4%	--	+15.8%	+237.4%	+29.7%	+70.7%	+69.7%	+41.4%
ANNUAL SHARE, BY DIAMETER	100.0%	92.3%	7.7%	80.4%	19.6%	75.7%	24.3%	78.9%	21.1%

TABLE 45

SMALL OPTICAL DISK DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1993 Estimate Units (000)	1993 Estimate %	1997 Projection Units (000)	1997 Projection %
VERY HIGH PERFORMANCE Supercomputers and high end imaging	--	--	--	--
MAINFRAME SYSTEMS General purpose,	--	--	--	--
NETWORKS/MINI/MULTIUSER Midrange systems and network servers	--	--	27.9	3.0
PERSONAL COMPUTERS Business and professional, single user	234.3	92.3	531.5	57.0
WORKSTATIONS Engineering and office, single user	9.1	3.6	292.8	31.4
CONSUMER, GAME AND HOBBY COMPUTERS	8.1	3.2	67.1	7.2
OTHER APPLICATIONS	2.4	.9	13.1	1.4
Total	253.9	100.0	932.4	100.0

TABLE 46

SMALL OPTICAL DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drives

	1993 Net Shipments							
	To United States Destinations				Worldwide			
	Units (000)			%	Units (000)			%
Drive Manufacturers	3.5"	2.5"	Total		3.5"	2.5"	Total	
Fujitsu	18.0	--	18.0	23.5	76.0	--	76.0	31.3
Matsushita Electric	21.0	--	21.0	27.4	59.0	--	59.0	24.3
Sony	6.0	--	6.0	7.8	41.1	--	41.1	16.9
IBM	9.1	--	9.1	11.9	19.4	--	19.4	8.0
Olympus Optical	4.0	--	4.0	5.2	16.0	--	16.0	6.6
Other U.S.	--	--	--	--	--	--	--	--
Other Non-U.S.	18.5	--	18.5	24.2	31.0	--	31.0	12.9
TOTAL	76.6	--	76.6	100.0	242.5	--	242.5	100.0

HIGH CAPACITY FLEXIBLE DISK DRIVES

1994 DISK/TREND REPORT

HIGH CAPACITY FLEXIBLE DISK DRIVES

Coverage

Examples of flexible disk drives in this group include:

5.25" Bernoulli principle drives

Iomega	Bernoulli 20, 44, 90, 150

3.5" flexible disk drives

Insite Peripherals	I325VM
NEC	FD 2135
Swan Instruments	FRD-3128

All types of floppy drives with capacities over 5 megabytes have been consolidated into this section, which includes data from the high capacity flexible disk drive product group in the 1994 DISK/TREND Report on flexible disk drives. 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 manufacturers of 3.5" drives.

Iomega's Bernoulli principle drives: Iomega's drives use the Bernoulli effect to control head/disk spacing. These are high performance drives, using flexible disks in a removable rigid 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 and the current 150 megabyte model in late 1992.

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. Insite uses a reflective servo

pattern applied to the surface of standard 3.5" diskettes to achieve high track density (1,245 TPI), resulting in a capacity of 21 megabytes, in a 1 inch high drive with downward read/write compatibility for .7 and 1.44 megabyte diskettes.

Since 1992, Insite has been delivering a version of the drive which is manufactured for Insite on a contract basis by Matsushita-Kotobuki Electronics. Insite also licensed the floptical technology to Iomega, which introduced drives compatible with Insite's in 1992, using Chinon as a contract manufacturing source, but Iomega has been phasing out of the floptical drive market in 1994. In November, 1993, O.R. Computer System Pte. Ltd., a major Singapore distributor of personal computers and peripherals, acquired control of 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 several approaches have been offered. Hitachi was the first to offer drives in this group, starting with a 6.15 megabyte 8" drive in 1984, followed in 1985 by a 4.15 megabyte 5.25" drive. Both of these drives were used only in limited applications, and only in Japan, and were phased out in 1992.

During the last several years there have been several announced high capacity 3.5" floppy drive programs. Brier Technology's 21 megabyte 3.5" drives used a unique "dual level" or "buried" recording system in which embedded servo information occupied the same position as data tracks, without reducing track capacity. The first version of the 21 megabyte Brier drive was delivered in early 1990, but after changes in ownership, and limited shipments of the drive in the personal computer add-on market, the Brier drive was phased out in 1992.

NEC delivered its 9.4 megabyte drive in August, 1988, for the domestic Japanese market, and later superseded it with a 10.18 megabyte model, followed by the current 21.4 megabyte drive, which incorporates read and write compatibility with .7 and 1.44 megabyte diskettes. All of these NEC drives have used embedded servos, with metal powder media. All of the other high capacity 3.5" floppy drive programs by several Japanese manufacturers have been dropped, including announced drives by Matsushita Communication Industrial, Citizen, Y-E Data and others. During the last few years, Japan Electronic Industry Development Association (JEIDA) organized a standards committee to attempt to achieve common standards for 20 and 40 megabyte drives to be produced by

Japanese floppy drive manufacturers. This activity was in a holding pattern during most of 1992/93, while the manufacturers involved pursued a "wait and see" policy, while assessing the market reception to the "floptical" drives offered by Insite and Iomega. At this time, NEC is the only participating company still active with a production drive.

Market status

Despite increasing shipments of 3.5" floppy drives in this group during 1994, total sales revenues are expected to decline from 1993's $80.9 million to $75.1 million in 1994, due to a slight current drop in shipments of Iomega 5.25" drives. 1993's total shipments of all floppy drives with capacities over 5 megabytes were 209,600 units, with an increase to 243,600 drives forecasted for 1994.

Iomega's Bernoulli principle drives: Although Iomega's original 8" drives have long since peaked and went out of production three years ago, shipments of the firm's 5.25" Bernoulli drives continued to grow each year until 1993. All of the 5.25" drives shown in this product group's revenue and shipment tables are Iomega's Bernoulli models. 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 most of the 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.

Iomega's Bernoulli drive shipments are currently all 5.25" models, totaling 106,200 in 1993. Iomega has continually upgraded the range of capacities available in the 5.25" drive series, and the higher capacity models now dominate current shipments. Nevertheless, unit shipments for 1994 are estimated to de-

cline to 103,000, as newer magneto-optical 3.5" drives and SyQuest's 270 megabyte 3.5" drive provide difficult competition.

Other flexible disk drives: Time has passed by the several 5.25" high capacity floppy drive programs previously introduced, and 3.5" drives currently provide the product group's long-term growth potential.

After numerous delays, 3.5" 20 megabyte "floptical" drives became available in volume 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. Although initial sales were concentrated in PCM/Reseller markets, adoptions by specialized system manufacturers have provided a major part of the current growth for floptical drives. Contract manufacturing is now concentrated at Matsushita-Kotobuki Electronics, for O.R. Computer's Insite Peripherals, the only remaining principal in the floptical program.

The future of most high capacity flexible disk drives will probably be found as backup devices used with Winchester disk drives and in applications such as data logging, in which access time is not a factor. The floptical standard has been adopted by two system manufacturers for technical workstation applications. Cartridge tape drives are the established competitor in these applications, and the new floppy drives could have a friendly reception as a tape drive replacement by end users and system OEMs, both of whom usually respond favorably to faster performance and easier system integration. The major challenge to 3.5" drive manufacturers will be to find ways to reduce prices as much and as fast as possible. It is clear that most of the mainstream personal computer market is not available to the existing 20 megabyte floppy drives through OEMs, due to prices several times higher than those of standard floppy drives -- leaving only specialized and high-end applications. Most of the current sales have been made in the aftermarket for add-on units.

Marketing trends

The DISK/TREND Report forecast of shipments and revenue for the high capacity flexible disk drive product group have again been lowered, in view of the continuing difficulty drive manufacturers have experienced in reducing prices low

enough to stimulate a major penetration of the personal computer market. Total shipments are forecasted to reach 600,000 drives in 1997, of which 86.9% are expected to be 3.5" models.

The majority of sales for high capacity 3.5" floppy drives are still currently through the PCM/Reseller channel, responding to users' demand for improved backup for personal computer graphics, desktop publishing and other applications with capacity requirements higher than those of conventional floppy drives. Because of the significant latent demand believed to exist for improved system backup devices, continuing PCM/Reseller growth is expected for this product group now that adequate production is available, at least for "floptical" drives.

OEM/Integrator shipments, at least for technical workstations, are now starting, but the OEM market will probably be limited to workstations, high-end personal computers and specialized applications, due to the relatively high price of 3.5" drives in this product group compared to conventional 3.5" floppy drives. Although continuing sales activity aimed at the OEM market is expected to increase OEM shipments to a majority of the total 3.5" drive shipments starting next year, the expected market penetration will be limited by the exceptionally strong market position of standard 1.44 megabyte 3.5" floppy drives, available to major system manufacturers next year at less than $25 per drive.

In the meantime, 5.25" Bernoulli drives are forecasted to grow in shipments in 1995 to 111,000 units, on the strength of continuing product improvements. Iomega's 150 megabyte drives introduced in late 1992 have been well received and have provided significant competition to alternative products offered by other manufacturers. Iomega adopted an aggressive price strategy in 1993, which is helping the firm to maintain its current market position, but the peak for 5.25" drives is expected in 1995, with lower shipments in succeeding years.

Although 3.5" drives are expected to prevail in the high capacity floppy drive market, there will be many challenges along the way. The most important of these is the lack of a consensus in the industry on just what formats should be used. The Insite "floptical" standard is currently in the lead, reinforced by a credible drive manufacturing organization and major media manufacturers.

The leading Japanese floppy drive manufacturers are still patiently observing the difficult early years of the "floptical" program, including the establishment of

large-scale production through Matsushita-Kotobuki Electronics, the startup of the Iomega program using Chinon for manufacturing, Iomega's phaseout of the program, the very slow response by system manufacturers and Insite Peripheral's purchase by O.R. Computer. So far, the response is mixed. Most drive manufacturers are still watching the situation, and waiting for an indication of the availability of a high volume market. Except for NEC, it appears that the majority will attend an occasional JEIDA standards committee meeting on high capacity floppies, but avoid any commitment to production until there is a clear indication of availability of a major market.

Technology trends

The major product development challenges in this product group during the remainder of the 1990's will be to increase capacity and lower product cost. If high capacity floppy drives are to achieve prominence in data storage markets, they must offer sufficient capacity to be useful with interchange of graphics and other applications, and they must provide aggressive price competition to tape cartridge drives, removable cartridge rigid disk drives and erasable optical disk drives.

Since the 3.5" form factor for data storage products in this class is clearly destined to prevail, the development task will be to increase capacities beyond the 20 megabytes now available and to achieve the design simplification required for low manufacturing cost.

Insite Peripherals' optical tracking method is perhaps the most innovative approach, with obvious potential for greater capacity and low manufacturing costs. Insite's reflective servo pattern is imprinted on the diskette as part of the media manufacturing process, and potentially will increase the media manufacturing cost only slightly when high shipment levels are achieved. Japanese drive manufacturers cooperating with the JEIDA standards activity have hoped to achieve a simpler design using metal powder media, with a lower manufacturing cost. None of the above product designs provide for media interchange except among drives of the same type, plus 1 and 2 megabyte 3.5" drives.

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.

Forecasting assumptions

1. High volume production of 3.5" high capacity floppy drives will continue to be available in the 1995-97 period.

2. Due to relatively high prices compared to 1.44 megabyte floppy drives, OEM adoptions of 3.5" high capacity floppy drives will be confined to technical workstations, high-end personal computers and specialized applications during the 1995-97 period.

3. Shipments of 5.25" Bernoulli drives will peak in 1995.

TABLE 47

HIGH CAPACITY FLEXIBLE DISK DRIVES

REVENUE SUMMARY

	DISK DRIVE REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993 Revenues		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	50.9	61.9	44.3	51.5	36.0	42.0	28.9	34.0	18.8	21.7
OEM/Integrator	2.2	2.4	2.1	2.5	2.0	2.4	1.4	1.7	.9	1.2
TOTAL U.S. REVENUES	53.1	64.3	46.4	54.0	38.0	44.4	30.3	35.7	19.7	22.9
Non-U.S. Manufacturers										
Captive	--	--	--	1.0	--	4.0	--	6.8	--	8.4
PCM/Reseller	6.3	9.9	7.0	11.4	12.0	18.0	14.3	21.5	14.3	21.7
OEM/Integrator	4.5	6.7	5.6	8.7	18.2	22.4	24.0	29.5	27.0	33.5
TOTAL NON-U.S. REVENUES	10.8	16.6	12.6	21.1	30.2	44.4	38.3	57.8	41.3	63.6
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	63.9	80.9	59.0	75.1	68.2	88.8	68.6	93.5	61.0	86.5
OEM Average Price ($000)		.214		.181		.149		.127		.110

TABLE 48

HIGH CAPACITY FLEXIBLE DISK DRIVES

UNIT SHIPMENT SUMMARY

	DISK DRIVE UNIT SHIPMENTS, BY SHIPMENT DESTINATION (000)									
	1993		Forecast							
	Shipments		1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
PCM/Reseller	93.6	115.2	98.0	115.0	90.0	105.0	85.0	100.0	65.0	75.0
OEM/Integrator	5.5	6.0	5.0	6.0	5.0	6.0	4.0	5.0	3.0	4.0
TOTAL U.S. SHIPMENTS	99.1	121.2	103.0	121.0	95.0	111.0	89.0	105.0	68.0	79.0
Non-U.S. Manufacturers										
Captive	--	--	--	2.0	--	8.0	--	15.0	--	21.0
PCM/Reseller	33.0	52.0	40.0	65.0	80.0	120.0	110.0	165.0	125.0	190.0
OEM/Integrator	24.4	36.4	35.6	55.6	130.0	160.0	195.0	240.0	250.0	310.0
TOTAL NON-U.S. SHIPMENTS	57.4	88.4	75.6	122.6	210.0	288.0	305.0	420.0	375.0	521.0
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	156.5	209.6	178.6	243.6	305.0	399.0	394.0	525.0	443.0	600.0
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	885.0	1,131.9	1,063.6	1,375.5	1,368.6	1,774.5	1,762.6	2,299.5	2,205.6	2,899.5

TABLE 49

HIGH CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY DISK DIAMETER

	1993 Revenues		Forecast 1994		1995		1996		1997	
	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"
U.S. MANUFACTURERS										
PCM/Reseller	4.2	57.7	5.4	46.1	--	42.0	--	34.0	--	21.7
OEM/Integrator	.2	2.2	--	2.5	--	2.4	--	1.7	--	1.2
TOTAL U.S. REVENUES	4.4	59.9	5.4	48.6	--	44.4	--	35.7	--	22.9
NON-U.S. MANUFACTURERS										
Captive	--	--	1.0	--	4.0	--	6.8	--	8.4	--
PCM/Reseller	9.9	--	11.4	--	18.0	--	21.5	--	21.7	--
OEM/Integrator	6.7	--	8.7	--	22.4	--	29.5	--	33.5	--
TOTAL NON-U.S. REVENUES	16.6	--	21.1	--	44.4	--	57.8	--	63.6	--
WORLDWIDE RECAP										
Captive	--	--	1.0	--	4.0	--	6.8	--	8.4	--
	--	--	--	--	+300.0%	--	+70.0%	--	+23.5%	--
PCM/Reseller	14.1	57.7	16.8	46.1	18.0	42.0	21.5	34.0	21.7	21.7
	+131.1%	-6.6%	+19.1%	-20.1%	+7.1%	-8.9%	+19.4%	-19.0%	+.9%	-36.2%
OEM/Integrator	6.9	2.2	8.7	2.5	22.4	2.4	29.5	1.7	33.5	1.2
	--	-18.5%	+26.1%	+13.6%	+157.5%	-4.0%	+31.7%	-29.2%	+13.6%	-29.4%
Total Revenues	21.0	59.9	26.5	48.6	44.4	44.4	57.8	35.7	63.6	22.9
	+238.7%	-7.1%	+26.2%	-18.9%	+67.5%	-8.6%	+30.2%	-19.6%	+10.0%	-35.9%
ANNUAL SHARE, BY DIAMETER	26.0%	74.0%	35.3%	64.7%	50.1%	49.9%	61.9%	38.1%	73.6%	26.4%

TABLE 50

HIGH CAPACITY FLEXIBLE DISK DRIVES

WORLDWIDE SHIPMENTS (000)

BREAKDOWN BY DISK DIAMETER

	1993 Shipments		Forecast 1994		1995		1996		1997	
	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"	3.5"	5.25"
U.S. MANUFACTURERS										
PCM/Reseller	14.0	101.2	18.0	97.0	--	105.0	--	100.0	--	75.0
OEM/Integrator	1.0	5.0	--	6.0	--	6.0	--	5.0	--	4.0
TOTAL U.S. SHIPMENTS	15.0	106.2	18.0	103.0	--	111.0	--	105.0	--	79.0
NON-U.S. MANUFACTURERS										
Captive	--	--	2.0	--	8.0	--	15.0	--	21.0	--
PCM/Reseller	52.0	--	65.0	--	120.0	--	165.0	--	190.0	--
OEM/Integrator	36.4	--	55.6	--	160.0	--	240.0	--	310.0	--
TOTAL NON-U.S. SHIPMENTS	88.4	--	122.6	--	288.0	--	420.0	--	521.0	--
WORLDWIDE RECAP										
Captive	--	--	2.0	--	8.0	--	15.0	--	21.0	--
	--	--	--	--	+300.0%	--	+87.5%	--	+40.0%	--
PCM/Reseller	66.0	101.2	83.0	97.0	120.0	105.0	165.0	100.0	190.0	75.0
	+164.0%	-1.7%	+25.8%	-4.2%	+44.6%	+8.2%	+37.5%	-4.8%	+15.2%	-25.0%
OEM/Integrator	37.4	5.0	55.6	6.0	160.0	6.0	240.0	5.0	310.0	4.0
	--	-5.7%	+48.7%	+20.0%	+187.8%	--	+50.0%	-16.7%	+29.2%	-20.0%
Total Shipments	103.4	106.2	140.6	103.0	288.0	111.0	420.0	105.0	521.0	79.0
	+303.9%	-1.9%	+36.0%	-3.0%	+104.8%	+7.8%	+45.8%	-5.4%	+24.0%	-24.8%
ANNUAL SHARE, BY DIAMETER	49.3%	50.7%	57.8%	42.2%	72.3%	27.7%	80.1%	19.9%	86.9%	13.1%

TABLE 51

HIGH CAPACITY FLEXIBLE DISK DRIVES

APPLICATIONS SUMMARY
Percentage of Worldwide Shipments

APPLICATION	1993 Estimate Units (000)	1993 Estimate %	1997 Projection Units (000)	1997 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	202.3	96.5	567.0	94.5
WORKSTATIONS Engineering and office, single user	7.3	3.5	33.0	5.5
CONSUMER, GAME AND HOBBY COMPUTERS	--	--	--	--
OTHER APPLICATIONS	--	--	--	--
Total	209.6	100.0	600.0	100.0

TABLE 52

HIGH CAPACITY FLEXIBLE DISK DRIVES

MARKET SHARE SUMMARY
Worldwide Shipments of Non-Captive Disk Drives

	1993 Net Shipments			
	To United States Destinations		Worldwide	
Drive Manufacturers	Units (000)	%	Units (000)	%
Iomega	99.1	63.3	121.2	57.8
Insite Peripherals	57.0	36.4	88.0	42.0
Other U.S.	--	--	--	--
Other Non-U.S.	.4	.3	.4	.2
TOTAL	156.5	100.0	209.6	100.0

PCMCIA FLASH CARD SPECIFICATIONS

1994 DISK/TREND REPORT

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.

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. 1x8 is 1 million 8 bit words, .512x16 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 standard PCMCIA form factor used for the card.

Interface

This describes the interface according to the PCMCIA definition. Flash disk cards are designated as PCMCIA-ATA. Flash memory is designated with the PCMCIA revision level specified by the manufacturer.

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 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.

Media read rate

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

Media write rate

Except as noted, media 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.

Burst transfer rate

This is the maximum rate at which data can be transferred between the 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.

1994 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	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES
MODEL	AMC001AFLKA	AMC001CFLKA	AMC002AFLKA	AMC002BFLKA	AMC002CFLKA
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)	1	4	2	1	4
Chip count per card	8	2	8	16	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	1 x 8	4 x 8	2 x 8	1 x 8	4 x 8
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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	64	256	128	64
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	1	1	2	2	2
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	Software	Software	Software	Software
PERFORMANCE: Avg. access time (ns)	250	150	250	200	150
Media read rate (MB/Sec)	8	13.3	8	10	13.3
Media write rate (MB/Sec)	.140	.125	.140	.140	.125
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	2000	1500	2000	1300	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	5 V, 12 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1992	5/94	1992	1993	5/94
COMMENTS					

MANUFACTURER	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	ADVANCED MICRO DEVICES	AMP	AMP
MODEL	AMC004AFLKA	AMC004CFLKA	AMC010CFLKA	1-797078-0	797078-1
DISK/TREND GROUP	40	40	41	40	40
MARKET	OEM	OEM	OEM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	2	4	4	2	2
Chip count per card	16	8	20	16	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2 x 8	4 x 8	4 x 8	8 x 2/16 x 2	8x.512/16x.256
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	No	No
Erasable block size (KB)	128	64	64	8	.512
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	4	4	10	4	.512
SECTOR ENDURANCE: (Kcycles)	100	100	100	10	10
Spare sectors	--	--	--	--	--
Wearout leveling	Software	Software	Software	--	--
PERFORMANCE: Avg. access time (ns)	250	150	150	200	200
Media read rate (MB/Sec)	8	13.3	13.3	5	5
Media write rate (MB/Sec)	.14	.125	.125	.065	.065
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	2000	1500	1500	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	5 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1992	5/94	5/94		
COMMENTS					

MANUFACTURER	AMP	AMP	AMP	AMP	AMP
MODEL	797078-2	797078-3	797078-5	797078-6	797078-7
DISK/TREND GROUP	40	40	40	40	40
MARKET	PCM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	2	2	2	2	2
Chip count per card	4	8	16	2	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	8 x 1/16 x .512	8 x 2/16 x 1	8 x 4/16 x 2	8x.512/16x.256	8 x 1/16 x .512
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)	.512	.512	.512	8	8
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	--	--	--	--	--
CAPACITY:					
Total capacity (Mbytes)	1	2	4	.512	1
SECTOR ENDURANCE: (Kcycles)	10	10	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	.065	.065
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, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	1Q94	1Q94	1Q94
COMMENTS					

MANUFACTURER	AMP	AMP	AMP	AMP	AMP
MODEL	797078-8	93-1890-515-2	93-1890-515-3	93-1890-515-4	93-1890-515-1
DISK/TREND GROUP	40	40	40	40	40
MARKET	PCM	PCM	PCM	PCM	PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	2	1	1	1	1
Chip count per card	8	4	8	16	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	8 x 2/16 x 1	8x.512/16x.256	8 x 1/16 x .512	8 x 2/16 x 1	8x.256/16x.128
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)	8	.128/.512	.128/.512	.128/.512	.128/.512
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	2	.512	1	2	.256
SECTOR ENDURANCE: (Kcycles)	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	--	--	--	--
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	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	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	1Q94	1Q94	1Q94
COMMENTS		Atmel chips	Atmel chips	Atmel chips	Atmel chips

MANUFACTURER	AMP	AMP	AMP	AMP	CENTENNIAL TECHNOLOGIES
MODEL	93-1890-535-1	93-1890-535-2	93-1890-535-3	93-1890-535-4	FL01M-15-1
DISK/TREND GROUP	40	40	40	40	40
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	4	4	4	4	4
Chip count per card	2	4	8	16	8
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	8 x 1/16 x .512	8 x 2/16 x 1	8 x 4/16 x 2	8 x 8/16 x 4	8 x 1/16 x .512
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No	No	No	No	
Erasable block size (KB)	.128/.512	.128/.512	.128/.512	.128/.512	
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	--	--	--	--	--
CAPACITY:					
Total capacity (Mbytes)	1	2	4	8	1
SECTOR ENDURANCE: (Kcycles)					100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE:					
Avg. access time (ns)	200	200	200	200	150
Media read rate (MB/Sec)	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	1993
COMMENTS	Atmel chips	Atmel chips	Atmel chips	Atmel chips	

MANUFACTURER	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	CENTENNIAL TECHNOLOGIES	FUJITSU	FUJITSU
MODEL	FL02M-15-1	FL256-15-1	FL512-15-1	MB98A8081X	MB98A8084X
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	1	2	.128	.128
Chip count per card	16	2	4	2	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	8 x 2/8 x 1	8x.256/16x.128	8x.512/16x.256	8x.256/16x.128	8x.256/16x.128
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)					
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	2	.256	.512	.256	.256
SECTOR ENDURANCE: (Kcycles)	100	100	100	10	10
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	150	150	150	200	200
Media read rate (MB/Sec)				5	5
Media write rate (MB/Sec)				.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	3.3 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	1993	1993	1993	4Q93	4Q93
COMMENTS					

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
MODEL	MB98A8091X	MB98A8092X	MB98A8094X	MB98A8101X	MB98A8102X
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)	.128	.256	.128	.128	.256
Chip count per card	4	2	4	8	4
Chip logic type					
Chip organization	8x.512/16x.256	8x.512/16x.256	8x.512/16x.256	8 x 1/16 x .512	8 x 1/16 x .512
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)					
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	--	--	--	--	--
CAPACITY:					
Total capacity (Mbytes)	.512	.512	.512	1	1
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	.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		
COMMENTS					

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
MODEL	MB98A8104X	MB98A8111X	MB98A8112X	MB98A8113X	MB98A8114X
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)	.128	.128	.256	1.024	.128
Chip count per card	8	16	8	2	16
Chip logic type					
Chip organization	8 x 1/16 x .512	8 x 2/16 x 1	8 x 2/16 x 1	8 x 2/16 x 1	8 x 2/16 x 1
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)					
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	--	--	--	--	--
CAPACITY:					
Total capacity (Mbytes)	1	2	2	2	2
SECTOR ENDURANCE: (Kcycles)	10	10	10	10	10
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE:					
Avg. access time (ns)	200	200	250	200	200
Media read rate (MB/Sec)	5	5	4	5	5
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	4Q93			1Q94	4Q93
COMMENTS					

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
MODEL	MB98A8122X	MB98A8123X	MB98A8133X	MB98A8601X	MB98A8602X
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)	.256	1.024	1.024	.128	.128
Chip count per card	16	4	8	2	4
Chip logic type					
Chip organization	8 x 4/16 x 2	8 x 4/16 x 2	8 x 8/16 x 4	8x.256/16x.128	8x.512/16x.256
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)					
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	4	4	8	.256	.512
SECTOR ENDURANCE: (Kcycles)	10	10	10	10	10
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	250	200	200	170	170
Media read rate (MB/Sec)	4	5	5	5.9	5.7
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		1Q94	1Q94		
COMMENTS					

MANUFACTURER	FUJITSU	HITACHI	HITACHI	HITACHI	HITACHI
MODEL	MB98A8143X	HB286116C	HB286216C	HB286416C	HB286516C
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)	1.024	4	4	4	4
Chip count per card	16	4	8	16	20
Chip logic type		NOR	NOR	NOR	NOR
Chip organization	8 x 16/16 x 8	.512 x 8	.512 x 8	.512 x 8	.512 x 8
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)		16	16	16	16
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	16	2	4	8	10
SECTOR ENDURANCE: (Kcycles)	10	1	1	1	1
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	200	200/250	200/250	200/250	200/250
Media read rate (MB/Sec)	5	5/4	5/4	5/4	5/4
Media write rate (MB/Sec)	.0625				
Burst transfer rate (MB/Sec)					
Block erase time (ms)	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, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1Q94	3Q94	3Q94	3Q94	3Q94
COMMENTS		Optional EEPROM CIS block	Optional EEPROM CIS block	Optional EEPROM CIS block	Optional EEPROM CIS block

MANUFACTURER	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS
MODEL	17JSSFP3MB	17JSSFP5MB	17P01001B1DA-25	17P0200B1DA-25	17P0400B1DA-25
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	Captive,OEM,PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	16	16	2	2	2
Chip count per card	2	3	4	8	16
Chip logic type	NAND	NAND	NOR	NOR	NOR
Chip organization	48, 4, 32	80, 4, 32	.256 x 8	.256 x 8	.256 x 8
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01
XIP	No	No	Yes	Yes	Yes
Erasable block size (KB)	4	4	256	256	256
Driver memory needed (KB)	12***	12***	--	--	--
Internal ECC	Yes	Yes	No	No	No
CAPACITY:					
Total capacity (Mbytes)	3	5	1	2	4
SECTOR ENDURANCE: (Kcycles)	250	250	100	100	100
Spare sectors	Yes	Yes	Programmable	Programmable	Programmable
Wearout leveling	Yes	Yes	Yes	Yes	Yes
PERFORMANCE:					
Avg. access time (ns)	.8 ms	.8 ms	250	250	250
Media read rate (MB/Sec)	7/4.3*/2.5**	7/4.3*/2.5**	4	4	4
Media write rate (MB/Sec)	1.2/1*/.8**	1.2/1*/.8**			
Burst transfer rate (MB/Sec)	8/4*/2**	8/4*/2**			
Block erase time (ms)	10	10	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	5/94	5/94	2Q93	2Q93	2Q93
COMMENTS	Toshiba chips. *At reduced power. **At low power. ***If no system ATA support.	Toshiba chips. *At reduced power. **At low power. ***If no system ATA support.			

MANUFACTURER	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS
MODEL	17P0400D1DA-25 Flash 2	17P0800D1DA-25 Flash 2	18P0101N1DA-25	18P015N1DA-25	18P0201N1DA-25
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	2	2	2
Chip count per card	4	8	4	4	8
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	1 x 8	1 x 8	.256 x 8	.256 x 8	.256 x 8
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	64	64	256	286	256
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	No	No	No	No	No
CAPACITY: Total capacity (Mbytes)	4	8	2	1.5	3
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	Programmable	Programmable	Programmable	Programmable	Programmable
Wearout leveling	Yes	Yes	Yes	Yes	Yes
PERFORMANCE: Avg. access time (ns)	250	250	250	250	250
Media read rate (MB/Sec)	4	4	4	4	4
Media write rate (MB/Sec)					
Burst transfer rate (MB/Sec)					
Block erase time (ms)	1600	1600	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, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	2Q94	2Q94	2Q93	2Q93	2Q93
COMMENTS	Intel chips Stainless steel package	Intel chips Stainless steel package	Includes 1 MB SRAM on card	Includes 512 KB SRAM on card	Includes 2 MB SRAM on card

MANUFACTURER	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS	IBM MICRO-ELECTRONICS
MODEL	18P515N1DA-25	17JSSFP10MB	17JSSFP20MB	17P1600D1DA-25 Flash 2	17JSSFP30MB
DISK/TREND GROUP	40	41	41	41	42
MARKET	OEM, PCM	Captive,OEM,PCM	Captive,OEM,PCM	OEM, PCM	Captive,OEM,PCM
PRODUCT TYPE: Generic	Flash Memory	Flash Disk	Flash Disk	Flash Memory	Flash Disk
Chip density (Mb)	2	16	16	8	16
Chip count per card	2	6	11	16	16
Chip logic type	NOR	NAND	NAND	NOR	NAND
Chip organization	.256 x 8	160, 4, 32	320, 4, 32	1 x 8	464, 4, 32
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type II
Interface	PCMCIA 2.01	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.01	PCMCIA-ATA
XIP	Yes	No	No	Yes	No
Erasable block size (KB)	256	4	4	64	4
Driver memory needed (KB)	--	12***	12***	--	12***
Internal ECC	No			--	Yes
CAPACITY: Total capacity (Mbytes)	1	10	20	16	30
SECTOR ENDURANCE: (Kcycles)	100	250	250	100	250
Spare sectors	Programmable	Yes	Yes	Programmable	Yes
Wearout leveling	Yes	Yes	Yes	Yes	Yes
PERFORMANCE: Avg. access time (ns)	250	.8 ms	.8 ms	250	.8 ms
Media read rate (MB/Sec)	4	7/4.3*/2.5**	7/4.3*/2.5**	4	7/4.3*/2.5**
Media write rate (MB/Sec)		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**
Block erase time (ms)	2000	10	10	1600	10
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
OPERATING VOLTAGE:	5 V, 12 V	5 V	5 V	5 V, 12 V	5 V
FIRST CUSTOMER SHIPMENT	2Q93	5/94	5/94	2Q94	5/94
COMMENTS	Includes 512 KB SRAM on card	Toshiba chips. * AT reduced power. **At low power. ***If no system ATA support.	Toshiba chips. *At reduced power. **At low power. ***If no system ATA support.	Intel chips Stainless steel package	Toshiba chips. *At reduced power. **At low power. ***If no system ATA support.

MANUFACTURER	IBM MICRO-ELECTRONICS	INTEL	INTEL	INTEL	INTEL
MODEL	17JSSFP40MB	iFD005P2SA Flash Drive	iMC001FLKA Series 1	iMC002FLKA Series 1	iMC002FLSA Series 2
DISK/TREND GROUP	42	40	40	40	40
MARKET	Captive,OEM,PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Memory	Flash Memory	Flash Memory
Chip density (Mb)	16	8	2	2	8
Chip count per card	21	6	4	8	2
Chip logic type	NAND	NOR	NOR	NOR	NOR
Chip organization	624, 4, 32	160, 2, 32	.256 x 8	.256 x 8	1 x 8
FEATURES: Package	PCMCIA Type II	PCMCIA Type II	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 1.0	PCMCIA 1.0	PCMCIA 2.01
XIP	No	No	Yes	Yes	Yes
Erasable block size (KB)	4	128*	512*	512*	128*
Driver memory needed (KB)	12***	--	--	--	--
Internal ECC	Yes	8 bits/sector	None	None	None
CAPACITY: Total capacity (Mbytes)	40	5.243	1	2	2
SECTOR ENDURANCE: (Kcycles)	250	100	100	100	100
Spare sectors	Yes	None	None	None	None
Wearout leveling	Yes	Yes	--	--	--
PERFORMANCE: Avg. access time (ns)	.8 ms	1000**	200	200	200
Media read rate (MB/Sec)	7/4.3*/2.5**	8	5	5	5
Media write rate (MB/Sec)	1.2/1*/.8*	.27	.1250*	.1250*	.2*
Burst transfer rate (MB/Sec)	8/4*/2**	5	5	5	5
Block erase time (ms)	10	--	2000	2000	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	5 V, 12 V	5 V, 12 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	5/94	1Q94	1990	1990	2Q92
COMMENTS	Toshiba chips. *At reduced power. **At low power. ***If no system ATA support.	32 KB buffer *Chip pair **10 msec. from sleep	*Chip pair	*Chip pair	*Chip pair

MANUFACTURER	INTEL	INTEL	INTEL	INTEL	INTEL
MODEL	iMC004FLKA Series 1	iMC004FLSA Series 2	iMC004FLSP Series 2+	iFD010P2SA Flash Drive	iMC010FLSA 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 Disk	Flash Memory
Chip density (Mb)	2	8	16	8	8
Chip count per card	16	4	2	12	10
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	.256 x 8	1 x 8	2 x 8	320, 2, 32	1 x 8
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type II	PCMCIA Type I
Interface	PCMCIA 1.0	PCMCIA 2.01	PCMCIA 2.01	PCMCIA-ATA	PCMCIA 2.01
XIP	Yes	Yes	Yes	No	Yes
Erasable block size (KB)	512*	128*	128*	128*	128*
Driver memory needed (KB)	--	--	--	None	--
Internal ECC	None	None	None	8 bits/sector	--
CAPACITY:					
Total capacity (Mbytes)	4	4	4	10.486	10
SECTOR ENDURANCE: (Kcycles)	100	100	1000	1000	100
Spare sectors	None	None	None	None	None
Wearout leveling	--	--	Yes	Yes	--
PERFORMANCE:					
Avg. access time (ns)	200	200	150	1000**	200
Media read rate (MB/Sec)	5	5	13	8	5
Media write rate (MB/Sec)	.1250*	.2*	.85	.27	.2*
Burst transfer rate (MB/Sec)	5	5	10 (Read)	5	5
Block erase time (ms)	2000	1600	300		1600
SIZE: (mm: H x W x D)	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	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V, 12 V	5 V, 12 V	5 or 3.3 V 12 V option	5 V	5 V, 12 V
FIRST CUSTOMER SHIPMENT	1990	2Q92	1Q94	1Q94	2Q92
COMMENTS	*Chip pair	*Chip pair	*Chip pair	32 KB buffer *Chip pair **10 msec. from sleep	*Chip pair

MANUFACTURER	INTEL	INTEL	INTEL	M-SYSTEMS	M-SYSTEMS
MODEL	iMCO2OFLSA Series 2	iMCO2OFLSP Series 2+	iMCO4OFLSP Series 2+	FlashCard-1M	FlashCard-2M
DISK/TREND GROUP	41	41	42	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)	8	16	16	8	8
Chip count per card	20	10	20	1	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	1 x 8	2 x 8	4 x 8	1 x 8	1 x 8
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	128*	128*	128*	128	128
Driver memory needed (KB)	--	--	--	22*	22*
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	20	20	40	1	2
SECTOR ENDURANCE: (Kcycles)	100	1000	1000	100	100
Spare sectors	None	--	--	--	--
Wearout leveling	--	Yes	Yes	--	--
PERFORMANCE: Avg. access time (ns)	200	150	150	150	150
Media read rate (MB/Sec)	5	13	13	12.5	12.5
Media write rate (MB/Sec)	.2*	.85	.85	.4	.4
Burst transfer rate (MB/Sec)	5	13 (Read)	13 (Read)		
Block erase time (ms)	1600	300	300	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 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 or 3.3 V 12 V option	3.3 to 5 V	3.3 to 5 V
FIRST CUSTOMER SHIPMENT	2Q92	1Q94	1Q94		
COMMENTS	*Chip pair	*Chip pair	*Chip pair	*For embedded Flash File system	*For embedded Flash File system

MANUFACTURER	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	M-SYSTEMS	MATSUSHITA ELECTRIC INDUSTRIAL
MODEL	FlashCard-4M	FlashCard-8M	FlashCard-10M	FlashCard-20M	BN-011HFRE
DISK/TREND GROUP	40	40	41	41	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	4	8	10	20	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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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
Driver memory needed (KB)	22*	22*	22*	22*	--
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	4	8	10	20	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					1994
COMMENTS	*For embedded Flash File system	*For embedded Flash File system	*For embedded Flash File system	*For embedded Flash File system	

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL
MODEL	BN-01MHFRE	BN-021HFRE	BN-02MHFRE	BN-04MHFRE	BN-256HFRE
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	2	2	1
Chip count per card	4	16	8	16	2
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	1 x 8/.512 x 16	.512x8/.256x16	2 x 8/1 x 16	4 x 8/2 x 16	1 x 8/.512 x 16
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)	256	128	256	256	128
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	1	2	2	4	.256
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	250	250	250	250	250
Media read rate (MB/Sec)	5	5	5	5	5
Media write rate (MB/Sec)	.0625	.0625	.0625	.0625	.0625
Burst transfer rate (MB/Sec)	--	--	--	--	--
Block erase time (ms)	2000	1000	2000	2000	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, 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	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MAXTOR	MAXTOR	MAXTOR
MODEL	BN-511HFRE	BN-512HFRE	Flash Card 1	Flash Card 2	Flash Card 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 Memory	Flash Memory	Flash Memory
Chip density (Mb)	1	2	8	8	8
Chip count per card	4	2	1	2	4
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2 x 8/1 x 16	.512x8/.256x16	1 x 8	1 x 8	1 x 8
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.10	PCMCIA 2.10	PCMCIA 2.10
XIP	Yes	Yes	Yes	Yes	Yes
Erasable block size (KB)	128	256	64	128	128
Driver memory needed (KB)	--	--	0*	22*	22*
Internal ECC	--	--	--	--	--
CAPACITY: Total capacity (Mbytes)	.512	.512	1	2	4
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	Yes	Yes	Yes
PERFORMANCE: Avg. access time (ns)	250	250	200	200	200
Media read rate (MB/Sec)	5	5	1.8	1.8	1.8
Media write rate (MB/Sec)	.0625	.0625	.03**	.055**	.11**
Burst transfer rate (MB/Sec)	--	--	1.8 (read)	1.8 (read)	1.8 (read)
Block erase time (ms)	1000	2000	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	1994	1994	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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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
Driver memory needed (KB)	22*	22*	22*	22*	22*
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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01
XIP					
Erasable block size (KB)					
Driver memory needed (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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)					
Driver memory needed (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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)					
Driver memory needed (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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)					
Driver memory needed (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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)					
Driver memory needed (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-G1EATXX	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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)					
Driver memory needed (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			

1994 DISK/TREND REPORT

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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)					
Driver memory needed (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

1994 DISK/TREND REPORT

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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.1	PCMCIA 2.1
XIP					
Erasable block size (KB)					
Driver memory needed (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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)					
Driver memory needed (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	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	Yes				
Erasable block size (KB)					
Driver memory needed (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	PREMAX ELECTRONICS	PREMAX ELECTRONICS	PREMAX ELECTRONICS	PREMAX ELECTRONICS	PREMAX ELECTRONICS
MODEL	FH002M-BN	FH004M-BN	FH008M-BN	JA-1024FLA	FH010M-BN
DISK/TREND GROUP	40	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)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA 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)					
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	None	None	None	None	None
CAPACITY: Total capacity (Mbytes)	2	4	8	1	10
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	--	--	--	--
Wearout leveling	--	--	--	--	--
PERFORMANCE: Avg. access time (ns)	70 (read)	70 (read)	70 (read)	350	70 (read)
Media read rate (MB/Sec)	10	10	10	--	10
Media write rate (MB/Sec)	.85	.85	.85	--	.85
Burst transfer rate (MB/Sec)	10 (read)	10 (read)	10 (read)	--	10 (read)
Block erase time (ms)	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, 12 V	5 V, 3.3 V 12 V option
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1994	1994
COMMENTS					

MANUFACTURER	PREMAX ELECTRONICS	QUANTUM	QUANTUM	QUANTUM	QUANTUM
MODEL	FH016M-BN	QC01P021-01-A-A Q Card-1	QC02P021-01-A-A Q Card-2	QC04P021-01-A-A Q Card-4	QC10P021-01-A-A Q Card-10
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)		4	4	4	4
Chip count per card		2	4	8	20
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization		1 x 4	1 x 4	1 x 4	1 x 4
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type II
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)		.512	.512	.512	.512
Driver memory needed (KB)	--	15	15	15	15
Internal ECC	None	None	None	None	None
CAPACITY: Total capacity (Mbytes)	16	1	2	4	10
SECTOR ENDURANCE: (Kcycles)	100	100	100	100	100
Spare sectors	--	100	200	400	1000
Wearout leveling	--	Yes	Yes	Yes	Yes
PERFORMANCE: Avg. access time (ns)	70 (read)	250	250	250	250
Media read rate (MB/Sec)	10	8	8	8	8
Media write rate (MB/Sec)	.85	.4	.4	.4	.4
Burst transfer rate (MB/Sec)	10 (read)	8	8	8	8
Block erase time (ms)	300	.1	.1	.1	.1
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, 3.3 V 12 V option	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1994	9/94	9/94	9/94	11/94
COMMENTS		Chips mfg. by Silicon Storage Technology	Chips mfg. by Silicon Storage Technology	Chips mfg. by Silicon Storage Technology	Chips mfg. by Silicon Storage Technology

MANUFACTURER	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY	SEAGATE TECHNOLOGY
MODEL	ST71P5	ST72P5	ST75P5	ST710P5	ST720P5
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)	4/8*	4/8*	4/8*	4/8*	16
Chip count per card	--	--	--	--	16
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2, 32, 80	2, 32, 80	2, 32, 160	2, 32, 320	2, 32, 640
FEATURES: Package	PCMCIA Type II	PCMCIA Type II	PCMCIA Type II	PCMCIA Type II	PCMCIA Type II
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
Driver memory needed (KB)	10	10	10	10	10
Internal ECC	Yes	Yes	Yes	Yes	Yes
CAPACITY: Total capacity (Mbytes)	1.8	2.6	5.2	10.4	20.9
SECTOR ENDURANCE: (Kcycles)	300	300	300	300	300
Spare sectors	Yes	Yes	Yes	Yes	Yes
Wearout leveling	Yes	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)	1.25	2.5	1.25	2.5	3
Media write rate (MB/Sec)	1.25	2.5	1.25	2.5	3
Burst transfer rate (MB/Sec)	3	3	3	6	6
Block erase time (ms)	2	2	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	5 V	5 V
FIRST CUSTOMER SHIPMENT	1993	1993	1993	1993	3Q94
COMMENTS	Made by SunDisk *16 mbit in 1Q95 **4 msec. from sleep	Made by SunDisk *16 mbit in 1Q95 **2 msec. from sleep	Made by SunDisk *16 mbit in 1Q95 **4 msec. from sleep	Made by SunDisk *16 mbit in 1Q95 **2 msec. from sleep	Made by SunDisk *2 msec. from sleep

MANUFACTURER	SEAGATE TECHNOLOGY	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
MODEL	ST740P5	ATA202SD11/01	ATA502SD11/01	HWB101ESX0/40	HWB201ESX0/40
DISK/TREND GROUP	42	40	40	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM	OEM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Memory	Flash Memory
Chip density (Mb)	16				
Chip count per card	32				
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	4, 32, 640				
FEATURES: Package	PCMCIA Type II	PCMCIA Type II	PCMCIA Type II	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.01	PCMCIA 2.01
XIP	No	No	No		
Erasable block size (KB)	.512	.512	.512		
Driver memory needed (KB)	10			--	--
Internal ECC	Yes	Yes	Yes	--	--
CAPACITY: Total capacity (Mbytes)	41.9	2.6	5.2	.512	1
SECTOR ENDURANCE: (Kcycles)	300	200	200		
Spare sectors	Yes	Yes	Yes	--	--
Wearout leveling	Yes	Yes	Yes	--	--
PERFORMANCE: Avg. access time (ns)	1.25 ms*	1.25 ms	1.25 ms	200	200
Media read rate (MB/Sec)	3	.625	.625		
Media write rate (MB/Sec)	3	.075	.075		
Burst transfer rate (MB/Sec)	6				
Block erase time (ms)	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	3.3 x 54 x 85.6	3.3 x 54 x 85.6
OPERATING VOLTAGE:	5 V	5 V	5 V		
FIRST CUSTOMER SHIPMENT	3Q94				
COMMENTS	Made by SunDisk *2 msec. from sleep				

MANUFACTURER	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON	SEIKO EPSON
MODEL	HWB201S8XO/40	HWB257ESXO/40	HWB401ESXO/40	HWB401S8XO/40	HWB513ESXO/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				
Chip organization					
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01	PCMCIA 2.01
XIP					
Erasable block size (KB)					
Driver memory needed (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	HWB801S8XO/40	ATA112SD11/01	ATA212SD11/01	HWB111S8XO/80	HWB161S8XO/80
DISK/TREND GROUP	40	41	41	41	41
MARKET	OEM	OEM, PCM	OEM, PCM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Disk	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	PCMCIA Type I	PCMCIA Type II	PCMCIA Type II	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.01	PCMCIA-ATA	PCMCIA-ATA	PCMCIA 2.01	PCMCIA 2.01
XIP		No	No		
Erasable block size (KB)					
Driver memory needed (KB)	--			--	--
Internal ECC	--			--	--
CAPACITY: Total capacity (Mbytes)	4	10.4	20.9	10	16
SECTOR ENDURANCE: (Kcycles)		200	200		
Spare sectors	--			--	--
Wearout leveling	--			--	--
PERFORMANCE: Avg. access time (ns)	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)					
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	5 V		
FIRST CUSTOMER SHIPMENT					
COMMENTS					

MANUFACTURER	SEIKO EPSON	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES	SMART MODULAR TECHNOLOGIES
MODEL	ATA412SD12/02	SM9FL1MP3 SM9FL1MP35V	SM9FL256KP3 SM9FL256KP35V	SM9FL2MP3 SM9FL2MP35V	SM9FL4MP3 SM9FL4MP35V
DISK/TREND GROUP	42	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)					
Chip count per card					
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization					
FEATURES: Package	PCMCIA Type II	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA-ATA	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1
XIP	No				
Erasable block size (KB)	.512				
Driver memory needed (KB)		--	--	--	--
Internal ECC		None	None	None	None
CAPACITY: Total capacity (Mbytes)	40	1	.256	2	4
SECTOR ENDURANCE: (Kcycles)	200				
Spare sectors		None	None	None	None
Wearout leveling		--	--	--	--
PERFORMANCE: Avg. access time (ns)	1.25 ms	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)					
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		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	SUNDISK	SUNDISK
MODEL	SM9FL512KP3 SM9FL512KP35V	SM9FL8MP3 SM9FL8MP35V	SM9FL16MP3 SM9FL16MP35V	SD-2.5 FLASHDISK	SD-5 FLASHDISK
DISK/TREND GROUP	40	40	41	40	40
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM	OEM
PRODUCT TYPE: Generic	Flash Memory	Flash Memory	Flash Memory	Flash Disk	Flash Disk
Chip density (Mb)				4/8	4/8
Chip count per card				5/3	10/5
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization				2, 32, 80	2, 32, 160
FEATURES: Package	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I	PCMCIA Type I
Interface	PCMCIA 2.1	PCMCIA 2.1	PCMCIA 2.1	Proprietary	Proprietary
XIP				No	No
Erasable block size (KB)				.512	.512
Driver memory needed (KB)	--	--	--	--	--
Internal ECC	None	None	None	Yes	Yes
CAPACITY:					
Total capacity (Mbytes)	.512	8	16	2.6	5.2
SECTOR ENDURANCE: (Kcycles)				50	50
Spare sectors	None	None	None	Yes	Yes
Wearout leveling	--	--	--	Yes	Yes
PERFORMANCE:					
Avg. access time (ns)	150/200/250	150/200/250	150/200/250	1.5 ms	1.5 ms
Media read rate (MB/Sec)				2.5	2.5
Media write rate (MB/Sec)				2.5	2.5
Burst transfer rate (MB/Sec)				3.75	3.75
Block erase time (ms)				N/A	N/A
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	1991	1991
COMMENTS	5V is 5 volt unit	5V is 5 volt unit	5V is 5 volt unit		

MANUFACTURER	SUNDISK	SUNDISK	SUNDISK	SUNDISK	SUNDISK
MODEL	SDP5-1 FLASHDISK	SDP5-1.8 FLASHDISK	SDP5-2.5 FLASHDISK	SDP5-5 FLASHDISK	SDP5A-1.8 FLASHDISK
DISK/TREND GROUP	40	40	40	40	40
MARKET	OEM, PCM	OEM	OEM, PCM	OEM, PCM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)	8	8	8	8	16
Chip count per card	1	2	3	5	1
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2, 32, 30	2, 32, 56	2, 32, 80	2, 32, 160	2, 32, 56
FEATURES: Package	PCMCIA Type II	PCMCIA Type II	PCMCIA Type II	PCMCIA Type II	PCMCIA Type II
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
Driver memory needed (KB)	10	10	10	10	10
Internal ECC	Yes	Yes	Yes	Yes	Yes
CAPACITY: Total capacity (Mbytes)	.98	1.8	2.6	5.2	1.8
SECTOR ENDURANCE: (Kcycles)	200	200	200	200	300
Spare sectors	Yes	Yes	Yes	Yes	Yes
Wearout leveling	Yes	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)	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)	N/A	N/A	N/A	N/A	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	5 V	5 V
FIRST CUSTOMER SHIPMENT	1992	1992	1992	1992	1993
COMMENTS					

MANUFACTURER	SUNDISK	SUNDISK	SUNDISK	SUNDISK	SUNDISK
MODEL	SDP5A-2.5 FLASHDISK	SDP5A-5 FLASHDISK	SD-10 FLASHDISK	SD-20 FLASHDISK	SDIA-10 FLASHDISK
DISK/TREND GROUP	40	40	41	41	41
MARKET	OEM, PCM	OEM, PCM	OEM	OEM	OEM, PCM
PRODUCT TYPE: Generic	Flash Disk	Flash Disk	Flash Disk	Flash Disk	Flash Disk
Chip density (Mb)	16	16	4/8	4/8	16
Chip count per card	2	3	20/10	40/20	5
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2, 32, 80	2, 32, 160	2, 32, 320	2, 32, 640	2, 32, 320
FEATURES: Package	PCMCIA Type II	PCMCIA Type II	PCMCIA Type I	PCMCIA Type I	1.8" IDE
Interface	PCMCIA-ATA	PCMCIA-ATA	Proprietary	Proprietary	IDE
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
Driver memory needed (KB)	10	10	--	--	N/A
Internal ECC	Yes	Yes	Yes	Yes	Yes
CAPACITY: Total capacity (Mbytes)	2.6	5.2	10.4	20.9	10.4
SECTOR ENDURANCE: (Kcycles)	300	300	50	50	300
Spare sectors	Yes	Yes	Yes	Yes	Yes
Wearout leveling	Yes	Yes	Yes	Yes	Yes
PERFORMANCE: Avg. access time (ns)	1.25 ms	1.25 ms	1.5 ms	1.5 ms	1.25 ms
Media read rate (MB/Sec)	3	3	2.5	2.5	3
Media write rate (MB/Sec)	3	3	2.5	2.5	3
Burst transfer rate (MB/Sec)	6	6	3.75	3.75	6
Block erase time (ms)	2	2	N/A	N/A	2
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	9.6 x 50.8 x 76.2
OPERATING VOLTAGE:	5 V	5 V	5 V	5 V	5 V
FIRST CUSTOMER SHIPMENT	1993	1993	1991	1992	1994
COMMENTS					

MANUFACTURER	SUNDISK	SUNDISK	SUNDISK	SUNDISK	SUNDISK
MODEL	SDP5-10 FLASHDISK	SDP5-20 FLASHDISK	SDP5A-10 FLASHDISK	SDP5A-20 FLASHDISK	SDP5A-40 FLASHDISK
DISK/TREND GROUP	41	41	41	41	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)	8	8	16	16	16
Chip count per card	10	20	5	10	20
Chip logic type	NOR	NOR	NOR	NOR	NOR
Chip organization	2, 32, 320	2, 32, 640	2, 32, 320	2, 32, 640	4, 32, 640
FEATURES: Package	PCMCIA Type II	PCMCIA Type II	PCMCIA Type II	PCMCIA Type II	PCMCIA Type II
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
XIP	No	No	No	No	No
Erasable block size (KB)	.512	.512	.512	.512	.512
Driver memory needed (KB)	10	10	10	10	10
Internal ECC	Yes	Yes	Yes	Yes	Yes
CAPACITY:					
Total capacity (Mbytes)	10.4	20.9	10.4	20.9	41.9
SECTOR ENDURANCE: (Kcycles)	200	200	300	300	300
Spare sectors	Yes	Yes	Yes	Yes	Yes
Wearout leveling	Yes	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)	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)	N/A	N/A	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	5 V	5 V
FIRST CUSTOMER SHIPMENT	1992	1993	1993	1993	1993
COMMENTS					

PCMCIA RIGID DISK DRIVE SPECIFICATIONS

1994 DISK/TREND REPORT

PCMCIA RIGID DISK DRIVE SPECIFICATIONS

Coverage

This section includes removable rigid disk drives packaged in PCMCIA form factors 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 the specification pages, capacities are listed as "U" for unformatted or "F" for formatted. In general, unformatted capacities are shown only for OEM/Integrator and PCM/Reseller drives without embedded controllers, and formatted capacities are given for captive drives and noncaptive drives with embedded controllers, such as SCSI or PC/AT. 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, or the data rate between the drive and its controller, if the controller is not embedded. 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.

1994 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	AURA ASSOCIATES	AURA ASSOCIATES	AURA ASSOCIATES	CALLUNA TECHNOLOGY	CALLUNA TECHNOLOGY
DRIVE	AU1085P-III	AU63-III	AU1170P-III	CT-80MC	CT-105MC
DISK/TREND GROUP	2	2	3	2	3
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM	OEM
MEDIA: Nominal disk diameter	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID
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: 62.9	F: 170	F: 85.33	F: 105
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	4
Tracks per surface	1498	1500	1498	1084	832
Track density (TPI)	3336	3200	3336	2490	2490
Maximum linear density (BPI) (FCI)	72000 54000	57000 43000	72000 54000	50411 37808	62244 46683
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	5400	5400	5400	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)	16	16	16	18	18
Average rotational delay (msec)	5.6	5.5	5.6	6.25	6.25
Average access time (msec)	21.6	21.5	21.6	24.25	24.25
Data transfer rate (KBytes/sec)	5000	5000	5000	4000	4000
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	1Q95	4Q93	1Q95	4/93	12/93
COMMENTS	PCMCIA Type III	PCMCIA Type III	PCMCIA Type III	PCMCIA Type III	PCMCIA Type III

MANUFACTURER	CALLUNA TECHNOLOGY	CALLUNA TECHNOLOGY	CALLUNA TECHNOLOGY	HITACHI	INTEGRAL PERIPHERALS
DRIVE	CT-130MC	CT-170	CT-210	DK120P-13	1841PA Ranger
DISK/TREND GROUP	3	3	4	3	2
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	Thin Film	Thin Film	Thin Film	MIG	MIG
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 130	F: 170	F: 210	F: 130	F: 42.5
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	2
Tracks per surface	1010	1467	1602	1260	1015
Track density (TPI)	2840	3300	3600	3200	2409
Maximum linear density (BPI)	67580	98000	111333	75000	58500
(FCI)	50685	73500	83500	50000	43875
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	4800	4800	4800	4464	3571
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	18
Average rotational delay (msec)	6.25	6.25	6.25	6.7	8.4
Average access time (msec)	24.25	22.25	22.25	22.7	26.4
Data transfer rate (KBytes/sec)	4000	11000	11000	5000	5000
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	10.5 x 54 x 85.6
FIRST CUSTOMER SHIPMENT	5/94	9/94	4Q94	4Q94	4Q92
COMMENTS	PCMCIA Type III	PCMCIA Type III	PCMCIA Type III	PCMCIA Type III	PCMCIA Type III Ramp loaded heads

MANUFACTURER	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS	INTEGRAL PERIPHERALS
DRIVE	1882PA Cobra	8105PA Viper	8170PA Viper	PocketFile 105	PocketFile 170
DISK/TREND GROUP	2	3	3	3	3
MARKET	OEM	OEM	OEM	PCM	PCM
MEDIA: Nominal disk diameter	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID
Recording medium	Thin Film	Thin Film	Thin Film*	Thin Film	Thin Film*
DRIVE: Heads	MIG	MIG	Thin Film	MIG	Thin Film
Interface	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA	PCMCIA-ATA
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 85	F: 105.4	F: 170.8	F: 105.4	F: 170.8
Capacity per track (Bytes)	Varies by zone	Varies by zone	Varies by zone	Varies by zone	Varies by zone
Data surfaces per spindle	3	4	4	4	4
Tracks per surface	1203	1107	1370	1107	1370
Track density (TPI)	2750	2840	3800	2840	3800
Maximum linear density (BPI)	71100	70000	84000	70000	84000
(FCI)	53325	52000	63000	52000	63000
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	3571	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)	18	15	12	15	12
Average rotational delay (msec)	8.4	6.7	6.7	6.7	6.7
Average access time (msec)	26.4	21.7	18.7	21.7	18.7
Data transfer rate (KBytes/sec)	5000	10700	12000	10700	12000
SIZE: (mm) H x W x D	12.5 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	3Q92	11/93	3/94	1/94	3/94
COMMENTS	Ramp loaded heads	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

MANUFACTURER	MAXTOR	MAXTOR	MAXTOR	MINISTOR PERIPHERALS	MINISTOR PERIPHERALS
DRIVE	MobileMax 105	MobileMax 131	MobileMax 171	MiniPORT 42P	MiniPORT 85P
DISK/TREND GROUP	3	3	3	2	2
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM	OEM
MEDIA: Nominal disk diameter	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID
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: 105	F: 131	F: 171.2	F: 42.4	F: 84.8
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	2	4
Tracks per surface	1254	1534	1675	1076	1076
Track density (TPI)	2727	3332	3555	2750	2750
Maximum linear density (BPI) (FCI)	58000 43500	58000 43500	67500 50625	55300 41500	55300 41500
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	4464	4464	4464	4464	4464
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)	19	19	16	16	16
Average rotational delay (msec)	6.72	6.72	6.72	6.7	6.7
Average access time (msec)	25.72	25.72	22.72	22.7	22.7
Data transfer rate (KBytes/sec)	4000	4000	7500	5000	5000
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	13.5 x 54 x 85.6
FIRST CUSTOMER SHIPMENT	4/94	4/94	8/94	2Q93	1Q93
COMMENTS	PCMCIA Type III *Glass disk	PCMCIA Type III *Glass disk	PCMCIA Type III *Glass disk	PCMCIA Type III	

MANUFACTURER	MINISTOR PERIPHERALS	MINISTOR PERIPHERALS	MINISTOR PERIPHERALS	MINISTOR PERIPHERALS	MINISTOR PERIPHERALS
DRIVE	MP87P	MiniPORT 128P	MP130P3	MP170P3	MP260P3
DISK/TREND GROUP	2	3	3	3	3
MARKET	OEM, PCM	OEM	OEM, PCM	OEM, PCM	OEM, PCM
MEDIA: Nominal disk diameter	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID
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: 88	F: 128	F: 131	F: 178	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	2	4	4	4	4
Tracks per surface	1445	1260	1305	1445	1305
Track density (TPI)	3400	3200	3200	3400	3200
Maximum linear density (BPI) (FCI)	94500 70875	75000 50000	76500 57375	94500 70875	76500 57375
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL
Rotational speed (RPM)	4464	4464	4464	4464	4464
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	16	15	15	15
Average rotational delay (msec)	6.72	6.7	6.72	6.72	6.72
Average access time (msec)	21.72	22.7	21.72	21.72	21.72
Data transfer rate (KBytes/sec)	8000	5000	8000	8000	8000
SIZE: (mm) H x W x D	10.5 x 54 x 85.6	13.5 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	3Q94	3Q93	4/94	3Q94	4/94
COMMENTS	PCMCIA Type III		PCMCIA Type III	PCMCIA Type III	PCMCIA Type III 2X version of MP130P3 using Stac data compression

MANUFACTURER	MINISTOR PERIPHERALS	NEC	NEC	SEAGATE TECHNOLOGY	SEIKO EPSON
DRIVE	MP340P3	D1632	D1741	ST7050P	EHDD170 Hard Disk Card
DISK/TREND GROUP	3	2	3	2	3
MARKET	OEM, PCM	OEM	OEM	OEM	PCM
MEDIA: Nominal disk diameter	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID	48 mm OD 12 mm ID
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	PC AT	PCMCIA-ATA	PCMCIA-ATA
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 340	F: 80	F: 125.9	F: 42.6	F: 170.8
Capacity per track (Bytes)	Varies by zone	Varies by zone	Varies by zone	Varies by zone	Varies by zone
Data surfaces per spindle	4	2	4	2	4
Tracks per surface	1445		1411	1074	1370
Track density (TPI)	3400		3200	2748	3800
Maximum linear density (BPI) (FCI)	94500 70875		59140 44355	53200 39900	84000 63000
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1, 7 RLL	1,7 RLL
Rotational speed (RPM)	4464	5400	5400	3545	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	16	17	16	12
Average rotational delay (msec)	6.72	5.56	5.56	8.46	6.7
Average access time (msec)	21.72	21.56	22.56	24.46	18.7
Data transfer rate (KBytes/sec)	8000	4500	4500	4000	12000
SIZE: (mm) H x W x D	10.5 x 54 x 85.6	10.5 x 54 x 85.6	15 x 50.8 x 76.9	10.5 x 54 x 85.6	10.5 x 54 x 85.6
FIRST CUSTOMER SHIPMENT	3Q94	1994	3Q93	1993	3/94
COMMENTS	PCMCIA Type III 2X version of MP170P3 using Stac data compression	PCMCIA Type III		PCMCIA Type III	PCMCIA Type III Ramp loaded heads. *Untextured disks. Mfg. by Integral Periph

RIGID DISK CARTRIDGE DRIVE SPECIFICATIONS

1994 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 the specification pages, capacities are listed as "U" for unformatted or "F" for formatted. In general, unformatted capacities are shown only for OEM/Integrator and PCM/Reseller drives without embedded controllers, and formatted capacities are given for captive drives and noncaptive drives with embedded controllers, such as SCSI or PC/AT. 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, or the data rate between the drive and its controller, if the controller is not embedded. 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.

1994 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 SYSTEMS	AVATAR SYSTEMS	AVATAR SYSTEMS	AVATAR SYSTEMS	MFM TECHNOLOGY
DRIVE	ASR-2085NI ASR-2085NS Remington	ASR-2128HI Maxim	ASR-3085FI ASR-3085FS Magnum	ASR-3085NI ASR-3085NS Colt	11/11 Micro-Magnum
DISK/TREND GROUP	1	1	1	1	1
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	65 mm OD 20 mm ID	65 mm OD 20 mm ID	65 mm OD 20 mm ID	65 mm OD 20 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film*	Thin Film*	Thin Film*	Thin Film*	Oxide Coated
DRIVE: Heads	Thin Film	Thin Film	Thin Film	Thin Film	Ferrite
Interface	SCSI-2, PC AT	PC AT	SCSI-2, PC AT	SCSI-2, PC AT	ST506
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	U: 13.6
REMOVABLE	F: 85.9	F: 85.9	F: 85.9	F: 85.9	U: 13.6
Capacity per track (Bytes)	Varies by zone	Varies by zone	Varies by zone	Varies by zone	U: 10,640
Data surfaces per spindle	2	2	2	2	4
Tracks per surface	1730	1730	1730	1730	640
Track density (TPI)	3100	3100	3100	3100	908
Maximum linear density (BPI) (FCI)	52100 39075	52100 39075	52100 39075	52100 39075	10890
Recording code	1, 7 RLL	1, 7 RLL	1, 7 RLL	1, 7 RLL	MFM
Rotational speed (RPM)	4500	4500	4500	4500	3254
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Linear, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	12	12	12	12	40
Average rotational delay (msec)	6.7	6.7	6.7	6.7	9.2
Average access time (msec)	18.7	18.7	18.7	18.7	49.2
Data transfer rate (KBytes/sec)	1200	1200	1200	1200	625
SIZE: (mm) H x W x D	19 x 72.4 x 101.6	22 x 72.4 x 101.6	25.4 x 101.6 x 146.1	12.7 x 101.6 x 146.1	41.3 x 146.1 x 266.1
FIRST CUSTOMER SHIPMENT	2/94	4Q94	2/94	1Q95	1986
COMMENTS	Removable data cartridge *Glass disk	Removable data cartridge *Glass disk. Includes H-P 1.3" Kittyhawk 42.8 MB drive	Removable data cartridge *Glass disk. Includes 3.5" 1.44 MB floppy drive	Removable data cartridge *Glass disk	Removable data cartridge

MANUFACTURER	MFM TECHNOLOGY	MFM TECHNOLOGY	MFM TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY
DRIVE	11/R Micro-Magnum	5/5 Micro-Magnum	5/R Micro-Magnum	SQ555	SQ1080
DISK/TREND GROUP	1	1	1	1	1
MARKET	OEM	OEM	OEM	OEM, PCM	OEM, PCM
MEDIA: Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	48 mm OD 12 mm ID
Recording medium	Oxide Coated	Oxide Coated	Oxide Coated	Thin Film	Thin Film
DRIVE: Heads	Ferrite	Ferrite	Ferrite	Ferrite	Thin Film
Interface	ST506	ST506	ST506	SCSI	PCMCIA-ATA
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	U: 6.4	--	--	--
REMOVABLE	U: 13.6	U: 6.4	U: 6.75	F: 44.39	F: 80
Capacity per track (Bytes)	U: 10,640	U: 10,032	U: 10,890	F: 17,408	F: 36,864
Data surfaces per spindle	2	4	2	2	2
Tracks per surface	640	320	311	1275	1472
Track density (TPI)	908	454	454	1086	3200
Maximum linear density (BPI)	10890	8725	8617	23642	72000
(FCI)				15761	54330
Recording code	MFM	MFM	MFM	2,7 RLL	1,7 RLL
Rotational speed (RPM)	3254	3443	3443	3220	5400
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil
Servo type	Embedded	Embedded	Embedded	Embedded	Embedded
Average positioning time (msec)	40	40	40	20	16
Average rotational delay (msec)	9.2	8.7	8.7	9.32	5.6
Average access time (msec)	49.2	48.7	48.7	29.32	21.6
Data transfer rate (KBytes/sec)	625	625	625	1250	10000
SIZE: (mm) H x W x D	41.3 x 146.1 x 266.7	41.3 x 146.1 x 266.7	41.3 x 146.1 x 266.7	41.3 x 146.1 x 203.2	10.5 x 54 x 85.6
FIRST CUSTOMER SHIPMENT	1986	1986	1986	1Q88	4Q93
COMMENTS	Removable data cartridge	Removable data cartridge	Removable data cartridge	Removable data cartridge	PCMCIA Type III

MANUFACTURER	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY
DRIVE	SQ3105A	SQ3105S	SQ3270A	SQ3270S	SQ5110
DISK/TREND GROUP	1	1	1	1	1
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
MEDIA: Nominal disk diameter	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	95 mm OD 25 mm ID	130 mm OD 40 mm ID
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	Thin Film
DRIVE: Heads	MIG	MIG			Ferrite
Interface	PC AT	SCSI-2	PC AT	SCSI-2	SCSI
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	--
REMOVABLE	F: 110	F: 110	F: 270	F: 270	F: 88.8
Capacity per track (Bytes)	Varies by zone	Varies by zone	F:	F:	Varies by zone
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	2043	2043	3140	3140	1774
Track density (TPI)	2100	2100	3280	3280	1470
Maximum linear density (BPI) (FCI)	40000 30000	40000 30000	60000 45000	60000 45000	28546 19031
Recording code	1,7 RLL	1,7 RLL	1,7 RLL	1,7 RLL	2,7 RLL
Rotational speed (RPM)	3600	3600	3600	3600	3220
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)	14.5	14.5	13.5	13.5	20
Average rotational delay (msec)	8.3	8.3	8.3	8.3	9.32
Average access time (msec)	22.8	22.8	21.8	21.8	29.32
Data transfer rate (KBytes/sec)	4000	4000 synch.	4000	4000	4000 synch. 1250 asynch.
SIZE: (mm) H x W x D	25.4 x 101.6 x 146.1	25.4 x 101.6 x 146.1	25.4 x 101.6 x 150	25.4 x 101.6 x 150	41.3 x 146.1 x 203.2
FIRST CUSTOMER SHIPMENT	3Q92	3/93	4Q93	2/94	2/91
COMMENTS	Removable data cartridge	Removable data cartridge	Removable data cartridge	Removable data cartridge	Removable data cartridge Read & write compatible with 44 MB & 88 MB cartridges

MANUFACTURER	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	SYQUEST TECHNOLOGY	
DRIVE	SQ5200C	SyDOS 44e SyDOS 44i	SyDOS 88e SyDOS 88i	SyDOS 105e SyDOS 105i	
DISK/TREND GROUP	1	1	1	1	
MARKET	OEM, PCM	PCM	PCM	PCM	
MEDIA: Nominal disk diameter	130 mm OD 40 mm ID	130 mm OD 40 mm ID	130 mm OD 40 mm ID	95 mm OD 25 mm ID	
Recording medium	Thin Film	Thin Film	Thin Film	Thin Film	
DRIVE: Heads	Ferrite	Ferrite	Ferrite	MIG	
Interface	SCSI-2	SCSI	SCSI	SCSI, IDE	
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes) FIXED	--	--	--	--	
REMOVABLE	F: 200	F: 44.39	F: 88.8	F: 110	
Capacity per track (Bytes)	Varies by zone	F: 17,408	Varies by zone	Varies by zone	
Data surfaces per spindle	2	2	2	2	
Tracks per surface	2260	1275	1774	243	
Track density (TPI)	1875	1086	1475	2100	
Maximum linear density (BPI) (FCI)	49820 37365	23642 15761	28546 19031	40000 30000	
Recording code	1,7 RLL	2,7 RLL	2,7 RLL	1,7 RLL	
Rotational speed (RPM)	3220	3220	3220	3600	
PERFORMANCE					
Actuator type	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	Rotary, Voice Coil	
Servo type	Embedded	Embedded	Embedded	Embedded	
Average positioning time (msec)	18	20	20	14.5	
Average rotational delay (msec)	9.32	9.32	9.32	8.3	
Average access time (msec)	27.32	29.32	29.32	22.8	
Data transfer rate (KBytes/sec)	5000 synch. 3000 asynch.	4000 synch. 1250 asynch.	4000 synch. 1250 asynch.	4000 synch. 1250 asynch.	
SIZE: (mm) H x W x D	41.3 x 146.1 x 203.2	41.3 x 146.1 x 203.2	41.3 x 146.1 x 203.2	25.4 x 101.6 x 146.1	
FIRST CUSTOMER SHIPMENT	2Q94	7/91	7/91	7/93	
COMMENTS	Removable data cartridge Read & write compatible with 44 MB, 88 MB & 200 MB cart.	Removable data cartridge	Removable data cartridge	Removable data cartridge	

SMALL OPTICAL DISK DRIVE SPECIFICATIONS

1994 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 medium: The composition of the active layer of optical media is the one described by the drive manufacturer. Recording formats also differ, and for some products announced to date, recorded media is generally not interchangeable between systems.

Operating mode: Rewritable (erasable) drives are indicated on the line describing the operating mode, with the technology type in parentheses. 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. The abbreviation "PC" means the IBM PC/AT interface.

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: Many optical disk drives have multistage head positioning systems. A coarse movement positions the head in the vicinity of the track to be located. A fine, or vernier, actuator then moves the head to the desired track. Where appropriate, the abbreviation "Crs" is used for "coarse".

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.

1994 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 DISK/TREND Report on optical disk drives.

MANUFACTURER	CHINON	FUJITSU	FUJITSU	IBM	IBM
DRIVE	MO300 MOA300 MOD300 MOX300	M2511A DynaMO 128	M2512A DynaMO	MD 3125B	MTA-3127 MTAS-3127
DISK/TREND GROUP	11	11	11	11	11
MARKET	OEM, PCM	Captive, OEM	OEM, PCM	OEM	OEM
MEDIA: Nominal disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording medium	RE-TM Alloy	RE-TM Alloy	RE-TM Alloy	RE-TM Alloy	RE-TM Alloy
Track format	Spiral	Spiral	Spiral	Spiral	Spiral
DRIVE: Operating mode	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)	Rd.Only,Rewrit.	Rewritable-(MO)
Interface	SCSI-2	SCSI-2	SCSI-2	SCSI	SCSI
Speed control	CAV	CAV	CAV/ZCAV	CAV	CAV
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 128	F: 128	F: 128/230	F: 127/122	F: 127
Capacity per track (Bytes)	F:	F: 12,800	F: N/A	F:12,700/12,200	F: 12,800
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	10000	10000	1000/17940	10000	9994
Track density (TPI)	15875	15875	15875/18273	15900	15900
Maximum linear density (BPI)	24440	24400	24400/29296	24400	24400
Rotational speed (RPM)	3000	3600	3600	3000	3000
PERFORMANCE					
Positioner type	Crs: Voice Coil Fine: Lens Actuator	Crs: Linear, Voice Coil Fine: Lens Actuator	Crs: Linear, Voice Coil Fine: Lens Actuator	Crs: Voice Coil Fine: Lens Actuator	Crs: Voice Coil Fine: Lens Actuator
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	45	30	35	40	40
Average rotational delay (msec)	10	8.3	8.3	10	10
Average access time (msec)	55	38.3	43.3	50	50
Data transfer rate (KBytes/sec)	625	1090 4000 synch.	1300-2100 5000 synch.	625 4000 synch.	625
SIZE (mm: H x W x D)	41.3 x 146.1 x 203.2	25.4 x 101.6 x 146.1	25.4 x 101.6 x 146	41.3 x 101.6 x 169	25.4 x 101.6 x 169
FIRST CUSTOMER SHIPMENT	1Q93	1992	3/94	3Q92	4Q93
COMMENTS	256 KB buffer	256 KB read cache DynaMO is external subsystem	256 KB read/ write cache DynaMO is external subsystem	122 MB with read only media P-ROM support	122 MB with read only media P-RPM support

MANUFACTURER	IBM	LASERBYTE	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL
DRIVE	MTA-3230	LB3230	LF-3000E LF-3002 LF-3004 LF-3090	LF-3100 LF-3104	LF-3200JA
DISK/TREND GROUP	11	11	11	11	11
MARKET	Captive,OEM,PCM	OEM, PCM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording medium	RE-TM Alloy	RE-TM Alloy	Tb-Fe-Co	Tb-Fe-Co	Tb-Fe-Co
Track format	Banded Spiral	Spiral	Spiral	Spiral	Spiral
DRIVE: Operating mode	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)
Interface	SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2	SCSI
Speed control	ZCAV	ZCAV	CAV	CAV	ZCAV
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 230	F: 229.1	F: 128	F: 128	F: 229.1
Capacity per track (Bytes)	F: 12,800*	F: 12,800	F: 12,800	F: 12,800	F: 12,800*
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	11510/17853*	17900	10000	10000	11510/17853*
Track density (TPI)	18273	18273	15875	15875	18273
Maximum linear density (BPI)	29540	24300	24440	24440	29540
Rotational speed (RPM)	3600	3600	3000	3000	3600
PERFORMANCE					
Positioner type	Crs: Voice Coil Fine: Lens Actuator	Crs: Voice Coil Fine: Lens Actuator	Crs: Linear, Voice Coil Fine:	Crs: Linear, Voice Coil Fine:	Crs: Voice Coil Fine: Lens Actuator
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	40	28	40	40	35
Average rotational delay (msec)	8.3	8.3	10	10	8.3
Average access time (msec)	48.3	36.3	50	50	43.3
Data transfer rate (KBytes/sec)	1475 max. 5000 synch.	920-1470	937.5	906 1500 avg.	2100 5000 synch.
SIZE (mm: H x W x D)	25.4 x 101.6 x 169	41.3 x 101.6 x 146	41.3 x 101.6 x 146	41.3 x 101.6 x 146	56 x 168 x 240
FIRST CUSTOMER SHIPMENT	5/94	2Q94	4Q91	3Q91	3Q94
COMMENTS	*Logical tracks Read only and partial read only modes	256 KB buffer Read only and partial read only modes	LF-3090 is external mount	LF-3100 is external mount Sold in Japan	256 KB buffer. *Logical tracks For use with Macintosh. External mount

MANUFACTURER	MATSUSHITA ELECTRIC INDUSTRIAL	MATSUSHITA ELECTRIC INDUSTRIAL	MOST	MOST	NEC
DRIVE	LF-3200JD	LF-3294	RMD 5200-S	RMD 5300-S	PC-0D301 PC-0D301R
DISK/TREND GROUP	11	11	11	11	11
MARKET	OEM	OEM	OEM, PCM	OEM, PCM	Captive
MEDIA: Nominal disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording medium	Tb-Fe-Co	Tb-Fe-Co	RE-TM Alloy	RE-TM Alloy	Tb-Fe-Co
Track format	Spiral	Spiral	Spiral	Spiral	Spiral
DRIVE: Operating mode	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)
Interface	SCSI	SCSI	SCSI-1/2	SCSI-2	SCSI
Speed control	ZCAV	ZCAV	CAV	CAV	CAV
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 229.1	F: 229.1	F: 128/256*	F: 230*/256/384	F: 128
Capacity per track (Bytes)	F: 12,800*	F: 12,800*	F: 12,800/**	**	F: 12,800
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	11510/17853*	11510/17853*	10000	12900	10000
Track density (TPI)	18273	18273	15875	18273	15375
Maximum linear density (BPI)	29540	29540	15875/39625	42900	24500
Rotational speed (RPM)	3600	3600	2400	2400	3000
PERFORMANCE					
Positioner type	Crs: Voice Coil Fine: Lens Actuator	Crs: Voice Coil Fine: Lens Actuator	Crs: Voice Coil Fine: Lens Actuator	Crs: Voice Coil Fine: Lens Actuator	Crs: Voice Coil Fine: Lens Actuator
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	35	35	35.2	35.2	40
Average rotational delay (msec)	8.3	8.3	12.5	12	10
Average access time (msec)	43.3	43.3	47.7	47.2	50
Data transfer rate (KBytes/sec)	2100 5000 synch.	2100 5000 synch.	512/820-1228	512/860-1500	1500
SIZE (mm: H x W x D)	56 x 168 x 240	41.3 x 101.6 x 151.5	41.3 x 146 x 203.2	41.3 x 146 x 203.2	100 x 170 x 280
FIRST CUSTOMER SHIPMENT	3Q94	2Q94	2Q92	3Q94	1992
COMMENTS	256 KB buffer. *Logical tracks For use w/DOS, PC-9800 and Panacom systems External mount	256 KB buffer *Logical tracks	*Zoned record. **Varies by zone. OROM support. 128 KB buffer.	*Also operates with 128 MB media **Varies by format	

MANUFACTURER	OLYMPUS	OLYMPUS	OLYMPUS	RICOH	SEIKO EPSON
DRIVE	128MO	MOS300E MOS300S	MOS320E MOS320S MOS321S*	RO-3012E RS-3102E Transporter 2	OMD 5010
DISK/TREND GROUP	11	11	11	11	11
MARKET	OEM	OEM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording medium	RE-TM Alloy	Tb-Fe-Co	Tb-Fe-Co	RE-TM Alloy	RE-TM Alloy
Track format	Spiral	Spiral	Spiral	Spiral	Spiral
DRIVE: Operating mode	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)
Interface	SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2
Speed control	CAV	CAV	CAV/ZCAV	CAV	CAV
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 128	F: 128	F: 230/128	F: 127.4	F: 128
Capacity per track (Bytes)	F: 10,000	F: 12,800	F: 12,800	F: 12,740	F: 12,800
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	10000	10000	11500**	10000	10000
Track density (TPI)	15875	15875	18273	15875	15875
Maximum linear density (BPI)	24440	24440	29300	24440	24440
Rotational speed (RPM)	3600	3600	4200	3000	3600
PERFORMANCE					
Positioner type	Crs: Linear, Voice Coil Fine: Lens Actuator	Crs: Linear, Voice Coil Fine: Lens Actuator	Crs: Linear, Voice Coil Fine: Lens Actuator	Crs: Linear, Voice Coil Fine: Lens Actuator	Crs: Linear, Voice Coil Fine: Lens Actuator
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	38	38	28	45	38
Average rotational delay (msec)	8.3	8.3	7.1	10	8.3
Average access time (msec)	46.3	46.3	35.1	55	46.3
Data transfer rate (KBytes/sec)	768	3000 synch. 768	1075-1720/896	640	768
SIZE (mm: H x W x D)	41.3 x 101.6 x 171.9	41.3 x 101.6 x 171.9	41.3 x 101.6 x 160	41.3 x 101.6 x 149.8	41.3 x 101.6 x 171.9
FIRST CUSTOMER SHIPMENT	1993	10/92	2Q94	3/93	2Q92
COMMENTS	External mount, DOS & Macintosh versions Similar to MOS300S	S version is external mount	*256 KB buffer, 1 MB optional. **17900 logical tracks.	256 KB buffer RS-3012E is external version	

MANUFACTURER	SEIKO EPSON	SONY	SONY	SONY	SONY
DRIVE	OMF 5000	MDM-111	RMO-S310PR	RMO-S310SC	RMO-S330
DISK/TREND GROUP	11	11	11	11	11
MARKET	OEM	OEM	PCM	PCM	PCM
MEDIA: Nominal disk diameter	86 mm	64 mm	86 mm	86 mm	86 mm
Recording medium	RE-TM Alloy	Tb-Fe-Co	Tb-Fe-Co	Tb-Fe-Co	Tb-Fe-Co
Track format	Spiral	Spiral	Spiral	Spiral	Spiral
DRIVE: Operating mode	Rewritable-(MO)	Rd.Only,Rewrit.	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)
Interface	SCSI, SCSI-2		Printer Port	SCSI-2	SCSI
Speed control	CAV	CLV	CAV	CAV	CAV
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 128	F: 140	F: 128	F: 128	F: 128
Capacity per track (Bytes)	F: 12,800	F: NA	F: 12,800	F: 12,800	F: 12,800
Data surfaces per spindle	1	1	1	1	1
Tracks per surface	10000		10000	10000	10000
Track density (TPI)	15875	15875	15875	15875	15875
Maximum linear density (BPI)	24440		24440	24440	24440
Rotational speed (RPM)	3600	990-420	1800	1800	1800
PERFORMANCE					
Positioner type	Crs: Linear, Voice Coil Fine: Lens Actuator	Crs: Fine:	Crs: Voice Coil Fine: Lens Acuator	Crs: Voice Coil Fine: Lens Acuator	Crs: Linear, Voice Coil Fine: Lens Acuator
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	38		120	120	120
Average rotational delay (msec)	8.3	42.5	16.6	16.6	16.6
Average access time (msec)	46.3		136.6	136.6	136.6
Data transfer rate (KBytes/sec)	768	150 2500 synch.	375	375	375
SIZE (mm: H x W x D)	142 x 66 x 284	25.4 x 101.6 x 149			52.4 x 160 x 240
FIRST CUSTOMER SHIPMENT	2Q93	2Q94	3Q94	3Q94	7/94
COMMENTS	Subsystem		128 KB buffer. Portable. Intern. battery and charger. Preliminary specification	128 KB buffer. Portable. Intern. battery and charger. Preliminary specification	External subsystem

MANUFACTURER	SONY	SONY	SONY	SONY	TEAC
DRIVE	RMO-S350 SMO-S301	RMO-S360 SMO-S303	SMO-E301 SMO-E301F	SMO-P301	OD-3000
DISK/TREND GROUP	11	11	11	11	11
MARKET	OEM, PCM	OEM, PCM	OEM	OEM	OEM
MEDIA: Nominal disk diameter	86 mm	86 mm	86 mm	86 mm	86 mm
Recording medium	Tb-Fe-Co	Tb-Fe-Co	Tb-Fe-Co	Tb-Fe-Co	Tb-Fe-Co
Track format	Spiral	Spiral	Spiral	Spiral	Spiral
DRIVE: Operating mode	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)	Rewritable-(MO)
Interface	SCSI	SCSI	SCSI, SCSI-2	SCSI	SCSI-2
Speed control	CAV	CAV	CAV	CAV	CAV
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 128	F: 128	F: 128	F: 128	F: 128
Capacity per track (Bytes)	F: 12,800	F: 12,800	F: 12,800	F: 12,800	F: 12,800
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)	24440	24440	24440	24440	24440
Rotational speed (RPM)	3000	3000	3000	3000	3000
PERFORMANCE					
Positioner type	Crs: Linear, Voice Coil Fine: Lens Acuator	Crs: Linear, Voice Coil Fine: Lens Acuator	Crs: Linear, Voice Coil Fine: Lens Actuator	Crs: Linear, Voice Coil Fine: Lens Actuator	Crs: Linear, Voice Coil Fine:
Servo type	Continuous	Continuous	Continuous	Continuous	Continuous
Average positioning time (msec)	40	40	38	40	42
Average rotational delay (msec)	10	10	10	10	10
Average access time (msec)	50	50	48	50	52
Data transfer rate (KBytes/sec)	625	625	625	625	640
SIZE (mm: H x W x D)	74 x 290 x 285	69 x 160 x 261	41.3 x 101.6 x 146	41.3 x 101.6 x 195.5	41.3 x 101.6 x 146
FIRST CUSTOMER SHIPMENT	6/91	1992	8/92	1991	4Q91
COMMENTS	External subsystems	External subsystems	Embedded SCSI controller Internal fan on E301F. (164.7 mm long).	Integrated controller	128 KB buffer

MANUFACTURER	TEAC				
DRIVE	OD-5000				
DISK/TREND GROUP	11				
MARKET	OEM				
MEDIA: Nominal disk diameter	86 mm				
Recording medium	RE-TM Alloy				
Track format	Spiral				
DRIVE: Operating mode	Rewritable-(MO)				
Interface	SCSI, SCSI-2				
Speed control	CAV				
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 127.4				
Capacity per track (Bytes)	F: 12,740				
Data surfaces per spindle	1				
Tracks per surface	10000				
Track density (TPI)	15875				
Maximum linear density (BPI)	24440				
Rotational speed (RPM)	3000				
PERFORMANCE					
Positioner type	Crs: Linear, Voice Fine: Lens Actuator				
Servo type	Continuous				
Average positioning time (msec)	42				
Average rotational delay (msec)	10				
Average access time (msec)	52				
Data transfer rate (KBytes/sec)	5300 synch.				
SIZE (mm: H x W x D)	41.3 x 146 x 153.5				
FIRST CUSTOMER SHIPMENT	1993				
COMMENTS	P-ROM, O-ROM compatible Mounts in 5.25" form factor				

HIGH CAPACITY FLEXIBLE DISK DRIVE SPECIFICATIONS

1994 DISK/TREND REPORT

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 DISK/TREND Report on flexible disk drives.

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.

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 capaci-

ties over 5 megabytes have been placed in the high capacity group, regardless of disk diameter.

1994 DISK/TREND product groups for flexible disk drives included in the Removable Data Storage report

Group number	Drives included
16.	High capacity flexible disk drives

Note: Other types of flexible disk drives are covered in the 1994 DISK/TREND Report on Flexible Disk Drives.

MANUFACTURER	INSITE PERIPHERALS	INSITE PERIPHERALS	INSITE PERIPHERALS	INSITE PERIPHERALS	IOMEGA
DRIVE	E325VM	ELF-20M External Drive Subsystem	ELF-20P External Drive Subsystem	I325VM	Io20S
DISK/TREND GROUP	16	16	16	16	16
MARKET	OEM	PCM	PCM	OEM	OEM
MEDIA: Nominal disk diameter	3.5"	3.5"	3.5"	3.5"	3.5"
Recording medium	Barium Ferrite	Barium Ferrite	Barium Ferrite	Barium Ferrite	Barium Ferrite
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 21	F: 21	F: 21	F: 21	F: 20.8
Capacity per track (Bytes)	F: 13,824	F: 13,824	F: 13,824	F: 13,824	F: 13,824
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	753	753	753	753	765
Track density (TPI)	1245	1245	1245	1245	1245
Maximum linear density (BPI)	23980 BPI* 17985 FCI	23980 BPI* 17985 FCI	23980 BPI* 17985 FCI	23980 BPI* 17985 FCI	23980 BPI* 17985 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	15 (including settling)
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	200
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 157.5
FIRST CUSTOMER SHIPMENT	3/93	12/93	12/93	10/93	4Q92
COMMENTS	*1,7 RLL Code 65 msec average position. 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 position. time Macintosh SCSI interface. Read/write downward comp. 800 KB/1.4 MB GEC format.	*1,7 RLL Code 65 msec average position. 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 position. 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 position. time Optical servo track system. SCSI interface Downward comp. with .7 & 1.4MB (Read & Write)

MANUFACTURER	IOMEGA	IOMEGA	IOMEGA	IOMEGA	NEC
DRIVE	Bernoulli 20	Bernoulli 44	Bernoulli 90	Bernoulli 150	FD 1335H
DISK/TREND GROUP	16	16	16	16	16
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	Captive, OEM
MEDIA: Nominal disk diameter	5.25"	5.25"	5.25"	5.25"	3.5"
Recording medium	High Density Oxide Coated	Barium Ferrite	Metal Powder	Metal Powder	Metal Powder
CAPACITY/RECORDING DENSITY					
Total capacity (Mbytes)	F: 21.4	F: 44.5	F: 90	F: 150.9	F: .7/1.4/10.18
Capacity per track (Bytes)	F: 16,128	F: 20,480	F: 29,696	F: 35,328	F: 19,968
Data surfaces per spindle	2	2	2	2	2
Tracks per surface	677	1088	1516	2594	80/255
Track density (TPI)	570	1095	1605	2117	135/431
Maximum linear density (BPI)	23511 BPI* 17633 FCI	28541 BPI* 21405 FCI	37961 BPI* 28470 FCI	35990 BPI* 26992 FCI	8717/17434/ 36595
Rotational speed (RPM)	1845.7	2027	2368	2368	360
PERFORMANCE					
Actuator type	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Voice Coil	Linear, Pulse Motor
POSITIONING: Track to track(msec)	6.2 (including settling)	3.7	2.4 (including settling)	2.5 (including settling)	92 (including settling)
Settling time (msec)	--	--	--	--	--
Head load time(msec)	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact	Continuous Contact
Average rotational delay (msec)	16.25	14.8	12.7	12.7	83.3
Data transfer rate (KBytes/sec)	666	692.5	1173.7	5000/3000 asyn.	31.25/62.5/156
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	41.3 x 146 x 203.2	25.4 x 101.6 x 130.0
FIRST CUSTOMER SHIPMENT	9/87	2/89	7/91	4Q92	1/90
COMMENTS	*1,8 RLL Code 40 msec average positioning time	*1,8 RLL Code 32 msec average positioning time	*1,7 RLL Code 20 msec average positioning time	*1,7 RLL Code 25 msec average positioning time Downward comp. 90 MB read/ write 44 MB read	Downward comp. with .7 & 1.4 MB (Read & Write) 329 msec average positioning time

MANUFACTURER	NEC	SWAN INSTRUMENTS	SWAN INSTRUMENTS		
DRIVE	FD 2135	88/44	170/88		
DISK/TREND GROUP	16	16	16		
MARKET	Captive, OEM	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)	U: 27.964 F: 21.418	F: 88 Fixed F: 44 Remov. F: 1.44 Remov.	F: 170.3 Fixed F: 88.3 Remov. F: 1.44 Remov.		
Capacity per track (Bytes)	Varies by zone	Varies by zone	Varies by zone		
Data surfaces per spindle	2	4	4		
Tracks per surface	326	1172/586	1840/937		
Track density (TPI)	542	1890/945/135	2970/1512/135		
Maximum linear density (BPI)	52539	62800/17434	73200/17434		
Rotational speed (RPM)	600	3600	3600		
PERFORMANCE					
Actuator type	Linear, Pulse Motor	Linear, Voice Coil	Linear, Voice Coil		
POSITIONING: Track to track(msec)	82 (including settling	3.5	3.5		
Settling time (msec)	--				
Head load time(msec)	Continuous Contact				
Average rotational delay (msec)	50	8.3	8.3		
Data transfer rate (KBytes/sec)	375/562.5	6000	6000/10000		
SIZE (mm: H x W x D)	25.4 x 101.6 x 129.5	25.4 x 101.6 x 146.1	25.4 x 101.6 x 146.1		
FIRST CUSTOMER SHIPMENT	6/93	2Q95	3Q95		
COMMENTS	Downward comp. with .7, 1.4 & 10.18 MB (Read & Write) 319 msec average positioning time	18 msec. average head positioning PCMCIA, SCSI or PC AT interface	18 msec. average head positioning PCMCIA, SCSI or PC AT interface		

MANUFACTURER PROFILES

1994 DISK/TREND REPORT

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. "1993 total net sales" covers the fiscal year ending in 1993 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, 1993, 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 1993 is used, as cited by the Federal Reserve Bulletin.

Country	Currency	Currency units/U.S. dollar
Italy	Lira	1,573.0
Japan	Yen	111.0
Netherlands	Guilder	1.86
South Korea	Won	806.0
United Kingdom	Pound	.667

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

U.S. Manufacturers

ADVANCED MICRO DEVICES
1 AMD Place
Sunnyvale, CA 94088

1993 total net sales: $1,648,280,000 Net income: $228,781,000

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 PCMCIA 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.

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. SGS-Thomson is expected to begin production in late 1994. A 1992 agreement also established Fujitsu as an AMD chip second source, and jointly funded development is expected to result in the production of 16 megabit chips by both firms in 1995.

AMP INCORPORATED
Harrisburg, PA 17105

1993 total net sales: $3,450,586,000 Net income: $296,656,000

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 256 kilobytes to 8 megabytes. AMP is using Atmel 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.

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

Atmel produces flash chips up to 4 megabits density using EEPROM architectures. The firm supplies chips to manufacturers of PCMCIA flash memory cards, including AMP, and also manufactures 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 are now in production by NEC, but for which Aura also retains manufacturing and sales rights. The firm began shipments of PCMCIA Type III rigid disk drives in 1993, and is currently developing an electronic camera which will use Aura PCMCIA 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's products include an 85 megabyte 2.5" cartridge drive and a similar drive packaged with a 3.5" floppy disk drive in a one inch form factor, intended for portable and desktop applications.

The company started production of its 85 megabyte 2.5" disk cartridge drive in mid-1994, using glass disks. 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 PCMCIA flash card 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 announced 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 PCMCIA memory cards in 1992, including flash memory, SRAM, DRAM and read-only memory.

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 PCMCIA Type III models, in production since 1992. Integral's 1.8" 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. A 105 megabyte PCMCIA Type III drive shipped in late 1993, a 170 megabyte version in early 1994, and higher capacity models are expected in late 1994.

INTEL CORPORATION
2200 Mission College Boulevard
Santa Clara, CA 95052

1993 total net sales: $8,782,000,000 Net income: $2,295,000,000

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. Intel's flash production program was delayed due to problems at several Japanese firms used for chip production, but the manufacturing logjam was removed in 1994. 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

1993 total net sales: $62,716,000,000 Net income: ($7,987,000,000)

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 the firm has 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" and 3.5" optical disk drives. The company was also the earliest manufacturer of floppy disk drives, which it no longer produces.

IBM Microelectronics Division supplies an entire line of PCMCIA cards, including flash memory and flash disk cards. Flash memory cards were announced in 1993, while 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 other cards are made by IBM in Canada.

IOMEGA CORPORATION
1821 West Iomega Way
Roy, UT 84067

1993 total net sales: $147,123,000 Net income: ($14,425,000)

Iomega, founded in 1980 by former IBM managers, was successful in establishing production capability for its unique 8 inch 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 includes drives offering 21.4 megabytes capacity, a 44.5 megabyte model (1989), a 90 megabyte model (1991) and a 150 megabyte model added in late 1992.

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 "floptical" drive was introduced in late 1992. However, after a year of limited sales success, and the arrival of new management, the Iomega floptical program is being phased out.

MAXTOR CORPORATION
150 River Oaks Parkway
San Jose, CA 95134

Total net sales: $1,153,000,000 (FY ending 3/94) Net income: ($258,000,000)

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 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 now produced by Maxoptix, a Maxtor subsidiary, through a partnership with Kubota. 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. Most of Maxtor's revenues are now derived from 3.5" drives sold for personal computer applications, with a major initiative under way in 1.8" PCMCIA drives. In February, 1994, Maxtor improved its financial status when Hyundai invested heavily in the firm, acquiring a 40% share of the company.

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 PCMCIA 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 PCMCIA Type III packaging.

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.

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 now offers 1.8" PCMCIA 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 have cooperated in developing a new family of high capacity 2.5" disk drives, manufactured by Hitachi and sold by both firms.

NATIONAL SEMICONDUCTOR CORPORATION
2900 Semiconductor Drive
Santa Clara, CA 95052

1993 total net sales: $2,014,000,000 Net income: $17,000,000

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 1995, assuming that a decision to enter the market is made.

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 PCMCIA flash memory product lines.

PREMAX ELECTRONICS, INC.
750 North Mary Avenue
Sunnyvale, CA 94086

Founded in 1993, Premax specializes in PCMCIA 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.

QUANTUM CORPORATION
500 McCarthy Boulevard
Milpitas, CA 95035

1993 total net sales: $2,131,000,000 Net Income: $2,700,000

Founded in 1980, Quantum is the largest volume producer of rigid disk drives. In mid-1994, the firm announced an agreement to purchase the storage business of Digital Equipment, with completion of the transaction scheduled for October 1, 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. The cards use chips obtained from Silicon Storage Technology, which worked with Quantum to design the chips and cards. 1, 2, 4 and 10 megabyte cards are being offered. Initially, Quantum is selling the cards through industrial distributors, but may add other channels in the future.

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 SunDisk flash drives rather than rigid disk drives. The 320 megabyte array uses 8 of SunDisk's 40 megabyte flash drives. The array will operate with higher capacity storage modules as they become available in the future.

SEAGATE TECHNOLOGY
920 Disc Drive
Scotts Valley, CA 95066

Total net sales: $3,500,000,000 (FY ending 7/94) Net income: $225,100,000

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" PCMCIA Type III rigid disk drive was announced in 1993. The firm also produces many of its own components, including heads, media and semiconductors.

In 1993, Seagate purchased a 25% share in SunDisk, and began marketing SunDisk PCMCIA flash disk cards through its own distribution channels.

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 is now the marketing channel for SST's PCMCIA 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 PCMCIA flash memory cards in 1992, with its designs based upon Intel and AMD chips.

SUNDISK CORPORATION
3270 Jay Street
Santa Clara, CA 95054

Founded in 1988, SunDisk is today the largest producer of flash disk ATA interfaced PCMCIA cards. Products range from 1.8 megabyte to 40 megabytes in capacity, with higher capacities anticipated in late 1994. Matsushita Electronics produces the chips for SunDisk, 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 SunDisk, and now distributes the SunDisk cards on a nonexclusive basis. Other announced SunDisk customers include Seiko Epson and Verbatim.

SunDisk 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.

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 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 1995.

SYQUEST TECHNOLOGY
47071 Bayside Parkway
Fremont, CA 94538

1993 total net sales: $206,400,000 Net income: $18,600,000

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 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. A unique 1.8" drive was introduced in late 1993, utilizing a disk cartridge which is removable from a PCMCIA Type III disk drive. In 1989, SyQuest began operations in Singapore. SyQuest also manufactures the disk cartridges for the drives, and cartridges accounted for a majority of the firm's revenue.

TEXAS INSTRUMENTS
13500 North Central Expressway
Dallas, TX 75265

1993 total net sales: $8,523,000,000 Net income: $472,000,000

TI is shipping flash memory chips, but has not yet entered the flash memory card business. Other TI components such as DSP processors have started appearing in PCMCIA rigid disk drives, such as Maxtor's recently announced 171 megabyte drive.

WESTERN DIGITAL CORPORATION
8105 Irvine Center Drive
Irvine, CA 92718

Total net sales: $1,540,000,000 (FY ending 6/30/94) Net income: ($73,100,000)

Western Digital, a major supplier of controllers and specialized semiconductor components, entered the rigid disk drive market by purchasing the rigid disk drive operations of Tandon at the end of 1987. The company has aggressively moved from heavy dependence on aftermarket distribution with the original product line purchased from Tandon to a primary emphasis on OEM sales. WD's early development and shipment of a two platter 340 megabyte 3.5" drive in the first half of 1992 boosted the firm's share of the personal computer disk drive market, and impacted the product development plans of most competitors. Western Digital's 3.5" product line has since been enhanced with 425, 540, 730 and 1,084 megabyte versions of the same design, providing additional penetration of the personal computer market for rigid disk drives. A 43 megabyte 1.8" PCMCIA Type III drive was introduced in early 1993. However, with the movement of Western Digital's only major OEM customer to a higher capacity drive purchased from a competitor, the company has departed from the 1.8" rigid disk drive market until overall shipments reach a higher level.

Asian Manufacturers

(All fiscal years end in March, 1993, unless otherwise noted. All companies are in Japan unless otherwise noted.)

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

1993 total net sales: $460,486,000 Net income: ($28,964,000)

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.

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

1993 total net sales: $31,166,079,000 Net income: ($293,500,000)

Fujitsu is Japan's largest producer of computer systems and also manufactures a wide variety of other electronic equipment. Computer products represented about 69% of Fujitsu's 1993 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

1993 total net sales: $67,844,490,000 Net income: $695,796,000

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 44% of 1993 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. Quantity production of PCMCIA flash memory cards by Hitachi is expected to begin in late 1994 using 4 megabit and 16 megabit 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.

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.

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

1993 total net sales: $65,566,378,000 Net income: $346,009,000

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 SunDisk, 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.

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 is scheduled for late 1994, with capacities ranging from 256 kilobytes to 8 megabytes.

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

1993 total net sales: $29,372,081,000 Net income: $256,829,000

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.

(MOST) MASS OPTICAL STORAGE TECHNOLOGIES
Subsidiary of Nakamichi Corporation
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 (nonexclusively) through Ocean Microsystems, another Nakamichi subsidiary.

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) is expected to go 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.

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

1993 total net sales: $31,643,671,000 Net income: ($406,554,000)

NEC has defined its product area as communications and computers, with computer products accounting for about 49% of 1993 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. NEC's floppy drive product line includes drives with capacities of 10 and 20 megabytes.

Under an agreement with Aura Associates, NEC is producing PCMCIA Type III 1.8" drives designed by Aura and also sold by Aura. In mid-1994, NEC and SunDisk 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.

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

1993 total net sales: $2,411,874,000 Net income: $34,279,000

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. 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.

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

1993 total net sales: $9,206,441,000 Net income: $45,180,000

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 24% of 1993 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.

SAMSUNG ELECTRONICS
7 Soonwha-Dong
Seoul
Korea

1992 total net sales: $7,574,024,000 Net income: $89,891,000

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.

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.

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

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 SunDisk 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.

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

1993 total net sales: $35,972,234,000 Net income: $326,667,000

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 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

1993 total net sales: $35,972,234,000 Net income: $326,667,000

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 fields a product line of 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 announced a proposed 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. Shipment in late 1994 seems likely. Sony is also looking for opportunities to apply the MD-DATA technology to other form factors.

In late 1993 and early 1994, Sony test marketed a line of flash memory PCMCIA cards with capacity from 2 to 16 megabytes, but after evaluating the results, the firm decided not to enter the flash card market.

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

1993 total net sales: $1,159,108,000 Net income: $8,703,000

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.

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

1993 total net sales: $41,689,180,000 Net income: $185,144,000

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 51% of 1993 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 and floppy drives.

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. Toshiba has entered into flash memory development agreements with other firms as well, including Samsung Electronics.

While the firm is not currently producing its own PCMCIA flash memory cards, it plans to start sampling them in the last quarter of 1994. Full production is expected in early 1995.

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 PCMCIA Type III format in mid-1993. The PCMCIA drive product line has since been expanded and includes 105 megabyte and 130 megabyte drives currently in production. A 170 megabyte PCMCIA drive is scheduled to begin shipping in September, 1994, to be followed by a 210 megabyte drive.

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. PCMCIA cards with 20 megabyte capacity became available in mid-1993. In November of 1993, M-Systems and Maxtor entered a strategic partnership, allowing Maxtor to offer a range of PCMCIA memory cards based on M-Systems flash memory technology with capacities from 1.6 to 20 megabytes.

N. V. PHILIPS
5600 MD Eindhoven
The Netherlands

1993 total net sales: $31,651,870,000 Net income: $1,057,304,000

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 turn a subsidiary of Philips Consumer Electronics. 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 makes use of a mechanism manufactured by Philips Key Modules Group. At that time, it was also indicated that there would be future joint developments.

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 plan at the present time to manufacture flash memory cards.

1994 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 is 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 1994 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1994 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.

1994 DISK/TREND REPORT

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 you are using the Lotus 1-2-3 data parsing commands)

   COPY A:*.MSK (if you are using AutoImport)

   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. An example of a Lotus 1-2-3 command is:

   /FR<filename>

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

   F (Flexible disk drive 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 FT2.WK1 is Flexible Disk Drive Report Table 2
   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 Tables 1 and 2, and the Revenue and Unit Shipment tables found in the product group sections of all DISK/TREND reports.
o FORMLINB.PRN	Used with Tables 3 and 4.
o FORMLINF.PRN	Used with Tables 5 through 12.
o FORMLIND.PRN	Used with Application tables.
o FORMLINE.PRN	Used with Drive Height, Drive Capacity and Track Density tables in Flexible Disk Drive Report.

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	Tables 5 to 12	Tables 3 to 7
MASKD	<-- All Product Group Application Tables ---->			N/A
MASKE	N/A	N/A	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	1993 Rigid Report	1993 Flexible Report	1994 Optical Report	1994 Array Report	1994 Removable Report
1	MASKA	MASKA	MASKA	MASKA	MASKA
2	MASKB	MASKB	MASKA	MASKB	MASKB
3	MASKC	MASKC	MASKB	MASKC	MASKC
4	MASKC	MASKC	MASKB	MASKC	MASKC
5	MASKC	--	MASKC	MASKC	MASKC
6	MASKC	--	MASKC	MASKC	MASKC
7	MASKH	MASKF	MASKC	MASKC	--
8	MASKH	MASKA	MASKC	--	--
9	MASKC	MASKA	MASKC	--	MASKA
10	MASKC	MASKE	MASKC	MASKA	MASKA
11	MASKC	MASKD	MASKC	MASKA	MASKC
12	--	MASKG	MASKC	--	MASKC
13	--	MASKA	--	--	--
14	MASKA	MASKA	--	--	MASKI
15	MASKA	MASKE	--	MASKA	--
16	--	MASKE	--	MASKA	MASKI
17	--	MASKD	MASKA	--	--
18	MASKD	MASKG	MASKA	--	MASKI
19	MASKI	MASKA	--	--	--
20	--	MASKA	--	MASKA	MASKI
21	MASKA	--	MASKD	MASKA	--
22	MASKA	--	--	--	MASKA
23	--	MASKE	MASKA	--	MASKA
24	--	MASKE	MASKA	--	MASKC
25	MASKD	MASKD	--	MASKA	MASKC
26	MASKI	MASKG	--	MASKA	MASKA
27	--	MASKA	--	--	MASKA
28	MASKA	MASKA	--	--	MASKA
29	MASKA	--	MASKE	--	MASKA
30	--	--	MASKD		MASKA
31	--	MASKD	--		MASKH
32	MASKD	MASKG	MASKA		MASKD
33	MASKI		MASKA		--
34	--		--		MASKA
35	MASKA		--		MASKA
36	MASKA		MASKD		--
37	--		--		--
38	--		MASKA		MASKI
39	MASKD		MASKA		MASKD
40	MASKI		--		--
41	--		--		MASKA
42	MASKA		MASKA		MASKA
43	MASKA		MASKA		--
44	--		--		--
45	--		--		MASKD
46	MASKD		MASKE		--
47	MASKI		MASKA		MASKA

Cross reference (continued)

Table Number	1993 Rigid Report	1993 Flexible Report	1994 Optical Report	1994 Array Report	1994 Removable Report
48	--		MASKA		MASKA
49	MASKA		--		--
50	MASKA		--		--
51	--		MASKE		MASKD
52	--		MASKA		--
53	MASKD		MASKA		
54	MASKI		--		
55	--		--		
56	MASKA		MASKE		
57	MASKA				
58	--				
59	--				
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 FT12.94F 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, F, 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 FT12 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 key strokes 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, F, 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. This can be done in one step using the copy command as follows:

   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= F (Flexible disk drive data)
   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, Flexible 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: OS194 Optical disk drive specification table.
RS194 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:

- o There are other "pop-up" programs resident in the memory of your computer. These should be removed.
- o 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.
- o 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.

Drive specifications: 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.